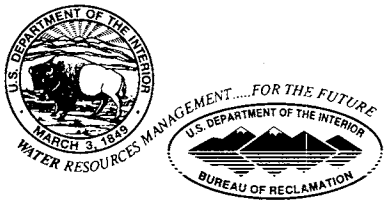
Yakima River Basin
Water Enhancement Project, Washington

Final Programmatic Environmental Impact Statement



U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Region
Upper Columbia Area Office
Yakima, Washington

January 1999

Acronyms and Abbreviations

ACP	Agricultural Conservation Program
BEA	Bureau of Economic Analysis
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BP	Before present
BPA	Bonneville Power Administration
°C	Degree Celsius
CAG	Conservation Advisory Group
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CRBG	Columbia River Basalt Group
Corps	U.S. Army Corps of Engineers
EIS	Environmental impact statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ft^3/s	Cubic feet per second
FWS	U.S. Fish and Wildlife Service
HAER	Historic American Building Survey or Engineering Record
IFIM	Instream Flow Incremental Methodology
IMPLAN	U.S. Forest Service input-output economic model
ITA	Indian Trust Asset
kW	Kilowatt
LFAR	Low flow augmentation reservoirs
MCL	Maximum contaminant level
mg/L	Milligrams per liter
MWh	Megawatthour
N	Nitrite or nitrate
National Register	*National Register of Historic Places*
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NMI	No measurable impact
NRCS	Natural Resources Conservation Service
NTU	Nephelometric turbidity unit
NWI	National Wetlands Inventory
P	Phosphorus
PEIS	Programmatic environmental impact statement
P.L.	Public Law
Reclamation	Bureau of Reclamation
RRA	Reclamation Reform Act
Secretary	Secretary of the Interior
SHPO	State Historic Preservation Office
SOAC	System Operations Advisory Committee
T	Soil loss tolerance values
TAG	Technical Activities Group
TCP	Traditional cultural properties
TDS	Total dissolved solids
Title XII	Title XII of the Act of October 31, 1994 (Public Law 103-434)
TMDL	Total maximum daily load
TWSA	Total water supply available
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
WDFW	Washington Department of Fish and Wildlife
WDOE	Washington State Department of Ecology
WIP	Wapato Irrigation Project
YRBWEP	Yakima River Basin Water Enhancement Project
YVCOG	Yakima Valley Conference of Governments
>	Greater than
<	Less than

Final Programmatic Environmental Impact Statement
Yakima River Basin Water Enhancement Project

Prepared by: Bureau of Reclamation

Cooperating agencies: Federal:
- Bureau of Indian Affairs
- Bonneville Power Administration
- Natural Resources Conservation Service

Tribal:
- Yakama Indian Nation

State of Washington:
- Department of Ecology

This programmatic environmental impact statement (PEIS) is prepared in compliance with the National Environmental Policy Act (NEPA) and Bureau of Reclamation (Reclamation) NEPA procedures.

Title XII of Public Law 103-434, enacted October 31, 1994, authorizes Phase 2 of the Yakima River Basin Water Enhancement Project to protect, mitigate, and enhance fish and wildlife and to improve the reliability of the water supply for irrigation through improved water conservation and management and other appropriate means. The provisions and measures of Title XII form the parameters and the methods for achieving improved instream flows and irrigation water supplies. This PEIS will evaluate the environmental impacts of implementing Title XII.

This PEIS provides "umbrella" coverage for implementing the general provisions of Title XII. Consequently, the PEIS does not discuss site specific impacts. Additional NEPA compliance for specific actions will be developed as appropriate. Much of the analysis in subsequent NEPA documents will refer to information in this document in a process called tiering.

The final EIS was prepared in compliance with the National Environmental Policy Act and Bureau of Reclamation procedures and is intended to serve environmental review and consultation requirements pursuant to all appropriate Executive orders, National Historical Preservation Act (Section 106), Fish and Wildlife Coordination Act, and Endangered Species Act (Section 7c). This final EIS will be used by decisionmakers in the Bureau of Reclamation and the Department of the Interior and is provided for public information. A record of decision will not be signed prior to 30 days following the *Federal Register* notice of availability of the final PEIS. Any decision regarding Title XII implementation as well as opportunities for future public involvement will be well publicized.

For further information: Environmental Programs Manager
PO Box 1749
1917 Marsh Road
Yakima WA 98907

(509) 575-5848

Yakima River Basin
Water Enhancement Project, Washington



Final Programmatic Environmental Impact Statement

U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Region
Upper Columbia Area Office
Yakima, Washington

Contents

	Page
Summary	S-1
1.0 Purpose of and Need for Proposed Action	S-1
2.0 Alternatives Including No Action	S-1
3.0 Affected Environment	S-2
3.1 Surface Water Hydrology	S-2
3.2 Surface Water Quality	S-3
3.3 Groundwater	S-3
3.4 Agricultural Resources	S-5
3.5 Fish	S-5
3.6 Vegetation and Wildlife	S-6
3.7 Threatened, Endangered, and Special Status Species	S-7
3.8 Socioeconomics	S-7
3.9 Recreation	S-8
3.10 Cultural Resource Properties and Paleontological Resources	S-9
3.11 Sacred Sites	S-9
3.12 Indian Trust Assets	S-9
4.0 Environmental Consequences	S-10
4.1 Surface Water Hydrology	S-10
4.2 Surface Water Quality	S-10
4.3 Groundwater	S-11
4.4 Agricultural Resources	S-12
4.5 Fish	S-13
4.6 Vegetation and Wildlife	S-14
4.7 Threatened, Endangered, and Special Status Species	S-15
4.8 Socioeconomics	S-15
4.9 Recreation	S-16
4.10 Cultural Resource Properties and Paleontological Resources	S-17
4.11 Sacred Sites	S-18
4.12 Indian Trust Assets	S-18
5.0 Cumulative Impacts	S-18

Contents

Page

Chapter 1 Purpose of and Need for Action 1
1.1 The Proposed Action 1
1.1.1 Purpose and Need 1
1.1.2 Project Location 1
1.2 Related Activities 2
1.2.1 Yakima River Basin Fish Passage/Protective Facilities 2
1.2.2 Yakima Fisheries Project 3
1.2.3 Columbia River Fish Management Plan 3
1.2.4 Yakima River Operation 3
1.2.5 Yakima River Water Conservation Demonstration Project 4
1.2.6 National Water Quality Assessment Program 4
1.2.7 Yakima Valley Conference of Governments' Yakima River Basin Water Quality Plan 5
1.2.8 Water Rights Adjudication 5
1.2.9 Federal Agricultural Conservation Program 5
1.2.10 Attaining Water Quality Standards in the Lower Yakima River 6
1.3 Project Background 6
1.3.1 Irrigation Development 6
1.3.2 Fish and Wildlife Resources 9
1.3.3 Development of the Yakima River Basin Water Enhancement Project and Title XII 9
Initial Authorization and Objectives of YRBWEP 9
Phase 1 of the Study 10
Phase 2 of the Study 10
Early Implementation Program 11
Comprehensive Legislation 11
Enhancement Roundtable Group 11
Partial Summary Judgment 12
1.4 Scoping 13
1.5 Environmental Justice 14
1.6 Authorities and Institutional Constraints 14
1.7 Document Scope and Organization 15

Chapter 2 Alternatives Including No Action 19
2.1 Overview of Title XII Provisions 19
2.1.1 Basin Conservation Program 19
Conservation Advisory Group 21
Basin Conservation Plan 23
2.1.2 Project Operations and Facilities Modifications 28
Project Operation Changes and Use of Conserved Water 28
Reports on Available Irrigation Water and Biologically Based Target Flows 28

Contents

Page

Chapter 2 Alternatives Including No Action (continued)
2.1 Overview of Title XII Provisions (continued)
2.1.2 Project Operations and Facilities Modifications (continued)
Water from Cle Elum Lake 29
Yakima River Basin Tributary Enhancement 30
Chandler Pumping Plant 31
Kachess Lake Augmentation 31
Kachess Dam Modification 32
Interim Comprehensive Basin Operating Plan 32
2.1.3 Yakama Indian Nation 32
Improvements to the Wapato Irrigation Project 32
Irrigation Demonstration Project 33
Toppenish Creek Corridor Enhancement Project 33
2.1.4 Summary of Estimated Water Supply Under Title XII Provisions 34
2.2 Alternatives Considered in Detail 35
2.2.1 Hydrology Model 35
2.2.2 No Action Alternative 36
2.2.3 Action Alternatives 37
Alternative 1 (Implementation of All Measures Except the Basin Conservation Program) 37
Alternative 2 (Implementation of All Measures Including the Basin Conservation Program)[1] 38
Alternative 3 (Implementation of Alternative 2A Minus Kachess Lake Augmentation and Tributary Program) 38
2.3 Range of Alternatives and Alternatives Eliminated 38
2.4 Summary Comparison of Alternatives 39

Chapter 3 Affected Environment 41
3.1 Overview 41
3.2 Surface Water Hydrology 46
3.2.1 Water Supply and Demands 46
Average Yearly Runoff at Key Locations 47
Reservoir Storage in the Yakima River Basin 47
Keechelus and Kachess Lakes 48
Rimrock Lake 48
Bumping Lake 49
Cle Elum Lake 49
Clear Lake 49
Hydrology Model Diversion Demands 50

[1] Alternative 2A is the preferred and environmentally preferred alternative.

Contents

Page

Chapter 3 Affected Environment (continued)

3.2 Surface Water Hydrology (continued)

Shortages 50
Return Flows 50

3.2.2 Pre-Title XII Operations (Before 1995) and Model Considerations 51
Target Flows 51
Reservoir Releases 53
Hydroelectric Generation 54
Kittitas Canal Bypass 54
"Flip-Flop" Operation 54
Other Model Considerations 55

3.3 Surface Water Quality 55
3.3.1 Surface Water Quality Overview 56
3.3.2 Yakima River Nutrients 57
3.3.3 Yakima River Suspended Sediment 58
3.3.4 Yakima River Water Temperature 59
3.3.5 Pesticides 59
3.3.6 Drains 60

3.4 Groundwater 61
3.4.1 Geological Setting 61
3.4.2 Bedrock Geology 61
3.4.3 Unconsolidated Deposits 64
3.4.4 Hydrogeology 64
3.4.5 Groundwater Basins 65
3.4.6 Aquifer Recharge and Discharge 66
3.4.7 Groundwater Use 67
3.4.8 Groundwater Quality 68

3.5 Agricultural Resources 70
3.5.1 Irrigation Diversions 70
3.5.2 Irrigated Lands 70
Irrigated Land Use and Trends 70
Irrigation Systems Types and Trends 72
3.5.3 Cropping Pattern Trends and Crop Yields 72
3.5.4 Soil Quality and Erosion 73
3.5.5 Yakima River Weeds 73

3.6 Fish 73
3.6.1 Salmon and Steelhead 74
Salmon and Steelhead Historical Perspective 74
Salmon and Steelhead Current Conditions and Trends 75
3.6.2 Resident Fish 79

Contents

Page

Chapter 3 Affected Environment (continued)

3.7 Vegetation and Wildlife 80
3.7.1 Riparian Vegetation and Associated Wildlife 81
Riparian Vegetation and Wildlife Historical Perspective 82
Riparian Vegetation and Wildlife Current Conditions and Trends 82
3.7.2 Wetlands 84
Wetlands Historical Perspective 85
Wetlands Current Conditions and Trends 85
Agricultural Land and Associated Wildlife 87
3.8 Threatened, Endangered, and Special Status Species 88
3.9 Socioeconomics 89
3.9.1 Social Well-Being and Relationships With the Biophysical Environment 89
Agricultural 89
Environmental 89
Recreational 90
Yakama Indian Nation 90
Property Owners Along the Shores of Cle Elum Lake 90
Culture, Attitudes, and Sociopsychological Conditions 90
Population Characteristics 90
3.9.2 Economics 91
Description of Current Regional Economy 94
Employment by Sector 95
Household Income by Sector 95
Sales Revenue by Sector 96
3.10 Recreation 97
3.10.1 Recreation Setting 97
Recreation Supply 98
Recreation Visitation 98
3.10.2 Recreational Use of Reservoirs 99
Upper Kittitas Basin Recreation 99
Lower Kittitas Basin Recreation 100
Upper Yakima Basin Recreation 100
3.10.3 Recreational Use of Rivers 101
Recreation in Upper Kittitas Basin—Upper Reach of the Yakima River From Teanaway to Thorp 101
Recreation in Lower Kittitas—Yakima River Canyon 101
Recreation in the Upper Yakima 101
Recreation in the Lower Yakima River, Mouth to Ahtanum Creek 102

Contents

Page

Chapter 3 Affected Environment (continued)
3.11 Cultural Resource Properties and Paleontological Resources 102
3.11.1 Cultural Historic Context 103
3.11.2 Previous Cultural Resource Investigations 105
Clear Lake 106
Rimrock Lake/Tieton Dam 106
Bumping Lake 106
Kachess, Keechelus, and Cle Elum Lakes 107
3.11.3 Traditional Cultural Properties 108
3.11.4 Paleontological Resources 108
3.12 Sacred Sites 108
3.13 Indian Trust Assets 108

Chapter 4 Environmental Consequences 109
4.1 Overview 109
4.2 Surface Water Hydrology 109
4.2.1 Summary of Impacts to Surface Water 110
4.2.2 Discussion of Impacts to Surface Water 113
Methods and Rationale 113
Method for Evaluating Impacts 115
No Action Alternative Impacts to Surface Water 116
Alternative 1 Impacts to Surface Water 117
Action Alternatives 2A, 2B, 2C, and 3 Impacts to Surface Water 117
4.3 Surface Water Quality 120
4.3.1 Summary of Impacts to Surface Water Quality 120
4.3.2 Discussion of Impacts to Surface Water Quality 120
Methods and Rationale 120
No Action Alternative Impacts to Surface Water Quality 122
Alternative 1 Impacts to Surface Water Quality 126
Alternatives 2A, 2B, and 2C Impacts to Surface Water Quality 126
Alternative 3 Impacts to Surface Water Quality 128
4.4 Groundwater 128
4.4.1 Summary of Impacts to Groundwater 128
4.4.2 Discussion of Impacts to Groundwater 128
Methods and Rationale 128
No Action Alternative Impacts to Groundwater 130
Alternative 1 Impacts to Groundwater 131
Alternative 2A Impacts to Groundwater 131
Alternative 2B Impacts to Groundwater 131
Alternative 2C Impacts to Groundwater 132
Alternative 3 Impacts to Groundwater 133

Contents

Page

Chapter 4 Environmental Consequences (continued)

4.5 Agricultural Resources 133
4.5.1 Summary of Impacts to Agricultural Resources 133
4.5.2 Discussion of Impacts to Agricultural Resources 136
No Action Alternative Impacts to Agricultural Resources 136
Alternative 1 Impacts to Agricultural Resources 136
Alternative 2A Impacts to Agricultural Resources 137
Alternative 2B Impacts to Agricultural Resources 137
Alternative 2C Impacts to Agricultural Resources 138
Alternative 3 Impacts to Agricultural Resources 138
4.6 Fish 138
4.6.1 Summary of Impacts to Fish 138
4.6.2 Discussion of Impacts to Fish 140
Methods and Rationale 140
No Action Alternative Impacts to Fish 141
Alternative 1 Impacts to Fish 144
Alternative 2A Impacts to Fish 145
Alternative 2B Impacts to Fish 146
Alternative 2C Impacts to Fish 146
Alternative 3 Impacts to Fish 146
4.7 Vegetation and Wildlife 147
4.7.1 Summary of Impacts to Vegetation and Wildlife 147
4.7.2 Discussion of Impacts to Vegetation and Wildlife 149
Methods and Rationale 149
No Action Alternative Impacts to Vegetation and Wildlife 150
Alternative 1 Impacts to Vegetation and Wildlife 151
Alternative 2A Impacts to Vegetation and Wildlife 152
Alternative 2B Impacts to Vegetation and Wildlife 153
Alternative 2C Impacts to Vegetation and Wildlife 154
Alternative 3 Impacts to Vegetation and Wildlife 154
4.8 Threatened, Endangered, and Special Status Species 154
4.9 Socioeconomics 155
4.9.1 Social Well-Being 155
Summary of Impacts to Social Well-Being 155
4.9.2 Discussion of Impacts to Social Well-Being 157
Methods and Rationale 157
No Action Alternative Impacts to Social Well-Being 158
Alternative 1 Impacts to Social Well-Being 160
Alternatives 2A, 2B, and 2C Impacts to Social Well-Being 161
Alternative 3 Impacts to Social Well-Being 162
4.9.3 Economics 162
Summary of Economic Impacts 162

Contents

Page

Chapter 4 Environmental Consequences (continued)
4.9 Socioeconomics (continued)
4.9.4 Discussion of Economic Impacts 164
Methods and Rationale 164
No Action Alternative Economic Impacts 166
Alternative 1 Economic Impacts 166
Alternative 2A Economic Impacts 167
Alternative 2B Economic Impacts 167
Alternative 2C Economic Impacts 167
Alternative 3 Economic Impacts 168
Power Reduction Economic Impacts for Action Alternatives 168
Receipts to Local Governments 169
4.10 Recreation 169
4.10.1 Summary of Impacts to Recreation 169
4.10.2 Discussion of Impacts to Recreation 171
Methods and Rationale 171
No Action Alternative Impacts to Recreation 171
Alternative 1 Impacts to Recreation 171
Alternative 2A Impacts to Recreation 172
Alternative 2B Impacts to Recreation 172
Alternative 2C Impacts to Recreation 172
Alternative 3 Impacts to Recreation 172
4.10.3 Mitigation for Reclamation 173
4.11 Cultural Resource Properties and Paleontological Resources 173
4.11.1 Discussion of Cultural Impacts 173
No Action Alternative 173
Action Alternatives 173
Paleontological Resources 175
4.11.2 Mitigation for Cultural Resource Properties 175
No Action Alternative 175
Action Alternatives 175
4.12 Sacred Sites 177
4.13 Indian Trust Assets 177
4.13.1 Summary of Impacts to Indian Trust Assets 177
4.13.2 Discussion of Impacts to Indian Trust Assets 179
Methods and Rationale 179
No Action Alternative Impacts to Indian Trust Assets 180
Alternative 1 Impacts to Indian Trust Assets 180
Alternatives 2A, 2B, 2C, and 3 Impacts to Indian Trust Assets 180
4.14 Cumulative Impacts 181
4.14.1 List of Pertinent Activities and Trends 182

Contents

Page

Chapter 4 Environmental Consequences (continued)
4.14 Cumulative Impacts (continued)
4.14.2 Impacts to Specific Resources 184
Surface Water Hydrology 184
Surface Water Quality 185
Groundwater 185
Agricultural Resources 185
Fish 185
Vegetation and Wildlife 186
Threatened, Endangered, and Special Status Species 186
Socioeconomic 186
Recreation 186
Cultural Resources Properties and Paleontological Resources ... 186
4.15 Unavoidable Adverse Impacts 187
4.16 Irreversible and Irretrievable Commitments of Resources 187
4.17 Short-Term Use Versus Long-Term Productivity 187
4.18 Mitigation 188

Chapter 5 Consultation and Coordination 189
5.1 Public Involvement 189
5.1.1 Scoping 189
5.1.2 Notice of Intent to Prepare a PEIS 190
5.1.3 Public Meetings 190
5.1.4 Notice of Availability 192
5.2 Agency Consultation 192
5.2.1 Cooperating Agencies 192
5.2.2 Interagency Coordination 192
5.2.3 Fish and Wildlife Coordination Act 193
5.2.4 Endangered Species Act Consultation 196
5.2.5 National Historic Preservation Act Consultation 197
5.3 Native American Coordination 198
5.3.1 Archeology 198
5.3.2 Traditional Cultural Properties 198
5.3.3 Sacred Sites 198
5.3.4 Indian Trust Assets 198
5.3.5 Government-to-Government Consultations 199

Comments and Responses
List of Preparers
Distribution List
Bibliography
Glossary
Index

Contents

Appendixes

Appendix	
A	Surface Water Hydrology
B	Fish
C	Socioeconomics
D	Environmental Commitments
E	Fish and Wildlife Coordination
F	Title XII—Yakima River Basin Water Enhancement Project

Tables

Table		Page
S-1	Summary of Impacts ..... Following page	S-10
2-1	Funding of the phases of the Basin Conservation Program	22
2-2	Estimated water supply and initial target instream flows criteria at Sunnyside Diversion Dam and Prosser Diversion Dam	29
2-3	Summary of estimated water conserved from certain Title XII provisions	35
2-4	Summary of alternatives ..... Following page	40
2-5	Summary of impacts ..... Following page	40
3-1	Average yearly runoff at key locations	47
3-2	Yakima River Basin reservoirs—hydrologic data	48
3-3	Pre-Title XII target flows	52
3-4	Title XII target flows based on TWSA	53
3-5	Spatial variation of water quality constituents—Yakima River	58
3-6	Seasonal variation of median values of selected water quality constituents—drains to the Yakima River	60
3-7	Estimates of potential groundwater use in the Yakima River watershed ...	67
3-8	Major irrigation districts and projects and measured diversions in the Yakima River Basin (1986)	71
3-9	Irrigated acreage of crops grown in the Yakima Project from 1982 to 1992	71
3-10	Salmon counts at Prosser	76
3-11	Identified problems and needs for aquatic resources	76
3-12	Approximate acres of woody riparian habitat within the Yakima River Basin	83
3-13	Acres of wetland habitat within the Yakima River Basin	86
3-14	List of threatened and endangered species that may occur in the Yakima River Basin	88
3-15	Yakima Project crop acreage and values	92

Contents

Tables

Table		Page
3-16	Agricultural production by division for Yakima Project	92
3-17	Agricultural irrigation by division	93
3-18	Summary of employment levels by sector for 1993	95
3-19	Household income by sector for 1993	96
3-20	Sales revenue by sector for 1993	97
3-21	Developed recreation facilities by county	98
4-1	Overview of impacts in an average year (1926-1994)	111
4-2	Overview of impacts in a dry year (1994)	112
4-3	Defined range of impacts for surface water flows	115
4-4	Summary of impacts to surface water quality	121
4-5	Diversions and return flows for Basin Conservation Program action alternatives	122
4-6	Streamflow impacts at selected sites on the Yakima River	123
4-7	Summary of impacts to groundwater	129
4-8	Canal diversion impacts for average dry year diversions	133
4-9	Summary of impacts to lands	135
4-10	Summary of impacts to fish	139
4-11	Summary of impacts to vegetation and wildlife	148
4-12	Summary of impacts to social well-being	156
4-13	Social impact assessment variables	158
4-14	Population projection by county (1990 to 2020)	158
4-15	Summary of impacts to economics	163
4-16	Annual impacts by alternative for each $1-million change in agricultural production attributable to purchase or lease	164
4-17	Changes in power for each alternative	164
4-18	Summary of impacts to recreation	170
4-19	Summary of impacts to Indian Trust Assets	178
A-1	Irrigation diversions in the Yakima River Basin—average monthly irrigation demands	A-4
A-2	Summary of hydrology impacts for instream target flows—period average (1926-1994)	A-8
A-3	Summary of hydrology impacts for instream target flows (1994)	A-9
A-4	Summary of hydrology impacts as percentage changes—period average values	A-10
A-5	Summary of hydrology impacts as percentage changes—Yakima River average July through October streamflow at key locations	A-11
B-1	Detailed summary of impacts to fish, based on hydrology model results	B-1
C-1	Population for cities, towns, and counties in the Yakima River Basin from 1940 to 1990	C-1

Contents

Figures

Figure		Page
S-1	Location map ..... Following page	S-2
1-1	Location map ..... Following page	2
1-2	Yakima River Basin Water Enhancement Project environmental compliance	16
2-1	Yakima River Basin Water Enhancement Project program elements	20
3-1	Conceptual comparison of measured flow and estimated unregulated flow	44
3-2	Major gauging stations within the Yakima River Basin ..... Following page	48
3-3	Generalized stratigraphic column adapted from YVCOG (1993)	62
3-4	Geologic map of the Yakima River Basin ..... Following page	62
3-5	Groundwater basin boundaries within the Yakima River Basin ..... Following page	66
3-6	Irrigation district and project boundaries within the Yakima River Basin ..... Following page	72
3-7	Irrigation diversion points within the Yakima River Basin .. Following page	72
3-8	Vegetation types within the Yakima River Basin ..... Following page	80
3-9	Wetlands within the Yakima River Basin ..... Following page	86
3-10	Employment levels in the Yakima region since 1978	94
3-11	Major recreation access points and developed and dispersed recreation areas within the Yakima River Basin ..... Following page	98
A-1	Schematic of the Yakima River Basin with representations of branch and reach endpoints used in monthly model	A-3
A-2	April TWSA for 1994, and 1926 to 1994 average	A-12
A-3	Annual diversions for 1994, and 1926 to 1994 average	A-13
A-4	Annual shortages for 1994, and 1926 to 1994 average	A-14
A-5	Instream flow releases for 1994, and 1926 to 1994 average	A-15
A-6	Average annual flows at key locations on the Yakima River, 1926 to 1994 ...	A-16
A-7	Average July through October flows at key locations on the Yakima River, 1926 to 1994	A-17
A-8	Flow impacts compared to no action - Martin (average year 1926-1994)	A-18
A-9	Flow impacts compared to no action - Easton (average year 1926-1994)	A-18
A-10	Flow impacts compared to no action - Cle Elum (average year 1926-1994) ...	A-19
A-11	Flow impacts compared to no action - Umtanum (average year 1926-1994) ..	A-19
A-12	Flow impacts compared to no action - Pomona (average year 1926-1994)	A-20
A-13	Flow impacts compared to no action - Parker (average year 1926-1994)	A-20
A-14	Flow impacts compared to no action - Prosser (average year 1926-1994)	A-21
A-15	Flow impacts compared to no action - Kiona (average year 1926-1994)	A-21
A-16	Flow impacts compared to no action - Martin (dry year 1994)	A-22
A-17	Flow impacts compared to no action - Easton (dry year 1994)	A-22
A-18	Flow impacts compared to no action - Cle Elum (dry year 1994)	A-23

Contents

Figures

Figure		Page
A-19	Flow impacts compared to no action - Umtanum (dry year 1994)	A-23
A-20	Flow impacts compared to no action - Pomona (dry year 1994)	A-24
A-21	Flow impacts compared to no action - Parker (dry year 1994)	A-24
A-22	Flow impacts compared to no action - Prosser (dry year 1994)	A-25
A-23	Flow impacts compared to no action - Kiona (dry year 1994)	A-25

Summary

1.0 Purpose of and Need for Proposed Action

The proposed action addressed in this document is to implement Phase 2 of the Yakima River Basin Water Enhancement Project (YRBWEP) authorized by Title XII of the Act of October 31, 1994, Public Law 103-434. Title XII specifically states that conserved water resulting from the expenditure of Federal funds shall not be used to expand irrigation in the Yakima River Basin (except as specifically provided in section 1204(a)(3) for actions on the Yakama Indian Reservation). The purpose of the proposed action is to meet the water needs of the basin through improved water conservation and management and other appropriate means. A need exists in the Yakima River Basin to:

- Protect, mitigate, and enhance fish and wildlife
- Improve the reliability of the water supply for irrigation while improving water quality in the basin.

See figure S-1 for a location map of the Yakima River Basin.

2.0 Alternatives Including No Action

Alternative 2A is identified as the preferred and environmentally preferred alternative, in accordance with 40 Code of Federal Regulations (CFR) 1502.14(e) and *Departmental Manual* Part 516, Chapter 4, 4.10A.

The No Action Alternative is presented as the most likely future condition that could be expected without implementing the actions specified in Title XII. In this case, the No Action Alternative includes the new operational criteria for target flows that were required for immediate implementation under Title XII. Impacts of the action alternatives are compared to the No Action Alternative.

The action alternatives represent implementation of various elements of Title XII. Because Title XII can be implemented in more than one way, and some portions may not be implemented until additional studies are completed, several action alternatives were developed using different components of Title XII. The intent is to do an incremental analysis of implementing Title XII that examines impacts if certain components were not accomplished as well as if all components were accomplished.

Alternative 1 includes implementing all Title XII measures except the Basin Conservation Program. Alternative 2 consists of all Title XII measures included in Alternative 1 plus different levels (Alternatives 2A, 2B, and 2C) of the Basin Conservation Program implementation at various locations within the basin. Alternative 2A includes implementing all Title XII measures plus a 7.5-percent, basin-wide reduction in diversion demands except for the Wapato Irrigation Project (WIP) and the Yakima-Tieton Canal. Alternative 2B includes implementing all Title XII measures plus a 15-percent reduction in diversion demands from the Yakima River downstream from the Roza Diversion Dam except for WIP and the Yakima-Tieton Canal. Alternative 2C includes implementing all Title XII measures plus a 21-percent reduction in diversions for the Sunnyside and Roza Canals.

Alternative 3 includes all Title XII measures except for implementing the Kachess Lake augmentation and tributary measures.

3.0 Affected Environment

3.1 Surface Water Hydrology

The surface water supply for the Yakima Project is obtained from the unregulated flows of the Yakima River and its tributaries, return flows, and stored waters. Average yearly runoff at key locations along the Yakima River and its tributaries for the period 1926 through 1994 is presented in table 3-1. Table 3-1 compares actual measured runoff at selected stations from 1984 through 1994 with the unregulated runoff data.

Average monthly diversion demands used in the hydrology model during years of full water supply (years when proration did not occur) from 1970 through 1994 are presented in table A-1 for all the canals in the basin. For each acre-foot of water diverted from the river, a portion returns to the river downstream from the point of diversion. Lag time for return flows was accounted for in the model through a repetitive mathematical process until flows appeared to reflect the actual historical conditions.

A list of the monthly minimum flows used in the model for pre-Title XII conditions is shown in table 3-3. These flows are used as a basis for quantifying storage release for instream flows and are considered the "existing instream flow agreements." Table 3-4 shows the flows implemented in 1995. These flows are stipulated in Title XII at Parker and Prosser, based on the forecasted total water supply available.

Water is released from the Yakima Project reservoirs during the irrigation season to meet diversion demands. In the fall, winter, and spring, releases are made in conjunction with system flood control guidelines. A "flip-flop" procedure of reservoir releases is used to minimize spring chinook spawning and subsequent incubation flows and also to minimize the potential impact on irrigation water supplies.

Yakima River Basin Water Enhancement Project Base Map



Scale = 1 : 700,000

NCRI NW

Map Design and Cartography
by NCRI-NW
Central Washington University
Ellensburg, Washington

Figure S-1.—Location map.

The Wapatox and Roza Power Plants and the Chandler Pumping Plant impact the flow regime at their respective diversion dams.

3.2 Surface Water Quality

Surface water quality in parts of the Yakima River Basin is poor. Water quality in headwater streams and the upper Yakima River is good but degrades when moving downstream to the mouth. This degradation is caused both by natural processes and the impacts of human activity.

Nutrient concentrations in the Yakima River Basin from 1941 to 1985 were similar to those observed in many rivers in the United States. Median concentrations for all data from the basin are 0.12 and 0.36 milligrams per liter (mg/L) for total phosphorus and nitrite plus nitrate, respectively. Table 3-5 presents a summary of the spatial variation of nutrient concentrations in the Yakima River from the U.S. Geological Survey for 1974 through 1981.

Significant suspended sediment concentrations in the Yakima River are associated with the discharge of agricultural return flows to the river, most importantly in the lower part of the basin. The spatial variation of suspended sediment concentrations for the Yakima River is shown in table 3-5.

Water temperatures in the upper basin are cold but warm as the river flows to the lower basin. In the lower basin, main stem temperatures in the late summer tend to be similar to the temperatures of the agricultural return flows because a high percentage of the riverflow in the late summer is return flows from agriculture. About 5 percent of the water temperature measurements from 1959 to 1985 exceeded State standards; the highest temperatures have occurred in the lower portion of the basin. Table 3-6 shows the spatial distribution of water temperatures in the Yakima River.

Table 3-6 summarizes historical water quality characteristics of the agricultural return flows in selected drains from 1974 to 1981. Comparison of data in tables 3-5 and 3-6 shows that the median values for total phosphorus, nitrite plus nitrate, and suspended sediment are considerably higher in the drains than in the Yakima River.

3.3 Groundwater

Geologic structures such as folds and faults alter the groundwater flow pattern in the Yakima River Basin. Folded ridges and troughs dominate the topography in the lower basin. The uplift of the ridges occurred slowly enough to allow the Yakima River to maintain its course across the structures, as seen at Union Gap where the river flows through Ahtanum Ridge. The bedrock folds determine flow patterns and form hydrologic boundaries.

Glacial outwash, reworked glacial deposits, and recently deposited river alluvium are important aquifers, primarily because of their storage capacities and high permeabilities. The aquifers are recharged during periods of high runoff and precipitation. They discharge to streams during late season dry periods and help maintain stream base flows.

The Yakima River Basin consists of three principal aquifer systems: the unconfined alluvial aquifer system, the Ellensburg Formation/postbasalt aquifer system, and the Yakima Basalt aquifer system. For the purposes of this document, the Yakima River Basin has been divided into the groundwater basins shown on figure 3-5. Structural bedrock controls (anticlines and synclines) effectively isolate each groundwater basin and prevent most underflow through the alluvial and Ellensburg Formation/postbasalt aquifers. Underflow through the basalt aquifers is probably significantly higher.

In certain areas, the Yakima River and its tributaries provide recharge to the groundwater system. Most of the water infiltrates into the shallow aquifers, but some leaks downward to recharge the deeper aquifers. Recharge from surface water irrigation applications maintains high water levels in the Ellensburg and alluvial aquifers. About 20 to 40 percent of the water applied to agricultural lands in the lower basin infiltrates beyond the root zone and enters the groundwater system. Groundwater discharge to the Yakima River occurs in all of the basins where structural bedrock constrictions prevent shallow aquifer materials continuing from one basin to another. Another major component of groundwater discharge is the withdrawal of groundwater by pumping wells.

Water right and claim documents indicate potential annual use of 840,000 acre-feet of groundwater in the Yakima River watershed. Actual annual use is estimated to be 400,000 acre-feet (Kirk, 1995). Most groundwater use occurs in the Kittitas Basin and the upper and lower Yakima groundwater basins. Groundwater pumpage from wells in the Yakima River Basin is mostly for irrigation; lesser quantities are withdrawn for municipal, industrial, and domestic uses. About 67,628 acres are irrigated by groundwater in the Yakima River Basin (Yakima Valley Conference of Governments [YVCOG], 1993).

Except for some local degradation from septic systems and industrial and agricultural activities, groundwater from all major aquifer systems in the Yakima River Basin generally meet drinking water standards (YVCOG, 1993). Published data concerning some types of groundwater contamination, such as from pesticides and herbicides, are not available. Therefore, the overall quality of the groundwater is undefined. Principal chemical constituents in basalt groundwater include bicarbonate, calcium, sodium, and magnesium. In general, groundwater has a low total dissolved solids content—less than 250 mg/L in the northern part of the watershed and less than 500 mg/L in the southern part. Isolated instances of fecal coliform contamination have been reported, but it is not a widespread problem in the basin.

3.4 Agricultural Resources

The Yakima Project area is among the leading agricultural area in the United States. It is or has ranked first in the United States in producing several crops and fruit trees. It is also a major center for the production of beef cattle. Yakima County ranked fifth in the United States in total agricultural production.

Table 3-8 summarizes the measured diversions and associated irrigated areas for 1986 in the major irrigation districts in the Yakima River Basin. Most surface water diversions in the Yakima River Basin are from Federal project diversions, incorporated irrigation districts, irrigation companies, or partnership ditches.

Lands planted with irrigated crops have decreased from 371,096 acres in 1982 to 360,675 acres in 1992. Table 3-9 shows the irrigated acreage of crops grown in the Yakima Project from 1982 to 1992. The use of sprinkler and drip irrigation systems on agricultural lands in the basin is increasing, which helps conserve water while reducing erosion and sedimentation problems. Over 45 percent of the area irrigated is perennial crops, including orchards, vineyards, hops, mint, and asparagus. The prevailing trend in the area is to convert from stress-tolerant crops to higher value crops. Productive soils, favorable climate, and long daylight hours result in generally high crop yields.

Soil quality is generally good, with only minor areas of salinity and a few toxic trace element problems. Erosion ranges from slight to severe, depending on soil texture and topography. Erosion caused by surface water is generally low on irrigated slopes of under 2 percent. Row crops under furrow or rill irrigation are the largest source of erosion, although overirrigation by sprinklers can also cause serious erosion. Soil blowing is a hazard in the basin. Most of the soils are well drained; however, drainage is restricted in some of the low lying areas, resulting in excessive salts or alkali and a high water table.

Noxious vegetation is a problem in the Yakima River Basin. Conveyance and distribution systems currently in use provide an avenue for abundant dissemination of weed seeds throughout the basin.

3.5 Fish

Salmon, steelhead, and resident fish are important resources within the Yakima River Basin. The precipitous decline of salmonid populations since the 1850s is attributable to many factors. Indigenous populations of sockeye, coho, and summer chinook salmon are extinct in the Yakima River Basin. Remaining populations of steelhead, spring chinook, fall chinook, and nonindigenous coho salmon require protection.

The Pacific salmon species produced in the Yakima River Basin include steelhead (which are proposed for listing under the Endangered Species Act [ESA]), spring chinook salmon, fall chinook salmon, and coho salmon. Salmon and steelhead estimated population trends are shown in table 3-10. The ability of fish populations to thrive depends on how well their

life requirements are met for each life stage. Important life requirement factors for salmonids include adequate streamflows and streamflow timing, adequate water quality (including temperature), presence of riparian areas and wetlands, presence of food, spawning gravel, large woody debris, and other elements. Salmonids depend upon a well-distributed interconnected network of suitable habitats that allow fish to survive, migrate, and reproduce. Table 3-11 identifies specific problems and needs for aquatic resources. The river below Prosser Dam, which could be affected by this Federal action, is important for fall chinook spawning, migration, and rearing. The reach below Sunnyside Dam is important for spring chinook rearing, summer chinook spawning and rearing, steelhead rearing, and upstream and downstream migration of all anadromous species. Most species must negotiate the Sunnyside and Prosser Diversion Dams, and instream flows and water quality in these areas can affect migration.

The Yakima and Naches Rivers, as well as tributaries, support resident fish such as rainbow and cutthroat trout, whitefish, sculpins, large-scale and bridgelip suckers, northern pikeminnow, and dace. Introduced species include brook trout, smallmouth bass, black crappie, channel catfish, and yellow perch.

Except for Rimrock and Clear Lakes, the reservoirs in the basin were natural lakes prior to construction of the dams (U.S. Fish and Wildlife Service [FWS], 1982). The reservoirs are considerably less productive than the original lakes (FWS, 1982). Bull trout (which are listed as threatened under the ESA) are found in every reservoir in the Yakima River Basin. Rainbow trout are abundant from Easton to Roza Diversion Dam. The Washington Department of Fish and Wildlife considers the Yakima River trout fishery of special significance to the State because of the large number of angler trips per year on the river and tributaries.

3.6 Vegetation and Wildlife

Plant communities found in eastern Washington reflect the influences of land use practices, elevation, climate, topography, and soils that characterize the area. Vegetation in the basin is a complex blend of forest, riparian areas, wetlands, bunchgrass, shrub-steppe, and cropland. The decrease in acreages of high quality wetland and riparian areas and associated wildlife habitat is attributable to many factors. The major landscape features likely to be affected by this Federal action include the Yakima and Naches River flood plains; areas adjacent to the reservoirs; tributary courses; and vegetated areas along canals, drains, or other irrigated, agriculture-related features.

Riparian conditions in the Yakima River Basin vary, ranging from severely degraded to nearly pristine. Good riparian habitat generally is found along some forested headwater reaches, whereas degraded riparian habitat is concentrated in the valleys and is frequently associated with agriculture; grazing; and fluctuating, regulated streamflow. The Yakima River Basin still contains remnants of contiguous aquatic and riparian vegetative cover types suitable for wildlife habitat.

Wetlands are critical ecological systems of importance to fish and wildlife. Existing acreages of wetland habitat are reduced compared to historical conditions. Existing wetlands include wet meadows, seeps, small shallow ponds and lakes, marshes, and riparian wetlands along streams. Wetlands have also formed from artificial water sources such as reservoirs, sewage lagoons, stockponds, irrigation canals, and irrigated cropland runoff.

Cropland has historically provided wildlife habitat throughout the Yakima River Basin. The quality of this habitat type has degraded over time.

3.7 Threatened, Endangered, and Special Status Species

Reclamation initiated informal consultation with a memorandum to the FWS and the National Marine Fisheries Service (NMFS), requesting a list of plants or animals on the Federal list of threatened or endangered species and any critical habitat. FWS indicated that 38 plants and animals were species of concern that could occur in the project area.

3.8 Socioeconomics

Groups that may be impacted by this action are agricultural, environmental, and recreational groups; the Yakama Indian Nation; and property owners along the shores of Cle Elum Lake. Issues impacting these groups are the most beneficial use of water, decline of anadromous fish runs, water conservation measures that could be employed to achieve water savings goals, the amount of water maintained instream, and maintaining an adequate water resource for agriculture. In 1990, about 29.6 percent of the study area population was classified as rural. Many small towns in the region are supported primarily by agriculture and agricultural processing plants. The 1990 census counted 27,522 persons within the Yakama Indian Reservation, 6,300 of whom were Tribal members.

According to Reclamation's *1993 Crop Report*, the Yakima Project diverts about 1,789,000 acre-feet of water to the 471,450-acre project area, mostly for growing crops. Of these 471,450 acres, 372,740 acres (80 percent) were irrigated during 1993. Acreage and values of the crops for 1993 are shown in table 3-16. The 471,450 acres are divided among seven divisions in the Yakima region. The breakdown of acres and crop value by division is shown in table 3-17. Reclamation's *1992 Summary Statistics* indicates that of the 1,789,000 acre-feet of water diverted through the project in 1992, 1,314,713 acre-feet (73 percent) reached the farms (Reclamation, 1992) as shown on table 3-17. The other 27 percent was lost to evaporation, leakage losses, or other reasons. Divisions had varied levels of onfarm water efficiency as shown in table 3-17.

The Yakima region has developed a diverse economy, providing many opportunities for employment and income. However, it still has a strong agricultural base. Between 1988 and 1993, personal income in this region grew annually at 8.9 percent, and per capita

income grew by 6.4 percent. However, growth may slow in the region through the year 2005. Employment through the year 2005 is forecast to grow 1.3 percent annually for the region. Personal income in the region has grown at a strong rate for the past 10 years, but regional unemployment remains higher than the State average. Employment levels in the Yakima region from 1978 to 1995 appear in figure 3-10. Total employment for the region by sector in 1993 appears in table 3-18. Household income by sector for 1993 appears in table 3-19, and sales revenue by sector for 1993 appears in table 3-20.

Fisheries have provided commercial and recreational activities in the Pacific Northwest for over 100 years. Catches of salmon and other ocean fishes have declined in recent years. Salmon catches from the Northwest may be less important to consumers because of increased output from salmon farms throughout the world and continuing large harvests from Alaska and Canada.

3.9 Recreation

The recreation setting of the Yakima River Basin varies from designated wilderness areas to urban greenways. The preferred recreation setting is water oriented, and public demand for access to rivers, streams, and reservoirs increases yearly. Demand for recreation sites along the corridor exceeds supply throughout the summer season. The Yakima River Basin contains 316 recreation sites. Table 3-21 describes recreation sites.

In 1995, the six State Park units in the Yakima Basin recorded 855,659 visitors; the U.S. Forest Service (USFS) estimated that the five major reservoirs located in the upper Kittitas and Upper Yakima basins attracted 1,370,000 visitors. The Bureau of Land Management counted visitor use in the Yakima River Canyon in 1994 and 1995 at 475,000 and 498,700, respectively. Resident fish resources provide about 64,000 angler days of use in reservoirs and 190,000 angler days of use on streams (FWS, 1996).

Keechelus Lake is managed primarily for day use activities and as a rest area. Fishing is the primary recreation activity on the reservoir. Water access has not been developed, and visitation in 1995 totaled 210,000. Visitation at Kachess Lake totaled 280,000 in 1995. Sunbathing and water play activities are ranked as the primary use, followed by motorized boating and fishing.

Sunbathing, water play, camping, motorized boating, and fishing are the primary activities on Cle Elum Lake during the summer. Cle Elum Lake received about 350,000 visitors in 1995 (USFS, Outdoor Recreation Planner, Wenatchee National Forest, personal communication, 1996).

Lake Easton State Park near Easton Diversion Dam provides facilities for camping, swimming, and boat launching and mooring. The reservoir provides a cold water sport fishery. Recreation use at Lake Easton is over 266,705 visitors annually.

Most recreation near Bumping Lake centers around water from mid-May to mid-October. Hunters use the area through November. The area is snow covered the remainder of the year and receives winter recreation use. Typical recreation activities at Rimrock Lake include sail boating, water skiing and jet skiing, fishing, wind surfing, canoeing, and boat-in camping. The reservoir receives about 60,000 visitor days annually. Clear Lake has high year-round recreational value.

The "flip-flop" procedure, which releases water from Rimrock Lake, has created late season high flows on the Tieton River that attract rafters and kayakers. White-water rafting and kayaking activities occur on the Teanaway River. Angler use is moderate. Several public and private campgrounds are located in the area. Developed recreation facilities in the Yakima River Canyon provide boat launching, picnicking, camping, and bathroom facilities, and many water-related recreation activities take place in the canyon. The Naches River is used heavily for white-water boating and fishing as well as sightseeing, camping, and picnicking. Public hunting and fishing permits issued by the Yakama Indian Nation allow non-Tribal members to hunt and fish within the Yakama Reservation subject to the rules and regulations of the Yakama Indian Nation.

3.10 Cultural Resource Properties and Paleontological Resources

Archeological evidence indicates that human occupation of areas east of the Cascade Mountains extends 9,000 to 12,000 years before the present. No archeological surveys were completed at Reclamation's Yakima Project facilities prior to their construction because their construction predates the laws that require such investigations. No systematic traditional cultural properties investigations have occurred either. However, significant archeological and traditional cultural property resources likely are present. No paleontological investigations have occurred at project reservoirs, and no fossil deposits have been reported.

3.11 Sacred Sites

The Yakama Indian Nation has informed Reclamation of one sacred site location at a project reservoir in order to prevent damage to that site. Reclamation anticipates that similar sites are present at all reservoirs, particularly where extensive fishing and other important actions occurred.

3.12 Indian Trust Assets

The United States has a trust responsibility to protect and maintain rights reserved by or granted to American Indian (Indian) Tribes or Indian individuals by treaties, statutes, and Executive orders. Indian Trust Assets (ITAs) are legal interests in property held in trust by the United States for Indian Tribes or individuals or legal interests that the United States is otherwise charged by law to protect. Specific rights were retained by the Tribes

signing the Treaty of 1855, including Reservation lands and rights for hunting, fishing, and gathering rights off Reservation. These rights are considered ITAs and are protected accordingly.

4.0 Environmental Consequences

The summary table S-1 shows impacts that are indicative of overall impacts to resources. Numbers have been rounded.

4.1 Surface Water Hydrology

Averages for the period 1926-1994 were summarized for the entire year and the period July through October. Pre-Title XII shortages were a bit less than under no action in an average year. Pre-Title XII flows were much less than under no action at Prosser from July through October in the average year. Changes in surface water flows mostly result from implementing the Basin Conservation Program under Alternatives 2A, 2B, 2C, and 3. Flows increase at Parker and Prosser as intended under Title XII. The largest increases are for the average flows at Parker and Prosser during July through October. The amount of shortages also decreases in average years. Table 4-1 summarizes the differences in flows and shortages for an average year.

In the dry year that was analyzed, 1994, pre-Title XII flows at Prosser were much less than under no action, particularly from July through October. In the 1994 model year under Alternatives 2B and 2C, there are moderate increases in releases for instream flows and decreases in shortages. In the 1994 model year under Alternatives 2A and 3, there are no increases in releases for instream flows and minor decreases in shortages. Table 4-2 summarizes the differences in flows and shortages for the model year 1994.

4.2 Surface Water Quality

The water quality of the Yakima River at the Umtanum station is expected to remain the same for the No Action Alternative as for the pre-Title XII conditions. At Parker, minor improvement in water quality should occur at this station for average year conditions. At Prosser, improvements in water quality are expected to occur. At Kiona, water quality impacts would not be measurable for every month of the year. For a dry year like 1994, some improvements in water quality would occur during the summer months, June through September, because of additional water release from the reservoirs.

Water quality in the Yakima River for Alternative 1 would be expected to be essentially the same as the No Action Alternative. Some improvement in water quality attributable to increased flows obtained through increased reservoir releases for Alternative 1 might occur

Table S-1.—Summary of impacts

Affected resource	No Action Alternative	Action Alternative: Implement Title XII				
		Alternative 1	Alternative 2A (preferred alternative)	Alternative 2B	Alternative 2C	Alternative 3
Surface Water Hydrology Note: The legislated minimum instream target flows below Sunnyside and Prosser Diversion (which were designated in Section 1205(a) of Title XII and implemented in 1995) are included in the No Action Alternative which was compared against all of the other action alternatives.	**Shortages and flows at Parker and Prosser—average year (1926-1994)**					
	Shortages are 57,000 acre-feet (relative to total annual average model diversion demands[1] of 2,450,000 acre-feet).	Minor decrease in shortages.	Moderate decrease in shortages.	Moderate decrease in shortages.	Moderate decrease in shortages.	Minor decrease in shortages.
	Average flows from Jul-Oct were 510 ft^3/s at Parker and 460 ft^3/s at Prosser.	No measurable impact for the July-Oct average flows at Parker and Prosser.	Moderate increases in the July-Oct average flows at Parker and Prosser.	Moderate increases in the July-Oct average flows at Parker and Prosser.	Moderate increase in the July-Oct average flows at Parker and major increase at Prosser.	Moderate increases in the July-Oct average flows at Parker and Prosser.
	Shortages and flows at Parker and Prosser in a dry year such as 1994					
	Shortages are 602,000 acre-feet (relative to total annual average model diversion demands of 2,450,000 acre-feet).	No measurable impact in shortages.	Minor decrease in shortages.	Moderate decrease in shortages.	Moderate decrease in shortages.	Minor decrease in shortages.
	Average flows from Jul-Oct were 300 ft^3/s at Parker and Prosser.	No measurable impact for the July-Oct average flows at Parker and Prosser.	No measurable impact for the July-Oct average flows at Parker and Prosser.	Minor increases in the July-Oct average flows at Parker and Prosser.	Moderate increases in the July-Oct average flows at Parker and Prosser.	No measurable impact for the July-Oct average flows at Parker and Prosser.
Surface Water Quality	**Surface water in the Yakima River**					
	Sediment, nutrients, and pesticide concentrations are higher at certain times of the year because of impacts of irrigation return flows. Temperature can be lower or higher because of drain water influences.	No measurable impacts on the water quality in the river compared with the No Action Alternative.	Some improvement in water quality below Parker is possible for sediment, nutrients, and pesticides. Improvement depends upon type of water conservation implemented in the basin.	Generally, same as Alternative 2A except concentrated in the area downstream from Roza.	Generally, same as Alternative 2A except concentrated in the area downstream from Roza and Sunnyside Canal diversions.	Generally, same as Alternative 2A.
	Water quality in the drains					
	Drain water quality shows sediment, nutrients, and pesticide concentrations are generally higher than in the irrigation water supply diverted from the river.	Generally, same as no action.	Some reductions in sediment, nutrient, and pesticide concentrations should occur depending on type of conservation implemented in the basin—specifically if surface runoff from onfarm practices is reduced.	Impacts are concentrated downstream from Roza; therefore, return flows are less than Alternative 2A. So sediment concentrations and loads should be lower.	Impacts are concentrated downstream from Roza and Sunnyside; therefore, return flows are less than Alternative 2A. So sediment concentrations and loads should be lower.	Generally, same as Alternative 2A.

[1] Model diversions are based on actual historical diversions from 1970-1994, excluding water-short years. See table A-1, in appendix A.

Table S-1.—Summary of impacts (continued)

Affected resource	No Action Alternative	Action Alternative: Implement Title XII				
		Alternative 1	Alternative 2A (preferred alternative)	Alternative 2B	Alternative 2C	Alternative 3
Groundwater	Groundwater levels higher than historical levels from increased recharge from irrigation applications. Locally, groundwater has higher than natural background levels of major solutes from agricultural chemicals.	Short-term minor impact near Cle Elum and Kachess Lakes because of higher reservoir levels and operational timing changes.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.	Short-term minor impact at Cle Elum; none at Kachess.
			About 82,000 acre-feet less recharge to aquifers basin-wide.	About 82,000 acre-feet less recharge to upper and lower Yakima groundwater basins (Kittitas and Naches basins not impacted).	About 57% fewer return flows from Roza and 59% fewer return flows from Sunnyside. About 82,000 acre-feet less recharge to upper aquifers within the area served by these two irrigation districts.	Generally, same as Alternative 2A.
			Minor lowering of groundwater levels in localized areas may impact wells that tap these aquifers.	Minor to moderate lowering of groundwater levels in localized areas will impact wells that tap these aquifers.	Lower groundwater levels will impact wells that tap these aquifers.	Generally, same as Alternative 2A.
			Less seepage water to dilute high solute levels in return flows from irrigation applications. May have slightly higher levels of solutes in groundwater basin-wide.	Slightly higher levels of solutes expected in groundwater in localized areas within upper and lower Yakima groundwater basins.	Higher levels of solutes expected in groundwater in localized areas because of reduced groundwater recharge/storage.	Generally, same as Alternative 2A.
Agricultural Resources	Low to moderate salinity and low trace element concentrations.	Irrigation management.	Slight improvement under good irrigation management.	Improvement under good irrigation management.	Improvement under good irrigation management.	Generally, same as Alternative 2A.
	Moderate wind and water erosion basin-wide.	Same as no action. Kachess shoreline erosion protection required.	Reduced water erosion and possible increased wind erosion. Kachess shoreline erosion protection required.	Reduced water erosion and increased wind erosion. Kachess shoreline erosion protection required.	Reduced water erosion and increased wind erosion. Kachess shoreline erosion protection required.	Reduced water erosion and possible increased wind erosion. Kachess shoreline not impacted.
	Expected small reduction in irrigated acreage due to conversion to suburban use. Existing noxious weeds.	Better protection of perennial crops in drought years.	More dependable water supply from reduced shortages. Better protection of perennial crops in drought years. Decreased irrigated acreage.	More dependable water supply from reduced shortages. Better protection of perennial crops in drought years. Reduced crop acreage and loss of agricultural jobs. Increased weed infestations.	More dependable water supply from reduced shortages. Better protection of perennial crops in drought years. Reduced crop acreage and loss of agricultural jobs. Increased weed infestations.	Generally, same as Alternative 2A.
	Low to moderate surface and subsurface drainage deficiencies.		Slightly improved surface and subsurface drainage.	Improved surface and subsurface drainages.	Surface and subsurface drainage slightly better than Alternative 2B.	Generally, same as Alternative 2A.

Table S-1.—Summary of impacts (continued)

Affected resource	No Action Alternative	Action Alternative: Implement Title XII				
		Alternative 1	Alternative 2A (preferred alternative)	Alternative 2B	Alternative 2C	Alternative 3
Fish	Salmon and steelhead migration, spawning, and rearing impaired. Streamflows often too high for trout in upper mainstem Yakima during the irrigation season.	Potential improved streamflows for salmon, steelhead, and rainbow trout in tributaries associated with water acquisition and tributary programs. Potential benefits to juvenile salmonid migration due to flushing flows from Cle Elum. Potential improved streamflows for fish from Prosser to Chandler if Chandler electrification is implemented.	Impacts same as Alternative1 plus potential benefits to salmonid migration, fall chinook spawning, and rearing below Parker. Water conservation could improve instream flows and water quality and thereby benefit fish.	Generally, same as Alternative 2A.	Generally, same as Alternative 2A.	Generally, impacts are similar to Alternative 2A. The absence of the tributary program means fewer potential benefits to salmon, steelhead, rainbow trout, and other resident fish.
Vegetation and Wildlife	Riparian health varies throughout basin; estimate 19,000 acres of riparian vegetation basin-wide.	Potential benefits to riparian areas below Parker.	Potential benefits to riparian areas below Parker and Prosser.	Generally, same as Alternative 2A.	Generally, same as Alternative 2A.	Generally, same as Alternative 2A. The absence of the tributary programs means fewer potential benefits to riparian areas.
	About 71,000 acres of wetland.	Potential minor benefits to wetlands associated with Yakima River below Sunnyside and Prosser. Yakama Indian Nation and ecosystem restoration activities could be beneficial.	Potential benefits to wetlands based on land and water acquisition programs, wetland banking, and developing a habitat plan. Potential minor adverse impacts to wetlands associated with agricultural return flows or seepage.	Potential minor adverse impacts to wetlands associated with agricultural return flows or seepage below Roza.	Potential minor adverse impacts to wetlands associated with agricultural return flows or seepage on Roza or Sunnyside lands.	Generally, same as Alternative 2A.
Threatened, Endangered, and Special Status Species	No impact to threatened and endangered species. Site-specific analysis to be conducted in the future.	Same as no action.	Same as no action.	Same as no action.	Same as no action.	Same as no action.

Table S-1.—Summary of impacts (continued)

Affected resource	No Action Alternative	Action Alternative: Implement Title XII				
		Alternative 1	Alternative 2A (preferred alternative)	Alternative 2B	Alternative 2C	Alternative 3
Socioeconomics	**Social**					
	Shoreline property around Cle Elum Lake eroding.	Small local labor force will be used to complete structural modifications.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.
	Same community cohesion levels that now exist between nonterritorial and territorial communities.	About 10 property owners around Cle Elum Lake impacted.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.
		The potential for friction and decreased community cohesion depends on the specific water conservation measures.	Increased friction in community cohesion anticipated (greater than Alternative 1). Degree of impacts to water right acquisitions will depend on type and amount of water conservation measures.	Increased friction in community cohesion anticipated (greater than Alternatives 1, 2A, and 3). Diversion reductions would probably require water acquisition and subsequent land use change.	Increased friction in community cohesion anticipated (greater than Alternatives 1, 2A, 2B, and 3). Diversion reductions would probably require water acquisition and subsequent land use change greater than Alternative 2B.	Increased friction in community cohesion anticipated (about the same as Alternative 2A).
	Economic					
	Employment in the Yakima region is about 191,000 workers, earning about $4 billion, with sales revenues of $13 billion. Reclamation projects irrigate 360,000 acres with 1,789,000 acre-feet of water, producing $665 million in crop value.	Some gains in sales revenues. Impacts due to actions likely to be minimal, affecting primarily agriculture.	No measurable gains in sales revenues. Will likely be achieved through water conservation; therefore, no economic impacts.	Economic impacts only from lease or purchase of water rights; about $800,000 reduced sales revenues over all industries for every 1,000 acre-feet of reduced water delivery.	Economic impacts only from lease or purchase of water rights; about $900,000 reduced sales revenues over all industries for every 1,000 acre-feet of reduced water delivery.	Generally, the same as Alternative 2A.
Recreation	Primary recreation activities include fishing the reservoirs and rivers for cold water sport species, white-water boating and kayaking, motorized boating, and other related activities such as camping, hiking, picnicking, and wildlife viewing.	No measurable impact.	Implementing the Basin Conservation Program could increase instream flows slightly, which could benefit flow-dependent recreation. Reservoir recreation would not be affected.	Generally, same as Alternative 2A. Reservoir recreation would not be affected.	Generally, same as Alternative 2A. Reservoir recreation would not be affected.	Generally, same as Alternative 2A. Reservoir recreation would not be affected.

Table S-1.—Summary of impacts (continued)

Affected resource	No Action Alternative	Action Alternative: Implement Title XII				
		Alternative 1	**Alternative 2A (preferred alternative)**	**Alternative 2B**	**Alternative 2C**	**Alternative 3**
Cultural Resources	Ongoing impacts from current operations and land uses would continue.	Historic structures could be adversely impacted by structural modifications. Raising Cle Elum Lake would adversely impact archeological and traditional cultural properties due to new erosion, stabilization actions, and possible relocation of facilities. Ground distributing activities at other locations could impact archeological or traditional cultural properties sites.	Same as for Alternative 1, except that a greater number of historic irrigation structures could be impacted, and additional archeological or traditional cultural properties sites could be impacted by implementing structural modifications for the Basin Conservation Program.	Generally, same as Alternative 2A.	Generally, same as Alternative 2A.	Generally, same as Alternative 2A.
Sacred Sites	One sacred site known; other sites may be present.	Possible impacts to any potential sacred sites on Federal lands cannot be determined at a programmatic level.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.
Indian Trust Assets	May not be adequately protected.	Indian Trust Assets under Alternative 1 would undergo little impact.	Positive impacts due to increased flows.	Generally, same as Alternative 2A.	Generally, same as Alternative 2A.	Generally, same as Alternative 2A.

in some months during the irrigation season for a dry year like 1994. Drain water quality is not expected to differ measurably with Alternative 1 compared to the No Action Alternative.

For Alternatives 2A, 2B, and 2C, the impact on the water quality of the return flows and, subsequently, the main river water quality compared with the No Action Alternative depends upon the type and location of water conservation methods. Yakima River water quality improvements can be achieved if onfarm water conservation methods are implemented that reduce surface water runoff and subsequent sediment loss from irrigated lands in areas that contribute return flows to the five drains indicated above.

The discussion above on the impacts of Alternative 2A compared with the No Action Alternative would also apply to Alternative 3.

The main river water quality in the reach below Parker will generally show improvement from implementing any of the action alternatives discussed above.

4.3 Groundwater

For the No Action Alternative, groundwater levels are expected to remain higher than historical levels, except where lowered by groundwater pumping, because of increased recharge from irrigation applications. Locally, groundwater has higher than natural background levels of major solutes because of agricultural chemicals.

Anticipated impacts to groundwater from Alternative 1 are considered negligible.

For Alternative 2A, upper aquifers would receive less recharge basin-wide. Minor lowering of groundwater levels in localized areas may impact wells that tap these aquifers. Less seepage water would be available to dilute high solute levels in return flows from irrigation applications. Groundwater may have slightly higher levels of solutes basin-wide.

For Alternative 2B, upper aquifers within the upper and lower Yakima groundwater basins would receive less recharge (Kittitas and Naches basins would not be impacted). Minor to moderate lowering of groundwater levels in localized areas would impact wells that tap these aquifers. Slightly higher levels of solutes would be expected in groundwater in localized areas within the upper and lower Yakima groundwater basins.

For Alternative 2C, return flows would decrease about 57 percent from Roza and 59 percent from Sunnyside. Upper aquifers within the area served by these two irrigation districts would receive less recharge. Lower groundwater levels would impact wells that tap these aquifers. Higher levels of solutes would be expected in groundwater in localized areas because of reduced groundwater recharge/storage.

Groundwater impacts from Alternative 3 would be identical to those discussed for Alternative 2A.

4.4 Agricultural Resources

No major impacts should occur to irrigated agriculture. The trend toward planting higher value crops will probably continue, as will implementing more efficient sprinkler and drip irrigation in adaptable crops. Although some alternatives may increase salinity, it is believed that proper water management will maintain soil salinity at harmless levels in most areas. Using best water management practices under the Basin Conservation Program (such as leveling to reduce the velocity of the applied irrigation water, using chemicals to improve infiltration, or converting to sprinkler or drip irrigation and thus reducing the volume of irrigation water applied) should result in less irrigation-induced erosion. Applying less water should reduce wetness and lower the water table. Any time the depth to shallow groundwater is less than 4 feet, crop yields are assumed to be affected, and soil salinity will increase. Orchards are particularly sensitive to fluctuating shallow groundwater.

Under the No Action Alternative, changes in annual diversions are not measurable. Current trends of land use will continue; changes in crops grown and total irrigated lands will vary. Irrigated lands will decrease. Some water conservation methods would be implemented, including more efficient irrigation delivery systems, which will reduce erosion, improve water quality, and increase crop yields.

A minor increase in average dry year diversions would occur for the Kennewick Canal under Alternative 1. Current trends of planting higher value crops will probably continue. Growers would implement a small number of water conservation measures. Kachess Lake augmentation would provide additional irrigation water to Kittitas Reclamation District and Roza Irrigation District in years of proration, which would enable growers to better protect perennial crops from drought. Raising Cle Elum Lake will require protection of 6,700 feet of shoreline from erosion. Water conserved by the Yakama Indian Nation could be used to irrigate additional lands or for other purposes.

Impacts under Alternative 2A would be the same as those under Alternative 1, except that the Basin Conservation Program would reduce diversions by 7.5 percent. Crop types may change because of decreased irrigated land acreages associated with the purchase or lease of water rights. Reduced deep percolation could produce adverse impacts by increasing salinity and toxic elements remaining in the root zone. Decreased conveyance losses in delivery systems may adversely influence wetlands and require mitigation. Shallow water wells could be adversely impacted. Beneficial impacts would include reduced soil wetness, reduced toxic elements in return flows, less runoff and water erosion, and increased crop yields and soil fertility. The net impact should result in a slight increase in crop yields and improved soil quality compared to the No Action Alternative. More efficient onfarm irrigation systems with good water management would result in less sediment and nitrates flowing to the river, drains, and wetlands, which would improve water quality. Some of the measures considered under the Basin Conservation Program and other YRBWEP activities will likely assist the dissemination of weed seeds through conveyance and distribution systems.

Land resources and water conservation impacts for Alternative 2B would be the same as those under Alternative 2A, except diversions would be reduced 15 percent; more reductions would come from converting a considerable number of lands to alternative uses. Weed infestations could increase.

Land resources and water conservation impacts for Alternative 2C would be the same as those listed for Alternative 2A, except diversions would be reduced 21 percent by water conservation and converting lands to alternative uses. This water supply reduction attributed to voluntary purchase or lease could result in retiring a substantial amount of agricultural land from irrigation, which may be considered an adverse impact to agricultural resources because these lands are a valuable resource. Diversion reductions attributable to water acquisitions would change the land use of an unspecified number of acres from irrigated agriculture to some other use not requiring Yakima River water. The number of acres would depend on the number of willing sellers. Increased wind erosion caused by decreased vegetation on abandoned lands would have an adverse impact. Weed infestations could increase. This alternative would increase target flows over Sunnyside Dam during prorated years because much of the return flow would be entering the river downstream from the target point. Operation and modification of facilities would be the same as Alternative 2A.

Land resources and water conservation impacts for Alternative 3 would be the same as those listed for Alternative 2A. Kachess shoreline would not be affected.

4.5 Fish

Implementing Title XII, particularly providing the legislated target flows and the Basin Conservation Program, would benefit most salmon and steelhead. Fish migrating through, spawning, or rearing below Sunnyside Diversion Dam and Prosser Dam in particular benefit from this Federal action. These benefits to fish are realized because of increased instream flows and improved water quality. Listed below are other potential benefits identified for fish:

- The wetlands program could benefit fish, especially during rearing and overwintering.

- The water acquisition and tributary programs may directly benefit fish in the specific areas where flows or habitat are improved. Some tributaries, like the Teanaway and Taneum, may especially benefit from conservation efforts. Improved tributary health is expected to benefit salmonids and resident fish.

- Recommendations of the System Operations Advisory Committee may lead to actions that directly benefit anadromous fish.

- The interim comprehensive basin operating plan could incorporate improved river management for anadromous fish. If implemented, this may help reduce in-river flow fluctuation and could improve flows during downstream salmonid migration.

Few impacts were identified for reservoir fisheries because, in general, few changes occur to reservoir volumes as a result of this Federal action. Resident fish, indicated by rainbow trout, may benefit in areas where the tributary program is implemented.

The broad analysis completed here showed that Alternative 2 (2A, 2B, and 2C) appeared to be more beneficial to anadromous fish than the other alternatives. Alternatives 1 and 3 are not recommended from the perspective of the fish analysis because these alternatives do not include water conservation or the tributary program, both of which could benefit fish.

This overall look at Title XII indicates that it would be technically advisable to monitor impacts to anadromous fish as individual elements of Title XII are implemented. Title XII is structured to provide streamflow increases at Parker and Prosser during the irrigation season, and this can result in streamflow decreases elsewhere in the basin at times (see figures A-9, A-17, and A-23). There are several species of anadromous salmonids, each with complex life stages and attendant habitat needs in various parts of the basin. Because of this inherent biological complexity, combined with the constraints of actual river operation, it would be prudent to monitor effects to anadromous fish associated with implementing Title XII elements. This can be accomplished, in part, through the tier-down National Environmental Policy Act (NEPA) process.

4.6 Vegetation and Wildlife

One goal of YRBWEP is to protect, create, and enhance wetlands and associated riparian and flood plain habitats. Therefore, this Federal action could benefit wetlands and riparian habitats in the basin. Adverse impacts to vegetation and wildlife associated with this Federal action are expected to be minor because of Reclamation's efforts to abide by the no net loss of wetlands policy, development of the Basin Conservation Program, the proposed Wetlands and Floodplain Habitat Plan, and the proposed wetlands enhancement project.

Few differences among alternatives could be identified for vegetation and wildlife. The tributary program could benefit specific riparian or wetland areas, and, therefore, Alternative 3, which excludes the tributary program, rates lower than other action alternatives from the perspective of vegetation and wildlife.

Generally, impacts could range from minor adverse to potentially beneficial under some circumstances. Benefits to wetland and riparian areas are most likely to occur if proposed actions are considered within the context of a well-developed Wetlands and Floodplain Habitat Plan as discussed in the Basin Conservation Program. Benefits are most likely to occur in tributaries where actions are taken (e.g., Teanaway River) and in the lower river

where flows are likely to be consistently increased. Implementing some conservation measures in the Yakima River Basin may result in the loss of some wetland areas. For example, any activities involving piping and lining open canals and/or drains could adversely impact a wide variety of wildlife that use canals and drains as wetland habitat. These losses should be fully offset through integration of wetland mitigation plans (see the Basin Conservation Program[1]).

4.7 Threatened, Endangered, and Special Status Species

FWS and NMFS provided species lists to Reclamation, after which Reclamation prepared a biological evaluation (see appendix E) to address the listed species. The biological evaluation determined that the proposed Federal action, being programmatic in nature, would have "no effect" on threatened and endangered species or critical habitat. FWS issued a concurrence by memorandum, and NMFS has concurred verbally. All parties have agreed that impacts would be evaluated on a site-specific basis, and appropriate consultation and/or conferencing will be completed at that time.

4.8 Socioeconomics

For the No Action Alternative, liability for repairs to eroding shoreline property around Cle Elum Lake has yet to be determined. Community cohesion would remain unchanged from current conditions between nonterritorial and territorial communities.

For Alternative 1, changes in the Yakima River system operations, flows, and return flows would be similar to the No Action Alternative. Little, if any, social impact is anticipated. Specialized labor skills from outside reasonable commuting distance would not be needed for work at Cle Elum Lake. Increased traffic from both workers and construction equipment on the roads to the dam and around the reservoir would not exceed the limits of the roads. Any necessary shoreline repairs will most likely not cause significant noise or air pollution impacts. A small labor force would be needed to modify the Chandler Pumping Plant facilities. No adverse labor construction impacts associated with these modifications are projected.

The impacts on social well-being for Alternatives 2A, 2B, 2C, and 3 would be the same as those described for Alternative 1.

Assuming that water deliveries other than those attributable to purchase or lease are not affected, the alternatives would have little or no economic impacts on the regional economy. Wapatox Power Plant would show little or no change in output; Roza and Chandler would show a net change from about 4,000 to 7,500 megawatthour (MWh), worth about $50,000 to $90,000, depending on the price of electricity.

---

[1] This plan may be obtained by contacting the YRBWEP manager at the Upper Columbia Area Office, PO Box 1749, Yakima WA 98907-1749, (509) 575-5848.

Based on the historic hydrologic record, about 79 percent of the time, Alternative 1 would have had little or no impact. However, during years when riverflows need to be prorated, impacts from this alternative would be positive. Divisions most impacted include Kennewick, Roza, and Kittitas because they could receive more water deliveries during the prorated years. Because WIP would experience no changes in diversions, the Yakama Indian Nation would not experience any impacts, with the possible exception of the benefits of a restored fishery.

Changes attributable to Alternative 2A likely can be absorbed by increased efficiency of water delivery, such as lining canals and removing phreatophytes, or other changes. The Yakama Indian Nation would experience no impacts because the changes in diversions do not include the associated irrigation district. For Alternative 2B, diversions to the Yakama Indian Nation would not be affected, and no impacts would occur. Irrigation districts likely could not absorb a reduction of the level specified in Alternative 2C through only water conservation measures. No other divisions, including the Yakama Indian Nation, would be impacted.

For Alternative 3, as in Alternative 2A, it is assumed that this level of reduction in diversions can be absorbed through various efficiency gains and would lead to no change in agricultural production for these divisions. The divisions which would not have changes in diversions, including water deliveries to the Yakama Indian Nation, would not have impacts either.

Alternative 1 would impact power generation the least. Roza Power Plant would reduce generation by 1,700 MWh; Chandler would generate an increase of 6,600 MWh, producing a net increase of 4,900 MWh. At $12 per MWh, this change totals $58,000. The other alternatives would generate positive changes at both powerplants. Alternative 2A would generate an additional 5,800 MWh, equal to a value of $69,000. Alternative 2B would generate 5,800 MWh, worth $70,000. Alternative 2C would generate an additional 4,200 MWh, at a value of $58,000. Alternative 3 would create an additional 7,500 MWh, worth $90,000 on average.

The YRBWEP could aid recovery of salmon, which could positively impact recreational fishing. Improvements in the salmon population could increase recreational fishing days, which would benefit the economy. Part of the increase in recreational fishing days would occur on Yakama Indian Nation land. Impacts to commercial fishing may be minimal because of factors including depressed consumer retail price of salmon caused by salmon farming throughout the world.

4.9 Recreation

Changes in project operations could affect recreation patterns, timing, or opportunities afforded for particular activities if project operations were dramatically altered from April through September and if these changes affected access and facilities or substantively

altered the physical setting in terms of water elevation or flow rate. However, most recreation has historically occurred higher in the system (upper basin) and would probably not be measurably affected on a basin-wide scale.

Recreational use of reservoirs would only benefit from increased storage at Cle Elum Lake; however, operational changes would probably have a more measurable effect on patterns of use. The proposed changes in operational withdrawals would probably have no measurable effect on recreation activities.

Modification of the radial gates on Cle Elum Dam will result in a 3-foot rise in Cle Elum Lake. Facilities at Wish Poosh Campground will be relocated. On average, the reservoir elevation would be 2 to 4 feet higher than current conditions during the recreation season, depending on when the increased storage is used for instream flows. Higher summer elevations would have a minor overall positive effect on recreation at Cle Elum Lake because boat launch ramps would remain operable for a slightly longer period of time, mudflat exposure would be slightly reduced, and shoreline access to the campgrounds and picnic areas would remain at a convenient distance for a longer period of time (Reclamation, 1987).

Improved streamflows would, on a basin-wide scale, benefit flow-dependent and water-related recreation activities. Recreational fishing opportunities in the mainstem Yakima and Naches Rivers could be improved if resident fish populations increased.

Increased streamflows in tributaries for fish and wildlife could provide a benefit for passive recreation activities such as bird watching, nature study, walking, or photography. Water supply enhancement opportunities in other tributaries have not been identified but, in general, passive recreation benefits could accrue for these activities. Recreational fishing opportunities would also benefit from increased streamflows because more habitat would be created for resident fish.

Overall, the No Action Alternative and the action alternatives will have no measurable impact on recreation.

4.10 Cultural Resource Properties and Paleontological Resources

The No Action Alternative would cause no new impacts upon cultural resource properties, including traditional cultural properties (TCPs), or upon paleontological resources. Existing effects from ongoing uses and operations would continue.

The action alternatives could have an adverse effect upon historical, archeological, and traditional cultural properties. Many Yakima Project irrigation facilities are eligible for the *National Register of Historic Places*. Structural changes to the facilities could damage their historic integrity. Archeological or TCP resources could be damaged or destroyed by implementation activities. Raising Cle Elum Lake 3 feet will initiate bank erosion that is

highly likely to damage or destroy archeological sites and perhaps TCPs. Construction activities associated with facility modification, new facilities, habitat improvements, or other actions would damage or destroy sites or TCPs within the impact area.

Reclamation will implement inventory, evaluation, and mitigation activities consistent with the requirements of the National Historic Preservation Act and will consult with appropriate parties about site significance, project effect, and appropriate treatment consistent with 36 CFR 800. As part of the project-specific environmental evaluation, cultural property and TCP inventories will be completed to determine if such resources are present. The impacts of the potential effects of proposed implementation actions upon resource properties would be assessed. If properties were eligible for the *National Register of Historic Places*, then mitigation would occur through archeological excavations, Historic American Engineering Record documentation, or other appropriate means.

4.11 Sacred Sites

Possible impacts to sacred sites on Federal lands cannot be determined at a programmatic level for any of the action alternatives. Reclamation will consult with potentially affected Tribes during the planning phase of specific actions to determine if sacred sites exist and will be affected. If specific impacts are identified during the evaluations conducted for site-specific actions associated with Title XII implementation, Reclamation will consult with the affected Tribes on a government-to-government basis to avoid, minimize, or mitigate effects.

4.12 Indian Trust Assets

Indian Trust Asset conditions for the proposed actions would undergo little impact under Alternative 1. The effect on ITAs for Alternatives 2A, 2B, 2C, and 3 would be positive because of increased instream flows at critical periods of time in the river. Additional water in the Yakima River at critical periods would have a positive effect on chinook salmon runs. Secondarily, increased flows would have a positive effect on wildlife of the area. Impacts for Alternative 3 would be the same as those listed for Alternatives 2A, 2B, and 2C.

5.0 Cumulative Impacts

Any alternative that includes implementing the Basin Conservation Program could have a comparatively significant beneficial effect on aquatic resources from increased streamflows within the Yakima River Basin. However, analysis of the interrelationship of each specific action is beyond the scope of this programmatic environmental impact statement. The specific role played by each action may be masked when added to the cumulative effects of all the other activities affecting the Yakima River Basin. No significant impacts have been identified at the program level for any of the action alternatives. Minor (nonsignificant) effects or significant localized effects may contribute to cumulative effects.

Chapter 1

Purpose of and Need for Action

This chapter presents the purpose of and need for the project, project location, project history, relationship of other activities to the project, public scoping process, authorities and institutional constraints, and document scope and organization.

1.1 The Proposed Action

The proposed action addressed in this document is to implement Phase 2 of the Yakima River Basin Water Enhancement Project (YRBWEP) authorized by Title XII of the Act of October 31, 1994, Public Law (P.L.) 103-434.

1.1.1 Purpose and Need

The **purpose** of the **proposed action** is to meet the needs of the basin through improved water conservation and management and other appropriate means. A **need** exists in the Yakima River Basin to:

- Protect, mitigate, and enhance fish and wildlife
- Improve the reliability of the water supply for irrigation

This programmatic environmental impact statement (PEIS) evaluates the environmental impacts of implementing requirements of Title XII. The provisions and measures of Title XII form the parameters and methods for achieving improved instream flows and irrigation water supplies.

1.1.2 Project Location

The Yakima River, a tributary to the Columbia River, drains an area of about 6,150 square miles (figure 1-1) and originates high on the eastern slopes of the central Cascade Mountains east of Seattle. The Yakima River flows for about 200 miles southeast to its confluence with the Columbia River near Richland, Washington. The terrain in the upper basin is rugged, and altitudes range up to 8200 feet in the Cascade Range. The lower valley, located downstream from the city of Yakima, is much flatter, and altitudes reach only a few hundred feet. The Naches River, the primary tributary to the Yakima, enters

the mainstem of the Yakima River at the city of Yakima. Precipitation in the Yakima River Basin ranges from about 8 inches annually in the lower and eastern valley to over 100 inches annually in the Cascade Range.

The Yakima River and tributaries support many water-related uses: three hydropower projects, six Federal reservoirs, five major diversion dams, various irrigation canals and pumping plants, fish, wildlife, aquatic and riparian ecosystems, drinking water, and recreation.

The region is nationally known for its fruit production, especially apples, pears, peaches, grapes, and cherries, in addition to many other crops such as hops, mint, and asparagus. The Yakima River and its tributaries also supply drinking water to the cities of Yakima and Cle Elum.

1.2 Related Activities

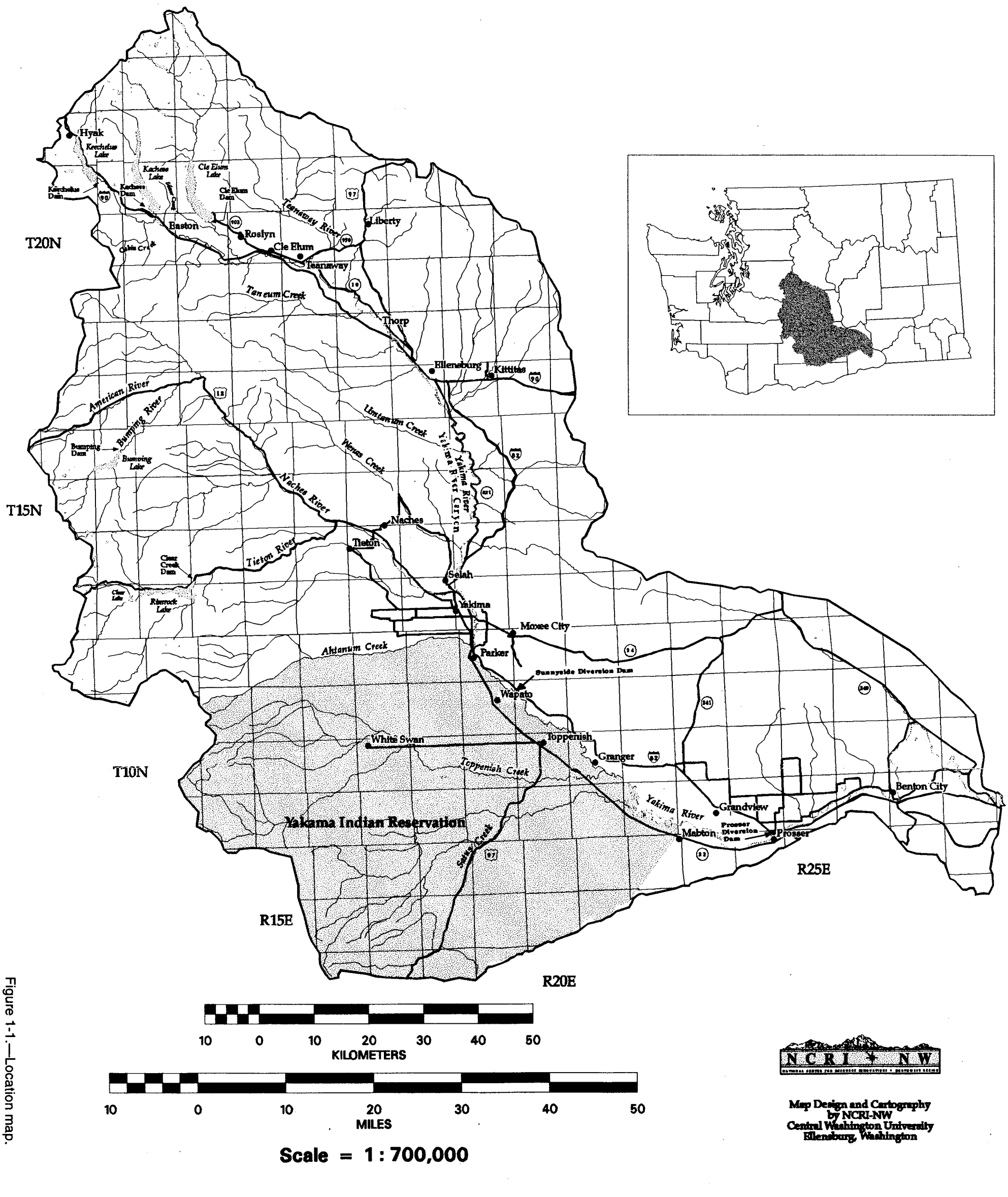
The Northwest Power Planning Council was directed by the Northwest Power Act of 1980 to develop a program to protect, mitigate, and enhance fish and wildlife on the Columbia River and its tributaries. The council's programs have included several activities within the Yakima River Basin, including the Yakima River Basin subplan of the Columbia River Fish Management Plan, the Yakima Fisheries Project, and the Yakima River Basin Fish Passage and Protective Facilities Program. Additional information on these programs is listed below.

1.2.1 Yakima River Basin Fish Passage/Protective Facilities

In the mid-1980s, the Bureau of Reclamation (Reclamation), the Bonneville Power Administration (BPA), the Yakama Indian Nation, the State of Washington, and local irrigation entities constructed fish ladders and screens pursuant to the Fish and Wildlife Program adopted by the Northwest Power Planning Council. Under Phase 1 of this program, improvements to existing fish passage facilities and installation of new fish ladders and screens at 16 of the largest existing diversion dams and canals were completed by fall 1989.

Under Phase 2 of the program, improvements are now being made to existing fish screens, and new screens are being installed at up to 66 sites. These sites include a few Federal facilities (Reclamation and Bureau of Indian Affairs [BIA]) but are primarily private canal companies or individually owned diversion structures.

Yakima River Basin Water Enhancement Project Base Map



Scale = 1 : 700,000

Map Design and Cartography
by NCRI-NW
Central Washington University
Ellensburg, Washington

Figure 1-1.—Location map.

1.2.2 Yakima Fisheries Project

The BPA is funding the Yakima Fisheries Project to undertake fishery research and restoration activities in the Yakima River Basin. These facilities are operated by the Yakama Indian Nation and managed jointly by the Yakama Indian Nation and the State of Washington. This effort will construct, operate, and maintain anadromous fish production facilities to facilitate research activities designed to increase knowledge of supplementation techniques. These techniques would be applied to rebuild naturally spawning anadromous fish stocks historically present in the Yakima River Basin.

The Yakima Fisheries Project is one part of a comprehensive effort to restore fisheries resources by the BPA, the Yakama Indian Nation, the State of Washington, and Reclamation.

1.2.3 Columbia River Fish Management Plan

Salmon harvest management in the river remains rooted in processes developed by the ongoing Federal court litigation *United States* v. *Oregon*. In the late 1980s, the Federal court approved the Columbia River Fish Management Plan, which addresses harvest allocation and production strategies.

The Columbia River Fish Management Plan currently directs fishery protection and enhancement efforts by rebuilding upper Columbia River chinook, sockeye, coho, and steelhead runs, while assuring an equitable sharing of harvestable fish between treaty and nontreaty fisheries.

Current activities sponsored by the Columbia River Fish Management Plan in the Yakima River Basin include programs for both fall chinook and coho salmon. The fall chinook program includes the production and release into the Yakima River of 1.7 million smolts from the Little White Salmon National Hatchery. Between 1983 and 1994, the smolts were transported and released directly into the Yakima River. The Yakama Indian Nation has developed acclimation facilities in the vicinity of Prosser Dam for final rearing and release of these fall chinook smolts. The coho program released 700,000 early-run coho into the Yakima River. This program is part of a larger effort to redistribute coho for release in upper Columbia tributaries rather than in the lower Columbia. Federal agencies, the State, and private entities have engaged in habitat improvement work throughout the Yakima River Basin.

1.2.4 Yakima River Operation

Since 1981, water releases have been made, by court order, from Reclamation's Yakima Project reservoirs in the fall, winter, and early spring to protect spring chinook in the Upper Yakima River. In June, July, and August, heavy releases are made from Yakima River reservoirs to meet downstream irrigation demands, and the Naches River (a Yakima

River tributary) reservoirs are operated to meet Naches system demand only. In September, storage releases from Yakima River reservoirs are reduced to meet only upper valley diversions and to keep river levels in the Yakima River at predetermined spawning flow levels. Concurrently, releases from Naches River reservoirs are increased to meet Naches system demands plus the lower Yakima system demands downstream from the Naches confluence. This river operation is commonly referred to as the "flip-flop" operation and is reviewed periodically by the System Operations Advisory Committee (SOAC).

SOAC is an advisory board to Reclamation consisting of fishery biologists representing the U.S. Fish and Wildlife Service (FWS), the Yakama Indian Nation, the Washington Department of Fish and Wildlife (WDFW), and irrigation entities represented by the Yakima Basin Joint Board (YBJB). Reclamation provides a fishery biologist as a liaison to SOAC.

Since 1981, SOAC has provided information, advice, and assistance to Reclamation on fish-related issues associated with the operations of the Yakima Project. Flows for maintaining fish life in the Yakima Basin are determined by the Reclamation Field Office Manager, according to the annual prevailing conditions, and in consultation with SOAC, irrigation district managers, and others.

1.2.5 Yakima River Water Conservation Demonstration Project

Phase 1, Amendment 1.3 of the Northwest Power Planning Council's Columbia River Basin Fish and Wildlife Program asks Reclamation to implement and evaluate tributary water conservation demonstration projects in Idaho, Oregon, and Washington. These projects will help determine the viability of providing additional instream flow and enhanced habitat to aid in the recovery of weak salmon and steelhead stocks. In Washington, improving flows by constructing low flow augmentation reservoir facilities is being examined for a demonstration project.

1.2.6 National Water Quality Assessment Program

The U.S. Geological Survey has selected the Yakima River Basin as part of its National Water Quality Assessment Program. The objectives of the program are to: (1) describe current water quality conditions for a large part of the United States' freshwater streams, rivers, and aquifers; (2) describe how water quality is changing over time; and (3) improve understanding of the primary natural and human factors that affect water quality conditions.

1.2.7 Yakima Valley Conference of Governments' Yakima River Basin Water Quality Plan

In August 1990, the Washington State Department of Ecology awarded a grant to the Yakima Valley Conference of Governments (YVCOG) to act as lead agency to develop a basin-wide water quality management plan for the Yakima River Basin. Plan components are watershed characterization and water quality assessment; problem identification; and goal, objective, and plan development. YVCOG published its "Yakima River Basin Water Quality Plan" in June 1995. The plan includes an action plan with specific recommendations and a proposed implementation strategy for use by the implementing agencies for protecting and improving water quality in the Yakima River Basin.

1.2.8 Water Rights Adjudication

Water supplies in the Pacific Northwest in 1977 were inadequate to meet the needs in many areas, including the Yakima River Basin. Motions were filed to reopen the judgment on the 1945 Consent Decree, which is described in Section 1.3.1 "Irrigation Development." However, the district court held that the 1945 Consent Decree was being correctly interpreted by Reclamation. At the same time, the Yakama Indian Nation filed an action in Federal District Court to determine the priority and quantity of the water rights of the Yakama Indian Nation under the Treaty of 1855. Later in the same year, the State of Washington filed in State court for a general adjudication of the Yakima River drainage basin. It was determined that treaty water claims should be addressed in the general adjudication. The Federal case was deferred to the State's case, and the prior filing by the Yakama Indian Nation did not proceed. The general adjudication by the State of Washington is ongoing.

1.2.9 Federal Agricultural Conservation Program

The Federal Agricultural Conservation Program has provided funds for irrigation system and irrigation water management improvements on agricultural land in the basin. The Natural Resources Conservation Service estimated that water conservation measures were being installed within the basin on an average of 12,300 acres per year from 1991 through 1994.

Congress has established the Environmental Quality Incentives Program to combine the functions of the Agricultural Conservation Program and other conservation cost-share programs. Funding for onfarm irrigation system improvements under the Agricultural Conservation Program was reduced significantly from 1994 to 1996.

1.2.10 Attaining Water Quality Standards in the Lower Yakima River

The Washington State Department of Ecology (WDOE) is responsible for a project to restore water quality in the lower Yakima River from the mouth of the Naches River downstream to the Columbia River (WDOE, 1995). The WDOE will use a total maximum daily load (TMDL) process to attain State water quality standards in this reach. Total maximum daily loads are estimates of the amount of specific pollutants that a water body can safely take up without threatening the beneficial uses. The TMDLs are used to set an enforceable limit on the amount of specific pollutants that can be discharged to protect water quality.

1.3 Project Background

In the Treaty of June 9, 1855, the Tribes and bands later to become the Yakama Indian Nation ceded 10.3 million acres to the United States and reserved a 1.4-million-acre homeland. In the Treaty of 1855, the Tribes of the Yakama Indian Nation retained the right to hunt, fish, and gather native foods and medicines off the Reservation.

Non-Indian missionaries first came to the Yakima Valley during 1848, which was the start of major changes in the area. Miners started arriving in 1854, leading to war and the construction of Fort Simcoe in the 1860s. Cattlemen were attracted by the abundance of bunch grass, wild game, and fertile bottom lands. The first irrigation ditch of record by non-Indians was constructed in 1864. Settlement started occurring in about 1866. Private canal companies formed along the river successfully irrigated a large area. Construction of the Northern Pacific Railway through the valley in 1886 gave greater impetus to irrigation development because of aggressive land marketing by the railway company and because of access to agricultural markets.

1.3.1 Irrigation Development

By 1902, about 121,000 acres were irrigated in the Yakima River Basin. This acreage was served by unregulated flows in the river and tributaries. Irrigation diversions exceeded the unregulated runoff during periods of low flow by the turn of the century.

Before additional irrigation developments could take place, reservoirs were needed to store early season natural runoff, which peaks in May and June. This water could subsequently be released and used during the dry summer months when natural runoff drops to its lowest point and irrigation demands are high.

A petition dated January 28, 1903, from citizens of Yakima County to the Secretary of the Interior (Secretary) requested United States involvement in irrigation. Investigations were initiated which led to the beginning of the construction of features of the Yakima Project by the Reclamation Service. The Yakima Project was authorized in 1905, and the Sunnyside

and Tieton Units were approved for construction in 1905. Early in 1906, investigation of storage sites was initiated, including Bumping Lake, McAllister Meadows (Tieton Reservoir), and Cle Elum, Kachess, and Keechelus Lakes (Reclamation, 1981).

Development of the Yakima Project progressed with the construction of Bumping Dam (1910), Kachess Dam (1912), Clear Creek Dam (1914), Keechelus Dam (1917), Tieton Dam (Rimrock Lake) (1925), and Cle Elum Dam (1933). These six Federal reservoirs have a total storage capacity of 1,070,000 acre-feet and provide the water supply necessary to help meet the irrigation needs by storing and regulating a portion of the flow of the Yakima River and its tributaries. Other principal features include several diversion dams, two hydroelectric generating plants, and numerous canals, laterals, and pumping plants.

During years of low runoff, disputes began over the use of water from the Yakima River. In 1945, the District Court of Eastern Washington issued a decree under Civil Action No. 21 called the 1945 Consent Decree. The 1945 Consent Decree is a legal document pertaining to water distribution and water rights in the basin. The 1945 Consent Decree established the rules under which Reclamation should operate the Yakima Project system to meet the water needs of the irrigation districts that predated the Yakima Project, as well as the rights of divisions formed in association with the Yakima Project. The 1945 Consent Decree determined water delivery entitlements for all major irrigation systems in the Yakima Basin except for lower reaches of the Yakima River near the confluence with the Columbia River. The decree states the quantities of water to which all water users are entitled (maximum monthly and annual diversion limits) and defines a method of prioritization to be placed into effect during water-deficient years. The water entitlements are divided into two classes—nonproratable and proratable. Nonproratable entitlements are held by those water users with the earliest filed water rights, and these entitlements are to be served first from the total water supply available (TWSA). All other water rights are proratable, which means they are of equal priority. Any shortages that may occur are shared equally by the proratable water users. The Government projects within the basin were basically constructed to manage water supplies to serve the proratable water users in the basin.

TWSA represents the combined quantity of unregulated flow, return flow, and stored water available for the period of April through September upstream from the Parker gauge at Sunnyside Diversion Dam on the Yakima River. Reclamation prepares forecasts of the total water supply available upstream from the Parker gauge beginning each March and continuing through the irrigation season. These forecasts are the basis for determining the adequacy of the TWSA to meet irrigation water entitlement stipulated in the 1945 Consent Decree and to assist in deciding the amount of prorationing, if any, that may be necessary. Any water supply deficiencies are first assessed against proratable entitlements and last against nonproratable entitlements, which has never happened. Instream flow requirements are met from TWSA prior to determining if prorationing is necessary.

Unregulated flows and return flows are generally adequate to meet irrigation diversions through June. From July through the end of the irrigation season, normally October 15, stored water is required to meet diversions. Storage releases have, however, begun as early as May in dry years and as late as August in wet years.

When the TWSA is not adequate to meet water entitlement, prorationing is necessary. Historically, the prorationing period has not started until the date of "storage control" (the date when stored water releases begin). The amount of prorationing is determined monthly by Reclamation in consultation with the water entities. Nonproratable entitlements can divert their full entitlement. This amount is deducted from the TWSA available for irrigation, and the remainder is available for proratable entitlements.

Under present operating procedures, a "water bucket" is determined for each entity. This "water bucket" represents the total amount of water available to the entity for the proration period.[1] The water supply in the entity's "water bucket" changes monthly as the result of changes in TWSA forecasts and the amount of water already diverted by the entity.

In any month, each entity can divert the amount of water in its "water bucket" up to its entitlement for that month. This procedure allows the entity to determine how it wants to use its "water bucket" supply. It may reduce its monthly diversions so there may be more water throughout the proration period or may use a greater amount, taking the risk of having to reduce diversions later in the proration period. In the case of an entity with only proratable entitlements, larger diversions early in the proration period could result in significant curtailment of diversions later in the season.

Prorationing has been imposed in 8 years between 1970 and 1996. In the most recent dry years, proratable water users received 58 percent of their proratable entitlement in 1992, 67 percent in 1993, and 37 percent in 1994.

A description of TWSA forecast computations appears in Appendix A "Surface Water Hydrology."

The Yakama Indian Reservation encompasses an area of about 1,400,000 acres, about 800,000 acres of which are located within the Yakima River Basin. Development of the Wapato Irrigation Project, which is operated by BIA, began just prior to the Spanish American War. About 142,000 acres of land on the Yakama Indian Reservation are irrigated through facilities of the Wapato Irrigation Project. The primary water supply is diverted from the Yakima River at the Wapato Diversion Dam. Water savings resulting from irrigation system improvements are available for use by the Yakama Indian Nation for irrigation and other purposes on the Reservation as well as for fish and wildlife in the Yakima River Basin.

[1] The period of proration extends from the date it is determined that proration must first occur through September.

1.3.2 Fish and Wildlife Resources

Prior to the early 1800s, hundreds of thousands of adult salmon and steelhead trout returned to the Yakima River system each year (McIntosh et al., 1994). By 1920, construction of impassable storage dams, unscreened irrigation diversions, logging and mining activities, fishing, low flows, flow regulation, water quality degradation, stream channelization, an intensive commercial fishery in the Columbia River downstream from the Yakima River, and other factors reduced the numbers of Yakima River salmon and steelhead to a total spawning population of about 11,000 fish (Reclamation, 1990).

A fishery rehabilitation program was initiated in the Yakima River Basin beginning in the 1930s by the Bureau of Commercial Fisheries. Fish ladders and screens were installed at many diversion dams under a cooperative effort of the Washington Department of Fish and Game and the FWS. By 1960, salmon and steelhead spawning populations had increased to about 19,000 fish. However, a combination of construction of dams on the Columbia River, overharvest of some fish stocks, inadequate fish ladders and screens, and other factors led to further declines. The Yakima River Basin anadromous fish runs fell to a low of 2,000 adults (total for all species spawning above Prosser Diversion Dam) in 1981.

Providing adequate streamflows in various river reaches at specific times of the year is critical to the successful rehabilitation of the Yakima River salmon and steelhead runs. Adequate flows are needed for adult migration upstream, spawning, embryo development, rearing and overwintering of juveniles, downstream migration of smolts, and food web maintenance.

The Yakima River Basin contains a broad spectrum of wildlife habitats, from coniferous forests in the upper basin to shrub-steppe and irrigated agricultural habitats in the middle and lower basins. Examples of species found in coniferous forests include elk, bear, cougar, and nongame birds. Some species found in shrub-steppe habitats include deer, coyotes, rabbits, and a variety of small reptiles. Irrigated agricultural valleys provide habitat for a variety of wildlife, including pheasants, quail, long-billed curlews, hawks, and mink. Canals and drains provide wetland habitat for species such as muskrats, river otters, waterfowl, raccoons, great blue herons, and small shorebirds. Most wildlife in the Yakima River Basin use riparian habitat along perennial streams or canals and drains at some point each year.

1.3.3 Development of the Yakima River Basin Water Enhancement Project and Title XII

Initial Authorization and Objectives of YRBWEP

The YRBWEP was initially authorized by Congress by the Act of December 28, 1979 (P.L. 96-162). The act authorized the Secretary to undertake a feasibility level study of the proposed YRBWEP. As previously noted, drought conditions that were prevalent

throughout the Western United States at that time focused attention on the need for additional efforts to expand and assure adequate water supplies in the Yakima River Basin.

Preliminary work on the feasibility study began in 1980. The YRBWEP study initially had two phases: Phase 1, preliminary identification of water needs, available resources, and potential plan elements which could meet the needs; and Phase 2, detailed studies of more promising plan elements, the formulation and evaluation of alternative plans, and the identification of a preferred plan for consideration.

Phase 1 of the Study

The Phase 1 report issued in August 1982 recommended early implementation of a fish passage and protective facilities program. The report concluded that:

- Irrigation water shortages must be reduced to acceptable levels.
- Improved streamflows are needed to preserve and enhance anadromous fish runs.
- The opportunity exists for new irrigation development on the reservation.
- Existing Yakima Project storage facilities and operational flexibility cannot meet the needs.
- Water conservation shows promise for meeting a portion of the water needs in the basin, provided that adequate regulation of the "saved" water can be achieved.
- Additional storage facilities are needed.
- Good water storage sites exist in the basin.
- A plan appeared to be economically justified.
- Phase 2 should be initiated.

Phase 2 of the Study

This phase began in late 1982 and was to consist of further refinement of needs and resources, formulation of alternative plans, detailed evaluation of the selected plan, and preparation of a planning report/environmental statement. Primary study activities included:

- East Selah Regulating Reservoir
- Fish passage and protective facilities
- A preliminary assessment of waterbanking

- Irrigation water supply
- Re-evaluation of potential storage sites
- Water conservation measures
- Instream flows for anadromous and resident fish

The Phase 2 Status Report (Reclamation, 1985) provided information on work activities and possible alternative plans and indicated issues that needed to be mutually addressed to implement an acceptable plan. Following receipt of public input, suggestions were made that the study be terminated until completion of the adjudication and until the Yakama Indian Nation's water claims were fully defined. It was decided that failure to resolve the water problems would not be prudent, and the study team was directed to proceed with plan formulation. In January 1986, the study team recommended detailed analysis and evaluation of four alternative plans.

Early Implementation Program

Interest in seeking expedited congressional action for authorization of elements that would be part of an overall YRBWEP became the focus of the study in late 1985. Consequently, additional work on the detailed analysis and evaluation of the four alternative plans was placed on hold.

In 1987, a "Policy Group" was formed to oversee the YRBWEP with respect to plan proposals, guidance on policy matters, and public involvement activities. Through this activity, the decision was made to pursue several legislative proposals, including early implementation legislation and comprehensive legislation.

Comprehensive Legislation

Comprehensive legislation dated September 2, 1988, stipulated the quantity of water to be available to the Yakama Indian Reservation, to off-reservation irrigation entities, and to instream flows. However, extensive efforts to reach an amenable solution failed, and comprehensive legislation was abandoned.

Enhancement Roundtable Group

During December 1988 and January 1989, legislators and basin interest groups met to develop a core group representing the various parties and discuss proceeding with a Phase 2 program emphasizing water conservation. The Enhancement Roundtable Group was formed as a result of this effort. An Enhancement Technical Activities Group (TAG) consisting of representatives from the irrigators, the Yakama Indian Nation, the State, BPA, and Reclamation was formed to guide and oversee work activities. Subsequent meetings of the Enhancement Roundtable Group considered draft Federal legislation to authorize a "pilot" water conservation program to assist in determining the amount of the

basin's water needs that could be met through water conservation and the amount and location of additional storage capacity that might subsequently be required as part of a comprehensive enhancement program.

On May 2, 1990, the TAG transmitted draft legislation for Phase 2 to legislators with the recommendation that they proceed with its review by legislative counsel and then submit it to the Enhancement Roundtable Group with a request that a decision be made regarding future action in seeking authorization. The TAG further recommended that the major focus of the YRBWEP at that time should be water conservation, providing a mechanism for developing, evaluating, and implementing entity specific water conservation measures and their integration into a basin-wide conservation program. Consequently, TAG recommended deferral of further activities related to additional storage, except those possibilities that could augment existing stored waters such as identified with the conveyance of Cabin Creek and Silver Creek flows for storage in the existing Kachess Lake.

Partial Summary Judgment

Some irrigators voiced concerns with the Phase 2 legislation in view of the motion for partial summary judgment filed by several irrigation districts. A significant order of the Superior Court entered on July 17, 1990, in response to this motion for partial summary judgment regarding the rights of the Yakama Indian Nation, determined that: (1) the treaty water rights to water delivered from the Yakima River for irrigation have been fulfilled and limited by prior actions at the current level and (2) the treaty water rights to maintain instream flows have been diminished and limited by the United States for developing irrigation, and the Yakama Indian Nation has been compensated for that diminution by virtue of a settlement in 1968. The maximum scope of the diminished treaty water right for fish remaining is the specific "minimum instream flow" necessary to maintain anadromous fish life in the Yakima River and carried a priority date of "time immemorial." This order also stated Reclamation was interpreting the 1945 Consent Decree correctly as the decree related to determining the TWSA and allocating water thereunder. The Amended Partial Summary Judgment Entered as Final Judgment Pursuant to Civil Rule 54(b) was signed by Judge Walter A. Stauffacher and entered into court on November 29, 1990 (State Superior Court of Yakima County, in re: *Washington State Department of Ecology* v. *James J. Acquavella, et al.*, Case No. 77-2-01484-5). The Amended Partial Summary Judgment was affirmed upon review by the Washington State Supreme Court on April 22, 1993 (*Affirmed Ecology* v. *Yakama Reservation Irrigation District,* 121 Wn. 2d 257, 850 P. 2d 1306 [1993]).

Since the partial summary judgment ruling, the following have also been ruled:

- No distinction exists between natural flow and storage for the purposes of providing water for the Yakama Indian Nation's treaty-reserved water right for fish.

- No Yakama Indian Nation surface water right in the Yakima River Basin is subject to State law or oversight.

- The Yakama Indian Nation enjoys a federally reserved, treaty-based right to an undiminished instream flow for Satus, Simcoe, and Toppenish Creeks to support fish and other aquatic life.

- The Yakima Field Office Manager shall be responsible for providing minimum instream flows to maintain all life stages of anadromous fish in the Yakima River Basin.

- The Yakama Indian Nation's minimum instream flow right for fish in those tributaries that presently and actually support anadromous fish availability at the "usual and accustomed" fishing stations shall be determined in accordance with the annual prevailing conditions as they occur. The rights have been extended to cover flows for resident fish.

- The Yakama Indian Nation's treaty-based water right allows the Yakima Field Office Manager to release stored water for flushing flows when they are absolutely necessary to maintain fish life in the Yakima River Basin.

- The Yakima Field Office Manager, in consultation with SOAC, irrigation districts, company managers, and others, shall have the authority to determine and administer the minimum amount of instream flow that is absolutely necessary to maintain fish in the Yakima River Basin.

- The water rights of the Yakama Indian Nation are affirmed and described by the Conditional Final Order, filed with the Adjudication Court on September 12, 1996. The Conditional Final Order incorporates the water right set forth in the Partial Summary Judgment, dated November 29, 1990; the water rights established in the Final Order re: Treaty Reserved Water Rights At Usual and Accustomed Fishing Places, dated March 1, 1995; and sets forth all of the remaining water rights of the Yakama Indian Nation.

Renewed interest was generated in proceeding with the Phase 2 legislative concept following the summary judgment. Draft legislation was introduced in late July 1991. By resolution dated April 8, 1992, the Tribal Council indicated its support for the bill as modified by Tribal comments. The bill was passed by Congress as Title XII of the Act of October 31, 1994, P.L. 103-434.

1.4 Scoping

The scoping process for Title XII was initiated shortly after the law was passed on October 31, 1994, to ask for input on issues and concerns consistent with National Environmental Policy Act (NEPA) requirements and implementing regulations. Efforts were made to notify all potentially interested parties about the YRBWEP scoping process and opportunities to provide comment.

A notice of intent to hold scoping meetings was published in the *Federal Register* on April 29, 1996. Legal notices announcing the time and location of scoping meetings and the scoping process were placed in several of the river basin newspapers. Also, an informational letter announcing the scoping meetings was sent to those individuals or entities on the project mailing list. Three meetings were held.

A more detailed description of the scoping process can be found in Chapter 5 "Consultation and Coordination."

1.5 Environmental Justice

On February 11, 1994, the President issued Executive Order 12898 on Environmental Justice in Minority Populations and Low-Income Populations. The PEIS did not find significant basin-wide impacts to minority and low income populations, including the Yakama Indian Nation. Site-specific NEPA compliance activities will determine if any actions might impact these populations.

1.6 Authorities and Institutional Constraints

On December 12, 1905, the Secretary authorized Reclamation to construct facilities to provide irrigation water to the initial divisions of the Yakima Project. Additional divisions of the Yakima Project were approved in 1911, 1935, and 1948.

In 1979, Congress authorized the YRBWEP study to address the needs within the basin (P.L. 96-162). Construction of fish passage ladders and protective screen facilities began in 1982 under the auspices of the Northwest Power Planning Council pursuant to the Northwest Power Act of 1980. Construction of fish ladders and screens was incorporated as Phase 1 of the YRBWEP in 1984. Phase 2 of the YRBWEP was authorized under Title XII of the Act of October 31, 1994, P.L. 103-434. Title XII centers on a voluntary cost-shared Yakima River Basin Water Conservation Program (Basin Conservation Program) to reduce demands on available water supply. In addition, other measures for modifying project facilities are authorized.

Title XII authorizes Phase 2 of the YRBWEP to protect, mitigate, and enhance fish and wildlife and to improve the reliability of the water supply for irrigation through improved water conservation and management and other appropriate means. The provisions and measures of Title XII form the parameters and methods for achieving improved instream flows and irrigation water supplies.

Other authorities under which this draft PEIS was prepared are:

- National Environmental Policy Act of 1969
- Regulations of the Council on Environmental Quality
- Fish and Wildlife Coordination Act
- Endangered Species Act
- National Historic Preservation Act
- Executive Order 12898 on Environmental Justice in Minority Populations and Low-Income Populations
- Executive Order 13007 on Indian Sacred Sites
- Executive Orders 11988 on Floodplain Management and 11990 on Protection of Wetlands

1.7 Document Scope and Organization

An environmental impact statement (EIS) that addresses a proposal to implement a specific policy, to adopt a plan for a group of related actions, or to implement a specific statutory program is referred to as a PEIS. This PEIS provides the "umbrella" environmental documentation for implementing Title XII.

Specific measures that will be implemented under the Basin Conservation Program depend upon the results of the water conservation plans, feasibility investigations of measures selected for consideration, and program criteria developed by the Conservation Advisory Group for consideration by the Secretary and the State. Therefore, the PEIS as it relates to the Basin Conservation Program cannot be specific on what will be implemented, where it will be implemented, diversion reductions, and site-specific environmental impacts of implementation. These aspects will have to be considered in separate NEPA compliance documents as water conservation measures are implemented over a period of years. The PEIS will address these facets as specifically as possible, using information on potential water conservation measures from existing studies and plans.

The coverage of general matters in a broad NEPA document such as this PEIS with subsequent narrowly focused documents is referred to as "tiering." Tiering will help to eliminate repetitive discussions and allow the site-specific documents to focus on specific issues. The anticipated tiering process for this document appears in figure 1-2.

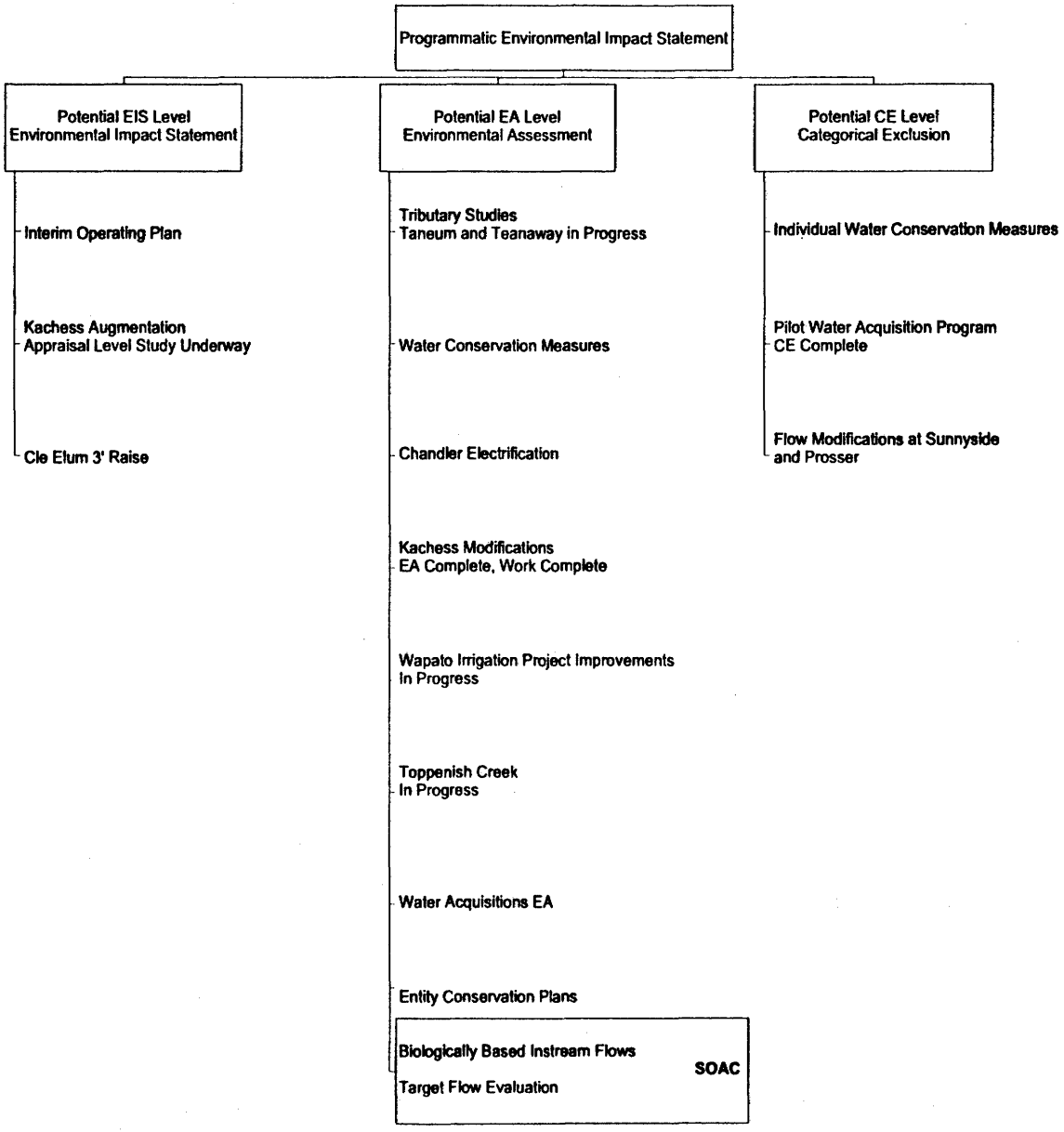


Figure 1-2.—Yakima River Basin Water Enhancement Project environmental compliance.

For NEPA compliance, subsequent tiering from this document will occur for specific follow-on actions as appropriate. However, site-specific environmental impacts on individual actions dictated by Title XII will, to the extent possible, be identified and evaluated in the PEIS to minimize subsequent NEPA compliance requirements. In general, the PEIS will be qualitative, discussing potential impacts of proposed actions. The PEIS will be structured to define and evaluate the environmental aspects of the measures authorized in Title XII. Because the emphasis of Title XII is on water conservation, alternative measures such as construction of additional storage facilities or changes in water entitlements and rights not specifically authorized by Title XII will not be considered in this PEIS.

A cumulative impacts section in this PEIS will discuss reasonably foreseeable effects at the area-wide or overall level to the extent that they are known. When a future site-specific NEPA document is prepared, the overall implications would be incorporated by referencing this PEIS. The site-specific documents tiering from the PEIS for implementing location-specific actions, such as a water supply enhancement project along a tributary, will include a cumulative impact section with a more narrow scope.

Any such required environmental documentation could incorporate the findings of this PEIS by reference and would include a more specific discussion of cumulative impacts.

This PEIS follows a commonly used format.

Chapter 1 includes the purpose and need for the proposed Federal action, location and setting, background of events leading to the proposed action, administrative actions, and a scoping summary.

Chapter 2 describes the process used to formulate alternatives, the range of alternatives, alternatives eliminated from detailed study, alternatives considered in detail, and a summary comparison of alternatives.

Chapter 3 describes the environmental and other resources of the area that would be affected by the implementation of the alternatives.

Chapter 4 describes and analyzes the environmental impacts of each alternative considered in detail.

Chapter 5 describes the scoping process and consultation with other agencies.

Comments on the draft PEIS and Reclamation's responses are included as part of this final PEIS.

A list of preparers, glossary, distribution list, and bibliography also are included as part of the document. Separate appendices contain sections on surface water hydrology, fish, socioeconomics, environmental commitments, and fish and wildlife consultation. The full text of Title XII is also included as an appendix.

Chapter 2

Alternatives Including No Action

This chapter begins with an overview of the components of Title XII because each alternative includes these components in some manner. Presenting the information in this order will allow a more thorough understanding of each alternative. The No Action Alternative and five action alternatives are then discussed. Alternative 2A is the preferred and environmentally preferred alternative.

2.1 Overview of Title XII Provisions

Title XII sets limits, or "side boards," on measures to be implemented or considered. Consequently, this programmatic environmental impact statement (PEIS) defines and evaluates environmental aspects according to measures authorized in Title XII.
Title XII emphasizes water conservation. Therefore, those who have current entitlements and rights will not be forced to give them up; water rights will change only through willing seller acquisitions or leases.

The provisions of Title XII have been arranged into the following three major areas (see figure 2-1).

- Basin Conservation Program
- Project operations and facilities modifications
- Yakama Indian Nation

2.1.1 Basin Conservation Program

The Basin Conservation Program (referred to in Title XII as the Yakima River Basin Water Conservation Program) will be administered by the Secretary of the Interior (Secretary), through the Bureau of Reclamation (Reclamation), in consultation with the State of Washington, the Yakama Indian Nation, Yakima River Basin irrigators, and other interested parties. The purpose of the program is to evaluate and implement water conservation measures to improve the availability of water supplies for irrigation and to

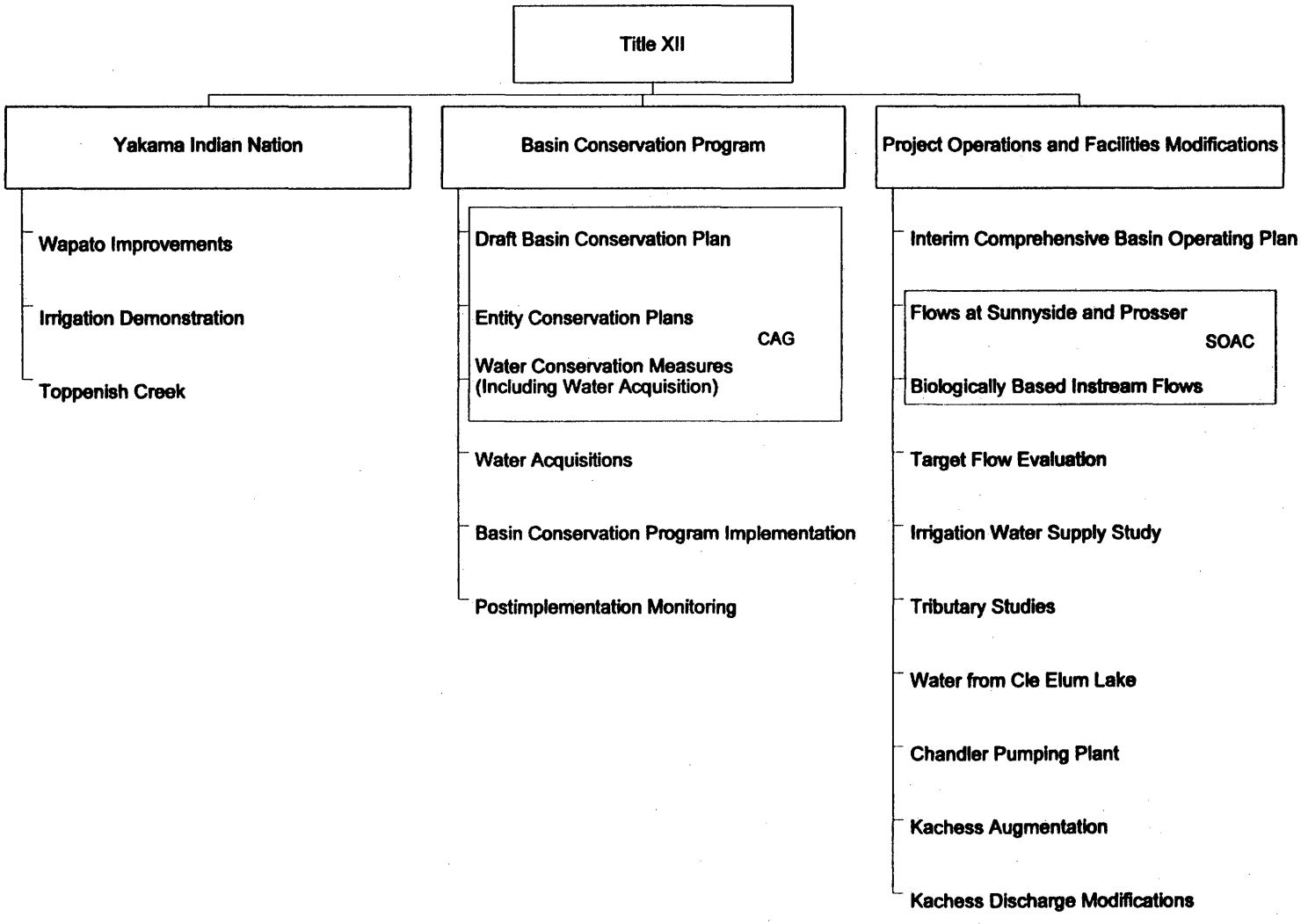


Figure 2-1.—Yakima River Basin Water Enhancement Project program elements.

protect and enhance fish and wildlife resources, including wetlands, while improving water quality in the Yakima River Basin. Specific goals are to realize sufficient water savings from the Basin Conservation Program to achieve: (1) by the end of the fourth year, not less than 40,000 acre-feet of water savings annually; and (2) by the end of the eighth year, not less than 110,000 acre-feet of water savings annually to protect and enhance fish and wildlife resources and 55,000 acre-feet annually for availability for irrigation.

Participation in the Basin Conservation Program is voluntary. The Secretary may make grants to eligible entities for the purposes of carrying out the provisions of Title XII under certain terms and conditions. The terms and conditions include a requirement that all water districts, irrigation districts, individuals, or other entities eligible to participate in the Yakima River Basin Water Enhancement Project (YRBWEP) must equip all surface water delivery systems within their boundaries with volumetric watermeters or equally effective water measuring methods by October 31, 1999.

The Basin Conservation Program consists of four phases:

- Development of water conservation plans that are consistent with applicable water conservation guidelines of the Secretary
- Investigation of the feasibility of specific potential water conservation measures identified in the conservation plans
- Implementation of measures that have been identified and determined to be feasible
- Monitoring and evaluation of implemented measures

Conservation Advisory Group

As required by Title XII, a Conservation Advisory Group (CAG) was approved by the Secretary on July 13, 1995, and members were appointed on October 30, 1995. The CAG is comprised of six members: two representing Yakima River Basin irrigators (one for nonproratable irrigators and one for proratable irrigators) and one each from the Yakama Indian Nation, environmental interests, the Washington State University Agricultural Extension Service, and the Washington Department of Fish and Wildlife. In addition, a facilitator and a designated Federal official have been appointed. The CAG is nonvoting, seeks consensus whenever possible with an option of a minority report to the Secretary, and will terminate 5 years after the date of its establishment unless extended by the Secretary.

The CAG is to provide recommendations to the Secretary and the State of Washington regarding how to accomplish the following actions:

- Structure and implement the Basin Conservation Program
- Establish a permanent program for measuring and reporting all estimated unregulated flow (measured flow corrected for storage, estimated diversions, and estimated return flows) and contract diversions within the basin
- Structure a process to prepare the Basin Conservation Plan
- Provide annual reviews of the implementation of the applicable water conservation guidelines
- Provide recommendations consistent with statutes of the State of Washington on rules, regulations, and administration of a process to facilitate the voluntary sale or lease of water

Costs incurred for implementation of water conservation measures under the Basin Conservation Program are based upon a cost-sharing formula as shown in table 2-1. State funding is only available to an applicant meeting the definition of "public body" contained in Revised Code of Washington 43.99E.030. Public body means the State of Washington or any agency, political subdivision, taxing district, or municipal or public corporation thereof, an agency of the Federal Government, and those Indian Tribes that may constitutionally receive grants or loans from the State of Washington. Federal funds and half of the non-Federal funds (the State's portion) are nonreimbursable grants. Costs of the Basin Conservation Program related to projects on the Yakama Indian Reservation are completely a Federal responsibility. Basin Conservation Program funds may also be used throughout all four phases of the Basin Conservation Program to mitigate for adverse impacts of program measures.

Table 2-1.—Funding of the phases of the Basin Conservation Program

Program phase	Non-Federal		Federal grant
	State grant	Local	
1. Development of water conservation plans	50%, but not more than $200,000 per recipient	(Residual amount if any)	50%
2. Investigation of specific water conservation measures	50%, but sum of items 1 and 2 not greater than $200,000 per recipient	20% after deducting State funds for item 2	Residual amount after deducting State and local funds for item 2
3. and 4. Implementation and postimplementation monitoring and evaluation	17.5%	17.5%	65.0%

To participate in the Basin Conservation Program, an entity must submit a proposed water conservation plan to the Secretary for approval. Plans that meet the water conservation guidelines of the Secretary may be approved.

Basin Conservation Plan

Title XII defines the Basin Conservation Plan as "a plan for implementing water conservation measures found in various water conservation plans developed under the Basin Conservation Program." These water conservation plans have been or will be prepared by water entities desiring to participate in the Basin Conservation Program.

The CAG views the plan as an outline of plan objectives, problems, needs, water conservation solutions, guidelines, processes, and procedures to make the program functional. The plan will be used in the development of the interim comprehensive basin operating plan, provided for in section 1210 of Title XII, describing the general framework within which the Yakima Project is operated.

The objectives of the plan are to:

- Meet the purposes of Title XII through implementing the program: (1) to protect, mitigate, and enhance fish and wildlife through improved water management; improved streamflows; improved water quality; protection, creation, and enhancement of wetlands; and other appropriate habitat improvements; and (2) to improve water supply reliability for irrigation.

- Realize sufficient results from the program to achieve water savings of not less than 40,000 acre-feet annually by the end of the fourth year and 165,000 acre-feet annually by the end of the eighth year. Of this amount, 110,000 acre-feet is to protect and enhance fish and wildlife resources, and 55,000 acre-feet is to improve the reliability of water supplies for irrigation.

- Assist in meeting State, Tribal, and local water resource policies and goals for the protection and enhancement of the economic, cultural, and environmental resources of the Yakima River Basin.

- Provide a framework for plan components and establish processes and procedures to plan, implement, and evaluate a range of water conservation measures within the Yakima River Basin to determine what can be done, how it can be done, where it should be done, and the effects of the measures.

A major focus of the plan is implementation of structural and nonstructural water conservation measures by entities and individuals who receive their water supply as part of the total water supply available (TWSA). The plan focuses primarily on those who divert

from the mainstem Yakima River and its major tributaries, the Naches and Tieton Rivers. Enhancement of water supplies in other tributaries is included in section 1207 of Title XII, and the plan is also applicable to those tributaries.

One of the main parts of the Basin Conservation Program is the stated assumption that the amount of water needed by agricultural crops in the basin will not be reduced or diminished in implementing this program. Crop consumptive needs are fixed for the irrigated acres; accordingly, efforts to identify water saving opportunities will focus on reducing transmission and application losses. Alternatively, reduced diversions could also be made by acquisitions or leasing of water rights and the conversion of associated lands from irrigated agriculture to alternate land uses.

The CAG released the Basin Conservation Plan August 12, 1997, and extended the 60-day comment period through October 31, 1997. The plan was revised and submitted to the Secretary through Reclamation's Commissioner for publication. The plan provides the basis for: (1) prioritizing and allocating funds to implement conservation measures under Title XII and (2) preparing an interim comprehensive basin operating plan. The plan presented, among other items, subarea problems and needs with associated potential solutions. This PEIS refers to the plan for site-specific solutions by basin subarea.

Implementation Measures.—Measures considered for implementation may include, among others:

- Conveyance and distribution system monitoring
- Automation of water conveyance systems, water measuring or metering devices and equipment (measurement of deliveries at delivery points is required for participation in the Basin Conservation Program)
- Lining and piping of water conveyance and distribution systems
- On-district storage
- Electrification of hydraulic turbines, tailwater recycling
- Consolidation of irrigation systems, irrigation scheduling
- Improvement of onfarm water application systems
- Eliminating and controlling weedy vegetation along conveyance and distribution systems

In addition to implementing existing technologies, Title XII encourages testing innovative measures such as water and water right transfers, waterbanking, dry year options, selling and leasing water, and other innovative allocation tools that will maximize the utility of

existing Yakima River Basin water supplies. Water acquired from voluntary sellers and lessors shall be administered as a block of water separate from the total water supply available for the Yakima Project in accordance with applicable Federal and State law.

In general, the solutions consist of structural and nonstructural water conservation activities and water acquisitions. The following summarizes the type of structural improvements to delivery systems considered for implementation in the basin under Title XII:

- Construct new concrete check structures fitted with automated radial gates to maintain a constant water surface elevation for deliveries into delivery systems and individual farm turnouts
- Reduce operational waste and spills through equalizing or regulating reservoirs
- Construct drain ponds with pump-back systems for tailwater reuse
- Construct closed pipe systems to replace canals and laterals, resulting in less seepage and evapotranspiration loss
- Repair or install water measurement structures and devices
- Construct new canal linings or repair existing canal linings where needed
- Rebuild/construct new stream/canal crossings by inverted siphon piping
- Consolidate irrigation systems
- Consider pump-back systems for tailwater recovery and reuse

The following summarizes nonstructural water conservation measures that could be implemented under Title XII to improve water delivery and water use efficiencies in the basin:

- Improve operating procedures (i.e., better water control by ditch riders)
- Improve water measurement and accounting
- Improve canal cleaning and maintenance program
- Clean canals of sediment deposits and other impediments to improve waterflow characteristics
- Promote awareness and concern for water quality and salt buildup in tailwater based upon water quality monitoring

- Institute moss removal programs and canal bank weed burning in conjunction with mechanical removal of vegetation with followup chemical control
- Improve technical capabilities of water district personnel
- Improve onfield irrigation water management and onfarm irrigation scheduling
- Implement tiered water pricing
- Encourage educational programs to inform water users about efficient water use and water management

These nonstructural improvements would reduce water diversions from the river system but would still meet the agricultural crop water needs under each diversion system and improve water quality.

Return Flows.—The impacts of water conservation measures are meant to reduce system losses and subsequently return flows; therefore, the hydrologic return flow characteristics within the Yakima River Basin must be fully understood. A reduction in water diversions at one point in the river system does not automatically increase flows at all points downstream by a similar amount as return flows from irrigation enter at different point downstream. Implementing water conservation measures will improve streamflows by the full amount of the reduced diversion in the reach of the river from the point of the diversion to the point that return flows enter the river. However, farther downstream, the amount of the streamflow improvement would be less because the reduction in water diversions would reduce return flows.

Reducing diversions from the Yakima River and its tributaries is necessary to achieve the desired results of the Basin Conservation Program. Most of the water used for onfarm irrigation is delivered by irrigation districts, companies, etc.; therefore, the reduced diversion needs to be accomplished by the irrigation water purveyor. The Basin Conservation Program funds for onfarm water conservation measures can be included as a part of an entity's water conservation plan if a diversion reduction will result from such implementation (Yakima River Basin Conservation Advisory Group, 1997).

Irrigation Efficiency.—Structural improvements to achieve onfarm conservation would generally consist of alternate forms of irrigation to reduce water losses through increases in irrigation efficiencies. Irrigation efficiency refers to crop water use relative to amount of water delivered to the crop. This comparison assumes that the crop consumptive use and leaching requirements are met. The following list summarizes expected irrigation efficiencies by water application method, assuming proper irrigation management techniques:

Method	Efficiency (%)
Flood irrigation	50
Border irrigation	70 to 75
Furrow irrigation	60 to 65
Subirrigation	65 to 70
Sprinkler irrigation	60 to 75
Drip systems	>90

Flood irrigation.—A method of irrigation where water is applied from field ditches onto land which has no guide preparation such as furrows, borders, or corrugations.

Border irrigation.—A method of flood irrigation where the field is divided into parallel rectangular strips separated by small earth dikes, and water introduced into the upper end flows across the field in a sheet between the border dikes.

Furrow irrigation.—Another method of flood irrigation where water channels (furrows) are cut in the soil between rows of crops during planting and cultivating.

Subirrigation.—A method most often used on land with a high water table and where subsurface drainage is needed to remove groundwater and provide soil aeration. The soil is aerated by lowering the high water table, thereby removing the ground-water below the crop rooting depth. Water conveyance and removal may be provided by:

- Open ditches with water elevation control structures
- Combination open ditches and subsurface drains and control structures
- Buried pipelines, subsurface drains, and water control structures

Sprinkler irrigation.—A method of irrigation in which the water is sprayed or sprinkled through the air to the ground surface.

Drip systems.—This method involves the slow application of water directly onto or into the soil at specific points, usually as drops, tiny streams, or miniature spray through emitters or applicators placed along a water delivery line.

Water Acquisitions.—Acquiring water by leasing or outright purchase of water rights is a stated option in the Basin Conservation Program and is based upon the concept of the "willing seller." These water transfers can make the water supply more "flexible" and can contribute significantly to satisfying both agricultural and anadromous fish needs. Through the acquisition of water rights or through leasing of irrigation water, additional "new" water not diverted would be available for streamflow augmentation. The quantity of additional water available in the basin for streamflow augmentation would be the quantity of consumptive use water *not* used by *not* producing crops on the land involved.

2.1.2 Project Operations and Facilities Modifications

The Basin Conservation Program is intended to reduce water diversions, allowing changes in the present operation of the Yakima Project to improve streamflow conditions in the Yakima River Basin at various facilities and the reliability of the water supply available for irrigation. The following are specific measures regarding the operations and modifications of facilities.

Project Operation Changes and Use of Conserved Water

Enactment of Title XII resulted in implementing an operational regime using estimates of the total water supply available to determine target instream flows (over Sunnyside and Prosser Diversion Dams).

The instream target flows in table 2-2 will be increased by 50 cubic feet per second (ft^3/s) for each 27,000 acre-feet of reduced annual water diversion achieved through implementing Basin Conservation Program measures. The Title XII goal is 165,000 acre-feet. Obtaining the entire goal would result in increasing flows by 300 ft^3/s. For example, in a year of ample water supplies, flows would increase from 600 ft^3/s without the Basin Conservation Program to 900 ft^3/s with the Basin Conservation Program. In years when the water supply is prorated, the initial flows obtained through implementing water conservation measures will be increased above 300 ft^3/s only in those cases where the return flows associated with the reduced diversion occur below the Sunnyside Diversion Dam. Such increases shall, however, not further diminish the amount of water that otherwise would have been delivered by an entity to its water users anywhere in the basin in years of water proration. If consumptive water is obtained from an entity in the basin (choosing to take land out of irrigation as a conservation measure or by other means of reducing or eliminating consumptive use), then the 300-ft^3/s target flow would be increased in all years. In marginal years, the target flows have a higher priority than diversions, and prorationing will result.

The initial instream target flows may be increased for interim periods from April through October to facilitate outward migration of anadromous fish. Flows to facilitate this migration are referred to as flushing flows. The increased initial target instream flows for interim periods can be obtained through voluntary sale and lease of water or water rights. If consumptive water is obtained by acquisition, the 300-ft^3/s target flow would be increased in all years.

Reports on Available Irrigation Water and Biologically Based Target Flows

Title XII requires that, within 3 years of the date of enactment, the Secretary shall submit a report with recommendations to Congress regarding whether or not the water supply available for irrigation is adequate to sustain the agricultural economy of the Yakima River Basin. However, the study that would be required to satisfy this requirement will likely be

Table 2-2.—Estimated water supply and initial target instream flows criteria at Sunnyside Diversion Dam and Prosser Diversion Dam

Water supply estimate for period (million acre-feet)				Target flow (ft^3/s) from date of estimate[1] through October downstream from Sunnyside and Prosser Diversion Dams	
April through September	May through September	June through September	July through September	Without Basin Conservation Program	With Basin Conservation Program
3.2	2.9	2.4	1.9	600	900
2.9	2.65	2.2	1.7	500	800
2.65	2.4	2.0	1.5	400	700
<2.65	<2.4	<2.0	<1.5	300	[2]300

Note: This is based on the table in Title XII, section 1205(a).
[1] "Estimate" refers to the project superintendent's water supply estimate.
[2] Only increased with reduced diversions below Sunnyside.

deferred for the following reasons: (1) the extent of participation in the Basin Conservation Program and what actually can be accomplished through water conservation will not be known for at least several years; (2) it is preferable that the Yakima River Watershed Council, which is currently in the process of developing a water resources plan for the Yakima River Basin, complete this process without the introduction of another study concerning the water resources of the Yakima River Basin; (3) activities by Reclamation at this time may only result in viewpoints of irrigation water needs that conflict with a recent report published by the Tri-County Water Resource Agency (April 1997); and (4) reaching some consensus on biologically based instream target flows prior to proceeding with irrigation water supply studies is advisable.

The System Operations Advisory Committee (SOAC) is a group of fishery biologists who advise the Yakima Project Superintendent on operations of the Yakima Project for fish and wildlife purposes. This group has asked for an extension of this process. Title XII also requires that, within 3 years of enactment, the target flows shall be evaluated by the SOAC, and a report will be prepared regarding what is necessary to have biologically based target flows.

Water from Cle Elum Lake

Under Title XII, actions at Cle Elum Lake include raising the gate elevation to 2243.0 feet, 3 feet above the present elevation, to provide an additional 14,600 acre-feet of storage capacity. The elevation increase will be achieved by modifying the radial gates. The water from developing additional storage capacity at Cle Elum Lake shall be exclusively dedicated to instream flows or flushing flows as determined by the Yakima Project

Superintendent or as otherwise determined by the SOAC. The increased water supply from this development will not be part of the Yakima River Basin TWSA estimated to be available to meet irrigation and municipal and industrial water diversions.

Other actions associated with the Cle Elum 3-foot rise include shoreline protection, construction of juvenile fish passage facilities at Cle Elum Dam, and any actions that may be necessary for environmental mitigation.

Yakima River Basin Tributary Enhancement

Following consultation with the State of Washington, tributary water right owners, and the Yakama Indian Nation, a study will be conducted by Reclamation concerning nonstorage items that can be implemented to enhance water supplies for fish and wildlife and irrigation purposes in Taneum Creek. Similar studies can be conducted in other tributaries upon agreement of the appropriate tributary water right owners to participate. Nonstorage measures can include, but are not limited to, the following:

- Water use efficiency improvements
- Conveyance of water from the Yakima Project through the facilities of any willing irrigation entity
- Construction, operation, and maintenance of groundwater withdrawal facilities
- Contract with willing entities to limit or forego present water use through lease or sale of water or water rights
- Other measures such as restoration of stream habitats

A draft report is to be prepared and made available to the public for a 45-day comment period. Following this, a final report is to be submitted by the Secretary to Congress and the Governor of the State of Washington. Implementing the proposed measures can then be initiated upon securing an appropriation, an agreement with the appropriate water right owners, and a finding by the Secretary and the State of Washington that implementation will not impair the water rights of any person or entity in the affected tributary.

Reclamation has concluded that a different process may be followed if non-Federal funding sources (such as the Northwest Power Planning Council) are to be used. Activities are currently underway in the Teanaway River anticipating the use of non-Federal funds.

Chandler Pumping Plant

Water for Chandler Power Plant and Kennewick Irrigation District is presently diverted from the Yakima River at Prosser Diversion Dam and transported by a canal 11 miles downstream to Chandler Pumping and Power Plant. The water is used to: (1) meet irrigation demands of the Kennewick Irrigation District; (2) operate two hydraulic turbines that pump water across the Yakima River into the Kennewick Main Canal; and (3) generate electricity at the 12,000-kilowatt Chandler Power Plant.

Water from operation of the hydraulic turbines and the hydroelectric generators re-enters the Yakima River 11 miles downstream from Prosser Diversion Dam. Replacing both or either of the hydraulic turbines with electric motors or constructing a new pumping station and installing automated control structures at the headworks of the Chandler Power Canal would reduce the amount of water that needs to be diverted, leaving conserved water in the river for instream flow purposes. At peak irrigation demand, about 425 ft^3/s is required to operate the hydraulic turbines, and at least one generator requiring an additional 200 ft^3/s is operated to absorb flow fluctuations in the Chandler Power Canal and allow stable flow deliveries to the Kennewick Irrigation District. Diversion reductions of up to 157,800 acre-feet could be realized by this action (Reclamation, 1987).

Other alternatives to replacing the hydraulic turbines are being considered. These alternatives include a planning effort to investigate a potential water exchange by pumping water from the Columbia River into a portion of the Kennewick Irrigation District system to reduce diversions into the Chandler Power Canal.

Kachess Lake Augmentation

This measure includes a plan for augmenting the stored water supplies in Kachess Lake from the flows of Cabin Creek and Silver Creek. A previous study indicated that about 35,000 acre-feet annually could be delivered from Cabin Creek, and about 10,000 acre-feet annually could be delivered from Silver Creek for storage in Kachess Lake during dry years when the reservoir is low (CH2M Hill, 1989). A more recent study indicates that these estimates are high (Reclamation, 1997).

The stored water resulting from this action would be used to enhance the water supply available to the Kittitas Reclamation District and the Roza Irrigation District. Implementation is contingent on completion of a feasibility study and an agreement with the two districts for prior payment of the construction costs allocated to irrigation. Based upon preliminary hydrologic and cost analyses, this measure does not appear feasible. Augmenting Kachess Lake storage would benefit irrigation only. No significant fish benefits have been identified. In addition, costs for financing construction, currently unidentified mitigation measures, and annual operation and maintenance costs would increase the cost of the potential measure (Reclamation, 1997). However, this measure will be retained as part of the YRBWEP plan until after other components have been implemented, at which time further evaluation may be done.

Kachess Dam Modification

The modifications at Kachess Dam included removing a hydraulic constriction caused by siltation in the current inlet to the discharge channel and deepening the outlet channel. These modifications allow the discharge of water at reduced reservoir levels, which improves reservoir operations for anadromous fish. A final environmental assessment/ finding of no significant impact was completed on April 11, 1996. Construction was completed in March 1997.

Interim Comprehensive Basin Operating Plan

Development of a draft interim comprehensive basin operating plan providing a general framework within which the Yakima Project is operated, including measures implemented under YRBWEP, will be prepared within 18 months after completion of the Basin Conservation Plan. Additional National Environmental Policy Act compliance will be conducted when elements of the plan are slated to be implemented by the Yakima Field Office Manager. It is anticipated that the plan will contain minor recommendations to changes in ramping rates and operational criteria for "flip-flop" operations.

2.1.3 Yakama Indian Nation

Title XII provides for developing a water conservation plan for the Wapato Irrigation Project and implementing appropriate measures. Also authorized are: (1) an irrigation demonstration project on the Yakama Indian Reservation if the Yakama Indian Nation decides to use the water savings for this purpose; and (2) a study to develop and implement a Toppenish Creek Corridor enhancement project to demonstrate integrated management of agricultural, fish, wildlife, and cultural resources.

Improvements to the Wapato Irrigation Project

The proposed system improvements and other activities relating to the Wapato Irrigation Project are to be coordinated between the Yakama Indian Nation and the Bureau of Indian Affairs. This item includes the preparation of plans, investigation of measures, and implementation of system improvements as certified by the Secretary to ensure consistency with the objectives of Title XII.

As of February 19, 1997, an Indian Self-Determination and Education Assistance Act contract (more commonly known as a 638 contract) was entered into with the Yakama Indian Nation. The contract was developed to pass Federal funds for Title XII work to the Yakama Indian Nation. The work listed in Title XII was for Wapato Irrigation Project improvements, implementing an irrigation demonstration project, and for a Toppenish Creek Corridor Enhancement Project. The method described to allocate these Federal funds was through annual funding agreements. In December 1997, an agreement to

provide annual funding was developed and is currently under review. Tasks to be completed by the Yakama Indian Nation are to: (1) develop a conservation plan for the Wapato Irrigation Project; (2) develop a hydrographic and meteorologic plan to provide information for future planning, management, and regulation of surface water and groundwater on the Wapato Irrigation Project; (3) develop a Toppenish Creek Corridor Enhancement Project plan; and (4) investigate potential Yakama Indian Nation irrigation demonstration project sites.

Improvements could include lining canals, lining and piping laterals, automating existing gauged check structures, eliminating weedy vegetation along distribution and conveyance systems and right-of-ways, and installing water measurement devices at turnouts. This item could result in annual water savings of up to 50,000 acre-feet (Reclamation, 1987). Water savings resulting from the irrigation system improvements shall be available for irrigation use and other purposes by the Yakama Indian Nation and for the protection and enhancement of fish and wildlife within the Yakima River Basin.

Irrigation Demonstration Project

This item includes the design, construction, operation, and maintenance of an irrigation project demonstrating cost-effective, state-of-the-art irrigation water management and conservation. This item also includes training of Yakama Indian Nation members in irrigation methods, operations and management, upgrading existing hydroelectric facilities, and constructing additional hydroelectric facilities on the Reservation to meet irrigation pumping power needs. The implementation of the irrigation demonstration project is at the discretion of the Yakama Indian Nation and contingent on concurrence of the Secretary. This implementation is also contingent on the Yakama Indian Nation deciding to use all or part of the water savings from the Wapato Irrigation Project system improvements for this purpose.

Toppenish Creek Corridor Enhancement Project

This item includes investigating measures to develop a Toppenish Creek Corridor enhancement project to demonstrate integrated management of agricultural, fish, wildlife, and cultural resources.

The Toppenish Creek drainage totals about 603 square miles and provides an average runoff of about 100,000 acre-feet. The main tributary to Toppenish Creek is Simcoe Creek.

Irrigation development in the Toppenish-Simcoe area began about 1860 with diversions from Toppenish and Simcoe Creeks. A Toppenish-Simcoe Project was authorized by Congress in 1920, and a diversion dam on Toppenish Creek, a feeder canal to Simcoe Creek, and some laterals were constructed. Funds for the remainder of the project were not appropriated, and the 14,000-acre project was not developed. Further investigations

were made in the 1950s and also again in the 1960s, but none of these investigations led to additional development. The existing Toppenish-Simcoe Unit of the Wapato Irrigation Project has a service area of about 3,000 acres.

2.1.4 Summary of Estimated Water Supply Under Title XII Provisions

As noted above, some Title XII provisions include estimates of the water that may be available for various purposes from implementing measures. A Title XII goal is to achieve 165,000 acre-feet of water savings in 8 years under the Basin Conservation Program. Of this amount, about 110,000 acre-feet is to protect and enhance fish and wildlife resources, and 55,000 acre-feet is to improve the reliability of water supplies for irrigation.

Cle Elum Dam modifications will result in about 14,600 acre-feet of additional storage capacity. The water available from the development of this additional storage capacity will be made available for fish and wildlife uses (instream flows and flushing flows).

An additional annual average of 15,400 acre-feet, without fish flushing flows, or 10,700 acre-feet, with fish flushing flows, may be diverted from Cabin and Silver Creeks during years of proration for augmenting storage water at Kachess Lake (Reclamation, 1997). This water may be available to enhance the water supply available to the Kittitas Reclamation District and/or the Roza Irrigation District in years of proration.

Wapato Irrigation Project improvements could result in an average annual water savings of up to 50,000 acre-feet. The water may be used by the Yakama Indian Nation for irrigation and other purposes on the Yakama Indian Reservation and for the protection and enhancement of fish and wildlife within the Yakima River Basin.

Table 2-3 presents the estimates of water supply that may be conserved from implementing measures under the Basin Conservation Program, the modifications at Cle Elum Dam, the Kachess Lake stored water augmentation from the flows of Cabin and Silver Creeks, reduced diversions at Chandler Power Plant, and the water saved from the Wapato Irrigation Project improvements.

The six reservoirs associated with Yakima Project water deliveries have a combined storage capacity of about 1,070,700 acre-feet. Water made available from implementing Title XII provisions could be stored in project reservoirs during dry years when excess storage capacity exists and released for use during the irrigation season or carried over for use during a subsequent season for irrigation and fish and wildlife enhancement.

Other provisions of Title XII, such as enhanced tributary flows and reduced diversions at the Chandler Power Plant, may also result in a more reliable and improved water supply for fish and wildlife use and irrigation use. Estimates of the degree of improvement and enhancement of water supply along the tributaries have not yet been made, except for the estimate that water conservation measures may result in maintaining a minimum

Table 2-3.—Summary of estimated water conserved from certain Title XII provisions

Provision	(Acre-feet)		
	Fish and wildlife use	Irrigation use	Total
Basin Conservation Program[1]	110,000	55,000	165,000
Cle Elum Dam modifications	14,600	0	14,600
Kachess Lake augmentation	—	—	5,000-15,000
Chandler Power Plant[2]	—	—	157,800
Wapato Irrigation Project improvements	—	—	50,000

[1] Identified in Title XII.

[2] Available only in Chandler bypass reach.

instream flow of 20 ft^3/s in Taneum Creek. Also, reduced diversions of up to 157,800 acre-feet to the Chandler Power Plant would help maintain instream flows in the reach of the Yakima River near Prosser Diversion Dam.

2.2 Alternatives Considered in Detail

Readers of this PEIS are encouraged to read Section 2.1 "Overview of Title XII Provisions" before reading the following detailed discussion of no action or the action alternatives. The components of Title XII are presented first in this chapter because each alternative includes these components in some manner. Presenting and reading the information in this order will allow a more thorough understanding of each alternative.

2.2.1 Hydrology Model

The hydrology model has been used for scoping alternative plans and operations and assessing broad impacts on the system before the enactment of Title XII. Impacts on irrigation water supply with varying instream flows can be estimated as well as impacts on the water supply and the river system from water conservation efforts. The hydrology model used a long-term water supply data base of unregulated flows (no storage regulation or diversions) spanning the period 1926 through 1994. Any level of development can be simulated for assessing alternative developments and operations. Section 4.2.2 "Discussion of Impacts to Surface Water" provides a more detailed description of the hydrology model.

2.2.2 No Action Alternative

Readers of this PEIS are encouraged to read Section 2.1 "Overview of Title XII Provisions" for details of Title XII components before reading the following specific discussion of the No Action Alternative.

The No Action Alternative for this PEIS includes instream target flows designated in section 1205(a) of Title XII that were implemented in 1995 but no other elements of Title XII. These new instream target flows became effective upon enactment of Title XII. This operation provides minimum flows below Sunnyside and Prosser Diversion Dams of 300 to 600 ft^3/s, depending upon the TWSA from April through September. The potential impacts associated with implementing the No Action Alternative will be assessed in the PEIS by comparing the No Action Alternative operation to pre-Title XII operating (flow) criteria. Pre-Title XII conditions reflect pre-Title XII operations, which in the early 1990s attempted to maintain a target flow of 300 ft^3/s over Sunnyside Diversion Dam. The No Action Alternative will serve as the basis of comparison for assessing potential impacts associated with the action alternatives.

The No Action Alternative is presented as the most likely future condition that could be expected without implementing additional Title XII provisions beyond the target flows. This alternative provides the basis for impact comparisons. The No Action Alternative includes implementing the new operational criteria required by Title XII. The following assumptions were used with the hydrology model to simulate conditions under the No Action Alternative:

- A target flow as determined pursuant to the Title XII operating criteria.
- Basin storage capacity is 1,070,700 acre-feet.
- Diversion demands represent historical diversions under a full water supply condition.
- When water supply is not sufficient to meet the instream and diversion demands, diversions for demands that have proratable entitlements are reduced.

Comparing diversions during low water supply years under the pre-1995 operational criteria presented in Chapter 3 "Affected Environment" with diversions during low water supply years under the post-1995 operational criteria results in the impact from implementing the new operational criteria under Title XII.

Before Title XII, various studies and activities were conducted regarding water conservation within the basin. Under the No Action Alternative, funding for conservation measures is anticipated to decrease from previous levels and will thereby result in fewer onfarm irrigation improvements.

2.2.3 Action Alternatives

The action alternatives describe five ways to implement Title XII measures. The description is handled in this manner because several of the elements (Kachess Lake augmentation and any tributary studies) require further study and analysis before they would be implemented. Presenting and evaluating elements of Title XII in this manner permits an incremental analysis of elements. Alternative 1 includes implementing all Title XII measures except the Basin Conservation Program. Alternative 2 consists of all Title XII measures included in Alternative 1 plus different levels (Alternatives 2A, 2B, and 2C) of water conservation program implementation at various locations within the basin. Alternative 3 includes all Title XII measures except for implementation of the Kachess Lake augmentation and tributary measures.

Alternative 1 (Implementation of All Measures Except the Basin Conservation Program)

Readers of this PEIS are encouraged to read Section 2.1 "Overview of Title XII Provisions" for details of Title XII components before reading the following specific discussion of Alternative 1.

The following outlines, in general, the major assumptions used with the hydrology model to demonstrate conditions by implementing all Title XII measures except for the Basin Conservation Program.

The alternative includes the assumptions in the No Action Alternative plus:

- Kachess Lake augmentation from Cabin and Silver Creeks
- Cle Elum Dam modifications, including 14,600 acre-feet of additional storage capacity
- Reduced diversions to the Chandler Pumping Plant
- Kachess Dam modifications
- Yakima River Basin tributary enhancement of instream flows
- An interim comprehensive basin operating plan

Yakama Indian Nation components included in Alternative 1 are the Wapato Irrigation Project, the Irrigation Demonstration Project, and the Toppenish Creek Corridor enhancement project. A planning document, "Water Conservation and Resource Enhancement Plan on the Yakama Indian Reservation within the Wapato Irrigation Project," dated December 31, 1992, provides information regarding water resources and water conservation opportunities on the Wapato Irrigation Project.

Alternative 2 (Implementation of All Measures Including the Basin Conservation Program)

Readers of this PEIS are encouraged to read Section 2.1 "Overview of Title XII Provisions" for details of Title XII components before reading the following specific discussion of Alternative 2.

The following outlines, in general, the major assumptions used with the hydrology model to demonstrate conditions by implementing provisions of Title XII with the Basin Conservation Program.

This alternative includes the assumptions in the No Action Alternative, plus the assumptions under Alternative 1, plus different methods of implementing the Basin Conservation Program.

- **Alternative 2A (preferred alternative)** includes implementation of all Title XII measures plus a 7.5-percent basin-wide reduction in diversion demands except for the Wapato Irrigation Project and the Yakima-Tieton Canal.

- **Alternative 2B** includes implementation of all Title XII measures plus a 15-percent reduction in diversion demands from the Yakima River downstream from the Roza Diversion Dam except for the Wapato Irrigation Project.

- **Alternative 2C** includes implementation of all Title XII measures plus a 21-percent reduction in diversion demands at diversion points between the Sunnyside and Roza Canals except for the Wapato Irrigation Project.

Alternative 3 (Implementation of Alternative 2A Minus Kachess Lake Augmentation and Tributary Program)

Readers of this PEIS are encouraged to read Section 2.1 "Overview of Title XII Provisions" for details of Title XII components before reading the following specific discussion of Alternative 3.

This alternative is essentially the same as Alternative 2A, except that Kachess Lake augmentation and the tributary program are not included. These two Title XII elements depend upon the outcome of feasibility studies and, therefore, may not be implemented.

2.3 Range of Alternatives and Alternatives Eliminated

The alternatives presented represent a range of reasonable alternatives. A primary objective of the YRBWEP study authorized in 1979 was to develop a comprehensive management plan for the basin to enable efficient use of the water supply. Before Title XII, various studies were conducted that identified storage and nonstorage measures to improve the water supply within the Yakima River Basin.

Some of the measures were not included within Title XII for various reasons discussed in chapter 1 and the YRBWEP phase 1 and phase 2 status reports (Reclamation and Washington State Department of Ecology, 1985).

2.4 Summary Comparison of Alternatives

Table 2-4 summarizes the elements of each alternative.

Table 2-5 summarizes the impacts of each alternative. Numbers have been rounded.

Table 2-4.—Summary of alternatives

Title XII element	Pre-Title XII conditions	No Action Alternative	Action Alternatives: Implement Title XII				
			Alternative 1	Alternative 2A (preferred alternative)	Alternative 2B	Alternative 2C	Alternative 3
Basin Conservation Program	Existing individual water conservation plans under both the Reclamation Reform Act and State Referendum 38	Same as pre-Title XII	Same as no action	Would increase basin-wide conservation planning and would likely improve basin-wide water management and increased variety of water conservation measures. Basin conservation plan prioritizes and allocates funds to implement conservation measures throughout basin	Same as Alternative 2A	Same as Alternative 2A	Same as Alternative 2A
Water conservation measures	Low flow augmentation reservoirs, lining canals, piping laterals, canal automation, Natural Resources Conservation Service onfarm practices	Same as pre-Title XII	Same as no action	Water conservation measures may exist under the Basin Conservation Program	Water conservation measures may exist under the Basin Conservation Program	Same as Alternative 2A	Same as Alternative 2A
Implementation	Water conservation measure implementation on 12,300 acres per year basin-wide	Same as pre-Title XII	Same as no action	Voluntary program and cost sharing available; water conservation location partly determines impacts—basin-wide here, excluding Wapato and Tieton	Same as Alternative 2A carried out below Roza, not including Wapato or the Naches River Basin	Same as Alternative 2A but carried out only on Roza and Sunnyside Districts	Same as Alternative 2A
Target instream flows	300 ft^3/s below Parker in 1984-94 Jul-Sep 300 ft^3/s below Prosser in 1984-94	See table 2-2; without Basin Conservation Program; 300 to 600 ft^3/s below Parker and Prosser	Same as no action	See table 2-2; with Basin Conservation Program; 300 to 900 ft^3/s below Parker and Prosser	Same as Alternative 2A	Same as Alternative 2A	Same as Alternative 2A
Cle Elum 3-foot raise	No modifications at Cle Elum	Same as pre-Title XII	Additional 14,400 acre-feet by modifying radial gates; water used for fish	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
Yakima River Basin tributary enhancement	Existing instream flows too low for resident and migratory fish in many tributaries	Same as pre-Title XII	Efficiency improvements, water conveyance changes, groundwater use, lease or sale of water rights, stream restoration	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as no action

Table 2-4.—Summary of alternatives (continued)

Title XII element	Pre-Title XII conditions	No Action Alternative	Action Alternatives: Implement Title XII				
			Alternative 1	Alternative 2A (preferred alternative)	Alternative 2B	Alternative 2C	Alternative 3
Chandler Pumping Plant	Water used to run pumps; instream flows insufficient	Same as pre-Title XII	Electrification of the pumps would provide 157,000 acre-feet of instream flows below the diversion	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
Kachess Lake augmentation	None	Same as pre-Title XII	About 5,000-15,000 acre-feet of additional storage; water for Kittitas and Roza	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as no action
Kachess Dam modification	Described in Kachess Dam Environmental Assessment (Reclamation 1996)	Same as pre-Title XII	Modification improves operational flexibility	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
Interim comprehensive basin operating plan	None	Same as pre-Title XII	Plan would provide a general framework for Yakima Project operations	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
Yakama Indian Nation							
Wapato Irrigation Project	None	Same as pre-Title XII	Water management plans, measures, and system improvements	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
Irrigation Demonstration Project	None	Same as pre-Title XII	Design, construct, operate, and maintain an irrigation project demonstrating cost-effective, state-of-the-art irrigation water management and conservation	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
Toppenish Creek Corridor enhancement	None	Same as pre-Title XII	Integrate management of agricultural, fish, wildlife, and cultural resources	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1

Table 2-5.—Summary of impacts

Affected resource	No Action Alternative	Action Alternative: Implement Title XII				
		Alternative 1	Alternative 2A (preferred alternative)	Alternative 2B	Alternative 2C	Alternative 3
Surface Water Hydrology Note: The legislated minimum instream target flows below Sunnyside and Prosser Diversion (which were designated in Section 1205(a) of Title XII and implemented in 1995) are included in the No Action Alternative which was compared against all of the other action alternatives.	**Shortages and flows at Parker and Prosser—average year (1926-1994)**					
	Shortages are 57,000 acre-feet (relative to total annual average model diversion demands[1] of 2,450,000 acre-feet).	Minor decrease in shortages.	Moderate decrease in shortages.	Moderate decrease in shortages.	Moderate decrease in shortages.	Minor decrease in shortages.
	Average flows from Jul-Oct were 510 ft^3/s at Parker and 460 ft^3/s at Prosser.	No measurable impact for the July-Oct average flows at Parker and Prosser.	Moderate increases in the July-Oct average flows at Parker and Prosser.	Moderate increases in the July-Oct average flows at Parker and Prosser.	Moderate increase in the July-Oct average flows at Parker and major increase at Prosser.	Moderate increases in the July-Oct average flows at Parker and Prosser.
	Shortages and flows at Parker and Prosser in a dry year such as 1994					
	Shortages are 602,000 acre-feet (relative to total annual average model diversion demands of 2,450,000 acre-feet).	No measurable impact in shortages.	Minor decrease in shortages.	Moderate decrease in shortages.	Moderate decrease in shortages.	Minor decrease in shortages.
	Average flows from Jul-Oct were 300 ft^3/s at Parker and Prosser.	No measurable impact for the July-Oct average flows at Parker and Prosser.	No measurable impact for the July-Oct average flows at Parker and Prosser.	Minor increases in the July-Oct average flows at Parker and Prosser.	Moderate increases in the July-Oct average flows at Parker and Prosser.	No measurable impact for the July-Oct average flows at Parker and Prosser.
Surface Water Quality	**Surface water in the Yakima River**					
	Sediment, nutrients, and pesticide concentrations are higher at certain times of the year because of impacts of irrigation return flows. Temperature can be lower or higher because of drain water influences.	No measurable impacts on the water quality in the river compared with the No Action Alternative.	Some improvement in water quality below Parker is possible for sediment, nutrients, and pesticides. Improvement depends upon type of water conservation implemented in the basin.	Generally, same as Alternative 2A except concentrated in the area downstream from Roza.	Generally, same as Alternative 2A except concentrated in the area downstream from Roza and Sunnyside Canal diversions.	Generally, same as Alternative 2A.
	Water quality in the drains					
	Drain water quality shows sediment, nutrients, and pesticide concentrations are generally higher than in the irrigation water supply diverted from the river.	Generally, same as no action.	Some reductions in sediment, nutrient, and pesticide concentrations should occur depending on type of conservation implemented in the basin—specifically if surface runoff from onfarm practices is reduced.	Impacts are concentrated downstream from Roza; therefore, return flows are less than Alternative 2A. So sediment concentrations and loads should be lower.	Impacts are concentrated downstream from Roza and Sunnyside; therefore, return flows are less than Alternative 2A. So sediment concentrations and loads should be lower.	Generally, same as Alternative 2A.

[1] Model diversions are based on actual historical diversions from 1970-1994, excluding water-short years. See table A-1, in appendix A.

Table 2-5.—Summary of impacts (continued)

Affected resource	No Action Alternative	Action Alternative: Implement Title XII				
		Alternative 1	Alternative 2A (preferred alternative)	Alternative 2B	Alternative 2C	Alternative 3
Groundwater	Groundwater levels higher than historical levels from increased recharge from irrigation applications. Locally, groundwater has higher than natural background levels of major solutes from agricultural chemicals.	Short-term minor impact near Cle Elum and Kachess Lakes because of higher reservoir levels and operational timing changes.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.	Short-term minor impact at Cle Elum; none at Kachess.
			About 82,000 acre-feet less recharge to aquifers basin-wide.	About 82,000 acre-feet less recharge to upper and lower Yakima groundwater basins (Kittitas and Naches basins not impacted).	About 57% fewer return flows from Roza and 59% fewer return flows from Sunnyside. About 82,000 acre-feet less recharge to upper aquifers within the area served by these two irrigation districts.	Generally, same as Alternative 2A.
			Minor lowering of groundwater levels in localized areas may impact wells that tap these aquifers.	Minor to moderate lowering of groundwater levels in localized areas will impact wells that tap these aquifers.	Lower groundwater levels will impact wells that tap these aquifers.	Generally, same as Alternative 2A.
			Less seepage water to dilute high solute levels in return flows from irrigation applications. May have slightly higher levels of solutes in groundwater basin-wide.	Slightly higher levels of solutes expected in groundwater in localized areas within upper and lower Yakima groundwater basins.	Higher levels of solutes expected in groundwater in localized areas because of reduced groundwater recharge/storage.	Generally, same as Alternative 2A.
Agricultural Resources	Low to moderate salinity and low trace element concentrations.	Irrigation management.	Slight improvement under good irrigation management.	Improvement under good irrigation management.	Improvement under good irrigation management.	Generally, same as Alternative 2A.
	Moderate wind and water erosion basin-wide.	Same as no action. Kachess shoreline erosion protection required.	Reduced water erosion and possible increased wind erosion. Kachess shoreline erosion protection required.	Reduced water erosion and increased wind erosion. Kachess shoreline erosion protection required.	Reduced water erosion and increased wind erosion. Kachess shoreline erosion protection required.	Reduced water erosion and possible increased wind erosion. Kachess shoreline not impacted.
	Expected small reduction in irrigated acreage due to conversion to suburban use. Existing noxious weeds.	Better protection of perennial crops in drought years.	More dependable water supply from reduced shortages. Better protection of perennial crops in drought years. Decreased irrigated acreage.	More dependable water supply from reduced shortages. Better protection of perennial crops in drought years. Reduced crop acreage and loss of agricultural jobs. Increased weed infestations.	More dependable water supply from reduced shortages. Better protection of perennial crops in drought years. Reduced crop acreage and loss of agricultural jobs. Increased weed infestations.	Generally, same as Alternative 2A.
	Low to moderate surface and subsurface drainage deficiencies.		Slightly improved surface and subsurface drainage.	Improved surface and subsurface drainages.	Surface and subsurface drainage slightly better than Alternative 2B.	Generally, same as Alternative 2A.

Table 2-5.—Summary of impacts (continued)

Affected resource	No Action Alternative	Action Alternative: Implement Title XII				
		Alternative 1	Alternative 2A (preferred alternative)	Alternative 2B	Alternative 2C	Alternative 3
Fish	Salmon and steelhead migration, spawning, and rearing impaired. Streamflows often too high for trout in upper mainstem Yakima during the irrigation season.	Potential improved streamflows for salmon, steelhead, and rainbow trout in tributaries associated with water acquisition and tributary programs. Potential benefits to juvenile salmonid migration due to flushing flows from Cle Elum. Potential improved streamflows for fish from Prosser to Chandler if Chandler electrification is implemented.	Impacts same as Alternative1 plus potential benefits to salmonid migration, fall chinook spawning, and rearing below Parker. Water conservation could improve instream flows and water quality and thereby benefit fish.	Generally, same as Alternative 2A.	Generally, same as Alternative 2A.	Generally, impacts are similar to Alternative 2A. The absence of the tributary program means fewer potential benefits to salmon, steelhead, rainbow trout, and other resident fish.
Vegetation and Wildlife	Riparian health varies throughout basin; estimate 19,000 acres of riparian vegetation basin-wide.	Potential benefits to riparian areas below Parker.	Potential benefits to riparian areas below Parker and Prosser.	Generally, same as Alternative 2A.	Generally, same as Alternative 2A.	Generally, same as Alternative 2A. The absence of the tributary programs means fewer potential benefits to riparian areas.
	About 71,000 acres of wetland.	Potential minor benefits to wetlands associated with Yakima River below Sunnyside and Prosser. Yakama Indian Nation and ecosystem restoration activities could be beneficial.	Potential benefits to wetlands based on land and water acquisition programs, wetland banking, and developing a habitat plan. Potential minor adverse impacts to wetlands associated with agricultural return flows or seepage.	Potential minor adverse impacts to wetlands associated with agricultural return flows or seepage below Roza.	Potential minor adverse impacts to wetlands associated with agricultural return flows or seepage on Roza or Sunnyside lands.	Generally, same as Alternative 2A.
Threatened, Endangered, and Special Status Species	No impact to threatened and endangered species. Site-specific analysis to be conducted in the future.	Same as no action.	Same as no action.	Same as no action.	Same as no action.	Same as no action.

Table 2-5.—Summary of impacts (continued)

Affected resource	No Action Alternative	Action Alternative: Implement Title XII				
		Alternative 1	Alternative 2A (preferred alternative)	Alternative 2B	Alternative 2C	Alternative 3
Socioeconomics	**Social**					
	Shoreline property around Cle Elum Lake eroding.	Small local labor force will be used to complete structural modifications.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.
	Same community cohesion levels that now exist between nonterritorial and territorial communities.	About 10 property owners around Cle Elum Lake impacted.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.
		The potential for friction and decreased community cohesion depends on the specific water conservation measures.	Increased friction in community cohesion anticipated (greater than Alternative 1). Degree of impacts to water right acquisitions will depend on type and amount of water conservation measures.	Increased friction in community cohesion anticipated (greater than Alternatives 1, 2A, and 3). Diversion reductions would probably require water acquisition and subsequent land use change.	Increased friction in community cohesion anticipated (greater than Alternatives 1, 2A, 2B, and 3). Diversion reductions would probably require water acquisition and subsequent land use change greater than Alternative 2B.	Increased friction in community cohesion anticipated (about the same as Alternative 2A).
	Economic					
	Employment in the Yakima region is about 191,000 workers, earning about $4 billion, with sales revenues of $13 billion. Reclamation projects irrigate 360,000 acres with 1,789,000 acre-feet of water, producing $665 million in crop value.	Some gains in sales revenues. Impacts due to actions likely to be minimal, affecting primarily agriculture.	No measurable gains in sales revenues. Will likely be achieved through water conservation; therefore, no economic impacts.	Economic impacts only from lease or purchase of water rights; about $800,000 reduced sales revenues over all industries for every 1,000 acre-feet of reduced water delivery.	Economic impacts only from lease or purchase of water rights; about $900,000 reduced sales revenues over all industries for every 1,000 acre-feet of reduced water delivery.	Generally, the same as Alternative 2A.
Recreation	Primary recreation activities include fishing the reservoirs and rivers for cold water sport species, white-water boating and kayaking, motorized boating, and other related activities such as camping, hiking, picnicking, and wildlife viewing.	No measurable impact.	Implementing the Basin Conservation Program could increase instream flows slightly, which could benefit flow-dependent recreation. Reservoir recreation would not be affected.	Generally, same as Alternative 2A. Reservoir recreation would not be affected.	Generally, same as Alternative 2A. Reservoir recreation would not be affected.	Generally, same as Alternative 2A. Reservoir recreation would not be affected.

Table 2-5.—Summary of impacts (continued)

Affected resource	No Action Alternative	Action Alternative: Implement Title XII				
		Alternative 1	**Alternative 2A (preferred alternative)**	**Alternative 2B**	**Alternative 2C**	**Alternative 3**
Cultural Resources	Ongoing impacts from current operations and land uses would continue.	Historic structures could be adversely impacted by structural modifications. Raising Cle Elum Lake would adversely impact archeological and traditional cultural properties due to new erosion, stabilization actions, and possible relocation of facilities. Ground distributing activities at other locations could impact archeological or traditional cultural properties sites.	Same as for Alternative 1, except that a greater number of historic irrigation structures could be impacted, and additional archeological or traditional cultural properties sites could be impacted by implementing structural modifications for the Basin Conservation Program.	Generally, same as Alternative 2A.	Generally, same as Alternative 2A.	Generally, same as Alternative 2A.
Sacred Sites	One sacred site known; other sites may be present.	Possible impacts to any potential sacred sites on Federal lands cannot be determined at a programmatic level.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.
Indian Trust Assets	May not be adequately protected.	Indian Trust Assets under Alternative 1 would undergo little impact.	Positive impacts due to increased flows.	Generally, same as Alternative 2A.	Generally, same as Alternative 2A.	Generally, same as Alternative 2A.

Chapter 3

Affected Environment

This chapter describes resources in the study area that would be affected by any alternatives that may be implemented. Resources and related topics presented are: surface water, groundwater, agriculture, fish, vegetation and wildlife, threatened and endangered species, socioeconomics, recreation, cultural, sacred sites, and Indian Trust Assets (ITA).

Many resources within the Yakima River Basin are interrelated, or linked, in part because they are associated with water. Section 3.1 "Overview" gives an overview of resource linkages, with emphasis on streamflow timing and magnitude, to better illustrate the interdependence of processes and resources in the study area.

The remaining sections of chapter 3 focus on the current affected environment of various resources including surface water, groundwater, agriculture, fish, vegetation and wildlife, socioeconomics, recreation, and culture. Some topics, such as fish and vegetation and wildlife, refer back to the overview to help show how one resource change can affect another and to discuss potential benefits associated with this proposed action. The reader should keep in mind that the present system exists within the boundaries of conditions dictated by river operations and other outside factors. The following discussion presents the details surrounding the affected resources necessary to understand and evaluate the effects of each alternative.

3.1 Overview

This programmatic environmental impact statement (PEIS) emphasizes system behavior rather than impacts on separate elements. This approach is accomplished mainly through use of the hydrology model, which incorporates several Yakima River Basin Water Enhancement Project (YRBWEP) elements. A complete scientific study of the Yakima River ecosystem is not provided here because such an analysis is outside the scope of Title XII. As discussed in Appendix D "Environmental Commitments," a program of monitoring and adaptive management is required to expand our understanding about the way changes in processes affect this system. The purpose of this overview section is to conceptually display predevelopment streamflow timing and magnitude (the hydrograph) because of the important postulated linkage between hydrograph shape and ecosystem functioning (Hynes, 1970; Peters, 1982; Minshall et al., 1985; Minshall, 1988; Poff and Ward, 1989; Tyus, 1990; Hill and Platts, 1991).

One aspect of YRBWEP is to enhance the native fisheries of the Yakima River Basin. The predevelopment hydrology of the Yakima River system is assumed to have been important in defining species diversity and abundance in the basin (Hynes, 1970; Stanford and Ward, 1983; Schlosser, 1985; Moyle and Williams, 1990). Efforts to improve the basin's aquatic ecosystem may need to restore key components of the predevelopment hydrology that have been lost. Therefore, it is important to understand the nature of the estimated predevelopment hydrograph and the changes in hydrologic regime that occurred with development. The following paragraphs describe, in general terms, what is known about the predevelopment hydrologic processes in the basin.

A predevelopment, healthy river system conceptually functions in a complex web; changes and processes occur along the river's length, across its flood plain width, from the surface through the ground, and dynamically in time (Vannote et al., 1980; Stanford et al., 1996). For example, what happens to the river upstream will impact the river downstream. The riparian zone tempers the way the river interacts with its flood plain. A groundwater/ surface water connection exists that must be examined as one system. Finally, the river functions dynamically through time from floods, land use practices, seasons, changes in groundwater or surface water use, and other factors. Aspects of these processes as they relate to the Yakima River are further explained below.

Water is principally delivered to the Yakima River system as snowmelt. Melt is generated during spring and early summer with occasional large winter runoff events, some caused by rain on snow. Large river basins with properly functioning flood plains capture a portion of streamflow during high flow events and release it later as base flow. In the Yakima River Basin, natural streamflow was moderated by natural storage mechanisms (Parker and Storey, 1916), particularly ground storage and storage in natural lakes, including the large natural lakes that existed at the current sites of Yakima Project reservoirs—Cle Elum, Kachess, Keechelus, and Bumping Lakes. These processes captured peak flows and released water as base flow, sustaining riverflows through extended periods of little precipitation. Pre-irrigation system maps show that, historically, the channel system in the basin was much more complex than it is now, with a myriad of side channels and dense riparian vegetation. Without reservoirs to capture most of the winter and spring runoff, overbank flows were much more frequent. Flood waters infiltrated into the flood plain sands and gravels and were released later (from natural groundwater storage), sustaining summer flows to an as-yet unquantified extent. Some of these mechanisms are still active in some stream reaches, but generally with different magnitude and timing.

Published information on the Yakima River predevelopment hydrograph is found in Parker and Storey (1916) and in U.S. Geological Survey (USGS) historical streamflow records. To estimate natural flow at Union Gap, Parker and Storey (1916) used a 16-year period of record (water years 1897-1912) and a formula to remove the effects of diversions, return flows, and reservoir storage in the basin during that period. Most of this period preceded the effect on the hydrograph of major storage, so their early estimates of natural flow include the effects of natural lake storage and release, which are not yet included in contemporary estimates of unregulated flow (measured flow corrected for storage, estimated diversions, and estimated return flows). Their work also preceded much of the

modification of watersheds, river channels, and flood plains by diking, road building, draining, and other processes that, in most cases, remove natural damping effects on the hydrograph. Parker and Storey (1916) recognized that it was, even then, impossible to exactly reproduce the natural hydrograph, but felt that their estimates were as accurate as could be generated. Parker and Storey (1916) provide natural flow estimates for the lower river at Union Gap and some upstream reaches. This historical information is combined with estimated unregulated streamflows and measured data to discuss below some postdevelopment changes in hydrograph shape and general magnitude.

The Yakima River watershed consists of two major arms—the upper mainstem and the Naches River. Most of the water storage is in the upper mainstem, which produces most of the basin's runoff. The natural hydrology in the upper mainstem was shaped by the annual cycle of snowpack accumulation and subsequent snowmelt, at times with rain on snow. Keechelus, Kachess, and Cle Elum provided natural lake storage, sustaining base flows for an unquantified duration below the lakes. A broad conceptualization of the effects of flow regulation on the hydrograph of the upper mainstem is depicted on figure 3-1a. In this figure, estimated unregulated flows depict the shape of the hydrograph without regulation. Measured flows show the recent average shape and magnitude of the hydrograph. In particular, note the large decrease in spring freshets (high flows), the anomalously high mid- to late-summer flows, and the unnaturally late streamflow decreases in early September associated with "flip-flop[1]."

The estimated unregulated flows of the Tieton and Naches River (figure 3-1b and c) indicate that the Naches arm of the Yakima River Basin would have produced a natural hydrograph similar to that of the upper mainstem. The hydrograph of the Naches arm represents the combined effects of the Tieton River, which is regulated throughout most years, and the Naches River, which is largely unregulated. Tieton Dam releases very little water down the Tieton River before the irrigation season (figure 3-1b [measured]). In late spring and early summer, flows from Tieton Dam releases are mostly diverted from the river by the Yakima-Tieton Irrigation District. In September, the Tieton River experiences its highest flows (figure 3-1b [measured]), as large releases from Tieton Dam are made to provide irrigation water and instream flows for fish to the lower basin during "flip-flop."

Upstream from the confluence with the Tieton River, the Naches River is unregulated except for Bumping Lake, the smallest of the storage reservoirs, and is, therefore, responsible for most of the winter flooding and spring freshets in the lower Yakima. Of all the major tributaries in the Yakima system, the shape of the average, recent, measured Naches hydrograph most closely resembles natural conditions. Figure 3-1c shows the combined effects of the Tieton and Naches drainages. Flows downstream from the confluence with the Tieton are less than under natural conditions until the beginning of "flip-flop" (September), when flows increase above natural conditions.

[1] The "flip-flop" operations are described in Section 3.2.2 "Pre-Title XII Operations (Before 1995) and Model Considerations."

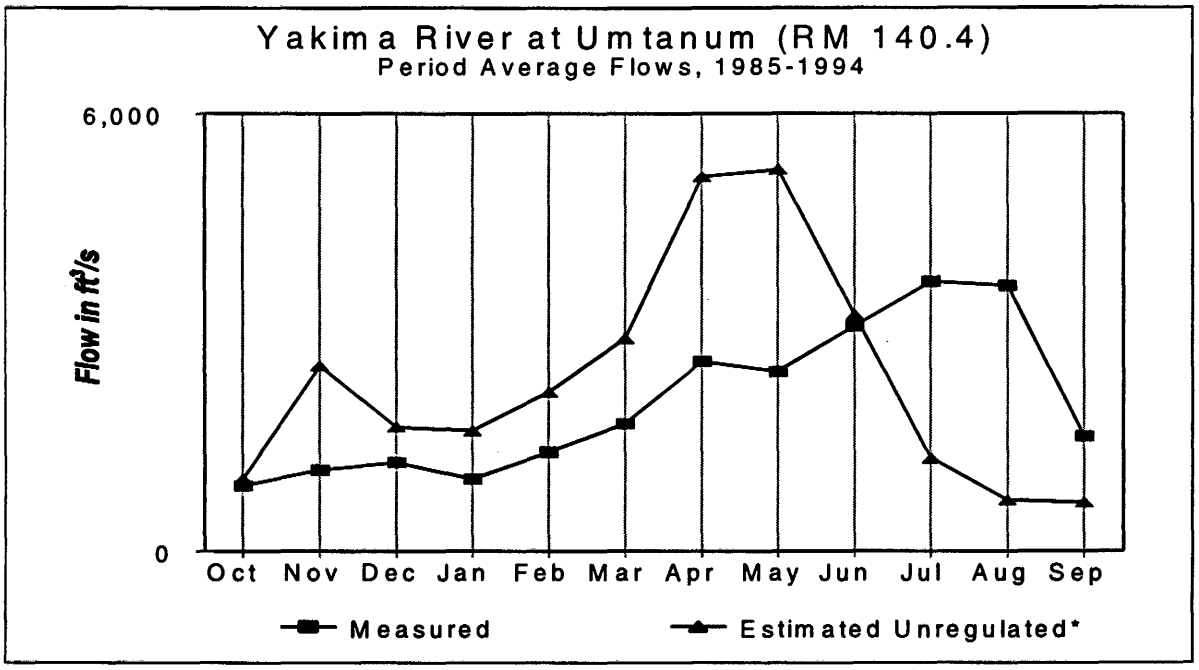


Figure 3-1a

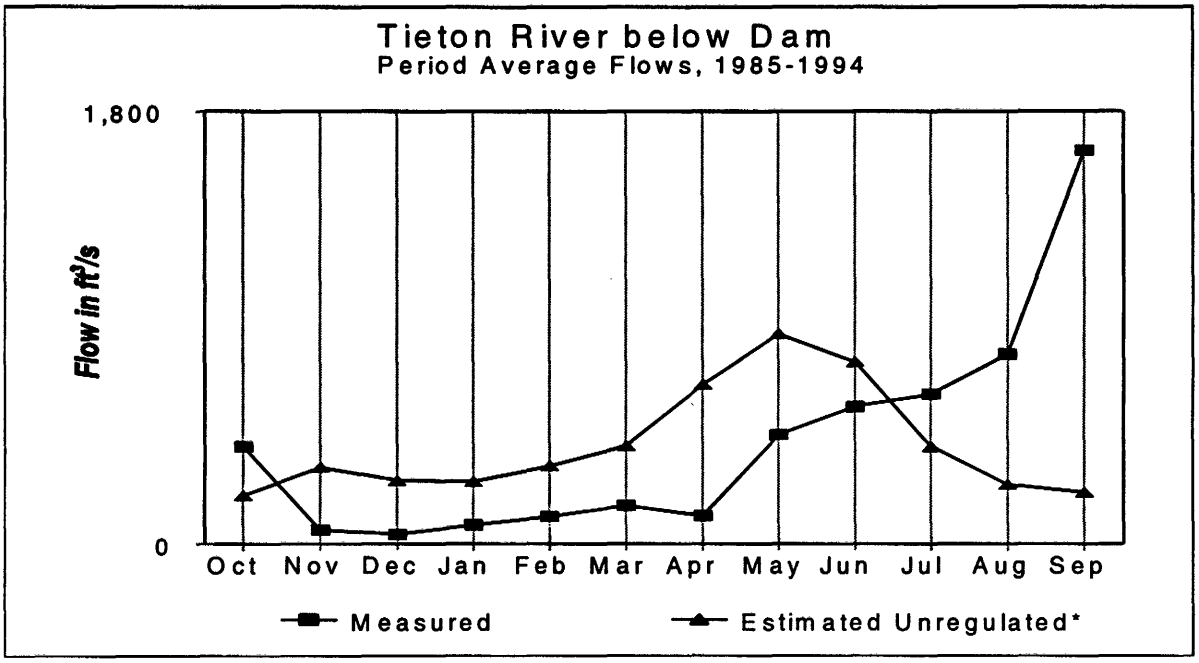


Figure 3-1b

Figure 3-1(a-b).—Conceptual comparison of measured flow and estimated unregulated flow (measured flow corrected for storage, estimated diversions, and estimated return flows).

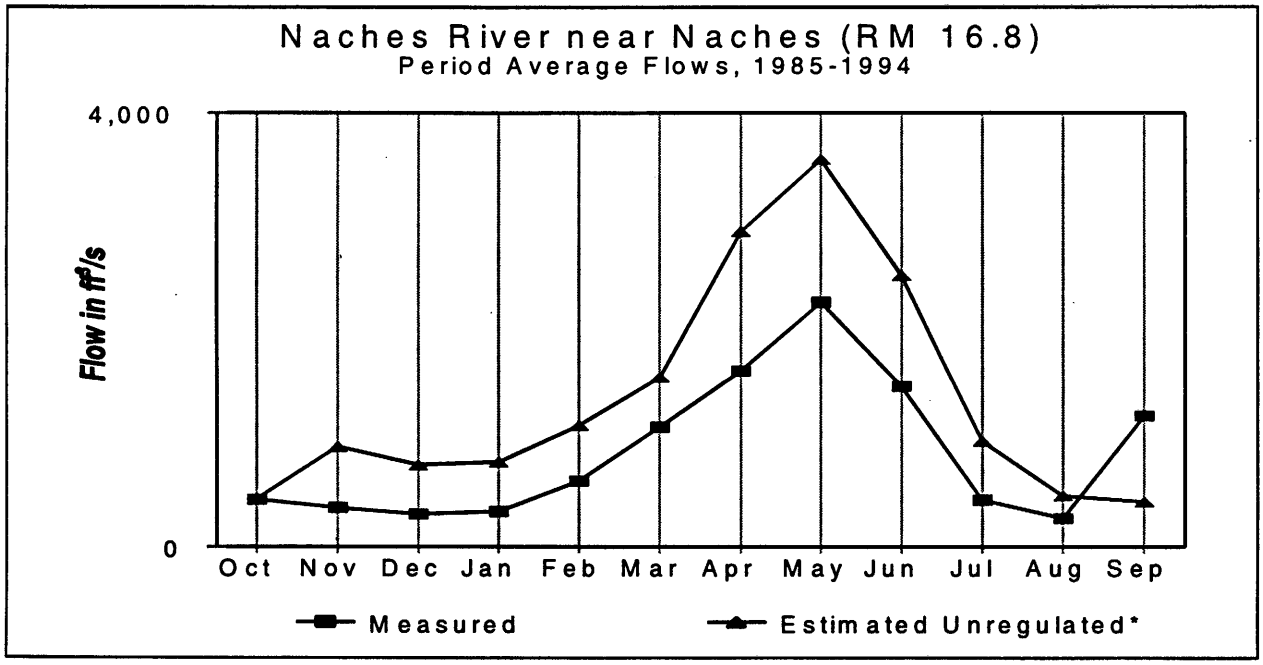


Figure 3-1c

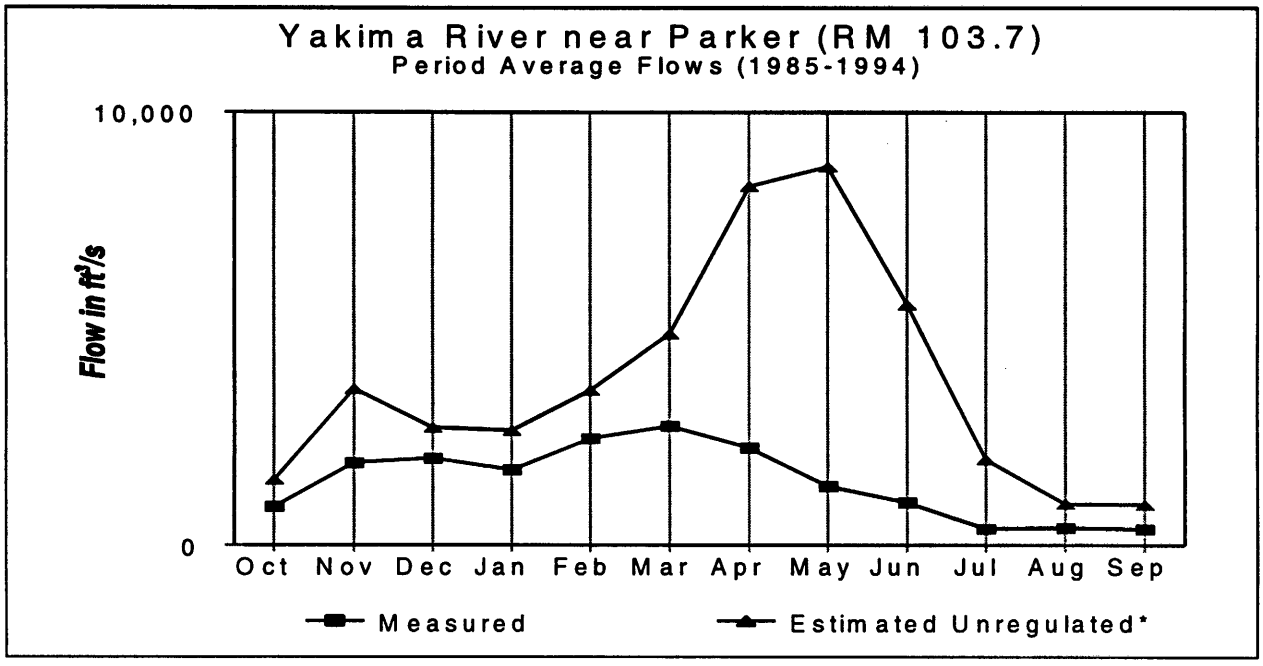


Figure 3-1d

Figure 3-1(c-d).—Conceptual comparison of measured flow and estimated unregulated flow (measured flow corrected for storage, estimated diversions, and estimated return flows).

The lower Yakima represents the combined effects of the hydrology of the upper mainstem and Naches arms. The general pattern of estimated natural flow at Union Gap recorded in Parker and Storey (1916) was runoff peaking in April through June in the range of 7,000 to 12,000 cubic feet per second (ft^3/s). Flows receded throughout the summer months, with annual lows in September and October. The lowest estimated mean monthly flow during this period was about 800 ft^3/s. Flows were higher below Union Gap in the late summer and likely fluctuated less than with the current development. These patterns are depicted conceptually in figure 3-1d. Notice that both peak flows and base flows are lower under measured conditions than under unregulated conditions. The flood peaks are lower because runoff is captured in reservoirs. The total volume passing Parker is lower because of upstream consumptive uses and because much of the volume is diverted and bypasses the measurement point at Parker. These changes in the hydrograph are postulated to have impacted ecosystem functioning, and the current ecosystem reflects, to a great extent, the new hydrologic regime.

The changes in hydrologic regime discussed above are linked to broad changes in river and ecosystem functioning. These changes in streamflow, streamflow timing, water storage mechanisms, and other changes associated with general development are assumed to have affected sediment transport; water quality, including temperature; and base flow amounts and timing. These factors act together and separately to affect other resources like fish, aquatic insects, wetlands, riparian areas, and wildlife. At yet another level, changes to physical and biological resources can affect cultural and social resources.

3.2 Surface Water Hydrology

3.2.1 Water Supply and Demands

This section describes runoff, reservoirs, water supply available, target flows at certain points, and hydrology model diversion demands along the Yakima River and its tributaries. A discussion is also included regarding general operational and hydrology model considerations. As noted in chapter 2, a hydrology model has been developed for the Yakima River Basin and has been used for many years to assess different types of river operations. In addition to the background information presented here, details concerning the hydrologic characteristics and historic measured streamflow data appear in many publications, including Yakima Valley Conference of Governments (YVCOG) (1995) and USGS (1991).

The surface water supply for the Yakima Project is obtained from the unregulated flow of the Yakima River and its tributaries, supplemented by the release of stored water from the six reservoirs in the basin, which have a combined storage capacity of 1,070,700 acre-feet. The total area of the drainage basin is 6,150 square miles (YVCOG, 1995).

A schematic showing the general location of the major tributaries to the Yakima River, storage reservoirs, flow measurement stations, and diversion points is presented on figure A-1 in Appendix A "Surface Water Hydrology."

Average Yearly Runoff at Key Locations

Average yearly runoff at key locations along the Yakima River and its tributaries for the period 1926 through 1994 is presented in table 3-1. Runoff at each station is the unregulated flow in the basin and is based upon historic measured streamflow data. Major gauging stations within the Yakima River Basin from which measured streamflow data are obtained are shown in figure 3-2. Runoff for the period 1926 to 1994 was determined using the historic measured flows where available and filling in missing data with typical hydrologic techniques—backing out the reservoir releases and adding back in the diversions. The unregulated flow shown in table 3-1 represents the average yearly runoff at the listed sites, assuming no development in the basin, including reservoirs and diversions. Also shown in table 3-1 is the actual measured runoff at selected stations for the period 1984 through 1994. These measured runoff data are included to compare with the unregulated (estimated) runoff data.

Table 3-1.—Average yearly runoff at key locations

Site	(Acre-feet)	
	1926-1994 estimated unregulated flow	1984-1994 measured flow
Yakima River at Martin	241,000	232,501
Kachess River	210,000	
Yakima River near Easton	643,000	296,935
Cle Elum River	664,000	
Yakima River at Cle Elum	1,450,000	1,065,622
Yakima River at Umtanum	1,965,000	1,523,699
Yakima River at Pomona	1,968,000	
Bumping River near Nile	205,000	
Tieton River below Tieton Dam	360,000	
Naches River near Naches	1,204,000	
Yakima River at Parker	3,323,000	1,142,382
Yakima River at Kiona	3,859,000	

Reservoir Storage in the Yakima River Basin

The six existing water storage and regulation facilities used to supplement the unregulated flow water supply available from the Yakima River are Keechelus Lake, Kachess Lake, Rimrock Lake, Bumping Lake, Cle Elum Lake, and Clear Lake (figure 1-1). Table 3-2 presents a summary of the pertinent hydrologic information for each of these reservoirs.

Table 3-2.—Yakima River Basin reservoirs—hydrologic data

Site	Active capacity (acre-feet)	Annual runoff (acre-feet)	Surface area (acres)	Normal maximum water surface elevation (feet)
Keechelus	157,800	241,000	2,562	2,517
Kachess	239,000	210,000	4,535	2,262
Rimrock	198,000	360,000	2,562	3,426
Bumping	33,700	205,000	1,303	3,426
Cle Elum	437,000	680,000	4,812	2,240
Clear Lake	5,300	NA	NA	NA

NA = Not available.

The following summarizes some of the important operational aspects of each reservoir and the part each plays in managing the water supply in the Yakima River Basin.

Keechelus and Kachess Lakes

With the existing operation and facilities, Keechelus storage is used in conjunction with the rest of the system to provide a portion of the water supply for the demands from the dam downstream to Sunnyside Diversion Dam. Keechelus also provides some carry-over storage in normal water years. A larger portion of the annual runoff, however, is used along with that of the Kachess River to satisfy upper basin demands.

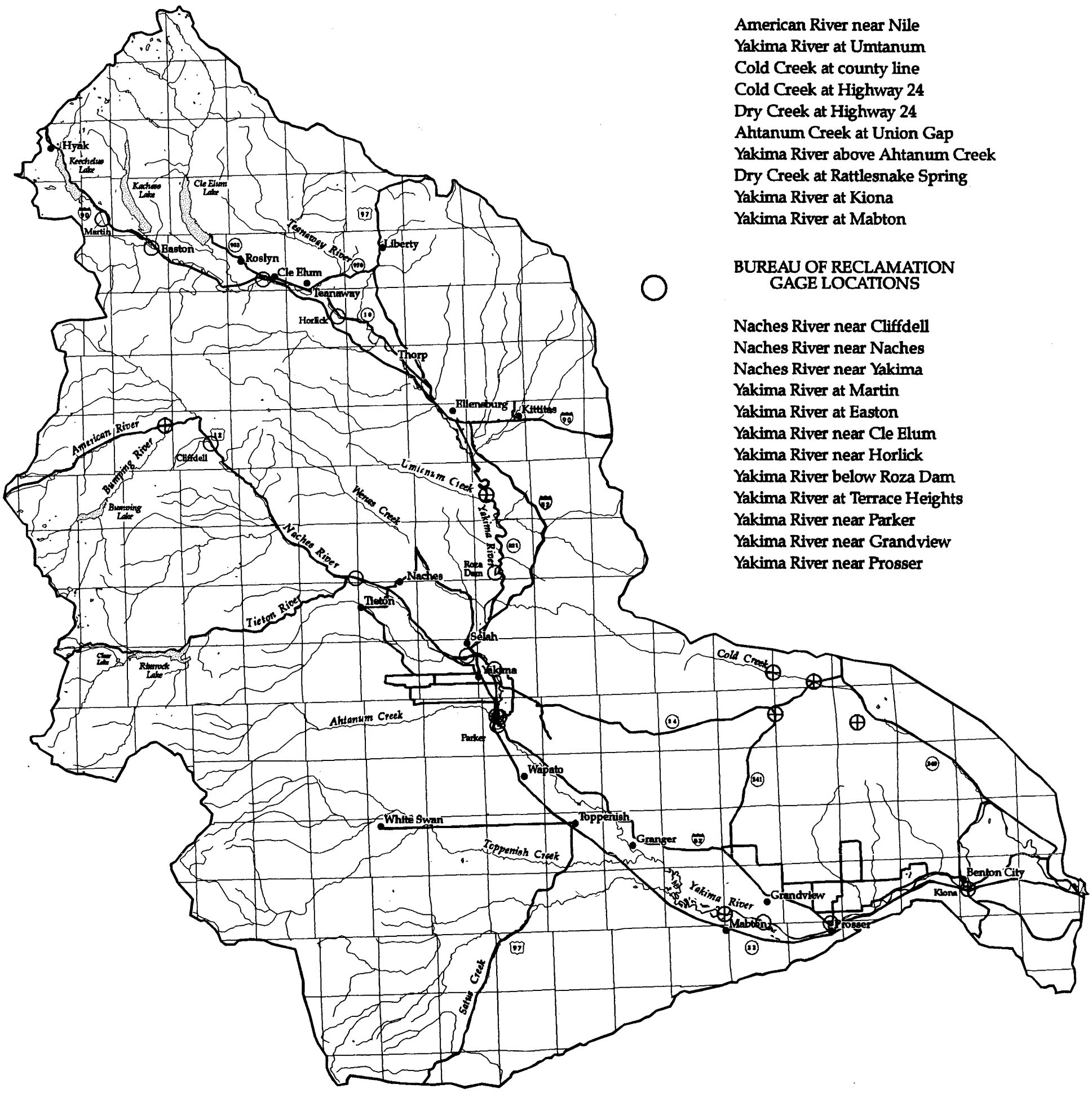
Minimum flows are set for the reach of the river between Keechelus Dam and Easton Diversion Dam. The operation is tailored to meet the instream flow needs in this reach and downstream. To meet these needs, stored water at Keechelus and Kachess Lakes is essentially reserved to meet demands above the confluence of the Yakima and Cle Elum Rivers. When meeting a high level of instream flows, the two upper Yakima arm reservoirs are stressed, and the ability of the reservoirs to refill is reduced.

An operations strategy commonly referred to as a mini "flip-flop" is attempted between these two reservoirs. Heavier releases are made from Keechelus during the summer to meet the upper basin demands, and releases from Kachess Lake are restrained. In the fall (September and October), heavier releases are made from Kachess to meet demands, and the releases from Keechelus Lake are restrained to provide reduced spawning flows.

Rimrock Lake

Rimrock has become a key feature in the existing operation of the river system because of its part in a "flip-flop" operation. Releases are made during the summer months to meet demands below Tieton Dam downstream on the Naches River to the confluence of the

Major Gaging Stations Within the Yakima River Basin



⊕ USGS AND COOPERATIVE GAGE LOCATIONS

American River near Nile
Yakima River at Umtanum
Cold Creek at county line
Cold Creek at Highway 24
Dry Creek at Highway 24
Ahtanum Creek at Union Gap
Yakima River above Ahtanum Creek
Dry Creek at Rattlesnake Spring
Yakima River at Kiona
Yakima River at Mabton

○ BUREAU OF RECLAMATION GAGE LOCATIONS

Naches River near Cliffdell
Naches River near Naches
Naches River near Yakima
Yakima River at Martin
Yakima River at Easton
Yakima River near Cle Elum
Yakima River near Horlick
Yakima River below Roza Dam
Yakima River at Terrace Heights
Yakima River near Parker
Yakima River near Grandview
Yakima River near Prosser

Figure 3-2.—Major gauging stations within the Yakima River Basin.

Yakima River. Later in the fall months (September and October), releases are also made for meeting lower Yakima River Basin needs, thereby allowing the releases from the upper Yakima arm reservoirs to be reduced to provide reduced spawning flows.

In any operation plan, stored water in the Naches River system must be made available when required to fulfill the natural and nonproratable rights for Wapatox Power Plant diversion. This right is modeled as a 300-ft^3/s diversion year round with up to 450 ft^3/s during the irrigation season.

Rimrock Lake supports an important Kokanee fishery and has a target minimum pool of 30,000 acre-feet. However, in dry years, Rimrock Lake is drafted to about 10,000 acre-feet.

Bumping Lake

The average annual runoff at Bumping Lake is far in excess of the existing reservoir capacity and allows the reservoir to fill every year. Depending on the timing of the runoff, the reservoir is filled a number of times each year. Bumping Lake is not used as a carry-over facility for existing operations. The facility is used to supplement water supply for demands in the upper Naches River during summer months.

Cle Elum Lake

Cle Elum Lake regulates 20 percent of the entire runoff above Parker and is the largest storage facility in the existing system. Thus, the reservoir is the main resource for meeting the large demands in the lower basin.

A large amount of the spring chinook spawning habitat in the basin is located in the Cle Elum River and in the Yakima River above the confluence with the Cle Elum River. All of these factors lead to conflicting needs for the operational releases from the reservoir.

The lower basin demands during the summer months (July and August) are mostly met from releases from Cle Elum. A larger portion of the lower basin demands during the spring chinook salmon spawning period (September and October) are met from releases from Rimrock.

Clear Lake

Supplementing flows and regulating Clear Lake (upstream from Rimrock Lake) are negligible when considering Clear Lake's small capacity (5,300 acre-feet) and its nearness to Rimrock Lake.

Hydrology Model Diversion Demands

The data show that actual monthly and annual diversions (demand) are normally significantly less than the entitlement amounts, which were established as maximum diversion limits by the 1945 Consent Decree and the contracts between the water users and Bureau of Reclamation (Reclamation). The Kittitas-Roza diversion bypass canals are used in the model to simulate various options of using excess capacity of the canal to divert water at Easton and "piggy-back" the water to different locations. The average diversion demand of the canals used in the hydrology model was derived using the measured (recorded) data for the years of full supply from 1970 through 1994 where available. Missing diversion data were estimated. The average monthly diversion demands during years of full water supply from 1970 through 1994 are presented in table A-1 in Appendix A "Surface Water Hydrology" for all of the canals in the basin. The table shows a total of about 2,450,000 acre-feet of total annual average model diversion demand. The Wapato Irrigation Project and the five major irrigation districts (Kittitas, Roza, Tieton, Sunnyside, and Kennewick) accounted for about 85 percent of the total diversions shown in table A-1. The data in this table were used in the hydrology modeling studies in the basin.

Shortages

Shortage is defined as the amount of demand or entitlement, whichever is less in a given month, minus the amount available for diversion in any given period of time. The hydrology model assumes that the demands associated with the available flow and the nonproratable rights are always met up to the entitlement or demand, whichever is less. The model user sets the amount of floodflow diversion and proratable right for each diversion in each irrigation season. Although judgment is involved in setting these amounts, the assignment is made based on the water supply conditions for the given year, which is similar to what is done in actual operation. Generally, if proration is imminent, floodflow diversion is restricted. Furthermore, it should be noted that any demand during any year is fully met during the months November through March.

Return Flows

General hydrologic return flow characteristics within the Yakima River Basin must be understood. Therefore, the following summarizes these characteristics in the three subareas within the basin.

Yakima River Above the Yakima River Canyon (Kittitas Valley).—The total average yearly diversions from the Yakima River above the canyon are about 500,000 acre-feet. The return flows resulting from these diversions enter the river upstream of the canyon. The diversion of water from the river during the early part of the irrigation season in this subarea, when the flows are unregulated, generates usable water through return flows to the river during the middle to later part of the irrigation season. Furthermore, most

return flows from this subarea are available for uses such as subsequent irrigation diversion or instream flows, except for return flows that re-enter the river after the end of irrigation season.

Yakima River From Roza Diversion Dam to Sunnyside Diversion Dam (Moxee Part of Yakima Valley).—All of the return flows resulting from the diversions from the Naches River and the Yakima River in the Moxee Valley enter the Yakima River in this subarea. Like the Kittitas Valley, diverting water from the river during the early part of the irrigation season when the flows are unregulated generates usable water via return flows during the middle to later part of the irrigation season. However, this diversion reduces spring freshets and/or modifies their timing in ways that do not effectively benefit fish runs.

Yakima Valley Residual Portion (Yakima Valley Downstream from Sunnyside Diversion Dam to Prosser Diversion Dam).—The total diversions from the Yakima River amount to about 1,400,000 acre-feet annually. The return flows resulting from these diversions accrue to the Yakima River primarily in the area downstream from the Parker gauge. The return flows in this portion of the valley are a part of the water supply for the Kennewick Irrigation District and the total flow at Prosser Diversion Dam.

For each acre-foot of water diverted from the river, a portion returns to the river downstream from the point of diversion. This water returns both on the surface and underground. The lag time for return flows for most of the canals is up to 2 months beyond the month of the diversion. In general, about half of the total return flow for a given diversion returns to the river during the same month that the diversion occurred. This portion of the return flow is generally made up of operational waste and short-term field runoff. Canals that divert for power production are exceptions to these generalities.

3.2.2 Pre-Title XII Operations (Before 1995) and Model Considerations

Target Flows

A list of the monthly minimum flows used in the model for pre-Title XII conditions is shown in table 3-3. These flows are used as a basis for quantifying storage release for instream flows and are considered the "existing instream flow agreements."

Table 3-4 shows the flows implemented in 1995. These flows are stipulated in Title XII at Parker and Prosser, based on the forecasted total water supply available (TWSA).

Table 3-3.—Pre-Title XII target flows (monthly)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
Yakima River at Prosser	200	200	50	50	50	200	200	200	200	100	50	200
Cle Elum River at Cle Elum	300	300	300	300	300	300	300	300	300	300	300	300
Yakima River at Parker	300	300	300	300	300	300	300	300	300	300	300	300
Naches River at Naches	300	300	300	300	300	300	300	300	300	300	300	300
Yakima River at Pomona	100	100	100	100	100	100	100	100	100	100	100	100
Bumping River at Nile	15	15	15	15	15	15	15	15	15	15	15	15
Yakima River at Cle Elum	100	100	100	100	100	100	100	100	100	100	100	100
Tieton River at Tieton Canal	125	125	125	125	125	125	125	125	125	125	125	125
Yakima River at Easton	30	30	30	30	30	30	30	30	30	30	30	30
Tieton River at Tieton Dam	20	20	20	20	20	20	20	20	20	20	20	20
Yakima River at Martin	20	20	20	20	20	20	20	20	20	20	20	20

Table 3-4.—Title XII target flows based on TWSA

TWSA (million acre-feet)				Parker and Prosser flows (ft^3/s)
Apr-Sept	May-Sept	Jun-Sept	Jul-Sept	
3.2	2.9	2.4	1.9	600
2.9	2.65	2.2	1.7	500
2.65	2.4	2.0	1.5	400
Less than above TWSA				300

Reservoir Releases

Releases from the storage reservoirs of the Yakima River system are made for three purposes: (1) irrigation demand, (2) flood control, and (3) instream flows. Throughout the irrigation season, late March through October, release of water from the six Yakima Project reservoirs is made to meet diversion demands. In the fall, winter, and spring months, releases are made in conjunction with system flood control guidelines, and, as the reservoirs are filled, the spring freshets are significantly modified.

Each year, as unregulated runoff recedes and irrigation demand increases, a point is reached where irrigation demand exceeds unregulated flow (usually late June or early July), and the system changes to storage control. During storage control, the flow passing Sunnyside Diversion Dam is controlled to a target level to minimize spill. Generally, the return flows and unregulated flow are sufficient downstream from this point to meet diversion demands. During the period of storage control before September, meeting lower basin demands from Cle Elum Lake is emphasized, and most of the demands above the Cle Elum River are met from Keechelus Lake.

After September 10 and into early October, most of the demand of the lower basin is met by releases from Rimrock Lake below Tieton Dam, and most of the upper basin demand is met from Kachess Lake. The objective of these releases, beyond continued diversion delivery, is to restrict the flow to target levels during September at Martin, Easton, and Roslyn. The reason for this "flip-flop" of releases is to keep spring chinook spawning and subsequent incubation flows as low as possible at this time in the channel, so incubation flows can be kept as low as possible the following winter, and to minimize the potential impact on irrigation water supplies. "Reduced" spawning flows with "flip-flop" are generally at or above the historic flow levels (see figure 3-1a).

In many years, releases needed to meet irrigation diversions will result in flows higher than desired. As incubation levels are assumed to be the same as stream levels, some egg mortality would probably occur. After mid-October, natural runoff is usually sufficient to meet any diversion demands without storage release. During mid-October through March, a portion of reservoir inflow is allowed to pass through to avoid dewatering redds.

Additional analyses are required to develop detailed operational criteria to be used in guiding project operations. These criteria could include use of runoff forecasts and current storage, precipitation, and irrigation demand information with tools and hydrology models in conjunction with specific instream flow levels. The information and criteria could be used to specify timing and quantities of reservoir releases and to explore alternatives and consequences of various operational schemes.

Hydroelectric Generation

Three hydroelectric powerplants are located along the Yakima River system which have impacts on the flow regime at their respective diversion dams. The Wapatox Power Plant on the Naches River is owned and operated by Pacific Power and Light Company. This powerplant has a recognized nonprorated limiting agreement right of 300 ft^3/s and can divert up to 450 ft^3/s when flow is incidentally available. The diversion opportunity at this powerplant is reduced in years when the reservoir system is drafted to meet the target flows at Parker. The Chandler Pumping Plant uses water from the Chandler Power Canal to operate pumps to convey water across the Yakima River into the Kennewick Main Canal (refer to the "Chandler Pumping Plant" subheading under the Section 2.1.2 "Project Operations and Facilities Modifications." The other hydroelectric facility is the Roza Power Plant, which is located along Roza Canal northeast of the city of Yakima. Water is diverted into the canal about 10 miles north of the city. The powerplant has 11,250 kilowatt (kW) of capacity.

Kittitas Canal Bypass

A portion of the storage released upstream from Easton is passed downstream to meet diversion demands. The Kittitas Canal diverts from Lake Easton, parallels the river, and has a number of wasteway facilities which pass water into the river. When spring chinook are spawning in the reach below Easton Diversion Dam (September), irrigation water volume is less than canal capacity. Then the canal is used along with wasteway 1146 to carry a portion of the flow that would normally pass over Easton Diversion Dam. Wasteway 1146 returns a portion of water diverted at Easton Diversion Dam to the Yakima River below the Swauk Creek confluence. The same canal system is also used to carry water for augmentation of flows in Taneum Creek. This usage allows the target flow below Easton Diversion Dam to be maintained, while releases from Keechelus and Kachess are continued for downstream demand. The amount of flow bypassed ranges from about 20 to 400 ft^3/s, and peak average monthly flow is about 300 ft^3/s.

"Flip-Flop" Operation

The "flip-flop" operation is incorporated in the model through the use of reservoir operation parameters. The basic concept is to draft heavily from Keechelus, Kachess, and Cle Elum Lakes on the Yakima arm to meet lower basin demands during the summer (July and

August) and store water in Clear, Tieton, and Bumping Lakes (Naches arm) for lower basin demands later in the year. In the fall (September and October), most lower basin demands are met from the Naches resources, and the upper Yakima reservoir releases are stored. This operation causes the fish to spawn at lower river stage levels, so the flows required to keep the redds watered during the incubation period (November through March) are minimized. Restraining to low flows also allows the reservoirs to store the winter runoff for the next irrigation season.

Other Model Considerations

In the future, operational criteria will need to be established for any plan to be considered for meeting the basin demands. The hydrology model simulates what could be done to meet the demands if the historical runoff sequence were to reoccur. In actual practice, reservoir releases are made in anticipation of demands. Because the demands change day to day, a lag occurs between the time and location of release versus that of the demands, and local runoff to the system will vary from that which has occurred historically. In the future, releases from the storage reservoirs are anticipated to differ from those simulated in the operation studies.

Instead of developing operational criteria for each reservoir for various model analyses, the model simulates operation strictly on a demand basis; no provisions are made for stipulated carry-over amounts or multiyear operational objectives. This assumption appears to be acceptable for the monthly simulation of the Yakima River system. The input to the model can be varied to dictate which reservoir or reservoirs will release water to meet demands for a branch of the river system when the local runoff is insufficient to meet the demands. Flood control is simulated to a degree simply by setting monthly maximum content levels for each reservoir.

3.3 Surface Water Quality

The following is a summary of the historical and current water quality characteristics of the surface water in the Yakima River Basin. The discussion that follows summarizes the existing water quality of the Yakima River and the agricultural drains that discharge return flows to the river. The water quality discussion is limited to summarizing the levels of those water quality parameters in the Yakima River and drains that are or can be of concern and can be impacted by implementing the YRBWEP. Much more detailed and complete discussions of the water quality throughout the basin are presented in the USGS report entitled "Surface-Water-Quality Assessment of the Yakima River Basin, Washington: Analysis of Available Water-Quality Data Through 1985 Water Year" (1991), in Volume I of the *Yakima River Basin Water Quality Plan* prepared by the Yakima Valley Conference of Governments (1995), and in the "Technical Report: Lower Yakima River TMDL" by the Washington State Department of Ecology (WDOE). The data and summaries presented here are primarily taken from the first two of the reports listed above.

3.3.1 Surface Water Quality Overview

Water quality in headwater streams and the upper Yakima River is high but degrades in moving downstream to the mouth. This degradation is caused both by natural processes and the impacts from man's activities. Point and nonpoint sources of contamination affect water quality.

Most water quality constituent concentrations in the mainstem have shown increases downstream and are largest in tributaries that contained agricultural return flow and point source discharges. The highest concentration levels of turbidity, nutrients, bacteria, and pesticides occur in agricultural drains rather than in the mainstem or natural tributaries and, therefore, cause degradation in the water quality of the Yakima River downstream from the drain discharge points. As indicated in USGS (1991), more than 70 percent of the irrigated land, 90 percent of the point source nutrient loads, and more than 80 percent of the population are located in the middle and lower basin areas downstream from Kittitas Valley. The greatest impacts generally occur downstream from Wilson Creek, which receives agricultural return flow from Kittitas Valley.

Observed trends in constituent concentrations (USGS, 1991) were detected at 43 locations in the Yakima River Basin during the 1974-1981 water years. A general decrease since 1970 in turbidity and concentrations of suspended sediment and phosphorus was indicated. The reductions may have been caused by changes in crop types from row crops to less erosive permanent crops (orchards) and to efforts to control erosion (sediment detention ponds, sprinkler irrigation, etc.). Water quality constituent values indicate that current water quality standards for turbidity, total DDT and other pesticides, stream temperature, pH, fecal-coliform bacteria, and dissolved oxygen are not met on the mainstem at various times. In addition, phosphorus concentrations have been detected on occasion at levels of concern relative to effects on aquatic life and eutrophication.

Currently, WDOE is conducting a total maximum daily load (TMDL) process for the Yakima River. In 1994 and 1995, WDOE conducted field water quality monitoring in the basin to collect additional sediment and pesticide water quality data and to determine the relationship between total suspended solids and turbidity and the relationship of the levels of suspended solids and levels of DDT. Joy and Patterson (1996) presented the results of the 1994-1995 water quality monitoring. One of the main water quality parameters the TMDL process focused on is DDT. Because of the DDT and suspended sediment concentration relation that exists, the TMDL process will focus on controlling suspended sediment concentrations in the drain water discharged to the Yakima River. The TMDL process will identify agricultural best management practices that can be used to meet clean water goals for the Yakima River.

In addition, every 2 years, WDOE publishes a list of proposed "impaired waterbodies," as required by section 303(d) of the Federal Clean Water Act. The list was approved by the Environmental Protection Agency (EPA) in April 1997. The 303(d) list identifies tributaries to and designated segments of the Yakima River where instream flows have been deemed inadequate to protect beneficial uses.

Six tributary streams and the mainstem of the Yakima River in the lower basin are listed on the 303(d) list for inadequate instream flow: Cowiche Creek, Wenas Creek, Big Creek, Taneum Creek, Manastash Creek, and the Teanaway River. These six streams commonly go dry or nearly dry in the late summer months because of irrigation diversions and, as a result, all characteristic uses for Class A waters are not met. In addition to flow impairment, the 303(d) list shows the Yakima River segments that currently fail to meet water quality standards for dissolved oxygen, pH, ammonia, temperature, fecal coliform bacteria, turbidity, and various pesticides.

During the last 100 years or so, flows in the mainstem of the Yakima River have dropped to very low levels at Sunnyside Diversion Dam and again downstream at Prosser Diversion Dam. These dams divert water for irrigation and have significantly impacted the flow in the river. The low flows contribute to temperature problems, low dissolved oxygen, and limited mixing with sediment-laden flows from Sulphur Creek, Granger Drain, and some other smaller drains.

The water quality parameters discussed hereafter are limited to those constituents that appear to be of most concern and would potentially be impacted by implementation of the various components of the YRBWEP. These parameters are nutrients, turbidity or suspended sediment, stream temperature, and pesticides. A brief discussion of each of these parameters and a summary of the general levels that exist in the Yakima River and the agricultural return flow drains follows. Additional details are contained in the above references and in recent data reports by WDOE.

3.3.2 Yakima River Nutrients

Phosphorus and nitrogen are essential nutrients for aquatic plant growth and, in sufficiently large concentrations, can adversely affect water quality through eutrophication, toxicity to aquatic life, and toxicity to warm-blooded animals that drink the water. Forms of nutrients that are readily available for biological uptake include orthophosphate and nitrite plus nitrate. Sources of phosphorus in the basin include the breakdown and erosion of minerals in soils, decaying vegetation, phosphate fertilizers, sewage effluent, and wastes from animals. Nitrogen sources in the basin include agricultural fertilizers, organic wastes, and atmospheric deposition.

Nutrient concentrations in the Yakima River Basin from 1941-1985 were similar to those concentrations observed in many rivers in the United States. Median concentrations in other rivers in the United States are 0.13 and 0.41 milligram per liter (mg/L) for total phosphorus (as P) and nitrite plus nitrate (as N) respectively; median concentrations for all data from the Yakima River Basin are 0.12 and 0.36 mg/L for total phosphorus and nitrite plus nitrate, respectively. Table 3-5 presents a summary of the spatial variation of nutrient concentrations in the Yakima River from USGS for the period 1974 through 1981.

Table 3-5.—Spatial variation of water quality constituents—Yakima River

Water quality constituent	Concentrations in mg/L	
	Upper[1]	Lower[2]
Total phosphorus, as P		
Median	0.04	0.13
Range	<0.01 to 0.32	<0.01 to 0.57
Nitrite plus nitrate, as N		
Median	0.13	1.0
Range	<0.01 to 2.50	<0.01 to 6.50
Suspended sediment		
Median	10.0	26.0
Range	<1.0 to 535	<1.0 to 490
Stream temperature (°C)		
Median	9.0	12.8
Range	0 to 20.3	0 to 27.3

[1] Upper reach extends from the headwaters of the Yakima River to below the city of Yakima at Union Gap.
[2] Lower reach extends from Union Gap to the mouth of the Yakima River.

3.3.3 Yakima River Suspended Sediment

Suspended sediment movement in streams is an important factor in the transport and presence of chemicals in the environment. Sediment may be transported in the water column or may settle out as streambed sediment for a period of time. Sediment deposition can cover the streambeds, thereby:

- Reducing benthic invertebrate populations
- Inundating gravel spawning beds
- If organically enriched, depleting dissolved oxygen in the overlying water for fish

Consequently, large suspended sediment concentrations and associated contaminants degrade water quality used for aquatic life propagation and recreation. Large suspended sediment concentrations often are associated with intense storm events that increase streamflows, soil erosion, channel erosion, and resuspension of bed sediment. Significant suspended sediment concentrations in the Yakima River are also associated with the discharge of agricultural return flows to the river, most importantly in the lower part of the basin. The spatial variations of suspended sediment concentrations for the Yakima River are shown in table 3-5. The first significant increase in median values occurred at Union Gap. Multiple site comparisons of sediment concentrations in the basin downstream from Union Gap indicate that the concentrations are similar from site to site and are similar to concentrations in the major tributaries (which consist primarily of agricultural return flows during the irrigation season). This similarity is expected because major sources of water in the mainstem (except during winter runoff and spring snowmelt) are agricultural return flows.

Joy and Patterson (1996) discuss the turbidity criterion as related to suspended sediment. The TMDL recommendation in the report says that the turbidity shall not exceed 5 nephelometric turbidity units (NTU) over background when the background turbidity is 50 NTU or less, or have more than a 10-percent increase in turbidity when the background is more than 50 NTU. The 5-NTU criterion is recommended to be applied to the mainstem Yakima River between the confluence of the Naches and Yakima Rivers and the Kiona gauge during the irrigation season. A TMDL target of 25 NTU (or 56 mg/L total suspended solids based upon the equation above) is further recommended for the mouths of tributaries and return drains. However, the report indicates that total suspended solids load targets are not set for project area tributaries and drains because water availability is so variable.

3.3.4 Yakima River Water Temperature

The main factors that control the mainstem water temperatures are streamflow (river morphology and slope), air temperature, rate of vertical mixing, time of travel, and the temperature of inflowing water from natural tributaries (including groundwater discharge), canal wasteways, and agricultural drains. Water in the upper basin is cold but warms as the river flows to the lower basin. As water flows through the stream reaches with a high rate of vertical mixing, the water temperature quickly equilibrates near air temperature. Slow moving water in shallow reaches will increase in temperature because of the long exposure time to the sun, particularly where shading riparian vegetation is missing. Fast flowing water in deep channels with minimal roughness, such as in canals, will increase in temperature the least. In the lower portion of the basin, the mainstem temperatures in the late summer tend to be similar to the temperatures of the agricultural return flows because a high percentage of the riverflow in the late summer is return flows from agriculture.

According to the USGS (1991) report, about 5 percent of the water temperature measurements from 1959-1985 exceeded State standards; the highest temperatures have occurred in the lower portion of the basin.

Table 3-5 shows the spatial distribution of water temperatures in the Yakima River. Median water temperatures are lowest upstream from Parker because of cooler air temperatures. Below the Wapato Canal diversion, median temperatures show an increase, reflecting the increases in quantities of agricultural return flows. Much of the summer heating of the river water is associated with: (1) low flows downstream from the Sunnyside Canal diversion, (2) slow stream velocities caused by a low stream gradient, and (3) low flows below Prosser Dam.

3.3.5 Pesticides

Pesticides (DDT and its metabolites, endosulphan, dieldrin, and others, as well as PCB-1260) are widespread low-level contaminants that have been observed in water and

sediment samples in the Yakima River system. In 1993, a Washington Department of Health advisory recommended that people eat fewer bottom fish from the lower Yakima River Basin. The concentrations of dieldrin and DDT compounds have apparently been decreasing (USGS, 1991) since the early 1970s because of the EPA ban on the use of DDT in 1972 and the ban in the production of dieldrin in 1974. However, these pesticides still show up in the drains and, subsequently, the Yakima River because of the residuals that exist in the irrigated soils in the basin. These compounds tend to adsorb to soils; subsequently, the sediment that is eroded from the agricultural fields is carried by the irrigation return flow water to the Yakima River. DDT was originally deposited in the irrigated soils decades ago when it was commonly used in agriculture. Recent water quality data have shown that the largest concentrations of DDT and dieldrin have occurred at sites that also have the largest suspended sediment concentrations. This relation suggests that reducing suspended sediment concentrations in the drains would result in reduced concentrations of DDT and other pesticides in the Yakima River.

3.3.6 Drains

Table 3-6 presents a summary of the historical water quality characteristics of the agricultural return flows in selected drains in from 1974 through 1981 time period (USGS, 1991).

Table 3-6.—Seasonal variation of median values of selected water quality constituents—drains to the Yakima River

Site name	Total phosphorus (mg/L)				Nitrite plus nitrate (mg/L)			
	Oct-Dec	Jan-Mar	Apr-Jun	May-Sept	Oct-Dec	Jan-Mar	Apr-Jun	May-Sept
Wilson Creek	.09	.13	.12	.11	0.27	0.36	0.24	0.24
Moxee Drain	.36	.41	.42	.36	2.73	2.53	.67	.80
Marion Drain	.14	.14	.15	.13	3.14	3.45	1.90	2.16
East Toppenish Drain	.54	.75	.34	.22	3.01	2.78	1.80	2.20
Granger Drain	.31	.29	.61	.42	3.32	3.68	2.02	1.66
Sulphur Creek	.27	.31	.34	.27	5.24	5.75	1.69	1.92
	Suspended sediment (mg/L)				Streamflow (ft^3/s)			
Wilson Creek	10	26	21	10	65	75	105	95
Moxee Drain	11	38	168	130	25	9	50	64
Marion Drain	8	20	33	15	150	150	250	200
East Toppenish Drain	8	8	28	14	17	8	25	44
Granger Drain	42	41	204	116	28	27	37	37
Sulphur Creek	27	38	96	66	120	80	230	250

Seasonal variations of the median values of selected parameters for some of the typical drains in the Yakima River area are presented in the table. Comparing data in tables 3-5 and 3-6 shows that the median values for total phosphorus, nitrite plus nitrate, and suspended sediment are considerably higher in the drains than in the Yakima River. The differences are particularly evident for suspended sediment for some of the drains, specifically Moxee and Granger drains and Sulphur Creek. In the lower portions of the Yakima River during the irrigation season, a large portion of the mainstem flow in most years consists of irrigation return flows. Therefore, parameter concentrations in the drain water, such as suspended sediment, can have a major influence on the same parameter concentrations in the mainstem of the Yakima River, particularly in the lower reaches of the basin during the irrigation season. Joy and Patterson (1996) discuss the suspended sediment in the tributaries and drains in much more detail and include water quality data from 1994 and 1995. The report discusses the levels of reductions necessary to meet the TMDL target criterion of 25 NTU.

3.4 Groundwater

3.4.1 Geological Setting

The occurrence, movement, and availability of groundwater are controlled, to a large degree, by the geological setting of the aquifer system; in particular, the geometry and boundaries of the aquifer and the hydraulic characteristics of the rock materials that make up the aquifer system. Other factors controlling the groundwater flow system include the distribution and rates of recharge and discharge and the development and use of the groundwater resource. Figure 3-3 is a stratigraphic column which describes the major geologic formations found in the Yakima Basin and their hydrologic characteristics.

3.4.2 Bedrock Geology

Figure 3-4 presents a view of the Yakima River Basin surface geology and was adapted from Kinnison and Sceva (1963). Several other studies in the region, especially Drost and Whiteman (1986), Drost et al. (1990), and U.S. Army Corps of Engineers (Corps) (1978), provided the majority of the geologic information for the following description.

The headwaters of the Yakima River are located on the eastern flank of the Cascade Mountains. Most of the rocks in the upper drainage basin are volcanic and sedimentary formations of Tertiary (2 to 65 million years ago). Pre-Tertiary metamorphics are exposed locally in the Kachess River Valley and the Tieton River Valley. In general, most of the igneous and metamorphic rocks in the upper basin have low permeability and are limited in area.

<table>
<tr><th colspan="3">Age</th><th colspan="2">Description</th></tr>
<tr><th>Period</th><th>Epoch</th><th>Approximate years before present</th><th>Geologic unit</th><th>Hydrologic characteristics</th></tr>
<tr><td rowspan="3">Quaternary</td><td>Recent</td><td>10,000 years</td><td>Sedimentary Deposits - Alluvium and Colluvium</td><td rowspan="2">Porosity and permeability ranges greatly, can be very high. Provides groundwater component of streamflow and serves as important aquifer.</td></tr>
<tr><td rowspan="2">Pleistocene</td><td rowspan="2">2 million years</td><td>Catastrophic Flood and Glacial Deposits</td></tr>
<tr><td>Tieton Andesite</td><td>Porosity and permeability probably similar to Columbia River Basalts Group (CRBG).</td></tr>
<tr><td rowspan="6">Tertiary</td><td>Pliocene</td><td>5 million years</td><td rowspan="3">Ellensburg Formation</td><td rowspan="5">Ellensburg Formation has moderate to high porosity and low to medium permeability. Permeable strata form important aquifers. CRBG water generally moves along interflow zones at top and bottom of individual flows. Permeability ranges from low (in centers of flows) to very high. Very important aquifers in Yakima River Basin.</td></tr>
<tr><td rowspan="2">Miocene</td><td rowspan="2">24 million years</td></tr>
<tr><td>Columbia River Basalts</td></tr>
<tr><td>Oligocene</td><td>38 million years</td><td rowspan="2">Continental Sedimentary Formations, Undifferentiated and Teanaway Basalt</td><td rowspan="3">Overall effective porosity and permeability are low except some of the volcanics, which are probably similar to CRBG.</td></tr>
<tr><td>Eocene</td><td>55 million years</td></tr>
<tr><td>Paleocene</td><td>65 million years</td><td rowspan="2">Pre-Miocene Metamorphic and Igneous Rocks, Undifferentiated</td></tr>
<tr><td>Pre-Tertiary</td><td></td><td></td><td></td></tr>
</table>

Figure 3-3.—Generalized stratigraphic column adapted from YVCOG (1993).

Geologic map of the Yakima River Basin

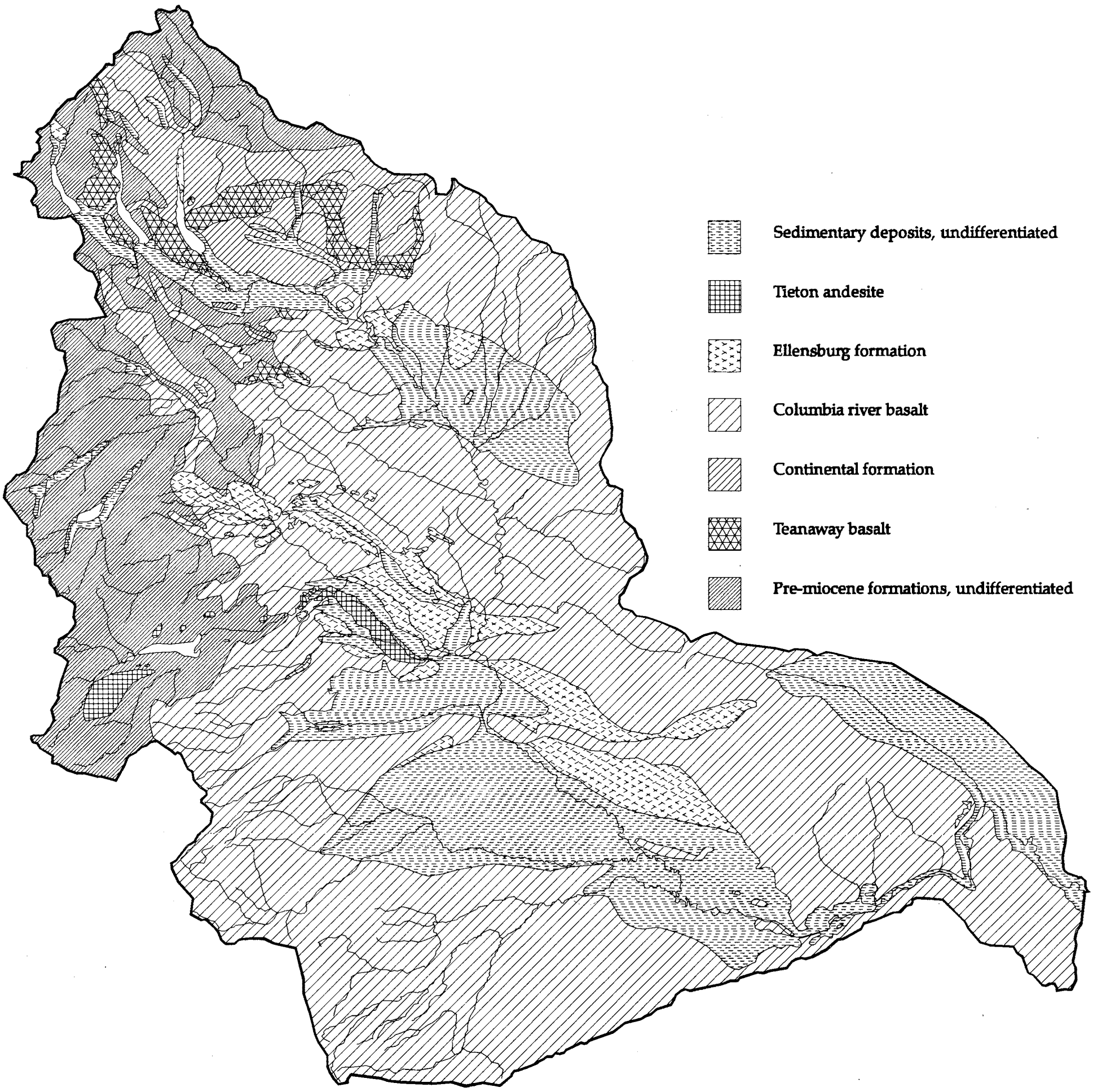


Figure 3-4.—Geologic map of the Yakima River Basin.

Rocks of the Columbia River Basalt Group (CRBG) underlie the central and lower Yakima drainage basin. Basalt flows lap onto the eastern edge of the Cascade Mountains and are interfingered with sediments that were eroded from the rising mountains. These sediments are termed the Ellensburg Formation and consist of volcanic and sedimentary rocks and unconsolidated lacustrine and alluvial deposits.

Geologic structures, such as folds and faults, alter the groundwater flow pattern. Folds alter the structural attitude and position of the basalt, which affects the direction of groundwater flow. A series of anticlines and synclines (folded ridges and troughs) dominates the topography in the lower Yakima River Basin. These east-west trending structures were formed as a result of major uparching of the northern Cascades caused by north-south compressional forces during the Tertiary. The uplift of the ridges was concurrent with the latest basalt flows, which occurred slowly enough to allow the Yakima River to maintain its course across the structures, as seen at Union Gap where the river flows through Ahtanum Ridge. The bedrock folds are important to the surface water and groundwater systems in that they determine flow patterns and form hydrologic boundaries.

In the Yakima area, basalt flows are part of the Yakima Basalt Subgroup, which is comprised of three major formations: the Grande Ronde, the Wanapum, and the Saddle Mountains Basalts. The Grande Ronde is the oldest and most voluminous of the three formations. The Grande Ronde is buried by younger basalts and sedimentary deposits in most areas of the Yakima River Basin. The Wanapum Basalt is exposed primarily along the axes of anticlinal ridges northeast of Yakima and along the Ahtanum Ridge west of Union Gap. The Wanapum ranges in thickness from a few feet, where it pinches out against exposures of the Grande Ronde Basalt, to several hundred feet. The Wanapum Basalt is generally overlain by Saddle Mountains Basalt or by thick sequences of sediments.

The Saddle Mountains Basalt is the youngest formation of the Yakima Basalts and was erupted during a period of waning volcanism, accelerated folding, canyon cutting, and development of thick sedimentary deposits between flows. It is primarily exposed along the flanks of anticlinal ridges. Within the lower drainage basin, the Saddle Mountains Basalt is generally buried by Ellensburg Formation sediments or by recent alluvial sediments. Sedimentary interbeds are common in the Saddle Mountains Basalt and are relatively thick, commonly 50 feet or greater.

The Ellensburg Formation is comprised of semiconsolidated to consolidated sedimentary rocks and sediments derived from parent materials in the Cascade Range. Thickness of the formation varies throughout the basin but ranges from a few feet to over 1,000 feet. Multiple, laterally discontinuous aquifers within the Ellensburg Formation and postbasalt sediments transmit large quantities of groundwater in the Kittitas and lower Yakima Valleys. These overburden formations are important to the local, shallow groundwater systems and, in some areas, can control the amount of water exchanged between the shallow groundwater systems and the basalt aquifers.

3.4.3 Unconsolidated Deposits

During the late Pleistocene, rivers cut through glacial deposits in the alpine valleys, leaving a series of terraces. These outwash terraces are prominent along the upper Yakima River and its tributary valleys. The glacial deposits are a heterogeneous mixture of clay, silt, sand, gravel, and cobbles. The upper reservoirs in the drainage basin, Keechelus, Kachess, Cle Elum, and Bumping, were natural lakes formed by the glaciers. At each site, the glacially deposited terminal moraine was used as the foundation for the manmade dam embankment, and the lakes were enlarged to increase storage capacity.

Glacial outwash, reworked glacial deposits, and recently deposited river alluvium are important aquifers, primarily because of their storage capacities and high permeabilities. The aquifers are recharged during periods of high runoff and precipitation. They discharge to streams during late season dry periods and help maintain stream base flows.

Synclinal troughs in the lower Yakima River Basin are partially filled with a mixture of sediments. Some of the sediments are from the Ellensburg Formation, eroded from the surrounding anticlinal ridges (colluvium), recently deposited river alluvium, and from windblown (eolian) sand and silt.

Most colluvial soils in the Yakima River Basin have high infiltration rates (Corps, 1978). The alluvial deposits range in thickness from a few feet to over 50 feet along the Yakima River in the Toppenish area. The alluvium is generally pervious and is a productive aquifer yielding large quantities of water.

Glaciolacustrine deposits of varved sands and silts occur in the lower Yakima River Basin to an elevation of about 1200 feet. They range locally to 150 feet in thickness and generally have low infiltration rates. Eolian silt and fine sand mantles much of the Yakima River Basin. Thickness ranges from a few inches to tens of feet. Sand dunes up to 20 feet high occur in the southeastern part of the basin. Infiltration rates in these materials vary, depending on the proportion of silt in the silt and sand mixture.

3.4.4 Hydrogeology

The Yakima River Basin consists of three principal aquifer systems: the unconfined alluvial aquifer system, the Ellensburg Formation/postbasalt aquifer system, and the Yakima Basalt aquifer system. The alluvial aquifer is an unconfined system consisting primarily of stream channel and flood plain deposits. This aquifer has a direct hydraulic connection with the surface water.

The Ellensburg Formation/postbasalt aquifer system consists of several confined aquifers having different confining pressures. The more productive aquifers are those located in permeable layers of gravel and well-sorted sand. Confining strata generally consist of clay or relatively impermeable basalt. In the lower part of the Ellensburg Formation, several flows of the Saddle Mountains Basalt are interbedded with the sediments. Well yields

from the various aquifers vary greatly. In the Kittitas and Yakima Valleys, where the formation thickness reaches 1,200 feet, wells yield as much as 1,500 gallons per minute. In areas where the sediments are fine grained and less permeable, yields are lower (Corps, 1978).

The basalt aquifer system contains several hydrogeologic units: from youngest to oldest, the Saddle Mountains unit, an upper confining layer, the Wanapum unit, a lower confining layer, and the Grande Ronde unit. Within these units are several confined aquifers. Water occurs primarily in interflow zones (the vesicular and brecciated zones at the top and bottom of individual flows).

3.4.5 Groundwater Basins

The Yakima River Basin has been divided into groundwater basins in previous reports by the USGS (Kinnison and Sceva, 1963) and the Corps (1978). This report follows the groundwater basin divisions of the Corps report. The boundaries of each basin are shown on figure 3-5.

The groundwater basins are physically separated from each other by bedrock ridges which inhibit flow across the basin boundaries. Recharge amounts and groundwater use vary from basin to basin, depending on the location within the greater Yakima River Basin and the physiography and local geologic setting.

Groundwater basins and subbasins of the Yakima River Basin:

- Roslyn
- Kittitas
- Upper Naches
- Upper Yakima
  - Roza-Umatanum
  - Wenas-Selah
  - Naches-Cowiche
  - Ahtanum-Moxee
- Lower Yakima
  - Toppenish
  - Prosser
  - Horse Heaven
- Cold Creek

3.4.6 Aquifer Recharge and Discharge

This section describes the ways that water enters (recharges) and exits (discharges) the aquifers and relates to surface flows. Groundwater recharge within a basin occurs by a combination of four mechanisms:

1. Direct precipitation/infiltration/deep percolation
2. Groundwater inflow from other basins
3. Infiltration from losing (influent) streams
4. Artificial mechanisms such as irrigation or waste disposal

Recharge rates to the unconsolidated deposits vary greatly because of variable precipitation and irrigation application rates and because of the variable permeability of the surficial soils. Direct infiltration to the basalt aquifers occurs in localized areas where the basalts are exposed, such as on anticlinal ridges.

Structural bedrock controls (anticlines and synclines) effectively isolate each groundwater basin and prevent most underflow through the alluvial and Ellensburg/postbasalt aquifers in all but the lower Yakima groundwater basin. Underflow through the basalt aquifers is probably significantly higher; however, the amount of underflow through the system has not been defined.

In certain areas, the Yakima River and its tributaries provide recharge to the groundwater system. Most of the water infiltrates into the shallow aquifers, where it is pumped by wells, captured by drains, or is returned to the surface water system near the downstream end of each basin. Some of the water, however, leaks downward to recharge the deeper aquifers.

Recharge from surface water irrigation applications maintains high water levels in the overburden (Ellensburg and alluvial) aquifers. A USGS study (Bauer and Vaccaro, 1990) estimated predevelopment and current recharge in selected basins of the Columbia Plateau from calculations using a deep percolation model. Average annual recharge in the 1850s (predevelopment) is estimated at 2.74 inches in the Kittitas Valley. Current recharge (1980s) in the same area is 9.72 inches. In the Ahtanum Valley, predevelopment recharge is estimated at 0.84 inch per year, and current recharge is 11.15 inches. About 20 to 40 percent of the water applied to agricultural lands in the lower basin infiltrates beyond the root zone and enters the groundwater system (Rockwell, 1979). The hydrology model estimates average return flows at 45 percent of surface water diversions.

Groundwater discharge also occurs by a combination of four mechanisms:

1. Natural springs and seeps
2. Groundwater outflow to other basins or vertical leakage to other aquifers
3. Groundwater outflow to gaining (effluent) streams
4. Groundwater withdrawal by wells

Groundwater Basin Boundaries Within the Yakima River Basin

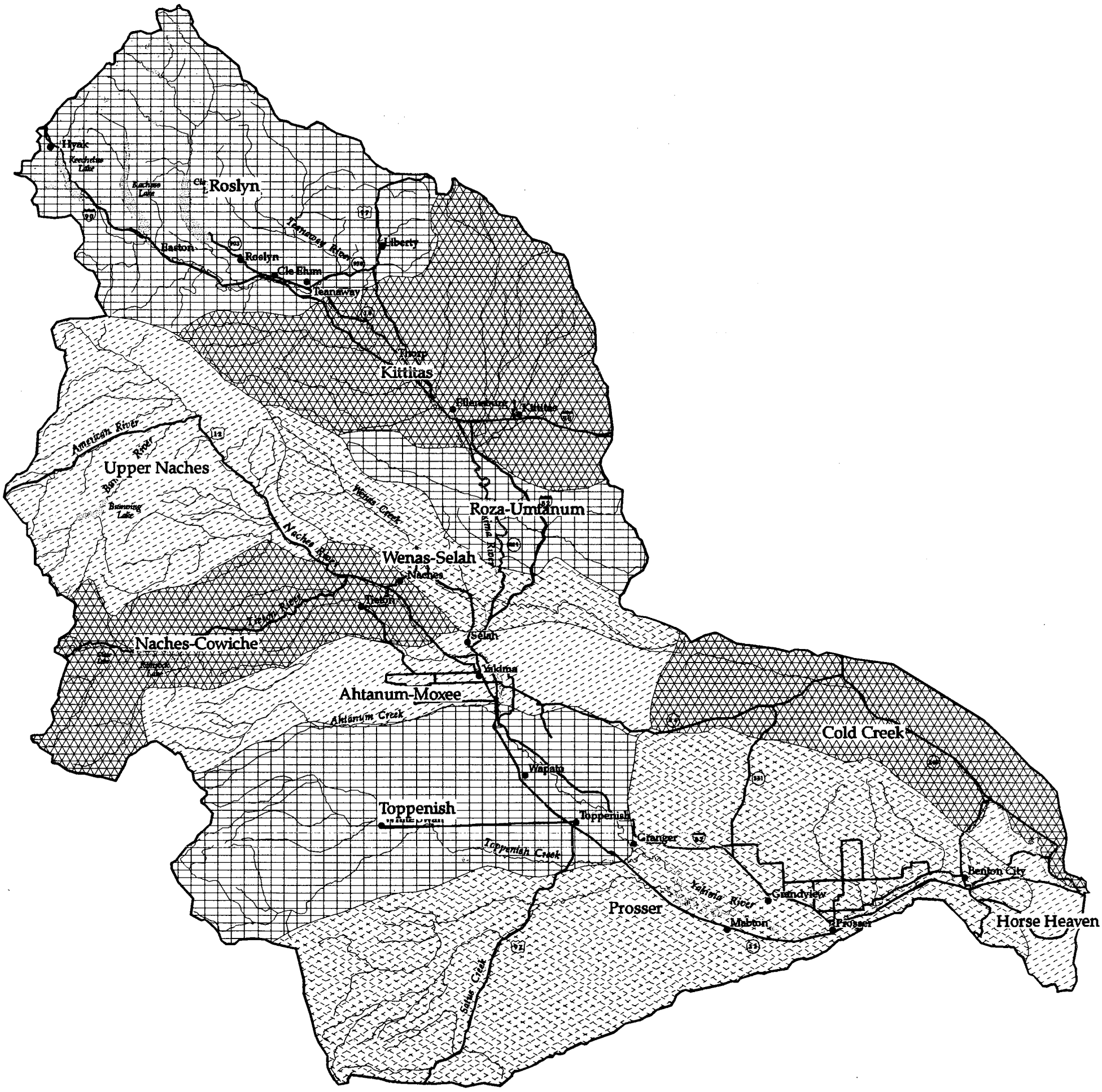


Figure 3-5.—Groundwater basin boundaries within the Yakima River Basin.

Groundwater discharge to the Yakima River occurs in all of the basins where structural bedrock constrictions prevent shallow aquifer materials from continuing from one basin to another. Complex folding can cause upward leakage to the river from the basalt and Ellensburg Formation aquifers where reduction in the aquifer transmissivities occur. At the downstream end of each basin, the groundwater is forced upward and discharges to the river, where it flows into the adjoining basin. A large volume of water is discharged from the Yakima Basalts into the overlying units (and then to the Yakima River) from vertical leakage (Foxworthy, 1962). Even though the thick, confining beds have low vertical conductivities, the high upward gradients cause a substantial amount of water to be driven from depth. Another major component of groundwater discharge is the withdrawal of groundwater by pumping wells, as further explained in the following section.

3.4.7 Groundwater Use

Water right and claim documents filed with WDOE indicate potential annual use of 840,000 acre-feet of groundwater in the Yakima River watershed. Actual annual use is unknown but is estimated at about 400,000 acre-feet (Kirk, 1995). Most groundwater use is concentrated in the Kittitas Basin and the upper and lower Yakima groundwater basins. Groundwater pumpage from wells in the Yakima River Basin is mostly for irrigation, and lesser quantities are withdrawn for municipal, industrial, and domestic uses. Table 3-7 lists the amount of groundwater, by permits/certificates and claims, listed in the State records for various uses throughout the Yakima River Basin.

Table 3-7.—Estimates of potential groundwater use in the Yakima River watershed

	(Acre-feet)	
	Groundwater permits/certificates	Groundwater claims
Irrigation	365,965	194,228
Domestic	55,169	29,892
Municipal	71,879	
Stock		1,650
Other	68,260	53,184
Total permitted use (potential use)	561,273	278,954
WDOE estimated actual use	392,891	10,000

Any groundwater user, excluding the Yakama Indian Reservation, that developed a use prior to 1945 was required to file a claim with the State in accordance with Revised Code of Washington chapter 90.14 Claims Registration Act. Estimated groundwater pumpage developed prior to 1945 is from studies completed by USGS (Cline and Collins, 1992).

About 67,628 acres are irrigated by groundwater in the Yakima River Basin (YVCOG, 1993). Irrigation of crops using groundwater began in the early 1900s with the development of artesian wells in the Moxee Valley. Advances in drilling methods and pump and irrigation equipment allowed the use of groundwater to expand rapidly in the late 1940s, both in area and in volume.

Pumpage from the overburden in the alluvial and Ellensburg Formation aquifers in Yakima County accounted for 83 percent of the total groundwater pumpage in 1945 (Cline and Collins, 1992). Although pumpage from the overburden (all unconsolidated sediments overlying the basalt) increased over three-fold, pumpage from the basalt aquifers increased more dramatically than pumpage from the overburden. Pumpage from the basalt aquifers (especially Grande Ronde and Wanapum aquifers) increased greatly after 1955.

The Wanapum aquifer is the principal aquifer for large primary irrigation projects, and water levels in this aquifer have been declining throughout most of the upper and lower Yakima groundwater basins (Kirk, 1995). Portions of the Saddle Mountains and Grande Ronde aquifers also show water level declines. WDOE is no longer issuing permits from the basalt aquifers in selected areas of the upper and lower Yakima groundwater basins.

WDOE has managed the Ellensburg Formation aquifer deliberately for municipal and domestic use, though some irrigation supply comes from this aquifer. Almost all municipalities within the watershed use groundwater to supply all or some water needs. These municipalities include Yakima, Ellensburg, Richland, Grandview, Toppenish, Union Gap, Prosser, Granger, and Moxee. Much of the recharge to the Ellensburg Formation aquifer comes from the application of irrigation water to agricultural lands. Water levels have been fairly stable, though some areas have experienced recent declines (Kirk, 1995).

The alluvial aquifer has a high degree of hydraulic connection with the streams and rivers of the Yakima watershed and, in general, WDOE does not issue any consumptive permits from this aquifer. The alluvial aquifer is found primarily along streams and rivers, though it covers nearly all of the Kittitas, Toppenish, and Ahtanum Valleys. Recharge to the aquifer is primarily from stream losses and infiltration of irrigation waters.

3.4.8 Groundwater Quality

Except for some local degradation from septic systems and industrial and agricultural activities, groundwater from all major aquifer systems in the Yakima River Basin generally meets drinking water standards (YVCOG, 1993). Only a few constituents exceeded drinking water regulation limits during a 1982 study of groundwater quality (Turney, 1986). Published data concerning some types of groundwater contamination, such as from pesticides and herbicides, are not available, however. Therefore, the overall quality of the groundwater is undefined.

Groundwater chemical composition is influenced by the source of recharge to the aquifer and the composition of rock materials through which it flows. Groundwater recharged by applying irrigation water has a higher concentration of the major solutes, especially sulfate, chloride, nitrate, and calcium. As the groundwater flows away from areas of recharge toward areas of discharge, the chemical composition changes because of reactions with the rock materials comprising the aquifer.

Principal chemical constituents in basalt groundwater include bicarbonate, calcium, sodium, and magnesium. Bicarbonate is the primary anion in basalt aquifers. Bicarbonate concentration varies with the level of total dissolved solids (TDS). Calcium, sodium, and magnesium are the primary cations in basalt aquifers. Calcium is predominant in natural recharge areas and areas with irrigation water recharge. As groundwater flows away from recharge areas, calcium concentration declines because of ion exchange processes and calcite precipitation. Magnesium follows the variation of calcium concentration at about 1/4 to 1/5 the concentration (mg/L) of calcium. Where sodium is the predominant cation, the magnesium to calcium ratio is about 1/10 to 1/4 of the calcium concentration. Sodium generally becomes more concentrated with distance from areas of natural recharge and is the predominant cation in the synclinal basins. Potassium generally follows the sodium content variation. The sodium to potassium ratio averages about 5:1 and ranges from 15:1 to 3:1.

In general, the groundwater has a low TDS content—less than 250 mg/L in the northern part of the watershed and less than 500 mg/L in the southern part. TDS concentrations are highest in heavily irrigated areas (YVCOG, 1993). In some areas, local recharge of irrigation water has increased the sulfate content in the groundwater. Sulfur compounds in agricultural fertilizers and the flushing of accumulated salts from soil horizons contribute to the higher sulfate concentrations in irrigation recharge waters. The groundwater generally contains low concentrations of chloride, though the levels are elevated in areas with recharge from irrigation and in the deeper basalt formations. Nitrate concentration is generally low (below the Federal primary maximum contaminant level of 10 mg/L) except in areas with high levels of recharge from irrigation. The average nitrate concentration is 0.6 mg/L in the northern part of the basin and 1.8 mg/L in the southern part (YVCOG, 1993). Very high nitrate levels (up to 100 mg/L) have been reported from the Satus Creek Basin presumably because of high application rates of fertilizer to asparagus fields in the area. Iron and manganese concentrations vary throughout the Yakima River Basin and frequently exceed Federal secondary maximum contaminant levels.

Isolated instances of fecal coliform contamination have been reported, but it is not a widespread problem in the basin.

3.5 Agricultural Resources

Yakima Project area is among the leading agricultural areas in the United States. It is or has ranked first in the United States in producing several crops and fruit trees. It is also a major center for producing beef cattle. Yakima County ranked fifth in the United States in total agricultural production.

3.5.1 Irrigation Diversions

Most surface water diversions in the Yakima River Basin are from Federal project diversions, incorporated irrigation districts, irrigation companies, or partnership ditches. The tributaries have some individual diversions. In incorporated irrigation districts, water rights are appropriated to lands within the irrigation district, and the district holds the rights in trust for all lands within their boundaries. Any reduction in diversions resulting from onfarm improvements must first be agreed to by the irrigation district. One-third of any saved water can be given to the irrigators during a dry year. However, a diversion reduction agreement must be in place before a given water conservation project will be authorized by Reclamation's Upper Columbia Area Office. These legal considerations will affect reducing diversions as a water conservation method.

Table 3-8 presents a summary of the measured diversions and associated irrigated areas for 1986 in the major irrigation districts in the Yakima River Basin. The Wapato Irrigation Project and the five major irrigation districts of the Yakima Project (Kittitas, Roza, Tieton, Sunnyside, and Kennewick) diverted about 90 percent of the total diversions for the major irrigation districts shown in table 3-8 during 1986. Irrigation district boundaries are shown in figure 3-6, and irrigation diversion points are depicted in figure 3-7.

3.5.2 Irrigated Lands

The irrigated lands are comprised primarily of the nearly level to strongly sloping bottom lands and lower terraces of the Kittitas, Yakima, Naches, Moxee, and Ahtanum Valleys.

Irrigated Land Use and Trends

Lands in irrigated croplands have decreased from 371,096 acres in 1982 to 360,675 acres in 1992. The lands irrigated vary from year to year depending on the water supply; 1992 through 1994 were some of the drier years on record. Table 3-9 shows the irrigated acreage of crops grown in the Yakima Project from 1982 to 1992.

Table 3-8.—Major irrigation districts and projects and measured diversions in the Yakima River Basin (1986)[1]

Name of irrigation unit	Irrigated area (acres)	1986 diversion (acre-feet)
Kittitas Reclamation District	52,900	322,000
Cascade Irrigation District	12,700	28,000
Ellensburg Town Canal	19,530	46,000
West Side Irrigation Company	7,000	24,000
Roza Irrigation District	66,600	360,000
Yakima-Tieton Irrigation District	25,600	91,000
Naches-Selah Irrigation District	9,800	38,000
Selah-Moxee Irrigation District	4,500	23,000
Moxee Sub "A"	300	2,000
Terrace Heights District	400	2,000
Union Gap Irrigation District	3,100	12,000
Yakima Valley Canal Company	3,200	17,000
Broadway Irrigation District	200	1,000
Special and Warren Act	38,500	21,000
Wapato Irrigation Project	111,000	632,000
Sunnyside Irrigation District	95,500	491,000
Kennewick Irrigation District	15,900	92,000

[1] This table shows actual diversions and acreages for a specific year and does not constitute a comprehensive list of diversions. This table does not identify which diversions represent Reclamation contracts.

Table 3-9.—Irrigated acreage of crops grown in the Yakima Project from 1982 to 1992

Crop	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Corn	14,937	13,941	21,095	18,444	13,995	10,958	8,859	14,124	12,244	13,134	13,489
Grain	52,176	48,846	43,839	35,996	32,726	27,095	26,740	27,951	31,370	19,449	27,417
Forage	136,797	139,242	135,851	146,014	134,833	135,010	134,617	136,769	140,931	139,268	139,390
Beans	7,731	1,225	2,436	2,975	2,413	2,308	2,385	3,226	3,046	2,949	3,834
Hops	28,928	27,024	23,150	21,000	20,324	23,539	23,791	23,237	26,924	28,472	29,500
Mint	15,874	14,106	16,854	18,959	15,258	13,880	15,342	16,492	19,144	19,474	18,664
Vegetables	28,267	27,521	28,587	27,655	27,296	33,045	30,041	27,185	29,818	30,108	24,158
Nursery	895	1,356	1,078	633	698	625	780	964	561	596	629
Seed crops	457	390	262	726	91	471	773	797	485	447	358
Fruits	82,071	91,566	94,080	90,570	95,000	102,231	103,281	100,017	101,146	99,580	102,226
Nuts	0	0	0	5	5	5	5	29	38	38	38
All crops	371,096	367,669	369,113	363,870	363,870	350,752	349,931	354,111	365,809	354,470	360,675

Irrigation Systems Types and Trends

Over the years, some of the irrigation methods used in the Yakima River Basin have evolved from flood irrigation to various forms of sprinkler irrigation and, in later years, to drip systems. However, drip systems still make up a small percentage of the total land irrigated by this method. Sprinkler irrigation, which is particularly favored by orchard growers, allows even disbursement of water to tree root zones and also provides an opportunity for seasonal frost protection and seasonal cooling. However, some crops such as hops and asparagus are not as amenable to sprinkler application, and farmers are converting hops to drip systems. The conversion of asparagus to drip systems is in the experimental stage. The use of sprinkler and drip irrigation systems on agricultural lands in the basin is increasing, and these improved onfarm management techniques are conserving water while reducing erosion and sedimentation problems. The reduction in surface return flows from irrigated lands has reduced erosion problems and improved water quality.

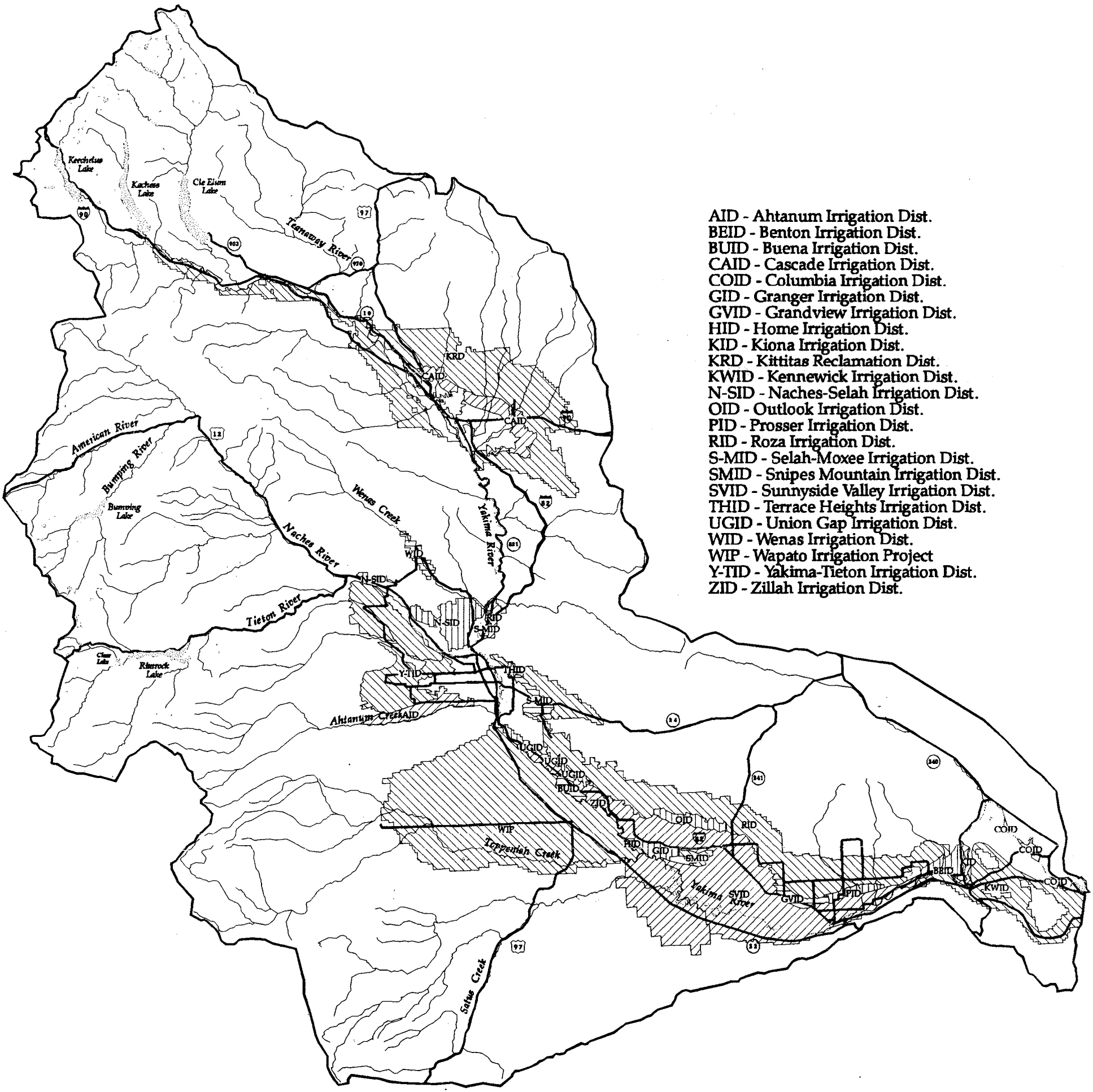
3.5.3 Cropping Pattern Trends and Crop Yields

From 1982 to 1992, orchards increased by 25 percent, grains decreased by 47 percent, row crops decreased slightly, and forage crops remained fairly constant. New varieties of apples, such as Gala and Grannie Smith, are replacing Red Delicious.

Over 45 percent of the irrigated area is used for perennial crops, including orchards, vineyards, hops, mint, and asparagus. Perennial crops require an adequate annual water supply. Plant stress in these crops, attributable to water shortages, can result in severe economic hardship to the grower because of lower production and reduced crop quality that may render them unmarketable, which occurred in 1994 and, to a lesser degree, in the mid-1970s. Water shortages can also damage plants enough to require rootstock replacement, which involves high replanting cost and continuing economic losses for several years. The prevailing trend in the area is to convert from stress-tolerant crops to the higher value crops; therefore, an adequate water supply to ensure against crop stress will become more critical.

Crop yields are generally high because of the productive soils, favorable climate, and long daylight hours attributable to the latitude. The frost-free period ranges from 130 to 190 days. Depending on the soil, average alfalfa yields vary from 4 to 8 tons per acre, winter wheat from 75 to 110 bushels per acre, apples from 330 to 1,000 bushels per acre, and field corn from 1.5 to 3.5 tons per acre. Crop yields have generally increased over the last 20 years.

Irrigation District Boundaries Within the Yakima River Basin



Scale = 1 : 700,000

NCRI • NW

Map Design and Cartography
by NCRI-NW
Central Washington University
Ellensburg, Washington

Figure 3-6.—Irrigation district and project boundaries within the Yakima River Basin.

Irrigation Diversion Points Within the Yakima River Basin

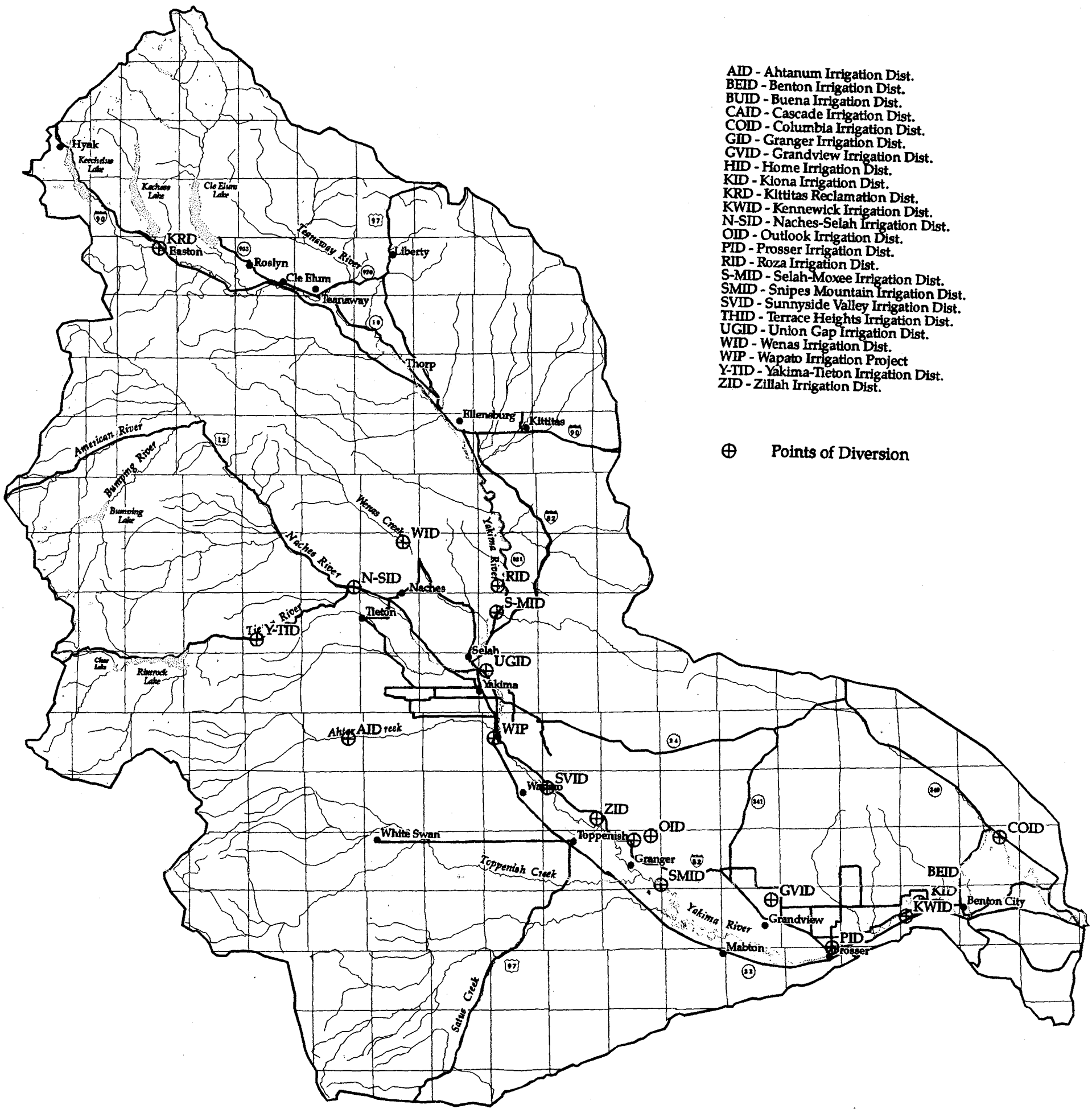


Figure 3-7.—Irrigation diversion points within the Yakima River Basin.

3.5.4 Soil Quality and Erosion

Over 60 different kind of soils are found in the basin. These soils were formed from alluvium, eolian sand, lake sediment, loess, and residuum derived from basalt and sandstone. The soils are sandy to clayey in texture and vary from shallow to deep. The soils of the basin are generally very productive with low organic matter, medium textures, good water holding capacity, and good structure.

Soil quality is generally good, with only minor areas of salinity and/or sodicity and a few toxic trace element problems.

Erosion can range from slight to severe, depending on soil texture and topography. In the Dawson and Domka (1987) report on onfarm conservation practices in the Yakima Basin in the mid 1980s, over 90,000 acres exceeded the soil loss tolerance values (*T* values). The *T* value is defined as the maximum soil loss that can be sustained without reducing the long-term productivity of the soil.

Erosion caused by surface water is generally low on irrigated slopes of under 2 percent. Under drip or sprinkler irrigation, steeper slopes can be irrigated with low to moderate erosion. Row crops under furrow or rill irrigation are the largest source of erosion, although overirrigation from sprinklers can also cause serious erosion.

Soil blowing is a hazard in the basin on the sandy, droughty soils with low organic matter and crop residue, especially in the area west of Mabton. Sandy loams to loamy sands are highly erodible.

Most of the soils are well drained; however, drainage is restricted in some of the low-lying areas, resulting in excessive salts or alkali and a high water table. Agricultural drains have been installed in some areas to lower the water table.

3.5.5 Yakima River Weeds

Noxious vegetation is a problem in the Yakima River Basin. Conveyance and distribution systems currently in use provide an avenue for abundant dissemination of weed seeds throughout the river basin.

3.6 Fish

The present Yakima River aquatic ecosystem differs from the natural system that predated Euro-American influence. The natural ecosystem contained communities of native species that evolved in a snowmelt, groundwater, and lake storage river system subject to seasonal flow variability. The fish fauna included about 28 native species (Patten et al., 1970; Reclamation, 1979).

The ability of fish populations to thrive depends on how well their life requirements are met for each life stage. Life stages include eggs, fry, juveniles, and adults. Fish must be able to migrate, if applicable, and reproduce. Important life requirement factors include:

- Presence of physical characteristics of the stream, including water and water quality, spawning gravel, large woody debris, hyporheic zone interactions, and a well-distributed interconnected network of suitable habitats that allow fish to survive, migrate, and reproduce
- Presence of riparian areas at the interface between the stream and upland that provide cover, shade, food, and stream stabilization
- Ability to migrate from spawning areas to rearing areas to growth areas unimpeded
- Presence of a food supply adequate for fish growth
- Ability to avoid or minimize competition and predation that otherwise could limit or threaten a fish population
- Presence of shallow surface and groundwater interaction zones

Implementing Title XII could alter instream flows in the mainstem and tributaries, water quality, wetlands, reservoir water releases, storage patterns, and water conservation efforts, thus directly affecting aquatic biological resources. Subtle changes in flow patterns could directly or indirectly affect fish resources. This discussion of fisheries focuses on fish-related issues that will be used as indicators in chapter 4 (salmon, steelhead, and resident fish). Although this discussion is focused, it is recognized that the actual Yakima River ecosystem is complex and multidimensional (Independent Scientific Group, 1996; Naiman et al., 1995; Stanford et al., 1995).

3.6.1 Salmon and Steelhead

Salmon and Steelhead Historical Perspective

Salmon and steelhead are important resources within the Yakima River Basin. Early land use activities such as mining, livestock grazing, timber harvest, beaver trapping, log rafting, and farming adversely affected anadromous salmonids in the Yakima River Basin (McIntosh et al., 1994). Grazing and agriculture, in particular, significantly impacted the basin soon after Euro-Americans arrived. Overfishing in the Lower Columbia River may also have affected Yakima River Basin stocks. Broad changes to the shape of the hydrograph, as discussed in Section 3.1 "Overview," likely affected salmon and steelhead because these fish would have been adapted largely to predevelopment hydrological regime.

Prior to 1880, anadromous fish runs are estimated to have been in the hundreds of thousands in the Yakima River Basin. Salmon populations declined precipitously because of factors mentioned above, and they remain low today (National Marine Fisheries Service [NMFS], 1981).

Indigenous populations of sockeye, coho, and summer chinook salmon are extinct in the Yakima River Basin. Sockeye were historically present in many of the natural lakes, including Kachess, Keechelus, Bumping, Cle Elum, and the smaller lakes above Cle Elum. Sockeye were extirpated from the Yakima River Basin when dams were built at the outlets of Bumping, Kachess, Keechelus, and Cle Elum Lakes. Natural production of nonindigenous stocks of coho salmon is very low.

Several programs have already been undertaken to improve salmon runs (Bonneville Power Administration [BPA], 1995). These programs include the Northwest Power Planning Council's Columbia River Basin Fish and Wildlife Program, State of Washington Wild Salmonid Policy, the Yakima Fisheries Project (BPA, 1995), Timber/Fish/Wildlife Agreement, Yakima Resource Management Cooperative, Fish Habitat Improvement Programs, and previous YRBWEP activities (Reclamation, 1985; 1987). See Section 1.2 "Related Activities."

Salmon and Steelhead Current Conditions and Trends

The Pacific salmon species produced in the Yakima River Basin include steelhead, spring chinook salmon, fall chinook salmon, and coho salmon. These fish spawn and rear within the basin, migrate to the ocean to grow to adult size, and return to the Yakima system to spawn. Each species uses specific areas within the basin for its respective life stages. This discussion focuses on those aspects of salmon and steelhead migration, spawning, and rearing that could be affected by changes in instream flows, river operations, or water quality.

Salmon and steelhead estimated population trends are shown in table 3-10. Salmon production in the basin is limited by factors both within and outside the Yakima River system. Limiting factors within the basin include reduced streamflows attributable to water storage projects and irrigation diversions; migration barriers at the storage dams; riparian corridor and streambank degradation; channelization, erosion and sedimentation from road building, agriculture, and other activities; and water quality degradation (Crase, 1985; Embrey and Watson, 1992; U.S. Fish and Wildlife Service [FWS] 1993).

This discussion focuses on those biological factors most likely affected by this Federal action, in combination with identified problems and needs of aquatic resources within the basin (table 3-11). In general, those factors are limited to instream flows, reservoir volumes, and factors indirectly affected by the former two factors (e.g., water quality).

Table 3-10.—Salmon counts at Prosser

Species	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Spring chinook	4,239	8,909	4,084	3,913	4,354	2,255	2,879	4,415	3,873	1,302	663
Fall chinook	273	735	536	232	670	1,505	971	1,612	1,065	1,520	1,081
Coho	30	230	83	18	291	289	269	190	165	560	633
Summer steelhead	2,191	2,230	2,465	2,840	1,162	814	834	2,263	1,184	554	918

Table 3-11.—Identified problems and needs for aquatic resources (modified from draft Basin Conservation Plan)

Location	Problem	Why this is a problem
Yakima River from Keechelus Dam to confluence of Cle Elum River	1. Seasonal low flows	1. Good overwintering habitat would be better used if additional reservoir releases could be made to maintain more side channel and river margin habitat.
	2. Hourly and daily flow fluctuations	2. Rapid flow fluctuations are a concern because this reach has a complex instream habitat and channel shape, including side channels, braids, and gravel bars. Abrupt flow decreases can cause spring chinook fry stranding.
Yakima River from confluence of Cle Elum River to Roza Diversion Dam	1. Sustained high flows	1. The river is confined in this area, and fish cannot escape the high velocities; available habitat is essentially reduced.
Cle Elum River to confluence with Yakima River	1. Seasonal low flows (winter)	1. The low flows reduce habitat for rearing juvenile salmonids.
	2. Sustained high flows preceding "flip-flop"	2. Fry and juveniles can be swept downstream—reduces sheltered rearing areas.
	3. Hourly and daily flow fluctuations	3. Stranding and loss of habitat.
Tributary streams above Naches	Flow depletions, especially in Big Creek, Taneum Creek, Manastash Creek, Swauk Creek, and Teanaway River	These creeks offer potential habitat for anadromous salmonids, but altered flows have reduced habitat.
Lower Wilson Creek	Need to improve water quality in lower Wilson Creek	Poor water quality can affect fish.
Naches River from Wapato Diversion Dam to Pacific Power and Light Power Plant discharge	1. Seasonal low flows	1. Flows may be too low for rearing and adult passage from July until "flip-flop" operations in September.
	2. Hourly and daily flow fluctuations	2. Fry and juveniles vulnerable to stranding.

Table 3-11.—Identified problems and needs for aquatic resources (modified from draft Basin Conservation Plan) (continued)

Location	Problem	Why this is a problem
Yakima River from Naches River confluence to Union Gap	Sustained high flows and impaired riparian zones	Important reach for juvenile steelhead and spring chinook rearing. Complex riparian areas reduced; thus, reduced cover for salmonids.
Yakima River from Naches River confluence to Sunnyside Diversion Dam and drains	Need to improve water quality in Yakima River, Wide Hollow Creek, and Moxee Drain	Most water quality problems affect fish.
Yakima River from Sunnyside Diversion Dam to Chandler Pumping and Power Plant discharge	1. Base flow over Sunnyside Diversion Dam	1. Fall chinook (spawning, incubation, and rearing).
	2. Additional flow during April-June outmigration	2. Additional flows may improve spring chinook smolt survival.
	3. Hourly and daily flow fluctuations Seasonally high water temperatures	3. Stranding, reduced food supply.
	4. Need to improve water quality	4. High temperatures, turbidity, nutrients, and pesticides preclude summer rearing of salmonids.
Yakima River from Chandler Pumping and Power Plant discharge to Columbia River	1. Additional flow during outmigration	Same as number 2 above.
	2. Need to improve water quality	Same as number 4 above.

Instream flows can affect salmon and steelhead upstream and downstream migration, spawning, and rearing (table 3-11). Instream flows can also affect the aquatic food base and water quality, including water temperature. To satisfy irrigation needs, a great volume of water is released from dams during the irrigation season, resulting in high flows in the reach from Cle Elum to Roza Diversion Dam that can adversely affect fish and fish habitat. Conversely, the lack of water for fish production is felt in the lower river during the irrigation season, especially in the reach below Parker. After the irrigation season ends, when releases are cut back to refill reservoirs, flows in most mainstem reaches become suboptimal or critically low for fish. Nonproject irrigation withdrawals also impact instream flows in many tributaries like the Teanaway River and Taneum, Manastash, Big, Wenas, and Ahtanum Creeks, and the lower reaches of these streams may be dewatered by late spring or early summer.

Many fishery experts consider the Instream Flow Incremental Methodology (IFIM) (Bovee, 1982) a standard technique for estimating the instream flow needed to protect aquatic habitats (Hunter, 1992). Instream flows for salmon and steelhead have been extensively studied in the Yakima River Basin (Reclamation, 1984a; 1984b). IFIM results were used as one source of information in the impact analysis to check for beneficial or adverse impacts to salmon or steelhead as a result of this Federal action.

The river below Prosser Dam is important for fall chinook spawning, migration, and rearing. The reach below Sunnyside Dam is important for spring chinook rearing, summer chinook spawning and rearing, steelhead rearing, and upstream and downstream migration of all species.

Detailed information on aquatic resources in the Yakima River Basin is available in the following references: Yakima Valley Conference of Governments Volume IIID (1995), BPA (1995), U.S. Forest Service (USFS) (1995), Fuhrer et al. (1996), and Independent Scientific Group (1996). Salmonid migration, spawning, and rearing are discussed below to support the analysis of impacts in chapter 4.

Chinook salmon are classified as spring, summer, and fall chinook corresponding to their season of freshwater entry at the mouth of the Columbia River as adults. Spring chinook enter the Yakima River system in peak numbers in May and June. Fall chinook enter the river from August to November. Coho salmon enter the river from September through November, and the peak of the run occurs in October. Summer steelhead enter the system in August through May, with dual peaks in the spring and fall.

Two migration reaches are considered: the Yakima River at Prosser and the Yakima River at Pomona. All species, except many fall chinook, must migrate past Prosser Diversion Dam. Spring chinook migrate past Prosser between April and July; median passage dates are between May 12 and May 28. Summer steelhead migrate past Prosser between September and May; the run has two peaks, one in the fall and one in February or March. If summer chinook are reintroduced to the basin, they would migrate past Prosser Diversion Dam in July and August. Fall chinook migrate past Prosser between September and November. Coho salmon migrate past Prosser between September and November.

Fish also migrate past the Yakima River at Pomona, downstream from the Roza Diversion Dam. Spring chinook migrate past Roza Diversion Dam between May and August (median dates between May 29 and June 17). Steelhead migrate past Roza Diversion Dam primarily between September and December.

Most juveniles migrate out of the Yakima River Basin between April and July. Species-specific information at Prosser is as follows: spring chinook (April through June); fall chinook (mid-April through July); coho (April through May), and steelhead (April through mid-June). Most species must negotiate the Sunnyside and Prosser Diversion Dams, and instream flows and water quality in these areas can affect migration. Spring chinook also migrate out of the Yakima system during the late fall, early winter period.

Spring chinook spawn in the Upper Yakima, Cle Elum, American, Bumping, and Naches Rivers, spawning from late July through early October. Egg incubation lasts through the fall and winter; peak juvenile emergence occurs from mid-April to mid-May. Important spring chinook spawning areas that could be affected by this Federal action include the Yakima River near Easton, the Yakima River below Keechelus, the Yakima River near Pomona, and the Cle Elum River near Roslyn. The "flip-flop" operational procedure

maintains flows for spring chinook spawning and incubation below the Easton Diversion Dam. The mini "flip-flop" attempts[2] to maintain flows for spring chinook spawning and incubation below Keechelus Lake (Reclamation, 1996).

Fall chinook spawn from late October through November. Spawning occurs in the mainstem from the river mouth upstream to the vicinity of Sunnyside Diversion Dam. Coho spawn in tributaries downstream from Sunnyside Diversion Dam, the lower Naches River, Cowiche Creek, Toppenish Creek, Ahtanum Creek, and Wide Hollow Creek. Peak spawning usually occurs in November. Peak emergence of naturally spawned coho occurs in February through April; rearing occurs throughout the tributaries and middle river basin for 1 year prior to emigration as yearling smolts in the second spring. Summer steelhead spawn from February through May. Minor steelhead spawning occurs upstream from Roza Dam. The largest population of wild steelhead spawns in Satus Creek, a tributary of the lower Yakima River.

Spring chinook usually rear in fresh water for 1 to 2 years, but some juveniles outmigrate as subyearlings during their first fall or winter. Most fall chinook juveniles undergo smoltification and outmigration in their first spring and summer.

Juvenile steelhead emerge from gravel in June or July and rear throughout the basin for 1 or 2 years (and sometimes 3 years) before smolting. Most steelhead smolts emigrate in April and May, although significant winter movement occurs. Two important rearing areas are downstream from Roza Diversion Dam.

3.6.2 Resident Fish

Several species of resident fish are important components of the ecosystem and contribute to sport fishing. The mainstem and many tributaries support resident rainbow and cutthroat trout, whitefish, sculpins, large-scale and bridgelip suckers, northern pikeminnow, dace, and others. Introduced species include brook trout, smallmouth bass, black crappie, channel catfish, yellow perch, and others. Many introduced species prefer warm water habitat and are established in the lower Yakima River (Embrey and Watson, 1992; FWS, 1982; Patten et al., 1970). Resident fish are represented in this analysis by *reservoir fisheries* and *rainbow trout*; other species are not discussed further.

Reservoir fisheries represent an important recreational fish resource within the basin. The reservoirs in the basin, except Rimrock and Clear Lake, were natural lakes prior to construction of the dams (U.S. Fish and Wildlife Service [FWS], 1982). These lakes supported a variety of fish, including mountain whitefish, rainbow and cutthroat trout, bull trout (*Salvelinus confluentus*), sockeye salmon, and burbot. Lake trout and brook trout were introduced into the reservoirs. Kokanee, the resident form of sockeye, also inhabited the natural lakes. The reservoirs are considerably less productive than the

[2] The "flip-flop" operations are described in Section 3.2.2 "Pre-Title XII Operations (Before 1995) and Model Considerations."

original lakes (FWS, 1982). Typically, the reservoirs store water during fall, winter, and spring, and release water on demand during spring, summer, and early fall. Annual reservoir drawdown may inhibit primary production (e.g., plankton) and prohibit littoral invertebrate production, an important food base for most of the fish. Carcasses of salmon spawning in the streams above the lakes previously contributed important nutrients to the natural lake systems. This source of nutrients is now absent.

Kokanee and other species discharged into the river below the dam have not survived because they cannot adapt to a stream environment. This problem exists mostly at Rimrock. Rimrock Lake has supported an important recreational fishery. Drafting of Rimrock to very low levels in water-short years has severely impacted that fishery several times. Fish losses from this reservoir may be avoided if operations could maintain a minimum pool of 30,000 to 40,000 acre-feet (FWS, 1986).

Bull trout, listed as a threatened species in June 1998, is found within every reservoir in the Yakima River Basin. Few bull trout occur in the lower Yakima River; high summer water temperature is a likely limiting factor. Under Section 7 of the Endangered Species Act, Reclamation has met with FWS to discuss conferencing requirements. All parties agreed that the decision to proceed on the administrative action would not necessitate conferencing at this time. Conferencing may be required for specific actions (please see the discussion in the Endangered Species Act Consultation section 5.2.4). When specific actions are implemented, appropriate analysis of the impacts of those actions on bull trout will be initiated.

Rainbow trout are abundant from Easton to Roza Diversion Dam. The Washington Department of Fish and Wildlife (WDFW) considers the Yakima River trout fishery of special significance to the State. The department estimates that 330,000 recreation angler trips are made per year on the Yakima River and tributaries. Of this 330,000, an estimated 108,000 angler trips per year are made to fish above Roza Dam on the mainstem Yakima River. In 1990, the Yakima River was designated a catch-and-release fishery. At the same time, the river was opened for year-round fishing.

High flows on the mainstem Yakima River during the irrigation season can adversely affect rainbow trout. In most instances, adequate flows for resident fish could be accomplished in conjunction with flows for anadromous fish through restoring more normative conditions.

3.7 Vegetation and Wildlife

Plant communities in eastern Washington reflect the influences of elevation, climate, topography, and soils. Vegetation is a complex blend of forest, riparian areas, wetlands, bunchgrass, shrub-steppe, and cropland (figure 3-8). Over one-third of the land in the Yakima River Basin is forested. Riparian areas occur along the Yakima River, Naches River, tributaries, and other waterways. Wetlands occur throughout the basin, and some

Vegetation Types Within the Yakima River Basin

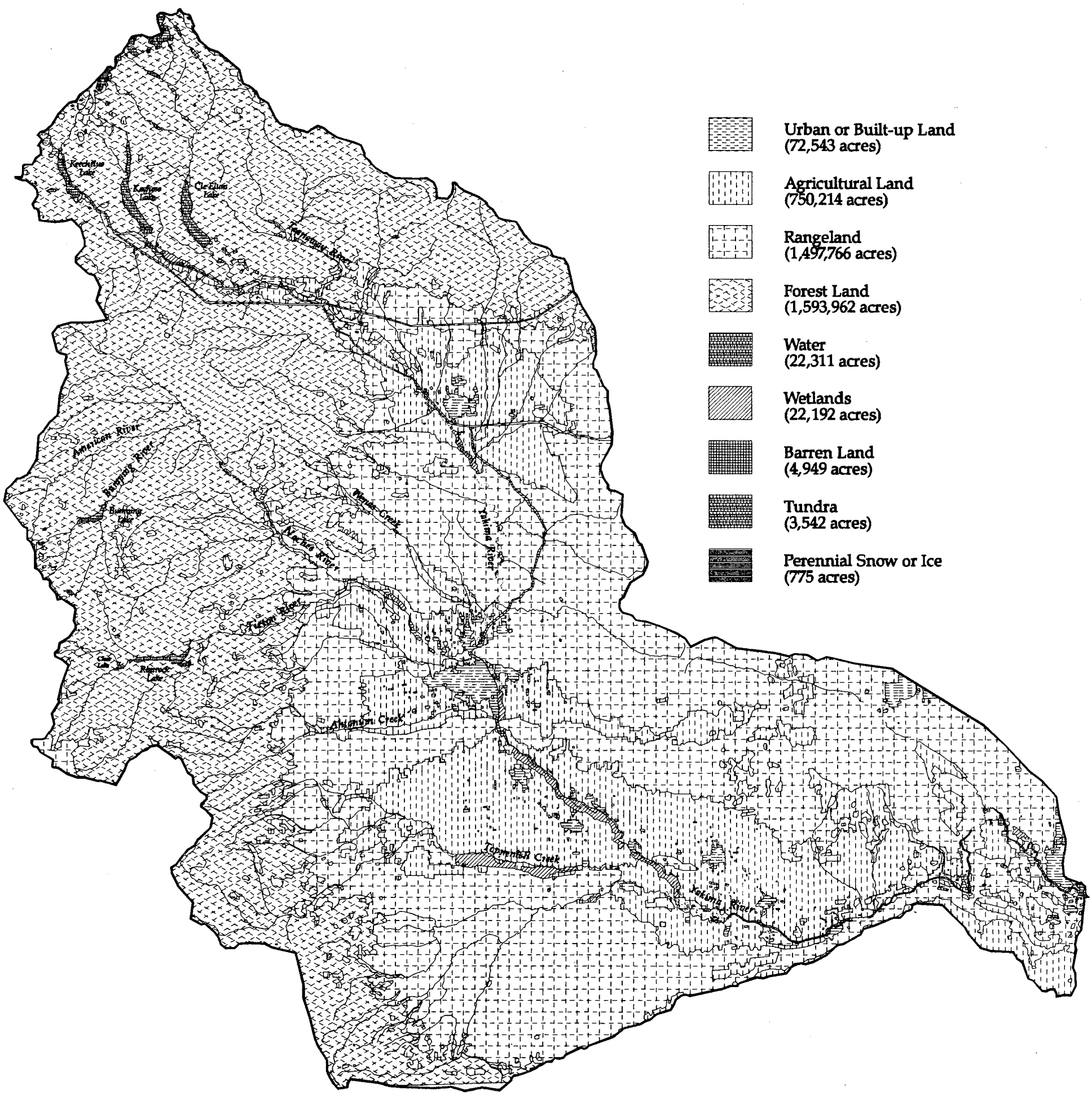


Figure 3-8.—Vegetation types within the Yakima River Basin.

depend upon agriculture. Conversely, many natural wetlands were displaced by agricultural practices like draining, diking, and flow regulation. Cropland accounts for about 15 percent of total basin area, and 77 percent of cropland is irrigated.

The Yakima River Basin contains a broad spectrum of wildlife habitats, from coniferous forests in the upper basin to shrub-steppe and irrigated agricultural habitats in the middle and lower basin. Examples of species found in coniferous forests include elk, bear, cougar, and nongame birds. Some species found in shrub-steppe habitats include deer, coyotes, rabbits, and a variety of small reptiles. Irrigated agricultural valleys provide habitat for a variety of wildlife, including pheasants, quail, long-billed curlews, hawks, and mink. Canals and drains provide wetland habitat for species such as muskrats, river otters, waterfowl, raccoons, great blue herons, and small shorebirds. Most wildlife in the Yakima River Basin use riparian habitat along perennial streams or canals and drains at some point each year.

The major landscape features likely to be affected by this Federal action include the Yakima and Naches River flood plains; areas adjacent to the reservoirs; tributary courses; and vegetated areas along canals, drains, or other irrigated or agriculture-related features. Riparian and wetlands plant species, important to many wildlife species, dominate these areas. The riparian zone and wetlands and associated wildlife will be the focus of this discussion and the environmental consequences analyses. Part of the information in the following sections was taken directly from the Fish and Wildlife Coordination Act Report, which is included as appendix E (FWS, 1996).

3.7.1 Riparian Vegetation and Associated Wildlife

Riparian habitat generally occurs adjacent to flowing water (e.g., streams and canals) and contains elements of both aquatic and terrestrial ecosystems that mutually benefit each other (WDFW, 1995). Some, but not all, riparian areas could also be classified as wetlands. Riparian communities are not controlled by the surrounding vegetation community but by available water, soil, stream channel substrate and morphology, elevation and latitude, climate, and land-use history (Brinson et al., 1981). A dynamic interaction exists between water and plants in the riparian zone: the availability of water supports plants that could not otherwise survive in semiarid regions, and the type of vegetation that survives reflects the water regime that supports it.

Benefits of properly functioning riparian communities include improved water quality, filtration of sediments, streambank stability, moderated streamflow (reduced flood damage), retention of water that extends late season flow, restoration of perennial streamflow, groundwater recharge, erosion protection, aggradation or maintenance of high water table, increased recreational opportunities, critical habitat for fish and wildlife, increased biological diversity, increased forage, and enhanced esthetics (Ohmart and Anderson, 1986; Bilby, 1988; Bureau of Land Management [BLM], 1991a). Plants in riparian zones and many animals supported by it are important to Native Americans and others.

Undisturbed riparian communities provide abundant food, cover, and water for wildlife and contain ecological features not found in uplands. Riparian vegetation supplies food and cover for insects emerging from the river as well as its own resident invertebrate populations. These invertebrates, in turn, support numerous mammals, birds, reptiles and amphibians, and other invertebrates. For these reasons and others, riparian areas generally provide high-value wildlife habitat.

Because of the dynamic interaction between riparian vegetation and water availability, dam operations and water conservation practices that change either specific release patterns or return flow patterns could affect the abundance and distribution of plants and, in turn, wildlife associated with these plant communities. Because of the variety of plants growing in the riparian zone and their differing water requirements, a comprehensive evaluation of the effects of all alternatives on all plants is beyond the scope of this report. Therefore, riparian vegetation is discussed only broadly and qualitatively.

Riparian Vegetation and Wildlife Historical Perspective

Historically, large sagebrush and bunchgrass communities existed throughout the project upland areas. These plant communities were most commonly established on the north facing slopes or adjacent to intermittent streams (Smith et al., 1958). Along the major river courses and associated side channels and flood plains, riparian vegetation consisted of willow, cottonwood, hawthorn, wild rose, and chokecherry (Rassmussen, 1976). Many of the riparian species still exist but are generally restricted to the water's edge or specifically protected by some landowners.

An influx of settlers occurred in the late 1800s in the Yakima River Basin. General development of the region altered the riparian ecosystem throughout the basin. Activities such as flood control, agriculture, and road building tended to reduce backwater areas, sloughs, oxbows, and meandering features of the river systems by channelizing the streams. Changes in the hydrologic regime (see Chapter 3 "Overview") would have altered riparian areas. Grazing and timber harvest also adversely affected riparian areas. These changes cumulatively tended to reduce the breadth, microhabitats, structural diversity, and connectivity of riparian areas (see Hall [1988] and Kaufman [1988] for a general discussion). Wildlife species dependent upon these features would likely have been affected (Raedeke et al., 1988; Ohmart and Anderson, 1986). Simultaneously, early agriculture provided wildlife habitat for several introduced game species (for a detailed description of historical biological conditions, see Oliver [1994]).

Riparian Vegetation and Wildlife Current Conditions and Trends

Riparian areas are currently estimated to encompass less than 1 percent of the land base in the Pacific Northwest, yet they support the greatest diversity and abundance of wildlife in the arid portions of the region (FWS, 1990). For the United States as a whole, about 70

to 90 percent of the natural riparian areas have been lost because of human activities (Ohmart and Anderson, 1986). Because of the importance of riparian areas combined with the large losses that have already occurred, remaining riparian areas must be protected.

About 90 percent of Washington's land-based vertebrate species use riparian habitat for essential life activities. Existing riparian conditions in the Yakima River Basin vary, ranging from severely degraded to nearly pristine. Good riparian habitat generally is found along some forested headwater reaches, whereas degraded riparian habitat is concentrated in the valleys and is frequently associated with agriculture; grazing;: and fluctuating, regulated streamflow.

The Yakima River Basin still contains remnants of contiguous aquatic and riparian vegetative cover types suitable for wildlife habitat. A rough estimate of basin-wide riparian acres is shown in table 3-12. The number of acres that might be affected by the proposed action is not known. Riparian habitats are associated with the backwaters, sloughs, and oxbows, as well as the main river channel. Riparian forests in the basin typically contain black cottonwood, alder, willow, silver maple, mulberry, hackberry, and other species. Higher elevation riparian forests are used by elk, deer, fur bearers, raptors, grouse, many neotropical bird species, and many other species. At lower elevations, the riparian forests may contain deer, fur bearers, rodents, bats, raptors, owls, herons, pheasant, quail, neotropical bird species, and many other species.

Table 3-12.—Approximate acres of woody riparian habitat within the Yakima River Basin[1,2]

Area	Acres of riparian vegetation
Yakima River Basin	19,000 acres
Toppenish and Satus Creeks area	5,160 acres

[1] Estimate calculated by adding all acres in the Yakima River Basin classified as palustrine woody in the National Wetlands Inventory.
[2] This number would be a subset of Yakima River Basin; data from BPA et al., 1994.

Riparian herbaceous habitat is common along many of the irrigation canals and drains, mainly because of regular disturbance (mowing, burning, pesticides) to destroy weeds and maintain a manicured appearance (Oakerman, 1979). Noxious weeds on ditchbanks and rights-of-way continue to be a problem today. Woody vegetation make up a very small percentage of the total plant cover along canals. Oakerman (1979) found that unlined canal/drain systems had more value as wildlife habitat than lined canal/drain systems. Within the Wapato Irrigation Project, unlined canals and drains provide habitat (nesting, brood rearing, feeding, and thermal and escape cover) for upland game, waterfowl, fur bearers, and many nongame birds (Yakama Indian Nation, 1992).

Efforts are being made to preserve, restore, and enhance riparian areas in the basin. BPA has funded or intends to fund projects benefiting riparian areas at Sunnyside, Wenas, and the Yakama Indian Reservation (BPA et al., 1994; 1996). The Yakama Indian Nation has also contributed to protecting and enhancing riparian areas along the Yakima River and plans to protect and manage additional areas as well (Yakama Indian Nation, Waterfowl Biologist, personal communication, 1996). On several Wildlife Areas in the basin, WDFW is also protecting and managing riparian areas along the Yakima, Tieton, and Naches Rivers and Taneum, Manastash, Umtanum, Wenas, Oak, and South Fork of Cowiche Creeks. The BLM manages land along the Yakima River northwest of Yakima and is attempting to improve wildlife habitats, including riparian areas (BLM, 1991b). The Yakima Greenway Foundation protects and manages riparian forest along the Yakima River in and near Yakima. The U.S. Department of Agriculture Wildlife Habitat Incentives Program offers an opportunity for landowners to obtain financial and technical assistance to enhance riparian habitats.

Several YRBWEP activities directly involve the Yakama Indian Nation; for this reason, those Yakama Indian Nation areas that could be affected are broadly discussed. Riparian habitats are degraded along Toppenish and Satus Creeks because of draining and excessive livestock grazing. Although current land use practices limit this type of habitat, residual vegetation remaining through the winter is necessary to provide critical early spring nesting cover for many species. Spring burning of canal banks in the project area is followed by herbicide applications through the summer. Late spring burning within the project area has decreased active waterfowl and pheasant nesting (Oakerman, 1979; Oliver, 1983). Ducks use the canals and drains of the Wapato Irrigation Project and areas of undisturbed wetland habitat. Vegetation overhanging water channels provides valuable escape and feeding cover for waterfowl broods. Much of this type of vegetation has been removed to improve flows, eliminating many miles of channels and creeks for use by waterfowl broods.

3.7.2 Wetlands

Wetlands are critical ecological systems of enormous importance to fish because of peak flow attenuation, base flow maintenance, thermal moderation caused by discharging groundwater, and food web production. Wetlands are important to a wide range of wildlife species because they provide specialized habitat values not found in upland areas. These habitat values include providing cover, water, shade, forage habitat, rearing habitat, breeding habitat, brood-rearing habitat, loafing areas, winter habitat, relief from extreme summer or winter temperatures, and biodiversity (Weller, 1986). Wetlands are among the most productive ecosystems in nature because of the ready availability of water, nutrients, and energy in close proximity (Weller, 1986). Wetlands also provide flood conveyance, shoreline protection, flood storage, water quality enhancement, sediment control, recreation, groundwater recharge, and esthetics.

Wetlands Historical Perspective

Wetlands in the basin were located along the major streams and rivers, especially along the Kittitas Valley, the lower Yakima River flood plain, and Toppenish and Satus Creeks. Additional wetlands were found along smaller tributaries, at seeps and springs, higher elevation wet meadows, and along the shorelines of natural lakes. Many of these wetlands have been lost or degraded.

The State of Washington has seen a decline of wetlands of about 30 percent (about 940,000 acres remain from about 1,350,000 acres originally). The loss of inland wetlands in Washington has been estimated at 25 percent (FWS, 1990). Losses have been attributed to agriculture conversion (drainage and leveling for crop production); filling for solid waste disposal, road construction, and commercial, residential, and urban development; construction of dikes, levees, and dams for flood control, water supply, and irrigation; discharges of materials (for example, pesticides, herbicides, nutrient loading from domestic sewage and agricultural runoff, and sediments from agriculture and other land development); hydrologic alteration by canals, drains, spoil banks, roads, and other structures; and groundwater withdrawal. Aside from the direct loss of wetlands, many wetlands have been reduced in quality from some of the above factors.

The riverine-wetland complex would have been integral to the ecosystem that evolved in the Yakima River Basin. Wetlands would have served several purposes important to fish and wildlife. For example, the wetlands and associated groundwater areas would have retained flood water that may have fed base flows in the river systems late in the season; these late season flows may have helped protect native fishes. These natural wetland reservoirs may have kept base flows cooler than present day flows, which may have provided suitable habitat for native fishes. Healthy native fish populations, especially salmonids, would have provided nutrients that contribute to the ecosystem and wildlife productivity. In addition, the wetlands (and the groundwater areas underneath the wetlands) may have provided backwater areas for fish rearing and a productive wildlife food source.

Stream restoration efforts are premised on the idea that wetland and riparian area functioning is tightly linked to overall ecosystem functioning and productivity (Kauffman et al., 1997). It has been suggested that if activities that cause the most ecosystem damage could be altered, the system will likely restore itself to some extent.

Wetlands Current Conditions and Trends

Wetlands areas within the Yakima River Basin are shown in figure 3-9; irrigation districts are also delineated. Irrigation districts are shown for reference in the event that onfarm water conservation occurs. Wetland acreages within the basin are shown in table 3-13. These data are based exclusively on the National Wetlands Inventory (NWI) classification

system (Cowardin et al., 1979). NWI mapping in Washington was completed using aerial photography taken from 1980 to 1984. These wetland acreage estimates likely overestimate wetlands remaining today.

Table 3-13.—Acres of wetland habitat within the Yakima River Basin[1]

Area	Acres of wetland habitat
Yakima Basin	43,695 acres
Toppenish and Satus Creeks area	1,548 acres

[1] Total wetland acres, including deep water habitats, as determined by NWI.

Of the 43,695 acres of wetlands in the basin, about 19,000 are palustrine herbaceous (emergent marsh, aquatic bed), and 19,000 acres are palustrine woody (shrubs and trees). These wetlands include wet meadows, seeps, small shallow ponds and lakes, marshes, and riparian wetlands along streams. Aside from natural wetlands, many wetlands have formed and been maintained from artificial water sources such as reservoirs, sewage lagoons, stock ponds, irrigation canals, and irrigated cropland runoff. Other wetland areas include lakes and streams (29,000 acres) and marshy unvegetated areas (4,000 acres). Total wetland areas equal about 2 percent of basin area.

In the semiarid lowlands, wetlands are critical to many species of wildlife because they provide good vegetative growth for food and cover, invertebrate production, and water. Recognition of the value of wetlands has historically focused on waterfowl populations, and tens of thousands of waterfowl can be found in the lower Yakima River Basin in winter and during migration. Oliver (1983) estimated that up to 300,000 ducks wintered on the Yakama Indian Reservation in the 1960s. Many wood ducks in eastern Washington are bred and raised along the Yakima and Naches Rivers. Waterfowl within just the Wapato Irrigation Project account for about 20 percent of the population in eastern Washington (Yakama Indian Nation, Waterfowl Biologist, personal communication, 1996). Also, as many as 40,000 Canada geese use areas flooded by Toppenish and Simcoe Creeks in the spring (BPA, 1994). Historically, sandhill cranes and swans nested in the basin and could conceivably return if wetland restoration and enhancement efforts were to continue (Parker, 1989 as cited in FWS, 1996). Many other birds, mammals, amphibians, and reptiles depend upon riparian areas.

As in other Yakima River Basin areas, most emergent wetland habitat in the Satus and Toppenish Creek areas has been removed through draining and land leveling—much the same fate as befell wetlands in the Kittitas Valley, Gap to Gap reach, Wenas, Ahtanum, and other once lush riverine wetland areas. Along most of these stream reaches, remaining areas are heavily grazed during spring and summer months, further decreasing their potential as wildlife habitat. Basic protection and enhancement activities have excellent potential to increase the quality of fur bearer, songbird nesting, and waterfowl brood-rearing habitat (BPA et al., 1994). Toppenish and Satus Creeks, with their low

Wetlands by Water District Within the Yakima River Basin

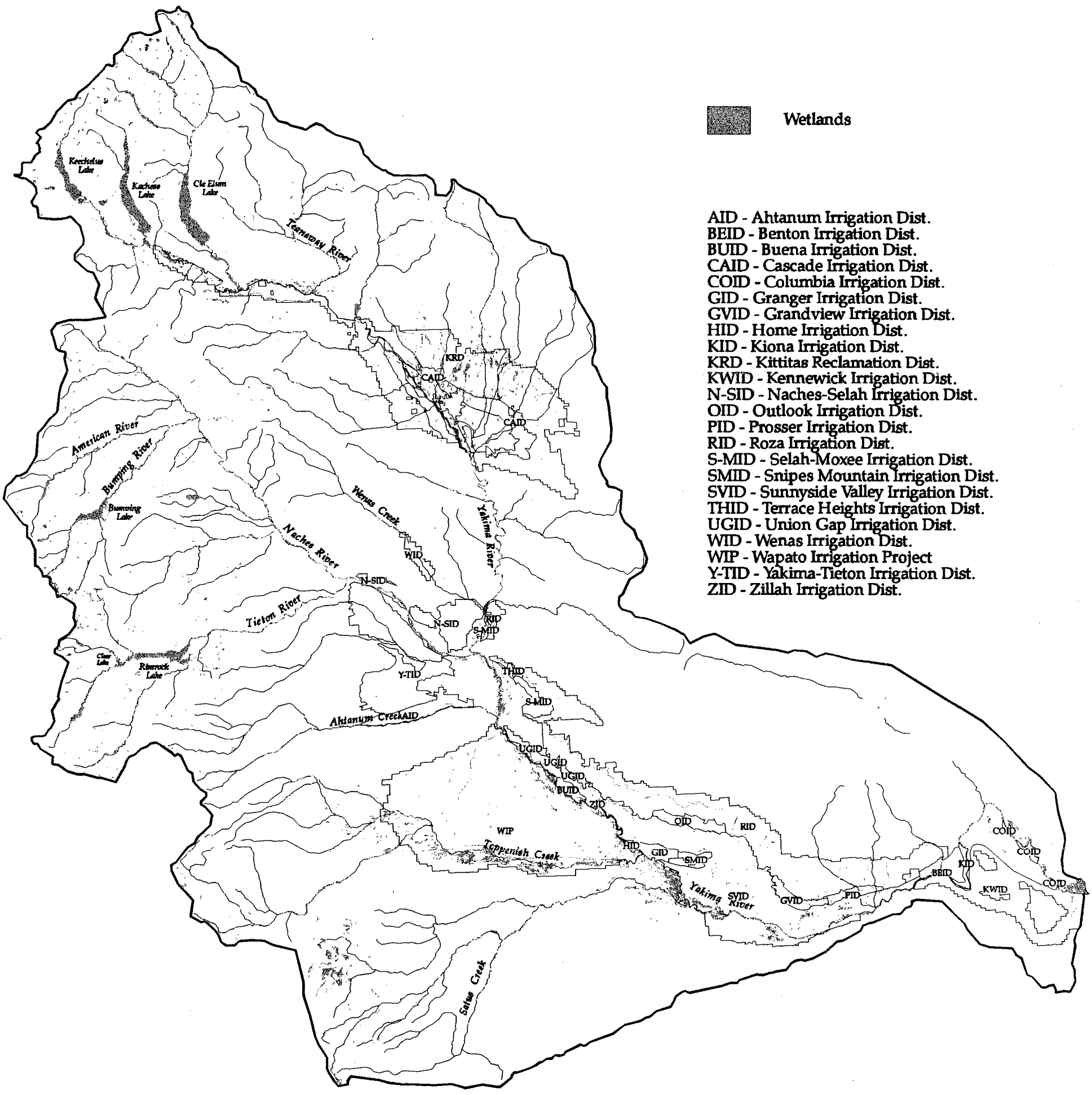


Figure 3-9.—Wetlands within the Yakima River Basin. Irrigation districts are also shown.

gradient, braided channels, and abundant sloughs and wetlands, provide excellent wintering habitats for wildlife. Spring floods immerse large acreages of pasture land next to the creeks. These flooded areas are heavily used by migratory waterfowl, annually attracting 20,000 to 40,000 of the Taverner's subspecies of Canada geese en route to nesting grounds on the North Slope of Alaska. Streambanks and nearby wetlands provide wintering habitats for upland game bird and waterfowl use. Refuges along Toppenish Creek provide important sanctuaries, especially for migratory and wintering waterfowl.

Continuing threats to wetland functions include overgrazing, intensive adverse agricultural practices (including increased chemical uses, buffer removal, feedlots, and dairy operations in and near wetlands), erosion, poor water quality of irrigation return flow, exotic species (for example, carp and purple loosestrife), dessication, and, fairly recently, the changes in older irrigation systems which reduced associated wetlands (for example, lining canals and changing from open waterways to piped and pressurized systems).

Efforts have been made to protect some remaining wetlands (Sunnyside Wildlife Area, Toppenish National Wildlife Refuge, Yakima Greenway, and several units managed by the Yakama Indian Nation). Over 300 acres of wetland/riparian areas along the Yakima and Naches Rivers were recently acquired by the Corps and are being managed by WDFW to help fulfill mitigation for construction of Lower Snake River dams and reservoirs. Several other Federal, State, Tribal, and local agencies are involved in restoring and enhancing wetlands in the basin.

Opportunities to protect and enhance wetlands include YRBWEP's water and land acquisition, mitigation under the Basin Conservation Program, and the following programs: Federal Aid in Wildlife Restoration, Migratory Bird Conservation Fund, Land and Water Conservation Fund, and the Wetland Reserve Program.

Agricultural Land and Associated Wildlife

Agricultural land in the southern two-thirds of the basin contains large tracts of orchards, vineyards, and hop fields, as well as a wide variety of other crops. Pasture, hay, corn, and wheat are the primary uses of agricultural land in the northern portion of the basin. Historically, croplands provided much higher quality habitat than exists in most places today. However, more efficient irrigation practices, larger fields, changes in crops, removal of fence rows, increased herbicide use, and other changes removed much of the wildlife habitat. Cropland and pasture in the lower Yakima River Basin can still be very important to large numbers of wintering waterfowl (especially mallard and Canada geese); however, their numbers do not approach the 300,000 recorded in the 1960s (Oliver, 1983). Orchards, vineyards, and hop fields provide only marginal habitat for some wildlife, including American robin, mourning dove, California quail, western meadowlark, and gopher snake.

3.8 Threatened, Endangered, and Special Status Species

The Endangered Species Act requires Federal agencies to consult with FWS and NMFS, as appropriate, to ensure that actions they authorize, fund, or carry out do not jeopardize the existence of a listed species or result in the adverse modification or destruction of their critical habitat. Informal consultation was initiated on April 12, 1996, with a memorandum to FWS and NMFS from Reclamation, requesting a list of plants or animals on the Federal list of threatened or endangered species and any critical habitat. FWS and NMFS sent memoranda dated April 16, 1996, and April 24, 1996, respectively, indicating that the listed species shown in table 3-14 may occur in the project area. FWS indicated that 38 plant and animal species of concern could occur in the project area.

Table 3-14.—List of threatened and endangered species that may occur in the Yakima River Basin

Species	Scientific name	Status
Bald eagle	*Haliaeetus leucocephalus*	Federal threatened
Gray wolf	*Canis lupus*	Federal endangered
Grizzly bear	*Ursus arctos horribilis*	Federal endangered
Marbled murrelet	*Brachyramphus marmoratus*	Federal threatened
Northern spotted owl	*Strix occidentalis caurina*	Federal threatened
Peregrine falcon	*Falco peregrinus*	Federal endangered
Bull trout	*Salvelinus confluentus*	Federal threatened
Snake River sockeye	*Oncorhynchus nerka*	Federal endangered
Snake River spring/summer chinook salmon	*Oncorhynchus tshawytscha*	Federal threatened
Snake River fall chinook salmon	*Oncorhynchus tshawytscha*	Federal threatened
Chinook salmon	*Oncorhynchus tshawytscha*	Candidate
Steelhead trout	*Oncorhynchus mykiss*	Proposed
Oregon checkermallow	*Sidalcea oregana calva*	Candidate
Basalt daisy	*Erigeron basalticus*	Candidate

Upon determination that an endangered or threatened species may be present in the area of a proposed action, the responsible agency must prepare a biological assessment to identify how the listed species might be affected. A biological evaluation (BE) is often prepared for a programmatic document when no adverse impacts are anticipated but an agency still wants to present an evaluation to the FWS and/or NMFS. A BE was prepared for this project that addressed the species listed in table 3-14. The BE was provided to both NMFS and FWS on December 6, 1996. The BE did not address candidate and

petitioned species, but their status would be monitored, and consultation would be initiated if they were added to the threatened or endangered species list. A letter of concurrence was received from FWS on December 20, 1996, and a verbal concurrence has been received from NMFS.

Bull trout was listed in June 1998, and steelhead was proposed for listing in February 1998. On July 15, 1997, Reclamation met with FWS to discuss conferencing requirements. All parties agreed that the decision to proceed on the administrative action would not necessitate conferencing, but conferencing would be required for specific actions.

3.9 Socioeconomics

3.9.1 Social Well-Being and Relationships With the Biophysical Environment

The Yakima River Basin is in Yakima, Kittitas, and Benton Counties. The Yakama Indian Reservation is located in the southwest portion of the basin just south of the city of Yakima. For the social analysis, the study area is generally defined by county boundaries because the demographic data are provided on a county by county basis.

Agriculture is an important industry for the basin (see Section 3.5 "Agricultural Resources").

The discussion of the affected human environment is presented below to help the reader understand general population trends and characteristics over the past 50 years. The discussion focuses on those potentially impacted by the project and provides information on selected social indicators intended to help measure the effect or impact to the human environment. The groups that may be impacted are: (1) agricultural, (2) environmental, (3) recreational, (4) Yakama Indian Nation, and (5) property owners along the shores of Cle Elum Lake.

Agricultural

This community includes farmers, farm workers, and other agriculturally dependent trade and service workers.

Environmental

Environmental organizations that have an interest in and concern for Title XII include: American Rivers, Sierra Club, National Resources Defense Council, Environmental Defense Fund, Friends of the River, Columbia Basin Institute, the Heritage Institute, and The Nature Conservancy.

Recreational

The recreational community consists of water-based recreation users. See Section 3.10 "Recreation."

Yakama Indian Nation

The Yakama Indian Nation includes the following tribes: Klick-atat, Klingquit, Kow-was-say-ee, Kam-milt-pah, Li-ay-was, Oche-chates, Palouse, Pisquose, Skin-pah, Se-ap-cat, Shyiks, Wehatchapan, Wish-ham, and the Yakama.

The Yakama Indian Reservation consists mainly of agricultural land along the eastern portion, and the upper, or western, portion is mainly forest land. The lands of the Reservation vary from well-timbered slopes to the vast stretches of grassland, rolling hills, and larger river valleys.

Property Owners Along the Shores of Cle Elum Lake

Private property owners live along the shores of Cle Elum Lake.

Culture, Attitudes, and Sociopsychological Conditions

Much of the material for cultural folkways and mores, attitudes, and sociopsychological conditions for a given project is gathered through research and review of relevant literature, the public scoping process, and personal interviews with individuals or entities from each of the communities mentioned above. Based on information gathered through these procedures, the primary concerns and issues affecting or having an impact on the above communities are:

- The most beneficial use of water
- Decline of anadromous fish runs
- Water conservation measures that could be employed to achieve water-savings goals
- The amount of water maintained instream
- Maintaining an adequate water resource for agriculture

Population Characteristics

Before 1870, non-Indian population growth of the study area was slow. Poor transportation kept immigration to a minimum. Population increased rapidly from 1880 to 1910 because of the new railroads, settlement of irrigated lands developed by Federal irrigation projects, and increased lumbering activity. Between 1910 and 1940, population grew slowly but steadily. County population trends over the 1940 to 1990 period have generally

been up (see table C-1 in Appendix C "Socioeconomics"). Between 1940 and 1950, Benton County experienced a tremendous jump, from just over 12,000 to over 51,000 residents, because of the establishment of the Hanford Atomic Works. The city of Richland experienced an 88-fold population increase as a result of the development.

In 1990, about 29.6 percent of the study area population was classified as rural. Many small towns in the region are supported primarily by agriculture and agricultural processing plants. Many of the rural residents are employed in the major cities of Yakima, a trade and food-processing center; Richland, with nuclear research; Kennewick, with a mixed industrial base; and Ellensburg, an educational, food-processing, and farm trade center.

Populations as a whole are increasing. The 1990 census data on population by race for the Yakima River Basin indicate that whites are the largest group (over 80 percent). Race and ethnicity are overlapping categories. In 1990, 16 percent of the population identified themselves as Hispanic, regardless of race. The percentage of Hispanics in the region has increased from about 10 percent in 1980. This is partly due to changes in census taking methods.

Among the persons living on the Yakama Indian Reservation, Tribal members are in the minority. The 1990 census counted 27,522 total persons within the Reservation boundaries and, of that total, about 6,300 were Tribal members. Many of the non-Indian residents live on or have developed business enterprises on allotted lands that were purchased from Indian owners in the earlier part of the century.

Prior to the 1990 census, the Bureau of the Census had not displayed information to facilitate comparisons of demographic information specific to the Reservation. Therefore, historical information and population trends are only briefly discussed below. The estimated enrollment of the Yakama Tribe in March 1975 was 6,650 members. About 70 percent (5,150) of the Tribal members resided on the Reservation. The enrollment register for July 1996 listed 8,586 Tribal members, and 5,685 Tribal members resided on the Reservation (Yakama Indian Nation, Economic Development Division, Business and Management Office, personal communication, 1995).

3.9.2 Economics

The Yakima region includes the south-central Washington counties of Kittitas, Yakima, and Benton. The Yakima River flows through these counties before converging with the Columbia River, near Richland, in Benton County. The Yakima Project is located in the Yakima River watershed, which closely matches these county boundaries.

According to the Reclamation's *1993 Crop Report*, in an average water year, the Yakima Project diverts about 1,789,000 acre-feet of water to the 471,450-acre project area, mostly for growing crops. Of these 471,450 acres, 372,740 acres (80 percent) were irrigated during 1993; the remaining acreage was used for dryland crops, idled lands, roads, ditches, and

urban lands. The irrigated acres produce a variety of crops, including fruits, hops, vegetables, and hay. Acreage and values of the crops for 1993 are shown in table 3-15. As indicated, fruit production represents two-thirds of the crop value in the region.

Table 3-15.—Yakima Project crop acreage and values

Crops	Acres	Crop value ($)	Percent of total crop acres	Percent of crop value
Fruits	104,373	444,158,446	29.1	66.8
Vegetables	25,329	41,888,905	7.1	6.3
Field crops (mostly hops)	48,840	115,340,125	13.6	17.3
Hay/pasture	138,454	47,987,518	38.6	7.2
Cereals	39,931	13,707,799	11.1	2.1
Other crops	1,204	1,859,363	0.3	0.3
Total	358,692	664,942,156	100.0	100.0
Cropland not harvested	14,609			
Other acres not irrigated[1]	98,710			
Total acres irrigable	471,450			

[1] Reclamation's *1993 Crop Report.*

The 471,450 total acres irrigable are divided among seven divisions in the Yakima region. These divisions range in size from about 25,000 acres (Kennewick Division) to about 136,000 acres (Wapato Division). As expected, the total crop value produced on the acres irrigated by project water also varies by division. The breakdown of acres and crop value by division is shown in table 3-16. The total crop value for 1993, according to the Bureau of Reclamation's *1993 Crop Report*, is over $664 million. Three of the seven divisions (Wapato, Sunnyside, and Roza) represent 75 percent of the project's total crop value. Project acres represent about 82 percent of the vegetable output and 81 percent of the orchard production from these counties.

Table 3-16.—Agricultural production by division for Yakima Project

Division	Total acres[1]	Acres irrigated[1]	Total crop value ($)[1]	Percent of value
Kennewick	25,471	7,398	9,613,222	1.4
Kittitas	59,104	55,516	23,487,313	3.5
Roza	72,511	65,626	164,567,949	24.7
Sunnyside	103,562	80,764	145,018,611	21.8
Contract	47,531	38,134	69,415,335	10.4
Tieton	27,271	25,048	83,863,960	12.6
Wapato	136,000	100,254	168,975,766	25.4
Total	471,450	372,740	664,942,156	100.0

[1] Reclamation's *1993 Crop Report.*

Reclamation's *1992 Summary Statistics* indicates that of the 1,789,000 acre-feet of water diverted throughout the project in 1992, 1,314,713 acre-feet (73 percent) reached the farms (Reclamation, 1992), as shown in table 3-17. The other 27 percent were lost to evaporation, leakage losses, or other reasons. Deliveries averaged 73 percent, but divisions varied on the efficiency of water deliveries. Also, divisions had varied levels of onfarm water efficiency, using from 2.42 to 4.62 acre-feet per acre as shown in table 3-17. The average for the Yakima Project was about 3.5 acre-feet per acre.

Table 3-17.—Agricultural irrigation by division

			(acre-feet)		
Division	Total acres[1]	Acres irrigated[1]	Water diverted from river[2]	Water delivered to farms[2]	Delivered water per acre
Kennewick	25,471	7,398	99,971	32,918	4.45
Kittitas	59,104	55,516	246,012	134,514	2.42
Roza	72,511	65,626	245,898	162,693	2.48
Sunnyside	103,562	80,764	423,999	373,215	4.62
Contract	47,531	38,134	156,713	133,138	3.49
Tieton	27,271	25,048	83,280	82,009	3.27
Wapato	136,000	100,254	533,195	396,225	3.95
Total	471,450	372,740	1,789,068	1,314,713	3.53

[1] Reclamation's *1993 Crop Report.*
[2] Reclamation's *1992 Summary Statistics.*

The Yakima region has developed a diverse economy, providing many opportunities for employment and income, but it still has a strong agricultural base. According to the Bureau of Economic Analysis (BEA), between 1988 and 1993, personal income in this region grew annually at 8.9 percent, and per capita income grew by 6.4 percent. However, growth may slow in the region; BEA forecasts State-wide growth for personal income at an annual rate of 2.6 percent and 2.5 percent for the region through the year 2005. During the same time period, employment (number of jobs) is forecast to grow at a 1.9-percent rate for Washington but at a 1.3-percent rate for the region, according to the State.

Personal income in the region has grown at a strong rate for the past 10 years, but unemployment within the region remains higher than the State average. In the early 1980s, the unemployment rate rose to around 15 percent and has fallen slowly since 1982, as shown in figure 3-10. In 1991 and 1992, the unemployment rate rose again and has remained around 10 to 12 percent for 1991 and 1992, higher than the State unemployment rate of 6.3 percent for 1991, shown in figure 3-10. The unemployment rate remained at about 10 percent through 1995.

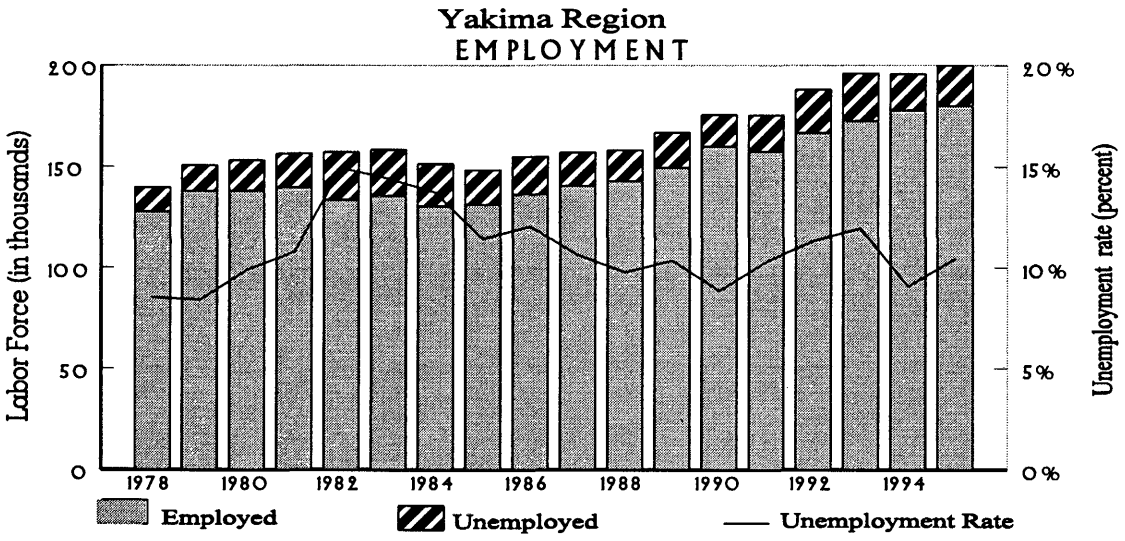


Figure 3-10.—Employment levels in the Yakima region since 1978.

Description of Current Regional Economy

Economic analysis uses county boundaries to define the region because most economic data are available only for counties. Most of the data in this study represent the 1993 calendar year, the most recent year available for economic impact analyses. Sources for data included Minnesota Implan Group, BEA, Bureau of the Census, and the State of Washington.

The economic descriptions and preliminary modeling were conducted with Micro-IMPLAN (Taylor et al., 1993), a modeling software package developed by USFS. Additional modeling and forecasting were accomplished using IMS Software (Agricultural Enterprises, Inc., 1992), a software package which modifies and enhances the output from Micro-IMPLAN.

Three measures describe the economy of the region for 1993—levels of employment, household income, and sales revenue. The first two indicate how residents are impacted by economic activity. Employment is the measure of number of actual jobs not converted to full-time equivalents. Household income represents workers' income, in addition to investment income and income received from outside the region, such as retirement funds. Sales revenue reflects gross earnings for businesses with some exceptions. Sales revenue for wholesale and retail trade sectors are sales margins, the difference between purchase price to the vendor and sales price, rather than gross revenues. Sales revenue for financial and insurance sectors only includes interest and commissions, and real estate sectors include brokers' commissions on real estate sales rather than property sales volume. Because the impacts are reported on an annual basis, these data also are presented annually.

Employment by Sector

Total employment in the region for 1993 was about 191,000 (including full and part time) as shown in table 3-18. Of this number, 51.1 percent were in the service (32.0 percent) and trade (19.1 percent) sectors. The service sector includes businesses that provide services to the public such as dry cleaners, barbers, automobile repair shops, bowling alleys, hospitals, lawyers, and accountants. The trade sector is an aggregation of trade industries including wholesale trade, general merchandising, food stores, apparel stores, and home furnishing stores.

Table 3-18.—Summary of employment levels by sector for 1993

Sector	Yakima region	Percent	Washington	Percent	United States	Percent
Agriculture	17,874	9.3	99,343	3.3	4,311,664	3.0
Natural resources	6,040	3.2	16,115	0.5	563,071	0.4
Construction	11,141	5.8	217,084	7.2	9,235,307	6.5
Manufacturing	16,629	8.7	360,541	12.0	18,684,040	13.2
Transportation, communications, and utilities	4,954	2.6	121,217	4.0	6,135,673	4.3
Trade	36,535	19.1	650,949	21.6	30,161,940	21.2
Financial, insurance, real estate	7,549	3.9	203,970	6.8	9,640,669	6.8
Services	61,188	32.0	819,033	27.2	41,037,520	28.9
Government	29,404	15.4	518,769	17.3	22,211,622	15.7
Total	191,314	100.0	3,007,021	100.0	141,981,504	100.0

The agricultural sector employed close to 18,000 workers. About 10,000 of the jobs were fruit and vegetable production, and over 80 percent of fruit and vegetable production stemmed from acres receiving project water. In addition to those directly employed in agriculture, over 5,100 are employed in fruit and vegetable processing, one indirect contribution of agricultural production to the regional employment. Table 3-18 presents a summary of employment by sector for the region; levels for the State and United States are shown for comparison.

Household Income by Sector

Household income totaled $6,624 million in the Yakima region for 1993. Of this total, $2,450 million, or 37 percent, reflect payments from outside the region for pensions, government support payments, distributions of business profits, and wages paid by firms outside the region to regional residents. The remaining $4,174 million was paid by firms to individuals for salaries, wages, and other payments within the region. Table 3-19 describes household income originating in the region. As with employment, the sector with the largest total was the service sector, with $1,432 million, or 34.3 percent of the total within the region. Household income levels are shown in table 3-19 for the region; State and United States data are shown for comparison.

Table 3-19.—Household income by sector for 1993
(in millions of dollars)

Sector	Yakima region	Percent	Washington	Percent	United States	Percent
Agriculture	138.5	3.3	457.6	0.6	10,922.6	0.3
Natural resources	56.9	1.4	813.5	1.0	41,109.8	1.1
Construction	273.8	6.6	5,844.9	7.3	224,872.0	5.9
Manufacturing	504.0	12.1	14,975.8	18.8	738,650.9	19.5
Transportation, communications, and utilities	135.9	3.3	4,513.2	5.7	231,302.0	6.1
Trade	557.7	13.4	12,875.6	16.2	592,561.8	15.7
Financial, insurance, real estate Services	122.5	2.9	4,845.3	6.1	295,015.4	7.8
Government	1,432.4	34.3	17,150.0	21.6	901,001.3	23.8
	952.6	22.8	18,044.7	22.7	742,441.2	19.6
Total	4,174.3	100.0	79,547.8	100.0	3,780,568.0	100.0

Agriculture employed 9.3 percent of the work force but paid only 3.3 percent of the wages. This difference is partly attributable to lower income per worker in agriculture compared to other sectors in the Yakima region. Many workers in the agricultural sector are seasonal. Each worker counts as one job in the employment data, but seasonal work leads to lower annual income. Also, hourly wages may be lower than in other sectors. Of the $139 million in household income paid by agricultural firms, $89.6 million comes from fruit production and $19.4 million from vegetable production, including acres receiving project water for irrigation.

Data are not available to indicate the level of household income by sector for minorities within the region. For this three-county region, there are 8,484 farm workers (according to the 1990 census). Of these, 6,625 (about 78 percent)[3] are Hispanic, while the overall population for the region is 16 percent Hispanic.

Sales Revenue by Sector

Sales revenue data are presented in table 3-20. Total sales revenue for the region in 1993 was estimated at $12.7 billion, which is about 5.5 percent of the total for the State of Washington. The services sector creates the most sales revenue within the region at 24.7 percent. This percentage is larger than for the State of Washington (17.8 percent) and for the United States (18.5 percent). The Yakima region depends more on agriculture than the State or the United States. Agriculture represents 8.4 percent of the total regional sales revenue, compared to about 2 percent for the State and for the United States. Employment and personal income also depend on agriculture.

[3] Equal Employment Opportunity, 1990 U.S. Bureau of the Census.

Table 3-20.—Sales revenue by sector for 1993
(in millions of dollars)

Sector	Yakima region	Percent	Washington	Percent	United States	Percent
Agriculture	1,067.3	8.4	4,291.3	1.9	171,842.2	1.5
Natural resources	141.4	1.1	3,377.1	1.4	183,496.6	1.6
Construction	1,364.4	10.7	27,671.6	12.0	1,086,589.7	9.9
Manufacturing	2,688.9	21.1	59,735.5	25.9	3,115,308.8	28.3
Transportation, communications, and utilities	487.3	3.8	15,400.8	6.7	788,174.3	7.2
Trade	1,241.9	9.7	26,388.4	11.5	1,149,214.2	10.4
Financial, insurance, real estate	1,247.0	9.8	31,321.4	13.6	1,674,106.3	15.2
Services	3,144.3	24.7	41,066.2	17.8	2,033,840.5	18.5
Government	1,363.6	10.7	21,201.5	9.2	810,886.7	7.4
Total	12,746.1	100.0	230,453.7	100.0	11,013,468.3	100.0

Comparing the household income and sales revenue percentages by sector with employment distributions for the Yakima region shows the relationship between labor and capital. In addition to lower wages in sectors such as agriculture, some sectors require less labor for a given level of sales. Manufacturing and financial, insurance, and real estate sectors tend to be less labor intensive. These industries use capital investments to generate sales revenue, and less labor is needed per dollar of sales. For the United States, agriculture is also very capital intensive. However, in the Yakima region, growing fruit and vegetables is more labor intensive than in most agricultural areas. In contrast, services and trade industries tend to be more labor intensive, and they reflect this factor with a higher percentages of household income compared to sales revenue.

3.10 Recreation

Rivers and reservoirs are discussed separately by basin: the upper and lower Kittitas Basin and the upper and lower Yakima River Basin. Limited recreation information is presented for the Yakama Indian Nation.

The format for presentation and basic information (if not cited) is taken from the *Yakima River Basin Water Quality Plan, Volume II* (YVCOG, 1993).

3.10.1 Recreation Setting

The recreation setting of the Yakima River Basin varies from designated wilderness areas to urban greenways. Features of the Yakima Project are mainly situated in roaded natural settings. Interagency Committee for Outdoor Recreation surveys indicate the number one

preferred recreation setting is water oriented. Public demand for access to rivers, streams, and reservoirs continues to increase yearly. Major recreation access points and developed and dispersed recreation areas within the Yakima River Basin are depicted in figure 3-11.

Recreationists are attracted to the basin by the quality of the scenery, water, and recreation opportunities. Primary recreation activities include fishing the reservoirs and rivers for cold water sport species, whitewater boating and kayaking, motorized boating, and other related activities such as camping, hiking, picnicking, and wildlife viewing.

Recreation Supply

The popularity of recreation in the Yakima River Basin reflects tourism and recreation trends which were predicted more than 20 years ago (Reclamation and WDOE, 1982). The I-90 corridor provides access to the basin from the Puget Sound, eastern Washington, and adjoining States. Demand for recreation sites along the corridor exceeds supply throughout the summer season. The Yakima River Basin contains 316 recreation sites. Management of recreation sites is divided among local, State, Federal, and private entities. Table 3-21 describes the recreation facilities by county.

Table 3-21.—Developed recreation facilities by county
(Interagency Committee for Outdoor Recreation, Washington State County Recreation Profiles in Yakima River Basin Water Quality Plan, 1995)

	Benton	Kittitas	Yakima	Total
Developed acreage	23,357	219,462	125,238	368,057
Shoreline (feet)	340,765	170,895	284,180	795,540
Boat launches	29	26	18	73
Camp units	508	2,387	2,175	5,070
Camp units with hookups	256	1,191	543	1,990
Swimming beach (feet)	2,260	1,432	400	4,092
Hiking trails	16	722	627	1,365
Horse trails	0	589	613	1,202
Off-road vehicle trails	1	302	171	474

Recreation Visitation

No single measurement of recreation visitation to the Yakima River Basin exists; but in 1995, the 6 State Park units recorded 855,659 visitors; the USFS estimated that the 5 major reservoirs located in the upper Kittitas and upper Yakima Basins attracted 1,370,000 visitors (196,098 visits in Naches River system, including Tieton, Bumping, American, Clear, Rimrock, and 841,000 visits to upper Kittitas Basin Lakes), and

Major Recreation Access Points and Developed and Dispersed Recreation Areas Within the Yakima River Basin

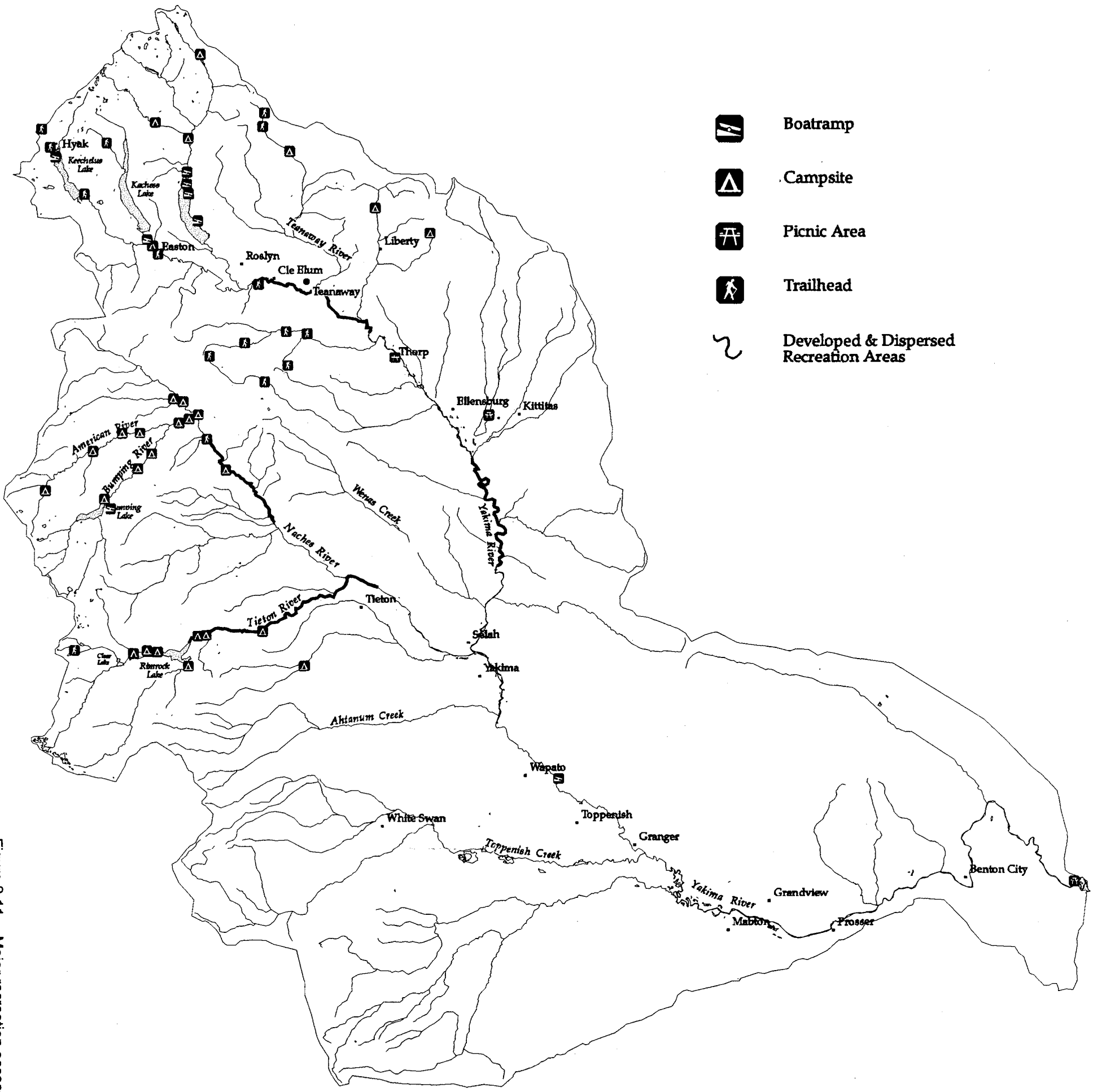


Figure 3-11.—Major recreation access points and developed and dispersed recreation areas within the Yakima River Basin.

BLM estimated visitation in the Yakima River Canyon to be over 498,000. Visitor use in the canyon was officially counted in 1994 and 1995 and totaled 475,000 and 498,700, respectively (BLM, Outdoor Recreation Planner, personal communication, 1996).

Angler use in the basin is highest in the more productive reservoirs, such as Rimrock and Bumping Lakes, and in the mainstem Yakima and Naches Rivers. Resident fish resources provide about 64,000 angler days of use in reservoirs and 190,000 angler days of use on streams (FWS, 1996).

3.10.2 Recreational Use of Reservoirs

The reservoirs of the Yakima Project serve as major destination recreation areas for people from eastern Washington and the Seattle-Tacoma area. Patterns, timing, and types of use at reservoirs have adjusted to seasonal drawdowns resulting from project operations.

Boat launching facilities are provided at Roza Diversion Dam. The dam delineates the end of the 21-mile recreation waters in the Yakima River Canyon.

Upper Kittitas Basin Recreation

The reservoirs in the upper Kittitas Basin are Keechelus Lake, Kachess Lake, and Cle Elum Lake. The reservoirs are located in the Wenatchee National Forest. Project operations vary from year to year, but the reservoirs are usually drawn down concurrently through the summer.

Recreation use patterns change with the seasonal water drawdown schedule. Recreation activities such as camping and water play move out onto the exposed mudflats as water levels are reduced. However, lack of sanitation facilities close to campers has resulted in heightened public health and sanitation concerns (USFS, Outdoor Recreation Planner, Wenatchee National Forest, personal communication, 1996).

Keechelus Lake, located along I-90, is the highest elevation reservoir in the upper Kittitas Basin. From a recreational standpoint, the area is managed primarily for day use activities and as a rest area. Fishing is the primary recreation activity on the reservoir. Water access has not been developed, and visitation in 1995 totaled 210,000 (USFS, Outdoor Recreation Planner, Wenatchee National Forest, personal communication, 1996). Land area totals 1,108 acres, water surface available for recreation totals 2,560 acres, and the shoreline measures 14 miles.

Kachess Lake is located between Keechelus and Cle Elum Lakes. Water surface available for recreation totals 4,535 acres, with 24 miles of shoreline. Developed public recreation acreage totals 100 acres, and undeveloped acreage totals 1,003 acres. Visitation totaled 280,000 in 1995 (USFS, Outdoor Recreation Planner, Wenatchee National Forest, personal

communication, 1996). Sunbathing and water play activities are ranked as the primary use, followed by motorized boating and fishing. The upper end of the reservoir is managed for nonmotorized craft and has a 15-mile-per-hour speed limit.

Cle Elum Lake is the lowest in elevation of the three reservoirs in the upper Kittitas Basin. Sunbathing, water play, camping, motorized boating, and fishing are the primary activities on Cle Elum Lake during the summer months. Water play activities are concentrated at Speelyi Beach, a developed facility with parking and restrooms. Cle Elum Lake received about 350,000 visitors in 1995 (USFS, Outdoor Recreation Planner, Wenatchee National Forest, personal communication, 1996). Water surface totals 4,812 acres, developed public use areas total 105 acres, undeveloped lands total 886 acres, and shoreline totals 19 miles.

Easton Diversion Dam, the largest of the diversion projects, occupies 112 acres of land and 240 acres of water surface. Lake Easton State Park provides facilities for camping, swimming, and boat launching and mooring. Recreation use totaled over 266,705 visitors annually; the reservoir provides a cold water sport fishery.

Lower Kittitas Basin Recreation

No project-related reservoirs or ponds are located in the lower Kittitas Basin.

Upper Yakima Basin Recreation

Bumping, Clear, and Rimrock Lakes are located in the Wenatchee National Forest. These reservoirs serve as a regional recreation destination location.

Most recreation near Bumping Lake is water oriented—boating, swimming, and fishing. The season of heavy use is from mid-May to mid-October. Hunters use the area through November. The area is snow covered the remainder of the year and receives winter recreation use. Facilities include 2 developed campgrounds, a marina, 2 boat launch ramps, and 15 cabin sites.

Rimrock Lake is a primary destination area for recreationists from eastern Washington and west of the Cascade Range. Typical recreation activities at the reservoir include sail boating, water skiing and jet skiing, fishing, wind surfing, canoeing, and boat-in camping. Facilities include 3 public boat ramps and 3 fee ramps; 49 private residences are located along the reservoir shore. The reservoir receives about 60,000 visitor days annually.

According to USFS, Clear Lake has high year-round recreational value. Facilities include 3 campgrounds, a boat launch, a picnic area, 4 private organized camps, and 91 homesites.

3.10.3 Recreational Use of Rivers

Yakima River headwaters are stored in Keechelus Lake. The river flows a total of 214.5 miles from the reservoir to the confluence with the Columbia River. Most riverflows in the basin are regulated by releases from upstream reservoirs or irrigation diversions. The "flip-flop" procedure, which releases water from Rimrock Lake, has created late season (September) high flows on the Tieton River that attract rafters and kayakers.

Dispersed recreation, such as fishing, nature study activities, boating, and sightseeing, occurs throughout the basin year round. The dispersion of this use makes it difficult to measure. Use is concentrated at four primary river-related recreation locations: (1) an upper reach of the Yakima River from Teanaway River to Thorp, (2) the Yakima River Canyon, (3) the Naches River corridor, (4) the Tieton River, and (5) the Lower Yakima River. Recreation use in these areas is described further.

Recreation in Upper Kittitas Basin—Upper Reach of the Yakima River From Teanaway to Thorp

Recreation uses include hunting, fishing, boating, and birdwatching. The Teanaway River is included in this reach because the river is regarded as an important recreation resource. White-water rafting and kayaking activities occur on a 6-mile run between river miles 10 and 4. Angler use is moderate, and the primary sport species are cutthroat and rainbow trout. Several public and private campgrounds are located in the area.

Recreation in Lower Kittitas—Yakima River Canyon

The Yakima River Canyon consists of 5,000 acres. Opportunities for dispersed recreation activities exist throughout the canyon. Developed recreation facilities which provide direct river access include three sites managed by BLM. Each site provides boat launching, picnicking, camping, and bathroom facilities. Recreation use is high from June through September. Water-related recreation activities include motorized and nonmotorized boating, camping, fishing, wildlife viewing, picnicking, jet skiing, swimming, and water skiing.

Recreation in the Upper Yakima

Recreation in the Naches River.—The Naches River corridor is composed of a main linear corridor dissected by numerous valleys. This pattern provides access to hundreds of dispersed recreation sites via forest loop roads, trail heads, and off-road vehicle trails. State Highway 410 passes through the valley bottom, and all developed recreation facilities are located along the highway. The Naches River is used heavily for white-water boating and fishing as well as sightseeing, camping, and picnicking.

Recreation in the Tieton River.—The Tieton River has been rated as having "high recreation value" for white-water kayaking, white-water boating, camping, and picnicking activities. Hiking/backpacking and wildlife viewing were rated as having average recreation value.

A 21-mile section of the river provides the only late-season white-water opportunity in Washington State. The rafting opportunity came about as a result of Reclamation operations involving the "flip-flop" procedure. Released water out of Rimrock Lake flows down the Tieton River, attracting 6,000 rafters and kayakers annually during the first 3 weeks of September. Most use occurs on weekend days.

State Highway 12 is designated as a Scenic Byway by Washington State.

Recreation in the Lower Yakima River, Mouth to Ahtanum Creek

Recreation uses include hunting, fishing, boating, and birdwatching. Public hunting and fishing permits issued by the Yakama Indian Nation allow non-Tribal members to hunt and fish within the Yakama Reservation subject to the rules and regulations of the Yakama Indian Nation. Stream systems include Toppenish/Simcoe, Satus Creek, and Spring/Snipes Creek. Corral Canyon, Snipes, and Spring Creeks are not part of the Yakama Indian Reservation.

3.11 Cultural Resource Properties and Paleontological Resources

Cultural resources are historic and traditional cultural properties that reflect a group's heritage. Federal law and regulation define historic properties to include prehistoric and historic sites, buildings, structures, districts, and objects included in or eligible for inclusion in the *National Register of Historic Places* (*National Register*). Traditional cultural properties have special heritage value to contemporary communities (often, but not necessarily, Native American groups) because they are associated with the historical practices or beliefs needed to maintain cultural identity. Traditional value can only be determined through consultation with the communities who used this area historically.

Numerous laws and regulations require identifying and managing the cultural resources on Federal lands. Principal laws directing management actions are the National Historic Preservation Act (NHPA), the Archeological Resources Protection Act, and the Native American Graves Protection and Repatriation Act. The NHPA requires that Federal agencies complete inventories and site evaluation actions within the area potentially affected by an undertaking. These actions identify cultural resources in the impact areas that may be eligible for the *National Register*. Reclamation's policy is to seek to avoid impacts to *National Register* eligible properties whenever possible. Regulations entitled "Protection of Historic Properties" (36 Code of Federal Regulations [CFR] 800) define the process for implementing requirements of the NHPA, including consultation with the appropriate State Historic Preservation Office (SHPO) and the Advisory Council on

Historic Preservation. The regulations (36 CFR 800) also specify that American Indian Tribes must be afforded an opportunity to participate when an undertaking may affect cultural resources of value to an Indian Tribe.

Reclamation recognizes and will take into account the fact that traditional Indian people have a broader definition of cultural resources than that contained in Federal cultural resource laws. The Yakama Indian Nation currently recognizes two broad types of cultural resources—archeological and current use resources. The Tribe's position is that these resources are culturally and socially important regardless of *National Register* status. For the purposes of this PEIS, the following discussion of cultural resources is based upon the more narrow definition.

3.11.1 Cultural Historic Context

The following outline of prehistoric land use patterns is largely synopsized from reports of Yakama Indian Nation archeological surveys near Cle Elum Lake and in the Yakima River Canyon (Lothson and Hemphill, 1994). Historic period use and events are synopsized from Babcock et al. (1986).

Archeological evidence indicates that human occupation of areas east of the Cascade Mountains extends back 9,000 to 12,000 years before present (BP). This evidence is clearly documented by Clovis materials found near East Wenatchee. An isolated Clovis-like point has also been collected at Cle Elum Lake, and Cascade or Vantage Phase artifacts (ca. 8,000 to 4,500 BP) have been found at Keechelus, Kachess, and Cle Elum Lakes. However, use of montane or upland areas appears to have been infrequent during early periods, and most sites found away from the lowland river corridors appear to date no earlier than 4,000 to 2,800 BP. Information presently available is insufficient to determine if this apparent settlement pattern reflects reality or is because most archeological investigations have occurred along the mainstem Columbia.

Despite data limits, archeological and ethnographic information and Tribal history are sufficient to outline prehistoric land use patterns. At the earliest periods of human occupation, the focus was on large game hunting by highly mobile groups, primarily using areas near rivers and their tributary creeks. A shift appears to have taken place during the Cascade Phase to hunting smaller "big" game (deer, mountain sheep, etc.), with an increasing reliance upon roots and fish; this shift most probably occurred in response to general environmental changes affecting resource availability. By about 3,500 BP, regional populations had adopted what has been characterized as the "Plateau Pattern," which was as follows (Lothson and Hemphill, 1994):

> *In early spring the people would leave their winter homes and base camps located at lower elevations and make their way in small task groups to the root grounds. Hunting small game animals and fishing as they went, the task groups arrived at the root grounds in late spring. Once at the root ground the women and young children would form up in larger task groups designed to exploit and process as*

much camas (later spring and early summer) and kouse as possible. Early spring activities included the collection of the first greens that grew on the south-facing slopes and selecting the best fishing spots for the spring Chinook.

In summer fishing was the most important activity . . .. Traps were constructed at the mouth of Lake Cle Elum and . . .. Thousands of people would gather at this location to fish for sockeye. Steelhead, bull trout, crayfish and mussels were also collected at this site and processed for winter storage . . .. In late summer the women would gather and dry berries . . .. Chinook, blueback salmon (sockeye) and summer steelhead were collected from the rivers and men set off for the fall hunting.

By August, the task groups moved into the mountains where they camped and harvested huckleberries. While the women . . . harvested the berries, men hunted deer and elk in the mountains. Some people moved down into the lowlands and to the rivers to dip-net the fall Chinook run . . .. In October, people moved back to the winter villages and processed the salmon collected during the fall run.

The first non-Indian settlement in the Yakima River Basin occurred from 1847 to 1852 with establishment of Catholic missions at seven locations in the Yakima, Kittitas, and Moxee Valleys. In 1846, Great Britain had ceded land claims south of the 49th parallel and, soon afterward, the U.S. Army began explorations for transcontinental railroad routes through the Yakima River Basin. In 1854, treaty negotiations began with area tribes in order to open lands for American settlement, and the Treaty of Walla Walla was signed in 1855 (Treaty of 1855). However, war with the Yakama and Kittitas Indians broke out within months of signature of the treaty, when miners began illegally crossing the Yakama Indian Reservation on their way to gold fields in north-central Washington. The U.S. Army moved into the area to subdue the Tribes, but fighting continued sporadically until 1858.

Settlement of the Yakima River Basin occurred rapidly after the Tribes were subdued. By 1860, cattle ranchers had settled along the Columbia and in the Yakima area, and sheep grazing soon followed. In the 1860s, wheat and oat farming began along the rivers, irrigated by small private irrigation ditches. Exceptionally wet years in the 1890s pushed farming into even the most arid upland areas, although many of these farms failed in subsequent dryer years. The Northern Pacific Railroad completed construction through the Yakima River Basin in 1885, linking the area to wider markets. This link resulted in a population boom and also converted farming from largely subsistence to commercial enterprises. The Northern Pacific also fostered expansion of irrigated agriculture; they had received large "checkerboard" land tracts from the Federal Government and launched an aggressive program to sell these lands to settlers. The Northern Pacific was initially a substantial backer of Walter N. Granger's Sunnyside Irrigation Project and was involved in developing coal mining and timber industries in the Cle Elum vicinity.

By the turn of the century, numerous private irrigation systems served the Yakima River Basin lands. However, overallocation of water and lack of reservoir storage resulted in

insufficient water to meet demands. Therefore, when the Reclamation Act was passed in 1902, Yakima Valley agricultural interests were among the first to petition the Secretary of the Interior to authorize a Federal irrigation project to serve the basin. The Tieton and the Sunnyside Divisions of the Yakima Project were authorized in 1905. Construction of associated diversion and carriage facilities began in 1906, and the first of the six Yakima Project storage dams was completed in 1910. New project divisions were authorized between 1911 and 1948—one was the Wapato Division, authorized in 1911, which serves lands on the Yakama Indian Reservation. Today, the Yakima Project serves 465,000 acres over an area extending from the Ellensburg vicinity to the Tri-Cities.

3.11.2 Previous Cultural Resource Investigations

Archeological investigations in the Yakima River Basin began in 1903 when Harlan I. Smith surveyed along the Yakima River from Kennewick to the Yakima Canyon. Mr. Smith documented numerous prehistoric sites, including camps, burials, and rock art sites (Babcock et al., 1986). No further significant investigations occurred in the Yakima River Basin for 50 years until a site at the confluence of Wenas Creek and the Yakima Canyon was excavated in 1956. The Wenas site contained stratified deposits dating from about 1,000 to 350 BP and possibly earlier. Recovered materials supported ethnographic data identifying the mouth of Wenas Creek as a highly important fishing village location. The first cultural chronology for the basin was developed using data from this site (Warren, 1968).

In the 1970s, a series of laws was enacted that required Federal agencies to complete cultural resource investigations prior to beginning potentially damaging actions. Numerous archeological surveys have occurred as a result. Many regional investigations have focused around reservoirs on the mainstem Columbia and on the Yakima Firing Range. Lesser investigations have occurred along the Yakima River and in upland locations associated with fish enhancement projects, logging activities, highway or utility construction, and other localized actions. Summarizing past regional investigations is beyond the scope of the PEIS. Instead, investigations and results around Reclamation facilities will be reviewed.

No archeological surveys were completed at Reclamation's Yakima Project reservoirs or other facilities prior to their construction because their construction predates the laws that require such investigations. However, a high probability exists that significant archeological and traditional cultural property resources are present. Bumping, Cle Elum, Kachess, and Keechelus Lakes are built on natural glacial lakes, which were the focus of summer fishing as well as berry picking and upland game hunting. Yakama Indian Nation informants reported important salmon fishing sites at the mouth of Cle Elum, Kachess, and Keechelus Lakes and, in 1853, Lieutenant George McClelland noted a large fishing village and fish weir at the mouth of Lake Kachess. McClelland was surveying for railroad routes through the Cascade Mountains and was exploring a trail used by regional Tribes that traveled up the Yakima River, along the shore of Lake Keechelus, and across Snoqualmie Pass. Ethnographic data indicate that a second trail diverged from the

Snoqualmie Pass trail at Lake Keechelus and traveled south of the lake up Roaring Creek and then over the Yakima Pass. Several important villages were reported on the Tieton River in areas inundated by or near Rimrock Lake, including a village named Miy a'way and a fishing site named Soo-Nooks. The same informants also report important sites in locations near a number of Yakima Project diversion dams; these sites and others at diversion dams have been confirmed by archeological survey and by reports by Yakama Indian Nation cultural resource staff.

Past archeological investigations at Reclamation reservoirs and their results follow.

Clear Lake

The USFS completed surveys in nearby campgrounds (Martinson, 1991) and areas on the south and west sides of the reservoir (Johansen, 1993) and monitored surface stripping of heavily sedimented areas within the reservoir pool associated with Reclamation's reconstruction of Clear Creek Dam in 1992 (Johansen, 1992). Areas adjacent to the dam were surveyed by a Federal Energy Regulatory Commission licensee (CH2M Hill, 1984). Two prehistoric sites have been recorded: a lithic scatter (061708-64) and a site with two peeled cedar "basket trees" (061708-128). In 1992, Reclamation and SHPO concurred that Clear Lake Dam was not eligible for inclusion in the *National Register* because of extensive past structural alterations. No determinations of eligibility have been completed for the archeological sites.

Rimrock Lake/Tieton Dam

In 1988, USFS surveyed near a tributary stream into Tieton River and recorded two sites. One (061708-142) is a lithic scatter covering the stream delta within the reservoir pool, and no data are available on the other site (061708-244) (Martinson, 1991). Dr. David Rice (1993) reported a large artifact scatter near Tieton Dam, which may be the remnants of the Miy a'way village. An historic-period cabin site is present within the pool (Johansen, 1992). Reclamation has determined Tieton Dam to be eligible for inclusion in the *National Register*.

Bumping Lake

In 1987, USFS completed a reconnaissance sampling survey that included lands in the lower portion of the reservoir and below the dam. Three prehistoric sites were recorded (45YA168, 062708-186, and 062708-188). Two are large lithic scatters located near the mouth of the glacial lake; one site possibly includes a pit house (Reid, 1987). The third recorded site was located farther up the reservoir along a tributary creek. Remnants of the dam construction camp were also documented (sites 061708-045 and 0187). In 1990, Reclamation contracted for intensive survey of 125 acres immediately above and below the dam and test excavation of selected sites (Draper, 1991). They re-examined sites 45YA168 and 062708-186 (redesignated as 45YA520) and recorded five new sites (45YA518 through

YA522). Test excavations were completed at YA520, YA521, and YA522. The first site proved to be remnants of recent campfires, and the latter two sites were found to be highly eroded remnants of low-density lithic scatters. All three were determined in consultation with SHPO to not be eligible for inclusion in the *National Register*. Reclamation and SHPO have determined Bumping Dam to be eligible for inclusion in the *National Register*, and Historic American Engineering Record documentation is presently being completed.

Kachess, Keechelus, and Cle Elum Lakes

In 1992, USFS contracted for archeological surveys of the drawdown zones of Kachess, Cle Elum, and Keechelus Lakes. The surveys occurred during a drought period, so the shorelines of the glacial lakes upon which the reservoirs are built were exposed. Thirteen previously identified sites were revisited, and 43 new prehistoric and historic sites were found (Hicks and Bishop, 1993). Much of the surface within the reservoirs was blanketed by heavy reservoir-deposited silts, so additional sites likely remain undetected, and recorded sites may be larger. Recorded prehistoric sites are primarily lithic scatters, perhaps denoting task-specific camps; others are more large and diverse artifact scatters, likely indicative of longer-term base camps or fishing villages. Historic period resources include the debris scatters marking dam construction camps, other camps, home/farmsteads, remnants of a sawmill and a resort, and a 1902 crib dam.

In 1990, proposed routes were surveyed for a power line extending from Hyak Substation at the west end of Keechelus Lake, down the Yakima River to the Ellensburg vicinity, and then through Johnson Canyon to Beverly on the Columbia River. The initial portion of the line passed along the southwest shore of Keechelus Lake. At that location, the surveyors recorded five prehistoric archeological sites (45KT316, KT478, KT834, KT835, and KT836) (DePuydt, 1990). All five sites lie along or near the shore of the glacial lake. In 1991, surveyors returned to test sites 45KT316, KT834, and KT836. Two of the sites were identified as fishing facilities/camps and the third as a camp (DePuydt, 1990). All three sites were recommended as eligible for inclusion in the *National Register*. Reclamation has determined Keechelus Dam to be eligible for inclusion in the *National Register*.

In 1995, Reclamation contracted for test excavations of portions of site 45KT1014, located near Kachess Dam (Regan, 1996), because the site would be affected by excavations to widen the reservoir outlet channel implemented as part of YRBWEP. Test excavations indicated that no significant archeological deposits were present within impact areas but did not rule out intact deposits elsewhere within the site. In 1996, SHPO concurred that Kachess Dam is eligible for inclusion in the *National Register*, as is the 1902 Columbia Canal Company crib dam located in the pool nearby. Historic American Engineering Record documentation of Kachess Dam is being completed.

3.11.3 Traditional Cultural Properties

Traditional cultural properties may include rock art sites; resource procurement areas, including food and medicines; and locales suitable for vision quests or other traditional religious/spiritual rites or ceremonies. Several rock art sites are known within the basin.

3.11.4 Paleontological Resources

Within the Yakima River Basin, the Ellensburg Formation has a high probability of containing Miocene fossils. This formation is composed of volcanic debris flows shed by long-extinct volcanoes to the west. In some areas, these flows were, in turn, covered by basaltic flows. Other fossiliferous formations may include the Swauk and Roslyn Formations, which have shale and coal seams. The presence of paleontological resources within the proposed areas of impact is unknown.

3.12 Sacred Sites

To prevent damage to a site, the Yakama Indian Nation has informed Reclamation of one sacred site location at a project reservoir. Reclamation anticipates that similar sites are present at all reservoirs, particularly where extensive fishing and other important actions occurred.

3.13 Indian Trust Assets

The United States has a trust responsibility to protect and maintain rights reserved by or granted to American Indian Tribes or Indian individuals by treaties, statutes, and Executive orders. ITAs are legal interests in property held in trust by the United States for Indian Tribes or individuals or legal interests that the United States is otherwise charged by law to protect. The Treaty of 1855 assigned specific rights to Tribes, including Reservation lands and rights for hunting, fishing, and gathering off Reservation. These rights are considered ITAs and are protected accordingly. Other common examples of ITAs include minerals and other natural resources. Reclamation's policy with regard to ITAs states that it will carry out its activities in a manner which protects ITAs and avoids adverse impacts when possible. When unable to avoid adverse impacts, Reclamation will provide appropriate mitigation or compensation.

Chapter 4

Environmental Consequences

4.1 Overview

This section presents impacts of action alternatives compared with the No Action Alternative. Included are impacts to surface water hydrology, including quantity and quality of surface water and groundwater in the basin. In addition, impacts are presented for agriculture; fish; vegetation and wildlife; threatened, endangered, and special status species; socioeconomics; recreation; cultural and paleontological resources; sacred sites; and Indian Trust Assets (ITAs).

4.2 Surface Water Hydrology

For the purposes of this programmatic environmental impact statement (PEIS), the hydrology model was used to determine the following for pre-Title XII conditions, No Action Alternative, and the action alternatives:

- River streamflow at a number of locations on the Yakima River and tributaries
- Reservoir storage and corresponding water surface elevations
- Canal and power diversions
- Total water supply available (TWSA)
- Reservoir releases

The hydrology model output is determined monthly for the 1926 to 1994 time period for the various alternatives. The No Action Alternative contains baseline conditions. That is, it represents the streamflows, diversions, reservoir levels, reservoir releases, and other data for each month of each year from 1926 through 1994, assuming the level of development in 1994 and the application of current operational elements in the basin. The model results for the No Action Alternative are *not* actual values but estimates of what would have occurred given the 1994 level of development in the basin and using Title XII target flows for the entire period 1926 through 1994. The pre-Title XII condition is the same as the No Action Alternative except that Title XII target flows were not incorporated into the model analysis for these conditions. See table 2-4 for a summary of alternatives and pre-Title XII conditions.

It should be pointed out that the measured flows serve as the basic input data to the hydrology model, and, therefore, the model results should be considered to be no more accurate than the accuracy of these measured flows. The accuracy of measuring flows depends upon the flow level as well as the devices used to measure flows. *Typically*, gauging station error ranges from 5 to 20 percent to even higher during very high flows.

4.2.1 Summary of Impacts to Surface Water

Averages for the period 1926-1994 were summarized for the entire year and the period July through October. Pre-Title XII shortages were a bit less than under no action in an average year. Pre-Title XII flows were much less than under no action at Prosser from July through October in the average year. Changes in surface water flows mostly result from implementing the Basin Conservation Program under Alternatives 2A, 2B, 2C, and 3. Flows increase at Parker and Prosser as intended under Title XII. The largest increases are for the average flows at Parker and Prosser during July through October. The amount of shortages also decreases in average years.

In the dry year that was analyzed, 1994, pre-Title XII flows at Prosser were much less than under no action, particularly from July through October. In the 1994 model year under Alternatives 2B and 2C, there are moderate increases from no action in releases for instream flows and decreases in shortages. In the 1994 model year under Alternatives 2A and 3, there are no increases from no action in releases for instream flows and minor decreases in shortages.

The following tables (table 4-1 and table 4-2) present a summary of the hydrology indicators that show the largest change in values with implementing the action alternatives as compared with the No Action Alternative. Table 4-8 shows the impacts of each of the alternatives for the main canal diversions for the Yakima River. The information in the tables is extracted from tables A-2, A-3, A-4, and A-5 in appendix A.

Tables A-2 and A-3 in the appendix present the target flow impacts at the Parker and Prosser locations on the Yakima River. The tables compare pre-Title XII conditions, for the listed target flow hydrology indicators, with the No Action Alternative. Also presented in the tables are the impacts of the five action alternatives compared with the No Action Alternative. The impacts presented in table A-2 are period average values from 1926 to 1994. The impacts presented in table A-3 are values for 1994 only, a modeled dry year. These impacts are expressed as a percentage of months where the specific hydrology indicator or condition is met. The tables present values in percent for the No Action Alternative for each of the hydrology indicators, and the impacts shown for the other alternatives are related to and compared with the No Action Alternative value. For each action alternative, impacts are shown as increases or decreases from the percent shown for the No Action Alternative. Pre-Title XII conditions are compared with the No Action Alternative in the same way. For example, in table A-2 for flows greater than 300 cubic

Table 4-1.—Overview of impacts in an average year (1926-1994)

Hydrology indicators	Pre-Title XII percent change	No Action Alternative (base value)	Action alternatives - percent change				
			Alternative 1	Alternative 2A (preferred alternative)	Alternative 2B	Alternative 2C	Alternative 3
Parker flow **Jul-Oct**							
	[1]-18	511 ft^3/s average flow	+2	+35	+43	+49	+34
	-10	20 percent of months ≥ 600 ft^3/s	+4	+49	+51	+52	+48
	0	5 percent of months ≥ 900 ft^3/s	0	+9	+16	+17	+8
Prosser flow **Jul-Oct**							
	-58	461 ft^3/s average flow	+2	+42	+49	+53	+40
	-14	17 percent of months ≥ 600 ft^3/s	+3	+51	+53	+53	+50
	0	3 percent of months >900 ft^3/s	0	+9	+17	+17	+8
Prosser flow **Year**	-5	42 percent of months ≥ 600 ft^3/s	+1	+19	+21	+21	+20
Shortages	-14	57,000 average acre-feet per year	-18	-21	-39	-49	-16
Releases for Instream flows	-32	81,000 average acre-feet per year	+2	+57	+60	+62	+53

[1] Percent of decrease or increase from the no action value.

Table 4-2.—Overview of impacts in a dry year (1994)

Hydrology indicators	Action alternatives—percent changes						
	Pre-Title XII condition	Base value	Alternative 1	Alternative 2A (preferred alternative)	Alternative 2B	Alternative 2C	Alternative 3
Parker flow **Jul-Oct**	[1]0	300 ft^3/s average flow	+8	0	+17	+33	0
Prosser flow **Jul-Oct**	-54	300 ft^3/s average flow	+8	0	+17	+33	0
Easton flow **Jul-Oct**	0	519 ft^3/s average flow	+5	-1	+29	+17	+8
Releases for instream flows	0	74,000 acre-feet	+8	0	+25	+49	0
Storage at Kachess Reservoir	-15	75,000 acre-feet	+17	+23	+4	-15	+12
Shortages	-3	602,000 acre-feet	-9	-17	-30	-28	-16

[1] Percent of decrease or increase from the no action value.

feet per second (ft^3/s) below Prosser Dam for year-round conditions, the number of months as a percentage of the total months in the modeling period is 84 percent for the No Action Alternative. For the pre-Title XII condition, the table shows a -41 percent change (i.e., a decrease of 41 percent from the No Action Alternative) compared with the No Action Alternative, which means that flows are greater than 300 ft^3/s only 43 percent of the time under the pre-Title XII condition, compared with 84 percent of the time for the No Action Alternative.

Table A-4 in Appendix A "Surface Water Hydrology" summarizes the impacts for other hydrology indicators, such as the April TWSA and annual diversions. Table A-4 in the appendix summarizes the hydrology impacts on the Yakima River for July through October streamflow at selected key locations on the river. Both tables A-4 and A-5 present the impacts in terms of percentage change compared with the No Action Alternative and are shown for period average conditions for the 1926 to 1994 modeling period and for 1994 only, a modeled dry year.

Detailed surface water hydrology impacts are presented in a number of tables in Appendix A "Surface Water Hydrology." Related figures are also included in the appendix. Tables A-2 through A-5 in the appendix present impacts for pertinent hydrology indicators. Figures A-2 through A-23 in the appendix show graphical comparisons of hydrology indicators for the No Action Alternative with the various action alternatives.

4.2.2 Discussion of Impacts to Surface Water

Methods and Rationale

The Yakima River Basin Water Enhancement Project (YRBWEP) hydrology model, described briefly in chapter 2, has been developed for analyzing the alternatives. The hydrologic computer model has been used for scoping alternative plans and operations of the Yakima River water supply before enactment of Title XII. The hydrology model uses a long period of record from 1926 through 1994 and conserves mass balance for the input water supply, diversions, reservoir contents, and return flows.

A data set of diversion patterns was derived that represents demands during full water supply conditions. The patterns are based on the average demands of full water supply years between 1970 and 1994. Water years when significant proration occurred were not used, which included the years 1973, 1977, 1979, 1987, 1988, 1992, 1993, and 1994. The full supply years for diversions were calculated in terms of "irrigation year," November through October. The model is based upon a water year, October through September. This diversion data set was used in the model to represent the present depletion levels in the basin. This diversion data set used October of a previous full water supply year instead of the October from a year following a year of prorated water supply to determine the pattern of diversions for full water supply years. The adjusted full water supply diversions were averaged for the 17 years, and this average full water supply diversion pattern was used in the hydrology model for the alternative model runs.

Return flows are computed using the hydrology model with historical diversions and lagged return flow factors adopted in 1984 for the basin. Historic diversion data were estimated for the model because small canals are not measured. Estimates were based on sporadic observations and measurements made during a data collection program from 1978 through 1984. The six major canals divert about 80 to 85 percent of the total basin diversions. The canals are continuously monitored for flow. Recorded and estimated diversions were used with the hydrology model to compute return flows for 1978 to 1994, and these data were used in modeling runs for the 1926 to 1994 modeling period.

For Alternatives 2A, 2B, 2C, and 3, one very important assumption in the model is that return flows, associated with specific canal diversions, are reduced on a one-to-one basis with the reduced diversions. Reduced diversions are a result of the Basin Conservation Program. This assumption means that every acre-foot of reduced canal diversion results in a corresponding acre-foot of reduced return flow. Monthly return flow factors are modified to reflect this assumption. Diversion reductions are assumed to be met by implementing such water conservation measures as onfarm conservation measures, canal and ditch seepage reduction, end of canal wastage, and/or other applicable measures without reducing the water needed by the agricultural crops. It should be pointed out that the diversion reductions for Alternatives 2B and 2C are most likely not achievable by the implementing conservation measures only. Water acquisitions and subsequent land use change would most likely be required to meet the diversion reductions for these two alternatives (see Section 4.3.2 "Discussion of Impacts to Surface Water Quality" and table 4-5).

The return flow factors used in the hydrology model are multiplied by the amounts of diversion, and the product is added to the local water supply at the appropriate location and time. The factors were originally derived through a repetitive mathematical process (and based on measurements when available) when the local reach gains describing the historical runoff were derived. The return flow factors were estimated and used to compute the local reach gains. If these gains were unrealistic, the factors were changed, and the gains were recomputed. The process continued until the gains and return flows appeared to reflect the actual historical runoff conditions.

For the water supply, the hydrology model used a long-term water supply data base of monthly estimated unregulated flows (no storage regulation, diversions, or return flows) for the period 1926 through 1994. The estimated unregulated water supply represents the gains to the river system that would occur assuming that the influence from man's activity was removed insofar as possible. The hydrology model was then used to superimpose levels of development on this estimated unregulated water supply for the various alternatives in order to make comparative analyses. Each level of development is defined by the major structural and operational elements of the river system that regulate the water supply. Reservoirs and physical diversions are structural elements, whereas diversion entitlements and instream flow demands are operational elements. Title XII specifies target flows based upon TWSA at Parker and Prosser (refer to table 3-4). These instream flow demands are included in the model as minimum flows, the stipulated level met if the water is physically available. The TWSA versus flow table is included in the

computer hydrology model, which allows the target flows at Parker and Prosser to be met for each alternative analysis by releasing water from the reservoirs if needed and available.

Method for Evaluating Impacts

The impacts are shown as a percentage change from the No Action Alternative, but it is important to assess these percentage changes in terms of generalized impact criteria; that is, to evaluate the significance of the numerical changes. The significance of the impacts of the various alternatives, compared with the No Action Alternative, is shown by ranges based in the percentage of change summarized in table 4-3.

Table 4-3.—Defined range of impacts for surface water flows

Type of impact	Change from No Action Alternative (percent)
No measurable impact	≤ 10
Minor impact	10 to 20
Moderate impact	20 to 50
Major impact	>50

No measurable impact (NMI) is related to the physical accuracy of measuring riverflows, diversions, and return flows. Flow measurement accuracy depends upon flow level and measurement devices used in the past. Typical gauging station error ranges from 5 to 20 percent to even higher during very high flows. Therefore, the model results reflect the accuracy of all measured flows (e.g., diversions, streamflows, and return flows). To assess the significance of the hydrology impacts presented herein, an overall measurement error of 10 percent was assumed in defining the NMI level of impact. The less than 10 percent class was selected because impacts shown in the model would not be measurable due to gauging error. It should be pointed out that the measured flows serve as the basic input data into the hydrology model; therefore, the model results should be considered to be no more accurate than the accuracy of measured flows.

The impacts for the action alternatives compared with the No Action Alternative are shown in tables A-4 and A-5 in terms of percentage change. The impacts from these changes should be assessed using the ranges in table 4-3. In addition to the tables, figures A-2 through A-7 in appendix A have been included to show graphically the comparison of the various action alternatives with the No Action Alternative. The figures in appendix A show the actual indicator values, whereas tables A-4 and A-5 show the percentage change in the action alternatives compared with the No Action Alternative.

No Action Alternative Impacts to Surface Water

The No Action Alternative includes implementing the congressionally mandated target flows at Parker and Prosser discussed earlier. Implementing these target flows based on TWSA, in a practical sense, has a negative impact on irrigation water supply. That is, to meet target flows, storage release is needed in summer months when reservoir releases are scheduled to meet diversion demands above Sunnyside Diversion Dam. In addition, in a dry year, proratable entitlements are reduced, which reduces late summer and fall return flows; again, this reduction results in increased storage draft in order to meet a given demand. However, when quantifying the impacts, the differences are small and generally in the category of not measurable based upon the impact criteria in table 4-3.

Implementing the Title XII flows assumed in the No Action Alternative modifies pre-Title XII conditions as shown in tables A-2 through A-5. The following summarizes pre-Title XII conditions when compared with the No Action Alternative for the indicators shown in the tables and the figures:

- Table A-2 shows 0- to 10-percent change for the hydrology indicators at Parker and 0- to 95-percent change at Prosser for the listed hydrology indicators for average year conditions.

- Table A-3 shows that the flows are considerably lower (major negative changes) at Prosser for the greater than 300-ft^3/s year (all months) condition and the July through October period for the 1994 dry year conditions. At Parker, the changes were zero for all of the hydrology indicators.

- Table A-4 shows that the only measurable changes in hydrology indicators for the average year are for instream flow releases (moderate decrease) and shortages (minor decrease).

- Table A-5 for the 1994 dry year shows that the only measurable change is a minor decrease in the Kachess Lake storage level.

- Table A-5 shows a minor decrease at Parker and a major decrease at Prosser for average July through October flows for 1926 to 1994. The table also shows a moderate decrease at Prosser and a minor decrease at Kiona for average July through October flows for the dry year, 1994.

- The flow changes by month for the eight stations on the Yakima River in figures A-8 through A-23 show measurable changes for some months. Most changes are minor; however, during summer months for Parker and Prosser, the figures show significant changes.

Alternative 1 Impacts to Surface Water

This alternative includes all the structural elements but does not include any element of the Basin Conservation Program. Most of the impacts of this alternative compared with no action are considered not measurable. For the 1926-1994 average year condition, there would be a minor decrease in shortages as compared to no action. For the 1994 year (a modeled dry year) condition, there would be minor increases in storage at Kachess Lake.

Action Alternatives 2A, 2B, 2C, and 3 Impacts to Surface Water

Alternative 1 structural elements are included in all other action alternatives. Alternatives 2A, 2B, 2C, and 3 assume that irrigation conservation is implemented at different locations because analyses show that location(s) of implementing conservation measures will affect timing and magnitude of diversion return flows and, as a result, will affect the river system water supply, which is particularly important in low runoff years. The location of conservation relative to Parker and Prosser is also very important when implementing Title XII. Implementing conservation measures implicitly increases flows in the reach from the diversion point downstream to the point where the return flows from that diversion have been regained. This condition can be seen comparing Alternative 2A with Alternatives 2B and 2C.

In all alternatives, demand reduction was excluded from Wapato Irrigation Project and Yakima-Tieton Canal. Because of this basic assumption, the Yakama Indian Nation experiences no surface water impacts. In Alternatives 2 (A, B, and C) and 3, diversion reduction percentages were those required for a total diversion reduction amount of 165,000 acre-feet—the amount or goal indicated in Title XII. Alternative 2A and 3 assume that all diversion demands in the basin will be reduced by 7.5 percent. The intent in this assumption is that implemented measures would allow the same crops and acreage to be grown with the reduced demand pattern; consumptive use would not change. As described in the return flows subsection in Section 3.2.1 "Water Supply and Demands," return flow routing parameters are adjusted with the demand patterns to properly simulate the impacts from implementing irrigation conservation measures as causing no reduction in consumptive use. Alternatives 2B and 2C differ from Alternatives 2A and 3 in the location and magnitude of the reduction in diversion demands in the basin. Alternative 2B involves a 15-percent reduction in diversion demands for the lower part of the basin below Roza, and Alternative 2C involves a 21-percent reduction in diversions for the Roza and Sunnyside Canals.

Irrigation conservation implementation and the resulting reduction in demands would trigger increases in instream flow targets at Parker and Prosser gauging stations. The upper three levels of flows at Parker and Prosser based on TWSA shown in table 2-2 are increased by 300 ft^3/s to reflect Title XII's intent that each 27,000 acre-feet of diversion reduction be accompanied by a 50-ft^3/s increase in instream flow at the two gauging stations. Alternatives 2A, 2B, 2C, and 3 include the Basin Conservation Program.

Technically, the Alternative 2A model analysis indicates that, from a system water supply standpoint, implementing basin-wide conservation has some negative impacts on the ability to meet irrigation demands and instream flow objectives. The spring and early summer diversions are reduced, which results in decreased return flows in the late summer and fall. Practically, this decrease results in less basin water supply available to meet irrigation demands, and a deeper reduction in proratable entitlements occurs. However, in general, the tables and figures show that for most of the time, the impacts are not measurable. The same is generally true in analyzing the results of the other action alternatives.

The following summarizes in some detail the impacts of Alternatives 2A, 2B, 2C, and 3 compared with the No Action Alternative. Tables 4-1 and 4-2, as well as tables and figures in appendix A, show the impacts for each alternative for the hydrology indicators for the dry year 1994 and the average of the period 1926 to 1994.

- Instream flows show major increases at Parker and Prosser during the average year July through October. Tables A-2 and A-3 summarize impacts for instream target flows at Parker and Prosser. For the dry year 1994, impacts are not measurable, which would be expected because Title XII imposes no increases in the target flows during low TWSA years.

- There are moderate decreases in shortages and major increases in instream flow releases in the average year for Alternatives 2A, 2B, and 2C. The more the Basin Conservation Program focuses on diversions upstream of Parker (whose return flows re-enter the river downstream of Parker and Prosser), the fewer the shortages. The more emphasis on these diversions, the fewer releases are needed for instream flows—which further minimizes shortages. The hydrology model shows that Alternative 2C reduces shortages more than Alternative 2B, and Alternative 2B reduces shortages more than Alternative 2A. There is a minor decrease in shortages and a major increase in instream flow releases for Alternative 3. Table A-4 shows that for many of the hydrology indicators and Title XII alternatives, the impacts are not measurable. The major impacts are primarily for instream flow releases, as would be expected, because increases in instream flows are one of the major aspects of Title XII.

Title XII flows negatively impact carryover storage and early spring refill capability as indicated by the April TWSA. However, figure A-2 in appendix A and table A-4 indicate that the alternative impacts on TWSA are less than 10 percent and are not measurable. The releases from storage to meet the instream flow requirements as stipulated decrease the amount of storage available for irrigation diversion and the associated return flows although again the impacts are not measurable (see figure A-3 in appendix A and table A-4). Figure A-3 in appendix A indicates a negative impact from implementing irrigation conservation basin wide that is assumed to reduce diversion without reduced crop acreage. Again, the impacts are less than 10 percent and not measurable.

Figure A-4 and table A-5 in appendix A show minor to moderate decreases in shortages for the various action alternatives compared with the No Action Alternative.

Figure A-5 and table A-4 in appendix A show major increases in the instream flow releases for the average year (1926 to 1994 modeling period) but no measurable impacts for the dry year, 1994, except for Alternatives 2B and 2C, which show a moderate increase.

In general, reaches directly downstream from one of the five storage reservoirs have low flows during winter months and high flows throughout the irrigation season. Reaches in the lower part of the river system (downstream from the Naches confluence) have high winter flows and low summer flows. Figure A-6 and table A-5 show the average annual flow at key locations on the Yakima River. At all locations except Martin and Prosser, alternative impacts are not measurable. Flows at Martin for Alternative 2B for the dry year (1994) show a minor increase. Flows at Prosser show a minor increase for Alternative 2C for both the period average (1926 to 1994) and the dry year (1994).

Figure A-7 in appendix A shows the average July through October flow (irrigation season) at key locations on the Yakima River. Flows at most locations on the river show no measurable change for the period average (1926 to 1994) and the dry year (1994). The primary exceptions are at Parker and Prosser, which generally show minor to moderate changes for all of the alternatives except Alternative 1.

Figures A-8 through A-23 in appendix A show impacts on Yakima River flow at seven locations for the action alternatives compared with the No Action Alternative. The figures in appendix A show monthly impacts for average year (1926 to 1994) conditions and for the dry year (1994).

The increase in streamflows, as stipulated from implementing Title XII, is evident in figure A-5 in appendix A, which shows the impacts of the action alternatives compared with the No Action Alternative. Major increases in instream flows occur with implementing the action alternatives (see table A-4).

The impacts shown in tables A-4 and A-5 are based upon comparing yearly averages (tables A-2 and A-3 are based on a period of record count of monthly flow exceedence). Yearly values inherently average out significant variations in the associated monthly values; therefore, it is important to determine if impacts occur when comparing monthly values for the action alternatives with the No Action Alternative. Therefore, figure A-7 and table A-5 in appendix A are included to illustrate the impacts on the Yakima River flow for the average July through October flow at key locations on the river as discussed above. Furthermore, figures A-8 through A-23 in appendix A illustrate the impacts on the Yakima River flow at the same key locations but for monthly rather than yearly flows. The impact criteria discussed above are also applied to the average July through October flow data and the monthly flow data in identifying the level of impact illustrated with each of the figures in appendix A. From the flow data shown on the figures in appendix A, specific months for each applicable alternative that show an impact can be identified.

4.3 Surface Water Quality

4.3.1 Summary of Impacts to Surface Water Quality

Table 4-4 presents a general summary of the impacts on the surface water quality within the basin from implementing Title XII.

4.3.2 Discussion of Impacts to Surface Water Quality

Methods and Rationale

The impacts of implementing Title XII components on the surface water quality within the basin are closely related to the impacts on riverflows and drain water flows. Therefore, the water quality impacts discussed herein are tied to and closely relate to the changes in flows in the Yakima River and in the return flows as impacted by reductions in diversions. Because some components of Title XII do not specify locations within the basin (specifically, water conservation), the impacts on water quality will be presented in general terms. The proposed Basin Conservation Program's goals are to reduce diversions by 165,000 acre-feet. Hydrology model studies assume that diversions and return flows would be reduced by a like amount—165,000 acre-feet. Reducing diversions and return flows can be accomplished through conservation measures or through water rights acquisitions. Assuming water conservation measures are implemented to reduce diversions, table 4-5 illustrates how this assumption would affect total diversions, total return flows and the percent reduction, and the reduced return flows as a percent of the reduced total diversions.

Table 4-5 shows the projected diversions and return flows under the various options for implementing the Basin Conservation Program. It should be pointed out that Alternatives 2B and 2C are, most likely, not physically possible if conservation actions alone are used to reduce diversions and return flows. This is because the reduced return flows shown as a percent of the reduced diversions are likely not achievable. Even the most efficient irrigation diversion systems have not experienced the efficiencies that would be required (i.e., 75-801) to meet the reduced diversions that are assumed with Alternatives 2B and 2C as indicated in the table. To meet the reduced diversions and return flows assumed with Alternatives 2B and 2C would most likely require water rights acquisitions and land use change.

The discussion of water quality impacts here will focus on parameters of interest or concern in the Yakima River Basin as discussed in chapter 3: temperature, suspended solids or sediment, nutrients, and pesticides.

Unless Yakima River flows or the return flows in the irrigation drains change by more than 10 percent at a given location in the river or in the drains because of implementing various components of Title XII compared with the No Action Alternative, the impacts on the flows and, subsequently, water quality would be considered *not measurable*. See

Table 4-4.—Summary of impacts to surface water quality

Impact indicator	No action	Proposed action				
		Alternative 1	Alternative 2A (preferred alternative)	Alternative 2B	Alternative 2C	Alternative 3
Surface water in the Yakima River	Sediment, nutrients, and pesticide concentrations are higher at certain times of the year because of impacts of irrigation return flows. Temperature can be lower or higher because of drain water influences.	No measurable impacts on the water quality in the river compared with the No Action Alternative.	Some improvement in water quality below Parker is possible for sediment, nutrients, and pesticides. Improvement depends upon type of water conservation implemented in the basin.	Same as Alternative 2A except concentrated in the area downstream from Roza.	Same as Alternative 2A except concentrated in the area downstream from Roza and Sunnyside Canal diversions.	Same as Alternative 2A.
Water quality in drains	Drain water quality shows sediment, nutrients, and pesticide concentrations are generally higher than in the irrigation water supply diverted from the river.	Drain water quality should remain about the same as the No Action Alternative.	Some reductions in sediment, nutrient, and pesticide concentrations should occur, depending on type of conservation implemented in the basin—specifically if surface runoff from onfarm practices is reduced.	Impacts are concentrated downstream from Roza; therefore, return flows are less than Alternative 2A. So sediment concentrations and loads should be lower. This reduction may not be true with other parameters.	Impacts are concentrated downstream from Roza and Sunnyside canals; therefore, return flows are less than Alternative 2A. So sediment concentration and loads should be lower. This reduction may not be true with other parameters.	Same as Alternative 2A.

Table 4-5.—Diversions and return flows for Basin Conservation Program action alternatives

Alternative	Total[1] diversions no action	Return flows no action	Reduced[2] diversions	Reduced[3] return flows	Percent reduction in return flows	Return flows as percent of reduced diversions
2A (preferred)	2,200,000	792,000	2,035,000	627,000	20.8	30.8
2B	1,100,000	396,000	935,000	231,000	41.7	24.7
2C	785,710	282,860	620,710	117,860	58.3	19.0
3	2,200,000	792,000	2035,000	627,000	20.8	30.8

[1] The diversions are determined assuming 165,000 acre-feet of water saved equals 7.5 percent of the total diversions for Alternative 2A, 15 percent of the total diversions for Alternative 2B, and 21 percent of the total diversions for Alternative 2C, respectively.
[2] For each action option, the diversions and return flows are reduced by 165,000 acre-feet per year.
[3] The Wapato Canal diversions are not included in any of the actions above.

table 4-3 for a defined range of impacts. This stated 10-percent change in flows represents a reasonable level of error for flow measurements, and the results of the hydrology model runs are based upon past flow data measured in the basin. Table 4-6 presents a summary of the Yakima River flows at Umtanum, Parker, Prosser, and Kiona for the dry year (1994) and the average year (1926 through 1994). The data in the table are average monthly flows in ft^3/s and are extracted from the output files from the Yakima River Basin hydrology model runs for the No Action Alternative, action alternatives, and the pre-Title XII conditions. The table allows for comparisons of riverflows for the No Action Alternative and action alternatives for dry year and average year conditions and to relate these flows to water quality conditions.

The following will summarize the *general* water quality impacts on the Yakima River and the return flow drains.

No Action Alternative Impacts to Surface Water Quality

The water quality of the Yakima River at the Umtanum station is expected to remain the same under no action as under the pre-Title XII conditions because the differences in flows indicated in table 4-6 for both the average year and the dry year (1994) are minor and less than measurable.

At Parker, the flow increases for the No Action Alternative for average year conditions from July through October compared with pre-Title XII conditions are minor to moderate; minor improvements in water quality should occur at this station. The increase in flows would be the result of additional releases from the upstream reservoirs to meet the Title XII flows at Parker, and this additional water in the river would be of higher quality than return flows from irrigation. Therefore, water temperatures, nutrients, suspended sediment, and pesticides would improve slightly because of the dilution effect of the

additional higher quality water in the river. No flow changes occur for dry year conditions; therefore, the water quality would be expected to remain the same for the No Action Alternative compared with pre-Title XII conditions.

Table 4-6.—Streamflow impacts at selected sites on the Yakima River

Average year	Month	Pre-Title XII	No action flow (ft^3/s)	Expressed as percent difference relative to no action value				
				1	2A	2B	2C	3
Station - Umtanum								
1994	Oct	0	1,012	11	(5)	2	2	(10)
	Nov	0	514	0	(3)	1	1	(3)
	Dec	0	571	0	(1)	0	0	(1)
	Jan	0	801	(11)	(11)	(11)	(11)	0
	Feb	0	583	(3)	(3)	(3)	(3)	(0)
	Mar	0	1,287	(13)	(13)	(13)	(13)	0
	Apr	0	2,080	(11)	(11)	(11)	(11)	0
	May	0	1,340	3	0	6	1	(0)
	Jun	0	2,427	2	1	7	3	0
	Jul	(2)	3,047	1	1	5	2	0
	Aug	(1)	2,539	5	8	2	1	3
	Sept	7	1,562	(4)	(7)	15	14	(3)
1926-1994	Oct	(3)	972	1	9	8	8	9
	Nov	4	1,316	(1)	(6)	(0)	2	(2)
	Dec	2	1,779	(4)	(7)	(5)	(3)	(3)
	Jan	1	1,494	(3)	(5)	(3)	(2)	(2)
	Feb	0	1,478	(3)	(4)	(3)	(3)	(0)
	Mar	0	1,812	(5)	(5)	(5)	(5)	0
	Apr	(0)	2,661	(3)	(3)	(3)	(3)	(1)
	May	2	3,973	3	3	4	6	(1)
	Jun	1	4,094	2	2	2	2	(1)
	Jul	(2)	3,414	1	2	(1)	(3)	1
	Aug	(3)	3,482	1	2	(0)	(3)	1
	Sept	(1)	1,548	2	2	2	(1)	2
Station - Parker								
1994	Oct	0	300	33	0	17	33	0
	Nov	0	938	0	(8)	(0)	0	(8)
	Dec	0	1,043	0	2	0	0	2
	Jan	0	1,260	(7)	(7)	(7)	(7)	0
	Feb	0	1,067	(1)	(2)	(1)	(1)	0
	Mar	0	1,297	(13)	(11)	(9)	(8)	2
	Apr	0	1,779	(15)	(9)	(10)	(5)	4
	May	0	300	0	0	17	33	0
	Jun	0	300	0	0	17	33	0
	Jul	0	300	0	0	17	33	0
	Aug	0	300	0	0	17	33	0
	Sept	0	300	0	0	17	33	0

Table 4-6.—Streamflow impacts at selected sites on the Yakima River (continued)

Average year	Month	Pre-Title XII	No action flow (ft^3/s)	Expressed as percent difference relative to no action value				
				1	2A	2B	2C	3
1926-1994	Oct	(6)	580	2	22	32	39	22
	Nov	4	2,261	(0)	(4)	(1)	1	(2)
	Dec	2	3,082	(2)	(5)	(3)	(1)	(3)
	Jan	1	2,745	(2)	(3)	(2)	(1)	(2)
	Feb	0	2,921	(2)	(2)	(1)	(1)	(0)
	Mar	0	2,732	(3)	(2)	(1)	(1)	1
	Apr	(0)	2,497	(3)	1	4	7	3
	May	2	3,779	3	7	11	16	2
	Jun	1	3,413	2	7	10	14	4
	Jul	(14)	614	1	30	38	44	28
	Aug	(29)	425	2	47	54	58	45
	Sept	(29)	425	2	47	54	58	45
Station - Prosser								
1994	Oct	(33)	300	33	0	17	33	0
	Nov	0	200	0	0	0	0	0
	Dec	0	50	0	0	0	0	0
	Jan	0	50	0	0	0	0	0
	Feb	0	50	0	0	0	0	0
	Mar	0	200	0	0	0	0	0
	Apr	0	572	(45)	(33)	(37)	(28)	8
	May	(33)	300	0	0	17	33	0
	Jun	(33)	300	0	0	17	33	0
	Jul	(67)	300	0	0	17	33	0
	Aug	(83)	300	0	0	17	33	0
	Sept	(33)	300	0	0	17	33	0
Station - Prosser								
1926-1994	Oct	(47)	444	2	44	52	55	42
	Nov	7	1,082	0	(7)	(2)	1	(4)
	Dec	4	1,714	(4)	(8)	(5)	(3)	(5)
	Jan	2	1,365	(3)	(6)	(4)	(1)	(4)
	Feb	1	1,478	(3)	(4)	(3)	(1)	(1)
	Mar	0	1,403	(5)	(4)	(3)	(2)	1
	Apr	(4)	1,612	(4)	4	7	9	6
	May	1	3,143	4	7	11	15	2
	Jun	(1)	3,044	2	6	8	10	3
	Jul	(49)	551	2	33	40	44	31
	Aug	(88)	425	2	47	54	58	45
	Sept	(53)	425	2	47	54	58	45

Table 4-6.—Streamflow impacts at selected sites on the Yakima River (continued)

Average year	Month	Pre-Title XII	No action flow (ft^3/s)	Expressed as percent difference relative to no action value				
				1	2A	2B	2C	3
Station - Kiona								
1994	Oct	0	1,275	12	1	(0)	(1)	(0)
	Nov	0	1,614	0	(6)	(3)	(4)	(7)
	Dec	0	1,695	0	1	(1)	(1)	1
	Jan	0	1,888	(5)	(5)	(5)	(5)	(0)
	Feb	0	1,684	(1)	(1)	(1)	(1)	0
	Mar	0	2,571	(7)	(6)	(5)	(5)	1
	Apr	0	2,993	(4)	(2)	(3)	(3)	6
	May	(7)	1,365	(10)	(13)	(12)	(11)	(13)
	Jun	(11)	938	(3)	(8)	(8)	(16)	(9)
	Jul	(33)	598	(2)	(10)	(9)	(22)	(11)
	Aug	(29)	638	(1)	(9)	(8)	(20)	(10)
	Sept	(12)	771	3	(3)	(3)	(10)	(3)
1926-1994	Oct	(2)	1,885	1	3	2	1	3
	Nov	3	3,138	(0)	(4)	(3)	(2)	(3)
	Dec	2	3,998	(2)	(4)	(3)	(2)	(2)
	Jan	1	3,748	(1)	(3)	(2)	(1)	(1)
	Feb	0	4,049	(1)	(2)	(1)	(1)	(0)
	Mar	0	4,112	(2)	(2)	(1)	(1)	0
	Apr	(0)	3,914	(3)	(1)	0	1	1
	May	1	5,035	2	3	5	6	(0)
	Jun	0	4,886	1	2	3	2	0
	Jul	(5)	1,667	0	4	(0)	(6)	3
	Aug	(9)	1,503	0	5	(1)	(9)	4
	Sept	(7)	1,802	1	5	1	(5)	5

Note: Values in ( ) mean a negative change compared with no action.

At Prosser, the increase in flows for the No Action Alternative compared with pre-Title XII conditions for the months of July through October for average year conditions and May through October for dry year conditions is minor to major, and water quality is expected to improve. As with the Parker station, this additional water in the river would be the result of additional releases above those required to meet irrigation diversion demands from the upstream reservoirs to meet the Title XII flows. Because this additional water in the river would be of higher quality, water quality would be expected to improve, with lower water temperatures and lower concentrations of nutrients, suspended sediment, and pesticides because of the dilution effect of the additional water.

At Kiona, water quality impacts for the average year conditions would not be measurable in any month. For dry years, some improvements in water quality would occur during the summer months, June through September, because of additional water release from the reservoirs.

Alternative 1 Impacts to Surface Water Quality

Data in table A-3 are used to compare Alternative 1 to the No Action Alternative with regard to water quality impacts. In almost all months for all four stations on the Yakima River, the difference in streamflows for these alternatives is considerably less than 10 percent. Therefore, the water quality in the river for Alternative 1 would be expected to be essentially the same as the No Action Alternative.

Some improvement in water quality for Alternative 1, attributable to increased flows obtained through increased reservoir releases, might occur in some months during the irrigation season for a dry year like 1994.

The drain water flows are not expected to differ with Alternative 1 compared with the No Action Alternative; therefore, the drain water quality is not expected to change.

Alternatives 2A, 2B, and 2C Impacts to Surface Water Quality

These action alternatives assume full implementation of all aspects of Title XII. The difference in Alternatives 2A, 2B, and 2C is the location within the basin where water conservation activities are assumed to occur. Impacts caused by reduced diversions attributable to water conservation measures (reducing canal seepage and other system delivery losses or implementing onfarm measures, such as conversion to more efficient water application methods) must be distinguished from reduced diversions attributable to water rights acquisitions. The water quality could either improve or degrade in the return flows in the drains, depending on the specific parameter and the type of water conservation measure implemented.

Another water conservation method for reducing diversions is system-level irrigation return flow reuse. This type of water conservation could be implemented through the developing sedimentation and water recycling ponds or wetlands. Implementing this type of water conservation method could have positive water quality impacts because the return flows from irrigation might be reduced to zero in some situations.

At the Umtanum station on the Yakima River, the difference in flows between full implementation of the action alternatives and the No Action Alternative is generally less than 10 percent for all months. Therefore, the water quality impacts on stream temperature, suspended sediment, nutrient, and pesticide concentrations are expected to be small and probably would not be measurable.

At the other three stations on the Yakima River, the differences in flows shown in table A-3 during the irrigation season are generally greater than 10 percent and are, therefore, considered measurable for all of the action alternatives compared with the No Action Alternative. Water quality impacts on the river for all the action alternatives with full implementation of the Basin Conservation Plan are expected to be similar for the Parker, Prosser, and Kiona stations. In the river reach below the Parker station, the water

quality should improve for the action alternatives compared with the No Action Alternative, specifically for temperature, sediment, nutrients, and pesticides. The level of improvement in water quality of the river relates to the water quality of the return flows from irrigation and how the water is conserved, which results in reduced canal and ditch diversions (the basic premise of Title XII). In general, the return flow water quality is lower than the quality of the water in the river; and by reducing diversions and leaving this water in the river, the water quality of the river improves compared with the No Action Alternative. This conclusion would be true even if the return flow water quality remained the same with respect to temperature and the concentrations of sediment, nutrients, and pesticides. However, depending on how the water is conserved, the water quality of the return flows could also improve. If the water conserved is obtained by reducing delivery system losses, such as canal lining to reduce seepage losses, better canal operation to reduce losses to canal wasteways, and other operational management improvements, the effects on the water quality in the return flows to the river would probably not be measurable with respect primarily to temperature, sediment, nutrients, and pesticides. However, if the reduced diversions were a result of onfarm conservation to reduce the surface water runoff from the irrigation of agricultural crops, the return flows to the river would be expected to improve in water quality.

The concentrations of sediment, nutrients, and pesticides in the return flows are related to the fraction of the total flow that is surface water runoff. The remaining portion is groundwater discharge. The concentration of suspended solids is much larger for the surface water runoff portion, and this concentration is key because nutrients and pesticides are adsorbed on the suspended solids and move with the sediment load. Furthermore, the temperature of the surface water runoff portion of the total return flows during the summer is higher than the temperature of the groundwater portion. Also, water with higher turbidity (higher suspended solids concentrations with surface water runoff) warms more rapidly than clear water. Finally, the method used to conserve water will affect the relative fractions of surface water runoff in the total return flows that will subsequently determine the extent of the return flows' and, ultimately, the Yakima River's water quality improvements.

If a given canal's reduced diversions came through acquiring water rights, then a portion of the lands served by the canal would change to an alternate land use, and the water not diverted to these lands for irrigation could be left in the river. The effects of this method of water conservation would be to reduce the quantity of return flows but not necessarily the temperature and the concentrations of sediment, nutrients, and pesticides unless conservation measures discussed above were also employed. Assuming that the concentrations of the important water quality parameters remain the same and the volume of return flows is reduced because of water acquisitions, then the total load of the above parameters would be lower in the drain flows to the river, and the negative impact of these return flows on the Yakima River water quality would be less.

It should be pointed out that the return flow drains, which currently have the most significant adverse impact on the water quality of the Yakima River in the lower part of the basin, include Wide Hollow Creek, Moxee drain, Granger drain, Marion drain, and the

Sulphur Creek wasteway. Water quality data indicate that these drains are the worst sediment loading sources in the lower portion of the basin. Therefore, improving the water quality (specifically, sediment or suspended solid reductions) of these drains would result in the greatest water quality benefits to the river.

In summary, the impact on the water quality of the return flows and, subsequently, the main river water quality for the action alternatives compared with the No Action Alternative depends upon the type and location of water conservation methods employed as discussed above. Yakima River water quality improvements can be achieved if onfarm water conservation methods are implemented that reduce surface water runoff and subsequent sediment loss from irrigated lands in areas that contribute return flows to the five drains listed above. The main river water quality in the reach below Parker will generally improve under any of the action alternatives with the Basin Conservation Program.

Alternative 3 Impacts to Surface Water Quality

The impacts of Alternative 3 compared with no action are the same as Alternative 2A and will not be repeated.

4.4 Groundwater

4.4.1 Summary of Impacts to Groundwater

Impacts to groundwater are summarized in table 4-7.

4.4.2 Discussion of Impacts to Groundwater

Methods and Rationale

Return flows constitute a significant amount of the total water supply available throughout the basin. Impacts to the groundwater resource and groundwater users are estimated based on hydrology model results. The hydrology model assumed that the reduction of diversions by 165,000 acre-feet from the Basin Conservation Program would be the result of return flow reductions of the same amount; no reduction of consumptive use was assumed. The model reduced diversions by reducing canal seepage and other sources of return flows, not by reducing crop production (consumptive use). Return flows, as calculated in the hydrology model, include all surface applied water and groundwater from natural recharge sources that discharge to the Yakima River. The hydrology model return flows are estimated to be 26 to 69 percent of diversions, averaging about 45 percent of diversions. Some of the surface applied water percolates to the groundwater table of the unconfined aquifer (the local geology dictates which aquifer is the uppermost, unconfined

Table 4-7.—Summary of impacts to groundwater

Impact indicator	No action	Alternative 1	Alternative 2A (preferred alternative)	Alternative 2B	Alternative 2C	Alternative 3
Groundwater storage (change of groundwater levels)	Groundwater levels higher than historical levels because of increased recharge from irrigation applications.	Short-term minor impact near Cle Elum and Kachess Lakes because of higher reservoir levels and operational timing changes.	About 82,000 acre-feet less recharge to upper unconfined aquifers basin-wide. Minor lowering of groundwater levels in localized areas may impact wells that tap these aquifers.	About 82,000 acre-feet less recharge in upper and lower Yakima groundwater basins (Kittitas and Naches Basins not impacted). Minor to moderate lowering of groundwater levels in localized areas will impact wells that tap these aquifers.	About 57% fewer return flows from Roza and 59% fewer return flows from Sunnyside. About 82,000 acre-feet less recharge to upper aquifers within the area served by these two irrigation districts. Lower groundwater levels will impact wells that tap these aquifers.	Same as Alternative 2A.
Groundwater quality (change of solute levels)	Locally, groundwater has higher than natural background levels of major solutes because of agricultural chemicals.	No anticipated impact.	Less seepage water to dilute high solute levels in return flows from irrigation applications. May have slightly higher levels of solutes in groundwater basin-wide.	Slightly higher levels of solutes expected in groundwater in localized areas within upper and lower Yakima groundwater basins.	Higher levels of solutes expected in groundwater in localized areas because of reduced groundwater recharge/storage.	Same as Alternative 2A.

aquifer at any specific location). The model assumes that about half of the return flows would be shallow runoff or the result of operational spills and would be directly routed through drains back to the river within the same month of diversion. The other half would temporarily go into groundwater storage and discharge back to the river system at some later time, as indicated by the lag times in the model.

The storage time in the upper aquifer causes a general decrease in water temperature and minor water chemistry changes. The sediments which make up the aquifer substrate tend to adsorb contaminants, lessen the amount of suspended solids, and raise the amount of dissolved solids in the water.

Because of geologic structural control of the groundwater flow (as described in chapter 3), the groundwater in all but the deepest basalt aquifers is returned to the surface at the lower end of each structural basin. Virtually all of the return flow from the Kittitas Basin returns to the river system at Manastash Ridge, and the water is reused downstream (except return flows that enter the river after the irrigation season). This same condition occurs in the upper Naches groundwater basin and the upper Yakima groundwater basin. If the return flows re-enter the river after the irrigation season, they are not reused.

No Action Alternative Impacts to Groundwater

In the Kittitas valley and lower Yakima River Basin, infiltration from surface applied irrigation waters has significantly raised water levels in the alluvial and Ellensburg Formation aquifers. In some of the lower areas, the water table is close to the surface and limits agricultural uses of the land.

Groundwater recharged during the irrigation season continues to discharge to the river through the following spring. Most of the irrigation return flows are reused downstream. A portion of the irrigation loss recharges the overburden aquifers and is pumped by municipal and domestic water wells. If the return flows re-enter the river after the irrigation season, they are not reused.

Water leaking from irrigation conveyance structures dilutes recharge waters from crop applications that tend to be relatively high in suspended solids and agricultural chemicals. Except for some local degradation from septic systems and industrial and agricultural activities, groundwater from all major aquifer systems in the Yakima River Basin generally meet drinking water standards (Yakima Valley Council of Governments [YVCOG], 1993). Published data concerning some types of groundwater contamination, such as from pesticides and herbicides, are not available, however, so the overall quality of the groundwater is undefined.

Alternative 1 Impacts to Groundwater

This alternative would involve operational and structural changes to the system, but the Basin Conservation Program would not be implemented. Structural modifications would allow Cle Elum and Kachess Lakes to hold additional storage water. The higher reservoir levels would probably raise groundwater levels in the adjacent area temporarily and may slightly increase seepage from the reservoirs.

Operational changes, such as timing of storage releases, may impact the pattern of groundwater fluctuations slightly but will not impact the long-term groundwater supply.

The anticipated impacts to groundwater from this alternative are considered negligible.

Alternative 2A Impacts to Groundwater

This alternative spreads the Basin Conservation Program's goals of reducing return flows by 165,000 acre-feet across the basin, which reduces recharge throughout the basin. Return flows throughout the basin average about 45 percent of surface diversions, or about 1 million acre-feet. A 165,000-acre-foot reduction is about a 15-percent decrease in the amount of return flows. The actual volume decrease in groundwater recharge is unknown but is assumed in the hydrology model to be about half of the return flow volume. Based on the measured rise of groundwater levels since pre-development (1850s), irrigation seepage losses are a significant source of recharge to the overburden aquifers. A decrease in the amount of recharge will cause a decline of groundwater levels in the upper aquifers (Ellensburg and alluvial) and will impact some well users. Most of the wells that pump from the upper aquifers serve municipal and domestic water supply needs.

Less seepage water from irrigation conveyance structures would enter the groundwater system. Water from crop applications would become a larger percentage of the recharge volume. Crop application water tends to be higher in suspended solids and solute levels from flushing of salts, agricultural fertilizers, and chemicals. Groundwater quality may be slightly degraded.

Alternative 2B Impacts to Groundwater

This alternative concentrates Title XII's goals and reductions in the upper and lower Yakima groundwater basins. These areas represent about 45 percent of total watershed diversions. In the Sunnyside Irrigation District, about 36 percent of diversions are returned to the river, and a 15-percent reduction of diversions is equivalent to a 42-percent reduction of return flows. In the Roza Irrigation District, 37.5 percent of diversions are returned to the river, and a 15-percent reduction of diversions equates to a 40-percent reduction of return flows.

Many farmers, especially those in proratable irrigation districts, have drilled wells into the upper aquifers (Ellensburg Formation and Saddle Mountains Basalt) to supplement their surface water supplies during water short years. Conservation methods that reduce the water supply to the shallow aquifers will impact wells completed in those aquifers. Declining water levels (less groundwater storage in the aquifers) will limit their availability for use during water short years. However, conservation measures that ensure a more stable surface water supply will decrease the need for the supplemental wells.

Concentrating the impacts in a smaller area (the upper and lower Yakima groundwater basins) would focus the impacts to the groundwater levels in those areas.

Groundwater quality impacts would also be concentrated in the upper and lower Yakima groundwater basins and would be similar to those discussed under Alternative 2A. The impacts to groundwater quality are expected to be greater in areas of groundwater discharge (i.e., in the lower parts of each sub-basin and at drains) because of the accumulation of groundwater flow in these areas.

Alternative 2C Impacts to Groundwater

This alternative concentrates Title XII's goals and reductions (and thus the entire groundwater impact) in the area served by two irrigation districts. Sunnyside Irrigation District would reduce return flows by approximately 92,000 acre-feet, which is a 59-percent reduction from current return flow volumes. Roza Irrigation District would reduce return flows by approximately 73,000 acre-feet, which is a 57-percent reduction from current return flow volumes. A moderate impact on groundwater levels in the upper aquifers could be expected.

Most groundwater pumpage for irrigation in the lower basins is from the basalt aquifers. Domestic wells and municipal wells are the primary users of the overburden aquifers, and these wells would most likely be impacted. The Washington State Department of Ecology (WDOE) (Kirk, 1995) estimates that about 30,000 acre-feet are pumped annually by at least 11 municipalities in the area that would be affected under this alternative. However, a more stable water supply would reduce the need for supplemental irrigation wells that pump from the overburden aquifers, and the reduced pumping could potentially improve groundwater levels. The volume and location of the impacts cannot be determined without detailed conservation plans specifying where the conservation activities would take place.

The groundwater quality would also be negatively impacted. Most of the reduction of return flows would be from conveyance structures. The conveyance water dilutes the applied agricultural water that deep percolates and that is usually higher in salts and dissolved solids. Reducing the volume of water but maintaining the same volume of contaminants could degrade the quality of the groundwater in the upper aquifers. Certain onfarm conservation measures eligible under the Basin Conservation Program could reduce the amount of agricultural contamination entering the groundwater.

Alternative 3 Impacts to Groundwater

Groundwater impacts from this alternative will be identical to impacts discussed for Alternative 2A.

4.5 Agricultural Resources

4.5.1 Summary of Impacts to Agricultural Resources

The impacts of water conservation activities to reduce canal diversions are mixed, depending upon the resource.

Table 4-8 presents the impacts of each alternative on canal diversions, compared with the No Action Alternative for main canals on the Yakima River during dry years. The table shows the full water supply diversions for each canal for each alternative. Alternative 1 has no impacts on the canal diversions compared with the No Action Alternative. Alternatives 2A, 2B, 2C, and 3 show the applicable reductions in diversions assuming full water supply conditions for the assumed implementation of the Basin Conservation Program. The table presents the percent differences relative to the no action values for the pre-Title XII condition and the action alternatives. The average dry year diversion is the average of 18 years of the total of 69 years in the modeling period (1926 to 1994) where full water supply conditions did not occur.

Table 4-8.—Canal diversion impacts for average dry year[1] diversions

Average dry year canal diversions (1,000 acre-feet)							
Canal	Pre-Title XII	No action	1	2A[2]	2B	2C	3
Kennewick	93.30	87.01	95.76	88.27	80.80	94.06	88.30
Kittitas	251.50	245.53	256.16	235.44	261.15	270.82	233.87
Reservation (new)	551.27	544.90	551.43	542.31	559.55	571.78	541.57
Reservation (old)	6.41	6.38	6.45	6.40	6.61	6.80	6.45
Roza	298.38	289.14	302.66	282.37	277.41	269.70	274.78
Sunnyside	418.37	416.65	418.40	396.59	369.72	344.68	396.24
Tieton	88.08	88.07	88.13	88.08	88.26	88.40	88.05
Percent difference relative to no action values							
Canal	Pre-Title XII percent difference	No action value	1 percent difference	2A[2] percent difference	2B percent difference	2C percent difference	3 percent difference
Kennewick	7	87.01	10	1	-7	8	1
Kittitas	2	245.53	4	-4	6	10	-5
Reservation (new)	1	544.90	1	0	3	5	-1
Reservation (old)	0	6.38	1	0	4	7	1
Roza	3	289.14	5	-2	-4	-7	-5
Sunnyside	0	416.65	0	-5	-11	-17	-5
Tieton	0	88.07	0	0	0	0	0

Table 4-8.—Canal diversion impacts for average dry year[1] diversions (continued)

Full water supply diversions (1,000 acre-feet)							
Canal	Pre-Title XII	No action	1	2A	2B	2C	3
Kennewick	96.75	96.75	96.75	89.49	82.23	96.75	89.49
Kittitas	311.67	311.67	311.67	288.29	311.67	311.67	288.29
Reservation (new)	622.45	622.45	622.45	622.45	622.45	622.45	622.45
Reservation (old)	7.36	7.36	7.36	7.36	7.36	7.36	7.36
Roza	362.07	362.07	362.07	334.91	307.76	286.03	334.91
Sunnyside	436.43	436.43	436.43	403.70	370.97	344.78	403.70
Tieton	88.81	88.81	88.81	88.81	88.81	88.81	88.81

[1] This is the average of the water short years between 1926 and 1994 (18 of the 69 modeled years).

Notes: The full water supply diversions tabulated above show reductions by alternative as follows:

- Tieton and both Reservation canals—no reductions for any of the alternatives.
- Reductions of 7.5 percent for the Kittitas and Kennewick Canals for Alternatives 2A and 3.
- Reductions of 7.5 percent for Alternatives 2A and 3, 15 percent for Alternative 2C, and 21 percent for Alternative 2C for both the Roza and Sunnyside Canals.

[2] Alternative 2A preferred.

The impacts to land resources are summarized in table 4-9 and described in greater detail later in this chapter.

No major adverse impacts should occur to irrigated agriculture. The trend toward planting higher value crops will probably continue, as will implementing more efficient sprinkler and drip irrigation in adaptable crops. Adequate water application rates to maintain a salt balance through deep percolation will need to continue. Soil salinity under irrigation depends, among other factors, on the ratio of deep percolation to the volume of irrigation water applied and irrigation water salinity. Although some alternatives may increase salinity, it is believed that proper water management will maintain soil salinity at harmless levels in most areas.

Less irrigation-induced erosion would occur if best water management practices were used under the Basin Conservation Program, such as leveling to reduce the velocity of the applied irrigation water, using chemicals to improve infiltration, or converting to sprinkler or drip irrigation and, thus, reducing the volume of irrigation water applied.

Applying less water should reduce wetness and lower the water table. Any time the depth to shallow groundwater is less than 4 feet, crop yields are assumed to be affected, and soil salinity will increase. Orchards are particularly sensitive to fluctuating shallow groundwater.

Table 4-9.—Summary of impacts to lands

		Proposed action				
Impact indicator	No action	Alternative 1	Alternative 2A (preferred alternative)	Alternative 2B	Alternative 2C	Alternative 3
Soil salinity electroconductivity and toxic trace elements (parts per million)	Low to moderate salinity and low trace element concentrations.	Same as no action.	Slight improvement (reduced salinity and toxic elements) under good irrigation management.	Improvement under good irrigation management.	Improvement under good irrigation management.	Same as Alternative 2A.
Erosion (tons/ acre)	Moderate wind and water erosion.	Same as no action, Kachess shoreline erosion protection required.	Reduced water erosion and possible increased wind erosion. Kachess shoreline erosion protection required.	Reduced water erosion and increased wind erosion. Kachess shoreline erosion protection required.	Reduced water erosion and increased wind erosion. Kachess shoreline erosion protection required.	Reduced water erosion and possible increased wind erosion.
Crops (acres)	Expected small reduction in irrigated acreage due to conversion to suburban use.	Better protection of perennial crops in drought years.	Slightly more dependable water supply from reduced shortages. Better protection of perennial crops in drought years. Decreased irrigated acreage.	More dependable water supply from reduced shortages. Better protection of perennial crops in drought years. Reduced crop acreage and loss of agricultural jobs. Increased weed infestations.	More dependable water supply from reduced shortages. Better protection of perennial crops in drought years. Reduced crop acreage and loss of agricultural jobs. Increased weed infestations.	Decreased irrigated acreage.
Drainage surface (acre-feet) sub-surface (depth to groundwater)	Low to moderate surface and subsurface drainage deficiencies.	Same as no action.	Slightly improved surface (reduced runoff) and sub-surface drainage (increased depth to water table).	Improved surface and subsurface drainage.	Surface and subsurface drainage slightly better than Alternative 2B.	Same as Alternative 2A.

4.5.2 Discussion of Impacts to Agricultural Resources

No Action Alternative Impacts to Agricultural Resources

Table 4-8 shows that changes in annual diversions for each of the canals are not measurable using ranges defined in table 4-3.

Current trends of land use will continue; changes in crops grown and total irrigated lands will vary with the total water supply available each year, economic return, demand, and other cultural factors. Irrigated lands will decrease as additional lands are converted to urban, alternative, and industrial use. Some water conservation methods would be implemented.

Water conservation methods will include switching to more efficient irrigation delivery systems. Improved irrigation delivery systems will facilitate more efficient onfarm irrigation systems. Sprinkler systems can improve irrigation efficiency by reducing excessive deep percolation and surface runoff from irrigated lands. Drip irrigation can improve irrigation efficiency by reducing losses caused by evaporation, runoff, deep percolation, and competition from weeds. Some crops such as hops, corn, or timothy hay are not as susceptible to converting from rill or furrow to more efficient irrigation methods. Acreage in crops that can be grown with more efficient irrigation methods may increase.

Converting to more efficient methods of irrigation, which reduces runoff especially in row crops, can reduce erosion and improve water quality by reducing sedimentation to streams, drains, and canals.

Water conservation measures could reduce the impacts of reduced available water in dry years. Increasing crop yields with existing water supplies will result from increased water use efficiency.

Alternative 1 Impacts to Agricultural Resources

Table 4-8 shows a minor increase in average dry year diversions for the Kennewick Canal.

As under no action, current trends of planting higher value crops will probably continue. Growers would implement a small number of water conservation measures.

Augmentation of Kachess Lake storage from flows from Cabin Creek and Silver Creek would provide additional irrigation water to Kittitas Reclamation District and Roza Irrigation District in years of proration. This additional water will enable the growers to better protect their perennial crops from damage caused by drought.

Raising Cle Elum Lake will require the protection of 6,700 feet of shoreline from erosion.

Water conserved by the Yakama Indian Nation could be used to irrigate additional lands on the Reservation or for other purposes, including protection and enhancement of fish and wildlife.

Alternative 2A Impacts to Agricultural Resources

Impacts would be the same as those under Alternative 1, with additional impacts from the Basin Conservation Program.

Diversions would be reduced by 7.5 percent. Most of this reduction could come from water conservation programs, with the remainder from converting lands to alternative uses. The crop types grown may change because of decreased irrigated land acreages.

Implementation of the Basin Conservation Program would provide a more dependable water supply from reduced shortages. It also could produce adverse impacts by increasing salinity and toxic elements remaining in the root zone from reduced deep percolation. Increased management intensity will be needed to control salinity. Also, shallow water wells could be adversely impacted. Beneficial impacts would include reducing soil wetness; reducing toxic elements in the return flows; producing less runoff, which would reduce water erosion; and increasing crop yields and soil fertility. The net impact should result in a slight increase in crop yields and improved soil quality when compared to the No Action Alternative. Water use efficiency should increase when a crop yield per unit volume of water is considered.

Water quality could be improved by more efficient onfarm irrigation systems with good water management because less sediment and fewer nitrates would flow to the river, drains, and wetlands.

Some of the measures considered under the Basin Conservation Program and other YRBWEP activities will likely assist the dissemination of weed seeds through conveyance and distribution systems. Bureau of Reclamation (Reclamation) will address the basin's noxious weed problem as part of the National Environmental Policy Act (NEPA) compliance process undertaken for specific actions required by Title XII.

Alternative 2B Impacts to Agricultural Resources

Land resources and water conservation impacts would be the same as Alternative 2A, except diversions would be reduced 15 percent. As this goal probably cannot be achieved through conservation measures alone, acquiring water rights may be necessary. This reduction in water diversions attributable to voluntary purchase or lease could result in retiring a considerable number of agricultural lands. This would adversely affect agricultural employment.

Alternative 2C Impacts to Agricultural Resources

Land resources and water conservation impacts would be the same as Alternative 2B, except diversions would drop by 21 percent from water conservation, thus requiring converting more lands to alternative uses. This reduction in water supply attributed to voluntary purchase or lease could result in a substantial number of acres of agricultural lands being retired from irrigation. Diversion reductions attributable to water acquisitions would change the land use of an unspecified number of acres from irrigated agriculture to some other use not requiring water from the Yakima River. The number of acres subject to changed land use would depend on the number of willing sellers who participate. This reduction could be considered an adverse impact to agricultural resources because these lands are a valuable resource. Increased wind erosion caused by abandoning these lands would have an adverse impact.

This alternative would increase the flows over the Sunnyside Diversion Dam from conserved water during the prorated years, as much of the return flow would be entering the river downstream from the target point.

Impacts in the operation and modification of facilities would be the same as Alternative 1.

Alternative 3 Impacts to Agricultural Resources

Land resources and water conservation impacts would be the same as Alternative 2A.

4.6 Fish

4.6.1 Summary of Impacts to Fish

This evaluation showed that implementing Title XII would benefit salmon and steelhead, especially provision of the legislated target flows and the water conservation program (tables 4-10 and B-1 [appendix B]). Fish migrating through, or spawning or rearing below, Sunnyside Diversion Dam, in particular, benefit from this Federal action. These benefits to fish are realized, in part, because of increased instream flows, especially below Prosser and Sunnyside Dams, as discussed in Section 4.2 "Surface Water Hydrology." Other potential benefits identified for fish include:

- The water acquisition program could benefit dewatered tributaries.
- Improved river management under the interim comprehensive basin operating plan could help reduce fish-damaging flow fluctuations and increase streamflows during downstream salmonid migrations.
- Efforts to protect wetlands (see Yakima River Basin Conservation Advisory Group, 1997) could benefit fish, especially during rearing and overwintering.

Table 4-10.—Summary of impacts to fish (see table B-1 [appendix B] for more detail)

Impact indicator	No action	Alternative 1	Alternative 2A (preferred alternative	Alternative 2B	Alternative 2C	Alternative 3
Salmon and steelhead	Salmon and steelhead population currently low. Migration, spawning, and rearing impaired. Improved summer base flows caused by implementing target flows.	Potential benefits to juvenile migration from flushing flows from Cle Elum. Potential benefits associated with the tributary program are increased instream flows from Prosser to Chandler.	Impacts same as Alternative1 plus potential benefits to salmonid migration, fall chinook spawning, and rearing below Parker. Water conservation could improve instream flows and water quality and thereby benefit fish.	Generally appears the same as Alternative 2A.	Generally appears the same as Alternative 2A.	No tributary program, so no benefits from this program.
Resident fisheries	Streamflows often too high for trout in upper mainstem Yakima during irrigation season.	No change anticipated in reservoir fisheries because no significant changes in monthly reservoir contents identified. Rainbow trout likely benefit from tributary program. No significant flow changes at Umtanum, an important reach for rainbow trout.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.	No tributary program, so no benefits from this program.

Implementing Title XII, including the Basin Conservation Program, may improve habitat for anadromous fish in areas throughout the basin (see table 4-10, Alternative 2A). On an annual basis, instream flow releases are expected to increase by 50 to 60 percent compared to the No Action Alternative because of water conservation efforts under the assumptions of this analysis (see Section 4.2 "Surface Water Hydrology"). Efforts to enhance and protect wetlands could also benefit fish.

Ecosystems in tributary streams, such as the Teanaway and Taneum, may especially benefit from conservation efforts. Improved tributary health is expected to benefit salmonids and resident fish.

This overall look at Title XII indicates that it would be technically advisable to monitor impacts to anadromous fish throughout the basin, and particularly in the upper basin, as individual elements of Title XII are implemented. Title XII is structured to provide streamflow increases at Parker and Prosser during the irrigation season, and this can result in streamflow decreases elsewhere in the basin at times (see figures A-9, A-17, and A-23 in appendix A). There are several species of anadromous salmonids, each with complex life stages and attendant habitat needs in various parts of the basin. Because of this inherent biological complexity, combined with the constraints of actual river operation, it would be prudent to monitor effects to anadromous fish to document improvements in fish production and to identify unanticipated results.

Minor, generally short-term impacts may occur from implementing various elements of Title XII, especially those that involve construction. These impacts will be monitored closely in the site-specific documents, and commitments will be made to construct facilities in a manner that will minimize or eliminate all such impacts.

4.6.2 Discussion of Impacts to Fish

Methods and Rationale

Physical characteristics of the environment, such as streamflows, significantly determine the limits of fish survival, growth, and reproduction (see Stanford et al. [1995] for an ecosystem-based discussion of these factors). The basic assumption here is that stream-flows are linked to fish habitat, and fish habitat is linked to fish populations, as discussed in Section 3.6 "Fish." This assumption is true at some level (i.e., fish live in water, and without water they cannot survive). This analysis is relative, which means that the same analysis (and, thus, usually the same bias) is applied to each alternative, which should provide some insight for separating the alternatives. Furthermore, this analysis emphasizes basin-wide impacts and provides little detail on site-specific impacts, which will be covered prior to implementing any element of Title XII. The focus of this analysis is to determine differences among alternatives. For salmon and steelhead, the analysis focuses on migration, spawning, and rearing.

Two levels of analyses were completed. The first level is linked to the hydrology model output. The model output provides a tool for relative analysis. At the second level, factors were qualitatively evaluated. For example, the effects of temperature are discussed broadly, as well as impacts associated with each element of Title XII.

Model-produced streamflows were evaluated based on the criteria established in Section 4.2.1 "Summary of Impacts to Surface Water." From this starting point, model data were then interpreted from the biological perspective. The hydrology model produces streamflow output at many river sites. All sites important to fish were checked for differences in streamflow. In most places, the differences among alternatives were much less than 10 percent (no measurable impact, see table 4-3)—these sites were not considered further. Of the remaining sites, hydrology model streamflows were compared to "operational flows," which were arrived at through informal consultation with State and Tribal agencies. These operational flows, and their effects on aquatic resources, are regularly discussed with agencies at river operational meetings.

The indicators used to evaluate impacts to fish were *salmon and steelhead migration, spawning, and rearing*. In addition, impacts to *reservoir fish and rainbow trout* were considered. Alternatives were analyzed by evaluating reservoir volumes (for reservoir fisheries) and streamflows in the Yakima River Canyon (for trout). Detailed information on analysis criteria is presented under each alternative.

No Action Alternative Impacts to Fish

No Action Alternative Impacts to Salmon and Steelhead.—One goal of Title XII is to provide improved streamflows for salmon and steelhead below Sunnyside and Prosser Diversion Dams. Hydrology model results showed increased streamflows below Sunnyside and Prosser Diversion Dams in an average year as a result of implementing Title XII (see figures A-13 and A-14 in appendix A). Other river reaches were checked to see what effect changed streamflows at Sunnyside and Prosser had on them. Model-generated streamflows for no action and action alternatives were compared. Streamflows were similar among alternatives at the Yakima River at Martin, Pomona, Umtanum, and Kiona; the Naches River at Naches; the Tieton River at the canal headworks; and the Bumping River near Nile (for example, see figures A8 through A23). In most cases, streamflow differences among alternatives at the above sites were well within the margin of error (no measurable impact, see method for evaluating impacts subsection in Section 4.2.2 "Discussion of Impacts to Surface Water"). Therefore, those sites are not discussed further with respect to fish. It should be noted, however, that in dry years like 1994, the model predicts that streamflows at some of the above sites could be lower (or higher) for some alternatives compared to the No Action Alternative. Greater streamflow changes between the No Action Alternative and the action alternatives were noted for the Yakima River at Easton, Parker, and Prosser (important reaches for salmonids), so these sites are discussed further with respect to fish. Flows at Pomona are also considered further because this area is important for salmonids and also serves as a check for potential impacts relatively high in the river system.

The following paragraphs discuss model streamflows as they relate to *salmonid migrations, spawning, and rearing*. Model results at two sites on the Yakima were used to monitor streamflows for adult migration: Yakima River at Pomona and Yakima River at Prosser. Spring chinook migrate past Pomona between May and August, and steelhead trout migrate past Pomona primarily between September and December. Field observations have found that flows above 300 to 400 ft^3/s were necessary for adult passage. Model-predicted flows for the No Action Alternative indicate that flows would not impede adult spring chinook passage (average streamflows under no action and pre-Title XII conditions were above 400 ft^3/s during migration). Adult steelhead passage in September and October may have been slightly better under pre-Title XII conditions than under no action.

Adequate instream flows in the reach below Prosser Dam are important because almost all salmon and steelhead must migrate through this reach. Fisheries managers have considered this reach a bottleneck because of low flows. Lack of adequate instream flows in this reach could threaten many of the salmon and steelhead restoration efforts that have already taken place. Field observations have shown that 400 ft^3/s facilitates adult salmonid migrations. Average model flows were uniformly above 400 ft^3/s during the migratory period for adult spring chinook for all alternatives, including no action. Average streamflows at Prosser during September (430 ft^3/s) and October (440 ft^3/s) reflect that many years within the period of record are higher than 400 ft^3/s. The flows for the No Action Alternative are much better for salmon and steelhead than those generated under pre-Title XII conditions (September, 200 ft^3/s; October, 240 ft^3/s). These higher flows may also reduce water temperatures (see Section 4.3 "Surface Water Quality"), which can sometimes block salmon and steelhead migrations.

The Yakima River reach below Prosser Diversion Dam is an important corridor to all downstream migrating juvenile salmon and steelhead. Inadequate streamflows and associated poor water quality conditions have made this reach a potential bottleneck for downstream migrants. Streamflows above 800 to 1,000 ft^3/s were used as the operational flow for downstream migration. The average model predicted flows at Prosser during April through June (the main downstream migration period) varied from 1,610 to 3,140 ft^3/s, under no action. Average flows in July changed from 280 ft^3/s (pre-Title XII) to 550 ft^3/s (no action). For the No Action Alternative, flows are above 800 ft^3/s for the downstream migration period 10 to 60 percent of the time, which is similar to the pre-Title XII conditions.

The No Action Alternative would continue several operational practices meant to provide streamflows for salmon (for example, the "flip-flop" and mini "flip-flop[1]" are designed to maintain spring chinook redds in the Cle Elum River and Yakima River below Keechelus and Easton Dams).

Four sites on the Yakima were used to monitor streamflows for *salmon and steelhead spawning*: Yakima River near Easton, Cle Elum River at Roslyn, Yakima River

[1] These are described in Section 3.2.2 "Pre-Title Operations (Before 1995) and Model Consideration."

Pomona, and the Yakima River at Prosser. Spring chinook spawning occurs in the Yakima River below Keechelus Dam and Cle Elum River below Cle Elum Dam. As an indicator of spawning success in these areas, the egg incubation flow was compared to the spawning flows. Incubation/spawning flow ratios greater than 50 percent occur about 70 percent of the time. Higher ratios are assumed to indicate better incubation success.

Fall chinook salmon spawning occurs below Sunnyside Diversion Dam from October through November. Spawning flows near Prosser may be acceptable when streamflows are above 550 ft^3/s (Reclamation, 1984a); therefore, the number of years over the period of record that flows in October and November were above 550 ft^3/s was counted. Fall chinook spawning under No Action Alternative conditions should be possible 20 to 40 percent of the time, based on this indicator, which represents improvement compared to pre-Title XII conditions.

The Yakima River below Sunnyside Diversion Dam likely represents important potential rearing habitat because of the braided nature of the river. This area has backwaters and shallow shoreline areas that should provide good rearing habitat and abundant fish food production. Inadequate flows, high temperatures in summer, too much sediment in areas, and fluctuating flows below Sunnyside Diversion Dam limit existing rearing habitat. This area was monitored by comparing model-predicted flows to Instream Flow Incremental Methodology (IFIM)-determined flows. Flows at Parker (below Sunnyside Dam) between November and June are typically above the IFIM-determined flows, and these flows are not affected by the alternatives. The results for the remaining months show that in the Pre-Title XII condition, streamflows below Parker from July through October are between 30 and 70 percent of the IFIM-determined flows. Flows are 50 to 70 percent of the IFIM-determined flows under no action.

The area below Roza Dam is important for spring chinook and steelhead rearing and overwintering. The number of years over the period of record when flows were above 400 ft^3/s was counted because this flow range encompasses most of the rearing habitat. The results indicate that the No Action Alternative may slightly impair rearing habitat compared to pre-Title XII conditions.

Ongoing programs like the Basin Conservation Program and Toppenish Creek Corridor enhancement project would not continue under no action. Therefore, those benefits to salmon and steelhead that could occur as a result of this program would not occur. Much of the basin-wide steelhead spawning occurs in Toppenish and Satus Creeks. Under no action, the Yakama Indian Nation would presumably continue to pursue ongoing and future aquatic restoration projects.

No Action Alternative Impacts to Resident Fisheries.—Reservoir fisheries were evaluated by looking for changes in reservoir volumes by alternative. Very few changes of significance occur to reservoir content as a result of implementing Title XII, as described in Section 4.2 "Surface Water Hydrology." In general, only the months of September and October showed differences among alternatives, so only these months are considered

further. Reservoir contents drop between July and September. This fluctuation is hard on reservoir fish populations. The annual cycle in reservoir levels will likely continue into the future. Model-predicted reservoir contents are sometimes slightly reduced in the No Action Alternative compared to the pre-Title XII conditions.

The Yakima River reaches at Umtanum and Pomona were used as indicators of potential impacts to rainbow trout. These two reaches are important rearing and spawning areas for rainbow trout. The only month showing differences among alternatives for the Umtanum reach was October. The average streamflow at Umtanum during October was 940 ft^3/s under pre-Title XII conditions and 970 ft^3/s under no action. These flows may be high for rainbow trout spawning and juvenile rearing and low for adult rearing. At Pomona, the model-predicted streamflows showed that in some months (April through August) and some years in the period of record, flows may be adequate for rainbow trout adult rearing.

Alternative 1 Impacts to Fish

Alternative 1 Impacts to Salmon and Steelhead.—Model results for parameters discussed under the No Action Alternative indicate no differences between the No Action Alternative and implementing Title XII without the Basin Conservation Program. Most changes in streamflow that occur are on the order of 1 percent, which is well within the error factor (no measurable impact—see table 4-3). Model results do not capture all factors that could affect salmon and steelhead, and these other factors are discussed below.

Actions related to the interim comprehensive basin operating plan and the System Operations Advisory Committee (SOAC) could improve flow fluctuation problems (identified in table 3-11) as well as other aquatic resource problems. Tributary enhancement in some areas (like Teanaway and Taneum) would improve rearing conditions for salmon and steelhead. These Title XII elements have the potential to improve and actively restore salmon, steelhead, and resident fish within the basin.

Electrifying Chandler Pumping Plant would increase instream flows between Prosser and Chandler by about 300 ft^3/s (on average) during the irrigation season. The project would help moderate some acute and unpredictable flow decreases in this area that can, in combination with high temperatures, block upstream migrations (Easterbrooks, 1988). More dependable and higher flows may also reduce water temperatures in this reach, especially during warm summer months. This action would benefit all salmonid species in the system now, plus summer chinook and sockeye if they are reintroduced.

The 14,600 acre-feet of water realized from raising the gates at Cle Elum would benefit migrating juvenile salmon because the water would be available for flushing flows or other fish-related needs. Fish passage facilities would be built at Cle Elum, which could allow sockeye salmon restoration.

Kachess Dam modification allows increased operational flexibility, which can be used for fish management purposes in the adjacent stream reaches. Under certain operational

conditions, over 80,000 acre-feet of water can be stranded. This modification allows fuller use of reservoir storage. Irrigation releases from Kachess and Keechelus can be timed in a manner that maintains spawning and incubation of spring chinook salmon with a technique called the mini "flip-flop." Currently, the mini "flip-flop" can only occur about every 5 out of 10 years; this frequency should increase to 8 or 9 out of every 10 years.

Augmentation of Kachess could increase the ability to operate the dam for the "flip-flop" and the mini "flip-flop[2]." However, appraisal level studies have shown that Kachess augmentation probably would not benefit fish because of the small amount of additional storage water (Reclamation, 1997). This element could also adversely affect fish in Cabin and Silver Creeks because instream flows in these creeks would be reduced. Concerns have been raised over the measure's potential impacts on spring flushing flows for salmonid downstream migrations.

Wapato Irrigation Project improvements and the Toppenish Creek Corridor enhancement project would likely benefit salmon and steelhead. Wapato Irrigation Project conservation measures and the irrigation demonstration project could have adverse impacts on migrating salmon and steelhead if these species are not considered during project development.

Alternative 1 Impacts to Resident Fish.—Implementing several components of Title XII could potentially impact reservoir fisheries. For example, raising the gates at Cle Elum will enlarge the reservoir, which could benefit reservoir fish. Because migratory fish will have access to the reservoir, overall fish production should improve. On the other hand, shoreline erosion could occur during construction, which could temporarily adversely impact fish through increased sediment in the water. Augmenting Kachess Lake probably would not adversely impact the reservoir fisheries there. The reservoir content would increase in certain years, which might benefit the fishery under some circumstances. Another aspect of Title XII, development of the interim comprehensive operating basin plan, will likely consider reservoir fisheries; therefore, adverse impacts can be avoided.

Rainbow trout may generally benefit from most of the Title XII elements. Tributary flow enhancement, in particular, is likely to benefit rainbow trout as well as bull trout and cutthroat trout.

Alternative 2A Impacts to Fish

Alternative 2A Impacts to Salmon and Steelhead.—Impacts to salmon and steelhead would be the same as those described under Alternative 1, except for those impacts relating to the Basin Conservation Program described below. The hydrology model integrates what happens to water in the basin as a result of this type of water conservation

[2] These are described in Section 3.2.2 "Pre-Title Operations (Before 1995) and Model Consideration."

program. Juvenile migration flows below Prosser Diversion Dam are improved, and rearing conditions below Parker are probably improved compared to the No Action Alternative.

Onfarm water conservation measures could improve water quality, and increased flows could improve water temperature, both of which would benefit salmon and steelhead. In particular, juvenile migration may be improved by water conservation efforts. Also, fall chinook spawning below Prosser improves, as does juvenile rearing during the autumn months below Prosser. Fish rearing and overwintering could benefit to the extent that wetlands are restored under the Basin Conservation Program.

Individual water conservation implementation efforts will be evaluated separately to ensure that implementation minimizes any possible adverse impacts. Constructing reregulating reservoirs in areas that would stabilize flow fluctuations and improve operating flexibility would benefit salmon and steelhead. Some water conservation actions (canal automation, reduced till, implementation of multiple measures) could improve water quality (see Section 4.3 "Surface Water Quality"), which would benefit aquatic resources.

Water conservation can also result in adverse impacts to fish if diversions are not reduced or if return flow changes reduce streamflows in critical reaches. Actual streamflows will need to be monitored in key areas (i.e., at Easton and at Pomona) to assure that streamflows are adequate for salmon and steelhead (see table B-1 in appendix B).

Alternative 2A Impacts to Resident Fish.—No differences in impacts to resident fish for this alternative compared to the No Action Alternative could be identified.

Alternative 2B Impacts to Fish

No differences between this alternative and Alternative 2A could be clearly defined for fish.

Alternative 2C Impacts to Fish

Few differences between this alternative and Alternative 2A could be clearly defined for fish. Small improvements in model-predicted flows occur below Prosser and Parker, which would benefit all salmonids. Also, model-predicted average September content improves at Rimrock, which would benefit reservoir fisheries.

Alternative 3 Impacts to Fish

Impacts to salmon and steelhead would be the same as those described under Alternative 2 except those relating to Kachess augmentation and tributary enhancement. Impacts to fish in Cabin and Silver Creeks would be eliminated because the water in these streams

would not be diverted under this alternative. Flows appear to be higher at Prosser during the month of July, which could benefit some fish. Those habitats that could benefit from the tributary program would not benefit under this action.

4.7 Vegetation and Wildlife

A goal of YRBWEP is to protect, create, and enhance wetlands and associated riparian and flood plain habitats. Therefore, this Federal action has the potential to benefit wetlands and riparian habitats in the basin. In general, adverse impacts to vegetation and wildlife associated with this Federal action are expected to be minor because of Reclamation's efforts to abide by the no net loss of wetlands policy, development of the Basin Conservation Program, the proposed Wetlands and Floodplain Habitat Plan, and the proposed wetlands enhancement project. The water conservation plan interim guidelines for feasibility investigations include sections on environmental compliance and wetlands protection.

This assessment focuses on riparian vegetation and associated wildlife, wetlands and associated wildlife, and agricultural land and associated wildlife. Impacts to vegetation and wildlife could be direct or indirect. Impacts to vegetation and wildlife would be direct (for example, if a high-value wetland area were expanded or protected or if a canal used by wetland-dependent wildlife were piped). Many impacts to vegetation and wildlife would be indirect.

Short-term impacts are defined as those that take place between 5 and 20 years after an alternative is implemented. Short-term impacts are difficult to predict because many are indirect and because the exact actions to be implemented are not completely known at this time. Long-term impacts take place between 20 and 50 years after implementing an alternative. Long-term impacts are more difficult to predict than short-term impacts.

4.7.1 Summary of Impacts to Vegetation and Wildlife

The summary of impacts to vegetation and wildlife (table 4-11) indicates that effects could range from minor to potentially beneficial under some circumstances. Benefits to wetland and riparian areas are most likely to occur if proposed actions are considered within the context of a well- developed Wetlands and Floodplain Habitat Plan, as discussed in the Basin Conservation Plan. Implementing some conservation measures in the Yakima River Basin may result in the loss of some wetland areas. These losses should be fully offset by integrating wetland mitigation plans (as proposed in the Basin Conservation Plan).

Streamflows are not likely to change enough to cause short- or long-term impacts. If large enough streamflow changes do occur, they will most likely benefit vegetation in the lower basin. Tributary enhancement could benefit vegetation associated with affected waterways. The interim comprehensive basin operating plan could be used to help improve the Yakima ecosystem; experiments in flow reregulation could benefit flood plain

Table 4-11.—Summary of impacts to vegetation and wildlife

Vegetation and wildlife	Pre-Title XII	No Action Alternative	Alternative 1	Alternative 2A (preferred alternative)	Alternative 2B	Alternative 2C	Alternative 3
Riparian areas and associated wildlife. Potential streamflow changes during the growing season (April to October).	Average years: potentially less water available in some areas.	Riparian health varies throughout basin; estimate 19,000 acres of riparian vegetation basin-wide.	Average years: potential benefits below Parker.	Average years: potential benefits below Parker and Prosser.	Generally, same as Alternative 2A.	Generally, same as Alternative 2A.	Generally, same as Alternative 2A, except fewer potential benefits in tributaries.
Wetlands and associated wildlife. Area of wetlands within basin.	Generally, same as no action.	About 71,000 acres of wetlands (including open water and riparian). Upper basin: 43,000 acres Lower basin: 28,000 acres	Potential minor benefits to wetlands associated with Yakima River below Sunnyside and Prosser; Yakama Indian Nation and ecosystem restoration activities could be beneficial.	Same as Alternative 1 PLUS potential benefits based on land and water acquisition programs, wetland banking, and development of a habitat plan. Potential minor adverse impacts to wetlands associated with agricultural return flows or seepage.	Same as Alternative 2A, except potential minor adverse impacts to wetlands associated with agricultural return flows or seepage below Roza.	Same as Alternative 2A, except potential minor adverse impacts to wetlands associated with agricultural return flows or seepage on Roza or Sunnyside lands.	Generally, same as Alternative 2A.
Agricultural land and associated wildlife.	Generally, same as no action.	Small portion of 550,000 Yakima Project irrigated acres affected; existing trend is for agricultural land to be less valuable wildlife habitat than in the past.	Generally, same as no action.	No measurable impacts to potential adverse impacts if crops changed or if agricultural practices more efficient.	Generally, same as Alternative 2A.	Generally, same as Alternative 2A.	Generally, same as Alternative 2A.

vegetation. Many wildlife impacts associated with this Federal action are indirect impacts and would be associated with changes in riparian and wetland vegetation. Agricultural lands continue to lose value as wildlife habitat, and this program could either expedite or not affect this trend, depending on implementation.

Channelizing, diking, and draining associated with irrigated agriculture in the Yakima River Basin have reduced the complexity of the Yakima River and its tributary/wetland system. Wetland habitats lost were replaced, to a lesser extent, with irrigation canals and drains and their associated vegetation. Surveys and an ongoing radio telemetry study performed by the Yakama Indian Nation have documented extensive waterfowl production in irrigation canals and drains. Activities associated with this Federal action involving the piping or lining of canals and drains could result in a direct loss of wetland habitat if such habitats are not considered.

4.7.2 Discussion of Impacts to Vegetation and Wildlife

Methods and Rationale

Although many kinds of vegetation grow within the Yakima River Basin, this impact assessment is limited to the vegetation most likely to be affected by this Federal action: flood plain riparian wetland vegetation and vegetation associated with irrigated agricultural lands. All wildlife impacts are based on estimated changes in wildlife habitat in the above-stated areas.

Riparian vegetation, wetlands, and agricultural lands that have wildlife value can be affected by changes in streamflow, agricultural return flows, and general water conservation activities. This analysis is done very broadly by assessing the areas of riparian and wetland vegetation and wetlands in the basin and estimating how much of this area might be affected by the proposed Federal action. This analysis is focused on the basin-wide impact of the proposed action and does not consider each YRBWEP element in detail. No quantitative analysis has been completed at this time. Detailed analysis will be completed in the site-specific documents.

Riparian and wetland assessments were based on the following premises:

- Flood plain riparian and wetland vegetation typically depend on groundwater. Any significant change in water table elevation during the growing season could potentially affect these communities (Rood and Mahoney, 1992).

- Certain riparian vegetation, including cottonwood, depends on specific hydrologic events (e.g., floods) for continued recruitment into the population. Alteration of the timing or magnitude of these events could affect seedling establishment (Rood and Mahoney, 1992).

- Significant modification, either to the groundwater table which supports established vegetation or the hydrology which creates conditions suitable for seedling establishment, may cause long-term effects to susceptible flood plain riparian and wetland vegetation communities.

Impacts related to groundwater were based on information reported in Section 4.4 "Groundwater." Although item 2 above is important, this analysis does not address riparian vegetation regeneration because flood frequencies are assumed to be unaffected by any alternative.

Riparian vegetation and associated wildlife were evaluated by looking at model predicted streamflow changes throughout the basin for each alternative. All locations where data were output from the hydrology model were checked for changes in average annual flow. Annual flow changes have been related to cottonwood growth (Stromberg and Patten, 1990). Annual flow represents a measure of flood plain riparian and wetland maintenance.

Monthly changes in streamflow were also considered. Average monthly depletions of streamflow greater than 20 percent in April through October were assumed to adversely affect riparian vegetation. This average represents a worst-case evaluation because average monthly streamflow depletions of 20 percent may not produce detectable changes in vegetation; the relationship between flow and riparian maintenance is not well understood (Stromberg and Patten, 1990). Increases in streamflows were also assumed to benefit riparian resources.

Wetlands and associated wildlife were evaluated similarly by identifying areas that could be affected by the Federal action and that also have wetlands. Again, identified water depletions caused by streamflows or water conservation were assumed to be detrimental to wetlands, and streamflow increases were assumed to be beneficial. Potential changes to *agricultural lands and associated wildlife* were estimated, based on information in Section 4.5 "Agricultural Resources."

No Action Alternative Impacts to Vegetation and Wildlife

The No Action Alternative represents few changes over conditions described in chapter 3. Table 4-11 summarizes these conditions. *Riparian vegetation and associated wildlife* and *wetlands and associated wildlife* would continue to suffer some degradation in the future where existing problems are not resolved (for detailed information on species and problems within the basin, see Oliver [1994]). *Agricultural lands* would likely continue a trend into the future toward reduced value for wildlife because of increased efficiencies of agricultural practices. Simultaneously, ongoing programs such as the lower Yakima Valley wetlands and riparian restoration project (and others) would continue to restore riparian and wetland areas in the future.

Under the No Action Alternative, existing water conservation efforts would continue. These efforts may affect riparian vegetation and associated wildlife, but safeguards are in

place to limit impacts. For example, Referendum 38 requires districts to monitor wetlands and riparian areas before cost sharing takes place. Water conservation efforts often occur on private land; therefore, effects to vegetation and associated wildlife can vary widely, depending upon actions of individual landowners.

The Yakama Indian Nation would continue efforts to restore lower basin riparian areas through various activities. Known inefficiencies associated with the Wapato Irrigation Project and also related to vegetation and wildlife (Hames et al., 1992) would continue into the future under the No Action Alternative.

Alternative 1 Impacts to Vegetation and Wildlife

Most flow changes associated with implementing Title XII would be too minor to impact *riparian vegetation and associated wildlife*. Average annual flows are similar among alternatives (Section 4.2 "Surface Water Hydrology"), and groundwater level changes are expected to be minor in most areas (Section 4.4 "Groundwater"). Model-predicted flow changes in April through October greater than 20 percent occurred at the Kachess River near Kachess, Yakima River at Easton, Cle Elum River near Roslyn, Yakima River at Parker, and the Yakima River at Prosser. Most of these flow changes barely exceeded 20 percent (see Section 4.2 "Surface Water Hydrology"); therefore, impacts to riparian areas are expected to be very minor.

Increased streamflows on the Yakima River below Easton in May and June could potentially improve riparian habitat in these areas. Without the Basin Conservation Program, only those *wetlands and associated wildlife* near rivers, reservoirs, or tributaries could be affected by this Federal action. Because model predicted streamflow changes under Alternative 1 would be minor compared to the No Action Alternative, few impacts to wetlands and associated wildlife are anticipated. No changes to *agricultural lands and associated wildlife* were identified. Minor impacts that could occur are noted below.

About 70 acres of riparian vegetation around the reservoir (coniferous trees with little or no understory) would be inundated by raising the gates at Cle Elum. Trees left in Cle Elum would die, become snags, and could be used as perching, feeding, and nesting sites. Other short-term impacts to vegetation and wildlife could occur during construction.

The SOAC or the interim comprehensive basin operating plan could propose ecosystem restoration activities that could benefit riparian and wetland habitat. Tributary enhancement may benefit riparian and wetland vegetation and associated wildlife. Site-specific impacts will need to be considered as each element is implemented. Short-term impacts to vegetation and wildlife could occur during the Kachess modification construction period. Augmentation of Kachess Lake could adversely affect riparian areas, wetlands, and associated wildlife below the point of diversion on Cabin and Silver Creeks. Loss of coniferous forest could occur along the pipeline alignments.

The Toppenish Creek Corridor enhancement element of YRBWEP would benefit riparian and wetland areas within the study area. The Wapato Irrigation Project could have both adverse and beneficial impacts to riparian, wetland, and agricultural areas and their associated wildlife.

Alternative 2A Impacts to Vegetation and Wildlife

Alternative 2A impacts would be the same as those identified under Alternative 1 plus impacts associated with water conservation efforts associated with the Basin Conservation Program.

The Basin Conservation Program is intended to "protect, mitigate, and enhance fish and wildlife through improved water management, improved instream flows, improved water quality, protection, creation, and enhancement of wetlands, and by other appropriate means of habitat improvement and to improve the reliability of the water supply for irrigation" (Title XII, section 1201 "Purposes"). Benefits to fish are more obvious than benefits to wildlife because streamflows are being enhanced at critical sites for anadromous fish. However, benefits could occur to riparian and wetland vegetation and associated wildlife, particularly in association with Yakama Indian Nation elements of Title XII. Simultaneously, water conservation activities could adversely impact riparian vegetation, wetlands, and associated wildlife in certain circumstances.

Maintaining wetland functions and values requires a coordinated effort by Reclamation, water conservation participants, and Yakima River Basin fish and wildlife resource managers. A first step in this effort should be the development of a Wetlands and Floodplain Habitat Plan to help guide wetlands activities in the Yakima River Basin. The plan should include an inventory, rating, and functional assessment of existing wetlands; a comparison of historical and current conditions at a landscape scale; and a ranking of priority areas for protection, creation, and enhancement as proposed in the Basin Conservation Plan. A wetlands enhancement project should be undertaken to protect, create, and enhance high-value wetlands and fish and wildlife habitat as proposed in the Basin Conservation Plan.

Model-predicted streamflow changes associated with implementing Title XII, including the Basin Conservation Program, result in some streamflow increases during the growing season. Annual streamflow increases have been associated with increased riparian tree growth, but no annual streamflow changes could be identified; therefore, impacts are not measurable by this criterion.

Canals and laterals throughout the system could receive less water from reduced diversions. This spread-out reduction could adversely impact wetland and riparian areas and associated wildlife. The extent of local impact must be determined with each measure. Impacts depend upon the conservation measure implemented, which will be identified in

the tier-down implementation process. Reclamation will work with individuals and districts to mitigate adverse impacts to riparian areas, wetlands, and associated wildlife. The following actions should help guide efforts to minimize adverse impacts.

Potential impacts to wetlands which could result from implementation of water conservation measures will be identified in the water conservation plans and in the feasibility investigations. As a starting point, Natural Resources Conservation Service (NRCS) and U.S. Fish and Wildlife Service (FWS) will inventory high-value wetlands. These include wetlands rated as Category I and II on the WDOE's wetland rating system, flood plain wetlands (particularly those in complex alluvial areas of the Yakima River and tributary streams), and wetlands which provide connections between areas of wildlife habitat or special aquatic sites. Wetlands determined to have high value should preferentially be protected.

How water is conserved will determine impacts to vegetation and wildlife. Impacts could include: reduced-till farming can improve wildlife habitat; reregulating reservoirs can cause minor reductions to riparian/wetland vegetation and associated wildlife; and lining canals and laterals can reduce wetland and riparian vegetation (Reclamation, 1988). Implementing multiple measures can reduce wetlands, particularly if the wetlands occur at the terminal part of the basin (FWS, 1995; Reclamation, 1989).

If farm water conservation efforts occur under the assumptions of Alternative 2A, a maximum of about 9,200 acres of wetlands could be affected. This acreage represents wetland acres as determined by the National Wetland Inventory that occur within irrigation districts that would be affected by Title XII.

Potential wetland and riparian area losses partly depend upon the original value of the areas affected. Studies have shown that wildlife habitat around canals and ditches is of relatively low value (Andersen and Nelson, 1995). In the Yakima River Basin, some areas that could be affected will represent high-value habitat (Oliver, 1994). Therefore, it will be important for site-specific documents to show riparian and wetland relative value. Particular attention should be paid to preserving high value areas or replacing lost areas of lower value with acreage in higher value areas.

Alternative 2B Impacts to Vegetation and Wildlife

Impacts associated with most elements of Title XII would be the same as those identified under Alternative 1.

Streamflow changes are estimated to be the same as those associated with Alternative 2A. Basin Conservation Program impacts would be the same as discussed previously; however, the distribution of impacts would be different. Because water conservation under this alternative only occurs below Roza, a maximum of 4,000 acres of wetland could be affected. Impacts to wetlands and associated wildlife affected by water conservation could be more

severe in the areas affected under this alternative because the water conservation efforts would be more concentrated than under Alternative 2A. In practice, impacts depend upon type, quantity, and location of water conservation measures implemented.

Alternative 2C Impacts to Vegetation and Wildlife

Impacts associated with most Title XII elements would resemble those identified under Alternative 1.

Basin Conservation Program impacts would be the same as discussed previously; however, distribution of impacts would differ. Because water conservation under this alternative occurs only below Roza and Sunnyside, a maximum of 3,200 acres of wetland could be affected. Other areas would not be impacted. Impacts to riparian and wetlands areas and associated wildlife within the Sunnyside and Roza Irrigation Districts could be more severe than Alternative 2A because water conservation efforts would be more concentrated in these districts.

Alternative 3 Impacts to Vegetation and Wildlife

Impacts associated with most Title XII elements would resemble those identified under Alternative 2A. Impacts associated with Kachess augmentation would not occur. Potential benefits associated with the tributary program would not occur. Model-predicted stream-flow changes were not sufficient to make a distinction for flood plain riparian and wetland impacts that differed from Alternative 2A.

4.8 Threatened, Endangered, and Special Status Species

Informal Endangered Species Act consultation was initiated on April 12, 1996. FWS and the National Marine Fisheries Service (NMFS) species lists were sent to Reclamation on April 16 and April 24, 1996, respectively. A biological evaluation (BE), which is included as appendix E, was prepared to address the listed species. The BE was provided to both NMFS and the FWS on December 6, 1996. Reclamation determined through the BE that the proposed Federal action would have "no effect" on threatened and endangered species or critical habitat. This determination was based on the analysis that this PEIS is an administrative action with the purpose of deciding which Title XII elements Reclamation will further consider for implementation. FWS issued a concurrence by memorandum dated December 20, 1996. NMFS has concurred verbally with Reclamation's no effect determination. Further Endangered Species Act compliance and site-specific analysis will be conducted before implementing each individual Title XII action.

Regarding evaluation of impacts to candidate species, all parties agreed that because this PEIS is an administrative action and because Reclamation would commit to evaluate such species when site-specific analysis is conducted, such an evaluation was not necessary for this document.

Bull trout were listed in June 1998. Steelhead were proposed for listing in February 1998. On July 15, 1997, Reclamation met with FWS to discuss conferencing requirements. All parties agreed that the decision to proceed on the administrative action would not necessitate conferencing, but conferencing would be required for specific actions. Reclamation has committed to consult with FWS on bull trout when site-specific analysis is needed.

4.9 Socioeconomics

4.9.1 Social Well-Being

Summary of Impacts to Social Well-Being

Table 4-12 summarizes impacts on social well-being and quality of life for each alternative.

Alternative 1 Impacts to Social Well-Being.—Changes in the Yakima River system operations, flows, and return flows would be similar to the No Action Alternative. Little, if any, social impact is anticipated.

Alternatives 2A, 2B, and 2C Impacts to Social Well-Being.—The impacts on social well-being from modifying existing structures would be the same as Alternative 1.

The difference in Alternatives 2A, 2B, and 2C is the location within the river basin where water conservation occurs. Until the water conservation plan is finalized and specific conservation measures are identified, specific social impacts to the human environment cannot be analyzed. Increased levels of friction in community cohesion will depend on the type of water rights acquisition. The more water rights are acquired, the greater the potential for friction.

Alternative 3 Impacts to Social Well-Being.—The social impacts under this alternative would be similar to those anticipated with Alternative 2A.

Table 4-12.—Summary of impacts to social well-being

No action	Alternative 1	Alternative 2A (preferred alternative)	Alternative 2B	Alternative 2C	Alternative 3
Shoreline property around Cle Elum Lake eroding.	Small local labor force will be used to complete structural modifications.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.
Same community cohesion levels that now exist between nonterritorial and territorial communities.	About 10 property owners around Cle Elum Lake impacted.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.
	The potential for friction and decreased community cohesion depends on the specific water conservation measures.	Increased friction in community cohesion anticipated (greater than Alternative 1). Degree of impacts to water right acquisitions will depend on type and amount of water conservation measures.	Increased friction in community cohesion anticipated (greater than Alternatives 1, 2A, and 3). Diversion reductions would probably require water acquisition and subsequent land use change.	Increased friction in community cohesion anticipated (greater than Alternatives 1, 2A, 2B, and 3). Diversion reductions would probably require water acquisition and subsequent land use change greater than Alternative 2B.	Increased friction in community cohesion anticipated (about the same as Alternative 2A).

4.9.2 Discussion of Impacts to Social Well-Being

Methods and Rationale

Social impacts are consequences to human populations of any public or private actions that alter the way people live, work, play, relate to one another, organize to meet their needs, and generally cope as members of society (Burdge, 1994). The impacts to the human environment will be presented in general terms because this document is a PEIS.

Actions and consequences discussed in other sections of this document affect people's beliefs, values, attitudes, and general social well-being. Social issues are often intangible and may be a secondary or tertiary repercussion of the action.

The kind and amount of social impact experienced by a specific individual or community depend on individual and community values and perceptions. If project impacts are seen as desirable, the human environment may respond differently than if the impacts are seen as negative or as a violation of held values. Also, the impact on people may differ if an impact is spread broadly across everybody in a community or is experienced by only one or a few persons within a primary or secondary group of a specific community.

It is critical to understand: (1) the history and development of the river basin, (2) the existing relevant population characteristics, (3) the values and norms espoused by different individuals and communities, (4) the most likely social conditions (projections) in the Yakima River Basin for the future without implementing Title XII (No Action Alternative), and (5) that different communities have different interests, objectives, and goals; as such, these different communities are impacted differently by the same actions. This information forms the baseline condition to which the action alternatives are compared.

Territorial communities are populations that function within a particular geographic area, such as the Yakama Indian Reservation or the residents who live around the shores of Cle Elum Lake. Nonterritorial communities ("special interest communities") are networks of associations that form around shared goals, values, and norms, such as the agricultural, environmental, or recreational community (Bell and Newby, 1974; Suttles, 1972).

The analysis of the social impacts to the human environment centered around the people within the affected communities. Table 4-13 displays the various social well-being indicators that are measurable (discussed as ranges and trends rather than specifics) and will likely have an impact on individuals or specific territorial or nonterritorial communities.

Table 4-13.—Social impact assessment variables

Resource	Indicator	Measurement unit
People	Property impacted around Cle Elum Lake	Number of acres
People	Labor construction impacts with specific operation and modification of facilities	Number of jobs
People	Community cohesion	Need for acquiring water rights to meet diversion reduction goals

No Action Alternative Impacts to Social Well-Being

As described in chapter 2, the No Action Alternative is the most probable future condition that would be expected to come about without implementing Title XII provisions beyond the 1995 target flows. Also, it provides a baseline condition to which action alternatives can be compared to establish both positive and negative impacts.

People are the primary resource for social assessment, and, as such, it is important to determine if the population of the study area is expected to grow, remain the same, or decline. The vast majority of the people that comprise the affected communities reside within the Yakima River Basin; exceptions to this statement are some of the environmentalist and recreationalist communities. The State of Washington does not desegregate population projections at the city and town levels. Therefore, population projections are made only at the county level and are shown in table 4-14 and in Appendix C "Socioeconomics."

Each of the three counties in the study area is projected to experience population increases for each of the periods shown in table 4-14.

Table 4-14.—Population projection by county (1990 to 2020)

County	1990	1995	2000	2005	2010	2020
Benton	112,560	130,998	146,020	155,320	163,037	181,806
Kittitas	26,725	30,101	32,493	34,714	36,842	42,241
Yakima	188,823	204,100	215,637	227,620	239,436	271,726
Percentage increase by county						
County		1990 to 1995	1995 to 2000	2000 to 2005	2005 to 2010	2010 to 2020
Benton		16.4	11.5	6.4	5.0	11.5
Kittitas		12.6	8.0	6.8	6.1	14.7
Yakima		8.1	5.7	5.6	5.2	13.5

Source: State of Washington, Office of Financial Management, Forecasting Division. Washington State County Population Projections, 1995. Medium Series.

Determining the exact number of individuals that might belong to specific nonterritorial or territorial communities in future years is difficult. However, it is assumed that some growth will occur in most of these communities. Status as of 1996 is:

- The irrigation districts located in the river basin range considerably in both land size and people served. However, entities that will be most affected are Kennewick, Kittitas, Roza, Sunnyside, Tieton, and Wapato.

- The number of people who belong to environmental groups is difficult to assess. Many of the environmentalist groups are national organizations; therefore, their membership is distributed throughout the United States and is considerable.

- The number of people that use recreation facilities is also difficult to estimate. Recreation use for the river basin is not measured in a specific unit. Refer to Section 3.10 "Recreation " for specifics on recreation use.

- As of April 1996, the Yakama Indian Nation had a listed enrollment of 8,586 members; of this total membership, 5,685 resided on the Reservation.

- About 10 persons have shoreline property around Cle Elum Lake.

Water is a limited resource, and, in many years, demand is much higher than supply. This condition has prevailed in the project area for several years. Under the No Action Alternative, even with the legislated flow releases at Sunnyside and Prosser Diversion Dams, this circumstance is highly likely to continue into the future. The issues and concerns that are paramount now would only increase in importance. The various communities, both "territorial" and "nonterritorial," discussed in Section 3.9.1 "Social Well-Being and Relationships With the Biophysical Environment," would remain the same in their views toward what constitutes the most beneficial use for water. Cohesion among the different communities is also highly likely to suffer. If anything, the high level of conflict surrounding: (1) instream flows for anadromous fish, (2) best water conservation measures, and (3) available water for recreation, etc., would accelerate.

A human individual is an extremely complex being, and the criteria which constitute a held value or value system for that individual are equally complex. The "values" held by a person or persons are some of the criteria which help to form individual personalities and are, in part, the basis for forming differing attitudes and beliefs. These values make individuals different and unique.

The value judgment that a person or community places on water usage often depends on several factors, (i.e., family, friends, the environment in which a person was raised, interest levels, etc.). In many cases, a high value for several differing uses of water is both espoused and encouraged by individuals within the different communities. However, whenever supply is limited, prioritizing that which is perceived to be the most critical need is natural. This value judgment creates conflict between the different interest communities in water short years.

While changes in society have changed some values and priorities, the perception held by each community that the most beneficial use of water is that use which will meet their specific needs best will likely remain unchanged.

Water conservation in the river basin is not a new concept. A variety of different measures has been implemented both on an individual and district level in years past. Predicting what solutions or measures would be used in the no action condition is difficult. However, unless more aggressive and more stringent measures are employed, goals of increased instream flows and more efficiency for onfarm irrigation will not likely be achieved.

A limited number of property owners along the shorelines of Cle Elum Lake experience shoreline erosion. Some disagreement exists regarding who has responsibility to make repairs to correct the erosion. Under no action, this issue will likely be resolved via litigation.

When comparing the pre-Title XII conditions to the No Action Alternative, the Title XII flow requirements at Parker and Prosser caused minor increases in shortages under no action in the average (1926-94) year. These minor increases in shortages adversely impacted the proratable water users. The hydrology summary of impacts (tables 4-1 and 4-2 in Section 4.2 "Surface Water Hydrology") compares the magnitude of shortage that could be experienced under pre-Title XII conditions, no action, and action alternatives.

Alternative 1 Impacts to Social Well-Being

Changes in the Yakima River system operations and flows, as well as the amount of water returned to the system through return flows, would be similar for Alternative 1 when compared to the No Action Alternative. Changes that will occur are small enough to make them difficult to measure; therefore, little, if any, social impact is anticipated.

Modifications to existing structures or facilities required by Title XII would require a small labor force. No adverse impacts are anticipated. The number of construction laborers needed at Cle Elum Lake to modify the radial gates to provide an additional 14,600 acre-feet of storage capacity, implement shoreline protection, and construct juvenile passage facilities would be relatively small (ranging between 25 and 50 workers). The nature of the work to accomplish these modifications would not require specialized labor skills from outside reasonable commuting distance. The road which provides access to the dam and radial gates and fish passage facilities, as well as the road around the reservoir, would experience increased traffic from both workers and construction equipment. However, the traffic is not anticipated to increase beyond limits that the road could adequately manage.

About 10 property owners have property fronting the reservoir, and some currently experience erosion. These properties would experience some shoreline erosion. However, modification plans include repairing these impacted shorelines. Shoreline repairs will most likely not cause significant noise or air pollution impacts.

The labor force necessary for structural modifications to Chandler Pumping Plant would be small. No adverse labor construction impacts from this construction are projected.

Reclamation prepared an environmental assessment for modifying Kachess Dam and completed a Finding of No Significant Impact in April 1996. Parties interested in modification to Kachess Dam are referred to this document for detailed information.

The study for augmenting Kachess Lake from Cabin Creek and Silver Creek flows is still preliminary and lacks sufficient information to project the number of construction laborers required to build such a project and subsequent labor construction impacts. Labor construction work force and associated impacts will need to be assessed if this study continues.

Title XII provides for funds to make improvements to the Wapato Irrigation Project for the Toppenish Creek Corridor enhancement project, and also for design, construction, and operation and maintenance of an irrigation demonstration project. These provisions are still in the early planning stages. Site-specific analysis of social impacts will need to be completed for these provisions and potential modifications once plans become more final.

The potential for friction and decreased community cohesion depends on the specific water conservation measures.

Alternatives 2A, 2B, and 2C Impacts to Social Well-Being

These alternatives assume full implementation of all components of Title XII. The impacts on social well-being from modifying existing structures would be the same for Alternative 2 as those described above for Alternative 1.

Until water conservation plans under the Basin Conservation Program are complete and specific conservation measures for achieving water saving goals, potential impacts on social well-being to the human environment are impossible to analyze. However, water conservation measures implemented in other areas of the United States have generally had less social impact compared to acquiring water rights to achieve additional water.

As a review of several case studies shows, acquiring agricultural water rights achieved the goal of providing an adequate water supply for another use but also caused considerable adverse social impact. Many individuals within the agricultural community considered that those individuals who sold an agricultural water right had betrayed the heritage and value structure of the area. The result was considerable animosity, hostility, and lack of cohesion within the agricultural community.

Achieving the percentage goals for reduced diversion for Alternatives 2B and 2C, and possibly Alternative 2A, may require acquiring water rights. Reclamation is conducting a pilot program for acquiring water rights in the upper basin. Analysis of the positive and negative consequences of the program could provide useful input in developing specific water rights acquisitions.

Alternative 3 Impacts to Social Well-Being

The social impacts under this alternative would be very similar to those anticipated with Alternative 2A.

4.9.3 Economics

Summary of Economic Impacts

The analysis compared the levels of economic activity under no action to the action alternatives. The alternatives can be considered without having to reduce water deliveries to farmers. This process would require that the conservation programs reduce water delivery losses so that the reductions in diversions would not affect water deliveries. Water can be acquired through purchase or lease as a means of increasing instream flows, but this program would be limited to willing sellers or lessors and has limited funding.

A summary of economic impacts is shown in table 4-15. Proportional impacts from changes in water deliveries attributable to purchase or lease are shown in table 4-16. Table 4-16 shows the impacts to the economy for each alternative if water rights were sold or leased or other reasons caused a change in production. The level of change is for each $1-million change in agricultural production. The impacts measure all effects on the economy, not just changes to the agricultural industries. These effects are more likely to occur with long-term changes in water rights rather than short-term changes. These values represent a weighted average of all crops and districts affected by the respective alternative. Table 4-16 shows impacts if water acquisition is needed—but water acquisition would probably not be needed for Alternatives 2A and 3. The numbers in table 4-16 represent about 0.02 of 1 percent of current levels in the economy and are considered insignificant impacts. Assuming that water deliveries otherwise are not affected, then the alternatives would have little or no economic impacts on the regional economy.

Changes in waterflows would also impact electricity generation at the powerplants receiving project water. Wapatox Power Plant would show little or no change in output; Roza would show a net change from about 4,000 to 7,500 megawatthours (MWh) worth about $50,000 to $90,000, depending on the price of electricity. Table 4-17 provides greater detail of these impacts. Economic impacts from Chandler electrification would need to be examined when proposals are made.

Table 4-15.—Summary of impacts to economics

No action	Alternative 1	Alternative 2A (preferred alternative)	Alternative 2B	Alternative 2C	Alternative 3
Employment in the Yakima region is about 191,000 workers, earning about $4 billion, with sales revenues of $13 billion. Reclamation projects irrigate 360,000 acres with 1,789,000 acre-feet of water, producing $665 million in crop value.	Some gains in sales revenues. Impacts due to actions likely to be minimal, affecting primarily agriculture.	No measurable gains in sales revenues. Will likely be achieved through water conservation; therefore, no economic impacts.	Economic impacts only from lease or purchase of water rights; about $800,000 reduced sales revenues over all industries for every 1,000 acre-feet of reduced water delivery.	Economic impacts only from lease or purchase of water rights; about $900,000 reduced sales revenues over all industries for every 1,000 acre-feet of reduced water delivery.	Generally, the same as Alternative 2A.

Table 4-16.—Annual impacts by alternative for each $1-million change in agricultural production attributable to purchase or lease

Impacts (changes)[1]	Alternative				
	1	2A (preferred alternative)	2B	2C	3
Jobs (No. of employees)	37.6	(35.1)	(30.1)	(31.3)	(35.1)
Household income (x $1,000)	970	(913)	(788)	(832)	(913)
Sales revenues (x $1,000)	1,948	(1,821)	(1,561)	(1,636)	(1,821)

[1] Negative numbers are in parentheses. Impacts include direct and indirect impacts.

Table 4-17.—Changes in power for each alternative

Powerplant	Alternative				
	1	2A (preferred alternative)	2B	2C	3
Total change per MWh	4,900	5,800	5,800	4,200	7,500
Value at $12 per MWh ($)	$59,000	$69,000	$70,000	$51,000	$90,000

4.9.4 Discussion of Economic Impacts

Methods and Rationale

The estimated impacts include two components: (1) direct impacts resulting from changes in water diversions on agricultural and other industries under any action alternative, and (2) indirect impacts created by the suppliers of goods and services purchased by the directly affected industries plus the induced effects created by changes in household income. Assuming a change in the level of output, purchases of production inputs and employment would change. These changes in purchases would cause indirect effects as the suppliers change their spending patterns. Also, employees of all affected businesses have different levels of income, leading to changes in their spending levels. All of these changes are included in this analysis in terms of employment, household income, and gross sales revenues. Estimates of changes in employment, household income, and sales revenues resulting from the proposed alternative were made using software packages called IMPLAN (Taylor et al., 1993), developed by the U.S. Forest Service, and IMS (Agricultural Enterprises, Inc., 1992), a software developed to modify IMPLAN and other input-output models.

Regional impacts measure economic gains or losses only to this region, with the assumption that the rest of the United States bears the offsetting gains or losses. Therefore, the reader should not consider regional impacts as representing economic benefits or costs for the United States. With the understanding that loss of employment is painful to those affected, regional impacts tend to be short-term effects; businesses tend to adapt and find ways to put people and resources back to work within a reasonable amount of time. Other

issues not considered in this analysis include impacts of new industries relocating to this region if management of those industries were attracted by the improved quality of life resulting from Title XII. Such relocations would partially offset any potential negative effects. Also, external factors that are not accounted for in this analysis, such as the ongoing northern spotted owl protection program, may affect the economy.

Economic impacts assume that changes in sales demand lead to changes in production. The economic impacts are measured using changes in numbers of jobs, dollars of household income, and dollars of sales revenue. Numbers of jobs and changes to dollars of household income show the impact to individuals within the region. Jobs indicate the number of people affected and are not converted to 40-hour-per-week averages. Changes in sales revenue show impacts on businesses, which also affect the level of taxes, such as sales taxes, collected by the local governments.

Sales revenue data reflect only portions of total sales for some sectors. Sales revenue for wholesale and retail trade sectors represents sales margins, the difference between purchase price to the vendor and sales price, rather than gross revenues. Sales revenue for finance, insurance, and real estate sectors includes interest income and brokers' commissions on real estate sales rather than changes in financial asset levels or property sales volume. This economic analysis was based on aggregated data for the counties of Kittitas, Yakima, and Benton, containing the watershed for the Yakima River. County level data are often the least aggregated level of data available.

Changes in variables, such as prices of agricultural output, are not normally taken into account by regional impact analyses. Using fixed prices allows comparisons of how alternatives affect physical production leading to economic consequences. Within this region, prices rise and fall for agricultural output based on numerous economic effects, including levels of production in the region and demand by consumers outside the region. Changes in water diversions for any given year probably will have little correlation with actual prices received by the producer during that year. For given price changes, the resulting economic impacts would then vary from the forecasted effects. Other variables affecting farmers in this region include the price of delivered water.

The analysis estimated the economic impacts by comparing levels of economic activity under no action to the action alternatives based on different levels of water diversions. Title XII authorizes purchase or lease of land, water, or water rights on a temporary or permanent basis for the Basin Conservation Program and for enhancing water supplies for Yakima River Basin tributaries. Water acquired through purchase or lease shall be administered separate from the TWSA. Any willing seller would require compensation for lost profits, which could amount to a minimum of hundreds of dollars per acre-foot.

Data are not specific enough to indicate who would be affected by actions that affect the agricultural sectors or show how the different alternatives would affect Hispanics or other ethnic groups basin-wide. However, of the 8,484 farm workers in the region, about

78 percent (6,625) are Hispanic, while about 16 percent of the population are Hispanic[3]. According to the United States 1990 census, about 1 percent of the white labor force work as farm workers, while 46 percent of the Hispanic labor force work as farm workers. Because such a large majority of farm workers are Hispanic, and a large percentage of Hispanics are farm workers, it is most likely that any actions affecting agriculture would disproportionately affect Hispanics. If agricultural production were to decline, most workers who would become unemployed would likely be Hispanic. This is supported by past changes in agricultural jobs. The January 1998 unemployment claims for farm workers within the State in that month revealed that 72 percent were Hispanic[4]. It is possible that alternatives could have different effects on Hispanics. Reducing irrigated acres may lead to a reduction in farm workers. It is not possible to determine which alternative could have a greater effect due to lack of data available. Yakima County has a larger population of Hispanics than Benton and Kittitas Counties, so an alternative that has a greater effect on farming in Yakima Country than in the other two counties could affect Hispanics more.

If Alternatives 2A and 3 do not reduce agricultural production, they would not have disproportionate impacts on Hispanics. If water rights acquisition under Alternatives 2B and 2C occurred, disproportional impacts to Hispanics could occur. While alternatives may have differing effects on Hispanics, it is not possible to determine which could have a greater effect due to lack of data available.

No Action Alternative Economic Impacts

This alternative is the most likely condition without implementing Title XII provisions beyond the 1995 target flows. These conditions require a target flow of 300 to 600 ft^3/s over Sunnyside Diversion Dam plus other operational changes. These changes slightly reduce the level of diversions in water short years compared to pre-Title XII conditions.

Alternative 1 Economic Impacts

Alternative 1 includes additional reservoir storage, including flows in excess of system demand from Cabin and Silver Creeks, modification of Cle Elum spillway, and electrification of Chandler Pumping Plant. Radial gates are proposed to be modified on Cle Elum

[3] Equal Employment Opportunity, 1990 U.S. Bureau of the Census.

[4] Washington State Employment Security, Agricultural Workforce in Washington State 1997. Prepared by Ronald Wahlers, Agriculture Labor Market Information, August 1998, Labor Market and Economic Analysis Branch, Olympia, Washington, page 26.

Dam, which will result in a 3-foot rise above current water level in Cle Elum Lake. On average, the reservoir elevation will be 2 to 4 feet higher than current conditions during the recreation season (Reclamation, 1987).

Alternative 1 increases the water supply and can help fill in shortages. Based on the historic hydrologic record, about 79 percent of the time, Alternative 1 would have had little or no impact. However, when riverflows need to be prorated, impacts from this alternative would be positive. Divisions most impacted include Kennewick, Roza, and Kittitas because more water could be delivered during the prorated years. Because the Wapato Irrigation Project would experience no changes in diversions, the Yakama Indian Nation would experience no impact. Table 4-16 shows the effects of this alternative for each $1-million change in agricultural output.

Alternative 2A Economic Impacts

Alternative 2 implements irrigation conservation components in addition to the Alternative 1 measures. These additional components are designed to meet target flows of 300 to 600 ft^3/s and may result in reduced water availability for diversions. Alternative 2 has three parts—A, B, and C—that reflect different assumptions toward meeting water conservation measures. Alternative 2A assumes that all diversions will be reduced by about 7.5 percent, except for Wapato and Yakima-Tieton Canals. With reductions spread over most of the irrigation divisions at a level of 7.5 percent, these changes likely can be absorbed by increased efficiency of water delivery, such as lining canals and removing competitive vegetation, or other changes. The Yakama Indian Nation would experience no impacts because the changes in diversions do not include the associated irrigation district.

Alternative 2B Economic Impacts

Alternative 2B assumes a higher level of diversion reductions (15 percent) to divisions producing higher valued crops, on average. This alternative affects Roza Canal and canals downstream from Roza Canal, again excepting Wapato and Yakima-Tieton Canals. The Basin Conservation Program would need to offset this loss in diversions to avoid reducing deliveries to farmers. Otherwise, acquiring water rights may be necessary to achieve the level of reduction. Acquiring water rights would lead to economic impacts, and table 4-16 shows the impacts for each $1-million change. As before, diversions to the Yakama Indian Nation would not be affected by this alternative, and no impacts would occur.

Alternative 2C Economic Impacts

Alternative 2C assumes that only Roza and Sunnyside Divisions will receive reductions in diversions at a 21-percent level. These irrigation districts likely cannot absorb a reduction of this level through only water conservation measures. It is unlikely that these irrigation districts could absorb a reduction of this level through only water conservation measures,

and this alternative may be difficult to put into practice without reducing deliveries to farms. Acquiring water rights would lead to economic impacts, and table 4-16 shows the impacts for each $1-million change. No other divisions, including the Yakama Indian Nation, would be impacted.

Alternative 3 Economic Impacts

Alternative 3 is similar to Alternative 2A except that the Kachess augmentation and tributaries programs have been removed. As in Alternative 2A, it is assumed that this level of reduction in diversions can be absorbed through various efficiency gains and would lead to no change in agricultural production for these divisions. The divisions which would not have changes in diversions, including water deliveries to the Yakama Indian Nation, would not have impacts either.

Power Reduction Economic Impacts for Action Alternatives

Power production is also impacted by the action alternatives because power is produced with water diverted at the Roza and Chandler diversions. A third powerplant receives water from the Wapato Diversion Dam, but the changes in production are so minimal that the impacts are not measurable by this analysis. Electrification of the hydropumps at Chandler Power Plant will reduce the demand for water to drive the pumps while slightly increasing power demand. The impacts to power production occur because of changes in the timing of flows; during years of drought, power generation has been subordinated. The annual net generating output for these powerplants totaled about 115,000 MWh in 1992 according to Reclamation's *1992 Summary Statistics*, with power generation fluctuating year to year. As shown in table 4-17, the proposed alternatives would change power generation from about 4,900 to 7,500 MWh, or by 4.2 to 6.5 percent from the 1992 output. Power generation can be purchased or sold on the network in the Pacific Northwest. The average value of electricity within this region is around $12 per MWh but varies greatly depending on the demand at the moment and time of day.

Alternative 1 would impact power generation the least. Roza Power Plant would reduce generation by 1,700 MWh; Chandler would generate an increase of 6,600 MWh, producing a net increase of 4,900 MWh. At $12 per MWh, this change totals $58,000. The other alternatives would generate positive changes at both powerplants. Alternative 2A would generate an additional 5,800 MWh, equal to a value of $69,000. Alternative 2B would generate 5,800 MWh, worth $70,000. Alternative 2C would generate an additional 4,200 MWh, at a value of $51,000. Alternative 3 would create an additional 7,500 MWh, worth $90,000 on average. These values are shown in table 4-17.

Receipts to Local Governments

The State of Washington exacts a 6.5-percent tax on retail sales, excluding food. The State sales tax provided $6.3 billion in revenues to Washington in 1992, 75 percent of total State Government receipts that year (U.S. Bureau of the Census, 1994b).

The estimates of changes to sales revenues, resulting from the proposed action alternatives shown in table 4-16, understate the gross impact to sales revenues because data for the wholesale and retail trade sectors are sales margins, the difference between purchase price and sales price, rather than gross sales volume.

4.10 Recreation

4.10.1 Summary of Impacts to Recreation

Impacts to recreation are summarized in table 4-18.

Changes in project operations could affect recreation patterns, timing, or opportunities afforded for particular activities if project operations were dramatically altered from April through September, and if these changes affected access and facilities or substantively altered the physical setting in terms of water elevation or flow rate. However, most recreation has historically occurred higher in the system (upper basin) and would probably not be measurably affected on a basin-wide scale.

Recreation use of reservoirs would benefit from increased storage capacity; however, operational changes would probably have a more measurable effect on patterns of use. The proposed changes in operational withdrawals would probably have no measurable effect on recreation activities. Site-specific impacts to recreation would be evaluated in a NEPA document tiered to this PEIS.

Modifying the radial gates on Cle Elum Dam will result in a 3-foot rise in Cle Elum Lake. Facilities at Wish Poosh Campground will be relocated. On average, the reservoir elevation would be 2 to 4 feet higher than current conditions during the recreation season, depending on when the increased storage is used for instream flows. Higher summer elevations would have a minor overall positive effect on recreation at Cle Elum Lake because boat launch ramps would remain operable for a slightly longer period of time, mudflat exposure would be slightly reduced, and shoreline access to the campgrounds and picnic areas would remain at a convenient distance for a longer period of time (Reclamation, 1987).

Improved streamflows would, on a basin-wide scale, benefit flow-dependent and water related recreation activities. Recreational fishing opportunities in the mainstem Yakima and Naches Rivers could be improved if resident fish populations increased.

Table 4-18.—Summary of impacts to recreation

No action	Alternative 1	Alternative 2A (preferred alternative)	Alternative 2B	Alternative 2C	Alternative 3
Primary recreation activities include fishing the reservoirs and rivers for cold water sport species, white-water boating and kayaking, motorized boating, and other related activities such as camping, hiking, picnicking, and wildlife viewing.	No measurable impact.	Implementing the Basin Conservation Program could increase instream flows slightly, which could benefit flow-dependent recreation. Reservoir recreation would not be affected.	Generally, same as Alternative 2A. Reservoir recreation would not be affected.	Generally, same as Alternative 2A. Reservoir recreation would not be affected.	Generally, same as Alternative 2A. Reservoir recreation would not be affected.

Increased streamflows in tributaries for fish and wildlife could provide a benefit for passive recreation activities such as birdwatching, nature study, walking, or photography. Water supply enhancement opportunities in other tributaries have not been identified but, in general, passive recreation benefits could accrue for these activities. Recreational fishing opportunities would also benefit from increased streamflows because more habitat would be created for resident fish.

Under pre-Title XII operating criteria, the river system would be operated at present levels and target flows. Lakes (Keechelus, Kachess, Cle Elum) on the Yakima arm are drawn down in summer and early fall, and Rimrock Lake on the Naches arm is drawn down in September.

4.10.2 Discussion of Impacts to Recreation

Methods and Rationale

Specific impact identification will be left to various site-specific studies where data collection methods could measure physical and social resource changes. Criteria used to evaluate potential recreation impacts were reservoir elevation (feet) and streamflows (ft^3/s).

No Action Alternative Impacts to Recreation

The No Action Alternative would increase the amount of water released over Sunnyside Dam from pre-Title XII conditions. Basin recreation would not be affected by the No Action Alternative mainly because opportunities for water-based or flow-dependent activities do not exist in this section of the river. Public access to the river is limited, and few facilities exist.

In the upper areas of the basin, recreation use has existed and adapted to project operations. Flow-dependent recreation would continue to be influenced by project operations such as the "flip-flop" (see Section 3.2.2 "Pre-Title XII Operations (Before 1995) and Model Considerations"), but no changes would be expected in patterns, timing, or type of use.

Reservoir-based recreation activities as discussed in chapter 3 would not change from pre-Title XII conditions.

Alternative 1 Impacts to Recreation

Although slight changes may occur, instream flows where recreation occurs would experience no measurable impact with implementing Alternative 1 compared to the No

Action Alternative. Historical averages of reservoir elevations show no measurable changes from the No Action Alternative; therefore, reservoir-based recreation activities would not be impacted. Therefore, recreation resources would not change.

The Kachess augmentation could improve the quality of reservoir-based recreation by holding additional water in Kachess Lake later in the season. More water would also remain in Keechelus Lake. Specific recreational benefits would need to be determined and presented in a NEPA document tiered to the PEIS. However, measurable changes from the No Action Alternative are not apparent.

Alternative 2A Impacts to Recreation

Implementing the Basin Conservation Program could increase instream flows where recreation occurs slightly, which could benefit flow-dependent recreation.

Historical averages of reservoir elevations show no measurable changes from the No Action Alternative; therefore, reservoir-based recreation activities would not be impacted.

Alternative 2B Impacts to Recreation

If instream flows where recreation occurs could be slightly improved, flow-dependent recreation could benefit. However, any changes would probably not be measurable.

Historical averages of reservoir elevations show no measurable changes from the No Action Alternative; therefore, reservoir-based recreation activities would not be impacted.

Alternative 2C Impacts to Recreation

If instream flows where recreation occurs could be improved through implementing the Basin Conservation Program, flow-dependent recreation could benefit.

Historical averages of reservoir elevations show no measurable changes from the No Action Alternative; therefore, reservoir-based recreation activities would not be impacted.

Alternative 3 Impacts to Recreation

Generally, impacts are the same as those discussed for Alternative 2A.

4.10.3 Mitigation for Recreation

Construction at Wish Poosh Campground consists of moving one vault toilet to higher ground, riprap protection at the boat ramp, and raising a section of the access road to the boat ramp (Reclamation, 1987).

4.11 Cultural Resource Properties and Paleontological Resources

4.11.1 Discussion of Cultural Impacts

No Action Alternative

The No Action Alternative would cause no new impacts upon identified or anticipated cultural resource properties, including traditional cultural properties (TCPs), because no new Federal undertaking would occur. Effects presently occurring to cultural properties would continue from ongoing uses and operations. Similarly, paleontological resources (if any are present) would not be impacted.

Action Alternatives

New construction actions or changes in present operations or use resulting from implementation of YRBWEP have the potential to adversely affect cultural resource properties or TCPs that are eligible for the National Register. The actual locations of many implementation actions are not presently identified. Therefore, the discussion of effect will primarily identify types of effects from anticipated kinds of actions rather than offer site-specific discussions of impacts.

Effects Upon Historic Structures.—As indicated in Section 3.11 "Cultural Resource Properties and Paleontological Resources," many of Reclamation's facilities have been determined eligible for, or are anticipated to be eligible for, the *National Register of Historic Places* (*National Register*). Physical alterations to the facilities could cause an adverse effect upon the structure's historic integrity. The adverse effect would occur if changes in the appearance, physical material, operational characteristics, or setting of the structure are of sufficient scope to cause loss of "historic integrity." Modifications to Kachess Dam outlet channel were of sufficient scope that they were determined to have an adverse effect upon the dam's historic integrity. Altering the outlet works or embankment for Cle Elum Dam for the 3-foot raise would cause adverse effects upon the dam's historic integrity, as would similar alterations to other storage or diversion structures. Relocation, piping, or lining formerly unlined segments of historic canals could cause an adverse effect if sufficiently large segments of any single canal were altered. Reclamation will assess the effect of proposed alterations at each facility when they are more clearly defined and will consult with the Washington State Historic Preservation Office (SHPO) about the effect upon *National Register* eligible facilities.

Effects On Archeological Sites and Traditional Cultural Properties.—Archeological sites and TCPs can be damaged or destroyed by any action that disturbs the soil matrix or surface that contains the site or the TCP resource. Project-associated ground-disturbing actions that could have an adverse effect upon these properties include:

- Construction to modify existing (or build new) storage, diversion, or delivery facilities
- Activities to improve habitat conditions; relocation of recreational facilities
- Creation of access roads or use of staging areas associated with construction
- Raising the elevation of a reservoir or other water feature above its historic elevation

Excavation to widen the Kachess outlet channel cut through an area that contained an archeological site and a sacred site, and associated access roads and stockpile areas affected other sites. Reclamation completed additional archeological surveys and test excavations in potential areas of impact to determine if archeological sites were present and if they were eligible for the *National Register*. Site eligibility was determined in consultation with the SHPO, and the effects of associated construction actions were determined in consultation with the SHPO and the Yakama Indian Nation. Consultations were also completed with the Yakama Indian Nation to determine if TCPs or other sensitive resources were present.

Raising the elevation of Cle Elum Reservoir 3 feet is likely to have an adverse effect upon archeological sites and perhaps also upon TCPs. Prior surveys within the reservoir pool have indicated a high probability that significant archeological sites are present. Raising the pool will initiate a new round of bank erosion that will continue until the banks stabilize at the new elevation. If archeological sites or TCPs are present within the bank areas that are eroded, they will be damaged or destroyed by the erosion. Raising the pool may also result in relocation of privately owned cabins, public recreational areas, and associated roads and utilities. If archeological sites or TCPs are present within the areas these facilities are moved to, then they are likely to be damaged by associated construction and by changes in use patterns. An archeological survey and TCP inventory will be completed around the pool perimeter to the anticipated point of erosion and at locations where affected facilities may be moved.

Reclamation will implement the requirements of Section 106 of the National Historic Preservation Act for all potential impact areas. When an action is identified and the area of potential effect known, Reclamation will determine if an archeological survey or TCP inventory needs to be completed. Reclamation will complete an archeological survey of all potential impact areas that have not been previously surveyed and where prior disturbance does not prohibit the presence of intact archeological deposits. Reclamation will consult with appropriate Tribes to determine if TCPs might be present in the impact area and will implement necessary inventories when necessary. If archeological sites or TCPs are found,

then necessary actions will be completed to determine if they are eligible for the *National Register*. Consistent with 36 Code of Federal Regulations (CFR) 800, consultations will be completed with the SHPO to determine if sites within potential impact areas are eligible for the *National Register* and to assess the project effect upon the eligible sites. Other interested or affected parties will be invited to participate in these consultations, consistent with Reclamation policy and 36 CFR 800. Interested parties will include the Yakama Indian Nation and other owners or managers of affected lands.

Paleontological Resources

There is a low probability that paleontological resources might be present at some reservoir locations at the north end of the Yakima Project. However, paleontological materials are not likely to be affected by the kinds of actions proposed because most will impact only shallow deposits. When Reclamation completes archeological investigations, the surveyors will be instructed to record fossil materials whenever noted and collect a sample for examination by a professional paleontologist. Further investigations will occur only if the paleontologist indicates the resource is likely to be of scientific value and if Reclamation determines that it is likely to be adversely affected by the proposed action.

4.11.2 Mitigation for Cultural Resource Properties

No Action Alternative

No mitigation actions would occur because no Federal undertaking would take place.

Action Alternatives

Reclamation's policy is to avoid adverse effects upon historic properties whenever possible. When avoidance is not possible, Reclamation seeks means to minimize the effects and mitigate the remaining effects consistent with standard professional practices defined in the *Secretary of the Interior's Standards and Guidelines*.

Historic Structures .—Where modification to historic structures cannot be avoided, then action will be taken to design the modifications to minimize the adverse effects. Examples of minimizing the adverse effects include designing new or replacement elements to be visually and structurally compatible with the historic facility or situating new intrusive features in unobtrusive locations. If these actions do not sufficiently minimize the adverse effects, then Reclamation will typically provide portions of or complete Historic American Buildings Survey or Engineering Record (HAER) documentation. The level of documentation needed will be determined in consultation with the SHPO and, if necessary, with the Advisory Council on Historic Preservation, consistent with the process defined in 36 CFR 800. Where appropriate, Reclamation may also further mitigate the adverse

effects by preparing educational materials presenting the historic data for the public. This mitigation generally involves placing interpretive display panels either at the facility or at an area facility that receives public use and is relatively protected from vandalism.

The channel widening modifications at Kachess Dam were determined to be an adverse effect upon the historic integrity of the dam. Reclamation minimized the adverse effects of the modifications through sensitive design of replacement structures and mitigated the remaining adverse effects by HAER documentation of Kachess Dam. The mitigation terms were determined in consultation with the SHPO. Reclamation anticipates that HAER documentation will also be completed to mitigate modifications to Cle Elum Dam. Reclamation cannot yet determine if mitigation will be necessary for other affected facilities.

Archeological and Traditional Cultural Properties.—As indicated above, Reclamation will first seek to avoid adverse effects and then to minimize unavoidable effects. In consultation with the SHPO, Advisory Council on Historic Preservation, the appropriate Indian Tribes, and affected landowners or managers, Reclamation will determine if minimization or mitigation actions are needed and the methods to be used. The consultation process will be consistent with the requirements of 36 CFR 800 and Reclamation policy.

Site avoidance is generally accomplished by relocating the damaging activity to a place without cultural resources value. Sometimes, direct effects to archeological sites can be avoided by using protective geotextile to cover the site and adding several feet of fill. Activities can then take place on top of the fill without damaging the site. This method can protect sites from surface erosion from reservoir operation and prevent relic collection.

The nature of mitigation depends upon the resource type and value. For archeological sites, mitigation would typically be scientific excavation of a portion of a site or sites, with the resulting data made available to researchers or interpreted for the public. Archeological site mitigation can also include site stabilization through armoring eroding shorelines or burying endangered surfaces. Mitigation can also occur through interpretation of scientific or other recovered information for the public. For TCPs, mitigation may be more varied. If the TCP consists of a harvestable resource, then mitigation might consist of either transplanting the resource to a protected location or setting aside and protecting other nearby lands that have the same resource. Some TCPs may have values that cannot be moved to or found in other locations. Consultation would be used to determine if other appropriate methods of mitigation exist for those resources.

Archeological materials collected during any YRBWEP investigations will be either returned to the landowner (private or Federal) or will be curated by Reclamation in a facility that meets standards defined in 36 CFR 79.

Paleontological Resources.—Reclamation does not anticipate that significant paleontological deposits will be found in potential project impact areas. However, if such were found, Reclamation would contract with a professional paleontologist to recover a sample of the fossil deposit and prepare an analysis of the material. This information would be presented to researchers and interpreted for the public. Recovered samples would be curated for long-term protection and research access. If the source was on Federal land and was of particular scientific value, Reclamation would consider protective measures if they were feasible.

4.12 Sacred Sites

No Action Mitigation for Sacred Sites

No mitigation actions would occur because no Federal undertaking would take place.

Action Alternatives Mitigation for Sacred Sites

Possible impacts to sacred sites on Federal lands cannot be determined at a programmatic level for any of the action alternatives. Reclamation will consult with potentially affected Tribes during the planning phase of specific actions to determine if sacred sites exist and will be affected. If specific impacts are identified during the evaluations conducted for site-specific actions associated with Title XII implementation, Reclamation will consult with the affected Tribes on a government-to-government basis to avoid, minimize, or mitigate effects.

4.13 Indian Trust Assets

4.13.1 Summary of Impacts to Indian Trust Assets

Impacts to Indian Trust Assets are summarized in table 4-19.

Conditions for the proposed actions would undergo little impact under Alternative 1.

The effect of Alternatives 2A, 2B, 2C, and 3 would be positive because of increased instream flows at critical periods of time in the river. Additional water in the Yakima River at critical periods would have a positive effect on chinook salmon runs. Secondarily, increased flows would have a positive effect on wildlife of the area.

The impacts on other ITAs cannot be determined until specific actions are implemented. When unable to avoid adverse impacts to ITAs, Reclamation will provide appropriate mitigation or compensation.

Table 4-19.—Summary of impacts to Indian Trust Assets

No action	Alternative 1	Alternative 2A (preferred alternative)	Alternative 2B	Alternative 2C	Alternative 3
May not be adequately protected.	Indian Trust Assets under Alternative 1 would undergo little impact.	Positive impacts due to increased flows.	Generally, same as Alternative 2A.	Generally, same as Alternative 2A.	Generally, same as Alternative 2A.

4.13.2 Discussion of Impacts to Indian Trust Assets

Methods and Rationale

Indian Trust Assets are defined as legal interests in property held in trust by the United States for Indian Tribes or Indian individuals. Common examples of ITAs include hunting and fishing rights, water rights, lands, minerals, and other natural resources. Although most ITAs are located on Reservations, they can also be located off Reservation.

Actions considered in this PEIS and specified in Title XII involve changes within the river basin to specific operations and provisions for modifying Basin Conservation Program, and Yakama Indian Nation provisions.

With respect to the operation and modification of facilities, the evaluation and analysis of ITAs focused primarily on different operational hydrologic scenarios for the Yakima River and tributaries within the basin. Reclamation developed a hydrology model to simulate different scenarios. However, any proposed modifications to existing facilities, for the most part, are located upstream from the Reservation and would have little impact on ITAs.

Nevertheless, changes in streamflows at specific locations could have an effect, either beneficial or adverse, on surface water conditions and specific ITAs, including the following: (1) fishing, through potential changes in anadromous fish habitat; (2) hunting, through possible changes in habitat for certain wildlife species that depend on streamflows for needed surface water supplies; and (3) gathering, through potential changes in specific types of riparian vegetation. Potential changes to simulated streamflow conditions are addressed in Section 4.2 "Surface Water Hydrology."

Guidelines, criteria, and specific water conservation measures for the Basin Conservation Program are under development. At the present time, estimating specifically what effect such guidelines and water conservation measures would have on surface and groundwater supplies and any potential impacts on ITAs is impossible.

The simulated conditions would result in a reduction in stream diversions of 7.5 percent basin-wide for Alternative 2A, a 15-percent reduction in diversions below Roza for Alternative 2B, and a 21-percent reduction in diversions from the Roza and Sunnyside Canals for Alternative 2C. These criteria were used for analysis of water conservation measures on ITAs. A more detailed analysis will need to be conducted when more specific information becomes available.

Several studies have been conducted focusing on the Yakama Indian Nation (i.e., Wapato Irrigation Project, Toppenish Creek Corridor enhancement project, and an Irrigation Demonstration Program on the Reservation). Title XII specifies that a grant of about $23 million will be provided to the Tribe for either improving or developing the three areas mentioned above.

However, at this time, specific actions to be undertaken on the Reservation are uncertain. Once more finalized plans are completed, further analysis would be needed to assess impacts on ITAs.

No Action Alternative Impacts to Indian Trust Assets

The No Action Alternative is the baseline condition for comparing other action alternatives. The No Action Alternative assumes the operation of existing and future facilities that are certain to be modified or constructed throughout the life of the project. It is assumed that water resource facilities will be operated in accordance with operating rules and criteria that are currently in effect as of September 1996.

Unless specific new policies are identified, the No Action Alternative is based on a continuation of existing policies and management intensity. The current policy of the United States toward Indian affairs stresses self-determination. In implementing this policy, the Bureau of Indian Affairs (BIA) is directed to assist and support Indian Tribes and individuals to facilitate self-determination. This support may include assistance in development of asset lands, including the development of water supply facilities, other utilities, shelter, and agriculture.

Identification of specific impacts or improvements that might occur to ITAs is not possible at the programmatic level of analysis. However, BIA is anticipated to continue to assist the Tribe and individual members to help develop ITAs on or near the Reservation. Changes in the trust and fee status of Indian lands on the Reservation are impossible to estimate. Therefore, the lands currently held in trust are assumed to be held in trust in the No Action Alternative condition.

Alternative 1 Impacts to Indian Trust Assets

Indian Trust Assets conditions would undergo little impact under this alternative. Table A-3, in Appendix A "Surface Water Hydrology," shows riverflows at selected stations along the Yakima River. As can be seen, the amount of water in the river when compared to the No Action Alternative is relatively similar for each month of the year.

Alternatives 2A, 2B, 2C, and 3 Impacts to Indian Trust Assets

The effect on ITAs for Alternatives 2A, 2B, 2C, and 3 would be positive. With respect to ITAs, these alternatives are similar and, therefore, are lumped together for analysis. The positive effect on ITAs would result from increased instream flows at critical periods of time in the river. Table A-3 in appendix A shows the increased flows and the months when

these increases would occur. Additional water in the Yakima River at critical periods would have a positive effect on chinook salmon runs. Secondarily, increased flows would have a positive effect on wildlife of the area.

4.14 Cumulative Impacts

Cumulative impacts are those effects on the environment resulting from the incremental consequences of a proposed action alternative when added to other past, present, and reasonably foreseeable future actions, regardless of who undertakes these actions. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time. No significant impacts have been identified at the program level for any proposed alternative. Minor (nonsignificant) effects or significant localized effects may contribute to cumulative effects.

The proposed action would not be implemented in a vacuum. Implementation would occur with other actions, events, and trends taking place at local and regional levels. For purposes of this discussion, these other actions are generated by five major entities: (1) Federal agencies, (2) the State of Washington, (3) other governmental agencies, (4) nongovernmental organizations, and (5) private individuals. Each of these groups will continue to initiate actions that will affect the environment through the foreseeable future.

These entities may coordinate their efforts with Reclamation through cooperative programs and efforts or through technical assistance from one or more Federal agencies. Some of the activities that these entities are carrying out which would have cumulative effects include:

- Acquisition of land by other Federal and State agencies as well as private organizations
- Protection of air and water quality and quantity
- Cleanup of contaminant problems by other Federal and State agencies
- Implementation of agricultural programs to encourage improvements in onfarm management practices and techniques
- Land and water management and management of resource uses by governmental agencies and nongovernmental organizations, and the protection and recovery of special status species such as anadromous fish through the Endangered Species Act and State laws

Other changes that are now affecting (and will continue to affect and transform) communities in the Yakima River Basin are:

- Regional population growth
- Changing demographics
- Economic competition and restructuring
- Changing laws, policies, and practices implemented by other Federal and State agencies

4.14.1 List of Pertinent Activities and Trends

The following activities affect some or all of the same resource areas that are potentially affected by the action alternatives. Land and water resources, water quality, biological resources, and socioeconomic resources are all affected, directly or indirectly, by these activities. Their inter-relationships are complex and not fully understood. Together, these activities may have more impact than the action alternatives.

- The Northwest's salmon restoration program has already accelerated the implementation of water conservation in an effort to provide instream flows without depriving existing irrigation farmland.
- The Environmental Protection Agency is undertaking a new watershed approach to ecosystem management.
- The U.S. Geological Survey will be implementing the National Water Quality Assessment Program in the Yakima River Basin. This program assesses the status or condition of waters throughout the United States and identifies trends, possibly providing guidance to the development of Federal, State, and local water quality and conservation plans.
- The U.S. Forest Service has implemented major new fisheries protection programs, and FWS is also improving its fisheries program to achieve greater efficiency.
- Under the Columbia River System Operation Review, a joint review of Columbia River management by Reclamation, the U.S. Army Corps of Engineers, and Bonneville Power Administration (BPA); a final environmental impact statement; and a record of decision have been completed. These documents present the potential environmental impacts associated with a number of alternatives to operate the existing system to provide more balance in resource benefits.
- The U.S. Department of Agriculture's crop price support system is an ongoing program throughout the United States to support agricultural production.

- Yakima River Basin populations are increasing.
- The basin has experienced recent drought conditions and could experience these conditions in the future.
- Listing of and recovery efforts for endangered and threatened species are ongoing.
- Acreage of riparian and wetlands habitats is decreasing.
- The market determined price of agricultural commodities and land.
- NRCS is implementing National Water Quality Assessment Programs.
- NRCS Irrigation Water Management Programs—These programs monitor and evaluate onfarm irrigation systems, including management. Cost sharing and grants are used to fund needed structural improvement to improve onfarm water management.
- Columbia River Fish Management Plan—This program directs fishery enhancement efforts by rebuilding upper Columbia River chinook, sockeye, coho, and steelhead runs, while assuring an equitable sharing of harvestable fish between treaty and non-treaty fisheries. Habitat improvement work throughout the Yakima River Basin has been performed by Federal, State, Tribal, and private entities.
- Yakima River Basin Fish Passage and Protective Facilities—Reclamation participated with the BPA in the implementation of congressionally authorized fish passage improvements within the Yakima River Basin, including fish screens and ladders. Phase 1 was completed by fall 1989. Phase 2 includes improvements to existing fish screens and installation of new screens at up to 66 sites.
- Yakima Fisheries Project—BPA will fund this project to undertake fishery research and enhancement activities in the Yakima River Basin with the State of Washington and the Yakama Indian Nation. These activities will include the construction, operation, and maintenance of anadromous fish production research facilities to enhance knowledge of supplementation techniques and to apply to the rebuilding of natural spawning anadromous fish stocks historically present in the basin.
- YVCOG Yakima River Basin Water Quality Plan—In August 1990, the WDOE awarded a grant to the YVCOG as lead agency to develop a basin-wide water quality management plan for the Yakima River Basin.

4.14.2 Impacts to Specific Resources

Any alternative involving the implementation of the Basin Conservation Program could have a comparatively significant effect on aquatic resources within the Yakima River Basin at a localized level. However, analysis of the inter-relationship of each specific action is beyond the scope of these alternatives. The specific role played by this action, when added to the cumulative effects of all the other activities affecting the West as a whole and the Yakima River Basin specifically, is not likely to be more than slightly measurable.

Cumulative impacts of the alternatives on the resource areas, when added to other actions, are summarized below.

Surface Water Hydrology

Currently, the trend throughout the West is to conserve water, with most saved water going to firm up district water supplies. This trend is also true for the Yakima River Basin. However, all action alternatives promote and require water conservation in various degrees by willing participants in the program. A portion of the saved water would be used to firm up water supplies, and the remainder would be allocated to instream flows for anadromous fishery enhancement as mandated by Title XII.

Potential impacts on the instream target flows at Parker and Prosser generally vary from no impact to, in a few cases, a major impact. The potential impact of action alternatives taken over the 1926 to 1994 average and the 1994 dry year on many of the hydrology indicators, shortages, and instream flow releases would range from minor (in most cases) to major (in a few instances). Many impacts would not be measurable. However, the major beneficial impacts primarily fall in the category of instream flows, which is one of the major aspects of Title XII. Potential impacts on specific canal diversions for dry or proratable years are mostly in the category of not measurable.

Man's activity in the Yakima River Basin has changed the magnitude and timing of streamflows, as described in Chapter 3, "Affected Environment." Title XII is intended to alleviate the effect of man's activity to an extent, particularly on the low-flow portion of the annual hydrological regime, without adversely impacting existing agricultural activity.

Alternative 2A provides increased flows at the Title XII target locations (Sunnyside Dam and Prosser) while decreasing shortages to irrigation, thus addressing the purpose and need delineated in Title XII. Other activities anticipated in the basin are generally intended to enhance flow and conserve water as well. The cumulative impact from this action will be to increase streamflows and firm up water supply for irrigation and other uses.

Surface Water Quality

The quality of water resources in the Yakima River Basin, and the West as a whole, has declined from historic levels as a result of development in the basin. The total maximum daily load regulatory process and other institutional and physical actions, are designed to improve water quality. Implementing Alternative 2A would likely result in at least slowing the historical decline in water quality in the Yakima River Basin. For this, as well as the other action alternatives, some improvement in the Yakima River is possible for sediment, nutrients, and pesticides. Benefits of Alternative 2A would accrue below Parker; benefits would be concentrated below Roza with Alternative 2B and below Roza and Sunnyside with Alternative 2C. Water quality benefits with Alternative 3 would be similar to Alternative 2A.

Groundwater

Groundwater levels may decline with implementation of any of the action alternatives involving the Basin Conservation Program and water rights acquisition because of a significant reduction in recharge of the upper aquifers from reducing irrigation diversions. This decline could impact wells that tap into these aquifers in localized areas.

Agricultural Resources

The amount of land being irrigated has been declining. This decline stems from many factors, including economic, population, and agricultural changes. Water rights buyouts would probably be used to implement the Basin Conservation Program at some level, resulting in converting some lands to dryland agriculture, rangeland, or other nonagriculture use. Under Alternative 2 (2A, 2B, and 2C) and Alternative 3, more lands could be converted to urban/suburban use, slightly increasing the overall trend toward land conversion. The more land retirements, the larger this effect could be. Alternative 2A would not appreciably affect that trend but may cause a slight increase in the rate of reduction. Alternatives 2B and 2C would likely cause an even greater increase in the rate of reduction of irrigated land by providing for a much larger reduction in irrigation diversions through the implementation of water conservation and efficiency methods and purchase of water rights from willing sellers. In addition, crop types may change because of decreased irrigated land acreages and a more dependable water supply.

Fish

Salmon and steelhead resources in the basin have declined due to various past activities associated with general development in the basin. Expected future human population growth and associated development within the basin will continue to place pressure on aquatic ecosystems and, therefore, salmon and steelhead. Simultaneously, several past, present, and future activities, such as those listed at the beginning of this section, are

geared to protect and restore salmon and steelhead. Implementation of Alternative 2A would tend to act synergistically with other ongoing salmonid restoration efforts in the basin, thereby improving the probability that salmon populations will increase in the future.

Vegetation and Wildlife

Riparian and wetland habitats, and associated wildlife, have been adversely impacted throughout much of the basin due to general development. Expected future human population growth and associated development within the basin will continue to adversely impact remaining riparian and wetland habitats. At the same time, Federal, State, and local agencies, and private individuals, support various riparian and wetland habitat improvements throughout the basin. Alternative 2A could benefit vegetation and wildlife, especially if an integrated Wetlands and Floodplain Habitat Plan is developed as recommended in the Basin Conservation Plan. Alternative 2A should contribute to other, local habitat improvement efforts in the basin.

Threatened, Endangered, and Special Status Species

Cumulative impacts associated with threatened and endangered species will be evaluated on a site-specific basis as part of tiered-down compliance.

Socioeconomic

Population trends will continue in the Yakima River Basin regardless of the alternative selected. Increasing populations represent a major factor of possible effects in the socioeconomic area. Smaller effects for any action alternative, both negative and positive, would be possible in the areas of employment, agricultural production and value, and social well-being. The level of impact on these areas would depend on the specific type and quantity of water conservation measures that are ultimately implemented in the basin.

Recreation

Implementing any of the action alternatives is not likely to appreciably alter existing general trends. The demand for recreational opportunities will continue to increase with population increases.

Cultural Resources Properties and Paleontological Resources

Activities associated with implementing water conservation plans could adversely affect cultural resources. Historic properties, including early Federal irrigation projects, will be

adversely affected because proposed implementation items will include the alteration of existing designs. However, the significance of these impacts from a cumulative perspective cannot be determined at the program level but will be examined on a site-specific basis as new facilities and changes to existing facilities are designed and water conservation plans are developed and implemented.

4.15 Unavoidable Adverse Impacts

Unavoidable adverse impacts are environmental consequences of an action that cannot be avoided either by changing the nature of the action or by mitigation if the action is undertaken. Unavoidable adverse impacts must be disclosed. This Federal action will not cause unavoidable adverse impacts.

4.16 Irreversible and Irretrievable Commitments of Resources

Irreversible commitments are decisions affecting renewable resources such as soils, wetlands, and riparian areas. Such decisions are considered irreversible because their implementation would affect a resource that has deteriorated to the point that renewal can occur only over a long period of time or at a great expense, or because they would cause the resource to be destroyed or removed. The proposed actions will not cause irreversible commitments of resources.

Irretrievable commitments of natural resources occur when a decision causes a loss of production or use of resources. They represent opportunities foregone for the time that a resource cannot be used. The primary impacts that would be irretrievable are those involving physical processes and resources. Some elements of the alternatives described herein may commit resources locally on a long-term basis.

Water could be considered an irretrievable resource in the context that it would be lost to certain purposes not included within the operational scope of the alternative ultimately chosen for implementation. For example, if water under a given scenario is used to provide more instream habitat for anadromous fish, that water may not be available for other uses such as the irrigation of crops, municipal and industrial uses, etc.

4.17 Short-Term Use Versus Long-Term Productivity

This analysis examines the relationship between short-term use of environmental resources and the maintenance and enhancement of long-term productivity. The development and implementation of water conservation plans could have a short-term negative economic impact on some water districts. However, the economic impact should stabilize once the plans are established, as plans will only be modified periodically. In

addition, the Basin Conservation Program associated with Title XII provides for cost-share assistance in developing and implementing these plans and, as such, would further limit the magnitude of the economic impact.

Implementing any of the proposed alternatives and associated elements of Title XII will provide a long-term benefit to fisheries and aquatic resources in the Yakima River Basin. Society, in general, in the Yakima River Basin, and to some degree outside the basin, will benefit from this implementation. In addition, the agricultural community will receive long-term benefits associated with improvement in the reliability of water supplies. A more detailed analysis of use versus productivity will be included with site-specific NEPA documents prepared for individual elements of Title XII.

Long-term positive effects for the Yakima River Basin as a whole are anticipated from the implementation of the water conservation component of this program.

4.18 Mitigation

At a broad, basin-wide level, no significant adverse impacts have been identified by this PEIS. General mitigation needs for vegetation and wildlife, recreation, and cultural resources are discussed in the appropriate sections of this document; however, no specific mitigation for the effects of the action alternatives are proposed at this time.

In the future, when a Federal action is proposed that tiers from, or is otherwise related to, implementation of the Title XII program, the anticipated site-specific impacts and their significance will be evaluated, and NEPA compliance will be conducted. This process will include development of appropriate mitigation plans. Any such action will also be subject to compliance with other Federal environmental statutes as well as with environmental statutes of the State of Washington.

Chapter 5

Consultation and Coordination

This chapter includes information on public involvement activities and coordination with State and Federal agencies, Native American Tribes, and private organizations that have occurred to date and activities that will occur during the processing of this document. In addition, this chapter serves as the public involvement summary report.

5.1 Public Involvement

Public involvement is a process by which interested and affected individuals, organizations, agencies, Native American Tribes, and governmental entities are consulted and included in the Bureau of Reclamation's (Reclamation) decisionmaking process. Through this process, members of the local community, affected groups and individuals in the Yakima River Basin, and interested Federal, State, and local agencies have been given an opportunity to voice any concerns and suggestions.

5.1.1 Scoping

The scoping process is an early and integral part of planning, environmental review, and documentation for an environmental impact statement (EIS). The process is designed to encourage the public and Government agencies to help identify issues and topics that should be addressed in the EIS.

The scoping process helps to:

- Identify issues, concerns, and possible impacts
- Identify existing information sources
- Develop alternatives

It is essential that the EIS team reflect concerns and desires of the public while analyzing impacts for consideration in this programmatic environmental impact statement (PEIS).

5.1.2 Notice of Intent to Prepare a PEIS

The notice of intent announcing Reclamation's plan to prepare a PEIS on the Yakima River Basin Water Enhancement Project (YRBWEP) was published in the *Federal Register* on May 23, 1995. In addition, legal notices announcing the time and location of the scoping meetings and process were placed in several of the Yakima River Basin newspapers. Also, an informational letter announcing the scoping meetings was sent to those individuals or entities on the project mailing list.

5.1.3 Public Meetings

The public scoping meetings were conducted by a small group of Reclamation staff from the Technical Service Center in Denver and the Upper Columbia Area Office in Yakima. The meetings were conducted in the following format:

- The meetings began with a welcome, introductions, and a purpose of meeting statement given by the study manager.
- The program manager gave a brief program overview.
- A National Environmental Policy Act (NEPA) specialist gave a presentation of NEPA and its relationship to the current PEIS effort.
- The study manager presented an overview of the alternatives being considered and discussed additional details of the study.
- A public involvement specialist explained the meeting format and guidelines and served as the facilitator for the question and answer portion of the meeting. Public input was recorded during the meeting.

Meeting dates, times, locations, attendance, and participation were as follows:

- A meeting was held in Yakima, Washington, on May 21, 1996, in the Red Lion Inn from 7:00 p.m. to 8:45 p.m. Four presentations were made, and comments were received.
- A meeting was held in Toppenish, Washington, on May 22, 1996, in the Yakama Indian Nation Seelatsee Auditorium from 7:30 p.m. to 8:35 p.m. Five presentations were made, and comments were received.
- Because of an apparent misunderstanding among several people concerning the location of the May 22 meeting, a third meeting was scheduled for June 25, 1997. That meeting was held in the Yakama Indian Nation Seelatsee Auditorium beginning at 7:30 p.m. However, no one came to the meeting. It was subsequently canceled with no presentations or comments made.

Key issues identified in public involvement activities and interagency team discourse have centered on the following:

- Question over whether this program would include funding for the restoration of streambanks as a habitat enhancement measure for fish and wildlife.
- Concern that the Yakima River Basin needs something more all inclusive or comprehensive than implementing the Title XII program can provide, such as issues the Yakima Basin Watershed Council is addressing.
- Concern that we seem to be repeating the same studies and processes over the years and not getting anything implemented that will solve the problems. Why don't we simply update the data we have and use the information to develop and implement the plans that will help solve the water problems in the basin?
- Concern that the irrigation water supply will be reduced as a result of implementing this program.
- Concern that the recreational aspects of the Yakima River, particularly jet boating in the canyon area, are being infringed upon by other special interest groups.
- Question of whether or not historical fish runs that were in the system 100 years ago can be re-established, or even whether the remnant that the system sustains now can be maintained.
- Concern over the deterioration of water quality in the Yakima River and the loss of wetlands in the Yakima River Basin.
- Concern over the ability to recharge the groundwater aquifers.
- Questions concerning probable floods that one could expect in the basin.
- Question concerning who pays for the power needed to run the turbines at the Chandler Power Plant after the electrification is completed.

Four public hearings on the draft PEIS were held in the Yakima River Basin. On June 2, 1998, hearings were held in Toppenish, Washington, on the Yakama Indian Reservation at Eagle Seelatsee Auditorium from 1:30 p.m. until 3:30 p.m. and from 7:00 p.m. until 9:00 p.m. No comments were received. One June 3, 1998, hearings were held at the Double Tree Inn, 1507 North First Street, in Yakima, Washington, from 1:00 p.m. until 3:00 p.m. and from 7:00 p.m. until 9:00 p.m. No oral comments were received. One written comment was received during the afternoon session, which is included in the comments and responses section in the attachments to this document.

5.1.4 Notice of Availability

The draft PEIS was filed with Environmental Protection Agency (EPA) and the Notice of Availability and Notice of Public Hearings appeared in the *Federal Register* on April 22, 1998.

5.2 Agency Consultation

5.2.1 Cooperating Agencies

As the lead agency, Reclamation has the responsibility for the development of this PEIS. Other agencies/entities that advised Reclamation of their desire to be cooperating agencies under the NEPA process include the Washington State Department of Ecology, the Bonneville Power Administration, the Bureau of Indian Affairs, the Natural Resources Conservation Service, and the Yakama Indian Nation. These agencies/entities have responsibility for implementation of the final plan for Title XII. In assuming this responsibility, these agencies and the Tribe agreed to perform the following duties:

- Participate in the NEPA process, including scoping.
- At the request of Reclamation, develop information and prepare environmental analyses, including portions of the PEIS on which the cooperator has specific expertise.
- At the request of Reclamation, make staff support available to the lead agency as a supplement to the lead agency's interdisciplinary capability.
- Review the draft and final PEIS.

Reclamation conducted followup discussions on the draft PEIS with cooperating agencies and EPA.

5.2.2 Interagency Coordination

A meeting was held on February 12, 1996, at the Reclamation Upper Columbia Area Office in Yakima, Washington, with representatives of several agencies/entities that are involved in related activities in the Yakima River Basin or who had an interest in the proposed program. The purpose of the meeting was to present information on the processes being considered for use in the YRBWEP effort and to gain feedback and suggestions on their ability to meet the goals and objectives of the PEIS as described in the plan of study. The following agencies and groups were represented:

- Environmental Protection Agency
- Bonneville Power Administration

- Bureau of Indian Affairs
- National Marine Fisheries Service (NMFS)
- U.S. Fish and Wildlife Service (FWS)
- U.S. Forest Service
- Washington State Department of Fish and Game
- Yakama Indian Nation
- Bureau of Reclamation
- Natural Resources Conservation Service
- Washington State Department of Ecology

The meeting generally followed the agenda and issues as presented below:

- An overview of the YRBWEP program was given by the program manager.
- The purpose of the PEIS and brief history of YRBWEP were presented by the study manager for the project.
- The YRBWEP plan of study and study scope were reviewed.
- NEPA compliance requirements were discussed among the group.
- A time schedule and task list were distributed to participants and discussed. The consensus of the group was that the tasks required to complete the PEIS had been adequately defined.
- The alternatives that had been developed were presented and discussed. It was generally agreed that the alternatives identified and the impact analysis approach described in the plan of study would adequately portray the historical, current, and future water scenarios in the basin.
- Expectations, roles, and responsibilities of cooperating agencies were discussed, as well as points of contact within Reclamation for coordinating technical and review input to the process.
- Reclamation's approach to public involvement was briefly discussed, which ended with general agreement that the approach was appropriate. It was mentioned that the first public meeting would help to define the level of public involvement required in the future, based upon level of participation and specific issues raised.

Agencies continued to be informed and received copies of the draft PEIS.

5.2.3 Fish and Wildlife Coordination Act

In accordance with Section 2(b) of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), FWS provided a Fish and Wildlife Coordination Act

Report on the Yakima River Basin Water Enhancement Project, dated October 3, 1996. The Fish and Wildlife Coordination Act Report addresses the various facets of Title XII. Recommendations contained in the report are listed below. All recommendations related to the project have been incorporated into the appropriate sections of the PEIS.

Recommendations to avoid or mitigate potential adverse impacts to fish and wildlife resources or enhancement of those resources are:

- Any construction efforts that may affect aquatic resources need to be conducted to prevent any adverse impacts to anadromous and resident fish.

- Opportunities to reduce the introduction of sediments and contaminants into the aquatic system need to be encouraged in the development of the Basin Conservation Program water conservation plans, Yakama Indian Nation projects, and any of the tributary programs.

- Mitigate for any flow changes attributable to implementing Title XII elements which may reduce the effectiveness of fish passage structures and screens.

- Continue efforts to moderate flow fluctuations in the regulated reaches of the river system by adopting more gradual ramping rates.

- Establish an accurate water measurement and accounting system to ensure maximum benefits to fish and wildlife resources.

- Develop a canal/drain right-of-way management plan to improve wildlife habitat associated with irrigation facilities. The management plan should include such things as eliminating, minimizing, and/or better managing mowing, spraying, burning, and grazing; establishing grass cover; and, where possible, maintaining tree and shrub cover along disturbed rights-of-way.

- To improve riparian and wetland habitats, grazed areas along the Yakima River, its tributaries, reservoirs, and wetlands should be fenced to exclude or manage the intensity and timing of livestock grazing.

- Any areas disturbed by the future construction of various project elements need to be revegetated with native vegetation. Plants removed during construction should be replaced with the same or similar species as soon as possible following construction.

- Do not remove any trees affected by the 3-foot Cle Elum Lake pool rise. These trees would die and become snags that would be valuable as perching, feeding, and nesting sites.

- The selection and siting of borrow areas, spoil sites, construction staging areas, etc., need to be analyzed to avoid or minimize impacts to important fish and wildlife habitats.

- Big game protection measures should be installed on existing canals where problems with trapping animals have been identified. Fences, bridges, ladders, ramps, and deflectors could be used to prevent trapping or to facilitate escape from the canals. In the future, if canals are modified for water conservation (for example, lining with cement), then fences, bridges, ladders, ramps, and/or deflectors should be incorporated into the construction specifications to prevent the trapping of animals or to facilitate their escape from the canals.

- As an alternative to riprapping, bioengineering techniques (live gabions, brush wattling, and/or willow stakes) can and should be used to reduce construction costs, potentially decrease operation and maintenance costs, and enhance riparian habitat where bank stabilization is proposed.

- To help control or reduce the spread of purple loosestrife, Eurasian milfoil, and other non-native weeds in the Yakima River Basin, appropriate vegetation management activities should be implemented. An active program for control of noxious weeds should be established to ensure program activities do not increase weed problems in the Yakima River Basin.

- To improve the success of habitat development through mitigation or enhancement activities, encourage buffers, which can be important for improving the quality of adjacent habitats.

- Fulfill habitat requirements of certain species in conjunction with project operations, construction, or mitigation and enhancement activities by implementing opportunities to benefit threatened and endangered species, neotropical migratory birds, and other species of concern.

- Wetland and riparian habitats that are adjacent to irrigation facilities and that would be dried up through water conservation measures must receive water directly for maintenance of those habitats.

- Implement wetland mitigation banking to mitigate wetland losses. Mitigation banking is the restoration, creation, enhancement, and, in exceptional circumstances, preservation of wetlands and/or other aquatic resources expressly for the purpose of providing compensatory mitigation in advance of authorized impacts.

- Combine mitigation efforts with ongoing conservation efforts so that such efforts maximize funding efficiency and facilitate a larger and more ecologically sound project. Furthermore, the potential for long-term success of mitigation efforts can be increased. A larger wetland mitigation project in the Yakima River flood plain will provide important flood control, public recreation, and water quality benefits; tie in with existing protected wetland and riparian areas; improve habitat for

wildlife which use wetlands; and perhaps benefit anadromous fish by providing rearing areas, reducing water temperatures through shading, and increasing invertebrate production.

- Mitigation activities should not be confined to Reclamation project lands. If mitigation opportunities are better on other lands, then interagency agreements, easements, fee title acquisition, or other mechanisms to accomplish this mitigation should be implemented.

- Mitigation measures for unavoidable project impacts need to be determined for each element and presented and fully evaluated before any program-specific construction begins.

- Set up a comprehensive management plan (similar to the interim comprehensive basin operating plan) and an interagency committee to facilitate coordination between various entities involved in Title XII and to guide mitigation and enhancement efforts throughout the Yakima River Basin. A basin-wide coordinated effort is needed to ensure that impacts are avoided on minimized and that mitigation measures are soundly developed and implemented. Good coordination across the various boundaries (district, Tribal, Federal, State, private, etc.) is needed to maximize the benefits of water conservation measures to irrigation interests and fish and wildlife resources.

5.2.4 Endangered Species Act Consultation

Consultation with FWS and NMFS is required under Section 7(a)(2) of the Endangered Species Act. Informal consultation was initiated on April 12, 1996, with a memorandum to FWS and NMFS from Reclamation requesting a list of plants and animals on the Federal list of threatened or endangered species and any critical habitat. On April 16, 1996, FWS sent a memorandum (No. 1-9-96-SP-143) indicating that six animal species—bald eagle (*Haliaeetus leucocephalus*), gray wolf (*Canis lupus*), grizzly bear (*Ursus arctos horribilis*), marbled murrelet (*Brachyramphus marmoratus*), northern spotted owl (*Strix occidentalis caurina*), and peregrine falcon (*Falco peregrinus*)—were the possible listed species in the project area. The only designated critical habitat noted in the letter was that for the northern spotted owl. On April 24, 1996, NMFS sent a memorandum (No. F/NW03) indicating that three anadromous fish species—Snake River sockeye salmon (*Oncorhynchus nerka*), Snake River spring/summer chinook salmon (*O. tshawytscha*), and Snake River fall chinook salmon (*O. tshawytscha*)—were the only listed species known to be downstream from the project area. Critical habitat for the listed species does not include the project area.

On December 6, 1996, Reclamation prepared and sent a biological evaluation to both FWS and NMFS addressing project impacts and determining that implementing Title XII would have "no effect" on any threatened or endangered species or critical habitat. FWS issued a

concurrence by memorandum dated December 20, 1996, upholding the determination of no effect. NMFS sent no memorandum; but after numerous telephone calls, it was indicated that NMFS would also concur with Reclamation's no effect determination.

In June 1997, FWS proposed to list bull trout (*Salvelinus confluentus*) in the Columbia and Klamath River Basins. Bull trout were listed in June 1998. Steelhead were proposed for listing in February 1998. On July 15, 1997, Reclamation met with FWS to discuss conferencing requirements. All parties agreed that the decision to proceed on the administrative action would not necessitate conferencing, but conferencing would be required for specific actions. Reclamation has committed to consult with FWS on bull trout when site-specific analysis is needed.

5.2.5 National Historic Preservation Act Consultation

Regulations (36 Code of Federal Regulations [CFR] 800) implementing Section 106 of the National Historic Preservation Act require consultation with various parties to determine: (1) if historic properties are present in the impact area that are eligible for the *National Register of Historic Places* (*National Register*); (2) the effect of the proposed action on *National Register*-eligible historic properties; and (3) the appropriate treatments to avoid, minimize, or mitigate adverse effects. For the Kachess channel modification component of YRBWEP, Reclamation consulted with the Washington State Historic Preservation Office (SHPO) about *National Register* eligibility and project effects upon Kachess Dam and four concentrations of archeological materials associated with prehistoric use of the area. Reclamation also consulted with the Yakama Indian Nation concerning the prehistoric archeological site. Reclamation and SHPO determined that Kachess Dam was eligible for listing on the *National Register*, that project actions would have an adverse effect upon its historic integrity, and that appropriate treatment was sensitive design of new structural elements and completion of Historic American Engineering Record documentation. Reclamation redesigned the construction project to avoid two archeological material concentrations. Reclamation and SHPO concurred that a third archeological material concentration did not contain significant intact deposits, and that the fourth deposit (which could not be avoided) could be protected from damage by placing geotextile fabric and covering the site with fill. One of the avoided archeological concentrations was also covered by geotextile and fill to protect it from erosion and vandalism. To address concerns of the Yakama Indian Nation, Reclamation also hired a Tribal monitor to be onsite during channel excavation. The monitor did not discover any previously undetected archeological deposits.

Reclamation has used the EIS public review process to provide the SHPO, the Advisory Council on Historic Preservation, the FWS, the U.S. Forest Service, and other identified consulting or interested parties an opportunity to comment upon Reclamation's assessment of effects of overall YRBWEP actions upon historic properties. They will receive the draft PEIS and be invited to comment. However, Section 106 consultation will not end there. As each implementation action for YRBWEP is identified, Reclamation will complete consultations consistent with 36 CFR 800 with the SHPO, appropriate Indian Tribes, and other appropriate parties. The Yakama Indian Nation has been involved as a cooperating

agency for preparation of the draft PEIS and has had opportunity throughout that process to provide information or comment pertinent to Section 106 responsibilities and cultural resources needs.

5.3 Native American Coordination

5.3.1 Archeology

As discussed earlier, consistent with 36 CFR 800, consultations were completed with the Yakama Indian Nation and the Nation's Cultural Resources Program manager and staff concerning the archeological sites in the impact area for the Kachess Dam channel modification component of YRBWEP. The Tribal staff were invited to visit the site while archeological survey and testing activities occurred and were provided with draft copies of the testing report for review and comment. Reclamation initiated coordination meetings with Tribal staff to discuss Tribal concerns about protection of archeological properties. In response to Yakama Indian Nation concerns, a haul route was abandoned to avoid an archeological material concentration, and a Tribal monitor was employed to be present during channel excavation.

Reclamation will consult with interested Tribes, consistent with requirements of 36 CFR 800 and Reclamation policy, for future actions.

5.3.2 Traditional Cultural Properties

Reclamation consulted with Yakama Indian Nation's Cultural Resources Program management and staff to determine if traditional cultural properties were present in the areas to be impacted during the Kachess Dam channel modification project. No traditional cultural properties were identified. Reclamation will consult with interested Tribes to determine if traditional cultural properties are present in impact areas for future implementation actions, consistent with 36 CFR 800 and Reclamation policy.

5.3.3 Sacred Sites

The Yakama Indian Nation identified a sacred site within the impact area for the Kachess Dam channel modification component. Reclamation modified the construction design to avoid the sacred site location. Reclamation will consult with interested Tribes to identify sacred sites in potential impact areas, consistent with Executive Order 13007 and Reclamation policy.

5.3.4 Indian Trust Assets

Reclamation has conducted informal discussions with staff of the Yakama Indian Nation on the status of concerns that the Tribe may have on Indian Trust Assets. Additional

discussions will occur as plans for site-specific projects tiering from this document are developed. Specific plans may be developed at that time to avoid or mitigate an anticipated impact.

5.3.5 Government-to-Government Consultations

Reclamation has coordinated the development of the PEIS with the Yakama Indian Nation Tribal staff and has given periodic updates of progress to the Tribal Council. Government-to-government consultation was initiated on February 9, 1998, with a letter inviting the Yakama Indian Nation to participate in formal consultation with Reclamation on the PEIS description and analysis of the alternatives presented and implementation of Title XII. Potential impacts to any of the resources discussed in this PEIS from implementing specific components of Title XII will be identified, and mitigation will be developed as part of any consultation effort as required.

COMMENTS AND RESPONSES

Contents

Page

Newell Campbell 1
Alan Matson 7
Larry Vinsonhaler 9
Wenatchee National Forest 13
Yakima Basin Joint Board 15
Environmental Protection Agency 19
Washington State Department of Fish and Wildlife 29
Yakima County Planning Department 33
U.S. Fish and Wildlife Service 35
Natural Resources Conservation Service 37

NEWELL P. CAMPBELL
GEOLOGIST
7913 ENGLEWOOD CREST DRIVE
YAKIMA, WASHINGTON 98908
(509) 966-1516

May 28, 1998

Mr. Robert Black
Bureau of Reclamation
Denver Federal Center
P.O. Box 25007
Denver, Colorado 80225-0007

Dear Mr. Black:

Thank you for providing me with a copy of the draft PEIS for the Yakima River Basin Water Enhancement Project. It is a good document providing much badly needed information. However, there are several parts that, in my opinion, need to have additional data included in the final EIS. These topics include: additional storage facilities, hydrology and geology, water temperatures, and fish habitat. The following pages contain comments and questions about these areas. Adding more information to these parts should help improve and clarify an already good draft. 1

If you have questions, please call me at (509) 966-1516.

Sincerely,

Newell P. Campbell

COMMENTS ON DRAFT PEIS

Additional Storage Facilities

The PEIS states that both Phase I (p. 10) and Phase 2 (P. 11) studies recommended that additional storage facilities are needed. Yet on p. 12, TAG recommended deferral of such studies. Why? Any EIS dealing with water enhancement must consider all aspects of the basin and this should include water storage. For example, this document should include both pro and con data on:

- Raising heights of pre-existing reservoirs -- including Bumping and Rimrock, as well as those upstream.
- Construction of additional reservoirs in canyons of the Yakima River Canyon (Roza, Selah, Squaw, Umtanum Creeks).
- Dams on other tributaries (Rattlesnake, Toppenish, Satus, Swauk, etc).
- Construction of a pipeline from the Columbia River up Cold Creek or Black Rock into the Yakima River (a previous study).

Since a major part of your document involves improving water volume and quality downstream from Yakima, the above projects would seem to be of value -- they might also provide recreation and flood control. Clearly, there are both positive and negative factors here but to leave the whole topic out of a document is remiss. It does not matter (to me) whether dams are built or not, the topic needs to be addressed.

2

Additional storage facilities:

Page 16 of the draft PEIS (Section 1.6 "Document Scope and Organization") states that *"Because the emphasis of Title XII is on water conservation, alternative measures such as construction of additional storage facilities . . . not specifically authorized in the legislation will not be considered in this PEIS."* That decision was made during the planning of Phase 2 of the project, which culminated in passage of Title XII. Title XII that specified that the major focus of the project is to be on water conservation, providing a mechanism for developing, evaluating, and implementing entity-specific water conservation measures and subsequent integration into a basin-wide conservation program (the Basin Conservation Program).

Other mechanisms for enhancing the basin's water supply beyond what is ultimately possible through measures used in Phase 2 will be the subject of Phase 3. The consideration of additional storage as one of these mechanisms will depend on the success of Phase 2. If additional supplies are needed, subsequent legislation and associated documents will address this need. Additional text has been added to the PEIS to clarify this question.

Geology/Hydrology

The geologic map is inadequate and out of date. The area has undergone extensive detailed mapping since 1963-1986 (your refs., p. 58). Contact the Washington Division of Geology and Earth Resources (Eric Schuster or Connie Manson) for newer mapping. You need to delineate areas of flood plains, terraces, and slackwater sediments -- all related to the "alluvial" aquifer (p. 65). Infiltration, position of the unconfined aquifer, water temperature and other criteria are affected by these rock units. Dividing the CRBG into three formations would be helpful, especially in showing areas of recharge or discharge.

Geologic map: This PEIS provides "umbrella" environmental documentation for implementing Title XII Section 1.6 "Document Scope and Organization" (page 15 of the draft PEIS). A general geologic map for the entire Yakima Basin was considered sufficient at this level. Additional NEPA documents will provide more detailed information on specific measures that will be implemented and will include more detailed and site-specific geology and hydrogeology information.

You state (p. 59) that folds and faults alter groundwater patterns but offer no details on faulting. Are they conduits or barriers? In my experience faults in CRBG or other volcanics contain sealed breccia zones and are almost always barriers to groundwater flow. Perhaps the thrust faults associated with the anticlines are an additional factor in controlling hydraulic boundaries. There are numerous local publications on faults as groundwater barriers, including one in the Moxee Valley. (Contact R. Bentley, CWU, S. Reidel, Battelle, or J. Bond, Moscow, ID for additional insights.)

Faults and hydraulic flow: Faults in the Columbia River basalts are usually barriers to groundwater flow. However, localized studies in areas where specific conservation activities will be implemented should define the role of faulting in each studied area and the impact of the faults on the local hydrogeology. That level of detail was not considered necessary for this PEIS.

The pre-tertiary Roslyn, Manastash, Naches, and Swauk Formations are sedimentary rock units that occupy a significant part of the upper basin. What are their roles in regard to storage capacity and permeability in downstream release of surface or groundwater? When reservoirs are in contact with these rocks how much water is retained in these rocks? Some additional comments are needed. (Shell Oil has porosity and permeability data on these rocks.)

Pre-Tertiary formations: The pre-Tertiary sedimentary rock formations (i.e., Roslyn, Manastash, Naches, and Swauk) are, in large part, composed of well-cemented sandstone interbedded with carbonaceous shale. The porosity and permeability of the formations are low (Kinnison and Sceva, 1963). Although these rocks provide an undetermined amount of water storage capacity, no environmental impacts affecting these formations are expected from implementing Title XII.

Anticlinal ridges along the Yakima River expose both Wanapum and Grande Ronde Basalt in their cores (p. 60 and p. 128). Could one say that along the river north of Yakima, the cores are places of recharge to these aquifers? And places of discharge toward the downstream end at Toppenish Ridge and Horseheaven Hills? Does increased pumping from deep wells cause more water to be removed from the river to recharge the lower basalt aquifers? Are contaminants from the Yakima River

Recharge/discharge areas: Specific areas of recharge and discharge from the basalts are more properly addressed in the site-specific NEPA documents that will tier from this PEIS. The areas and amount of discharge and recharge to the basalts depend on the local hydraulic gradient and the influences of local pumping. These conditions change with location and time and haven't been fully defined for the basin. The USGS National Water Quality Assessment Program study planned for the Yakima Basin will help to define the extent of contamination entering the aquifers.

entering the groundwater at points of recharge? Which aquifers (if any) are presently being contaminated? (I realize these topics are now in litigation but you can't just ignore it in an EIS.) The discharge-recharge problem at these points may also have a bearing on water temperature (see below).

The Ellensburg Formation is mostly composed of impermeable mudflows and ash/tuff (clayey) sediments. Water within this unit is concentrated only at the top and at the base. The basal producing zone (clean fluvial sands) behaves much like an interflow zone in basalt, while the upper part is related to and may be considered part of the upper alluvial aquifer (see Todd Kirk, DOE, for comments).

Ellensburg Formation: Comment noted.

A stratigraphic column of rock units including their hydrologic characteristics would be helpful to the average reader (?), as would a map locating natural recharge-discharge sites. I think these are available (p. 63).

Stratigraphic column: A generalized stratigraphic column has been included in the final PEIS section 3.4.1 as figure 3-3. A map locating natural recharge/discharge sites is not needed at this programmatic level of detail.

Bumping Lake is probably not a glacial moraine-dammed lake but rather a mudflow dammed lake from an event down Deep Creek about 500 years ago.

Bumping Lake: Comment noted.

4

Fossils (p. 106) from the Ellensburg Formation consist of occasional, and usually fragmented, remains of camel, horse, rodents, and reptiles (low impact) and leaf fossils from lacustrine rocks that are of poor quality. Leaf fossils from Swauk Manastash, Naches, and Roslyn rocks are of better quality -- localities are very widespread and numerous (low impact). Mammoth bones, sometimes whole skeletons out of slackwater sediments or glacial flood debris, are limited to the lower valley south of Union Gap. (can't predict locations). Contact Jim Martin at S.D. School of Mines on vertebrates.

Fossils: More detailed cultural resources surveys will be done for site-specific actions.

East of the Columbia River the USGS has called the entire CRBG a sole source aquifer, implying that the Saddle Mountains, Wanapum and Grande Ronde units are all internally connected. Although I disagree, more comments on the nature of confining layers, fracture seals and interflow zones are justified (p. 61). A sole source designation for the Yakima Basin would be devastating. Should this be addressed in the EIS?

Sole source controversy: Discussion about the sole source designation of the Columbia River Basalt Group (CRBG) is beyond the scope of this document. However, the nature of confining layers and interflow zones will necessarily be discussed when specific implementation measures are defined and studied. The nature of those layers at each site will determine the impact those measures have on underlying aquifers.

There is nothing in the document or your alternatives (p. 128-130) about the effects produced by reducing the volume of water produced from deep aquifers. Is this not an alternative? What would be the effects on stream flow?

Water Temperatures

Water temperature data are lacking in the PEIS. Some points to be considered are:

- Water released from reservoirs should be cooler than normal stream flow. What role do reservoirs play in helping to keep stream temperatures colder? Would additional reservoirs placed near the downstream part of the drainage (i.e., Satus Creek) help cool the lower Yakima River?

- Water entering the unconfined alluvial aquifer from irrigation should be cooled in the subsurface and provide additional cooler water when the aquifer discharges into the Yakima River. Since many irrigated crops lie on terrace deposits (far more than the modern flood plain), a fair amount of water should be retained in the unconfined aquifer. Does this result in a steeper gradient with the result that more, cooler water is discharged from the unconfined aquifer than would be returned under natural conditions? Does irrigation recharge to the unconfined aquifer help cool stream flow? To what extent?

- Conversely, because of low temperature geothermal conditions under the valley, water from upwelling of deep aquifers into the river (i.e. at Manastash and Ahtanum Ridges) should warm the river water -- geothermal effect -- and likewise water from deep well production may add heat to the unconfined aquifer. To what extent do these effects have on surface stream temperatures?

5

Effects of deep aquifer pumping: Reducing the volume of groundwater pumping to increase streamflow may be one of several specific implementation measures studied during site-specific studies. The impacts from reduced pumping would depend on the local geology and hydraulic gradients and the current use of groundwater in the local area.

Water temperature:

- The PEIS is limited to those issues that could be *affected by* the proposed Federal action. Reservoir operations under the action alternatives will not change sufficiently to impact stream temperatures.

- While comprehensive data are not available to answer this question, it is our professional judgment that effects would be very minor, if any.

- While comprehensive data are not available to answer this question, it is our professional judgment that effects would be very minor, if any.

If no data exists, perhaps some additional temperature studies -- including a series of shallow monitoring wells across a terrace and flood plain in both irrigated and natural areas -- would be of value. Some of the above questions are partly answered in Vaccaro (1986) and others documents. Details from these reports need to be added to the EIS.

Fish

A significant part of the PEIS relates to maintaining fish life and fish runs in the Yakima River (p. 12 and 13). However, quality of water as it relates to fishing does not stop at the mouth of the Yakima River but continues downstream to the mouth of the Columbia River. Water temperature, silting, irrigation discharge, reservoirs, fishing practices, and other criteria in the Lower Columbia clearly affect fish populations in the Yakima River Basin. How can you limit this EIS to only the Yakima River with regard to fish? Should not the lower Columbia effects also be involved, both pro and con? Has there been any research that correlates the decline in migrating fish populations reaching the mouth of the Yakima River with the addition of many hundreds of nets along the lower Columbia River? What percentage of fish reaching the mouth of the Yakima survive upstream as far as Roza? How do changes over the years in the fish population in the Yakima compare with the Columbia River upstream from the Yakima River? With the Wenatchee River? I assume data on these topics are available -- it should be included in the EIS.

6

Newell P. Campbell
May, 1998

Additional temperature studies: Additional field studies to answer the questions posed are beyond the scope of the PEIS, as this is a broad programmatic document and study. These issues would be considered in site-specific documents.

Fish: The purpose of the PEIS is to disclose the impacts associated with the proposed Federal action. The PEIS focuses on those issues that could be *affected by* the proposed Federal action. It is true that anadromous fish are affected by activities in the lower Columbia River and by ocean conditions. This Federal action would not affect the lower Columbia River or the ocean. Even so, enhancing the Yakima River ecosystem will likely improve anadromous fish runs. We are encouraged that Umatilla River salmon restoration efforts have resulted in increased salmon runs even though these fish too must negotiate the lower Columbia River and ocean conditions.

June 3, 1998 - Wednesday
Double Tree Inn
1:00 P.M - 3:00 P.M

Yakima River Basin Water Enhancement Project

Questions:

1) What effect will the following have on the project (EIS)

A) I-90 Land Exchange (Plum Creek - USFS)

B) The Trend West proposed development at Cle Elum/Roslyn

C) The proposed Interior Columbia River Basin Ecosystem Management Project

Alan Matson
55 W. Wash. #191
Yakima, Wa. 98903
(509) 452-1506
Fax (509) 452-1506

A. I-90 land exchange (Plum Creek USFS): The U.S. Forest Service's proposed action to exchange privately owned forested property for property managed by the Forest Service should have no effect on the conservation efforts Reclamation proposes for the Yakima Basin. Both actions will go through their own independent approval processes. The USFS issued a draft EIS in September 1998, with a final EIS and Record of Decision following sometime in the near future.

B. Trend West proposed development at Cle Elum/Roslyn: At this time, the State of Washington is doing an EIS for this development. Reclamation's involvement is the possibility of exchanging Cle Elum Reservoir water for water the company has obtained in the Teanaway River basin. This is another example of an agency action which will proceed independently of other actions. There is a cumulative effect of providing water in the Teanaway which will eventually return to the Yakima River. However, at this time, Reclamation does not know whether or not Trend West will want to proceed with the exchange— especially if the company acquires enough water in the local area. If Trend West decides it wants to proceed, then Reclamation will probably adopt and augment the State's EIS and issue Reclamation's own Record of Decision.

C. Proposed Interim Columbia River Basin Ecosystem Management Project: The Yakima River Basin Water Enhancement Project appears consistent with the Department of the Interior Columbia River Basin Ecosystem Management Project. Actions within the Yakima River Basin, implemented as a result of the Columbia Basin program, could increase the effectiveness of YRBWEP implementation.

July 1, 1998

Bob Black
Bureau of Reclamation
Denver Federal Center
PO Box 25007
Denver, CO 80225-0007

Dear Bob:

The following comments on the April 1998 Draft Programmatic Environmental Impact Statement (PEIS) for the Yakima River Basin Water Enhancement Project are provided for your consideration. While I did not receive a copy of the draft PEIS from your office or the Upper Columbia Area Office, I did obtain a copy courtesy of Bob Hamilton of the PN Regional Office and took it upon myself to review.

These comments represent my review of selected sections of the PEIS and are not all inclusive. My emphasis was on the accuracy of the PEIS and clarification and not on "word smithing." I would appreciate a response at your convenience as to your views on comments 1, 4, and 15.

This was a complex document to develop and extremely difficult to present the alternatives in a manner so the impacts can be identified. The "team" that prepared this document is to be commended!

6

1. Page S-1, section 2.0, last paragraph continuing on page S-2: This comment relates to the discussion of alternatives 2A, 2B, and 2C. The following "bullets" are references in the PEIS which I used in support of the comment:

- Page 114, last paragraph: "In all alternatives, demand reduction was excluded from WIP and Y-T."
- Page 119, Table IV-2: Total diversions and reduced diversions.
- Appendix A, Table A-1: Diversions by entities.

Comment 1 follows:

Alternative 2A = 7.5 % basin-wide reduction excluding WIP and Y-T. <u>This is a correct explanation.</u>

Alternative 2B = 15 % reduction in diversions from Yakima River downstream from Roza Diversion Dam excluding WIP and Y-T. <u>The following is more explicit</u>:

Alternative 2B = 15% reduction for (1) all Yakima River diversions from the Roza Canal

1. Correction made.

downstream to the Sunnyside Canal excluding WIP; and (2) all Naches/Tieton River diversions excluding Y-T.

Alternative 2C = 21% reduction in diversions at diversion points between the Sunnyside and Roza Canals. While I cannot reconstruct the no action diversion figure shown in Table IV-2 for Alternative 2C (785,710 acre-feet) from the historical diversions shown in Table A-1, I suggest that this alternative may represent the following:

Alternative 2C = 21% reduction in diversions for the Roza and Sunnyside Canals.

2. Page S-2, section 3.1, paragraph 2, sentence 1: Revise to read, "....years of full water supply (years when proration did not occur) from 1970 through 1994....."

3. Page S-6, section 3.5, paragraph 1, sentence 1: Revise to read "....in the Yakima River below the Easton Diversion Dam and in the Cle Elum River below Cle Elum Dam."

4. Page S-12, section 4.4: This entire section implies a reduction in irrigated agricultural land, cropping, and crop yields associated with the Basin Conservation Program. In paragraph 4, sentence 2 on page S-12, and paragraph 2, sentence 2 on page S-13 it is stated that the irrigated agricultural area will decrease with implementation of the Basin Conservation Program. In fact, page S-13 indicates a water supply reduction associated with implementation of Alternative 2C will result in the retirement of over 30,000 acres of agricultural land. What is the basis for the this statement? A reduction in irrigated land will occur only with the purchase or lease of water and water rights, which is just one element of the overall program. The summary should be explicit regarding what measures will result in the retirement of irrigated land and to imply that all conservation measures will decrease the irrigated land base, cropping, and yields is not appropriate!

10

The statement on page S-17, paragraph 1, sentence 1, appropriately emphasizes this point!

5. Page 9, 1.3.1: I suggest that the discussion concerning the "water bucket" which appears on page 4-8, lines 1 through 12 of the Conservation Advisory Group's June 25, 1997, draft report be included after the paragraph continuing from page 8. Also, in paragraph 2 on page 9, reference should be made to irrigation improvements on WIP which are authorized by Title XII.

6. Page 21, section 2.1.1, Conservation Advisory Group, paragraph 1, sentence 1: I believe the charter for the Conservation Advisory Group was approved by the Secretary on July 13, 1995, and the members appointed October 30, 1995.

7. Page 23, section 2.1.1, Basin Conservation Plan, paragraph 8: A draft Basin Conservation Plan (Plan) was released for public comment August 12, 1997, with the comment period extending through October 31, 1997. Following receipt and review of comments, the draft Plan was revised and in April 1998 was submitted to the Secretary through the Commissioner of Reclamation for publication.

2. Correction made.

3. Correction made.

4. Comment noted. Appropriate revisions have been made to these sections to accommodate these concerns.

5. Suggested text added.

6. Correction made.

7. Correction made.

8. Page 28, section 2.1.2, 2nd full paragraph, sentence 1: Delete first sentence.

9. Page 29, section 2.1.2, 3rd full paragraph, next to last sentence: Revise to read, "The water supply from the development of additional storage capacity at Cle Elum Lake shall not be a part of the TWSA estimates and shall be ...."

10. Page 29, section 2.1.2, 5th full paragraph: Revise to read as follows (additions redlined):

> Following consultation with the State of Washington, tributary water right owners, and the Yakima Indian Nation, a study will be conducted by Reclamation concerning nonstorage items that can be implemented to enhance water supplies for fish and wildlife and irrigation purposes in Taneum Creek. Similar studies can be conducted in other tributaries upon agreement of the appropriate tributary water right owners to participate. Nonstorage measures can include, but are not limited to the following:
>
> Note: Include "bullets" here.
>
> A draft report is to be prepared and made available to the public for a 45-day comment period. Following this, a final report is to be submitted by the Secretary to Congress and the Governor of the State of Washington. Implementation of the proposed measures can then be initiated upon securing an appropriation, an agreement with the appropriate water right owners, and a finding by the Secretary and the State of Washington that implementation will not impair the water rights of any person or entity in the affected tributary.

11

Reclamation has concluded that a different process may be followed if non-Federal funding sources (such as the Power Council) are to be used. Activities are currently underway in the Teanaway River anticipating the use of non-federal funds.

11. Page 31, section 2.1.2, Interim Comprehensive Basin Operating Plan: It is stated that a specific environmental impact statement will be prepared for the Operating Plan. It could be possible that a environmental impact statement may not be necessary. Why not leave this matter open for resolution at a latter date?

12. Page 35, section 2.2.2, paragraph 2, sentence 3: Replace word "minimum" with "target."

13. Page 37, section 2.2.3, description of Alternative 2: See comment 1.

14. Table II-4: In the line entitled "Target Instream Flows" and under all of the "Alternatives" headings the entry shown is "300 to 900 cfs." However, I can find no prior explanation of the "900 cfs" figure.

8. Correction made.

9. Correction made.

10. Correction made.

11. Reclamation is changing those sections of the PEIS to reflect that the appropriate NEPA compliance document will be developed after the interim comprehensive basin operating plan is given to the Yakima Field Office Manager. The Yakima Field Office Manager will decide what elements of the plan will be implemented.

12. Correction made.

13. Correction made.

14. The Title XII goal is 165,000 acre-feet. If the entire goal were achieved, instream flows would increase by 300 ft^3/s. The 900 ft^3/s is derived from adding the 300 ft^3/s to the basin's flow of 600 ft^3/s in the best year. Text in Section 2.1.2 "Project Operations and Facilities Modifications" and table 2-2 in the final PEIS has been changed to clarify these figures.

15. Page 119, Table IV-2 and Table A-1: I have tried to determine the derivation of the "Total Diversions No Action" figure of 2,200,200 acre-feet by using the average diversion figures from Table A-1. Table IV-2 indicates that WIP diversions are not included in the alternatives.

Item	Acre-Feet
Table A-1 Total Annual Diversions	2,451,121
Less WIP (New Reservation Canal)	622,434
Total without WIP	1,828,687

This figure does not check.

Next I deducted all diversions downstream of Sunnyside Diversion Dam which are the top five in Table A-1 on the basis that TWSA represents the water supply upstream from Sunnyside Diversion Dam.

Item	Acre-feet
Table A-1 Total Annual Diversions	2,451,121
Less: Columbia Canal	71,169
Richland Canal	16,722
Kiona Canal	8,608
Kennewick Canal	96,745
Snipes Allen Canal	5,584
Total	2,252293

While this figure is closer to the 2,200,200 acre-feet shown on Table IV-2 it still does not check.

I suggest that table IV-2 be reviewed for all alternatives. Also note that some of the commas are misplaced on Table A-1 (for example Sunnyside Canal).

Sincerely,

Larry Vinsonhaler
2567 Lynx Way
Boise, Idaho 83705

cc John Tiedeman, Upper Columbia Area Office, Yakima, WA
Bob Hamilton, PN Region Office, Boise, ID

12

15. Numbers in these tables are not equivalent. Table IV-2 in the draft PEIS and 4-5 in the final PEIS are based on the model results, which used a period of record from 1926 to 1994. Table A-1 in appendix A shows the average monthly diversion demands measured between 1970 to 1994. This table provides an example of measured data. Thus, these numbers cannot be added together to show Total Diversions No Action.

Total Diversions No Action is based on the Basin Conservation Program goals. The smaller the area under the Basin Conservation Program, the more water must be saved to meet the goal of conserving 165,000 acre-feet. The 2,200,200 acre-feet represents the total diversion in the area that would be covered under the Basin Conservation Program under Alternative 2A. Likewise, the 1,100,000 acre-feet represents the total diversions in the area under Alternative 2B, and the 785,710 acre-feet represents diversions in the area under Alternative 2C.

Period of records for the model were different for flows and diversions.

Streamflow diversions are 1926-1994
Historic diversions are 1970-1994, excluding water-short years

Table A-1: Correction made.

United States Department of Agriculture | Forest Service | Wenatchee National Forest | 215 Melody Lane
Wenatchee, WA 98801-5933
TTY (509) 662-4396
Voice (509) 662-4335

File Code: 1500/2500

Date: July 15, 1998

Mr. Robert Black
Bureau of Reclamation
Denver Federal Center
P. O. Box 25007
Denver, CO 80225-0007

Dear Mr. Black:

Thank you for the opportunity to comment on the draft programmatic environmental statement for Phase 2 of the Yakima River Basin Water Enhancement Project. The Wenatchee National Forest includes considerable acreage within the Yakima River Basin. Two Ranger Districts, located at Cle Elum and Naches, manage 350,000 acres and 500,000 acres within the Upper Yakima Subbasin and Naches Subbasin respectively. The Forest is a participating partner with various Federal, State, Corporate, County, and private efforts to identify and assess water and watershed issues and to develop and implement strategies for resolution. A focal point for the Forest is watershed management, including inventory and monitoring of ecologic condition and watershed treatment to maintain system health.

13

Issues specific to the Yakima River Basin on which the Wenatchee Forest has focused, include reduction of stream sedimentation, maintenance and improvement of aquatic habit, and maintenance or lowering of stream water temperature. Implementation of the conservation measures and target instream flows as identified in the Draft PEIS should benefit these issues. The Wenatchee Forest supports these program elements.

The proposal to raise the gate elevation of Cle Elum Lake raises a number of concerns. There are numerous capital investments including roads, trails, and recreation sites that could be impacted. There is a major impact on known and unknown archeological sites. There are issues regarding aquatic and terrestrial species and loss of critical aquatic and terrestrial habitat. Some of the same concerns arise for the proposal to augment water supplies in Kachess Lake with streamflow from Cabin and Silver Creeks. In general, structural measures proposed as elements of the plan will involve impacts to other natural resource values. The Wenatchee Forest would like to be involved in identifying these concerns and issues and evaluating trade-offs and mitigation as these project plan details are formulated.

Reclamation recognizes the concerns expressed in your letter. Staff at the Yakima area office met with members of the Cle Elum Ranger District on May 1, 1998, and had a site visit on May 7, 1998, to discuss these issues. These contacts have led to a request from the Cle Elum Ranger District that a Memorandum of Agreement be in place prior to any further discussions. This is currently being developed. Reclamation is required and committed to coordinating any of its proposed actions, especially rising pool elevations and Kachess augmentation, with the appropriate office which may affect any National Forest interests. As noted in the document, Reclamation is planning a site-specific NEPA document for the pool rise. The document does mention potential impacts to the Wish Poosh campground and has included some corrective actions as part of the mitigation commitments. Archeological sites will be examined in more detail for the site-specific action. Reclamation has indicated, in Section 4.11.2 "Mitigation for Cultural Resource Properties," that the agency will attempt to avoid any sites; but if avoidance is not possible, then other means to protect such sites will be considered. Species issues will also be specifically addressed through site-specific NEPA documents.

In general, the Wenatchee Forest highly supports and encourages conservation measures as timely and effective approaches toward resolution of water management issues in the Yakima River Basin. Lake and stream modification measures will be considerably more difficult to assess, plan, and mitigate.

SONNY J. O'NEAL
Forest Supervisor

cc:
Elton Thomas, Resources Group Leader, WNF
Glenn Hoffman, PLME Group Leader, WNF
District Ranger, Cle Elum Ranger District
District Ranger, Naches Ranger District

14

TR

YAKIMA BASIN JOINT BOARD

A Partnership of Public Entities Promoting the Multiple Uses of the Yakima Valley's Water Supply

IRRIGATION ENTITIES
KENNEWICK IRRIGATION DISTRICT
KITTITAS RECLAMATION DISTRICT
ROZA IRRIGATION DISTRICT
SUNNYSIDE DIVISION
YAKIMA TIETON IRRIGATION DISTRICT

NON MEMBER REPRESENTATIVES
CASCADE IRRIGATION DISTRICT
ELLENSBURG WATER COMPANY
MUNICIPALITIES
CITY OF YAKIMA
ENCOMPASSING 63 MUNICIPAL IRRIGATION DISTRICTS

PO BOX 6900
KENNEWICK, WA 99336

July 21, 1998

Mr. Robert Black
Bureau of Reclamation
Denver Federal Center
PO Box 25007
Denver, CO 80225-0007

15

Dear Mr. Black:

Thank you for the opportunity to review the Draft Programmatic Environmental Impact Statement for the Yakima River Basin Water Enhancement Project. We offer the following comments, which are identified by (section/page #):

1. (1.2.1/3) Fish Passage/Protective Facilities - Previously constructed screen and fishway facilities to protect anadromous fish migrants are briefly mentioned in this section only. Why is there no discussion of evaluation/monitoring programs? Were the facilities largely ineffective? Was there no evaluation program? If not, why?

2. (1.2.2/3) Yakima Fisheries Project - Yakima summer steelhead, spring chinook, and fall chinook are active or potential candidates for listing under the Endangered Species Act. The draft PEIS fails to address limitations on hatchery production of these populations should they be listed as threatened or endangered. Production of anadromous fishes in hatcheries is widely believed to constitute a threat to wild populations due to non selective harvest and competition/predation. Hatcheries may play a limited role in recovery planning, but they are not recommended to provide fish for harvest.

1. Fish passage facilities have been evaluated either by Bonneville Power Administration or by the National Marine Fisheries Service. Screen and passage facilities were determined to function adequately.

2. The Yakima Fisheries Project is discussed as an activity related to this proposed Federal action. This PEIS addresses the impacts associated with the proposed implementation of Title XII.

3. (1.2.3/3) Columbia River Fish Management Plan - The PEIS should discuss potential impacts of candidate species under the ESA on the Columbia River Fish Management Plan. Neither Yakima fall chinook nor coho are presently listed under the ESA, but the possibility of future listing of fall chinook should not be ignored. Coho native to the Yakima are currently considered to be extinct and are, therefore, not a candidate for ESA listing. Yakima summer steelhead is an active candidate for listing.

4. (3.1/41-42) Union Gap and Parker are over 100 miles upstream of the confluence of the Yakima and Columbia Rivers. You used these locations as representative of the hydrologic conditions of the lower Yakima River, but they are not. An additional graph in Figure III-1, depicting measured and estimated unregulated flow at Kiona, is required to accurately portray the hydrologic conditions of the lower Basin.

5. (3.2/49) The explanation of the effects of reducing return flows in the Kittitas Valley was difficult to comprehend. Why would reducing return flows work to the detriment of the spring freshet?

6. (3.3.4/57-58) Air temperature and reservoir outflow temperature influence water temperature in the upper Yakima Basin, while the lower Yakima mainstem is influenced primarily by air temperature (Vaccaro, 1986; cited in your bibliography). As a general principal, factors other than flow dictate water temperature (Bartholow, 1989[1]). Although you conclude the temperatures in the lower mainstem are primarily a function of irrigation return flows, return flows are generally cooler than the mainstem river at the point of return (Vaccaro, 1986). The concluding sentence of this section is completely inaccurate.

7. (3.6/70) Fish - Current mixture of fish species in the Yakima River is probably more diverse today than historically due to introductions of exotic species. Exotic species have potentially curtailed production and productivity of preferred anadromous salmonids due to competitive interactions and predation. Thus, the presence of exotic species is probably detrimental to preferred native species, suggesting that high diversity is not necessarily a condition which is beneficial to preferred native species.

8. (3.6.1/73-74) There exists considerable controversy over the validity of the Instream Flow Incremental Methodology. IFIM is a collection of parametric models and analytical procedures for predicting changes in fish habitat related to changes in discharge. The models produce "habitat suitability index curves". These are curves, which hypothesize and rank suitability index numbers for individual microhabitat variables that are assumed by analysts to determine fish preference for each variable.

1 Bartholow, J.M. 1989. Stream Temperature Investigations: Field and Analytic Methods. Biological Report 89(17). US Dept. of the Interior, Fish and Wildlife Service, Washington, DC

3. The Columbia River Fish Management Plan is discussed as an activity related to this proposed Federal action. This PEIS addresses the impacts associated with the proposed implementation of Title XII.

4. The term "lower Yakima River" should be interpreted relative to operations, which extend to Parker and now also to Prosser. Unregulated flows are estimated only at Parker, so these were the data used for comparison. The draft PEIS was limited to potential changes in Reclamation operations. As Reclamation does not regulate operations at Kiona, information presented about these flows is for comparison purposes only.

5. The text referred to model calculations. We deleted these paragraphs, as they were confusing and unnecessary.

6. The section discusses surface flows and is accurate for surface flows.

7. Comment noted. The text in the final PEIS has been altered to remove the reference to "relatively diverse" fish fauna to avoid confusion on this issue.

8. We considered the work referred to in this comment in our analysis. We are aware of limitations associated with IFIM work. The fish analysis relied on the IFIM work only as a broad tool to look for differences among alternatives; the IFIM work was a relatively small part of the analysis. To avoid misinterpretation, we removed tables showing recommended or "optimum" flows and clarified the text.

Our group previously retained an IFIM Expert to critique these studies. He prepared a detailed report (cited in your bibliography) and concluded that the data in most cases were seriously flawed for numerous technical reasons (TRPA 1995). In addition, users of the IFIM process know that any number of methods can be used in data collection, interpretation, and flow recommendation, all biologically rational and all providing different results, depending on various assumptions and priorities.

9. (4.6/139) Given the problems with IFIM studies described above, Reclamation should resist the temptation to characterize the flows recommended in the IFIM studies as "optimum." Flow impacts need to delineate the response (survival) of fish during spawning/incubation, rearing, and juvenile/adult migrations, not just a hypothetical relationship between flow and habitat availability. The effects of flow levels on juvenile migrant survival is uncertain, but recently the use of techniques such as PIT-tags have demonstrated the ability to define such responses (Skalski, 1998[2]). Reclamation should support the application of rigorous scientific studies to help define biological responses to management actions in the Yakima Basin.

10. (Appendix A/A-16) Figures A-6 and A-7 appear incorrect. How could average flows between Prosser and Mabton (PROS-MABT) possibly be lower than those at Parker (PARK) given the volume of tributary flow entering the river below the Parker gage?

17

Sincerely,
YAKIMA BASIN JOINT BOARD

Chuck Garner, President

CWG:PM:ds

2 Skalski, J.R. 1998 Can. J. Fish. Aquat. Sci. 55:761-769.

9. References to "optimum" flows have been removed from the final PEIS. This document was based on existing information because there is another level of NEPA compliance prior to the implementation of actions. Reclamation is currently supporting scientific studies to help define biological responses to management actions in the Yakima Basin.

10. The graph was mislabeled. These flows should be labeled "Prosser," not "Prosser-Mabton."

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue
Seattle, Washington 98101

JUL 22 1998

July 22, 1998

Robert Black
Bureau of Reclamation
Denver Federal Center
P.O. Box 25007
Denver, CO 80225-0007

Dear Mr. Black:

In accordance with our responsibilities under the National Environmental Policy Act and Section 309 of the Clean Air Act, the Environmental Protection Agency has reviewed the Yakima River Basin Water Enhancement Project draft Environmental Impact Statement (draft EIS). The draft EIS analyzes alternatives in order to meet the stated purpose and need of protecting, mitigating, and enhancing fish and wildlife as well as improving the reliability of the water supply for irrigation along the Yakima River in Washington state.

Based on our review, we have rated the draft EIS EC-2 (Environmental Concerns -- Insufficient Information). Our concerns are based on a lack of information on water quality, indirect impacts from tribal water uses, the range of alternatives and environmental justice. Detailed comments on these concerns are enclosed. 19

This rating and a summary of our comments will be published in the *Federal Register*. A copy of our rating system is enclosed. Thank you for the opportunity to review this draft EIS. Please contact Dan Robison at (509) 575-5845 if you have any questions about our comments.

Sincerely,

Richard B. Parkin, Manager
Geographic Implementation Unit

Enclosure

EPA Detailed Comments on Yakima River Basin Water Enhancement Project Draft EIS

General Comments

Alternatives

According to the Council on Environmental Quality regulations at 40 CFR Parts 1500-1508, describing the alternatives section of an environmental impact statement:

> This section is the heart of the environmental impact statement. Based on the information and analysis presented in the sections on the Affected Environment (§ 1502.15) and the Environmental Consequences (§ 1502.16), it should present the environmental impacts of the proposal and the alternatives in comparative form, thus sharply defining the issues and providing a clear basis for choice among options by the decision maker and the public. In this section agencies shall:
>
> (a) Rigorously explore and objectively evaluate all reasonable alternatives, and for alternatives which were eliminated from detailed study, briefly discuss the reasons for their having been eliminated.
>
> (b) Devote substantial treatment to each alternative considered in detail including the proposed action so that reviewers may evaluate their comparative merits.
>
> (c) Include reasonable alternatives not within the jurisdiction of the lead agency.
>
> (d) Include the alternative of no action.
>
> (e) Identify the agency's preferred alternative or alternatives, if one or more exists, in the draft statement and identify such alternative in the final statement unless another law prohibits the expression of such a preference.
>
> (f) Include appropriate mitigation measures not already included in the proposed action or alternatives.
>
> *§ 1502.14 Alternatives including the proposed action*

The draft EIS does not include a discussion of additional water storage in the basin. Therefore EPA believes that it does not give a complete picture of the potential range of alternatives. The final EIS should include an alternative that discusses additional water storage in more depth. With the implementation of additional water storage, there is some potential to meet the acre feet goals that have been established in the watershed. Installation of numerous equalizing reservoirs throughout the basin could also have a significant impact on available water. The final EIS should discuss the feasibility of these equalizing reservoirs.

Water Quality

The draft EIS uses monthly and annual flow comparisons as a basis for disclosing impacts on fish and water quality. However, the models that have been chosen to indicate flow data are not, according to your staff, capable of indicating low flows over a period of a few hours or even two or three days. This may be a critical period to ensure fish survival. The draft EIS

Alternatives: Page 16 of the draft PEIS (Section 1.6 "Document Scope and Organization" in the final PEIS) states that *"Because the emphasis of Title XII is on water conservation, alternative measures such as construction of additional storage facilities . . . not specifically authorized in the legislation will not be considered in this PEIS."* That decision was made during the planning of Phase 2 of the project, which culminated in passage of Title XII. Title XII specified that the major focus of the project is to be on water conservation, providing a mechanism for developing, evaluating, and implementing entity-specific water conservation measures and subsequent integration into a basin-wide conservation program.

Other mechanisms for enhancing the basin's water supply beyond what is ultimately possible through measures used in Phase 2 will be the subject of Phase 3. The consideration of additional storage as one of these mechanisms will depend on the success of Phase 2. If additional supplies are needed, subsequent legislation and associated documents will address this need. Additional text has been added to the PEIS to clarify this question.

Alternatives comment 2: Equalizing reservoirs are presented in the draft PEIS as one type of structural water conservation improvement under the Basin Conservation Program that may be considered for implementation in the future as plans are developed and submitted for approval. The feasibility of such an improvement cannot be determined at this time but will be addressed as it is proposed in the future. An assessment of its feasibility will be done at that time, along with required environmental compliance documents.

Water quality: This programmatic EIS is meant to provide a broad look at the effects of implementing a complex legislative package with many yet-to-be-defined parts. No actions will be implemented based solely on this NEPA document. Site-specific documents will be prepared for individual actions, once the action is better defined. Our staff intends to evaluate flow fluctuations over short time periods where appropriate in the site-specific, action-specific NEPA documents. From a technical perspective, it is neither accurate nor consistent with the purpose to evaluate such detailed questions at the programmatic level where individual actions have not yet been defined.

does not contain enough information to understand the impacts to fish and to water quality in the even that a short duration, low flow event occurs. It is possible that temperatures in that situation could rise quickly, and these impacts are should be evaluated in the final EIS. Additionally, flow fluctuation is only addressed in a generalized way. What would be the impacts of the various alternatives on flow over a 24 hour period? Would fluctuations of 8-12 inches be common? If so, what does this mean to fish survival or to stream temperatures?

Indirect Impacts

Part of the purpose of this proposal is to look at where potential savings from water losses could be possible. The draft EIS states on page 33 that the Yakama Indian Nation has the choice of whether to utilize the entire 50,000 acre feet in the Wapato Irrigation Project on Reservation, or whether to return some or all of this flow to the Yakima River. The draft EIS presently assumes that they will use the water for irrigation. However, since 50,000 acre feet is nearly 1/3 of the overall flow increase for the YRBWEP, EPA recommends that the final EIS evaluate the potential impacts if this water were returned to the river.

Environmental Justice

The draft EIS is mainly silent regarding the large minority community in the lower Yakima Valley. There are at least two impacts which should be addressed regarding this segment of the population. First, what impact will the alternatives have on the non-anadromous fish populations in the River and how would this impact the use by the Hispanic community who utilizes this fisheries for human consumption? Second, what are the social and economic impacts to the Hispanic community by changes in agriculture use brought about by any of the alternatives? Using county-wide income and employment figures does not address the potential impacts to this specific community. The current estimate of over 27,000 Hispanic workers in the lower valley makes this a significant population who's needs must be addressed. The final EIS should evaluate these environmental justice issues as part of the impacts section in chapter four of the EIS.

In general, limiting the scope of a draft EIS, to ". . . keep the scope of the analysis manageable, . . ." (Page 72) isn't justification for not evaluating the full range of impacts which may result from the action under consideration. This includes the storage issue and the impacts of the flow savings on the Reservation as two examples.

Part II Page Specific Comments

Page S-1, Purpose and Need. The last sentence of item 1.0 leaves out water quality, which is a very important item included on page 19. The sentence needs to read, "A need exists in the Yakima River Basin to protect, mitigate, and enhance fish and wildlife, to improve the reliability of the water supply for irrigation while improving water quality in the Basin."

Flow fluctuation: The hydrology model maintains a minimum of 300 ft^3/s in the stream as required by Title XII.

Indirect impacts: Section 1204 of Title XII provides for the development of water conservation efforts for the Yakama Indian Nation's (YIN) proposed system improvements. These improvements are the Wapato Irrigation Project, the Irrigation Demonstration Project, and the Toppenish Creek Corridor enhancement project. Such actions shall be coordinated with the Bureau of Indian Affairs. Annual water savings estimates were based on the above improvements and the measures in Title XII. These annual water savings of up to 50,000 acre-feet were cited in Reclamation's 1987 Plan of Study for the YIN on-reservation program.

Section 1204(a)(3) states that water savings resulting from irrigation system improvements shall be available for exclusive use by the YIN for irrigation and other purposes on the reservation. The intent of this section was to provide YIN the necessary discretionary authority to decide how water saved can best be used. Title XII is a funding source for these projects, and specific implementation of each project is therefore the responsibility of the YIN and BIA. The implementation of the irrigation demonstration project is at the discretion of the YIN and contingent on concurrence of the Secretary of the Interior. This implementation is also contingent on the YIN deciding to use all or part of the water savings from the Wapato Irrigation Project system improvements for this purpose. An Indian Self-Determination and Education Assistance Act contract (more commonly known as a 638 contract) was entered into with the YIN on February 19, 1997. The contract was developed to pass Federal funds from Title XII to the YIN. These Federal funds are allocated through annual funding agreements. The YIN is entitled to use the 50,000 acre-feet for any purpose stated in the contract. At this time, the YIN or BIA has not developed any specific criteria for the proposed system improvements, the Irrigation Demonstration Project, or the Toppenish Creek corridor enhancement project.

Environmental justice: Analysis of the relationships between the Hispanic community and agriculture has been added to the PEIS.

We recognize that the Hispanic population might consume nonanadromous fish. Site-specific activities will examine this issue if appropriate.

Second ¶ of comment: The sentence on page 72 in the draft PEIS has been rewritten in the final PEIS (page 75). The sentence in question referred specifically to biological factors that could be affected by the Federal action and was not meant to apply to the entire draft PEIS process. See sections 1.3.3 and 2.1 of the draft and final PEIS to understand why storage was not addressed here.

Page S-1: Correction made.

Page S-2, Include a discussion of the impacts of the Yakama Indian Nation returning the entire 50,000 acre feet of savings in the Wapato Irrigation Project to the Yakima River flow.

Page S-4, Include a discussion of groundwater contamination from pesticides, septic tanks and other sources. Data on the health of groundwater in the lower valley is inconclusive as to the extent of contamination. Thus the statement that water quality is generally "good to excellent" is not correct. More properly it is unknown.

Page S-5, third paragraph. There seems to be a conflict between the first sentence that states soil quality is generally good and the final sentence that reports excessive salts and alkali and a high water table. There seems to be an increasing acreage of highly alkaline soils developing in the lower valley. Is this correct and if so would any of the alternatives reviewed in the draft EIS impact this trend?

Page S-5. In the middle of the second paragraph under 3.5 Fish, it states that, ". . . during the irrigation season results in higher than optimal flows in the reach from Cle Elum to Roza. . . " What is the definition of optimal flow and how is it determined?

Page S-13. What is the basis for the conclusion of increased wind erosion from abandoned lands?

Page S-15. Where does one see the Basin Conservation Plan mentioned at the end of the second paragraph?

2 Page 16. Excluding storage impacts seems to fragment the whole process. Additional storage in the basin could drastically impact the alternatives covered in this draft EIS.

Figure I-2, page 16. Throughout the draft EIS it states that project specific actions will have NEPA review. It is important for the public to have an opportunity to participate if impacts from proposed projects are not disclosed in this draft EIS. This table shows that only EA level review is most likely and this will not be as involved from a public input standpoint. Therefore, the draft EIS should be much more in depth in its review of the cumulative impacts of all the projects.

Additionally, what is the basis for a Categorical Exclusion for flows at Sunnyside and Prosser, an EA for a biologically based instream flow by SOAC, which incidentally isn't being produced in the near future, and an EIS for an interim operating plan? These all are so closely intertwined it is not possible to separate them into three different levels of environmental review.

Page 19. How will review and comments on the preferred alternative be handled if that alternative is not chosen until the final EIS? What is the process should a preferred alternative be chosen that is not one of the ones listed in the draft EIS?

Page 19. The statement in item 2.1 is confusing since it says the emphasis of Title XII is water conservation yet at the bottom of the page and elsewhere the purpose of the program is to evaluate and implement measures to improve the availability of water supplies for irrigation and to protect and enhance fish and wildlife resources, including wetlands, while improving the

Page S-2: At this time, the YIN and BIA have not developed any specific criteria for the proposed system improvements, the Irrigation Demonstration Project, or the Toppenish Creek Corridor enhancement project. Therefore, Reclamation does not know what the impacts may be, since we do not know either how much water would be conserved or how it may be used. Specific analysis should be accomplished before implementing any system improvement. The YIN or BIA would be responsible for these analyses.
Page S-4: The statement in question refers to the cited Yakima Valley Conference of Governments' Water Quality Plan (1993) claim that overall groundwater quality is good to excellent. This assessment does not discount the local occurrence of degraded groundwater quality from septic systems or industrial and agricultural activities. While the localized areas of contamination are not fully defined, Reclamation agrees that the overall quality is more properly labeled as "unknown." The final PEIS has been changed to reflect this.
Page S-5 third ¶: The first sentence states, *"Soil quality is generally good, with only minor areas of salinity. . ."* The final sentence states, *"Most of the soils are well drained; however, drainage is restricted in some of the low lying areas, resulting in excessive salts or alkali and a high water table"* (emphasis added). Both sentences indicate most of the soils are of good quality with small areas having salt problems. No significant areas with increasingly higher levels of alkaline soils or salts were found in the lower valley.
Page S-5 summary section 3.5: This sentence has been revised in the final PEIS to increase clarity. References to "optimum flow" have been removed from the final PEIS.
Page S-13: There would be less vegetation to protect the soil from the wind.
Page S-15: The Basin Conservation Plan is available from the Upper Columbia Area Office, Yakima, Washington.
Page 16 comment 1: See response to general comment on alternatives.
Page 16 comment 2: There has been and will continue to be public input throughout this process, including input to the interim comprehensive basin operating plan. Reclamation's EA process includes public scoping and an opportunity for public review and comment of draft documents. The public should have ample occasion to comment on this process. Reclamation will incorporate public comments within the most appropriate environmental document.
Page 16 comment 3: Flows at Sunnyside and Prosser were strictly an operational issue and, thus, warranted developing a CE for the NEPA compliance. Flows were stipulated in Title XII. The level of NEPA compliance for all actions associated with Title XII was based on Reclamation's perception of the issues surrounding these tasks. The ultimate level of compliance for any site-specific action could change.
Page 19 comment 1: As stated in the first paragraph of chapter 2, the Council on Environmental Quality does not require a Federal agency to identify a preferred alternative in a draft PEIS. Reclamation decided the best course of action was to receive public comment on all the alternatives developed to get an unbiased perspective as to which alternative may cause some concern. Reclamation has been doing public involvement in the basin since the early 1980s and believes it has a perspective on what the public feelings and concerns would be. At the close of the 90-day public comment period, Reclamation had received no comments in regards to the adequacy or scope of the alternatives. To determine a preferred alternative, the PEIS team took into account all review comments, compiled and analyzed those comments, made any necessary changes and clarified the document, developed a list of criteria for determining a preferred alternative, and determined which alternative should be described in the final PEIS as the preferred alternative. Alternative 2A is preferred and environmentally preferred alternative.
In regards to selection of an alternative not described in the draft PEIS, Title XII sets limits, or "side boards," on measures to be implemented or considered. Consequently, the PEIS defines and evaluates different environmental aspects according to the measures authorized in the legislation. Reclamation would never select an alternative that was not describe in the document or authorized by the legislation. If another alternative was described, through either public participation or other means that Reclamation determines fits the scope of the purpose and need and requires equal consideration, then that alternative would be analyzed and an amended draft document would be submitted for another public review period.

quality of water in the Yakima River Basin. This latter statement could include storage facilities in addition to conservation.

Page 28. Several crucial documents that would or could have a bearing on this draft EIS have been deferred indefinitely or have not been completed. Therefore much of the data this draft EIS was to be based on has not yet been created, thus calling into question the validity of the conclusions of the draft EIS. Among these is the Report to Congress by the Secretary on the availability of a water supply adequate to sustain the agricultural economy of the Yakima Basin and target flows evaluated by SOAC that define the biological flows needed to sustain a viable fishery in the Basin. On Page 29, the draft EIS states that these reports shall provide the basis for the third phase of the YRBWEP. However, reviewing the earlier portions of the draft EIS, no mention of a Phase III is included. How could these reports possibly impact the conclusions and selection of a preferred alternative under this draft EIS?

Page 37. As stated earlier, inclusion of the extremes of no flow savings from the WIP or total flow return to the Yakima River needs to be included in the discussion here.

Page 38. Table II-4 references the Reclamation Reform Act and State Referendum 38. What are these and how do they impact the conclusions of this EIS? Under Alternative 2A, Water Conservation measures it states, "More alternatives may exist". Clarify this statement.

Page 44. Average yearly runoff doesn't address the critical needs of fish on a day-to-day basis. Timing of flow is critical, not average yearly flows.

Page 51. Table III-4. Are these target flows specifically listed in Title XII or are these numbers that have been adopted by policy by the Bureau of Reclamation? What is the basis for 300 cfs when there is less than above TWSA?

Page 52. It is not clear whether the hydrologic model looks at all temperature impacts such as flow variations of 8-12 inches on a daily basis. How does this impact temperature when flows increase and pass over heated gravel beds?

Page 54. Low flow isn't listed here as a water quality impaired parameter. It should be.

Page 55. Again low flow is the main parameter but isn't listed as such.

Page 56. What is the relevance to comparing nutrient levels in the Yakima with those observed in many rivers in the United States? How does the level in the Yakima compare to state water quality standards?

Page 56. The last sentence on this page is not correct. Phase II of the lower Yakima TMDL proposes to address sediment loading in tributary drains. Water availability is not the reason sediment loads are not set for tributaries.

Page 58. Sediment loading and hourly/daily fluctuation in water depth are also two of the largest

Page 19 comment 2: Title XII emphasizes water conservation. Later in the text, information is presented on the proposed uses for the conserved water, including improvement of available water supplies for irrigation, fish and wildlife, and water quality. The document has been edited to provide additional clarification.

Page 28: The draft PEIS discussed Title XII requirements for SOAC to evaluate the target flows. Currently, there is no mechanism to change the minimum flow recommendation of 300 ft^3/s, even if the SOAC recommends a higher flow. This would conceivably carry over into Phase 3. If funding is approved to achieve the biologically based target flows, then the next phase of the project will be implemented.

Page 37: It would be inappropriate to include a discussion of the impacts of the YIN returning water from WIP to the Yakima River under the format heading of "Alternatives Considered in Detail." This section is only to describe what the details of the various alternatives are in the PEIS. See the response to the comment on page S-2 (comment page 22) on discussions of impacts of the YIN returning water.

Page 38: The Reclamation Reform Act of 1982 requires districts that have certain repayment or water service contracts with the United States to develop water conservation plans which include definite goals, appropriate water conservation measures, and a time schedule for meeting the water conservation objectives. State Referendum 38 authorizes the State Finance Committee to issue State General Obligation Bonds, in part, for agricultural water supply facilities. Certain irrigation districts have developed water conservation plans in accordance with the requirements of the RRA. Many districts have cost share funding from the RRA or State Referendum 38. Such water conservation plans are useful with minor supplementation in the Yakima River Basin Water Enhancement Project which also provides funding for developing entity water conservation plans. Entity water conservation plans will identify the water conservation measures that will be proposed for implementation funding in the YRBWEP.

Page 44: Average yearly runoff was not used to determine impacts to fish; the section referred to discusses basic hydrologic factors and does not address fish issues. Flow timing, as it relates to impacts to fish, is important and is discussed under "Fish" (sections 3.6 and 4.6) and Section 3.1 "Overview" of the PEIS.

Page 51: Target flows are listed in Title XII.

Page 52: Flow impacts on a daily basis are beyond the scope of the PEIS.

Page 54: The impact of low flows and return flows on nutrients, turbidity or suspended sediment, stream temperature, and certain pesticides is discussed in Section 4.3.2 "Discussion of Impacts to Surface Water Quality."

Page 56 comment 1: This comparison of nutrient levels came from USGS, 1991. This comparison is relevant, as it provides an overall picture of nutrient levels.

Page 56 comment 2: This sentence is taken from the referenced State water quality report (Joy and Patterson, page 67).

Page 58 comment 1: Hourly/daily fluctuations in water depth considerations are beyond the scope of the document.

contributors to temperature increases.

Page 58, Section 3.3.5 Drains. Using 1974-84 data isn't very current. The Department of Ecology doesn't allow data older than 10 years for evaluation of water quality standards. Shouldn't this document, the draft EIS, reflect the use of current data also? Why does the document only reference the 94/95 data? It should use this more recent data set.

Page 64 Table III-7. Does this table include the disputed claims on file at the Department of Ecology or only actually issued permits?

Page 67. It is confusing to read that any saving in diversion by on farm improvements must be agreed to by the irrigation district vs. the statement that conservation savings are to be allocated one third to irrigation districts, two thirds to instream flow. What is the difference between these two concepts? Where in Title XII does the one third/two third split come from? Is this statutory or a policy decision by the Bureau?

Page 71.This draft EIS should include discussion of all relevant impacts, not just those related to fish. It is not a complete document otherwise.

Page 72. Limiting the scope of an EIS to make it "manageable" makes it an incomplete document.

Page 73. Reference is made to the Instream Flow Incremental Methodology for estimating instream flow needs. Table III-12 on Page 75 includes such estimates for various points on the mainstem. However, the draft EIS does not use these recommended flows for its analysis. Instead it uses a much lower flow figure of 300 cfs. The draft EIS does not explain why the IFIM numbers are not used. It further confuses the issues by talking about "optimum" flows and "beneficial" and "adverse" impacts to salmon and steelhead. No mention is made to impacts on resident, non-anadromous fisheries.

Page 74. Table III-11 does not include a discussion of Ahtanum Creek or tributaries coming from the Yakama Indian Reservation. This leaves the draft EIS lacking in complete coverage of the entire Basin.

In the same table it states that the river is totally confined from the Cle Elum River to Roza Dam. Is this correct?

Page 76. Be more specific regarding numbers of fish. "Many fish," vs "A few steelhead," vs "A significant number of spring chinook," etc. These are value judgements that don't tell the reader whether it is two, twelve, a hundred or thousands.

Page 77. Non-anadromous fish are of significance to the Hispanic population and should be addressed in this document.

Page 81. Make an estimate of the number of acres that may be impacted by this action. Will the

Page 58 comment 2: In section 3.3.5 "Drains," (Section 3.6.6 in the final PEIS) using the 1974-1984 data is valid for determining trends. Use of just 1994-1995 is not sufficient to determine trends. Additionally, 1994 was a drought year, one of the most severe on record, and data collected during that year would not necessarily be representative of the drain water quality. Therefore, no change in the document is necessary.

Page 64: Table III-7 in the draft PEIS and table 3-7 in the final PEIS include only actually issued permits and claims.

Page 67: The savings in onfarm improvements can be made by individual participating farms through diversion reduction agreements, in which the actual water diversion needs to be made at the Yakima River diversion point. Since the irrigation district services and holds the river diversions in trust for all the participating farm units within a district, when a farm enters into a diversion reduction agreement, the irrigation district is responsible for managing the amount of water to be diverted from the Yakima River diversion point. So agreement from the irrigation district is necessary. The following text has been added after the sentence in question: "*One-third of any saved water can be given to the irrigators during a dry year. However, a diversion reduction agreement must be in place before a given water conservation project will be authorized by Reclamation's Upper Columbia Area Office.*" (Section 3.5.1 "Irrigation Diversions," page 70 of the final PEIS).

Page 71: This paragraph has been modified to specify that the paragraph itself discusses only fisheries related impacts. The PEIS is not limited to fisheries impacts.

Page 72: Comment noted. The sentence has been changed to improve clarity in the final PEIS. The sentence was meant to refer to the use of specific indicators in the impact analysis for the Fish section and not to refer to the entire PEIS

Page 73: Some existing IFIM flows, as shown in table III-12 of the draft PEIS, were used in the analysis of fish impacts in the draft PEIS. For example, table IV-8 on page 140 of the draft PEIS uses these flows. These tables were removed from the final PEIS. The IFIM data were also used to estimate impacts to rearing fall chinook in the Parker reach. However, the IFIM flow data were not the only data used for the analysis. Although the text on page 139 of the draft PEIS states that 300-400 ft^3/s was considered necessary for adequate adult salmonid passage, the actual analysis used 400 ft^3/s as the criterion for adult salmonid migration past the dams. This is clarified on pages 76 and 140 of the final PEIS.

Several aspects of Title XII could affect salmon and steelhead. Some aspects of Title XII could be beneficial to, or adversely affect, various aquatic resources, depending upon the details of actual implementation. For example, water conservation can result in increased instream flows in a particular reach during a particular time, and this might benefit fish. However, water conservation could also decrease return flows in some areas, which could have adverse impacts to fish.

Impacts to specific resident fish (rainbow trout and fish species in the reservoirs) were evaluated in the draft PEIS.

Page 74: Ahtanum, Toppenish, and Satus Creeks are mentioned throughout the draft PEIS (see pages S-8, 13, 31-33, 37, 40, 66, 73, 76, 81, 82, 84, 85, 100, 142, 144, 150). In the final PEIS, these are Section 3.8 in the Summary, Project Summary Judgement in 1.3, 2.1.3 "Yakima Indian Nation," 2.2.3 (under Alternative 1), 3.1 "Overview," 3.4.8 "Groundwater Quality," 3.6.1 "Salmon and Steelhead Current Conditions and Trends," 3.7 "Vegetation and Wildlife Current Conditions and Trends," 3.7.2 "Wetlands," 3.10.3 "Recreational Use of Rivers," and 4.6.2 "Discussion of Impacts to Fish" 4.7.2, "Discussion of Impacts to Vegetation and Wildlife." Reclamation does not have any facilities in Ahtanum Creek or the tributaries coming from the Yakama Indian Reservation. The Council on Environmental Quality Regulations, in Part 1502.15, specifically state that an EIS should describe the environment of the areas *to be affected* by the alternatives considered. Other areas of the Yakima Basin are likely to be more strongly affected by this Federal action than the tributaries named and therefore these other areas received more attention in the PEIS.

Page 74 comment 2: Table III-11 in the draft and table 3-11 in the final PEIS state that the river is confined from the Cle Elum River to Roza Dam. Below Ellensburg, the river is confined by canyon walls. Above Ellensburg, the river is confined by dikes, agriculture, and general development. This area receives high flows during the irrigation season because releases are being made from the upper Yakima River reservoirs.

Page 76: Comment noted. The text of the final PEIS has reduced the vague references to numbers of fish. discussed under each alternative.

number go up or down? That is of some benefit in reviewing the impacts if nothing else is available.

Page 83. Re-regulation of flows "may" be used to guide the restoration effort. Will the concept be used or not? If so, where is a more detailed discussion of possibilities in this draft EIS? This discussion needs included along with that of main storage alternatives.

Page 89. No mention is made of the most significant minority population in the lower valley: the Hispanic community. This must be included to show the total population picture within the Basin.

Page 94. Using annualized household income as a comparison does not give a very clear picture of minority household impacts from changed agricultural practices due to actions of YRBWEP. Comparing household income against sales revenue also does not show the impacts on farm workers. A discussion of national comparisons vs. Yakima County doesn't show the impacts on minority families in the Yakima Basin.

Page 107. Since the Bureau acknowledges water as an ITA, has the Bureau been compensating or mitigating the adverse impacts of inadequate water in the Yakima River to the Yakama Nation?

Page 110. The discussion of impacts to surface water is very difficult to follow especially when the tables are in the appendix. Use of monthly and/or annualized flows does not address the impact to fish on a day-to-day basis. Showing percentage change when compared to the no action alternative is also difficult to follow. What margin of safety is included in these figures? Since they are only as accurate as the measured flow used as the input, how can discussions of a low flow target of 300 cfs be very meaningful against a model that is, at best, plus or minus 20-50%?

Page 111. Is a one-to-one reduction reasonable? How does the model determine the amount of diversion reduction to expect from the various structural element changes?

Page 115. Clarify in the third paragraph whether the decrease results in less basin water supply available to meet demands means for fish or for irrigation.

Page 116. The discussion of impacts to instream flow is very confusing. It also does not clarify the critical stretch of concern on the mainstem of the river nor the critical time of year for different species. There needs to be a bottom line in the discussion of impacts, i.e. what is the one with the least impacts to irrigators, which one with the least impact to fisheries, which one with the least overall impact. A simple table is missing showing this summary.

Page 128. The conclusion that the quality of groundwater in the Yakima River Basin is generally good to excellent is misleading since there is not sufficient data to draw this conclusion especially for the unconfined aquifer in the lower valley.

Page 77: Subsequent NEPA documents that deal with the site-specific elements of Title XII (as shown on page 17 of the draft PEIS) will address this issue if appropriate.
Page 81: These questions are addressed in chapter 4 of the draft PEIS. For example, see table IV-9 in the draft PEIS and table 4-11 in the final PEIS where acreages are presented under no action, and the nature of the impact is
Page 83: The concept of reregulation of flows has been eliminated from the project as a possible measure. The concept has been removed from the final PEIS.
Page 89: A discussion of population by race and Hispanic ethnicity has been added to Section 3.9 "Socioeconomics."
Page 94: Data are not available to indicate the level of household income by sector for minorities within the region. Added some detailed data to Section 3.9.2 "Household Income by Sector" (page 96 of the final PEIS) and Section 4.9.3 " Discussion of Economic Impacts" (page 166 of the final PEIS).
Page 107: We have initiated measures to enhance the quality of water to help protect the Yakama Indian Nation fishing rights. It was not Reclamation's intent to acknowledge water as an ITA. Section 3.13 " Indian Trust Assets" has been revised to reflect the specific rights assigned to Tribes by the Treaty of 1855, considered to be protected as ITAs. This is consistent with other areas of the PEIS containing discussions of ITAs.
Page 110: Discussion of impacts to surface water has been clarified.
Page 111: This assumption of a one-to-one reduction is based on the assumption that active conservation methods do not decrease the crop consumption rates. Therefore, all the reductions would be reflected in return flows. This was clarified in the text. This model is a generalized, broad overview for the PEIS. Site-specific actions would evaluate structural element impacts to diversion reductions.
Page 115: This section referred solely to irrigation demands. Text has been clarified.
Page 116: We have added a summary table of impacts overall (table 2-7 in the final PEIS) and summary tables of impacts to hydrology (tables 4-1 and 4-2 in the final PEIS).
Page 128: See response to comments on page S-4 in this letter.

Page 133. What is the basis for Alternative 2A and 2B causing increased weed infestation and a loss of jobs in the Agriculture sector?

Page 135. It is not valid to state that the loss of 30,000 acres of agricultural lands from irrigation is an adverse impact because these lands are a valuable resource unless, elsewhere in the document, there is an equal statement that converting these acres to shrub-steppe is a positive impact because of the shortage of shrub-steppe in the region and the nation. The problem is that it is unknown what might happen to these acres. Can the Bureau determine which acres these are? Isn't it likely they would be marginal farm lands at best? Would this then be as major an adverse impact as if they were highly productive lands? In fact, conversion from irrigation to other uses may actually be a beneficial use of the land rather than the marginal use now undertaken. The problem is that the statement in the draft EIS is very value laden and not based on what in known will happen to any land taken out of irrigation.

Page 136. One of the most critical flaws in the whole draft EIS is that contained in the second paragraph of section 4.6.1. Short-term flow fluctuations may have impacts to salmon and steelhead survival. This kind of analysis is not easily incorporated into the hydrology model used for this analysis. We recommend that the Bureau disclose the impacts of short term flow fluctuations in the final EIS. This may mean use of a different model, or extrapolating from the existing model using best professional judgement.

Page 137, Table IV-7. Since Alternative 3 does not address tributaries so no potential benefits from this program occur, then Alternative 3 should be discarded as not meeting the purpose and need of the draft EIS.

Page 139. The second paragraph under the No Action alternative discusses "optimum" flows. It states that sometimes flows will be too low at Parker and Prosser while other times flow will be too high while at times flows higher than the "optimum" are needed to maintain ecosystem integrity and the aquatic food base, for channel maintenance and for downstream migration of smolts. Saying flows are too low or too high is subjective. A more definitive description needs to be included here.

Page 141. Why do very few adult steelhead pass Pomona under current conditions? Is this significant in itself? If not, why is it mentioned here?

Page 141. Temperature can always block salmon and steelhead depending on its severity.

Page 141. Use of Average flow at Prosser does not address the impacts of short-term low flows. How accurate is the use of 400 cfs average? Can this go from zero to 1000?

Page 142. Showing improvement compared to Pre-Title XII conditions doesn't tell whether the improvement is adequate. Where does the draft EIS define what is acceptable improvement under Title XII vs unacceptable? Is there a time frame lain out for reaching these acceptable levels?

Page 133: Alternative 2A does not list an impact from increased weed infestations. Under Alternatives 2B and 2C, reduced diversions will result in abandoning irrigated lands. Reduced weed control on some of these lands will result in spreading weed seeds to adjacent lands. Fewer irrigated lands will reduce crop production requiring agricultural labor and, thus, lower the demand for agricultural workers.

Page 135: The third sentence in the next to last paragraph states, *"This reduction could be considered an adverse impact to agricultural resources because these lands are a valuable resource"* (page 138 in the final PEIS). Converting lands from irrigated agricultural to shrub-steppe or other nonagricultural use is an adverse impact from an agricultural resources standpoint, as it reduces the potential for agricultural production. The lands of the Yakima River Basin are some of the most agriculturally productive lands in the Western United States. This statement is provided to show impacts to agricultural resources and does not discount the value of the land for non-agricultural uses.

Reclamation cannot predict which acres would be affected, as these are the landowners' decisions. Productivity is only one of many factors landowners will consider when determining which lands to retire; thus, predicting that marginal lands will be retired first is not valid. However, even retiring the least productive 30,000 acres will have a definite adverse impact on agricultural resources.

Page 136: The aspect of Title XII that could affect short-term flow fluctuations is the interim comprehensive basin operating plan. It is anticipated this plan will consider flow fluctuations and could incorporate improved river management for anadromous fish. A NEPA document will be prepared before implementing this plan. If implemented, this may help reduce in-river flow fluctuations. Flow fluctuations would not differ among action alternatives because each action alternative includes developing the interim comprehensive basin operating plan in the same way. Furthermore, it is not clear that Reclamation's operations alone can alter short-term flow fluctuations, because the reservoirs are high in the system and releases take days to reach some areas where flow fluctuations are an issue. Operators have experimented with more gentle transitions in flow changes; for example, the "flip-flop" is implemented more gradually now than historically. Reclamation is currently exploring opportunities in the Yakima Basin to acquire more information on the effects of flow fluctuations and general ecosystem functioning.

Short-term flow fluctuations are best evaluated as each element of Title XII is implemented because the actions will be more clearly defined compared to the broader scope of the PEIS. The text has been changed to clarify that the focus of the programmatic analysis is to determine the differences among alternatives.

Page 137: Alternative 3 is presented in this manner as a way to distinguish among the various components of Title XII and to display a range of alternatives. In this sense, Alternative 3 is a necessary component of Title XII as presented in the draft PEIS.

Page 139: The second paragraph under no action on page 139 of the draft PEIS refers the reader to Section 3.6.1, which describes conditions and defines optimum flows as used in the analysis. Optimum flow discussions have been removed from the final PEIS.

Page 141 comment 1: This sentence has been deleted in the final PEIS.

Page 141 comment 2: Comment noted.

Page 141 comment 3: The hydrology model is a tool that allows us to carefully examine *relative* differences among alternatives. Average monthly flows here refer to the average over the period of record or in this case, from 1926 to 1994. Model simulated flows at Prosser in September varied from 300 to 600 ft^3/s; in October, from 300 to 1,395 ft^3/s.

Page 142: The purpose of this PEIS is to disclose impacts of the proposed action and other alternatives compared to no action. Pre-Title XII conditions are disclosed so that the public has a fuller view of the impacts of Title XII (the target flows were implemented immediately and, thus, were incorporated into the no action alternative). Specific goals of Title XII are discussed in Section 2.1.1 Basin Conservation Program; the goals refer to water savings.

Page 148. Table IV-9. This is a confusing table. It is listed as a summary of impacts of the alternatives. How does one read the numbers under the no action alternative? Are these impacts or are these a statement of the situation . What is the meaning of the acreage listed?

Page 150. List the positive and negative impacts of the Wapato Irrigation Project in their own alternative as compared to the alternatives covered by this document.

Page 151. If one objective of the draft EIS is to point out what actions must be monitored to avoid adverse impacts, where in the document is this done? What are the impacts if it isn't done?

Page 161. Pointing out the adverse impacts within the agriculture community of selling water rights in Utah needs to be balanced by pointing out positive impacts such as being able to provide adequate electric power to users through the region etc. This format is rather one sided. Again, what are the impacts if no monitoring is done on the social well being segment?

Page 164. The draft EIS lacks a discussion of impacts to farm workers.

Appendix A Surface Water Hydrology. Why is residual storage at the end of September subtracted if it is the quantity of water that cannot be discharged from the reservoirs because of hydraulic constraints? This number would always be in the formula but is meaningless. If it is used to describe the size of storage it is misleading also because it really isn't storage if it can't be used.

Figure A-1 is very confusing and hard to decipher. It should be redone or removed, it is impossible to read for someone not familiar with its design.

Page 148: Table IV-9 in the draft PEIS and table 4-11 in the final PEIS have been clarified. Numbers in the no action column refer to the numbers of acres that are currently in the basin.

Page 150: Since, at this time, the YIN or BIA has not developed any specific criteria for the proposed system improvements, the Irrigation Demonstration Project, as well as the Toppenish Creek Corridor enhancement project, it would be extremely difficult to list the positive and negative impacts from each action. As stated in the PEIS, specific analysis should be accomplished before implementing that action. Title XII is a funding source for these projects, and specific implementation of each project is, therefore, the responsibility of the YIN and BIA.

Page 151: From a technical perspective, water conservation efforts should be evaluated site specifically because, depending on many case specifics, the effort could either beneficially or adversely impact fish and wildlife (or both). This information has been added to the summary section of the final PEIS, and Section 4.7.2 "Discussion of Impacts to Vegetation and Wildlife" has been clarified. The comprehensive management plan discussed in the last bullet of Appendix D "Environmental Commitments" emphasizes the need for a basin-wide coordinated effort to "maximize the benefits of water conservation measures to irrigation interests and fish and wildlife resources."

Page 161 comment 1: Discussion was provided as an example of social impacts. Test has been clarified. See page 166 in the final PEIS.

Page 161 comment 2: Text has been changed from "monitoring" to "analysis." Water acquisitions using methods based on the analysis of impacts would help promote community cohesion. We are monitoring water rights acquisition procedures.

Page 164: Data are not specific enough to indicate who would be affected by actions that affect the agricultural sectors or show how the different alternatives would affect Hispanics or other ethnic groups. We added explanations to Section 4.9.3 "Discussion of Economic Impacts."

Appendix A: Water can be released, but at a limited rate. Kachess Dam modification was one of the structural modifications studied and was included in the PEIS, in Section 2.1.2 "Project Operations and Facilities Modifications." The modification decreased the hydraulic constraint; the procedure is necessary.

Appendix A figure A-1: Figure A-1 is designed to show end points used in the hydrology model. Chapter 4 has been redesigned to discuss hydrologic impacts without requiring the reader to consult figure A-1, which is retained for technical reference.

EPA
Attachment 1

SUMMARY OF THE EPA RATING SYSTEM
FOR DRAFT ENVIRONMENTAL IMPACT STATEMENTS:
DEFINITIONS AND FOLLOW-UP ACTION *

Environmental Impact of the Action

LO--Lack of Objections

The EPA review has not identified any potential environmental impacts requiring substantive changes to the proposal. The review may have disclosed opportunities for application of mitigation measures that could be accomplished with no more than minor changes to the proposal.

EC--Environmental Concerns

The EPA review has identified environmental impacts that should be avoided in order to fully protect the environment. Corrective measures may require changes to the preferred alternative or application of mitigation measures that can reduce the environmental impact. EPA intends to work with the lead agency to reduce these impacts.

EO--Environmental Objections

The EPA review has identified significant environmental impacts that should be avoided in order to provide adequate protection for the environment. Corrective measures may require substantial changes to the preferred alternative or consideration of some other project alternative (including the no-action alternative or a new alternative). EPA intends to work with the lead agency to reduce these impacts.

EU--Environmentally Unsatisfactory

The EPA review has identified adverse environmental impacts that are of sufficient magnitude that they are unsatisfactory from the standpoint of public health or welfare or environmental quality. EPA intends to work with the lead agency to reduce these impacts. If the potential unsatisfactory impacts are not corrected at the final EIS stage, this proposal will be recommended for referral to the CEQ.

Adequacy of the Impact Statement

Category 1--Adequate

EPA believes the draft EIS adequately sets forth the environmental impact(s) of the preferred alternative and those of the alternatives reasonably available to the project or action. No further analysis of data collection is necessary, but the reviewer may suggest the addition of clarifying language or information.

Category 2--Insufficient Information

The draft EIS does not contain sufficient information for EPA to fully assess environmental impacts that should be avoided in order to fully protect the environment, or the EPA reviewer has identified new reasonably available alternatives that are within the spectrum of alternatives analyzed in the draft EIS, which could reduce the environmental impacts of the action. The identified additional information, data, analyses, or discussion should be included in the final EIS.

Category 3--Inadequate

EPA does not believe that the draft EIS adequately assesses potentially significant environmental impacts of the action, or the EPA reviewer has identified new, reasonably available alternatives that are outside of the spectrum of alternatives analyzed in the draft EIS, which should be analyzed in order to reduce the potentially significant environmental impacts. EPA believes that the identified additional information, data, analyses, or discussions are of such a magnitude that they should have full public review at a draft stage. EPA does not believe that the draft EIS is adequate for the purposes of the NEPA and/or Section 309 review, and thus should be formally revised and made available for public comment in a supplemental or revised draft EIS. On the basis of the potential significant impacts involved, this proposal could be a candidate for referral to the CEQ.

* From EPA Manual 1640 Policy and Procedures for the Review of Federal Actions Impacting the Environment

February, 1987

State of Washington
DEPARTMENT OF FISH AND WILDLIFE

July 22, 1998

Mr. Robert Black
USDI Bureau of Reclamation
Denver Federal Center
P.O. Box 25007
Denver, CO 80225-0007

29

Subject: Draft Programmatic Environmental Impact Statement (PEIS) for the Yakima River Basin Water Enhancement Project (YRBWEP), Washington

Dear Mr. Black:

Thank you for the opportunity to review the Draft PEIS for YRBWEP. Washington Department of Fish and Wildlife (WDFW) is working with the Bureau of Reclamation as a participant in the Conservation Advisory Group (CAG), and the System Operations Advisory Committee (SOAC) referenced in the Draft PEIS. We are acutely aware of the issues addressed in the PEIS, and are looking forward to the implementation of Title XII measures and the Basin Conservation Plan in a manner that will help restore fish, wildlife and their habitat.

The Draft PEIS provides analysis of general environmental impacts associated with implementation of Title XII for six potential scenarios (the "no action" alternative and three action alternatives, with alternative two presented in three different approaches). While this splitting of the YRBWEP into various scenarios is helpful in understanding the variations of impacts, the public and decision makers need to understand that the elements of Title XII are intended to work together synergistically so that strategic, conscientious implementation of all of the Title XII YRBWEP elements as a package will provide greater benefits than that provided by each element in isolation. However the converse is also true. A poorly implemented program has significant potential to cause adverse impacts which undermine the intent of Title XII. We offer the following comments.

Conservation may inadvertently decrease instream flows
Unless carefully managed, conservation improvements have the potential to actually decrease instream flows and have significant adverse affects on fish and wildlife. Improved irrigation delivery and water application can increase not only crop production but also the consumptive use of water by the crop. Improved water supplies and reliability can encourage switching from crops which require relatively modest amounts of irrigation (such as wheat) to more water intensive crops (such as orchards). Water conservation creates the illusion of "new water" and can encourage "water spreading" which is already a controversial problem in the Yakima River Basin. The enclosed article by Huffaker and Whittlesey is a good attempt to explain these problems in simple terms. Bureau staff are well aware of these potential pitfalls and have discussed the issues with advisory groups. Good models, measurement and monitoring are essential to minimize these problems.

The analysis in the PEIS should explain how the Basin Conservation Program can result in unintended adverse impacts to fish. The PEIS should also identify and describe monitoring of diversions, instream and return flows, acreage of irrigated lands and changes in fish and wildlife habitat including wetlands, as mitigation measures necessary to ensure the Program achieves the intent of Title XII.

30

The PEIS does not point out the essential need for water acquisition as part of YERBWEP
Water acquisition is essential to the success of YRBWEP. The PEIS needs to emphasize that water acquisition provides the most immediate relief for instream flow problems affecting fish (including species listed and proposed for listing under ESA). Implementing structural conservation measures will take considerable time whereas the current water leasing pilot program is already improving instream conditions for fish. Secondly the PEIS needs to emphasize that water acquisition is necessary in order to address instream flow problems during years of proration. Lastly, the PEIS should note that acquired water and associated lands are necessary to provide flexibility to manage and restore the river system to more "normative" conditions.

Hydrologic Model is not a reliable predictor of affects on fish, wildlife and habitat
The hydrologic model used in the PEIS, while useful for gross comparisons between alternatives, provides a very coarse measure of changes in the river environment. We are not confident that it accurately predicts benefits or adverse impacts to fish, wildlife or their habitat. Discharge measured at gaging stations on the river cannot be interpreted without concurrently considering variations in operations (e.g. ramping, fluctuations, freshets, etc.), factors that relate to channel morphology (e.g. side channels, wetted width etc.) and habitat structure both in channel and within the floodplain. Ultimately, additional parameters and site specific information are needed to improve the model's predictive ability. Until a more complete model is available, the PEIS

Conservation: We agree that implementing water conservation measures can result in unintended adverse impacts to fish and wildlife. We address this issue in the summary (Summary Section 4.6 "Vegetation and Wildlife") and in chapter IV (Section 4.6.2 "Impacts to Fish" and Section 4.7.2 "Impacts to Vegetation and Wildlife"). Our efforts to avoid adverse effects are also addressed in the environmental commitments section (appendix D). These discussions are on a broad overview level as appropriate for a programmatic document. Site- and action-specific documents would discuss impacts to fish and wildlife in more detail.

Need for water acquisition: Comment noted.

The final PEIS emphasizes the benefits of water acquisition in the fish sections. Specific references to the benefits of water acquisition for fish can be found in the Summary Section 4.6 "Vegetation and Wildlife" and in Section 4.6.1 "Summary of Impacts to Fish."

Water acquisition could be an important tool to address instream flow problems during years of proration. It is unknown at this time if a significant amount of water can be acquired with a voluntary program. The diversion reduction agreement with the individual irrigation districts will also include a diversion reduction during years of proration. The details of the diversion reduction agreements are also unknown at this time. This agreement may increase instream flows during years of proration.

Title XII addresses increasing instream flows in the Yakima River system. To restore the river system to a more "normative" condition is not referred to in Title XII.

Hydrologic model: We agree that the model provides a broad, not specific, look at the differences among alternatives. One purpose of the PEIS is to disclose and discuss the elements of Title XII and to look for the broad ramifications of overall implementation. The model was not used alone to look at impacts to fish and wildlife–other factors are also considered, as discussed in Section 4.6.2 "Discussion of Impacts to Fish" and Section 4.7.2 "Discussion of Impacts to Vegetation and Wildlife." The detailed evaluations of fish and wildlife will occur at the site-specific, action-specific level. This is the level where "interpretation on a reach-by-reach basis while considering the observations and experience of the basin's fish and wildlife managers" will occur.

predictions as to effects on fish, wildlife and habitat should be viewed cautiously. Interpretation on a reach-by-reach basis while considering the observations and experience of the Basin's fish and wildlife managers is necessary.

Kachess Reservoir augmentation with flows from Cabin and Silver Creeks should be analyzed as a separate alternative.
Although the feasibility assessment is not yet complete, early indications are that diversion of flows from Cabin and Silver Creeks will not make significant water available to improve flows, but will likely adversely affect fish is several ways. Including this element in alternative 2 is not warranted and detracts from the usefulness of the alternative.

An EIS for this element should be required and the discussion in the PEIS on Tiering of NEPA review should state so explicitly.

31

Tributary enhancement is important element of Title XII
Tributary streams provide spawning and rearing habitat and instream flows essential to the restoration of salmonid populations in the Yakima River Basin. The PEIS should explicitly note the need for enhancement in the tributaries and that based on current activities in the basin, such enhancement appears feasible.

Preferred Alternative Recommendation
Since the Basin Conservation Program is a voluntary program, the Bureau will likely not be able to select an alternative exactly described in the PEIS and WDFW does not recommend any of the alternatives as presented. The full range of Title XII elements need to be implemented, including water acquisition and innovative conservation measures as described in the act. WDFW recommends implementation consistent with the Basin Conservation Plan prepared by the Conservation Advisory Group. This plan has the best chance of integrating the several Title XII elements and the voluntary Basin Conservation Program to achieve the goals of Title XII.

Alternative 2A, without augmentation of Kachess Reservoir with flows from Silver and Cabin creeks, probably provides the closest prediction of flow changes from implementation of this plan, since the Basin Conservation Plan does not preclude conservation measures above Roza Dam. While other alternatives appear to provide somewhat higher target flows using the assumptions of the PEIS hydrologic model, we lack confidence in the hydrologic model

Kachess Reservoir: It is a requirement of NEPA and a consensus from the PEIS team that all portions of Title XII be considered on an equal basis. Therefore, Kachess augmentation was included in Alternative 2 since that alternative includes all measures of Title XII, plus different levels of water conservation. Also, since the assessments are not complete, it would be inappropriate for this agency to come to any preconceived decision on the implementation or nonimplementation of such an action. As stated on page 31 in the draft and final PEIS, Reclamation is deferring any decision on this measure until other components of Title XII have been implemented and all appropriate assessments have been completed.

As for the decision to do an EIS on this measure, the document reflects Reclamation's position that an EIS will probably be necessary in figure I-2 of the draft and final PEIS. A description of tiering is found on page 16. It is not necessary to include a specific discussion of tiering in relation to the potential implementation of one measure since this is a programmatic document about implementing Title XII and not a site specific document.

Tributary enhancement: The final PEIS has been changed to reflect this comment.

Preferred alternative recommendation: The PEIS team has analyzed all the comments received and recommended Alternative 2A as the preferred and environmentally preferred alternative. Just because a portion of a program is voluntary does not mean that it cannot be implemented. Implementing just the Basin Conservation Program alone will not provide the maximum benefit necessary to meet the purpose and need in the Yakima River Basin. Title XII is very specific in its scope of how the maximum benefit should be achieved, and that is the basis of this document's discussion.

predictions of benefits and impacts to fish and wildlife and therefore recommend program implementation not be based simply on these predicted target flows.

Sincerely,

Brent D. Renfrow
Area Habitat Biologist

Enclosure

PLANNING DEPARTMENT

128 North Second Street • Room 417 • Courthouse • Yakima, Washington 98901
(509) 574-2230 • 1-800-572-7354 • FAX (509) 574-2231

RICHARD F. ANDERWALD, AICP
DIRECTOR OF PLANNING / SPECIAL PROJECTS

STEVEN [illegible]
ASSISTANT DIRECTOR

RECEIVED
JUL 27 1998

DATE	INITIALS	CODE
		2580

July 22, 1998

Mr. Robert Black
Bureau of Reclamation
Denver Federal Center
P.O. Box 25007
Denver CO 80225-0007

Re: Draft Programmatic Environmental Impact Statement (Draft PEIS) for Implementing Provisions of Phase 2 of the Yakima River Basin Water Enhancement Project

Dear Mr. Black:

We reviewed the Draft Programmatic Environmental Impact Statement for the Yakima River Basin Water Enhancement Project. We are pleased to see this project going forward.

Surface Water Hydrology. In reviewing the Draft PEIS, it was clear that surface water hydrology impacts had been considered in determining impacts on fish, agriculture, water quality, etc., yet it was difficult to understand and evaluate the impacts on surface water hydrology. We offer the following suggestions to make the surface water hydrology information and analyses more accessible.

33

1. In the summary, the statement that "Impacts of Alternative 2A, 2B, 2C, and 3 are not measurable" needs some explanation. At first reading, this seems to say that it wasn't possible to determine the surface water impacts for most of the alternatives. In Section 4.2, however, "measurable" is defined as a change of 10% or less from the No Action Alternative. As the Draft PEIS states in several places, the level of accuracy of flow measurements in the model could account for this amount of change. The summary should explain the findings from the environmental analysis in a way that the general reader can understand without having to refer to other sections of the plan. Since so much of the other analysis derives from the impacts on surface water hydrology, it might be worthwhile to spend more time with this section.

2. In Section 4.2, Surface Water Hydrology (Section 4.1 in Table of Contents), a difficult subject is made more difficult by placing the flow tables (4.2 and 4.3) in the water quality section, and referring the reader to figures and tables in the appendices. The text of this section talks about "major increases in the instream flow releases for the average year" and "a moderate increase" for Alternatives 2B and 2C for the dry year. A summary table with a few explanations would be helpful, either here or in the summary section. In Section 4.2.1, the narrative doesn't provide the reader with a summary analysis of the tables, just references to tables and figures found elsewhere. The reference to Table IV-2 is confusing in that Prosser Dam is mentioned in the narrative, but not in the table that appears in Section 4.3.2 (Water Quality).

3 One would expect that the large reductions in withdrawal from Alternatives 2A, 2B and 2C, combined with the Water Conservation Plan, would have a significant positive effect on water quantity. If this is not the case, some explanation is needed, even in the summary.

Agricultural Resources. Ground leveling and all actions and conservation methods that affect wetlands and floodplains must be undertaken carefully. While Section 4.4 refers to ground leveling as a best management practice, this is the typical way wetlands are lost and floodplains filled. Yakima County has specific goals, policies and regulations dealing with this issue. In some areas, implementation of ground leveling could be counter productive to endangered species efforts. We would like to be involved in any plans or activities that relate to our regulatory and enforcement responsibilities under the statutes of Washington State and Yakima County ordinances enacted pursuant to those statutes.

Surface water hydrology:

1. The less than 10 percent class was selected because impacts shown in the model would not be measurable due to gauging error. See table 4.3 in the final PEIS. We modified the Summary Section 4.1, rewrote hydrologic section 4.2, and added tables 4-1 and 4-2 to address these concerns.

2. The table references were incorrect. These references should have been to tables appendix A. To clarify, we have developed summary tables of surface water hydrology impacts (tables 4-1 and 4-2), in the final PEIS.

3. Water quantity is increased at Parker and Prosser as intended by Title XII. The summary of surface water impacts has been rewritten to reflect this.

Agricultural resources: Ground leveling will only occur on currently disturbed and under production agricultural lands. Reclamation follows the Executive Order 11988 of 1977 for Floodplain Management and Executive Order 11990 of 1977 for the Protection of Wetlands.

Fish. Alternatives 2A, 2B and 2C all appear to have the same impacts to salmon, steelhead and resident fish. Given the differences in diversion demands, it would be helpful to understand why this is the case.

General Comments. Is there any difference among the alternatives in how well they meet the goals of the legislation? If so, that should be part of the analysis. Also, a table summarizing all impacts ("y" axis) for all alternatives ("x" axis) would help the reader understand the summary section, with categories such "no measurable impact," "minor impact," "moderate impact," and "major impact" filing in the boxes. Finally, some additional editing is needed to assure consistency between Table of Contents and text, and between narrative and tables referenced.

Thank you for the opportunity to comment on this proposal. We would like to look at this analysis again, when we have a clearer view of the impacts. We hope that these comments will prove helpful

Sincerely,

Elaine A. Taylor

Elaine A. Taylor
Long Range Planning Manager

G:\USERS\ELAINETW\PREVIEW\grouse.doc

Fish: There are no *basin-wide* differences in diversion demands among Alternatives 2A, 2B, or 2C. However Alternatives 2B and 2C differ from Alternative 2A in the location of the reduction in diversion demands. In other words, Alternatives 2A, 2B, and 2C are the same, except for *where* water conservation measures are implemented (and how much at the location selected). Broad implications for fish of the differences in water conservation application were not detectable from the analyses conducted; however, see Section 4.2.2 "Discussion of Impacts to Surface Water" for more information.

General comments: Corrections made. A summary table of impacts has been added to the summary and chapter II. (See tables S-1 and 2-5 in the final PEIS).

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Ecological Services
517 South Buchanan
P.O. Box 1157
Moses Lake, Washington 98837
(509)765-6125 Fax: (509)765-9043

July 22, 1998

Memorandum

To: Robert Black, U.S. Bureau of Reclamation,
Denver, Colorado
Attn: D-8580

From: Kurt R.Campbell, Supervisor, U.S. Fish and Wildlife Service
Moses Lake, Washington

Subject: Comments on Draft Programmatic Environmental Impact Statement

This is in reference to the Bureau of Reclamation's Draft Programmatic Environmental Impact Statement (PDEIS) for the Yakima River Basin Water Enhancement Project. We provide the following comments for your consideration.

35

The recent listing of bull trout as threatened under the Endangered Species Act by the U.S. Fish and Wildlife Service on June 10th, 1998, amends the previous "proposed" status. See page I-2 of the PDEIS for all bull trout references in the document, some of which now need to be changed.

Pages S-6 and 77- Bull trout occur below the city of Yakima, WA. The last confirmed report was June 17, 1997 near Benton City by Anthony Fritts and Dave Burgess (WDFW, fisheries personnel, Yakima River Species Interactions Studies Group, Ellensburg, WA (509) 925-4467).

Page 77- Bull trout are also located in the mainstem and several tributaries and are important components of the ecosystem.

Page 86- Steelhead are now listed as proposed, rather than candidate species. Contact the National Marine Fisheries Service for more information on that species.

Page 98- Keechelus Lake is the highest reservoir in the Upper Kittitas Basin; however, Bumping Lake is the highest in the Basin.

Page 99- "Bumping, Clear and Rimrock Lakes ..." are administered by the Wenatchee National Forest, not the Snoqualmie National Forest.

Recent listing: Comment noted; references to "proposed" status for bull trout will be changed throughout the document.

Pages S-6 and 77: Comment noted. The text has been altered to reflect the comment.

Page 77: Comment noted.

Page 86: Comment noted. The text of the final PEIS has been appropriately modified to reflect this comment.

Page 98: Correction made.

Page 99: Correction made.

Page 151- We recommend that "criterium" be changed to criterion.

We appreciate the opportunity to provide comments. If you have any questions, or need some clarification or additional information contact Don Haley of my staff at (509) 765-6125.

c: FWS, Spokane, WA
FWS, Yakima, WA (Jeff Thomas)

Page 151: Correction made.

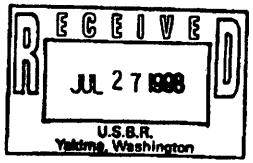
USDA

United States Department of Agriculture

Natural Resources Conservation Service

316 W. Boone Ave, Suite 450
Spokane, WA 99201-2348

Phone 509-323-2967
Fax 509-323-2979



Date: July 23, 1998

Jerry Jacoby, NRCS/BOR Liaison
USDI Bureau of Reclamation
PO Box 1749
Yakima, WA 98907-1749

Thank you for the opportunity to review the **Draft Programmatic Environmental Impact Statement, Yakima River Basin Water Enhancement Project.** My staff has reviewed the document and we are providing the following general comments:

1. The DEIS has not identified a preferred alternative. This should be done at this stage in order to develop a comparison of the alternatives and an analysis of the predicted effects that include the preferred alternative. The preferred alternative can then be easily assessed using this process.
2. It is difficult to determine if any of the identified alternatives satisfy the goals of Title XII of Public Law 103-434, Yakima River Basin Water Enhancement Project.
3. The DEIS should contain the information that was used to determine the "effects." Examples are: sources of sediment, pesticide impacts, and impacts to farm units.
4. It is not clear whether the water that will be conserved will remain in the river or be used for additional irrigation of lands in the project area.
5. Why was a draft programmatic EIS developed without selecting a preferred alternative?

37

Sincerely,

Acting

LEONARD JORDAN
State Conservationist

cc: Frank R. Easter, WPTL, Spokane SO

1. The Council on Environmental Quality does not require that a preferred alternative be identified in a draft environmental impact statement. Reclamation decided not to identify a preferred alternative in the draft to ensure, to the maximum extent possible, that we did not bias the public comments toward any alternative. Reclamation believes that the draft PEIS displayed a valid comparison of all alternatives to the No Action Alternative. In the final PEIS, Reclamation has identified Alternative 2A as the preferred and the environmentally preferred alternative.

2. The purpose of Phase 2 of Title XII is to meet the water needs of the basin through improved water conservation and management and other appropriate means. The goals are to protect, mitigate, and enhance fish and wildlife and to improve the reliability of the water supply for irrigation. Specific items to meet those goals are to realize sufficient water savings from the Basin Conservation Program and the water acquisition program, which is designed to achieve: (1) by the end of the fourth year, not less than 40,000 acre-feet of water savings annually, and (2) by the end of the eighth year not less than 110,000 acre-feet of water savings annually to protect and enhance fish and wildlife resources and 55,000 acre-feet annually for availability for irrigation. Participation in the Basin Conservation Program and water acquisition program is voluntary. The five action alternatives evaluated in the PEIS incorporate each of these areas. Therefore, it is Reclamation's position that all of the alternatives evaluated in the PEIS will at some level meet the goals of Title XII.

3. The information used to develop the affected surface water quality is cited in Section 3.3 "Surface Water Quality."

4. Title XII specifically states that water conserved shall not be used to expand irrigation in the Yakima River Basin except on the Yakama Indian Reservation. The following sentence has been added to the Summary Section 1.0 "*Title XII specifically states that conserved water resulting from the expenditure of Federal funds shall not be used to expand irrigation in the Yakima River Basin, except as specifically provided in section 1204(a)(3) on the Yakama Indian Reservation.*"

5. See response to comment 1 in this letter.

List of Preparers

Robert Black has a B.S. in zoology, an M.S. in aquatic biology, and an M.S. in public administration. Robert has 22 years of experience with the Bureau of Reclamation (Reclamation) in the area of project and natural resource planning and environmental compliance activities. Robert contributed to chapters in this programmatic environmental impact statement (PEIS) addressing purpose and need, alternatives, and consultation and coordination.

Susan Black has a B.A. in economics and 15 years of experience with Reclamation. Susan's contribution to this document involved revisions to the social, environmental justice, Indian Trust Assets (ITAs), and public involvement sections.

Kayti Didricksen has a B.S. in geology and is presently completing an M.S. in hydrogeology. Kayti has worked for Reclamation since 1978 and currently works in the Water Systems Investigations group of the Pacific Northwest Regional Office.

Earl R. Ekstrand is a natural resource economist, has a Ph.D. in economics from Colorado State University, and has spent about 5.5 years working on Federal projects.

Tom Hovland served as an engineer and technical writer for Reclamation for 12 years, and has retired from Reclamation. Tom served as the technical writer for the draft PEIS.

Stan Isley has a B.S. in environmental science from Southern Illinois University and has worked for the Washington State Department of Ecology (WDOE) since 1979. Stan has worked on water rights and water resource issues in Ecology's Water Resources Program since 1981. Since January 1996, Stan has been assigned to Reclamation as WDOE's liaison, helping Reclamation's Upper Columbia Area Office, Yakima River Basin Water Enhancement Project team implement the various provisions of the 1994 Yakima River Basin Water Enhancement Project Act.

Jerry Jacoby is a resource conservationist and has worked as a conservationist with the Natural Resources Conservation Service (NRCS) for 37 years. Jerry assisted with the preparation of the water conservation part of the programmatic environmental impact statement/review and comment and served as the NRCS's cooperating agency contact person.

Jack Jibson graduated from the University of Idaho with a B.S. in agronomy (soils) in 1963. Jack worked for 8 years as an agronomist for the Utah-Idaho Sugar Company, 3 years for the U.S. Soil Conservation Service as a soil scientist, and 19 years for Reclamation as a soil scientist. Jack has classified soils in 14 States and Somalia, Africa, during his career.

Deena Larsen has an M.A. in english and has served as a technical writer at Reclamation for 7 years. Deena served as the technical writer for the final PEIS.

Roger Larsen has a B.S. in civil engineering and has over 23 years of experience as a Reclamation hydraulic engineer. Roger developed the Yakima River Basin Water Enhancement Project operations simulation model and performed operations simulations for the programmatic environmental impact statement.

Ken Mangelson has a B.S. in civil engineering, an M.S. in hydrology, and a Ph.D. in hydraulics and water quality. Ken has 26 years of experience as a water resources and water quality engineer and contributed to the water quality, water conservation, and surface water hydrology portions of the PEIS.

Kate Puckett has a B.A. and an M.S. in biological sciences and 13 years of experience, 6 of which are with Reclamation. Kate contributed to the fish and vegetation and wildlife sections of the PEIS.

Monica Rodriguez has 7 years of experience as an editorial assistant. Monica has been with Reclamation for 14 years.

Val Rohde contributed to the social, ITA, and public involvement portions of the programmatic environmental impact statement and has retired from Reclamation.

Warren Sharp works as a hydraulic engineer in Reclamation's Upper Columbia Area Office. He has a B.S. and M.S. in civil engineering (hydraulics, hydrology, and water resources) and 18 years of experience, 8 of which are with Reclamation. Warren prepared figures, tables, and summary text relative to surface water hydrology portions of the PEIS.

John Tiedeman has a B.A. in biological sciences and has been an environmental compliance specialist with Reclamation for 20 years. John provided program management and National Environmental Policy Act compliance oversight of this document.

Distribution List

The draft Yakima River Basin Water Enhancement Project Programmatic Environmental Impact Statement (PEIS) was sent to the following agencies, groups, and individuals for their information. The final PEIS was sent to Federal agencies, congressional delegations, Washington State Legislature, State agencies, Indian Tribes, and libraries, as well as all groups and individuals who submitted written comments (indicated by asterisks and bold). Other copies will be sent upon request.

Other than the Federal agencies and the congressional delegation in Washington, DC, all locations are in the State of Washington, unless otherwise noted.

Federal Agencies

Advisory Council on Historic Preservation (2)
Department of Agriculture
- Forest Service (2)
- Natural Resources Conservation Service (2)

Department of Army, Corps of Engineers (5)
Department of Commerce (8)
Department of Energy (2)
- Bonneville Power Administration (2)
- Federal Energy Regulatory Commission (2)

General Accounting Office (2)
Department of the Interior
- Fish and Wildlife Service (3)
- Geological Survey (3)
- Bureau of Indian Affairs (2)
- Bureau of Land Management (2)
- National Park Service (5)
- Natural Resources Library (3)
- Office of Environmental Policy and Compliance (5)

Environmental Protection Agency (5)
Office of Management and Budget

Congressional Delegations

Washington Senators
- Slade Gorton
- Patty Murray

Washington Congress
- Jennifer Dunn 8th district
- Doc Hastings 4th district
- Jim McDermott 7th district

Washington State Legislature

Gary Chandler, Representative 13th district
James Clements, Representative 14th district
Alex Deccio, Senator 14th district
Jim Honeyford/Bruce Chandler Representative 15th district
Barbara Lisk, Representative 15th district
Joyce Mulliken, Representative 18th district
Irv Newhouse/Jim Honeyford, Senator 15th district
Mary Skinner, Representative 14th district

Federal Agencies (regional and local offices)

Department of Agriculture
- ***Forest Service**, Cle Elum, Naches, and **Wenatchee**
- ***Natural Resources Conservation Service**, Ephrata and **Spokane**

Department of Army
- Corps of Engineers, Portland, Oregon; Seattle, Walla Walla

Department of Commerce
- National Marine Fisheries Service, Portland, Oregon; Seattle

Department of Energy
- Bonneville Power Administration, Portland, Oregon
- Richland Operations Office, Richland

***Environmental Protection Agency**, **Seattle**, Olympia, and Yakima

General Accounting Office, Portland, Oregon

***Department of the Interior**,
- **Fish and Wildlife Service, Moses Lake**, Spokane, and Vancouver
- Geological Survey, Portland, Oregon; Tacoma
- Bureau of Indian Affairs, Portland, Oregon; Toppenish
- Bureau of Land Management, Portland, Oregon; Wenatchee
- National Park Service, Seattle
- Bureau of Reclamation, Boise, Idaho; Denver, Colorado

Department of Transportation
- Federal Railroad Administration, Vancouver

State Agencies

Governor, Olympia
Agriculture Department, Olympia
Department of Ecology, Olympia and Yakima
***Department of Fish and Wildlife, Yakima**, and Vancouver
Department of Natural Resources, Olympia
Office of Archaeology and Historic Preservation, Olympia
Transportation Department, Olympia
Central Washington University, Ellensburg
Washington State University, Pullman

Indian Tribes

Puyallup Nation, Puyallup
Columbia River Intertribal Fish Commission, Portland, Oregon
Colville Confederated Tribes, Nespelem
Yakama Indian Nation, Toppenish
Yakama Tribal Council, Toppenish

Libraries

Carpenter Memorial Library, Cle Elum
Central Washington University Library, Cheney
Columbia Basin Community College, Pasco
Eastern Washington State University, Ellensburg
Ellensburg Public Library, Ellensburg
Ephrata Public Library, Ephrata
Kennewick City Library, Kennewick
Main Spokane Public Library, Spokane
Mid-Columbia Public Library, Kennewick
Pasco Public Library, Pasco
Prosser City Library, Prosser
Richland City Library, Richland
Royal City Public Library, Royal City
Soap Lake Public Library, Soap Lake
Sunnyside City Library, Sunnyside
University of Washington Libraries, Seattle
Yakima Valley Regional Library, Yakima

Interested Organizations

Environmental Groups

American Fisheries Society, Bethesda, Maryland
American Rivers, Washington, DC; Seattle
American Water Resources Association, Herndon, Virginia
Defenders of Wildlife, Washington, DC
Ducks Unlimited, Inc., Memphis, Tennessee
Environmental Defense Fund, Inc., New York, New York; Oakland, California
Friends of the Earth, Seattle
The Fund for Animals, Inc., New York, New York
Kittitas Audubon Society, Ellensburg
Mid-Columbia Archaeological Society, Richland
National Audubon Society, New York, New York
National Water Resources Association, Arlington, Virginia
National Wildlife Federation, Washington, DC
The Nature Conservancy, Arlington, Virginia
Natural Resources Defense Council, Inc., New York, New York
Northwest Conservation Act Coalition, Seattle
Pacific Fishery Management Council, Portland, Oregon
Rebound, Everett
Seattle Audubon Society, Seattle
Sierra Club, San Francisco, California; Seattle
Trout Unlimited, Vienna, Virginia
Washington Environmental Council, Federal Way
The Wildlife Society, Bethesda, Maryland

Water Districts

Benton Irrigation District, Benton City
Cascade Irrigation District, Ellensburg
Columbia Irrigation District, Kennewick
Ellensburg Water Company, Ellensburg
Grandview Irrigation District, Grandview
Granger Irrigation District, Granger
Kennewick Irrigation District, Kennewick
Kittitas Reclamation District, Ellensburg
Lower Wapatox Irrigation District, Naches
Moxee Ditch Company, Moxee
Naches-Selah Irrigation District, Selah
Old Union Ditch, Yakima
Outlook Irrigation District, Outlook
Prosser Irrigation District, Prosser
Roza Irrigation District, Sunnyside
Selah-Moxee Irrigation District, Yakima
South Naches Irrigation District, Naches
Sunnyside Valley Irrigation District, Sunnyside
Terrace Heights Irrigation District, Yakima
Union Gap Irrigation District, Wapato
Wapato Irrigation District, Wapato
Wapatox Power Canal, Naches
Yakima Reservation Irrigation District, Yakima
Yakima-Tieton Irrigation District, Yakima
Zillah Irrigation District, Zillah

Other Organizations and Individuals

Adams Conservation District, Ritzville
Adams County, Othello
Adams County Commissioners, Ritzville
Allison, Leroy, Warden
Baird Law Office, Ephrata
Baker, Susan, Seattle
Baker, W. Ron, Moses Lake
Baker-Roberts, Inc., Woodinville
Battelle, Richland
Bauermeister, Jim, Colfax
Baugher, Forrest, Parker
Beak Consultants, Portland, Oregon
Benton County, Prosser
Benton County Planning Department, Prosser
Bernheisel, Lee, Carlton
Big Bend Council of Economic Development, Moses Lake
Booker, Mark, Othello
Brownlow, Ronald C., Rainier, Oregon
Burgess, Wis, Pasco

Burlington Northern Railroad, Seattle
Caddis Valuation Service, Spokane
***Campbell, Newell, Yakima**
CH2M Hill, Bellevue and Yakima
City of Cle Elum, Cle Elum
City of Ellensburg, Ellensburg
City of Ephrata, Ephrata
City of Everett, Everett
City of Kennewick, Kennewick
City of Odessa, Odessa
City of Pasco, Community Development Dept., Pasco
City of Prosser, Prosser
City of Royal City, Royal City
City of Seattle—Lights, Seattle
City of Sunnyside, Sunnyside
City of Toppenish, Toppenish
City of Yakima, Yakima
Clark Jennings & Associates, Inc., Pasco
Cochran, Jeff, Royal City
Cole, Ivan, Moses Lake
Columbia Asphalt and Gravel, Yakima
Conner, L.A., Pasco
Cornell Pump Co., Portland, Oregon
Curdy, Jim, Mattawa
David Dornbush and Company, San Francisco, California
Devries, Adrian, Coeur D'Alene, Idaho
Dore, Elizabeth K., Seattle
Douglas County Commissioners, Waterville
Dubois, Robert J., Spokane
Dyck, Alven, Ritzville
Dynamac Corporation, Rockville, Maryland
Economic & Engineering Services, Inc., Olympia
Eggers, Donald B., Kennewick
Farrens, Greg, Walla Walla
Fetterolf, F. Gary, Richland
Foianini Law Office, Ephrata
Foster Pepper & Shefelman, Seattle
Foster Wheeler, Bellevue
Franklin County Conservation District, Pasco
Frisbie, Jack, Richland
G.O. Klock & Associates, Wenatchee
Gardner, Howard R., Richland
Gering, Ralph A., Ritzville
Gilreath, John, Ellensburg
Golder Associates, Redmond
Grand Canyon Monitoring and Research Center, Flagstaff, Arizona
Grant County Public Utility District, Ephrata
Gross, Henry M., Marlin
Guderian, Thomas J., East Wenatchee
Hanson Environmental Research Services, Bellingham
Hart, John, Connell
Harza Engineering Company, Chicago, Illinois
Harza NW Engineering Corp., Bellevue
Hayden, Dennis, Pasco
Hayward, Ben, Yakima
Hirz, Ralph, Moses Lake
Hobson, Calvin, Courtland, Kansas
Huckell/Weinman Associates, Edmonds
Hurless, Harry D., Vancouver
Institute of the North American West, Seattle
International Brotherhood of Electrical Workers, Local Union No. 77, Kennewick
Isaak, Phillip, Coulee City
J R Simplot Inc., Hermiston, Oregon
Jantz, Joe, Ritzville
Jantz, Willard K., Shawnee Mission, Kansas
Johnson, Eddie, Wilbur
Jones & Stokes Association, Bellevue
JUB Engineering, Kennewick
Kauffman, Kris, Lakewood
Kelley, Beverly, Kennewick
Ketchersid, W.H., Wallula
Kittitas County Commissioner, Ellensburg
Kittitas County Planning Department, Ellensburg
Knotts, Robert, Yakima
Kramer, Robert A., Harrington
Laframboise, Richard, Yakima
Lathim, Duane, Kahlotus
Lemargie & Whitaker, Ephrata
Lester, David, Yakima
Lewis, E.W., Seattle

Lincoln County Commissioners, Davenport
Lincoln County Conservation District, Davenport
Llewellyn, George R., Silverdale
Logan, Shawn R., Othello
Lyle, Chris, Ritzville
Maike, Shirley, Medical Lake
***Matson, Alan, Yakima**
McDonald, David I., Pasco
Melcher, Mr. & Mrs. Gorden D., Ritzville
Meninick, Jerry, Toppenish
Mercer, Don, Prosser
Merchant, Jim, Portola Valley, California
Metzgar, Roy, Everett
Michel, Clayton, Othello
Miles, Harold C., Nampa, Idaho
Moeller, Don, Spokane
Monk, Pat, Ellensburg
Montgomery Water Group, Inc., Kirkland
Moos, Don, East Wenatchee
Morrison Knudsen Co., Boise, Idaho
Moses Lake Conservation District, Moses Lake
Mundy, Phil, Lake Oswego, Oregon
Munson Engineers, Inc., Wenatchee
Myers, Dan G., Wilson Creek
Newsdata Corporation, Seattle
Niemi, Holland & Scott, Kennewick
Noona, Doug, Bozeman, Montana
Northwest Agricultural Consultants, Kennewick
Northwest Economic Associates, Vancouver
Northwest Power Planning Council, Portland and Pendleton, Oregon
Northwestern University, Evanston, Illinois
O'Neil, Robert, Almira
Olsen, L.J., Othello
Ortman, David E., Seattle
Othello Conservation District, Othello
Owsley, J.B., Connell
Pace International LP, Parker
Pacific Associates, Wenatchee
Pacific Northwest Project, Kennewick
Port of Pasco, Pasco
Preston Gates and Ellis, Seattle
Prudential Ranch & Home Real Estate, Moses Lake
Public Works Department, Everett
Quick, Glen, Wapato
Rathbun, Corrin, Kennewick
Resource Management International, Beaverton, Oregon
Ripfel, Dr. Hans C.F., West Richland
Rode, William C., Espanola
Rosholt, Robertson & Tucker, Boise, Idaho
RW Beck & Associates, Seattle
Schell, Harvey C., Marlin
Schuster, Elmer, Toppenish
SCM Consultants, Inc., Kennewick
Self, Win M., Davenport
Selle, Fred, Brier
Seneca Foods Corp., Pasco
Shuler, Royce and Ilene, Warden
Simond, Ed, Wapato
Skone & Connors Produce, Inc., Warden
Snyder, Lester E., Washtucna
Soap Lake City Hall, Soap Lake
Spies, Christian G., Ocean Beach, New York
Spokane Chamber of Commerce, Agriculture Department, Spokane
Stadelman, Dave, Ephrata
Stahl, Jacob, Odessa
Stanhope, William, Spokane
Stetson Engineering, San Rafael, California
Stober, Jerry, Athens, Georgia
Sumption, Pat, Seattle
Sun Basin Properties, Inc., Othello
Talbott, George H., Oysterville
Taylor, Paul, Spokane
Teo, Harris Jr., Toppenish
Tetra Tech, Inc., San Bernadino, California; Falls Church, Virginia
The Research Group, Corvallis, Oregon
Town of Wilson Creek, Wilson Creek
Tri-County Water Resources Agency, Yakima
Tuck, Bob, Selah
Turnbull, William H., Ephrata
Twin City Foods, Stanwood

Upper Grant Conservation District, Ephrata
Valicoff, Robert, Wapato
***Vinsonhaler, Larry, Boise, Idaho**
Warden Hutterian Brethren, Warden
Washington State Farm Bureau, Olympia
Washington Water Resource Association, Yakima
Weiss, Bill, Quincy
Wentz, Greg, Yakima
Wollweber, Glenn, Ford
***Yakima Basin Joint Board, Kennewick**
Yakima County, Yakima
***Yakima County Planning Department, Yakima**
Yakima Regional Clean Air Authority, Yakima
Yamamoto, Harry, Warden

Media

Agri Equipment Today, Yakima
Associated Press, Yakima
Daily Record, Ellensburg
Davenport Times, Davenport
Franklin County Graphic, Connell
Goodfruit Grower, Yakima
KAPP-TV Channel 35, Yakima
KBBO-AM, Yakima
KEPR-TV, Tri Cities
KFFM-FM, Yakima
KIMA-TV Channel 29, Yakima
KIT-AM and KATS-FM, Yakima
KMWX-FM, Yakima
KNDO-TV Channel 23, Yakima
KREW-AM and KREW-FM, Sunnyside
KUTI-AM and KXDD-FM, Yakima
Odessa Record, Odessa
Othello Outlook, Othello
Sunnyside Sun Daily News, Sunnyside
Toppenish Review, Toppenish
Tri-City Herald, Tri-Cities
Wapato Independent, Wapato
Yakima Herald-Republic, Yakima
Yakima Nation Review, Toppenish
Yakima Newsletter, Vancouver

Bibliography

Agricultural Enterprises, Inc., 1992. IMS and IMSDEMO, Interindustry Input-Output Program. Colorado, p. 43.

Andelman, S.J., and A. Stock, 1994. Management, Research and Monitoring Priorities for the Conservation of Neotropical Migratory Landbirds that Breed in Washington State. Washington Department of Natural Resources, Olympia, Washington.

Andersen, D.C., and S.M. Nelson, 1995. Government Highline Canal. In Prism Wetland Study, Colorado River Basin Salinity Control General Investigation. National Biological Service, Bureau of Reclamation, Denver, Colorado.

Anthony, R.G., and F.B. Isaacs, 1989. Characteristics of Bald Eagle Nest Sites in Oregon.

Anthony, R.G., R.L. Knight, G.T. Allen, B.R. McClelland, and J.I. Hodges, 1982. Habitat Use by Nesting and Roosting Bald Eagles in the Pacific Northwest.

Armstrong, S., C. Aulbach, T.L. Becenti, N.P. Campbell, S. Crane, J. Hendry, J. Jennings, E. Kandle, R. Ray, and T.R. Repasky, 1995. A Multi-Disciplinary Study of Groundwater in Toppenish Creek Basin. Yakama Indian Reservation (Hydrogeology Symposium Oral Presentation Abstract), pp. 136-137.

Babcock, W.A., T.E. Eckert, and G.D. Williams, 1986. Yakima River Basin Historical Resource Survey: Vol. 1—Overview and Management Recommendations. Heritage Research Center, Missoula, Montana.

Bailey, R.G., P.E. Avers, T. King, and W.H. McNab (eds.), 1994. Ecoregions and Subregions of the United States. Prepared for U.S. Department of Agriculture, Forest Service.

Barr Engineering Co., 1992. Assessment of Feasibility of Replacing Diverted Surface Water by Groundwater for Irrigation in the Western Portion of the Toppenish Creek Basin. Prepared for Yakama Indian Nation Water Resources Planning Program.

Bartholow, J.M., J.L. Laake, C.B. Stalnaker, and S.C. Williamson, 1993. A Salmonid Population Model with Emphasis on Habitat Limitations. In Rivers, vol. 4(4), pp. 265-279.

Bartrand, E.L., T.N. Pearsons, and S.W. Martin, 1994. Movement of Resident Rainbow Trout Within the Upper Yakima River Basin, Chapter 3. In Yakima River Species Interactions Studies—Annual Report 1993. DOE/BP-99852-2. Edited by T.N. Pearsons, et al. U.S. Department of Energy, Bonneville Power Administration, Portland, Oregon, pp. 44-69.

Bauer, H.H., and J.J. Vaccaro, 1990. Estimates of Groundwater Recharge to the Columbia Plateau Regional Aquifer System, Washington, Oregon, and Idaho, for Predevelopment and Current Land-use Conditions. USGS Water Resources Investigations Report 88-4108.

Bayley, P.B., 1995. Understanding Large River-Floodplain Ecosystems, Significant Economic Advantages and Increased Biodiversity and Stability Would Result from Restoration of Impaired Systems. In BioScience, vol. 45(3), pp. 153-158.

Beecher, H.A., 1990. Standards for Instream Flows. In Rivers. Habitat Management Division, Washington Department of Wildlife, Olympia, Washington, pp. 97-109.

Bell, C., and H. Newby, 1974. Community Studies. Praeger, New York, New York.

Berman, C.H. and T.P. Quinn, 1991. Behavioral Thermoregulation and Homing by Spring Chinook Salmon, *Oncorhynchus tshawytscha* (Walbaum), in the Yakima River. In Journal of Fish Biology, vol. 39, pp. 301-312.

Bjornn, T.C., 1971. Trout and Salmon Movements in Two Idaho Streams as Related to Temperature, Food, Stream Flow, Cover, and Population Density. In Transactions of the American Fisheries Society, vol. 100(3), pp. 423-438.

Blatner, K.A., D.M. Baumgartner, and L.R. Quackenbush, 1991. NIPF Use of Landowner Assistance and Education Programs in Washington State. In Western Journal of Applied Forestry, vol. 6(4), pp. 90-94.

Bolke, E.L., and J.A. Skrivan, 1981. Digital-Model Simulation of the Toppenish Alluvial Aquifer, Yakama Indian Reservation, Washington. U.S. Geological Survey, Water-Resources Investigations Open-File Report 81-425, p. 34.

Bonneville Power Administration, 1990. Yakima-Klickitat Production Project, Environmental Assessment and Finding of No Significant Impact. DOE/EA-0392. Bonneville Power Administration, Office of Power Sales, Portland, Oregon.

Bonneville Power Administration, 1990. Yakima-Klickitat Production Project, Preliminary Design Report, Executive Summary. Refined Project Goals and Harvest Management Plan, Yakima-Klickitat Production Project, Preliminary Design Report, Appendix A. DOE/BP-00245-1. Bonneville Power Administration, Division of Fish and Wildlife, Portland, Oregon, 22 pp.

Bonneville Power Administration, May 1994. Lower Yakima Valley Wetlands and Riparian Restoration. DOE No. 0941. Final Environmental Assessment and Finding of No Significant Impact. Bonneville Power Administration, Portland, Oregon.

Bonneville Power Administration, 1995. Yakima Fisheries Project, Revised Draft Environmental Impact Statement. DOE/EIS-0169, DOE/BP-2588. Bonneville Power Administration in Cooperation with Washington Department of Fish and Wildlife and Yakama Indian Nation, Portland, Oregon.

Bonneville Power Administration, 1996. Yakima Fisheries Project Final Environmental Impact Statement. DOE/EIS-0169. Bonneville Power Administration, Portland, Oregon.

Bonneville Power Administration, 1996. Washington Wildlife Mitigation Projects Draft Programmatic Environmental Assessment. DOE/EA-10962. Bonneville Power Administration, Portland, Oregon, 89 pp.

Bonneville Power Administration, Yakama Indian Nation, and Bureau of Indian Affairs, 1994. Lower Yakima Valley Wetlands and Riparian Restoration Project Final Environmental Assessment and Finding of No Significant Impact. DOE/BP-0941. Bonneville Power Administration, Portland, Oregon, 58 pp.

Bovee, K.D., 1982. A Guide to Stream Habitat Analysis Using the Instream Flow Incremental Methodology. FWS/OBS 82/86. U.S. Fish and Wildlife Service, Washington, DC.

Bovee, K.D., 1994. Data Collection Procedures for the Physical Habitat Simulation System. Internal publication. U.S. Department of the Interior, National Biological Survey, Fort Collins, Colorado, 159 pp.

Boyle, K., and R. Bishop, 1987. Valuing Wildlife in Benefit-Cost Analysis: A Case Study Involving Endangered Species. In Water Resources Research, vol. 23(5), pp. 943-950.

Brill, T., and K.T. Duffy, 1995. The Western Sawmill Industry in Transition. A Briefing Prepared for the Southern Utah Planning Authorities Council, State of Utah. Department of Natural Resources, Office of Energy and Resource Planning, Salt Lake City, Utah, p. 23.

Brinson, M.M., B.L. Swift, R.C. Plantico, and J.S. Barclay, 1981. Riparian Ecosystems: Their Ecology and Status, Biological Services Publication FWS/OBS-81/17. Prepared for the U.S. Department of the Interior, Fish and Wildlife Service, Eastern Energy and Land Use Team, Kearneysville, West Virginia, 154 pp.

Brookshire, D., L. Eubanks, and A. Randall, 1983. Estimating Option Prices and Existence Values for Wildlife Resources. In Land Economics, vol. 59, pp. 1-15.

Brown, T., 1993. Measuring Non-Use Value: A Comparison of Recent Contingent Valuation Studies, Benefits and Cost Transfer in Resource Planning. Sixth Interim Report, Western Regional Research Publication W-133.

Burdge, R.J., 1994. A Community Guide to Social Impact Assessment. Social Ecology Press, Middleton, Wisconsin.

Bureau of the Census, 1994a. Statistical Abstract of the United States: 1994, p. 1,011.

Bureau of the Census, 1994b. State Government Tax Collections: 1992, p. 48.

Bureau of Land Management, 1991a. Riparian-Wetland Initiative for the 1990's. U.S. Department of the Interior, Bureau of Land Management, Washington, DC.

Bureau of Land Management, 1991b. Draft Spokane Resource Management Plan Amendment/Environmental Impact Statement Supplement. BLM-OR-ES-91-33-1792. Spokane, Washington, 163 pp.

Bureau of Land Management, 1996. Personal Communication. Outdoor Recreation Planner.

Bureau of Reclamation, n.d. Indian Reservations Within the Wapato Irrigation Project. An Advisory Resource Enhancement Plan for the Yakama Indian Nation Completed Pursuant to Cooperative Agreement No. 9-FC-10-09860 for Toppenish, Washington, 34 pp. plus appendices.

Bureau of Reclamation, 1974. C.R. Lentz Review, Yakima Project Water Rights and Related Data, Preliminary Record. Pacific Northwest Region, Yakima Project, Yakima, Washington.

Bureau of Reclamation, March 1977. Status Report for the Yakima Valley Water Management Study.

Bureau of Reclamation, 1979. Final Environmental Impact Statement, Proposed Bumping Lake Enlargement, Yakima Project, Washington. Pacific Northwest Region, Boise, Idaho, 178 pp. plus appendices.

Bureau of Reclamation, October 1979. Yakima Valley Water Management Study, Washington: Monthly River Basin Planning Model Documentation. Pacific Northwest Region, Boise, Idaho.

Bureau of Reclamation, 1981. Project Data Book. U.S. Department of the Interior, Water and Power Resources Service, U.S. Government Printing Office, Denver, Colorado.

Bureau of Reclamation, January 1981. Cle Elum and Tieton Powerplants, Yakima Project, Washington. Pacific Northwest Region, Boise, Idaho.

Bureau of Reclamation, June 1981. Cle Elum and Tieton Powerplants, Yakima Project, Washington, Formulation Working Document. Pacific Northwest Region, Boise, Idaho.

Bureau of Reclamation, July 1981. East Selah Gravel Pits Reregulation Storage: 1981 Reevaluation, Yakima Project, Washington. Pacific Northwest Region, Boise, Idaho.

Bureau of Reclamation, October 1981. Yakima River Basin Water Enhancement Project Newsletter 2, Yakima River Basin Water Enhancement Project Feasibility Study.

Bureau of Reclamation, January 1982. Yakima River Basin Water Enhancement Project Newsletter, Yakima River Basin Water Enhancement Project Feasibility Study.

Bureau of Reclamation, April 1982. Yakima River Basin Water Enhancement Project Newsletter 4, Yakima River Basin Water Enhancement Project Feasibility Study.

Bureau of Reclamation, June 1982. Yakima River Basin Water Enhancement Project Newsletter 5, Yakima River Basin Water Enhancement Project Feasibility Study.

Bureau of Reclamation, 1984. Summary Report on System Maintenance and Rehabilitation Program for Water Conservation, Roza Irrigation District, Yakima Project, Washington.

Bureau of Reclamation, February 1984. Fish Passage and Protective Facilities, Yakima River Basin, Washington, Interim Predesign Report. Pacific Northwest Region, Boise, Idaho.

Bureau of Reclamation, March 1984. Yakima River Basin Water Enhancement Project, Washington, Working Paper. Ahtanum Creek Development, Pacific Northwest Region, Boise, Idaho.

Bureau of Reclamation, March 1984. Yakima River Basin Water Enhancement Project, Working Paper. Toppenish-Simcoe Creek Development, Pacific Northwest Region, Boise, Idaho.

Bureau of Reclamation, July 1984. Fish Passage and Protective Facilities, Yakima River Basin, Washington, Environmental Assessment. Pacific Northwest Region, Boise Idaho.

Bureau of Reclamation, October 1984a. Initial Flow Recommendations, Yakima River Basin, Final Report and Appendices (2 volumes). Contract Report to the Bureau of Reclamation by Parametrix, Inc., Bellevue, Washington, and Hardin-Davis, Albany, Oregon, and Bellevue, Washington.

Bureau of Reclamation, October 1984b. Review of Existing IFIM Data, Yakima River Basin, Final Report, Contract Report to the Bureau of Reclamation by Parametrix, Inc., Bellevue, Washington, and Hardin-Davis, Albany, Oregon, and Bellevue, Washington.

Bureau of Reclamation, November 1984. Fish Passage and Protective Facilities, Yakima River Basin, Washington, Finding of No Significant Impact. Pacific Northwest Region, Boise, Idaho.

Bureau of Reclamation, November 1984. Fish Passage and Protective Facilities, Yakima River Basin, Washington, Predesign Report. Pacific Northwest Region, Boise, Idaho.

Bureau of Reclamation, 1985. Yakima River Basin Water Enhancement Project, Washington, Phase 2 Status Report. Pacific Northwest Region, Boise, Idaho.

Bureau of Reclamation, April 1985. Estimating Actual Fish Production in the Yakima River Basin, Washington. Pacific Northwest Region, Boise, Idaho.

Bureau of Reclamation, 1986. Preliminary Evaluation of Nonstorage Elements Being Considered for Early Implementation. Pacific Northwest Region, Boise, Idaho.

Bureau of Reclamation, May 1986. Yakima River Basin Water Enhancement Project, Washington, Preliminary Evaluation of Nonstorage Elements Being Considered for Early Implementation.

Bureau of Reclamation, 1988. Environmental Assessment, Coachella Canal In-Place Lining Prototype, California. Lower Colorado Region, Boulder City, Nevada.

Bureau of Reclamation, 1989. Dolores Project Colorado, Final Supplement to the Final Environmental Statement. Upper Colorado Region, Salt Lake City, Utah.

Bureau of Reclamation, November 1989. Kittitas Valley Water Conservation Study, Washington, Yakima River Basin Water Enhancement Project, Draft Assessment. Pacific Northwest Region, Boise, Idaho.

Bureau of Reclamation, June 1990. Fish Passage and Protective Facilities: Phase II, Yakima River Basin, Washington, Planning Report to the Bonneville Power Administration. Pacific Northwest Region, Boise, Idaho.

Bureau of Reclamation, July 1990. Yakima River Basin Water Enhancement Project, Washington, Off-Reservation Study Activities, Draft Report.

Bureau of Reclamation, October 1990. Yakima Basin Fish Passage Project—Phase II, Draft Environmental Assessment. Pacific Northwest Region, Boise, Idaho.

Bureau of Reclamation, July 1991. Water Conservation Study for Sunnyside Valley Irrigation District and the Joint Use Facilities of the Sunnyside Division. Sunnyside Valley Irrigation District and the Washington State Department of Ecology, Yakima River Basin Water Enhancement Project.

Bureau of Reclamation, 1992. Summary Statistics, Water, Land, and Related Data. Published by Water, Land, and Cultural Resources, Program Analysis Office, Bureau of Reclamation, Denver, Colorado.

Bureau of Reclamation, 1992. Clear Creek Dam Rehabilitation, Finding of No Significant Impact. PN FONSI 92-1. Pacific Northwest Region, Boise, Idaho.

Bureau of Reclamation, May 1994. Yakima River Water Conservation Demonstration Project, Washington, Draft Environmental Assessment. Pacific Northwest Region, Boise, Idaho.

Bureau of Reclamation, 1996. Achieving Efficient Water Management: A Guidebook for Preparing Agriculture Water Conservation Plans. Prepared by Hydrosphere Resource Consultants, Boulder, Colorado.

Bureau of Reclamation, 1996. Yakima River Basin Water Enhancement Project Plan of Study for the Preparation of a Programmatic Environmental Impact Statement. Bureau of Reclamation, Boise, Idaho, 45 pp.

Bureau of Reclamation, April 1996. Modifications to Kachess Dam, Yakima River Basin Water Enhancement Project, Washington, Finding of No Significant Impact and Final Environmental Assessment. PN FONSI-96-01. Pacific Northwest Region, Upper Columbia Area Office, Yakima, Washington.

Bureau of Reclamation, 1997. Appraisal Report on Kachess Augmentation, Internal Document. Pacific Northwest Region, Upper Columbia Area Office, Yakima, Washington.

Bureau of Reclamation, 1997. Kachess Lake Augmentation Draft Status Report. Pacific Northwest Region, Upper Columbia Area Office, Yakima, Washington.

Bureau of Reclamation and Fish and Wildlife Service, 1968. Bumping Lake Enlargement, Joint Report. Pacific Northwest Region, Boise, Idaho.

Bureau of Reclamation and Washington State Department of Ecology, July 1981. Yakima River Basin Water Enhancement Project Feasibility Study, Yakima River Basin Water Enhancement Project Newsletter 1.

Bureau of Reclamation and Washington State Department of Ecology, August 1982. Yakima River Basin Water Enhancement Project, Washington. Pacific Northwest Region, Boise, Idaho.

Bureau of Reclamation and Washington State Department of Ecology, September 1982. Yakima River Basin Water Enhancement Project Feasibility Study, Yakima River Basin Water Enhancement Project. Newsletter 6.

Bureau of Reclamation and Washington State Department of Ecology, December 1982. Yakima River Basin Water Enhancement Project, East Selah Reregulating Reservoir, Study Team Report. Yakima River Basin Water Enhancement Project Feasibility Study.

Bureau of Reclamation and Washington State Department of Ecology, March 1985. Yakima River Basin Water Enhancement Project, Washington, Phase 2 Status Report. Pacific Northwest Region, Boise, Idaho.

Bureau of Reclamation and Washington State Department of Ecology, April 1985. Yakima River Basin Water Enhancement Project, Washington, Phase 2 Status Report. Pacific Northwest Region, Boise, Idaho.

Bureau of Reclamation and Washington State Department of Ecology, January 1986. Yakima River Basin Enhancement Project, Washington, Plan Formulation Summary. Pacific Northwest Region, Boise, Idaho.

Bureau of Reclamation and Washington State Department of Ecology, February 1987. Yakima River Basin Early Implementation Program: Executive Summary, Support Material, Environmental Analysis. Pacific Northwest Region, Boise, Idaho.

Busack, C., C. Knudsen, A. Marshall, S. Phelps, and D. Seiler, 1991. Yakima Hatchery Experimental Design, Annual Progress Report. DOE/BP-00102, Project No. 89-082, Contract No. DE-B179-89BP00102. Bonneville Power Administration, Division of Fish and Wildlife, Portland, Oregon, 226 pp.

Carlino, G.A., 1992. Are Regional Per Capita Earnings Diverging? Federal Reserve Bank of Philadelphia. In Business Review, pp. 3-12.

Carson, R.T., and R.C. Mitchell, 1993. The Value of Clean Water: The Public's Willingness to Pay for Boatable, Fishable, and Swimmable Water Quality. In Water Resources Research, vol. 29(7), pp. 2,445-2,454.

Carter, B.H., 1989. Keechelus Dam, vol. I, Engineering Geology in Washington. In Washington Division of Geology and Earth Resources Bulletin, vol. 78, pp. 512-519.

Carter, S.L., 1978. Archaeological Reconnaissance Mt. Baker-Snoqualmie Group of the Selected Alpine Lakes Wilderness Exchange Lands, Mt. Baker-Snoqualmie National Forest.

CH2M Hill, May 1977. Yakima Valley Water Management Study: A Status Report on Water Quality Investigations, Yakima River Basin, Washington.

CH2M Hill, 1984. Cultural Resources in the Clear Creek Dam and Clear Lake Reservoir Hydroelectric Project Area. Prepared for Yakima-Tieton Irrigation District, Federal Energy Regulatory Commission, No. 4539.

CH2M Hill, June 1984. East Selah Reregulating Reservoir, Phase 1 Report.

CH2M Hill, 1989. Appraisal Assessment of Augmenting Kachess Reservoir Stored Waters by Gravity Feed from Cabin Creek and Silver Creek. Prepared for Bureau of Reclamation.

CH2M Hill, 1989. Appraisal Assessment of Change in Point of Diversion of City of Yakima's Domestic Water Supply.

CH2M Hill, 1989. Appraisal Assessment of Tributary Storage Potentials, Kittitas Valley, Washington.

CH2M Hill, 1990. Yakima River Basin Salmon and Steelhead Facilities Preliminary Design Report, in Yakima/Klickitat Production Project Preliminary Design Report, Appendix C. DOE/BP-00245-4. Prepared for U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife, Portland, Oregon.

Chapman, D., C. Peven, A. Giorgi, T. Hillman, and F. Utter, 1995. Status of Spring Chinook Salmon in the Mid-Columbia Region. Don Chapman Consultants, Boise, Idaho, 477 pp.

Chapman, D.W., 1986. Salmon and Steelhead Abundance in the Columbia River in the Nineteenth Century. In Transactions of the American Fisheries Society, vol. 115, pp. 662-670.

Chapman, D.W., and T.C. Bjornn, 1969. Distribution of Salmonids in Streams, with Special Reference to Food and Feeding. In H.R. MacMillan Lecture in Fisheries, Symposium on Salmon and Trout in Streams, held at the University of British Columbia, February 22 to 24, 1968. Edited by T.G. Northcote, Institute of Fisheries. The University of British Columbia, Vancouver, pp. 153-176.

Chestnut, L.G., and R.D. Rowe, 1990. Preservation Values for Visibility Protection at the National Parks, Report for the U.S. Environmental Protection Agency and National Park Service. RCG/Hagler, Bailly Inc., Boulder, Colorado.

Clark, E.H., J. Haverkamp, and W. Chapman, 1985. Eroding Soils: The Off-Farm Impacts. The Conservation Foundation, Washington, DC.

Cleveland, G., and D. Griffin, 1990. Cultural Resource Assessment of the Toppenish Creek Basin: A Preliminary Overview of Land Use and Historic Properties. Report to the Yakama Indian Nation Water Resources Program, Toppenish, Washington, and the Bureau of Reclamation, Boise, Idaho.

Cleveland, G., and D. Griffin, 1990. Integration of Cultural, Agricultural, Wildlife, and Fisheries Resources in the Toppenish Creek Corridor (Part II) Yakama Indian Nation, Toppenish, a Tribal Enhancement Project.

Cline, D.R., and C.A. Collins, 1992. Ground Water Pumpage from the Columbia Plateau, Washington and Oregon, 1945 to 1984. U.S. Geological Survey, Water Resources Investigations Report 90-4085.

Clune, T., and D. Dauble, 1991. The Yakima/Klikitat Fisheries Project: A Strategy for Supplementation of Anadromous Salmonids. In Fisheries, vol. 16(5), pp. 28-34.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe, 1979. Classification of Wetlands and Deepwater Habitats of the United States, Biological Services Publication FWS/OBS/-79/31. U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC, 131 pp.

Crase, F.T., 1985. Estimating Actual Fish Production in the Yakima River Basin, Washington. Prepared as an Internal Planning Document, U.S. Department of the Interior, Bureau of Reclamation, Pacific Northwest Region, Boise, Idaho.

Crocker, T.D., and J.F. Shogen, 1991. Ex Ante Valuation of Atmospheric Visibility. In Applied Economics, vol. 23(1), pp. 143-151.

Dahl, T.E., and C.E. Johnson, 1991. Status and Trends of Wetlands in the Conterminous United States, Mid-1970's to Mid-1980's. U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC.

Daubenmire, R., 1970. Steppe Vegetation of Washington. EB1446.

Dauble, D., R. Mueller, and G. Martinson, 1994. Evaluation of Water Quality Conditions Near Proposed Fish Production Sites Associated with the Yakima Fisheries Project.

Dawson, R.H., and W.F. Domka, 1987. Onfarm Conservation Practices in the Yakima Basin—Phase II. Vol. I, Main Report, Submitted to Bureau of Reclamation.

DePuydt, R., 1990. A Cultural Resources Survey Along Puget Sound Power and Light's Proposed Upgrade of the Wanapum-Hyak Electrical Transmission Line, Report 100-73. Archaeological and Historical Services for Puget Sound Power and Light. Eastern Washington University Reports in Archaeology and History, Cheney, Washington.

DePuydt, R., 1994. Cultural Resource Survey and Monitoring of Drilling at Washington State Department of Transportation's Proposed Quarry Site in Kachess Lake, Kittitas County, Washington, Short Report DOT 94-24. Archaeological and Historical Services, Eastern Washington University, Cheney, Washington.

DFPI, 1993. 1992-93 Directory of the Forest Products Industry. Miller Freeman, Inc., San Francisco, California, p. 1,088.

Dick, T.A., 1993. The Yakima Project, Bureau of Reclamation History Program. Denver, Colorado.

Dobler, F., 1990. Shrub Steppe Ecosystem Studies: Phase I Completion Report for 1988-1990. Unpublished draft on file, Washington Department of Wildlife.

Don Chapman Consultants, Inc., 1989. Summer and Winter Ecology of Juvenile Chinook Salmon and Steelhead Trout in the Wenatchee River, Washington. Funded by Chelan County Utility District No. 1, Wenatchee, Washington.

Draper, J.A., 1991. Results of an Archaeological Survey and Test Excavations at Bumping Lake Reservoir, Yakima County, Washington. Center for Northwest Anthropology, Washington State University, Contributions in Cultural Resource Management Report No. 37.

Drost, B.W., and K.J. Whiteman, 1986. Surficial Geology, Structure, and Thickness of Selected Geohydrologic Units in the Columbia Plateau, Washington. U.S. Geological Survey Water Resources Investigations Report 84-4326.

Drost, B.W., K.J. Whiteman, and J.B. Gonthier, 1990. Geologic Framework of the Columbia Plateau Aquifer System, Washington, Oregon, and Idaho. U.S. Geological Survey Water Resources Investigations Report 87-4238.

East Selah Reregulating Reservoir Study Team, December 1982. Yakima River Water Enhancement Project, East Selah Reregulating Reservoir Study Team Report.

Easterbrooks, J.A., 1988. Chandler Powerhouse Subordination Biological Justification, December 6, 1988. Washington Department of Fisheries, Yakima, Washington.

Eitemiller, D. Overview of the Ronald Quadrangle. Central Washington University, Ellensburg, Washington.

Embrey, S.S., and B.D. Watson, 1992. Fish and Other Aquatic Biological Communities. In Surface Water Quality Assessment of the Yakima River Basin, Washington: Analysis of Available Water Quality Data Through 1985 Water Year. U.S. Geological Survey Open-File Report 91-453, National Water Quality Assessment Program, Portland, Oregon.

Environmental Defense Fund, 1994. Restoring the Yakima River's Environment.

Fast, D.E., J.D. Hubble, M.S. Kohn, and B.D. Watson, 1991. Yakima River Spring Chinook Enhancement Study, Final Report. DOE/BP-39461-9. Project No. 82-16, Contract No. DE-A179-83BP39461. U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife, Portland, Oregon, 345 pp.

Fast, D.E., J.D. Hubble, and B.D. Watson, 1986. Yakima River Spring Chinook Enhancement Study—Annual Report FY 1985. DOE/BP-39461-2. U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife, Portland, Oregon, 287 pp.

Fast, D.E., M.S. Kohn, and B.D. Watson, 1989. Yakima River Spring Chinook Enhancement Study—Annual Report FY 1989. DOE/BP-39461-7. U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife, Portland, Oregon, 93 pp.

Fielder, P.C., 1992. Effects of Recreational Use on Bald Eagles Along the Rock Island Project. PUD Annual Report, Wenatchee, Washington.

Flagg, T.A., L.W. Harrell, J.L. Mighell, and E. Slatick, 1990. Cle Elum Lake Sockeye Salmon Restoration Feasibility Study, 1988-1989—Annual Report. DOE/BP-64840-2. Project 86-45, Contract DE-AI79-86-BP64840. U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife, Portland, Oregon, 44 pp.

Forest Service, 1990. Determination of Eligibility—Clear Lake Bridge, Wenatchee National Forest.

Forest Service, 1991. Rimrock Lake Visitor Survey, Wenatchee National Forest, Naches Ranger District.

Forest Service, 1991. Tieton River Recreation Environmental Assessment.

Forest Service, 1994. United Eagle Timber Sale Biological Evaluation. Forest Service, Colville, Washington.

Forest Service, 1995. Draft Environmental Impact Statement: Snoqualmie Pass Adaptive Management Area Plan, Wenatchee National Forest, Wenatchee, Washington and Montana, and Mt. Baker-Snoqualmie Nation Forest, Montlake Terrace, Washington.

Forest Service, 1996. Tieton Watershed Assessment, pp. 130-145.

Foster, J.H., W.L. Myers, W.E. Tillet, and J.C. Hoag, 1984. Columbia Basin Wildlife/ Irrigation Development Study. Report No. REC-ERC-83-6. Engineering and Research, Denver, Colorado, p. 245.

Foxworthy, B.L., 1962. Geology and Ground-Water Resources of the Ahtanum Valley, Yakima County, Washington. U.S. Geological Survey Water-Supply Paper 1598, p. 100.

Franklin, J.F., and C.T. Dyrness, 1973. Natural Vegetation of Oregon and Washington. General Technical Report PNW-8. U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

Franklin, J.F., and J.M. Trappe, 1963. Plant Communities of the Northern Cascade Range: A Reconnaissance. In Northwest Science.

Freeman, A.M., III, 1982. Air and Water Pollution Control: A Benefit-Cost Assessment. John Wiley and Sons, New York.

Fretwell, M.O., 1979. Quality of Surface and Ground Waters, Yakama Indian Reservation, Washington, 1973-1974. U.S. Geological Survey Open-File Report 77-128, p. 215.

Fuhrer, G.J., D.J. Cain, S.W. McKenzie, J.F. Rinella, J.K. Crawford, K.A. Skach, and M.I. Hornberger, 1996. Surface Water Quality Assessment of the Yakima River Basin in Washington: Spatial and Temporal Distribution of Trace Elements in Water, Sediment, and Aquatic Biota, 1987-91. U.S. Geological Survey Open-File Report 95-440, 190 pp.

Furniss, M.J., T.D. Roelofs, and C.S. Yee, 1991. Road Construction and Maintenance. In Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats, vol. 19, American Fisheries Society Special Publication, pp. 297-323.

Garfield, L., 1988. Draft Nomination of Federal Irrigation Projects Within the State of Washington, Draft Report.

Gehring, J., 1992. Element Stewardship Abstract: *Rorippa columbiae* (Robinson) Howell.

Gilbert, J.D., 1989. Tieton Dam, Vol. I. Washington Division of Geology and Earth Resources Bulletin 78, pp. 527-532.

Gore, J.A., and F.D. Shields, Jr., 1995. Can Large Rivers be Restored? Most Restoration Projects are Only Attempts to Rehabilitate Selected River Sections to a Predetermined Structure and Function. In BioScience, vol. 45(3), pp. 142-52.

Gregg, D.O., and L.B. Laird, 1975. A General Outline of the Water Resources of the Toppenish Creek Basin, Yakama Indian Reservation, Washington. U.S. Geological Survey Open File Report 75-19.

Hagen, D.A., J.W. Vincent, and P.G. Welle, 1992. Benefits of Preserving Old-Growth Forests and the Spotted Owl. In Contemporary Policy Issues, vol. 10, pp. 13-25.

Hall, F.C., 1988. Characterization of Riparian Systems. In Streamside Management: Riparian Wildlife and Forestry Interactions (Kenneth J. Raedeke, ed.). College of Forest Resources, University of Washington Contribution No. 59, pp. 7-12.

Hartmann, G., and G. Lindeman, 1979. Cultural Resource Survey and Testing on the Yakima Firing Center, Yakima and Kittitas Counties, Washington, Phase I, Final Report. Central Washington Archaeological Survey, Central Washington University, Ellensburg, Washington.

Hartmann, G.D., and G.O. Stephenson, 1980. Cultural Resources Reconnaissance and Testing on the Yakima Firing Center, Yakima and Kittitas Counties, Washington, Phase II, Final Report. Central Washington Archaeological Survey, Central Washington University, Ellensburg, Washington.

Hames, T.R., J.D. Reichel, B.K. DeWard, and J.P. Bisch, 1992. Opportunities for Optimizing Wildlife Use of Land and Water on the Yakama Indian Reservation by Improving the Wapato Irrigation Project, Yakama Indian Nation, Wildlife Resource Management Program.

Hicks, B.A., and G. Bishop, 1993. A Cultural Resource Survey of the Drawdown Zones of Cle Elum, Kachess, and Keechelus Lakes, Kittitas County, Washington, vols. I, II, and III. Report by BOAS, Inc., Seattle, to the Wenatchee National Forest, Cle Elum Ranger District.

Hill, M.T., W.S. Platts, and R.L. Beschta, 1991. Ecological and Geomorphological Concepts for Instream and Out-of-Channel Flow Requirements. In Rivers, vol. 2(3), pp. 198-210.

Hillman, T.W., J.S. Griffith, and W.S. Platts, 1987. Summer and Winter Habitat Selection by Juvenile Chinook Salmon in a Highly Sedimented Idaho Stream. In Transactions of the American Fisheries Society, vol. 116(2), pp. 185-95.

Hindmam, J.N., G.A. McMichael, J.P. Olson, and S.A. Leider, 1991. Yakima River Species Interactions Studies. Annual Report FY 1990. DOE/BP-01483-1. U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife, Portland, Oregon, 75 pp.

Hitchcock, C.L., and A. Cronquist, 1973. Flora of the Pacific Northwest. University of Washington Press, Seattle, Washington.

Hockersmith, E., J. Vella, L. Stuehrenberg, R.N. Iwamoto, and G. Swan, 1994. Yakima River Radio-Telemetry Study: Spring Chinook Salmon, 1991-1992. DOE/BP-00276-1. U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife, Portland, Oregon, 98 pp.

Hockersmith, E., J. Vella, L. Stuehrenberg, R.N. Iwamoto, and G. Swan, 1995. Yakima River Radio-Telemetry Study: Steelhead, Annual Report 1989-1993. DOE/BP-00276-2. U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife, Portland, Oregon, 98 pp.

Hollenbeck, J.L., and S.L. Carter, 1986. A Cultural Resource Overview: Prehistory and Ethnography, Wenatchee National Forest. U.S. Department of Agriculture, Forest Service, Wenatchee, Washington.

Hosey and Associates Engineering Company and Fish Management Consultants, March 1988. Evaluation of Effectiveness of Fish Protection Facilities, Chandler Facility Evaluation, Draft Report.

Hosey and Associates Engineering Company and Fish Management Consultants, May 1988. Evaluation of Effectiveness of Fish Protection Facilities, Columbia Facility Evaluation, Draft Report.

Hosey and Associates Engineering Company and Fish Management Consultants, June 1989. Evaluation of Effectiveness of Fish Protection Facilities, Roza Facility Evaluation, Draft Report.

Hosey and Associates Engineering Company and Fish Management Consultants, January 1990. Evaluation of Effectiveness of Fish Protection Facilities, Easton Facility Evaluation, Draft Report.

Hosey and Associates Engineering Company and Fish Management Consultants, September 1990. Evaluation of Effectiveness of Fish Protection Facilities, Chandler, Columbia, Roza, and Easton Screening Facilities Evaluation, Completion Report.

Hosey and Associates and Thomas R. Payne & Associates, 1982. Instream Flow Assessment, Yakima River Between Sunnyside Dam and the Zillah Wasteway. Prepared for Sunnyside Valley Irrigation District.

Hunn, E.S., 1990. Nch'i-Wána "The Big River." University of Washington Press, Seattle, Washington.

Hunsaker, C.T., and D.A. Levine, 1995. Hierarchical Approaches to the Study of Water Quality in Rivers: Spatial Scale and Terrestrial Processes are Important in Developing Models to Translate Research Results to Management Practices. In BioScience, vol. 45(3), pp. 193-203.

Hunter, M.A., 1992. Hydropower Flow Fluctuations and Salmonids: A Review of the Biological Effects, Mechanical Causes, and Options for Mitigation. State of Washington Department of Fisheries Technical Report No. 19.

Hynes, H.B.N., 1970. The Ecology of Running Waters. University of Toronto Press, Toronto, Canada, 555 pp.

Independent Scientific Group, 1996. Return to the River, Restoration of Salmonid Fishes in the Columbia River Ecosystem. Development of an Alternative Conceptual Foundation and Review and Synthesis of Science Underlying the Fish and Wildlife Program of the Northwest Power Planning Council. Prepublication copy, 584 pp.

Instream Flow and Fish Production Objectives Work Group, December 1987. Completion Report for the Yakima River Basin Water Enhancement Project.

Interagency Committee for Outdoor Recreation, 1990. Assessment and Policy Plan 1990-95. Washington Outdoors.

Interagency Committee for Outdoor Recreation, 1995. Assessment and Policy Plan 1995-2001. State of Washington Outdoor Recreation and Habitat, p. 10.

International Engineering, March 1984. Yakima River Basin Water Enhancement Study, Preliminary Report for Swauk Creek Dam, Lake Cle Elum Tunnel, and Lake Cle Elum Pumping Plant. International Engineering, Northwest District Office, Boise, Idaho.

Johansen, D., 1992. Personal Communication to Lynne MacDonald.

Johansen, D.O., and C.M. Gates, 1967. Empire of the Columbia, A History of the Pacific Northwest. Harper & Row, New York, New York.

Johnson, A., D. Norton, and B. Yake, 1986. Occurrence and Significance of DDT Compounds and Other Contaminants in Fish, Water, and Sediment from the Yakima River Basin. Prepared for Washington State Department of Ecology, Olympia, Washington.

Johnson, B.L., W.B. Richardson, and T.J. Naimo, 1995. Past, Present, and Future Concepts in Large River Ecology: How Rivers Function and How Human Activities Influence River Processes. In BioScience, vol. 45(3), pp. 134-141.

Johnson, O., 1964. River Mile Index Yakima River. Hydrology Subcommittee Columbia Basin Interagency Committee, Columbia River Basin, Washington, 39 pp.

Johnson, R.R., and C.H. Lowe, 1985. On the Development of Riparian Ecology. In Riparian Ecosystems and Their Management: Reconciling Conflicting Uses. Forest Service General Technical Report RM-120, pp. 112-116.

Joy, J., and B. Patterson, 1996. A Suspended Sediment and DDT Total Maximum Daily Load Evaluation Report for the Yakima River. Prepared for Washington State Department of Ecology, Environmental Investigations and Laboratory Services Program, Watershed Assessments Section, Draft Report (Revised November 15, 1996).

Kandl, E., 1993. A Preliminary Groundwater Quality Study for the Ahtanum Creek Basin on the Yakama Indian Reservation, Washington. Prepared for Yakama Indian Nation Water Resources Planning Program.

Kandl, E., 1993. A Preliminary Groundwater Quality Study from the Satus Creek Basin, Yakama Indian Reservation, Washington. Prepared for Yakama Indian Nation Water Resources Planning Program.

Kandl, E., 1993. Toppenish Creek Basin Groundwater Quality Study: Monthly Nitrate/ Quarterly Geochemical Sampling, 1988-89. Phase 2 Investigation. Prepared for Yakama Indian Nation Water Resources Planning Program.

Karr, J.R., K.D. Fausch, P.L. Angermeier, P.R. Yant, and I.J. Schlosser, 1986. Assessing Biological Integrity in Running Waters: A Method and Its Rationale. Illinois Natural History Survey Special Publication 5, Champaign, Illinois, 28 pp.

Kaset International, 1994. Forest Service Values Poll Questions, Results and Analysis. Prepared for U.S. Department of Agriculture, Forest Service, p. 28.

Kauffman, J.B., 1988. The Status of Riparian Habitats in the Pacific Northwest Forests. In Streamside Management: Riparian Wildlife and Forestry Interactions (Kenneth J. Raedeke, ed.). College of Forest Resources, University of Washington Contribution No. 59, pp. 45-55.

Kauffman, J.B., R.L. Beschta, N. Otting, and D. Lytjen, 1997. An Ecological Perspective of Riparian and Stream Restoration in the Western United States. In Fisheries, vol. 22(5), pp. 12-24.

King, D.A., D.J. Flynn, and W.W. Shaw, 1988. Total and Existence Values of a Herd of Desert Bighorn Sheep, Benefits and Costs in Natural Resource Planning, Interim Report. Western Regional Research Publication W-133.

King, J.S., L.G. Stutzman, G. Thompson, and W. Thompson, 1995. Cultural Resources Assessment of the Kenetect Washington Windplant No. 1 Project, Klickitat County. Historical Research Associates, Inc., Seattle, Washington.

Kinnison, H.B., and J.E. Sceva, 1963. Effects of Hydraulic and Geologic Factors on Streamflow of the Yakima River Basin, Washington. U.S. Geological Survey Water Supply Paper 1595.

Kirk, T., 1995. Summary of the Groundwater Presentation Given to the Yakima River Basin Watershed Council. Unpublished.

Larsen, D., 1994. Washington Mill Survey 1990. Washington State Department of Natural Resources, Olympia, Washington, p. 14.

Larsen, D., 1995. Washington Timber Harvest: 1993. Washington State Department of Natural Resources, Olympia, Washington, p. 50.

Ligon, F.K., W.E. Dietrich, and W.J. Trush, 1995. Downstream Ecological Effects of Dams, A Geomorphic Perspective. In BioScience, vol. 45(3), pp. 183-192.

Lind, D., 1993. Irrigation Diversions in the Toppenish Creek Basin and Their Effect on Streamflow, Fish Habitat, and Fish Passage. Yakama Indian Nation, Fisheries Resource Management Program, 22 pp., plus tables and figures.

Lindeman, G., 1975. SR 82—Union Gap Vicinity—SR 97 Connection, Historic Survey Project Report No. 19. Washington Archaeological Research Center, Pullman, Washington.

Link, R.A., 1989. Cle Elum Dam, Vol. I. Washington Division of Geology and Earth Resources Bulletin 78, pp. 488-494.

Lockhart, A.C., 1989. Kachess Dam, Vol. I. Washington Division of Geology and Earth Resources Bulletin 78, pp. 507-512.

Loomis, J.B., 1987. Balancing Public Trust Resources of Mono Lake and Los Angeles Water Rights: An Economic Approach. In Water Resources Research, vol. 23, pp. 1,449-1,456.

Loomis, J.B., and D.S. White, 1995. The Economic Benefits of Endangered Species, A Summary of the Literature. Report to the Forest Service From Colorado State University, Fort Collins, Colorado, p. 18.

Lothson, G.A., 1993. Phase 1 Cultural Resource Reconnaissance Survey of Satus Creek Wildlife Recreation Area. Yakama Indian Nation, Washington.

Lothson, G.A., and C. Hemphill, 1994. Yakama Indian Nation, Yakima—Cle Elum River Archaeology.

Mack, R.S., D.J. Cocheba, D. Green, and D.W. Hedrick, 1989. An Economic Impact Analysis of the Proposed Yakima/Klickitat Fishery Enhancement Project. DOE/BP-00245-5. Agreement No. DE-AI79-89BP96453. Prepared for U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife, Portland, Oregon.

Martin, S.W., J.A. Long, and T.N. Pearsons, 1994. Comparison of Survival, Gonad Development, and Growth Between Rainbow Trout With and Without Surgically Implanted Dummy Radio Transmitters. Chapter 2. In Yakima River Species Interactions Studies—Annual Report 1993. DOE/BP-99852-2. U.S. Department of Energy, Bonneville Power Administration, Portland, Oregon, pp. 34-43.

Martin, S.W., and T.N. Pearsons, 1994. Age and Growth of Rainbow Trout in the Upper Yakima River Basin. Chapter 5. In Yakima River Species Interactions Studies—Annual Report 1993. DOE/BP-99852-2. U.S. Department of Energy, Bonneville Power Administration, Portland, Oregon, pp. 105-124.

Martin, S.W., T.N. Pearsons, and E.L. Bartrand, 1994. Rainbow and Steelhead Trout Temporal and Spatial Spawning Distribution in the Upper Yakima River Basin, Chapter 1. In Yakima River Species Interactions Studies—Annual Report 1993. DOE/BP-99852-2. U.S. Department of Energy, Bonneville Power Administration, Portland, Oregon, pp. 4-33.

Martin, S.W., T.N. Pearsons, and S.A. Leider, 1994. Rainbow Trout Distribution and Population Abundance Variation in the Upper Yakima River Basin, Chapter 4. In Yakima River Species Interactions Studies—Annual Report 1993. DOE/BP-99852-2. U.S. Department of Energy, Bonneville Power Administration, Portland, Oregon, pp. 70-104.

Martinsen, R., December 1991. Clear Creek Dam Rehabilitation. Letter Report, Naches Ranger District files.

McIntosh, B.A., J.R. Sedell, J.E. Smith, R.C. Wissmar, S.E. Clarke, G.H. Reeves, and L.A. Brown, 1994. Historical Changes in Fish Habitat for Select River Basins of Eastern Oregon and Washington. In Northwest Science, vol. 68, Special Issue, pp. 36-53.

McMichael, G.A., 1994. Effects of Parentage, Rearing Density, and Size at Release of Hatchery-Reared Steelhead Smolts on Smolt Quality and Post-Release Performance in Natural Streams, Chapter 9. In Yakima River Species Interactions Studies—Annual Report 1993. DOE/BP-99852-2. U.S. Department of Energy, Bonneville Power Administration, Portland, Oregon, pp. 194-210.

McMichael, G.A., J.P. Olson, E.L. Bartrand, M. Fisher, J.N. Hindman, and S.A. Leider, 1992. Yakima River Species Interactions Studies—Annual Report 1991. DOE/BP-01483-2. Project No. 89-105, Contract No. DE-B179-89BP01483. U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife, Portland, Oregon, 177 pp.

McMichael, G.A., T.N. Pearsons, and S.A. Leider, 1994. The Effects of Releases of Hatchery-Reared Steelhead on Wild Salmonids in Natural Streams, Chapter 7. In Yakima River Species Interactions Studies—Annual Report 1993. DOE/BP-99852-2. U.S. Department of Energy, Bonneville Power Administration, Portland, Oregon, pp. 143-165.

McMichael, G.A., C.S. Sharpe, M. Fischer, and T.N. Pearsons, 1994. Examination of Competition Among Hatchery-Reared Steelhead, Naturally-Produced Rainbow Trout, and Spring Chinook Salmon Using Small Enclosures in a Natural Stream, Chapter 8. In Yakima River Species Interactions Studies—Annual Report 1993. DOE/BP-99852-2. U.S. Department of Energy, Bonneville Power Administration, Portland, Oregon, pp. 166-193.

Merker, C.R., 1985. Big Game Mortality in the Highline Canal of the Yakima Project. Prepared for the Bureau of Reclamation, Pacific Northwest Region, Boise, Idaho.

Meuth, J.L., 1989. Yakama Indian Nation Waterfowl Management Plan, Yakama Indian Nation, Toppenish, Washington, p. 190.

Minshall, G.W., 1988. Stream Ecosystem Theory: A Global Perspective. In Journal of the North American Benthological Society, vol. 7, pp. 263-288.

Minshall, G.W., K.W. Cummins, R.C. Petersen, C.E. Cushing, D.A. Bruns, J.R. Sedell, and R.L. Vannote, 1985. Developments in Stream Ecosystem Theory. In Canadian Journal of Fisheries and Aquatic Science, vol. 42, pp. 1,045-1,055.

Mitchell, S. Report on Waterbanking, Preliminary Assessment of Waterbanking and a Water Supply Market as Part of the Yakima River Basin Water Enhancement Project.

Molenaar, D., 1985. Water in the Lower Yakima River Basin. Washington State Department of Ecology Supply Bulletin 53.

Mongillo, P., and L. Falconer, 1980. Yakima Fisheries Enhancement Study Final Report. Prepared for Washington Department of Game, Yakima, Washington.

Moyle, P.B., and J.E. Williams, 1990. Biodiversity Loss in the Temperate Zone: Decline of the Native Fish Fauna of California. In Conservation Biology, vol. 4, pp. 275-284.

Naiman, R.J., J.J. Magnuson, D.M. McKnight, and J.A. Stanford, 1995. The Freshwater Imperative. Island Press, Washington, DC, 165 pp.

National Marine Fisheries Service, 1981. Planning Aid Letter to the Bureau of Reclamation for the Anadromous Fish Portion of Problems and Needs, Phase I, of the Yakima River Basin Water Enhancement Project Feasibility Study. 8 pp.

National Park Service, 1995. Economic Impacts of Protecting Rivers, Trails, and Greenway Corridors. Washington, DC, p. 138.

Neitzel, D.A., C.S. Abernethy, and E.W. Lusty, 1987. A Fisheries Evaluation of the Richland and Toppenish/Satus Canal Fish Screening Facilities, Spring 1986, Annual Report. DOE/BP-01830-2, Contract No. DE-AC06-76RLO 1830. U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife, Portland, Oregon, 53 pp.

Neitzel, D.A., C.S. Abernethy, and E.W. Lusty, 1989. A Fisheries Evaluation of the Westside Ditch and Wapato Canal Fish Screening Facilities, Spring 1989, Annual Report. DOE/BP-01830-8, Project No. 85-62, Contract No. DE-AC06-76RLO 1830. U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife, Portland, Oregon.

Neitzel, D.A., C.S. Abernethy, and E.W. Lusty, 1989. Velocity Measurements at Six Fish Screening Facilities in the Yakima River Basin, Washington, Summer 1988, Annual Report. DOE/BP-01830-4, Project No. 85-62, Contract No. DE-AC06-76RLO 1830. U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife, Portland, Oregon, 47 pp.

Neitzel, D.A., C.S. Abernethy, and E.W. Lusty, 1990. A Fisheries Evaluation of the Wapato, Sunnyside, and Toppenish Creek Canal Fish Screening Facilities, Spring 1988, Annual Report. DOE/BP-01830-6, Project No. 85-62, Contract No. DE-AC06-76RLO 1830. U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife, Portland, Oregon.

Neitzel, D.A., C.S. Abernethy, E.W. Lusty, and L.A. Prohammer, 1985. A Fisheries Evaluation of the Sunnyside Canal Fish Screening Facility, Spring 1985, Annual Report. DOE/BP-01830-1, Contract No, DE-AC06-RLO 1830. U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife, Portland, Oregon, 29 pp.

Neitzel, D.A., C.S. Abernethy, E.W. Lusty, and S.J. Wampler, 1988. A Fisheries Evaluation of the Richland and Wapato Canal Fish Screening Facilities, Spring 1987, Annual Report. DOE/BP-01830-3, Project No. 85-62, Contract No. DE-AC06-76RLO 1830. U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife, Portland, Oregon, 45 pp.

Neitzel, D.A., C.S. Abernethy, and G.A. Martenson, 1990. A Fisheries Evaluation of the Westside Ditch and Town Canal Fish Screening Facilities, Spring 1990, Annual Report. DOE/BP-01830-9, Project No. 85-62, Contract No. DE-AC06-76RLO 1830. U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife, Portland, Oregon.

Niemi, E., and E. Whitelaw, 1995. .The Economic Consequences of Protecting Salmon Habitat in Idaho, Preliminary Report. Prepared for the Pacific Rivers Council, Eugene, Oregon, ECO Northwest, p. 62.

North Yakima Conservation District and Soil Conservation Service, 1994. Moxee Watershed Plan and Environmental Assessment for Moxee Watershed, Yakima County, Washington. Prepared by North Yakima Conservation District in Cooperation with Soil Conservation Service, Yakima, Washington.

Noss, R.F., E.T. LaRoe, III, and J.M. Scott, 1995. Endangered Ecosystems of the United States: A Preliminary Assessment of Loss and Degradation, Biological Report 28. National Biological Service, Washington, DC.

Oakerman, G., 1979. Yakima River Basin Wildlife Enhancement Study. Contract No. 7-07010-SS038. Prepared for Washington Department of Game and Bureau of Reclamation, Yakima, Washington, 146 pp.

Ohmart, R.D., and B.W. Anderson, 1986. Riparian Habitat. In Inventory and Monitoring of Wildlife Habitat. Bureau of Land Management Service Center, Denver, Colorado, pp. 169-199.

Oliver, W.H., 1983. Farm-Wildlife History, Relationships and Problems on Yakama Indian Reservation. Contract No. 82-7134. Yakama Indian Nation, Toppenish, Washington, 181 pp.

Oliver, W.H., January 1988. Water Rights Claim for Wildlife Habitat on the Yakama Indian Reservation. Project Completion Report Fulfilling Water Report Contract No. 87-498.

Oliver, W.H., 1994. Yakima River Basin—Fish and Wildlife Mitigations, History, Problems, and Prescriptions, Related to 100+ Years Irrigation Development. Senior Environmental Corps, Washington Department of Fish and Wildlife.

Olsen, D., and J. Richards, 1994. Inter-Basin Comparison Study—Columbia River Salmon Production Compared to Other West Coast Production Areas, Phase II Analysis. Study Sponsored by the U.S. Army Corps of Engineers, Portland, Oregon, 29 pp.

Olson, F., 1993. Compilation of Flow and Fish Habitat Information. Prepared for the Naches River IFIM at Oak Flats.

Orr, E.L., and W.N. Orr, n.d. Geology of the Pacific Northwest, The McGraw-Hill Companies, Inc., New York.

Pace, B., and G. Young, 1978. Yakama Indian Nation: Wapato History and Heritage. Wapato History Committee.

Pacific Northwest Laboratory, 1990. Experimental Design Plan for the Yakima/Klickitat Production Project. In Yakima/Klickitat Production Project, Preliminary Design Report, Appendix A. DOE/BP-00245-2. U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife, Portland, Oregon, p. 107.

Parker, G.L., and F.B. Storey, 1916. Water Powers of the Cascade Range Part III, Yakima River Basin. U.S. Geological Survey Water Supply Paper 369, 169 pp.

Parker, R.C., 1989. Draft Southcentral Waterfowl Management Plan, Unpublished Report on File, Washington Department of Wildlife, Moses Lake, Washington.

Patten, B.G., R.B. Thompson, and W.D. Gronlund, 1970. Distribution and Abundance of Fish in the Yakima River, Washington, April 1957 to May 1958, Special Scientific Report—Fisheries No. 603. U.S. Fish and Wildlife Service, Bureau of Commercial Fisheries, Washington, DC.

Pearsons, T.N., and S.W. Martin, 1994. Assemblage Structure of Fishes Associated with Rainbow Trout in the Upper Yakima River Basin, Chapter 6. In Yakima River Species Interactions Studies—Annual Report 1993. DOE/BP-99852-2. U.S. Department of Energy, Bonneville Power Administration, Portland, Oregon, pp. 125-142.

Pearsons, T.N., G.A. McMichael, E.L. Bartrand, M. Fisher, J.T. Monahan, and S.A. Leider, 1993. Yakima River Species Interactions Study—Annual Report 1992. DOE/BP-01483-3. Project No. 89-105, Contract No. DE-B179-89BP01483. U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife, Portland, Oregon, 98 pp.

Pearsons, T.N., G.A. McMichael, S.W. Martin, E.L. Bartrand, M. Fischer, and S.A. Leider, 1994. Yakima River Species Interactions Studies—Annual Report 1993. DOE/BP-99852-2. U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife, Portland, Oregon, 247 pp.

Perala, O.J., 1992. Water-Resource Development, Surface Water Quality Assessment of the Yakima River Basin, Washington: Analysis of Available Water Quality Data Through 1985 Water Year. U.S. Geological Survey Open-File Report 91-454, Portland, Oregon, pp. 30-38.

Peters, J.C., 1982. Effects of River and Streamflow Alteration on Fishery Resources. In Fisheries, vol. 7(2), pp. 20-22.

Pimental, D., P. Resosudarmo, C. Harvey, D. Kurz, K. Sinclair, S. Crist, M. McNair, L. Shpritz, L. Fitton, R. Saffouri, and R. Blair, 1995. Environmental and Economic Costs of Soil Erosion and Conservation Benefits. In Science, vol. 267, pp. 1,117-1,123.

Poff, N.L., and J.V. Ward, 1989. Implications of Streamflow Variability and Predictability for Lotic Community Structure: A Regional Analysis of Streamflow Patterns. In Canadian Journal of Fisheries and Aquatic Science, vol. 46, pp. 1,805-1,817.

Power, M.E., A. Sun, G. Parker, W.E. Dietrich, and J.T. Wootton, 1995. Hydraulic Food-Chain Models, An Approach to the Study of Food-Web Dynamics in Large Rivers. In BioScience, vol. 45(3), pp. 159-167.

Prych, E.A., 1983. Numerical Simulation of Groundwater Flow in Lower Satus Creek Basin, Yakama Indian Reservation, Washington. U.S. Geological Survey Water-Resources Investigation 82-4065, p. 78, 1 plate.

Pucherelli, M.J., R.C. Clark, and K. Szabados, 1991. A Comparative Analysis of Riffle Habitat of Select Sites on the Yakima River (Habitat). Applied Sciences Referral Memorandum No. 91-4-2, 124, Denver, Colorado.

Raedeke, K.J., R.D. Taber, and D.K. Paige, 1988. Ecology of Large Mammals in Riparian Systems of Pacific Northwest Forests. In Streamside Management: Riparian Wildlife and Forestry Interactions. College of Forest Resources, University of Washington Contribution No. 59, pp. 113-132.

Rasmussen, J.J., 1976. Soil Survey of Yakama Indian Reservation Irrigated Area, Washington: Part of Yakima County. U.S. Department of Agriculture, 51 pp.

Regan, D.C., S. Gough, and J.R. Galm, 1996. Cultural Resources Investigations for the Yakima Basin Enhancement Projects, Kachess Lake, Kittitas County, Washington. Draft Short Report SR-500. Archaeological and Historical Services, Eastern Washington University, Cheney, Washington.

Reid, C., 1987. Bumping Lake Timber Sale. Wenatchee National Forest Cultural Resource Reconnaissance Report No. 061708-88-03.

Reiser, D.W., and T.C. Bjornn, 1979. Influence of Forest and Rangeland Management on Anadromous Fish Habitat in Western North America, Habitat Requirements of Anadromous Salmonids. U.S. Department of Agriculture Forest Service Anadromous Fish Habitat Program. Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

R.H. Dawson and Associates, Inc., 1987. Onfarm Conservation Practices in the Yakima Basin—Phase II, Boise, Idaho.

Ribaudo, M.O., 1989. Water Quality Benefits from the Conservation Reserve Program, Bulletin AER-606. U.S. Department of Agriculture, Economic Research Service, Washington, DC.

Rice, H.S., 1975. SR 82—Union Gap Vicinity—SR 97 Connection, Archaeological Survey Project Report No. 20. Washington Archaeological Research Center, Pullman, Washington.

Rinella, J.F., S.W. McKenzie, and G.J. Fuhrer, 1992. Surface Water Quality Assessment of the Yakima River Basin, Washington: Analysis of Available Water Quality Data Through 1985 Water Year. U.S. Geological Survey Open-File Report 91-453, National Water Quality Assessment Program, Portland, Oregon.

Rockwell International, 1979. Hydrologic Studies Within the Columbia Plateau, Washington: An Integration of Current Knowledge. RHO-BWI-ST-5.

Rood and Mahoney, 1992. Instream Flow Needs for Riparian Vegetation: Cottonwood Forest Ecosystems. In Instream Flow Needs. Seminar Proceedings, Interdepartmental Instream Flow Needs Task Force, Edmonton Inn, Alberta, Canada, pp. 55-73.

Roza Irrigation District, June 1990. Assessment of the Potential for Water Deliveries from the Roza Main Canal to Four Irrigation Districts: Selah-Moxee Irrigation District, Moxee Ditch Association, Moxee-Hubbard Irrigation Company, Union Gap Irrigation District. Consolidated Study by Roza Irrigation District, Yakima Project, and Sunnyside, Washington.

Rubin J., G. Helfand, and J.B. Loomis, 1991. A Benefit-Cost Analysis of the Northern Spotted Owl. In Journal of Forestry, vol. 89(12), pp. 25-30.

Ruehle, T.E., and C.S. McCutcheon, 1994. Pit-Tag Studies with Juvenile Salmonids at the Chandler Canal Fish Collection Facility, Yakima River, 1990. DOE/BP-07099-1. Project 90-65, Contract DE-AI79-90BP07099. Prepared for U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife, Portland, Oregon, 37 pp.

R.W. Beck and Associates, 1990. Klickitat Salmon and Steelhead Hatchery Preliminary Design Report. Yakima/Klickitat Production Project Preliminary Design Report—Appendix C. DOE/BP-00245-4. Prepared for U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife, Portland, Oregon.

Sanders, L., R.G. Walsh, and J.B. Loomis, 1990. Toward Empirical Estimation of the Total Value of Protecting Rivers. In Water Resources Research, vol. 26(7), pp. 1345-1357.

Schamberger, M.L., M.J. Hay, J.J. Charbonneau, and R.L. Johnson, 1992. Economic Analysis of Critical Habitat Designation Effects for the Northern Spotted Owl. U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC, p. 94.

Schlosser, I.J., 1985. Flow Regime, Juvenile Abundance, and the Assemblage Structure of Stream Fishes. In Ecology, vol. 66, pp. 1,484-1,490.

Schulze, W.D., E.G. Walther, D.S. Brookshire, M.A. Thayer, J. Molenar, W. Malm, K.K. MacFarland, S. Ben-David, and R.L. Whitworth, 1983. The Economic Benefit of Preserving Visibility in the National Parklands of the Southwest. In Natural Resources Journal, vol. 23, pp. 149-73.

Skrivan, J.A., 1987. Ground-Water Hydrology of the Toppenish Creek Basin, Yakama Indian Reservation, Washington. U.S. Geological Survey Water-Resources Investigation Report 82-4010, p. 47.

Smith, H.I., 1910. The Archaeology of the Yakima Valley. Anthropological Papers of the American Museum of Natural History, vol. 6, Part 1. New York.

Smith, W.C., 1971. Descriptive Archaeology of the Umtanum Creek Site (45-KT-101). Department of Anthropology and Museum of Man Occasional Papers, No. 1. Central Washington University, Ellensburg, Washington.

Smith, W.C., 1977. Archaeological Explorations in the Columbia Basin: A Report on the Mesa Project 1973-1975. Central Washington Archaeological Survey, Ellensburg, Washington.

Smith, L.H., C.H. Dwyer, F.K. Nunns, G.M. Schafer, H. Olsen, and D.W. Klauss, 1958. Soil Survey of Yakima County, Washington. U.S. Department of Agriculture, Series 1942, No. 15, 143 pp.

Smith-Kuebel, C., and T.R. Lillybridge, 1993. Sensitive Plants and Noxious Weeds of the Wenatchee National Forest. Forest Service, in cooperation with Bonneville Power Administration, Portland, Oregon.

Sparks, R.E., 1995. Need for Ecosystem Management of Large Rivers and Their Floodplains: These Phenomenally Productive Ecosystems Produce Fish and Wildlife and Preserve Species. In BioScience, vol. 45, No. 3, pp. 168-82.

Stalmaster, M.V., 1987. The Bald Eagle. Universe Books, New York, New York.

Stalnaker, C., B.L. Lamb, J. Henriksen, K. Bovee, and J. Bartholow, 1994. The Instream Flow Incremental Methodology, A Primer for IFIM, Internal Publication. National Biological Survey, Fort Collins, Colorado, 99 pp.

Stanford, J.A., 1994. Instream Flows to Assist the Recovery of Endangered Fishes of the Upper Colorado River Basin. U.S. Fish and Wildlife Service, Denver, Colorado, Biological Report, 24, and National Biological Service, Washington, DC, 47 pp.

Stanford, J.A., and J.V. Ward, 1983. Insect Species Diversity as a Function of Environmental Variability and Disturbance in Streams. In Stream Ecology: Application and Testing of General Ecological Theory, Plenum Press, New York, New York, pp. 265-278.

Stanford, J.A., and J.V. Ward, 1988. The Hyporheic Habitat of River Ecosystems. In Nature, vol. 335, pp. 64-66.

Stanford, J.A., J.V. Ward, W.J. Liss, C.A. Frissell, R.N. Williams, J.A. Lichatowich, and C.C. Coutant, 1995. A General Protocol for Restoration of Regulated Rivers. A Contribution to the Symposium on Restoration of Regulated Rivers, Lycksels, Sweden, September 25-28, 1995. Proceedings in Press in Regulated Rivers: Research and Management.

State of California. California Timber Harvest by County, Annual Reports 1979-1993. Property Taxes Department, Timber Tax Division, Sacramento, California.

Stempel, J.M., 1985. Conversion of Weighted Usable Area to Potential Fish Production in the Yakima River Basin. U.S. Fish and Wildlife Service, Moses Lake Suboffice, Olympia, Washington.

Stoll, J., and L.A. Johnson, 1984. Concepts of Value, Nonmarket Valuation and the Case of the Whooping Crane. Presented at the 49th North American Wildlife and Natural Resources Conference. Wildlife Management Institute, Washington, DC, pp. 382-393.

Stromberg and Patten, 1990. Riparian Vegetation Instream Flow Requirements: A Case Study from a Diverted Stream in the Eastern Sierra Nevada, California. In Environmental Management, vol. 14(2), pp. 185-194.

Suttles, G., 1972. The Social Construction of Communities. University of Chicago Press, Chicago, Illinois.

Swanson, C.S., and J.B. Loomis, 1993. Role of Nonmarket Economic Values in Benefit-Cost Analysis of Public Forest Management Options, Unpublished Report Prepared for the Forest Ecosystem Management Assessment Team, p. 57.

Swanson, E.H., Jr., 1962. Early Cultures in Northwestern America. In American Antiquity, vol. 28, pp. 151-158.

Swenson, J.E., T.C. Hinz, S.J. Knapp, H.J. Wentland, and J.T. Herbert, 1981. A Survey of Bald Eagles in Southeastern Montana.

Tabor, R.A., R.S. Shively, and T.P. Poe, 1993. Predation on Juvenile Salmonids by Smallmouth Bass and Northern Squawfish in the Columbia River Near Richland, Washington. In North American Journal Fishery Management, vol. 13, pp. 831-838.

Taylor, C., G. Alward, S. Winter, and E. Siverts, 1993. Micro IMPLAN User's Guide. Forest Service, Land Management Planning Group, Fort Collins, Colorado, p. 129.

Taylor, E.B., 1988. Water Temperature and Velocity as Determinants of Microhabitats of Juvenile Chinook and Coho Salmon in a Laboratory Stream Channel. In Transactions of the American Fisheries Society, vol. 117(1), pp. 22-28.

Taylor, M., and W. Verran, Jr., 1978. Irrigation: Wapato History and Heritage. Wapato History Committee.

Thomas, A.E., 1975. Migration of Chinook Salmon Fry from Simulated Incubation Channels in Relation to Water Temperature, Flow, and Turbidity. In Progressive Fish Culture, vol. 37(4), pp. 219-223.

Thomas, J.W., R.G. Anthony, M.G. Raphael, A.G. Gunderson, E.D. Forsman, B.G. Marcot, R.S. Holthausen, G.H. Reeves, D.M. Solis, and J.R. Sedell, 1993. Viability Assessments and Management Considerations for Species Associated with Late-Successional and Old-Growth Forests of the Pacific Northwest, Portland, Oregon. Forest Service, p. 523.

Townsend-Moller, D.A., and R.G. Dunham, 1975. Social Assessment of the Yakama Indian Nation. Social Research Center, Washington State University, Pullman, Washington, Prepared for the Bureau of Reclamation.

Townsend-Moller, D.A., and R.G. Dunham, 1976. Planning for Indian Water Resources: A Case Study in Social Assessment. Social Research Center, Washington State University, Pullman, Washington, Prepared for the Resource Analysis Branch, Bureau of Reclamation, Division of Planning Coordination and the Pacific Northwest Region, Contract No. 14-06-100-8671.

Tyus, H.M., 1990. Effects of Altered Streamflows on Fishery Resources. In Fisheries, vol. 15(3), pp. 18-20.

Uebelacker, M., 1984. Time Ball: A Story of the Yakama People and the Land, a Cultural Resource Overview. Yakama Indian Nation, Toppenish, Washington.

U.S. Army Corps of Engineers, 1978. Yakima Valley Regional Water Management Study—vol. I, Summary; vol. II, Water Quality; vol. III, Water Budget; vol. IV, Geology and Ground Water. U.S. Army Corps of Engineers, Seattle, Washington.

U.S. Congress, October 1994. Title XII, Yakima River Basin Water Enhancement Project, Public Law 103-434. Laws from 103rd Congress, 2nd session, 108 Stat., 4550.

U.S. Department of Agriculture, 1985. Influence of Forest and Rangeland Management on Anadromous Fish Habitat in Western North America. General Technical Report PNW-181. Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon, p. 27.

U.S. Department of Agriculture, U.S. Department of the Interior, U.S. Department of Commerce, and U.S. Environmental Protection Agency, 1993. Forest Ecosystem Management: An Ecological, Economic, and Social Assessment. Report of the Forest Ecosystem Management Assessment Team, Portland, Oregon.

U.S. Department of Agriculture, U.S. Department of the Interior, U.S. Department of Commerce, and U.S. Environmental Protection Agency, 1994. Final Supplemental Environmental Impact Statement on Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl, Portland, Oregon.

U.S. Department of Energy, October 1990. Yakima Basin Fish Passage Project-Phase II, Draft Environmental Assessment.

U.S. Department of the Interior and U.S. Department of Commerce, 1993. The 1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. Fish and Wildlife Service and Bureau of the Census, Report for Washington, Washington, DC, 41 pp.

U.S. Fish and Wildlife Service, 1984. Spring Chinook Salmon (*Oncorhynchus Tshawytscha*) Spawning Ground Surveys in the Yakima River Basin. Fisheries Assistance, Union Gap, Washington.

U.S. Fish and Wildlife Service, 1985. Conversion of Weighted Usable Area to Potential Fish Production in the Yakima Basin. Moses Lake Suboffice, Ecological Services, Olympia, Washington.

U.S. Fish and Wildlife Service, 1986. The Potential for Draining Rimrock Reservoir, Yakima River Basin, Washington. Memo from Field Supervisor, U.S. Fish and Wildlife Service, Ecological Services, Olympia, Washington, to Regional Director, Bureau of Reclamation, Boise, Idaho. 2 pp.

U.S. Fish and Wildlife Service, 1986. Potential Fish and Wildlife Impacts of Alternative Plans Proposed for the Yakima River Basin Water Enhancement Project.

U.S. Fish and Wildlife Service, 1986. Recovery Plan for the Pacific Bald Eagle.

U.S. Fish and Wildlife Service, 1987. Fish and Wildlife Coordination Act Report for the Early Implementation Measures of Yakima River Basin Water Enhancement Project.

U.S. Fish and Wildlife Service, 1987. Northern Rocky Mountain Wolf Recovery Plan.

U.S. Fish and Wildlife Service, 1990. Regional Wetlands Concept Plan, Portland, Oregon, 18 pp.

U.S. Fish and Wildlife Service, 1993. Sunnyside Reregulation Reservoir Feasibility Study, Fish and Wildlife Coordination Act Report. Prepared by Steve Fransen for the Bureau of Reclamation.

U.S. Fish and Wildlife Service, 1993. Updating Our Thinking on the Role of Human Activity in Wolf Recovery.

U.S. Fish and Wildlife Service, 1994. Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin, Recovery Program Organization, Mission, and Staffing Plan. U.S. Fish and Wildlife Service, Region 6, Denver, Colorado.

U.S. Fish and Wildlife Service, 1995. Draft Environmental Impact Statement, Water Rights Acquisition for Lahontan Valley Wetlands, Churchill County, Nevada. Vol. 1, Portland, Oregon.

U.S. Fish and Wildlife Service, 1995. Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin, Section 7 Consultation, Sufficient Progress, and Historic Projects Agreement, and Recovery Action Plan (RIPRAP). U.S. Fish and Wildlife Service, Region 6, Denver, Colorado.

U.S. Fish and Wildlife Service, 1995. Supplemental Fish and Wildlife Coordination Act Report. Yakima River Water Conservation Demonstration Project, Olympia, Washington.

U.S. Fish and Wildlife Service, 1996. Fish and Wildlife Coordination Act Report, Yakima River, Chandler Pumping Plant Electrification, Moses Lake, Washington.

U.S. Fish and Wildlife Service, 1996. Personal Communication, Outdoor Recreation Planner, Wenatchee National Forest.

U.S. Fish and Wildlife Service, 1996. Planning Aid Memorandum for the Proposed Modifications to the Kachess Dam, Moses Lake, Washington.

U.S. Fish and Wildlife Service, 1996. Yakima River Basin Water Enhancement Project, Preliminary Draft Fish and Wildlife Coordination Act Report. Prepared for Bureau of Reclamation, Yakima, Washington.

U.S. Fish and Wildlife Service and Washington Department of Game, 1982. Yakima River Basin Water Enhancement Project. Planning Aid Report on Wildlife and Resident Fish Resources in the Yakima Basin. U.S. Fish and Wildlife Service, Olympia, Washington, 63 pp.

U.S. Forest Service, 1996. Personal Communication, Outdoor Recreation Planner, Wenatchee Resource Area.

U.S. Geological Survey, 1975. Water Resources of the Toppenish Creek Basin, Yakama Indian Reservation, Washington. U.S. Geological Survey Water Resources Investigation, pp. 42-74.

U.S. Geological Survey, 1991. Water Resources Data, Washington.

U.S. Geological Survey, 1992. Surface Water Quality Assessment of the Yakima River Basin, Washington: Analysis of Available Water Quality Data Through 1985 Water Year. U.S. Geological Survey Open-File Report 91-453, Portland, Oregon.

Vaccaro, J.J., 1986. Comparison of Unregulated and Regulated Streamflow for the Yakima River at Union Gap and Near Parker, Washington. Water Resources Investigations Open-File Report 82-646. Prepared for U.S. Geological Survey, Tacoma, Washington, 54 pp.

Vaccaro, J.J., 1986. Simulation of Streamflow Temperatures in the Yakima River Basin, Washington, April-October 1981. Water Resources Investigations Report 85-4232. U.S. Geological Survey, Tacoma, Washington, 91 pp.

Van Winkle, W., H.I. Jager, and B.D. Holcomb, March 1996. An Individual-Based Instream Flow Model for Co-Existing Populations of Brown and Rainbow Trout. Interim Report. Lockheed Martin Energy Systems, Inc., Oak Ridge, Tennessee, TR-106258, Research Projects 2932-02;9046-02;9111-01.

Vannote, R.L., G.W. Minshall, K.W. Cummins, J.R. Sedell, and C.E. Cushing, 1980. The River Continuum Concept. In Canadian Journal of Fisheries and Aquatic Science, vol. 37, pp. 130-137.

Vinsonhaler, L., 1983. Memorandum Draft Report on Waterbanking from Larry Vinsonhaler to Project Superintendent. Bureau of Reclamation, Yakima, Washington.

Wahlers, R., 1998. Washington State Employment Security Agricultural Workforce in Washington State 1997. Agriculture Labor Market Information, Lab of Market and Economic Analysis Branch, Olympia, Washington.

Walsh, R.G., D. Bjonback, and R. Aiken, 1987. Public Benefits of Programs to Protect Endangered Wildlife in Colorado. In Issues and Technology in the Management of Impacted Western Wildlife, Thorne Ecological Institute, Boulder, Colorado, pp. 65-71.

Walsh, R.G., D.M. Johnson, and J.R. McKean, 1990. Nonmarket Values from Two Decades of Research on Recreation Demand. In Advances in Applied Microeconomics, vol. 5, JAI Press, Inc., Greenwich, Connecticut, pp. 167-193.

Walsh, R.G., J. Loomis, and R. Gillman, 1984. Valuing Option, Existence, and Bequest Demands for Wilderness. In Land Economics, vol. 60(1), pp. 14-29.

Walsh, R.G., R. Rosenberger, J.R. McKean, and C. Mucklow, 1994b. Recreation Value of Ranch Open Space. Report XCM-167. Colorado State University Cooperative Extension, Fort Collins, Colorado.

Walsh, R.G., L. Sanders, and J.R. McKean, 1990b. Toward Empirical Estimation of the Total Value of Protecting Rivers. In Water Resources Research, vol. 26(7), pp. 1,345-1,357.

Walsh, R.G., F.A. Ward, and J.P. Olienyk, 1989. Recreational Demand for Trees in National Forests. In Journal of Environmental Management, vol. 28, pp. 255-268.

Walsh, R., K. Bonetti, and J. Bowker, 1994. Economic Benefits of Preserving Wilderness and Other Natural Areas. Report to Southeastern Forest Experiment Station. Forest Service, Athens, Georgia.

Ward, F.R., 1995. California's Forest Products Industry: 1992, Resource Bulletin PNW-RB-206. Forest Service, Pacific Northwest Research Station, Portland, Oregon, p. 68.

Ward, J.V., 1995. Ecological Connectivity in Alluvial River Ecosystems and Its Disruption by Flow Regulation. In Regul. River, vol. 11, pp. 105-119.

Ward, J.V., and J.A. Stanford, 1995. The Serial Discontinuity Concept: Extending the Model to Floodplain Rivers. In Regul. River, vol. 10, pp. 159-168.

Warren, C.N., 1968. The View from Wenas Creek: A Study in Plateau Prehistory, Occasional Papers of the Idaho State University Museum 24. Idaho State University, Pocatello, Idaho.

Warren, D.D., 1995. Production, Prices, Employment, and Trade in Northwest Forest Industries, Second Quarter 1994. Resource Bulletin PNW-RB-205. Forest Service, Pacific Northwest Research Station, Portland, Oregon, p. 130.

Washington Department of Fish and Wildlife, 1995. Draft Priority Habitat Management Recommendations—Riparian. Washington Department of Fish and Wildlife, Olympia, Washington, 196 pp.

Washington Department of Fisheries, 1990. Yakima/Klickitat Production Project Genetic Risk Assessment. In Yakima/Klickitat Production Project, Preliminary Design Report, Appendix A. DOE/BP-00245-2. U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife, Portland, Oregon, 20 pp.

Washington Department of Game, August 1979. Yakima River Basin Wildlife Enhancement Study. Washington Department of Game, Applied Research Section.

Washington Department of Game, October 1980. Yakima Fisheries Enhancement Study, Final Report. Washington Department of Game, Applied Research Section.

Washington Department of Game, March 1981. Yakima Fisheries Enhancement Study, Phase II Interim Report.

Washington Department of Game, April 1981. A Preliminary Survey of Six Reservoir Sites Proposed by the Yakima River Basin Water Enhancement Project. Washington Department of Game, Applied Wildlife Ecology Section.

Washington Department of Game, April 1981. Yakima Water Management Study, Terrestrial Interim Report. Washington Department of Game, Applied Wildlife Ecology Section.

Washington Department of Game, June 1981. Effects of Mt. St. Helens Ashfall on Three Trout Streams and Bumping Lake in the Yakima Basin, Washington. Washington Department of Game, Applied Research Bulletin No. 16.

Washington Department of Game, March 1982. Yakima Wildlife Enhancement Study, Phase II Final Report. Washington Department of Game, Applied Wildlife Ecology Section.

Washington Department of Game, August 1982. Yakima Fisheries Enhancement Study, Phase II Final Report. Washington Department of Game, Applied Wildlife Ecology Section.

Washington Department of Game, September 1982. Tieton Canal Big Game Mortality, Yakima-Tieton Irrigation District. Washington Department of Game, Habitat Management Division.

Washington Department of Game, September 1982. Yakima Wildlife Enhancement—Phase II Final Report. Prepared by Hoppis, L.L., for Washington Department of Game, Applied Wildlife Ecology Section, Olympia, Washington, and Bureau of Reclamation.

Washington Department of Game, 1984. Big Game Migration and the Proposed Horsetail Dam. Washington Department of Game, Habitat Management Division.

Washington Department of Game, 1985. Evaluation and Comparison of Resident Fishery in Existing and Enlarged Bumping Lake.

Washington Department of Game, January 1985. Big Game Mortality in the Highline Canal of the Yakima Project. Washington Department of Game, Habitat Management Division.

Washington Department of Wildlife, 1991. Management Recommendations for Washington's Priority Habitats and Species. Wildlife Management, Fish Management, and Habitat Management Divisions, Washington Department of Wildlife, Olympia, Washington.

Washington Public Power Supply System, 1977. PSAR WNP-1/4. Vols. 2A and 2B.

Washington State Historic Preservation Office, 1996. Office Files Visit, Olympia, Washington.

Watson, B., 1989. Draft Columbia Basin System Planning—Yakima Subbasin. Unpublished Draft Report.

Weller, M.W., 1986. Marshes. In Inventory and Monitoring of Wildlife Habitat, Prepared for Bureau of Land Management, Service Center, Denver, Colorado, XVII, pp. 201-224.

Wells, M., 1992. Biodiversity Conservation, Affluence and Poverty: Mismatched Costs and Benefits and Efforts to Remedy Them. In Ambio, vol. 21, pp. 237-243.

Whiteman, K.J., J.J. Vaccaro, J.B. Gonthier, and H.H. Bauer, 1994. The Hydrogeologic Framework and Geochemistry of the Columbia Plateau Aquifer System, Washington, Oregon, and Idaho. U.S. Geological Survey Professional Paper 1413-B, p. 73.

Wissmar, R.C., B.A. McIntosh, J.E. Smith, G.H. Reeves, H.W. Li, and J.R. Sedell, 1994. A History of Resource Use and Disturbance in Riverine Basins of Eastern Oregon and Washington (early 1800s-1990s). In Northwest Science, vol. 68, Special Issue, pp. 1-35.

Yakama Indian Nation, 1992. Integration of Cultural, Agricultural, Wildlife, and Fisheries Resources in the Toppenish Creek Corridor: A Tribal Enhancement Project. Department of Natural Resources, Toppenish, Washington.

Yakama Indian Nation, 1992. Water Conservation and Resource Enhancement Plan on the Yakama Indian Reservation Within the Wapato Irrigation Project. An Advisory Resource Enhancement Plan for the Yakima Indian Nation Completed Pursuant to Cooperative Agreement No. 9-FC-10-09860 for the Bureau of Reclamation, Toppenish, Washington, 34 pp., plus appendices.

Yakama Indian Nation, 1992. Water Conservation and Resource Enhancement Plan on the Yakima, Draft Priority Habitat Management Recommendations—Riparian. Washington Department of Fish and Wildlife, Olympia, Washington, 196 pp.

Yakama Indian Nation, 1995. Personal Communication, Business and Management, Economic Development Division.

Yakama Indian Nation, 1996. Personal Communication, Waterfowl Biologist.

Yakama Indian Nation and Bureau of Reclamation, March 1987. Plan of Study for the Yakama Indian Nation On Reservation Program.

Yakama Indian Nation and E.J. Kandl, 1992. A Preliminary Groundwater Quality Study for the Satus Creek Basin, Yakama Indian Reservation, Washington. Yakama Indian Nation, Water Resources Planning Program.

Yakama Indian Nation and E.J. Kandl, 1992. A Salt Balance Study for the Toppenish and Satus Creek Basins for the 1990-1991 Irrigation Season. Yakima Indian Nation, Water Resources Planning Program.

Yakama Indian Nation and E.J. Kandl, 1993. A Preliminary Groundwater Quality Study for the Portion of the Ahtanum Creek Basin on the Yakama Indian Reservation, Washington. Yakama Indian Nation, Water Resources Planning Program.

Yakama Indian Nation and E.J. Kandl, 1993. A Study of Turbidity and Sediment Concentrations in the Agricultural Return Flows of the Toppenish Creek Basin on the Yakama Indian Reservation, Washington. Yakama Indian Nation, Water Resources Planning Program.

Yakama Indian Nation and E.J. Kandl, 1993. Toppenish Creek Basin Groundwater Quality Study: Monthly Nitrate/Quarterly Geochemical Sampling (1988-89 Phase Two Investigation). Yakama Indian Nation, Water Resources Planning Program.

Yakima River Basin Conservation Advisory Group, June 1997. Draft Basin Conservation Plan for the Yakima River Basin Water Conservation Program, Report to the Secretary of the Interior. Yakima, Washington.

Yakima Valley Conference of Governments, 1993. Draft Yakima River Basin Water Quality Plan, vols. I, II, and III, Plan Report.

Yakima Valley Conference of Governments, March 1993. Yakima River Basin Water Quality Plan, Plan Report, Watershed Characterization Water Quality Assessment Problem Identification, vol. I of III, Preliminary Draft. Yakima Valley Conference of Governments, Yakima, Washington.

Yakima Valley Conference of Governments, 1995. Yakima River Basin Water Quality Plan, vol. IIID of four volumes, Yakima, Washington.

Yakima Valley Conference of Governments, June 1995. Yakima River Basin Water Quality Plan, Plan Report, Watershed Characterization Problem Identification, vol. I of IV. Yakima Valley Conference of Governments, Yakima, Washington.

Yakima Valley Visitors and Convention Bureau, 1996. Yakima—A Visitors Guide. Yakima, Washington.

Young, C., 1976. Areas of High Ecological Value in Yakima Watershed, Unpublished Final Report on File.

Glossary

A

1945 Consent Decree: See *Consent Decree* (1945)

abiotic: The absence of living organisms.

abrasion: Wearing away of surfaces by friction.

absorption: Taking in of fluids or other substances through, or as if through, cells or tissues.

abutment: A structure that supports the ends of a dam or bridge.

acclimation: Adjustment of an organism to a new habitat or environment.

accretion: Gradual increase in flow of a stream attributable to seepage, groundwater discharge, or tributary inflow.

acre-foot: Volume of water (43,560 cubic feet) that would cover 1 acre 1 foot deep.

active storage: Reservoir capacity that can be used for irrigation, power, municipal and industrial use, fish and wildlife, recreation, water quality, and other purposes.

Advisory Coucil on Historic Preservation: Executive agency responsible for ensuring requirements of National Historic Preservation Act and 36 CFR Part 800 are met.

aerate: To supply or charge with gas, usually air.

affected environment: Existing biological, physical, social, and economic conditions of an area subject to change, both directly and indirectly, as the result of a proposed human action. Also, the chapter in an environmental impact statement describing current environmental conditions.

aggradation: Process of filling and raising the level of a streambed, flood plain, or sandbar by deposition of sediment. The opposite of degradation.

air quality: Measure of the health-related and visual characteristics of the air, often derived from quantitative measurements of the concentrations of specific injurious or contaminating substances.

algae: Simple plants containing chlorophyll. Most algae live submerged in water.

algal bloom: Rapid and flourishing growth of algae.

alluvial: Sedimentary material transported and deposited by the action of flowing water.

alternatives: Courses of action that may meet the objectives of a proposal at varying levels of accomplishment, including the most likely future conditions without the project or action.

ambient: Surrounding natural conditions (or environment) at a given place and time.

amphibian: Vertebrate animals that have life stages both in water and on land (e.g., salamanders, frogs, and toads).

anthropogenic: Human-created.

anticline: A fold in rocks that curves upward in a convex way.

appropriation: Amount of water legally set apart or assigned to a particular purpose or use.

aquatic: Living or growing in or on the water.

archaic: In American archeology, a cultural stage following the earliest known human occupation in the New World (about 5,500 B.C. to A.D. 100). This stage was characterized by a hunting and gathering lifestyle and seasonal movement to take advantage of a variety of resources.

archeology: Study of human cultures through the recovery and analysis of their material relics.

arroyo: A gully or channel cut by an ephemeral stream.

artifact: A human-made object.

attribute survey: Survey to determine the important components of the recreational experience.

authorization: An act by the Congress of the United States that authorizes use of public funds to carry out a prescribed action.

automatic generation control: Computerized power system regulation to maintain scheduled generation within a prescribed area in response to changes in transmission system operational characteristics.

B

backwater: A relatively small, generally shallow area of a river with little or no current.

base load: Minimum load in a power system over a given period of time.

Basin Conservation Plan: A plan for prioritizing and implementing water conservation measures found in the various water conservation plans developed under the Basin Conservation Program.

Basin Conservation Program: The Yakima River Basin Water Conservation Program established under section 1203(a) of Title XII.

bed elevation: Height of streambed above a specified level.

bedload: Sediment moving on or near the streambed and frequently in contact with it.

bed material: Unconsolidated material of which a streambed is composed.

benefit-cost ratio: The ratio of the present value of project benefits to the present value of the project costs; used in economic analysis.

benthic: Bottom of rivers, lakes, or oceans; organisms that live on the bottom of water bodies.

biological diversity: Number and kinds of organisms per unit area or volume; the composition of species in a given area at a given time.

biological opinion: Document stating the U.S. Fish and Wildlife Service and the National Marine Fisheries Service opinion as to whether a Federal action is likely to jeopardize the continued existence of a threatened or endangered species or result in the destruction or adverse modification of critical habitat.

critical habitat.—Specific areas with physical or biological features essential to the conservation of a listed species and that may require special management considerations or protection. These areas have been legally designated via *Federal Register* notices.

jeopardy opinion.—U.S. Fish and Wildlife Service or National Marine Fisheries Service opinion that an action is likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of critical habitat. The opinion includes reasonable and prudent alternatives, if any.

no jeopardy opinion.—U.S. Fish and Wildlife Service or National Marine Fisheries Service opinion that an action is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat.

biomass: Total mass or amount of a living organism in a particular area or environment.

brecciated: A rock made up of highly angular, coarse fragments.

built environment: Modifications to the environment by man—buildings, roads, cities, etc., compared to the natural environment (see definition of *cultural resources*).

C

candidate species: Plant or animal species not yet officially listed as threatened or endangered but is undergoing status review by the U.S. Fish and Wildlife Service.

capacity: In power terminology, the load for which a generator, transmission line, or system is rated, expressed in kilowatts. In this document, also refers to powerplant generation capability under specific operating conditions and the amount of marketable resource under such conditions.

carnivore: Any flesh-eating or predatory organism.

catch: At a recreational fishery, refers to the number of fish captured, whether they are kept or released.

channel: Natural or artificial watercourse, with definite bed and banks to confine and conduct continuously or periodically flowing water.

chironomid: Group of two-winged flying insects that live their larval stage underwater and emerge to fly about as adults.

Cladophora: Filamentous green alga.

colluvium: A general term applied to loose and incoherent deposits, usually at the foot of a slope and brought there chiefly by gravity.

Columbia River Fish Management Plan: Addresses harvest allocation and production strategies.

community: All members of a specified group of species present in a specific area at a specific time; a group of people who see themselves as a unit.

community cohesion: Ability of a community to have a unified response when facing a problem; e.g., an external threat to their sustainability.

Consent Decree (1945): A legal document pertaining to water distribution and water rights in the Yakima River Basin issued by the District Court of Eastern Washington under Civil Action No. 21 in 1945. The Consent Decree:

- Establishes the rules under which the Bureau of Reclamation should operate the Yakima Project system to meet the water needs of the irrigation districts that predated the Yakima Project, as well as the rights of divisions formed in association with the Yakima Project.

- Determines water delivery entitlements for all major irrigation systems in the Yakima River Basin except for lower reaches of the Yakima River near the confluence with the Columbia River.

- States the quantities of water to which all water users are entitled and defines a method of prioritization to be placed into effect during water deficient years.

conservation: Increasing the efficiency of energy and water use, production, or distribution.

Conservation Advisory Group (CAG): The Yakima River Basin Conservation Advisory Group established under section 1203(c) of Title XII.

Conserved water: Water saved and attributable to the program established under the Basin Conservation Program.

consumer surplus: The value of a commodity, good, or opportunity above the cost to the consumer; measured using willingness to pay, as specified in Federal guidelines for water resources planning.

consumptive water use: Total amount of water used by vegetation, man's activities, and evaporation of surface water.

contingent valuation: Survey method asking for the maximum values that users would pay for access to a particular activity.

Council on Environmental Quality (CEQ): Council established by the National Environmental Policy Act (NEPA), under the Executive Office of the President. CEQ provides regulations and oversight for NEPA compliance.

cross-sectional area: Area of a stream, channel, or waterway, usually measured perpendicular to the flow.

cubic foot per second (ft^3/s): As a rate of streamflow, a cubic foot of water passing a reference section in 1 second of time. A measure of a moving volume of water (1 ft^3/s = 0.0283 cubic meters per second).

cultural resources: Any buildings, sites, districts, structures, or objects significant in history, architecture, archeology, culture, or science.

D

dead storage: Reservoir capacity from which stored water cannot be evacuated by gravity.

debris fan: Sloping mass of boulders, cobbles, gravel, sand, silt, and clay formed by debris flows at the mouth of a tributary.

debris flow: Flash flood consisting of a mixture of rocks and sediment containing less than 40 percent water, by volume; forms debris fan.

degradation: Process wherein elevation of streambeds, flood plains, and sandbars is lowered by erosion. The opposite of aggradation.

delta: Sediment deposit formed at the mouths of streams where they enter larger bodies of water.

depletion: Loss of water from a stream, river, or basin resulting from consumptive use.

deposition: Settlement of material out of the water column and onto the streambed. Occurs when the energy of flowing water is unable to support the load of suspended sediment.

desiccation: The process of drying out.

discharge (flow): Volume of water that passes a given point within a given period of time; expressed in this document in cubic feet per second.

dissolved oxygen (DO): Amount of free oxygen found in water.

drawdown: Lowering of a reservoir's water level; process of depleting reservoir or groundwater storage.

drift: Food organisms dislodged and moved by river current. Can include algae, plankton, and even larval fish.

dynamic equilibrium: Condition achieved when the average sand load transported by flowing water is in balance with the sand load being supplied by tributaries.

E

ecology: The relationship between living organisms and their environments.

ecosystem: Complex system composed of a community of fauna and flora and that system's chemical and physical environments.

eddy: Current of water moving against the main current in a circular pattern (see *recirculation zone*).

efficiency: Ratio of useful output to total input, usually expressed as a percentage.

electrical demand: Energy requirement placed upon a utility's generation at a given instant or averaged over any designated period of time; expressed in kilowatts.

electric power system: Physically connected electric generating, transmission, and distribution facilities operated as a unit under one control.

endangered species: A species or subspecies in danger of extinction throughout all or a significant portion of its range.

energy: Electric capacity generated and/or delivered over time; usually measured in kilowatthours.

Enhancement Roundtable Group: A core group representing various parties organized to discuss actions for a Yakima River Basin Water Enhancement Program Phase 2, emphasizing water conservation.

Enhancement Technical Activities Group (TAG): Representatives from the irrigators, the Yakama Indian Nation, Washington State, the Bonneville Power Administration, and the Bureau of Reclamation, formed to guide and oversee Yakima River Basin Water Enhancement Program Phase 2 work activities.

eoilian: Windblown.

epilimnion: See *stratification*.

eutrophic: Nutrient enrichment of a body of water that contains more organic matter than existing biological oxidization processes can consume. A body of water which has become, either naturally or by pollution, rich in nutrients and often seasonally deficient in dissolved oxygen.

eutrophication: A process where more organic matter is produced than existing biological oxidization processes can consume.

excess capacity: Power generation capacity available on a short-term basis in excess of the firm capacity available through long-term contracts.

existence value: Value people place on simply knowing that an area or feature continues to exist in a particular condition.

extirpated species: A species which has become extinct in a given area.

F

Federal Energy Regulatory Commission (FERC): Agency primarily responsible for ensuring adequate energy supplies at just and reasonable rates and providing regulatory incentives for increased productivity, efficiency, and competition.

"flip-flop" operation: In September, storage releases from Yakima River reservoirs are reduced to meet only upper valley diversions and to keep river levels in the Yakima River at predetermined spawning flow levels. Concurrently, releases from Naches River reservoirs are increased to meet Naches system demands plus the lower Yakima system demands downstream from the Naches confluence. This river operation is reviewed periodically by the System Operations Advisory Committee.

flood control pool: Reservoir volume above the active conservation and joint use pool that is reserved for flood runoff and then evacuated as soon as possible to keep that space in readiness for the next flood (see *reservoir capacity*).

flow: Volume of water passing a given point per unit of time.

instream flow requirements.—Amount of water flowing through a stream course needed to sustain instream values.

minimum flow.—Lowest flow in a specified period of time.

peak flow.—Maximum instantaneous flow in a specified period of time.

return flow.—Portion of water previously diverted from a stream and subsequently returned to that stream or to another body of water.

fluctuating flows: Water released from a dam that varies in volume with time.

fluctuating zone: Area of a sandbar or vegetation zone that is within the range of fluctuating flow.

food chain: A succession of organisms in a community in which food energy is transferred from one organism to another as each consumes a lower member and, in turn, is consumed by a higher member.

forage fish: Generally, small fish that produce prolifically and are consumed by predators.

forced outage: Unscheduled shutting down of a generating unit or other facility for emergency or other unforeseen reasons.

forebay: Impoundment immediately above a dam or hydroelectric plant intake structure. The term is applicable to all types of hydroelectric developments (storage, run-of-river, and pumped storage).

fry: Life stage of fish between the egg and fingerling stages.

full pool: Volume of water in a reservoir at maximum design elevation.

G

gated spillway: Overflow section of dam restricted by use of gates that can be operated to control releases from the reservoir to ensure the safety of the dam.

gauging station: Specific location on a stream where systematic observations of hydrologic data are obtained through mechanical or electrical means. Also referred to as a "gauge."

generation: Process of producing electrical energy by transforming other forms of energy; also, amount of electric energy produced, expressed in kilowatthours.

generator: Machine that converts mechanical energy into electrical energy.

geomorphology: Geological study of the configuration and evolution of landforms and earth features.

gigawatthour (Gwh): One billion watthours of electrical energy.

gradient: See *slope*.

H

habitat: Area where a plant or animal lives.

harvest: In a recreational fishery, refers to numbers of fish that are caught and kept (see *catch*).

headwater: The source and upper part of a stream; water upstream from a dam.

herbivore: Animal that feeds on plants.

human environment: Natural and physical environment and the relationship of people with that environment, including all combinations of physical, biological, cultural, social, and economic factors in a given area.

hydraulic: Powered by water.

hydroelectric plant: Electric powerplant that uses falling water as its motive force.

hydroelectric power: Electrical capacity produced by water.

hydrograph: A graph showing, for a given point in a stream, the discharge, stage, velocity, or other property of water with respect to time. This can be measured or modeled.

hydrologic cycle: The continuous circulation of water from the atmosphere to Earth by precipitation, and from Earth to the atmosphere by evaporation and transpiration. The land phase includes infiltration, runoff, and exchange between surface water and groundwater.

hydrology: Science dealing with water and snow, including their properties and distribution.

hyporheic zone: Groundwater habitats created by the movement of river water from the active channel to areas to the side and beneath the active channel. Uniquely adapted organisms that can provide food for fish live in the groundwater habitat (Naiman et al., 1995).

I

impoundment: Body of water created by a dam.

inactive storage: The reservoir capacity that can be released from the dam but is not available for power generation.

Indian Trust Assets: Legal interest in property held in trust by the United States for Indian Tribes on individuals, or property that the United States is otherwise changed to protect.

indicator: Organism, species, or community that indicates presence of certain environmental conditions.

inflow: Water flowing in.

interim comprehensive basin operating plan: A plan to provide a general framework within which the Yakima Project Superintendent operates the Yakima Project, including measures implemented under the Yakima River Basin Water Enhancement Project, including, but not limited to: (1) operating capability and constraints of the system; (2) information on water supply calculations and water needs; (3) system operations and streamflow objectives; and (4) the System Operations Advisory Committee activities.

inundate: To cover with impounded waters or flood waters.

Irrigation Demonstration Project: The Yakama Indian Reservation Irrigation Demonstration Project authorized in section 1204(b) of Title XII.

J

juvenile: Young fish older than 1 year but not capable of reproduction.

K

kilovolt (kV): 1,000 volts.

kilowatt (kW): Unit of electric power (capacity) equal to 1,000 watts, or about 1.34 horsepower.

kilowatthour (kWh): Basic unit of electric energy equaling an average of 1 kilowatt of power applied over 1 hour.

L

larval fish: An immature stage that develops from the fertilized egg before assuming the characteristics of the adult.

limnology: Scientific study of the physical characteristics and biology of lakes, ponds, and streams.

littoral zone: The zone between the high and low water marks.

load: Amount of electrical power or energy delivered or required at a given point.

M

main channel: The deepest or central part of the bed of a stream, containing the main current.

mainstem: The main course of a stream.

median: Middle value in a distribution above and below which lie an equal number of values.

megawatt (MW): One million watts of electrical power (capacity).

megawatthour (MWh): One million watthours of electrical energy.

metalimnion: See *stratification*.

mil: Monetary cost and billing unit used by utilities equal to 1/1,000 of one U.S. dollar (equivalent to 1/10 of one cent).

milligram per liter (mg/L): Equivalent to 1 part per million.

million acre-feet (maf): A unit of volume; the volume of water that would cover 1 million acres to a depth of 1 foot.

mitigation (measures): Action taken to avoid, reduce the severity of, or eliminate an adverse impact. Mitigation can include one or more of the following:

- Avoiding impacts
- Minimizing impacts by limiting the degree or magnitude of an action
- Rectifying impacts by restoration, rehabilitation, or repair of the affected environment
- Reducing or eliminating impacts over time
- Compensating for the impact by replacing or providing substitute resources or environments to offset the loss

mitigation (as used in cultural resource compliance procedures): Any treatment of historic or prehistoric property that will offset adverse effects that may result from an agency's action (e.g., construction of a canal may partially destroy a prehistoric Indian village). Mitigation of this effect might include excavating the village before construction to retrieve information before it is destroyed.

multipurpose dam: Barrier constructed for two or more purposes such as storage, flood control, navigation, power generation, recreation, and fish and wildlife enhancement.

multipurpose reservoir: Reservoir planned to operate for more than one purpose.

N

***National Register of Historic Places*:** A federally maintained register of districts, sites, buildings, structures, architecture, archeology, and culture.

National Water Quality Assessment Program:

- Describes current water quality conditions for a large part of the United States freshwater streams, rivers, and aquifers
- Describes how water quality is changing over time
- Improves understanding of the primary natural and human factors that affect water quality conditions.

neotropical: A bird that migrates to tropical regions during the winter.

nominal dollars: Dollar value in the indicated year, not adjusted for inflation.

nonconsumptive water use: Water uses including swimming, boating, water-skiing, fishing, maintenance of stream-related fish and wildlife habitat, hydropower generation, and other uses that do not substantially deplete water supplies.

nonproratable water: That portion of the total water supply available under provisions of sections 18 and 19 of Civil Action No. 21 (Federal District Court Judgment of January 31, 1945) that is not subject to proration in times of water shortage.

nonterritorial communities: Networks of associations around shared goals, values, and norms, such as the agricultural, environmental, or recreational community; also known as "special interest communities."

O

off-peak energy: Electric energy supplied during periods of relatively low system demand.

omnivore: Animal that eats both vegetable and animal substances.

on-district storage: Small water storage facilities located within the boundaries of an irrigation entity, including reregulating reservoirs, holding ponds, or other new storage methods that allow for efficient water use.

on-peak energy: Electric energy supplied during periods of relatively high system demand.

operational losses: Losses of water resulting from evaporation and seepage.

outage: Period during which a generating unit, transmission line, or other facility is out of service.

outflow: Water flowing out.

P

palustrine habitat: Marsh habitat.

peak demand: See *peak load.*

peaking power: Powerplant capacity typically used to meet the highest levels of demand in a utility's load or demand profile.

peak load: Maximum electrical demand in a stated period of time.

peak load plant: Powerplant that normally is operated to provide power during maximum load periods.

penstock: Conduit pipe used to convey water under pressure to the turbines of a hydroelectric plant.

permeability (soil): Ease with which gasses, liquids, or plant roots penetrate or pass through a layer of soil.

phase 1 of the Yakima River Basin Water Enhancement Program (YRBWEP): Preliminary identification of water needs, available resources, and potential plan elements which could meet the needs.

phase 2 of the Yakima River Basin Water Enhancement Program (YRBWEP): Detailed studies of more promising plan elements, the formulation and evaluation of alternative plans, and the identification of a preferred plan for consideration.

phreatophytes: Vegetation that consumes a lot of water.

plankton: Tiny plants (phytoplankton) and animals (zooplankton) with limited powers of locomotion, usually living free in the water away from substrates.

pool: A deep area of a stream between rapids or where the current is slow.

power: Electrical capacity generated, transferred, or used; usually expressed in kilowatts.

power demand: Rate at which electric energy is required and delivered to or by a system over any designated period of time.

powerplant: Structure that houses turbines, generators, and associated control equipment.

powerplant capacity: Maximum flow that can pass through the turbines at a dam. Also refers to the electrical capacity of the generators expressed in megawatts.

primary production: Creation of organic matter by photosynthesis.

programmatic environmental impact statement (PEIS): An environmental impact statement that addresses a proposal to implement a specific policy, to adopt a plan for a group of related actions, or to implement a specific statutory program.

proratable water: That portion of the total water supply available under provisions of sections 18 and 19 of Civil Action No. 21 (Federal District Court Judgment of January 31, 1945) that is subject to proration in times of water shortage.

public involvement: Process of obtaining citizen input into each stage of development of planning documents. Citizen input is required in all environmental impact statements.

R

ramp rate: The rate of change in instantaneous output from a powerplant. The ramp rate is established to prevent undesirable effects caused by rapid changes in loading or, in the case of hydroelectric plants, discharge.

range: Geographic region in which a given plant or animal normally lives or grows.

rapid: A section of a river where the current is very fast moving, caused by a steep descent in the riverbed through a constriction of the main channel.

rated head: Water depth for which a hydroelectric generator and turbines were designed.

reach: Any specified length of a stream, channel, or other water conveyance.

recirculation zone: Area of flow composed of one or more eddies immediately downstream from a constriction in the channel, such as a debris fan or rock outcrop.

Reclamation Reform Act of 1982 (RRA): Requires districts that have certain repayment or water service contracts with the United States to develop water conservation plans which include definite goals, appropriate water conservation measures, and a time schedule for meeting the water conservation objectives.

recreational benefit: Value of recreational activity to the recreationist, usually measured in dollars above the cost of participating in recreational activity (travel, entrance fees, etc.). Used for valuing recreational resources produced through Federal projects and synonymous with the consumer surplus associated with the recreational activity.

recruitment: Survival of young plants and animals from birth to a life stage less vulnerable to environmental change.

redd: Depression in riverbed or lakebed dug by fish to deposit eggs.

reregulation dam: Low dam located downstream from a large hydroelectric powerplant used to even out the flows farther downstream.

reserve generating capacity: Extra generating capacity available to meet unanticipated capacity demand for power in the event of generation loss caused by scheduled or unscheduled outages of regularly used generating capacity.

reservoir: Artificially impounded body of water.

reservoir capacity:

active capacity.—Reservoir capacity normally usable for storage and regulation of reservoir inflows to meet established reservoir operating requirement.

active conservation capacity.—Capacity assigned to regulate reservoir inflow for irrigation, power, municipal and industrial use, fish and wildlife, navigation, recreation, water quality, and other purposes.

flood control capacity.—Reservoir capacity assigned to the sole purpose of regulating flood inflows to reduce flood damage downstream.

surcharge capacity.—Reservoir capacity provided for use in passing the inflow design flood through the reservoir. Reservoir capacity between maximum water surface elevation and the highest of the following elevations:

- Top of exclusive flood control capacity
- Top of joint use capacity
- Top of active conservation capacity

resilience: Ability of any system to resist or to recover from stress.

riffle: A stretch of choppy water caused by an underlying rock shoal or sandbar.

riparian: Of, on, or pertaining to the bank of a river, pond, or lake.

riprap: Stones placed on the face of a dam, on streambanks, or on other land surfaces to protect them from erosion.

river corridor: A river and the strips of land adjacent to it, including the talus slopes at the bases of cliffs, but not the cliffs themselves.

S

sacred site: Any specific, discrete, narrowly delineated location on Federal land that is identified by an Indian Tribe, or Indian individual determined to be an appropriately authoritative representative of an Indian religion, as sacred.

sand load: See *sediment load*.

scheduled outage: Shutdown of a generating unit or other facility for inspection or maintenance, in accordance with an advance schedule.

sediment: Unconsolidated, solid material that comes from weathering of rock and is carried by, suspended in, or deposited by water or wind.

sediment load: Mass of sediment passing through a stream cross section in a specified period of time, expressed in millions of tons.

seepage: Relatively slow movement of water through a medium, such as sand.

site: In archeology, any location of past human activity.

slope: Change in elevation per unit of horizontal distance.

sodic soil: (1) Contains sufficient exchangeable sodium to interfere with the growth of most crop plants. (2) The sodium-adsorption ratio of the saturation extract is 15 or more.

sodicity: The exchangeable-sodium content of the soil. High sodium content.

spawn: To lay eggs, especially when referring to fish.

spawning beds: Places in which eggs of aquatic animals lodge or are placed during or after fertilization.

spills: Water releases that cannot be put to use for project purposes (includes floodflows).

spillway: Overflow channel of a dam.

stage: See *water surface elevation*.

stratification: Thermal layering of water in lakes and streams. Lakes usually have three zones of varying temperature:

epilimnion.—Top layer with essentially uniform warmer temperatures.

metalimnion.—Middle layer of rapid temperature decrease with depth.

hypolimnion.—Bottom layer with essentially uniform colder temperatures.

stream: Natural watercourse:

ephemeral.—Stream that flows briefly only in direct response to precipitation and whose channel is above the water table.

intermittent or seasonal.—Stream on or in contact with the groundwater table that flows only at certain times of the year when the groundwater table is high.

perennial.—Stream that flows continuously throughout the year.

structural elements: In this report, physical facilities rather than a change in dam operations.

substrate: Surface on which a plant or animal grows or is attached.

surface water: Water on the surface of the Earth. An open body of water, such as a river, stream, or lake.

syncline: A fold in rocks in which the strata dip inward from both sides toward the axis.

System Operations Advisory Committee (SOAC): A group of fishery biologists:

- Assembled by the Yakima Project Superintendent in response to the supplemental instructions entitled "Supplementary Instructions to the Water Master," and dated November 28, 1980, in the case of *Kittitas Reclamation District et al.* v. the *Sunnyside Valley Irrigation District et al.* (E.D. Washington, Civil No. 21).
- Who advise the Yakima Project Superintendent on operations of the Yakima Project for fish and wildlife purposes.
- Who, together with others, were identified for consultation on November 29, 1990, in the amended partial summary judgment entered in the basin adjudication (Yakima County Superior Court No. 77-2-01484-5).

T

tailwater: Water immediately downstream from a dam.

talus: Sloping accumulation of rock debris; also, rock fragments at the base of a cliff as the result of sliding or falling.

Technical Activities Group (TAG): See *Enhancement Technical Activities Group*.

temporary structure: Any structure that can be readily and completely dismantled and removed from the site between periods of actual use. The structure may or may not be authorized at the same site from season to season or from year to year.

terrace: The surface form of a high sediment deposit having a relatively flat surface and steep slope facing the river.

territorial communities: Populations that function within a particular geographic area.

thalweg: Line connecting the deepest points along a riverbed.

tiering: The coverage of general matters in a broad National Environmental Policy Act document with subsequent narrowly focused documents; helps to eliminate repetitive discussions and allows the site-specific documents to focus on specific issues.

toe: The point at which the bottom of a slope or embankment intersects the natural ground, such as the upstream or downstream toe of the dam or the downstream toe of a landslide or debris fan.

topography: Physical shape of the ground surface.

Toppenish Enhancement Project: The Toppenish Creek Corridor enhancement project authorized by section 1204(c) of Title XII.

total maximum daily loads (TMDL): Estimates of the amount of specific pollutants that a water body can safely take without threatening beneficial uses.

total water supply available (TWSA): The combined quantity of unregulated flow, return flow, and stored water available for the period of April through September upstream from the Parker gauge at Sunnyside Diversion Dam on the Yakima River.

traditional cultural property (TCP): A site or resource that is eligible for inclusion in the *National Register of Historic Places* because of its association with cultural practices or beliefs of a living community.

transmission line: Facility for transmitting electrical energy at high voltage from one point to another point. Transmission line voltages are normally 115 kilovolt or larger.

transport capacity: The capacity of a river to carry sediment in suspension or to move sediment along the riverbed. Usually expressed as mass per unit of time.

tributary: River or stream flowing into a larger river or stream.

turbidity: Cloudiness of water measured by how deeply light can penetrate into the water from the surface.

U

undertaking: Any project, activity, or program that could change the character or use of historic properties.

use value: The economic benefit associated with the physical use of a resource, usually measured by the consumer surplus or net economic value associated with such use.

V

varved: A sedimentary bed or lamination that is deposited within one year's time.

velocity: Rate of flow of water or water-sediment mixture; expressed in feet per second or miles per hour.

vesicular: Containing many small cavities formed by the expansion of a gas bubble or steam when the rock solidifies.

visitor day: Twelve visitor hours which may be aggregated by one or more persons in single or multiple visits.

visitor use: Visitor use of recreation and wilderness resources for inspiration, stimulation, solitude, relaxation, education, pleasure, or satisfaction.

W

watershed: Surface drainage areas above a specified point on a stream.

water surface elevation (stage): The elevation of a water surface above or below an established reference level, such as sea level.

water year: Period of time beginning October 1 of one year and ending September 30 of the following year and designated by the calendar year in which it ends.

wetlands: Lands including swamps, marshes, bogs, and similar areas such as wet meadows, river overflows, mudflats, and natural ponds.

wilderness: Tract or region of land uncultivated and uninhabited by human beings, or unoccupied by human settlements (see 78 Stat. 891, Wilderness Act of 1964, section 2 (c) for legal definition).

willingness to pay: Method of estimating the value of activities, services, or other goods, where value is defined as the maximum amount a consumer would be willing to pay for the opportunity rather than do without. The total willingness to pay, minus the user's costs of participating in the opportunity, defines the consumer surplus and benefits.

Y

Yakama Indian Nation: The Confederated Tribes and Bands of the Yakama Indian Nation as redesignated under section 1204(g) of Title XII.

Yakima Fisheries Project: Funded by Bonneville Power Administration to undertake fishery research and restoration activities in the Yakima River Basin; one part of a comprehensive effort to restore fisheries resources by the Bonneville Power Administration, Yakama Indian Nation, State of Washington, and Bureau of Reclamation.

Yakima Project Superintendent: The individual designated by the Regional Director, Pacific Northwest Region, Bureau of Reclamation, to be responsible for the operation and management of the Yakima Federal Reclamation Project, Washington.

Yakima River Basin Water Conservation Program: (1) A program established and administered to evaluate and implement measures to improve the availability of water supplies for irrigation and the protection and enhancement of fish and wildlife resources, including wetlands, while improving the quality of water in the Yakima River Basin; and (2) a Federal action to improve streamflow and fish passage conditions; it shall be considered part of a comprehensive program to restore the Yakima River Basin anadromous fishery resource.

Yakima River water conservation demonstration project: Will help determine the viability of providing additional instream flow and enhanced habitat to aid in the recovery of weak salmon and steelhead stocks. In Washington, improved flows through the construction of reregulating facilities was selected as the demonstration project.

Young-of-year: Refers to young (usually fish) produced in one reproductive year. Small fish, hatched from eggs spawned in the current year, are considered young-of-year (age 0).

Index

A

acquiring water rights: see water rights acquisition
action alternatives: S-1-2, 35-37
adult migration: 9, 142
Agricultural
    Conservation Program: 5
    Enterprises, Inc: 94, 164
    production: S-5, S-12, S-16, 70, 95, 134, 162, 164, 166, 168, 182, 186
    resources: S-5, S-12-13, 70, 87, 133, 136-138, 148, 185
Alternative
    1: S-2, S-10-12, S-15-16, S-18, 37-38, 111-112, 117, 119, 121, 126, 129, 131, 133, 135-139, 144-145, 148, 151-156, 160-161, 163, 166-168, 170-171, 177-178, 180
    2: S-2, S-14, 37-38, 146, 161, 167, 185
    2A: S-1-2, S-10-16, S-18, 19, 37-38, 110-112, 114, 117-118, 121-126, 128-129, 131-135, 137-140, 145-146, 148, 152-156, 161-164, 167-168, 170
    2B: S-2, S-10-11, S-13-16, S-18, 37-38, 110-112, 114, 117-120, 124, 122-126, 129, 131, 133-135, 137-139, 146, 148, 153, 155-156, 161-164, 166-168, 170, 172, 177-180, 185
    2C: S-2, S-10-11, S-13-16, S-18, 37-38, 110-112, 114, 117-126, 129, 132-135, 138, 139, 146, 148, 154-156, 161-164, 166-168, 170, 172, 177-180, 185
    3: S-2, S-11, S-13-14, S-16, S-18, 37-38, 111-112, 118, 121, 128-129, 133, 135, 138-139, 146, 148, 154-156, 162-163, 168, 170, 172, 178, 185
anadromous fish: S-7, S-13, S-14, 3, 9, 10, 12, 14, 27-28, 32, 75, 80, 90, 140, 152, 159, 179, 181, 183, 187, 196
apples: 2, 72
aquifers: S-4, S-11, 4, 62-69, 129-132, 185, 191
Archeological Resources Protection Act: 102
archeology: 102-108, 173-175, 198
artifacts: 106-107
attitudes: 90, 157, 159
authorizations: 1, 9, 11-12, 15-16

B

bald eagle: 88, 196
bank stabilization: 195
Basin Conservation
    Plan: 22-24, 32, 76-77, 126, 147, 152, 186
    Program: S-2, S-10, S-12-15, S-18, 15-16, 19, 21-24, 26-29, 34, 37-38, 87, 110, 114, 117-118, 120, 122, 128, 131-134, 137, 140, 143-147, 151-154, 161, 165, 167, 170, 172, 179, 184-185, 188, 194
beef: S-5, 70
big game: 195
bioengineering: 195
biological evaluation (BE): 88, 154, 196
boating: S-8-9, S-17, 98-101, 169, 173
Bonneville Power Administration (BPA): 2-3, 11, 75, 78, 83-84, 86, 182, 192
borrow areas: 195
broad rearing: 83-86
bull trout: S-6, 79, 80, 88-89, 104, 145, 155, 197
Bumping Lake: S-9, 7, 43, 47, 49, 55, 64, 75, 78, 98-100, 105-107, 141
bunchgrass: S-6
Bureau of
    the Census: 91, 94, 96, 166, 169
    Commercial Fisheries: 9
    Economic Analysis: 93-94
    Indian Affairs: 2, 8, 32, 180, 192-193
    Land Management: S-8, 8, 84, 99, 101
    Reclamation: S-7, S-9, S-12, S-15, S-17-18, 2-9, 11-12, 15, 19, 29-31, 33-34, 39, 50, 71, 73, 75, 77, 79-80, 88-89, 93, 98, 102-103, 105-108, 136-137, 143, 145, 152-155, 161-163, 167, 169, 173-177, 179, 181-182, 189-190, 192-193, 196-199
burning: 26, 83, 84, 194

C

Cabin Creek: 12, 31, 34, 37, 136, 145, 146, 151, 161, 166
canals: S-2, S-6-7, S-15-16, 2, 7, 9, 25, 33, 38, 50-51, 59, 81, 83-87, 114, 117, 121, 133-134, 136, 149, 152-153, 167, 173, 179, 195
candidate species: see Threatened, Endangered, and Special Status Species
Cascade Mountains: S-9, 1, 61, 63, 103, 105
cattle: S-5, 70, 104
CH2M Hill: 31, 106
Chandler: S-3, S-15-16, 31, 34-35, 37, 54, 77, 139, 144, 161-162, 166, 168, 191
Civil Action No. 21: 7

Claims Registration Act: 67
Cle Elum: S-7-8, S-12, S-15, S-17, 2, 7, 29, 30, 34-35, 37, 43, 47-49, 52-54, 64, 75-78, 89-90, 99-100, 103-105, 107, 129, 131, 136, 139, 142-145, 151, 156-160, 166-167, 169, 171, 173-174, 176, 194
Clean Water Act: 56
Clear Creek: 7, 106
Code of Federal Regulations (CFR): S-1, S-18, 102-103, 175-176, 197-198
Columbia
    River: 1-4, 6-7, 9, 31, 62-63, 74, 75, 77-78, 91, 101, 107, 182-183
    River basin: 4, 75
    River Fish Management Plan: 2, 3, 183
commercial fishing: S-16, 9
concurrence: S-15, 33, 89, 154, 196-197
Consent Decree: 5, 7, 12, 50
Conservation Advisory Group: 16, 21-24, 26, 138
construction staging areas: 195
consultation: S-7, S-15, 4, 8, 14, 19, 30, 80, 88-89, 102, 107, 141, 154, 174-176, 189, 192, 196-197, 199
contaminants: 58-59, 130, 132, 194
cooperating agencies: 192-193
Corps: see U.S. Army Corps of Engineers
cougar: 9, 81
Council on Environmental Quality: 16
coyotes: 9, 81
critical habitat: S-7, S-15, 81, 88, 154, 196
crop
    acreage: S-6, 92, 118, 135
    crop yields: S-5, S-12, 72, 134, 136-137
cultural resources: S-9, S-17, 32-33, 102-103, 105-106, 173, 175-176, 186, 188-198

D

Department of
    Agriculture: 84
    Ecology: see Washington State Department of Ecology
dissolved oxygen: 56-58
District Court of Eastern Washington: 7
diversions: S-2, S-5, S-12-13, S-16, 4, 6, 8-9, 22, 24, 26, 28-31, 33-37, 42, 44-45, 47, 50-51, 53, 57, 66, 70-71, 75, 101, 109-110, 113-115, 117-118, 120-122, 126-128, 131, 133-134, 136-138, 146, 152, 162, 164-168, 179, 184-185
document scope: 1, 16
drains: S-3, S-6, S-11-12, S-15, 1, 9, 27, 55-57, 59-61, 66, 73, 77, 81, 83-85, 120-122, 126-128, 130, 132, 136-137, 149

drawdown: 80, 99, 107
drought conditions: 9, 183
dry year options: 24

E

Early Implementation Program: 11
easements: 196
East Selah Regulating Reservoir: 10
Easton: S-6, S-8, 47-48, 50, 52-54, 78-80, 100, 112, 141-142, 146, 151
economics: 91, 162-163
electrification: 24, 162, 168, 191
employment: S-7-8, 93-96, 137, 163-164, 166, 186
Endangered
    species: see Threatened, Endangered, and Special Status Species
    Species Act: S-5-6, 16, 80, 88, 154, 181, 196
Enhancement
    Roundtable Group: 11-12
    Technical Activities Group (TAG): 11-12
entitlement: 7-8, 50
Environmental
    assessment: 32, 161
    Defense Fund: 89
    documentation: 16, 18
    Justice: 14-15
    Protection Agency: 56, 182, 192
    Quality Incentives Program: 5
erosion: S-5, S-12-13, S-17, 56-58, 72-73, 75, 81, 87, 134-138, 145, 160-161, 174, 176, 197
Eurasian milfoil: 195
evapotranspiration: 25

F

fall chinook: S-5-6, 3, 75-79, 88, 104, 139, 143, 146, 196
Federal
    Agricultural Conservation Program: 5
    Energy Regulatory Commission: 106
    Register: 15, 190, 192
fee title acquisition: 196

fish: S-1, S-5-9, S-13-14, S-17-18, 1-4, 6, 8-12, 14-16, 21, 23, 27-35, 41, 43, 46, 51, 55, 58, 60, 73-81, 84-85, 90, 99, 102-105, 109, 138-147, 152-153, 159-160, 169, 171, 179, 181, 183-185, 187-188, 191, 193-196
Fish and Wildlife
Coordination Act: 16, 81, 193, 194
Service: S-6, 4, 75, 79, 153, 193
fish
ladders: 2, 9, 15, 183, 195
passage: 2, 10, 15, 30, 77, 144, 160, 183, 194
rearing: S-6, S-13, 3, 9, 74-79, 138-144, 146, 196
runs: S-7, S-9, 9-11, 51, 75, 90, 191
screens: 2, 9, 14, 183
"flip-flop": S-2, S-9, 4, 32, 43, 48, 53-54, 76, 78-79, 101-102, 142, 145, 171
flood control: S-2, 53, 55, 82, 85, 195
floods: 42, 87, 149, 191
flow
fluctuations: 31, 76-77, 138, 146, 194
regulation: 9, 43, 81
flows, annual: 151
flushing flows: 14, 28-29, 34, 139, 144-145
forest: S-6, S-8, 78, 80, 84, 90, 99-101, 151, 164, 182, 193, 197
Forest Service: see U.S. Forest Service
Fort Simcoe: 6
fruit production: 2, 72, 92, 96
funding: 3, 5, 22, 30, 32-33, 36, 162, 191, 195

G

geology: 61, 64, 128
gray wolf: 88, 196
grazing: S-6, 74, 82-84, 104, 194
grizzly bear: 88, 196
groundwater
basins: S-4, S-11, 65, 67-68, 129, 131-132
levels: S-11-12, 42, 127, 129, 133, 151
quality: S-11, 68, 129-132
recharge: 66, 84
use: S-4, S-11, 30, 33, 65, 67, 149

H

habitat: S-6, S-13-15, S-17-18, 3-4, 9, 23, 49, 75-77, 79, 81-88, 140, 143, 147-149, 151-154, 171, 174, 179, 183, 186-187, 191, 194-196
Historic
    context: 41, 103
    American Engineering Record: S-18, 107, 175-176, 197
hops: S-5, 2, 71, 72, 92, 136
household income: S-8, 94-97, 164-165
human environment: 89, 155, 157, 161
hydroelectric: 7, 31, 33, 54
hydrogeology: 64
hydrograph: 41-43, 46, 74
hydrology: S-2, S-10, 8, 26, 35-38, 41-43, 46, 50, 54-55, 66, 109-116, 118, 120, 122, 128, 131, 138, 141, 143, 145, 150, 160, 179-180, 184
hydrology model: S-2, 35-38, 41, 46, 50, 54-55, 66, 109-110, 113-115, 118, 120, 122, 128, 131, 141, 145, 150, 154, 179
hydropower: S-3, S-15-16, 2, 7, 13, 31, 37, 54, 97, 144, 161-162, 164, 166, 168

I

IMPLAN: 94, 164
Independent Scientific Group: 74, 78
Indian Trust Assets: S-9-10, S-18, 41, 103, 108-109, 177-180, 198
indicators: 110, 115, 121, 129, 135, 139, 143, 158
institutional constraints: 1, 15
Instream
    Flow Incremental Methodology (IFIM): 77, 143
    flow releases: 116, 118-119, 140, 184
    flows: S-2, S-6, S-10, S-13, S-17-18, 1, 10-12, 14-15, 28-29, 34-35, 37, 43, 48, 51, 53, 56, 74-75, 77-78, 110-112, 118-119, 138-139, 142, 144-145, 152, 159, 160, 162 169-172, 177-178, 180, 182, 184
interagency: 192, 196
interim comprehensive basin operating plan: S-14, 23-24, 32, 37, 138, 144, 147, 151, 196
irrigated lands: S-5, S-11-12, 70, 72, 90, 128, 135-136
irrigation
    demands: 3, 6, 31, 118
    development: 6, 10, 33, 36
    diversions: 6, 8-9, 53, 57, 70, 75, 101, 185
    efficiency: 26, 136

irrigation (continued)
methods: S-5, S-12, 27, 33, 72, 134, 136
scheduling: 24, 26
system: 5, 8, 33, 42
water supply: 10-11, 29, 35, 116, 121, 191

K

Kachess
Dam: 7, 32, 37, 107, 144, 161, 173, 176, 197-198
Lake: S-2, S-8, S-12, 12, 31, 34-35, 37-38, 42-43, 47-48, 53-54, 64, 75, 99, 103, 105, 112, 116-117, 129, 131, 136, 145, 151, 161, 172
River Valley: 61
Kennewick
Canal: S-12, 31, 54, 133-134, 136
City: 91-93
Irrigation District: S-16, 31, 51, 70-71, 159
Kiona: S-10, 47, 59, 116, 122, 125-126, 141
Kittitas
Basin: S-4, S-8, S-11, 50, 56, 63, 65-68, 70, 85, 97-101, 129-130
Canal: 50, 54, 133-134
County: 89, 91-93, 158-159, 165-167
Indians: 104
Irrigation District: S-12, S-16, 31, 34, 71, 136
Kittitas-Roza Diversion bypass canal: 50
Klamath: 197

L

land use: S-6, S-12-13, 24, 42, 70, 74, 84, 103, 114, 120, 127, 136, 138, 156
legislation: 11-12, 14, 35
lining: S-15-16, 24, 33, 87, 127, 149, 153, 167, 173, 195
Little White Salmon National Hatchery: 3
location map: S-1, 3
logging: 9, 105
low flows: 4, 9, 55, 57, 59, 76, 119, 142

M

marbled murrelet: 88, 196
maximum contaminant levels (MCL): 69
McAllister Meadows: 7
migratory birds: 195
mini "flip-flop": 48, 79, 142, 145
minimum flows: S-2, 36, 48, 51, 114
mining: 9, 74, 104
mink: 9, 81
mitigation: S-12, S-15, S-18, 22, 30-31, 87, 108, 147, 173, 175-177, 187-188, 194-196, 199
model: see hydrology model
monitoring: 21, 22, 24-25, 41, 56
muskrats: 9, 81

N

Naches
    basin: S-11, 65, 70, 87, 98, 129-130
    River: S-6, S-9, S-17, 1, 4, 6, 24, 43, 45-49, 51-52, 76-81, 84, 86, 99, 101, 141, 169, 171
National
    Environmental Policy Act (NEPA): S-14, 14-18, 32, 137, 147, 169, 172, 188, 190, 192-193
    Historic Preservation Act (NHPA): S-18, 16, 102, 174, 197
    Marine Fisheries Service (NMFS): S-7, S-15, 75, 88-89, 154, 193, 196
    Register of Historic Places, S-17-18: 102-103, 173, 175, 197
    Water Quality Assessment Program: 4, 182
    Wetlands Inventory: 83, 85-86
Native American Graves Protection and Repatriation Act: 102
Natural Resources Conservation Service (NRCS): 5, 153, 183, 192-193
nesting: 83-84, 86-87, 151, 194
No Action Alternative: S-1, S-10-12, S-15, S-17, 19, 35-38, 109-113, 115-123, 125-130, 133-137, 139-144, 146, 148, 150-151, 155-160, 162-163, 165-166, 170-171, 175, 180
nonproratable: 7, 8, 21, 49-50
nonstructural: 23, 25, 26
Northern
    Pacific Railway: 6
    spotted owl: 88, 165, 196

Northwest
Power Act: 2, 14-15
Power Planning Council: 2, 15, 30
Notice of
Availability: 192
Intent: 14, 190
nutrients: 56-57, 77, 80, 84-85, 120-122, 125, 127, 185

O

onfarm irrigation: S-12, 5, 26, 36, 136-137, 160, 183
operational criteria: S-1, 3, 32, 36, 54-55

P

Pacific Northwest: S-8, 5, 82, 168
paleontological resources: S-9, S-17, 102, 108-109, 173, 175, 177, 186
Parker: S-2, S-10, S-11, S-14, 7, 42-43, 46-47, 49, 51-54, 59, 77, 86, 110-112, 114-119, 121-123, 125-126, 128, 139-141, 143, 146, 148, 151, 160, 184-185
peregrine falcon, 88, 196
permeability, 61-62, 66
Phase
1: 2, 4, 10, 15, 39, 183
2: S-1, 1-2, 10-12, 14, 15, 39, 183
piping: S-15, 24-25, 33, 149, 173
plan of study: 192-193
population: S-5, S-7, S-16, 9, 56, 74-75, 79, 86, 89-91, 96, 104, 149, 157-158, 166, 182, 185-186
program
elements: 20
manager: 190, 193, 198
programmatic environmental impact statement (PEIS): S-18, 1, 15-16, 18-19, 24, 35-38, 41, 103, 105, 109, 154-155, 157, 169, 172, 179, 188-194, 197-199
project
background: 6
history: 1
location: 1
property owners: 90, 159-161
proratable: 7-8, 21, 28, 36, 50, 116, 118, 132, 160, 184
Prosser: S-2, S-6, S-10, S-13, S-14, 3, 9, 28, 29, 31, 35-36, 51-53, 57, 59, 65, 68, 76, 78, 110-119, 122, 124-126, 138-144, 146-148, 151, 159-160, 184

Public
involvement: 11, 189-191, 193
Law 103-434: see Title XII
Law 96-162: 9
meetings: 190, 193
purple loosestrife: 87, 195

R

radial gates: S-17, 25, 29-30, 134, 144-145, 151, 160, 166-167, 169, 173
ramping rates: 32, 194
Reclamation: see Bureau of Reclamation
record of decision: 182
recreation: S-8-9, 97-102, 169-173, 191
reduced diversions: 24, 29, 34-35, 37, 114, 120, 122, 126-128, 152
related activities: 2, 98, 170, 192
releases: S-2, S-9-10, 3-4, 8, 43, 47-49, 53-55, 74, 76-77, 101, 109-112, 116, 118-119, 122, 125-126, 131, 140, 145, 159, 184
reregulation: 147
resident fish: S-5-6, S-8, S-13-14, S-17, 11, 14, 74, 79-80, 99, 140, 143-146, 169, 171, 194
return flows, S-2, S-3, S-11-12, S-15, 8, 22, 26, 28, 42, 44-45, 50-51, 53, 55, 58-61, 66, 72, 113-118, 120-122, 126-132, 137, 148-149, 155, 160
Richland: 1, 68, 91
rights-of-way: 83, 194
Rimrock: S-6, S-9, 7, 47-49, 53, 79-80, 98-102, 106, 146, 171
riparian: S-6-7, S-14, 2, 9, 42, 46, 59, 74-75, 77, 80-87, 147-154, 179, 183, 186-187, 194-195
Roza
Canal: 117, 133-134, 167, 179
Diversion Dam: S-2, S-6, 38, 51, 76-80, 99, 143
Irrigation District: S-11-12, 31, 34, 70-71, 92-93, 117, 121, 129, 131-132, 136, 148, 154, 159, 185
Power Plant: S-3, S-15-16, 54, 162, 168
runoff: S-2, 6, 47, 53

S

sacred sites: S-9, S-18, 16, 41, 108-109, 177, 198
sales revenue: S-8, 94, 96-97, 165
salinity: S-5, S-12, 73, 134-135, 137
salmon: S-5, S-8, S-13, S-16, S-18, 3, 4, 9, 49, 74, 75, 77-80, 88, 104-105, 138-146, 177, 181-183, 185-186, 196

salmonid: S-5, S-14, 75, 78, 138, 139, 142, 144-145, 186
Satus
    Creek: 79, 83-86, 102, 143
    Creek basin: 69
scoping: 14-15, 90, 189
Secretary of the Interior: 6, 9, 15, 16, 19, 21-24, 28, 30, 32-33, 105, 175
sediment: S-3, S-11-12, 25, 46, 56-61, 73, 84, 120-122, 125-128, 137, 143, 145, 185
Seelatsee Auditorium: 190-191
seepage: S-11, 25, 114, 126-129, 131, 148
shortages: S-10, 7, 10, 50, 72, 110-112, 116-119, 135, 137, 160, 167, 184
shrub-steppe: S-6, 9, 80-81
Silver Creek: 12, 31, 34, 37, 136, 145-146, 151, 161, 166
Simcoe Creek: 33, 86, 102
social well-being: S-15, 89, 155-158, 160-162, 186
soil quality: S-5, S-12, 73, 137
spawning: S-2, S-6, S-13, 3-4, 9, 48, 49, 53-55, 58, 74-75, 77-80, 138-146, 183
Special Status Species: see Threatened, Endangered, and Special Status Species
spring chinook: S-2, S-5-6, 3, 49, 53, 75-79, 88, 142-145, 196
State Historic Preservation Office (SHPO): 102, 106-107, 173-176, 197
steelhead: S-5-6, S-13, 3-4, 9, 74-79, 88-89, 104, 138-146, 155, 183, 185-186, 197
storage: S-2, S-4, S-11, S-17, 4, 7-12, 22, 24, 29, 31, 34-38, 42-49, 51, 53-55, 64, 73-75, 84, 104-105, 109, 112, 114, 116-119, 129-132, 136, 145, 160, 166, 169, 173-174
storage
    capacity: 7, 12, 29, 34, 36-37, 46, 64, 160, 169
    control: 8, 53
    dams: 9, 10, 75, 105
summer chinook: S-5-6, 75, 78, 88, 144, 196
Sunnyside
    Canal: S-2, 38-39, 117, 121, 133-134, 179
    Diversion Dam: S-6, S-11, S-13, 7, 28-29, 36, 48, 51, 53, 57, 77-79, 116, 141, 143, 148, 166, 184-185
    Irrigation District: 50, 70-71, 92-93, 105, 129, 131, 154, 159, 167
    Irrigation Project: 104
    Unit: 6
    Wildlife Area: 84, 87
surface
    water: S-2-5, S-10-11, 13, 21, 33, 41-42, 46, 55-56, 63-64, 66, 70, 73, 109-110, 113-117, 120-122, 126-128, 132, 141, 179, 184-185
    water quality: S-3, S-10, 55-56, 120-122, 126, 128, 185
System Operations Advisory Committee (SOAC): S-13, 4, 14, 29-30, 144, 151

T

Taneum Creek: S-13, 30, 35, 54, 57, 76-77, 84, 140, 144
target flows: S-1, S-13, 28-29, 36, 46, 51-54, 109-110, 114-116, 118, 138-139, 158, 166-167, 171, 184
Teanaway River: S-9, S-13-14, 30, 57, 76-77, 101, 140, 144
Technical Activities Group (TAG): see Enhancement Technical Activities Group
Threatened, Endangered, and Special Status Species: S-7, S-15, 88-89, 109, 154-155, 186, 195-196
tiering: 16, 18, 199
Tieton
    Dam: 48, 53, 106
    Irrigation District: 50, 70-71, 92-93, 133-134, 159
    Lake: 55, 98
    River: S-9, 24, 38, 43, 47, 52, 84, 101-102, 141
    River Valley: 61
    Unit: 7, 105
Title XII: S-1, S-2, S-10, S-13-14, S-18, 1, 9, 14-16, 19, 21, 23-25, 28-29, 32, 34-39, 41, 43, 51-52, 74, 79, 89, 109-114, 116-120, 122-127, 133-134, 137-138, 140-145, 148, 151-154, 157-158, 160-161, 165-166, 171, 177, 179, 184, 188, 191-192, 194, 196, 199
Toppenish Creek: 79, 83-87, 102
    Corridor enhancement project: 32-33, 37, 143, 145, 152, 161, 179
    Municipality: 68, 190-191
Toppenish-Simcoe
    Project: 33
    Unit: 34
total
    dissolved solids (TDS): S-4, 69
    maximum daily load (TMDL): 6, 56, 59, 61, 185
    water supply available (TWSA): S-2, 7-8, 12, 23, 25, 28, 30, 36, 51, 53, 109, 113-114, 116-118, 128, 136, 165
traditional cultural properties: S-9, S-17-18, 102, 105, 108, 173-174, 176, 198
trapping: 74, 195
Treaty of 1855: S-10, 2-3, 5-6, 12-13, 104, 108, 183
trends: S-5, S-12, 56, 70, 72, 75, 82, 85, 89-91, 98, 136, 157, 181-182, 186
Tribal Council: 14, 199
tributary: S-2, S-4, S-6, S-13-14, S-17, 1-2, 4, 6-7, 13, 17-18, 24, 26, 30, 33-34, 37-38, 43, 46-47, 56-59, 61, 64, 70, 74, 76-77, 79-81, 103, 106, 109, 138-140, 144-147, 149, 151, 153-154, 165, 168, 171, 179, 194

U

U.S.
Army Corps of Engineers: 61, 182
Forest Service: S-8, 78, 164, 182, 193, 197
Geological Survey: S-3, 4, 42, 46, 55-57, 59-60, 65-67, 182
Umtanum Station: S-10, 47, 84, 122-123, 126, 139, 141, 144
unconsolidated deposits: 64, 66
United States versus *Oregon*: 3
unregulated
flows: S-2, 6, 8, 22, 35, 43-45, 47, 114
runoff: S-2, 6, 53
Upper Columbia Area Office, S-15, 70, 190, 192

V

values: 157, 159-160
visitation: S-8, 98-99

W

Wapato
Canal: 59, 105
Diversion Dam: 8, 76, 168
Division: 92-93, 105, 159
Irrigation Project: S-2, S-16, 8, 32-35, 37-38, 50, 70-71, 83-84, 86, 117, 145, 151-152, 161, 167, 179
Wapatox Power Plant: S-3, S-15, 49, 54, 162
Washington
Department of Fish and Wildlife: S-6, 4, 21, 80-81, 84, 87
State: 2, 5, 19, 22, 30, 158, 169, 181, 183, 188, 190-193
State Department of Ecology: 5-6, 12, 55, 57, 67-68, 98, 132, 192-193
State Historic Preservation Office: see State Historic Preservation Office
State University Agricultural Extension Service: 21
waste: 25, 51, 66, 85

water
conservation: S-1, S-7, S-11-14, S-16, 1, 4-5, 10-12, 15-16, 19, 21-23, 25-26, 28-29, 32, 34-37, 70, 74, 82, 85, 87, 90, 114, 120-121, 126-128, 133, 136-140, 145-147, 149-156, 159-161, 163, 167, 179, 182, 184-188, 194-196
conservation measures: S-7, S-12, S-16, 5, 11-12, 16, 19, 21-23, 25-26, 28, 32-34, 90, 114, 120, 126, 136, 146, 153-154, 156, 159, 161, 167, 179, 186, 195-196
conveyance: 24, 27, 33, 146
measurement and accounting: 21, 25, 194
quality: S-1, S-3, S-6, S-10-13, 4-6, 9, 21, 23, 25-26, 46, 55-58, 60-61, 72, 74-78, 81, 84, 87, 97-98, 120-123, 125-128, 136-137, 139, 142, 146, 152, 181-183, 185, 191, 195
rights: S-12, 5, 7, 11-12, 14, 18-19, 24, 27-28, 30, 70, 120, 126-127, 137, 155, 158, 161-163, 165-168, 179, 185
rights acquisitions, S-13, 25, 27, 114, 120, 126-127, 137-138, 148, 155-157, 161-163, 165-168, 181, 185, 196
supply: 34, 46
temperature: S-3, 59, 77, 80, 130, 146
year: 91, 113
waterbanking: 11, 24
waterfowl: 9, 81, 83-84, 86-87, 149
watershed: S-4, 5, 29, 43, 67-69, 91, 131, 165, 182, 191
weeds: 24, 33, 73, 83, 136, 195
Wenas Creek: 57, 77, 84, 86, 105
wetlands: S-6, S-7, S-12-14, 16, 21, 23, 46, 74, 80-81, 83-87, 126, 137-138, 140, 146-154, 183, 186-187, 191, 194-196
Wetlands and Floodplain Habitat Plans: S-14, 147, 152, 186
wildlife habitat: S-6-7, 82-84, 86-87, 148-149, 152-153, 194
willing seller: 19, 27, 165
Wish Poosh Campground: S-17, 169, 173

Y

Yakama Indian
Nation: S-7, S-9, S-12, S-16, 2-6, 8, 11-15, 19, 21, 30, 32-34, 37, 83, 84, 86-87, 89-91, 97, 102-103, 105-106, 108, 117, 137, 143, 148-149, 151-152, 159, 167-168, 174-175, 179, 183, 190, 192-194, 197-199
Reservation, S-1, S-7, S-10, 6, 8, 10-12, 22, 33-34, 37, 67, 84, 86, 89-91, 102, 104-105, 108, 133-134, 152, 157, 159, 179, 188, 191, 196
Yakima
Basin Watershed Council: 191
County: S-5, 6, 12, 68, 70, 166

Yakima (continued)
Field Office Manager: 14, 32
Fisheries Project: 2-3, 75
Project: S-2, S-5, S-7, S-9, S-17, 3, 4, 6-7, 10, 15, 23, 25, 28-30, 32, 34, 42, 46, 53, 70-71, 91-93, 97, 99, 105-106, 148, 175
River Basin Water Quality Plan: 51, 55, 97-98
River Basin Water Enhancement Project (YRBWEP): S-1, S-12, S-14-16, 1, 9-12, 14-16, 20-21, 31-32, 38-39, 41-42, 55, 57, 75, 84, 107, 113, 137, 147, 149, 152, 173, 176, 190, 192-193, 197-198
River Water Conservation Demonstration Project: 4
Valley Conference of Governments: 5, 183
Yakima-Tieton
Canal: S-2, 38, 71, 117, 167
Irrigation District: 43

Appendix A

SURFACE WATER HYDROLOGY

Surface Water Hydrology

Tables A-2 and A-3 in the appendix present the target flow impacts at the Parker and Prosser locations on the Yakima River. The tables present comparisons of pre-Title XII conditions, for the listed target flow hydrology indicators, with the No Action Alternative. Also presented in the tables are the impacts of the five action alternatives compared with the No Action Alternative. The impacts presented in table A-2 are period average values for the period 1926 to 1994. The impacts presented in table A-3 are values for 1994 only, an extremely dry year. These impacts are expressed as a percentage of months where the specific hydrology indicator or condition is met. The tables present values in percent for the No Action Alternative for each of the hydrology indicators, and the impacts shown for the other alternatives are related to and compared with the No Action Alternative value. For each action alternative, impacts are shown as increases or decreases from the percent shown for the No Action Alternative. The pre-Title XII condition is compared with the No Action Alternative in the same way. For example, in table A-2 for flows greater than 300 cubic feet per second (ft^3/s) below Prosser Dam for year-round conditions, the number of months as a percentage of the total months in the modeling period is 84 percent for the No Action Alternative. For the pre-Title XII condition, the table shows a -41 percent change (i.e., a decrease of 41 percent from the No Action Alternative) compared with the No Action Alternative, which means that only 43 percent of the time is the greater than 300-ft^3/s condition met with the pre-Title XII condition, compared with 84 percent of the time for the No Action Alternative.

Table A-4 summarizes the impacts for other hydrology indicators, such as the April total water supply available (TWSA) and annual diversions. Table A-4 summarizes the hydrology impacts on the Yakima River July through October streamflow at selected key locations on the river. Both tables A-4 and A-5 present the impacts in terms of percentage change compared with the No Action Alternative and are shown for period average conditions for the 1926 to 1994 modeling period and for 1994 only, a dry year.

In addition to the tables, figures A-2 through A-7 have been included to show graphically the comparison of the various options of the action alternative with the No Action Alternative. The appendix figures show the actual indicator values, whereas tables A-4 and A-5 show the percentage change as compared with the No Action Alternative.

TWSA Forecasts

Total water supply available forecasts are computed as follows:

- Unregulated flow is estimated for three precipitation scenarios—50 percent of normal, normal, and 150 percent of normal for the ensuing months.

- Current end-of-month reservoir contents (the amount of water stored in the reservoirs at the end of the prior month) are added.

- Estimated irrigation return flows are added. Irrigation return flows are the amount of water that returns to the river system after diversion and application to the land. Three estimates are made, based on diversions anticipated with the three precipitation scenarios.

  (The sum of the above three items provides a volume used to determine instream flow targets in accordance with the operating criteria of Title XII).

- Residual storage at the end of September is subtracted. The residual storage is that quantity of water that cannot be discharged from the reservoirs because of hydraulic constraints, about 50,000 acre-feet, and anticipated carryover storage.

- Estimated flow passing Sunnyside Diversion Dam is subtracted. This estimate includes unregulated flows and target flows provided pursuant to Title XII. Target flows identified in Title XII are subtracted.

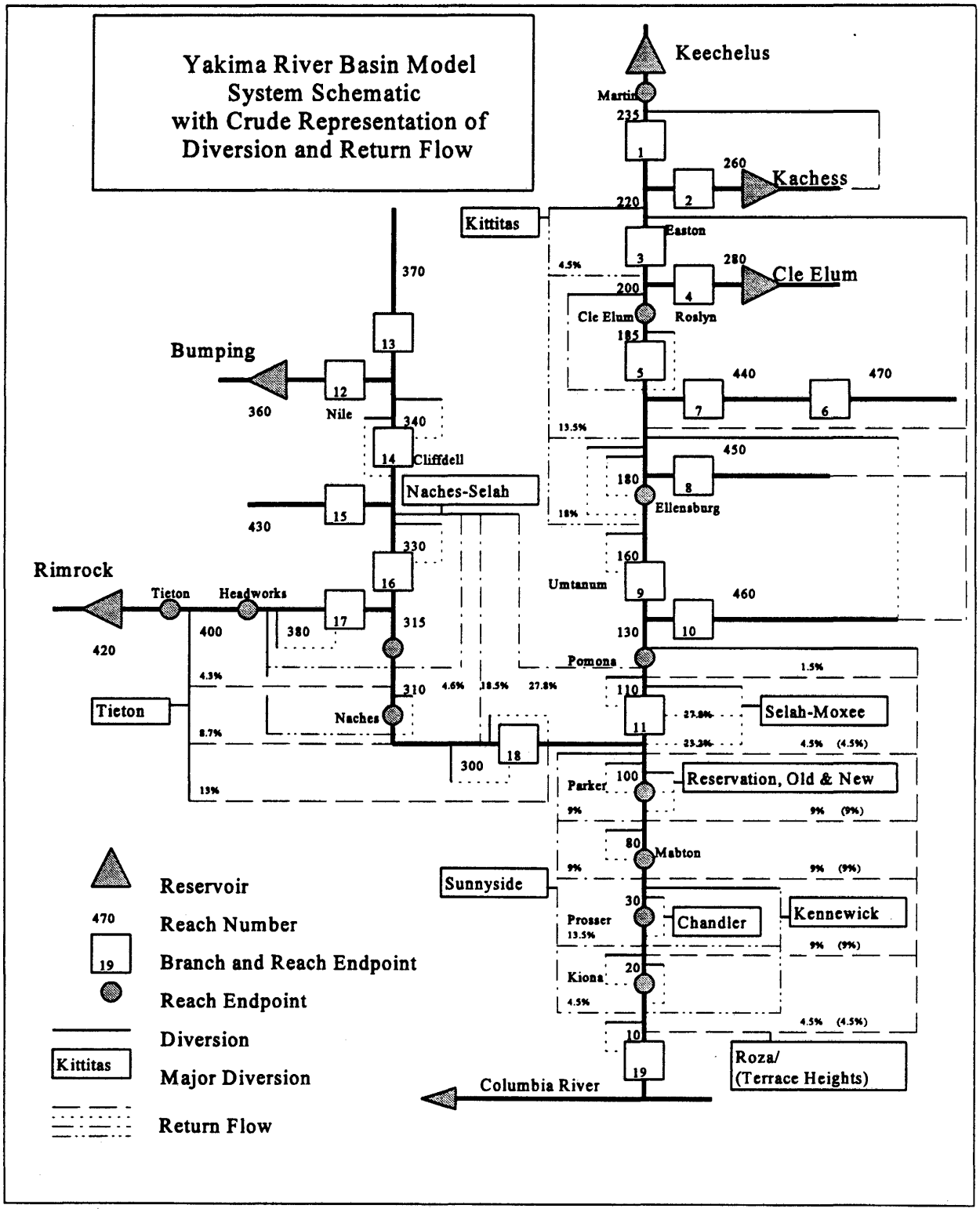


Figure A-1.—Schematic of the Yakima River Basin with representations of branch and reach endpoints used in monthly model.

Table A-1.—Irrigation diversions in the Yakima River Basin—average monthly irrigation demands
(1970 through 1994 average for full water supply conditions in acre-feet)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Yearly totals
Columbia Canal	4,526	0	0	0	0	679	7,867	10,745	11,482	12,468	12,618	10,784	71,169
Richland Canal	2,008	1,320	665	204	130	420	1,290	1,714	1,956	2,411	2,355	2,249	16,722
Kiona Canal	574	0	0	0	0	64	1,030	1,591	1,451	1,336	1,398	1,164	8,608
Kennewick Canal	5,691	0	0	0	0	1,416	10,511	15,205	15,678	17,460	17,008	13,776	96,745
Snipes and Allen Canal	243	26	16	11	9	33	200	795	809	1,102	1,489	851	5,584
Sunnyside Canal	29,194	0	0	0	0	10,016	43,102	68,006	71,389	76,768	76,512	61,445	436,432
Reservation Canal - New	19,568	1,523	0	0	194	11,274	58,636	108,651	114,570	116,472	107,168	84,398	622,454
Reservation Canal - Old	508	1,230	1,458	1,509	1,053	776	438	267	118	0	0	0	7,357
Blue Slough Canal	352	322	266	152	203	361	467	642	609	531	506	316	4,727
Richartz Canal	182	184	186	95	59	99	259	357	291	336	312	231	2,591
Union Gap Canal	527	0	0	0	0	212	1,927	3,191	3,259	3,543	3,348	2,394	18,401
Hubbard-Granger Canal	273	0	0	0	0	16	670	1,445	1,787	1,972	1,941	959	9,063
Moxee Co. Canal	128	0	0	0	0	6	463	806	853	887	755	449	4,347
Boise-Cascade Log Ditch	654	936	1,051	900	787	869	1,187	1,110	1,237	1,072	674	551	11,028
Taylor Canal	112	32	31	11	21	44	222	533	585	583	589	294	3,057
Selah-Moxee Canal	1,388	0	0	0	0	393	2,345	3,608	3,945	4,458	4,258	3,184	23,579
Roza Irrigation District	19,775	0	0	0	0	9,984	33,683	55,013	62,448	69,269	67,209	44,685	362,066
Terrace Heights	134	0	0	0	0	0	318	474	512	561	538	391	2,928
Stanfield Canal	161	87	69	53	45	63	172	431	718	798	1,059	328	3,984
Vertrees No. 1 Canal	52	0	0	0	0	20	135	378	542	620	582	158	2,487
Tjossem Canal, Irrigation	55	0	0	0	1	41	306	1,027	1,141	1,298	976	419	5,264
Vertrees No. 2 Canal	39	8	0	0	9	28	48	108	124	164	171	88	787
Fogarty and Dyer Canal	167	29	34	46	46	102	192	639	891	808	615	289	3,858
Bull Canal	123	1	0	0	1	84	527	1,001	972	1,175	1,262	607	5,753
Ellensburg Mill Feed Canal, Irr.	487	32	25	21	24	122	539	1,226	1,268	1,131	1,126	904	6,905
Ellensburg Power Canal, Irr.	185	0	0	0	0	77	912	1,436	1,477	1,702	1,562	999	8,350
City of Ellensburg M&I	208	141	88	98	89	91	131	229	315	339	432	262	2,423
Woldale Co. (Olson) Canal	885	103	0	0	5	7	345	1,896	2,083	2,185	2,146	1,744	11,399
Ellensburg Town Canal	2,258	15	0	0	5	5	2,063	6,909	7,359	8,250	8,341	5,889	41,094
Mills and Sons Canal, Irr.	73	6	2	2	5	19	368	739	931	1,131	1,022	361	4,659
Westside Canal	1,199	5	0	0	0	11	1,376	4,771	4,406	4,944	4,645	3,531	24,888
Cascade (Old) Canal	286	0	0	0	0	0	497	1,605	1,387	1,245	1,144	936	7,100
Cascade (New) Canal	948	0	0	0	0	0	752	3,121	3,263	4,732	4,748	2,788	20,352

Table A-1.—Irrigation diversions in the Yakima River Basin—average monthly irrigation demands
(1970 through 1994 average for full water supply conditions in acre-feet) (continued)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Yearly totals
O'Connor Canal	6	0	0	0	0	0	5	19	45	75	59	21	230
Younger Canal	25	12	5	5	5	5	42	319	563	494	475	181	2,131
Knoke Canal	36	0	0	0	0	5	50	241	314	388	273	145	1,452
City of Cle Elum M&I Canal	101	82	75	84	72	82	91	117	130	139	151	132	1,256
Kittitas Canal	16,916	0	0	0	0	0	8,634	46,960	54,028	65,561	68,412	51,154	311,665
Cascade from KRD	1,266	0	0	0	0	3,074	2,975	3,074	2,975	3,074	1,608	1,276	19,322
Old Union Canal	420	11	5	5	4	88	813	1,174	1,249	1,284	1,292	1,055	7,400
Fruitvale Power Canal	654	0	0	0	0	86	1,290	1,879	1,979	2,078	2,166	1,692	11,824
City of Yakima Irr. Canal	698	0	0	0	0	384	1,397	1,590	1,471	1,436	1,494	1,446	9,916
Naches-Cowiche Canal	443	0	0	0	0	44	956	1,476	1,672	1,951	1,733	1,297	9,572
Chapman-Nelson Canal	102	0	0	0	1	1	141	261	298	263	272	269	1,608
Congdon Canal	676	0	0	0	0	275	2,229	2,626	2,541	2,724	2,609	1,971	15,651
Morrissey Canal	53	13	0	0	0	11	55	115	80	75	84	65	551
Gleed Canal	381	0	0	0	0	81	914	1,713	1,790	2,044	1,966	1,289	10,178
City of Yakima, Naches Pump	820	619	603	610	561	638	696	874	954	1,058	1,071	952	9,456
Kelley Llowry Canal	231	16	0	0	6	106	623	9	1,119	1,079	1,034	674	4,897
South Naches Channel Co.	1,661	294	73	182	113	424	2,392	3,948	3,859	4,174	4,194	3,402	24,716
Clark Canal	70	30	19	11	8	24	173	233	201	156	158	102	1,185
Foster-Naches Canal	55	0	0	0	0	4	71	139	159	155	139	119	841
Wapatox Irrigation Canal	248	0	0	0	0	1	340	847	1,167	1,406	1,410	912	6,331
Naches-Selah Canal	2,495	11	122	8	116	552	3,678	7,087	7,726	8,299	8,289	6,801	45,184
Stevens Canal	69	17	15	9	11	31	145	205	222	239	288	200	1,451
Carmack Parker Canal	52	52	38	14	16	20	55	144	142	49	72	61	715
Fredericks Hunting Canal	4	0	0	0	0	0	58	122	104	94	99	45	526
Nile Ditch Assn. Canal	249	78	59	39	25	56	278	454	451	482	588	476	3,235
Emerick Canal	19	14	4	0	0	4	30	75	92	34	59	21	352
Anderson Canal	106	51	26	8	8	19	114	238	212	162	271	154	1,369
Tenant Canal	151	46	29	15	21	102	191	165	223	236	249	266	1,694
Sinclair Cobb Canal	54	0	0	0	1	2	34	59	146	146	185	158	785
Cobb Upper Side Canal	1	0	0	0	0	1	8	8	9	52	19	14	112
Tieton Canal	36	0	0	0	0	179	2,671	12,766	17,312	19,548	19,905	16,938	89,355
Total													2,451,121

The following summary brings attention to the more significant impacts based strictly on magnitude of change relative to no action for each alternative. The term "releases for instream flow" applies specifically to releasing from storage to satisfy instream flow requirements.

Alternative 1

- 18% decrease, shortages, period average 1926-1994 (table A-4)
- 17% increase, Kachess storage, 1994 only (table A-4)

Alternative 2A

- 57% increase, releases for instream flow, period average 1926-1994 (table A-4)
- 51% increase, Prosser flow Jul-Oct % months > 600 ft^3/s, period average 1926-1994 (table A-2)
- 49% increase, Parker flow Jul-Oct % months > 600 ft^3/s, period average 1926-1994 (table A-2)
- 42% increase, Prosser flow Jul-Oct, period average 1926-1994 (table A-5)
- 35% increase, Parker flow Jul-Oct, period average 1926-1994 (table A-5)
- 23% increase, Kachess storage, 1994 only (table A-4)
- 21% decrease, shortages, period average 1926-1994 (table A-4)

Alternative 2B

- 60% increase, releases for instream flow, period average 1926-1994 (table A-4)
- 53% increase, Prosser flow Jul-Oct % months > 600 ft^3/s, period average 1926-1994 (table A-2)
- 51% increase, Parker flow Jul-Oct % months > 600 ft^3/s, period average 1926-1994 (table A-2)
- 49% increase, Prosser flow Jul-Oct, period average 1926-1994 (table A-5)
- 43% increase, Parker flow Jul-Oct, period average 1926-1994 (table A-5)
- 39% decrease, shortages, period average 1926-1994 (table A-4)
- 30% decrease, shortages, 1994 only (table A-4)
- 29% increase, Easton flow Jul-Oct, 1994 only (table A-5)
- 25% increase, releases for instream flow, 1994 only (table A-4)
- 21% increase, Prosser flow (year) % months > 600 ft^3/s, period average 1926-1994 (table A-2)

Alternative 2C

- 62% increase, releases for instream flow, period average 1926-1994 (table A-4)
- 53% increase, Prosser flow Jul-Oct, period average 1926-1994 (table A-5)
- 53% increase, Prosser flow Jul-Oct % months > 600 ft^3/s, period average 1926-1994 (table A-2)
- 52% increase, Parker flow Jul-Oct % months > 600 ft^3/s, period average 1926-1994 (table A-2)
- 49% decrease, shortages, period average 1926-1994 (table A-4)
- 49% increase, releases for instream flow, 1994 only (table A-4)
- 49% increase, Parker flow Jul-Oct, period average 1926-1994 (table A-5)
- 33% increase, Parker flow Jul-Oct, 1994 only (table A-5)
- 33% increase, Prosser flow Jul-Oct, 1994 only (table A-5)
- 28% decrease, shortages, 1994 only (table A-4)
- 21% increase, Prosser flow (year) % months > 600 ft^3/s, period average 1926-1994 (table A-2)

Alternative 3

- 53% increase, releases for instream flow, period average 1926-1994 (table A-4)
- 50% increase, Prosser flow Jul-Oct % months > 600 ft^3/s, period average 1926-1994 (table A-2)
- 48% increase, Parker flow Jul-Oct % months > 600 ft^3/s, period average 1926-1994 (table A-2)
- 40% increase, Prosser flow Jul-Oct, period average 1926-1994 (table A-5)
- 34% increase, Parker flow Jul-Oct, period average 1926-1994 (table A-5)
- 20% increase, Prosser flow (year) % months > 600 ft^3/s, period average 1926-1994 (table A-2)

Table A-2.—Summary of hydrology impacts for instream target flows—period average (1926-1994)

Hydrology Indicators	Pre-Title XII[1]	No Action Alternative	Action alternative				
			Alternative 1[1]	Alternative 2A[1]	Alternative 2B[1]	Alternative 2C[1]	Alternative 3[1]
Parker flow - year % months ≥300 ft³/s	0	100	0	0	0	0	0
Parker flow - year % months ≥600 ft³/s	-4	68	0	18	18	19	17
Parker flow - year % months ≥900 ft³/s	0	61	0	3	6	7	3
Parker flow -Jul-Oct % months ≥300 ft³/s	0	100	0	0	0	0	0
Parker flow - Jul-Oct % months ≥600 ft³/s	-10	20	4	49	51	52	48
Parker flow - Jul-Oct % months ≥900 ft³/s	0	5	0	9	16	17	8
Prosser flow - year % months ≥300 ft³/s	-41	84	-2	-2	-2	-2	0
Prosser flow - year % months ≥600 ft³/s	-5	42	1	19	21	21	20
Prosser flow - year % months ≥900 ft³/s	0	32	-1	3	7	7	4
Prosser flow - Jul-Oct % months ≥300 ft³/s	-95	100	0	0	0	0	0
Prosser flow - Jul-Oct % months ≥600 ft³/s	-14	17	3	51	53	53	50
Prosser flow - Jul-Oct % months ≥900 ft³/s	0	3	0	9	17	17	8

[1] Percent of months change compared with the No Action Alternative.

Table A-3.—Summary of hydrology impacts for instream target flows (1994)

Hydrology Indicators	Pre-Title XII[1]	No Action Alternative	Action Alternative				
			Alternative 1[1]	Alternative 2A	Alternative 2B[1]	Alternative 2C[1]	Alternative 3[1]
Parker flow - year % months ≥300 ft³/s	0	100	0	0	0	0	0
Parker flow - year % months ≥600 ft³/s	0	50	0	0	0	0	0
Parker flow - year % months ≥900 ft³/s	0	50	0	-8	-8	0	-8
Parker flow - Jul-Oct % months ≥300 ft³/s	0	100	0	0	0	0	0
Parker flow - Jul-Oct % months ≥600 ft³/s	0	0	0	0	0	0	0
Parker flow - Jul-Oct % months ≥900 ft³/s	0	0	0	0	0	0	0
Prosser flow - year % months ≥300 ft³/s	-50	58	0	0	0	0	0
Prosser flow - year % months ≥600 ft³/s	0	0	0	0	0	0	8
Prosser flow - year % months ≥900 ft³/s	0	0	0	0	0	0	0
Prosser flow - Jul-Oct % months ≥300 ft³/s	-100	100	0	0	0	0	0
Prosser flow - Jul-Oct % months ≥600 ft³/s	0	0	0	0	0	0	0
Prosser flow - Jul-Oct % months ≥900 ft³/s	0	0	0	0	0	0	0

[1] Percent of months change compared with the No Action Alternative.

Table A-4.—Summary of hydrology impacts as percentage changes—period average values

Hydrology indicators	Pre-Title XII	No Action Alternative average year values (1,000s of acre-feet unless otherwise indicated)	Action alternatives				
			Alternative 1	Alternative 2A	Alternative 2B	Alternative 2C	Alternative 3
Average year - 1926-1994							
April TWSA	-1	3,018	1	-1	1	1	-1
Diversions	0	2,382	0	-5	-6	-6	-5
Shortages	-14	57	-18	-21	-39	-49	-16
Return flows	0	576	0	-7	0	1	-7
Instream flow releases	-32	81	2	57	60	62	53
Storage levels							
Kachess	3	141	7	8	8	9	0
Cle Elum	1	257	4	2	5	7	2
Tieton	2	117	0	-1	1	3	-1
Bumping	1	14	1	0	1	1	0
Dry year - 1994							
April TWSA	-1	1,958	1	0	0	-1	-1
Diversions	1	1,797	3	-1	1	0	-1
Shortages	-3	602	-9	-17	-30	-28	-16
Return flows	1	439	1	-3	1	2	0
Instream flow releases	0	74	8	0	25	49	0
Storage levels							
Kachess	-15	75	17	23	4	-15	12
Cle Elum	0	81	-1	2	-3	0	-1
Tieton	-2	50	1	1	-1	-2	0
Bumping	0	12	0	2	0	0	-1

Table A-5.—Summary of hydrology impacts as percentage changes—Yakima River average July through October streamflow at key locations

Location	Pre-Title XII	No Action Alternative	Action alternative				
			Alternative 1	Alternative 2A	Alternative 2B	Alternative 2C	Alternative 3
Average July through October flows ft^3/s - 1926-1994							
MART	-2	490	0	1	0	-2	1
EAST	-7	363	3	18	2	-2	13
CLEE	-3	1,924	1	6	1	-2	5
UMTA	2	2,354	1	3	1	-1	2
POMO	-4	863	1	6	4	3	5
PARK	-18	511	2	35	43	49	34
PROS-MABT	-58	461	2	42	49	53	40
KION	-5	1,714	0	4	1	-5	4
Average July through October flows in ft^3/s - Dry Year, 1994							
MART	2	485	4	-10	17	12	-1
EAST	0	519	5	-1	29	17	8
CLEE	0	1,778	2	4	6	3	2
UMTA	0	2,040	3	1	6	4	-1
POMO	-3	781	3	7	6	4	3
PARK	0	300	8	0	17	33	0
PROS-MABT	-54	300	8	0	17	33	0
KION	-15	821	5	-4	-4	-11	-5

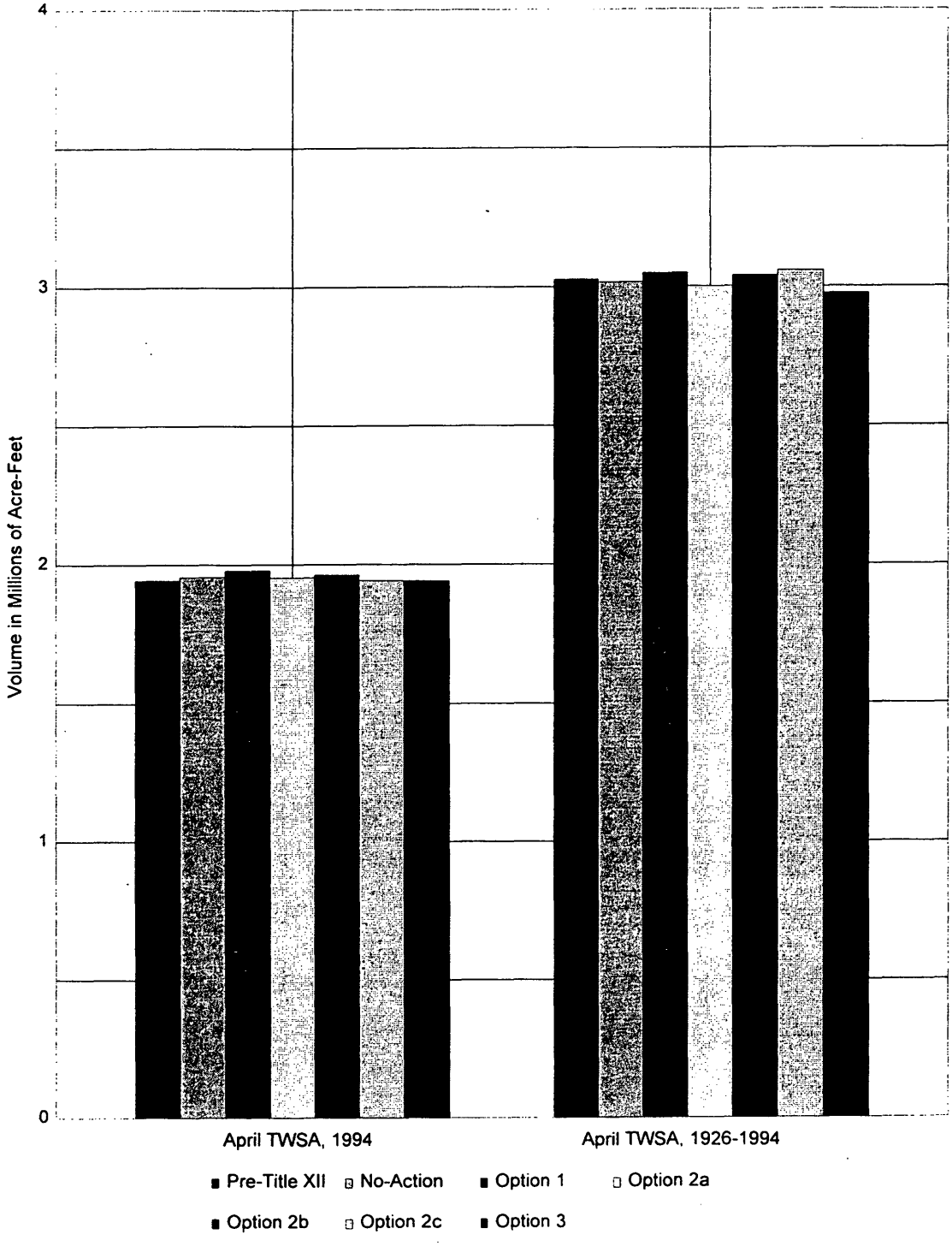


Figure A-2.—April TWSA for 1994, and 1926 to 1994 average.

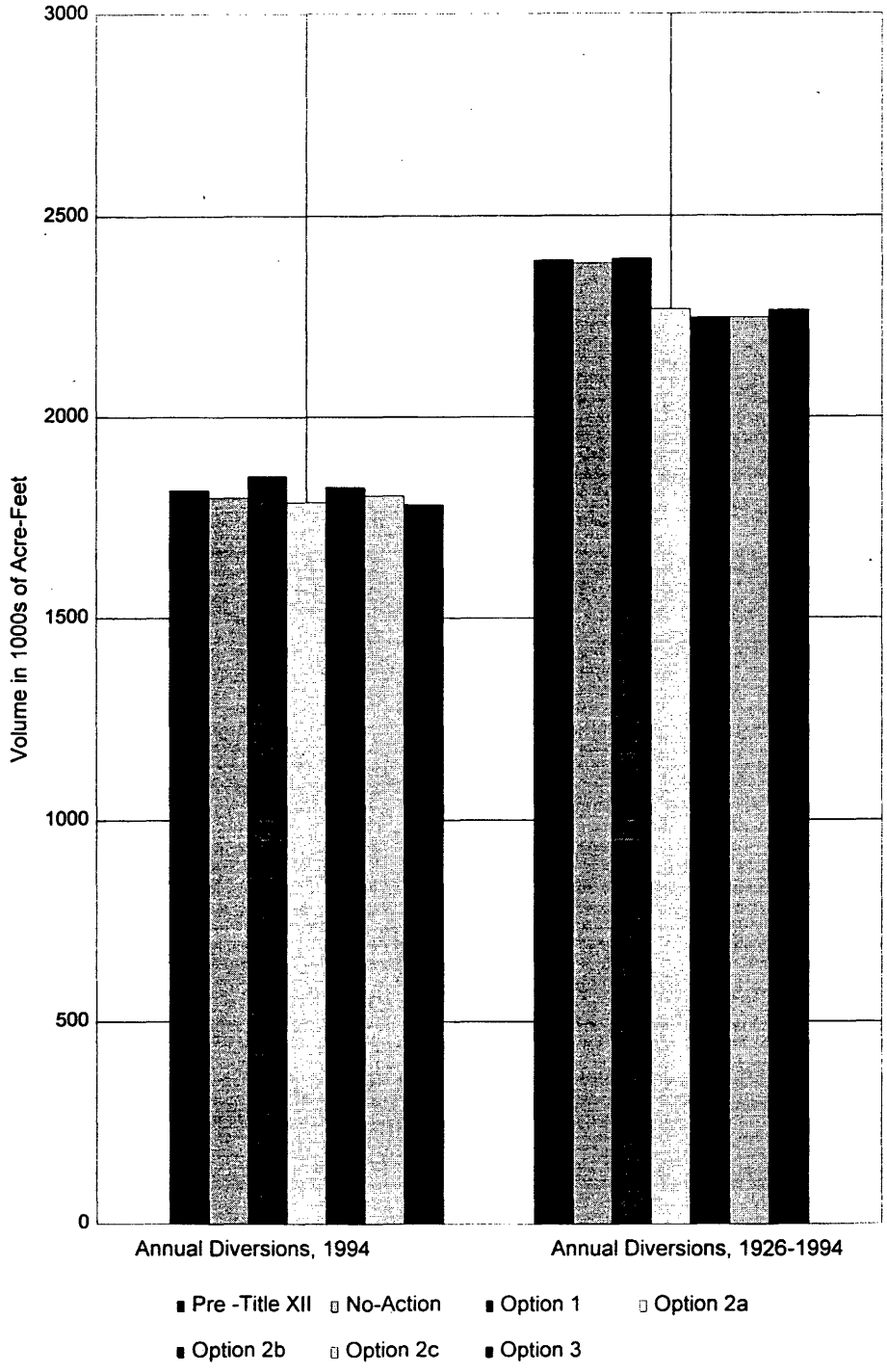


Figure A-3.—Annual diversions for 1994, and 1926 to 1994 average.

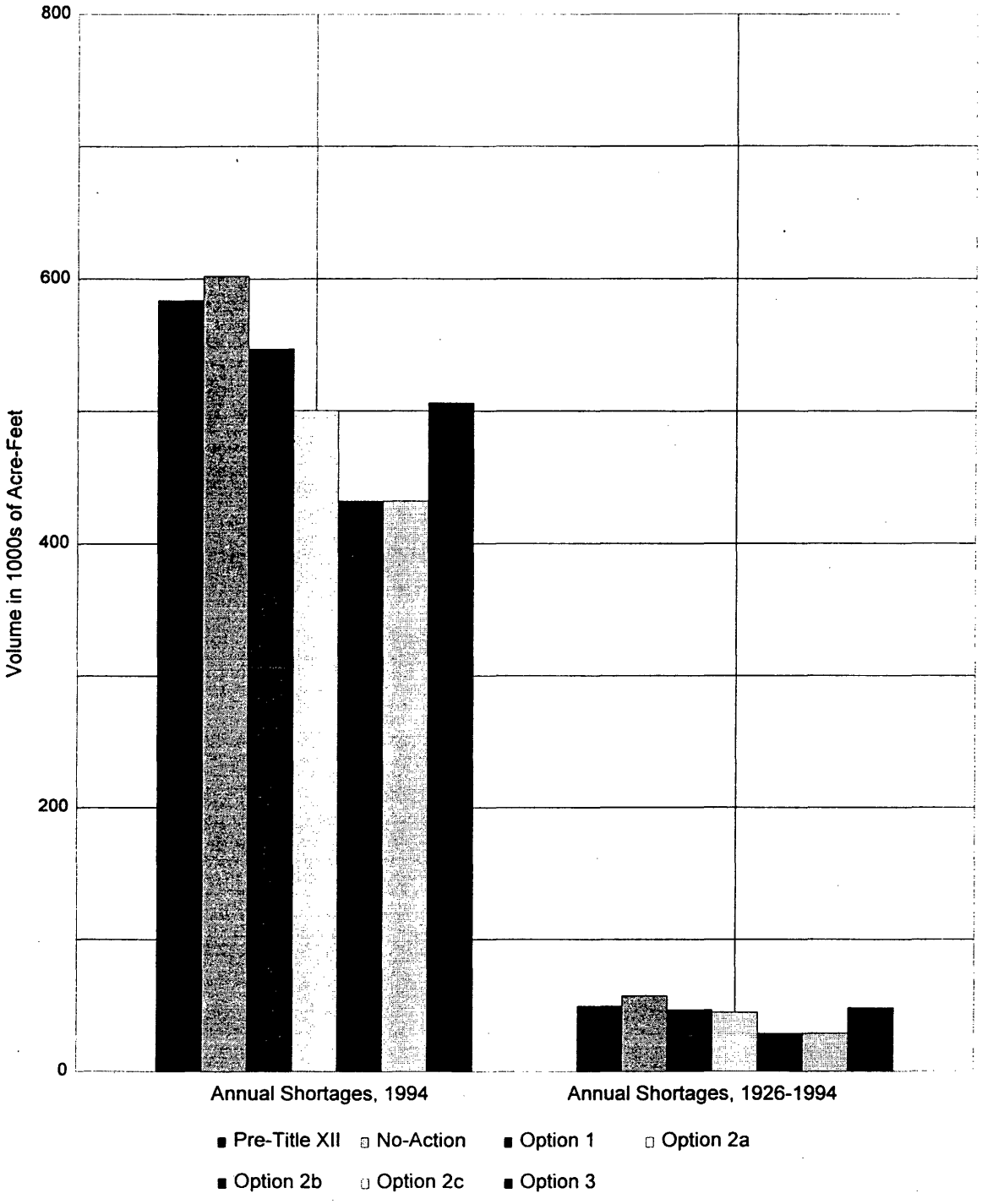


Figure A-4.—Annual shortages for 1994, and 1926 to 1994 average.

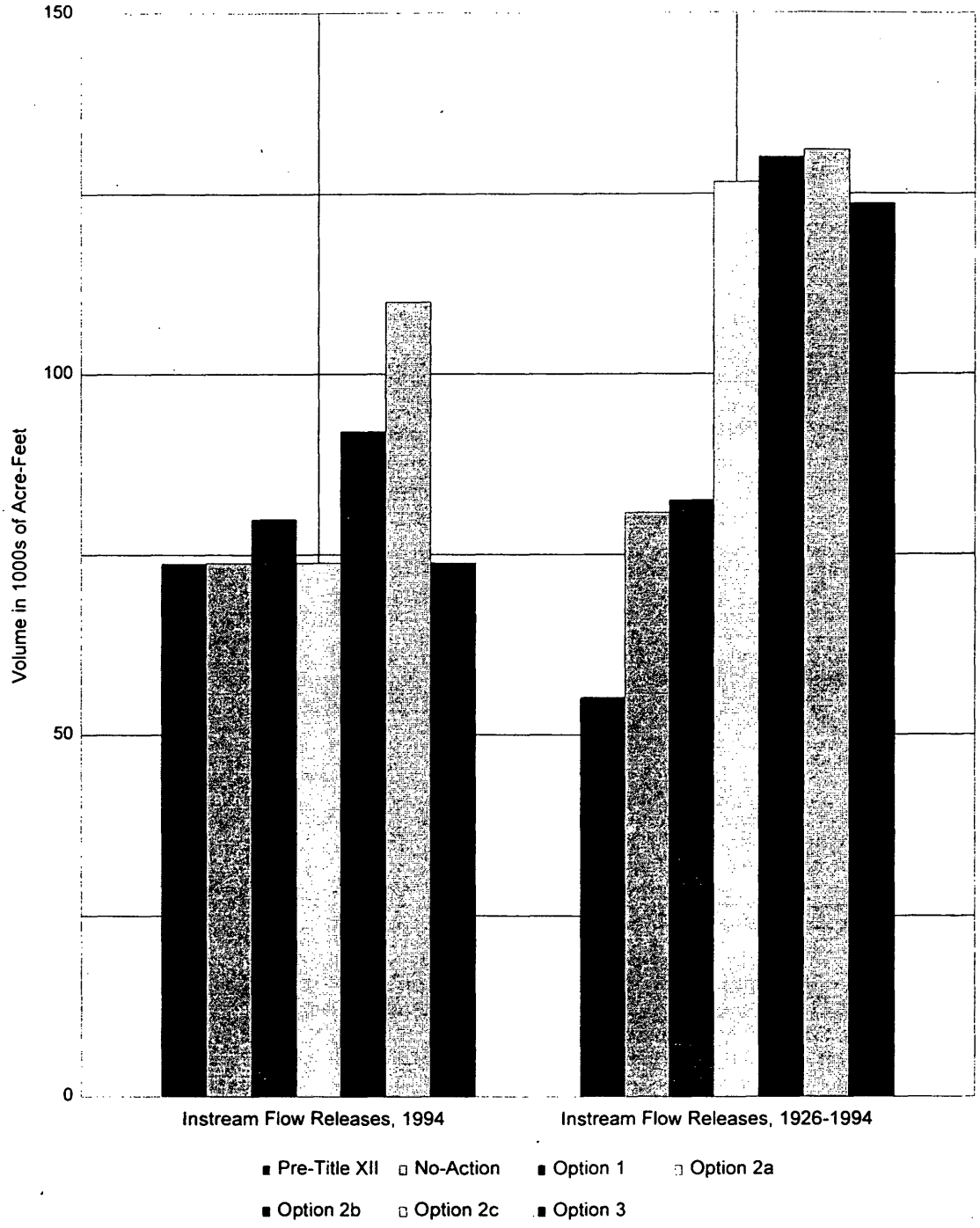


Figure A-5.—Instream flow releases for 1994, and 1926 to 1994 average.

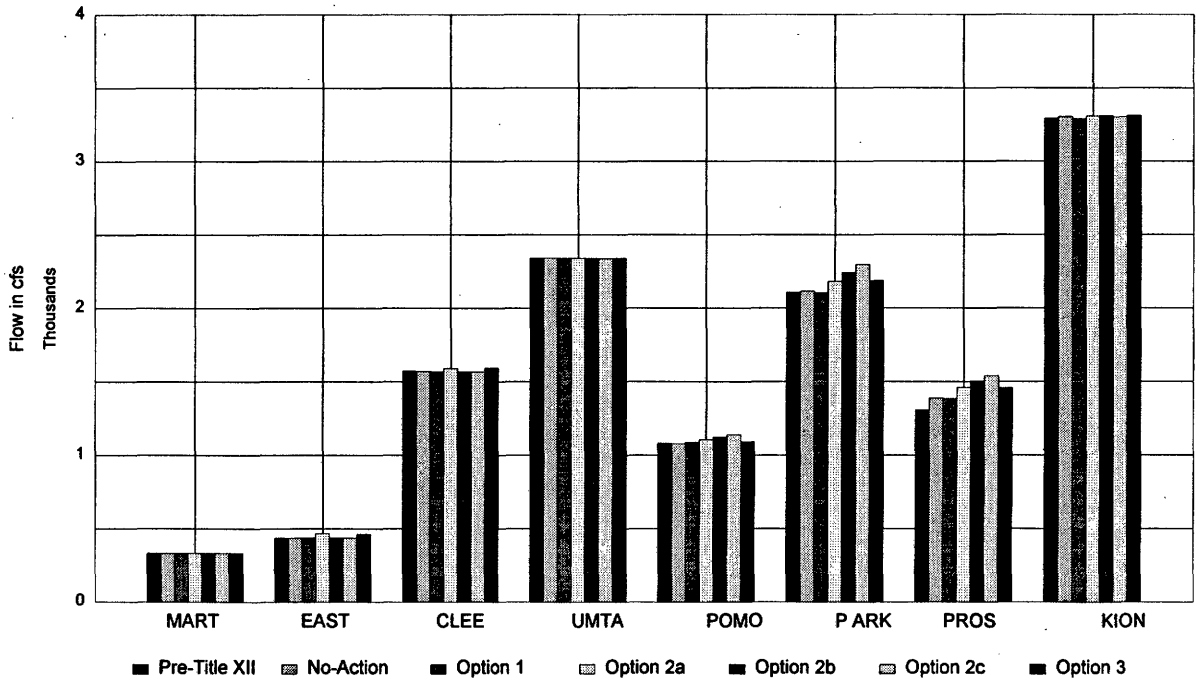


Figure A-6.—Average annual flows at key locations on the Yakima River, 1926 to 1994.

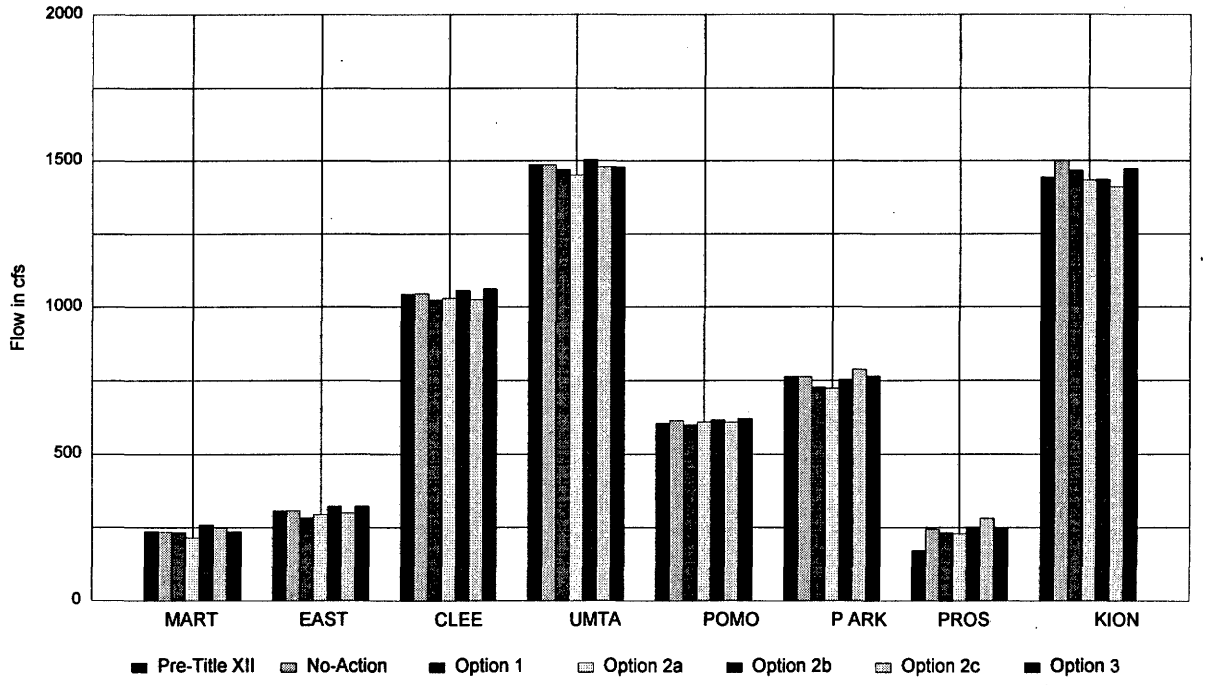


Figure A-7.—Average July through October flows at key locations on the Yakima River, 1926 to 1994.

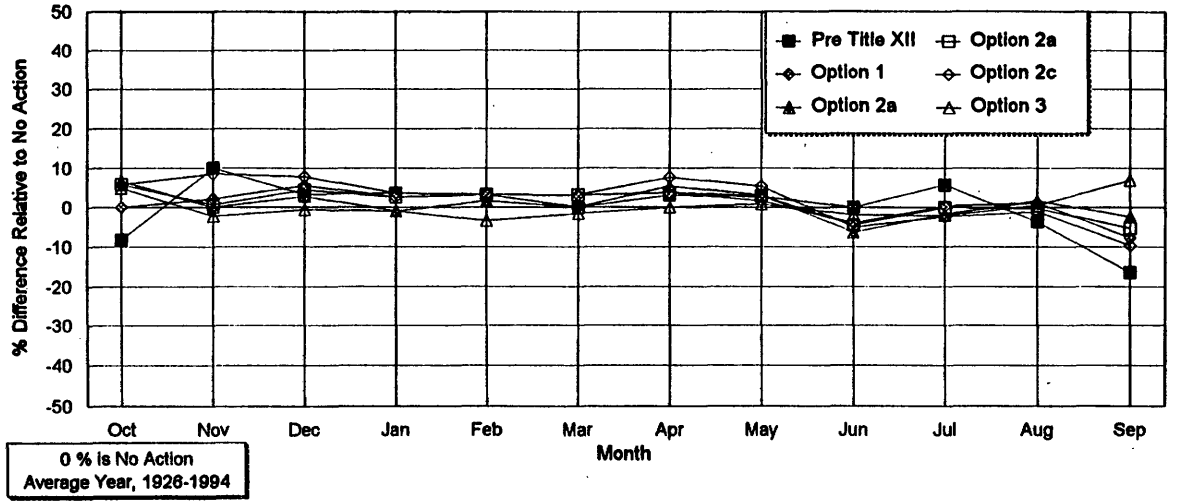


Figure A-8.—Flow impacts compared to no action - Martin (average year 1926-1994).

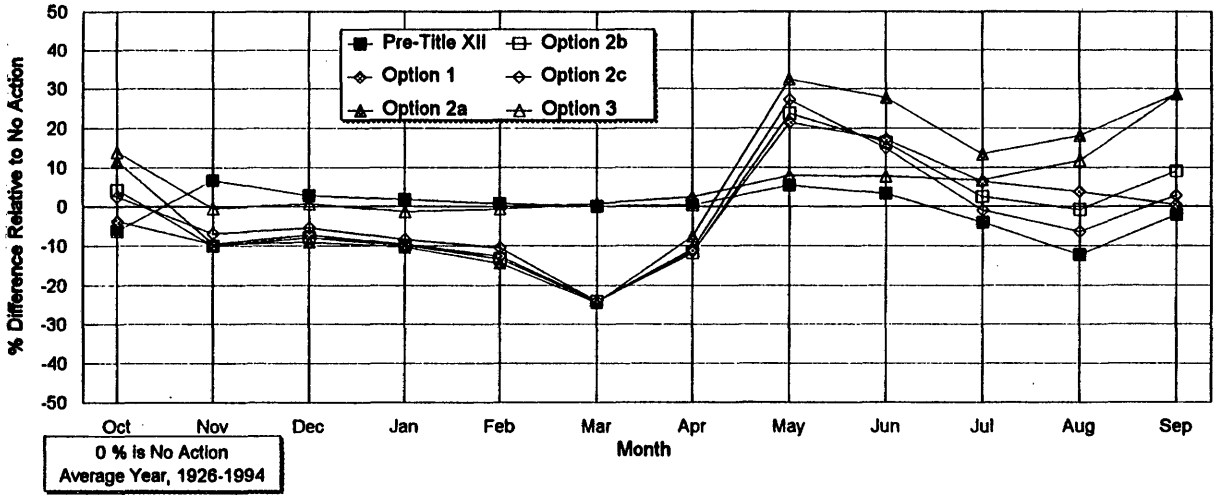


Figure A-9.—Flow impacts compared to no action - Easton (average year 1926-1994).

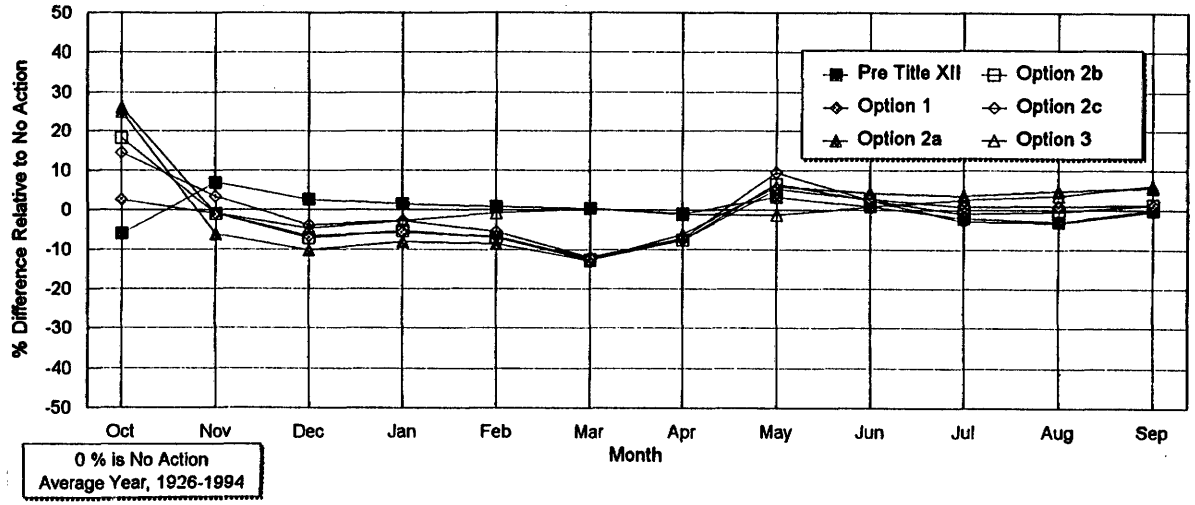


Figure A-10.—Flow impacts compared to no action - Cle Elum (average year 1926-1994).

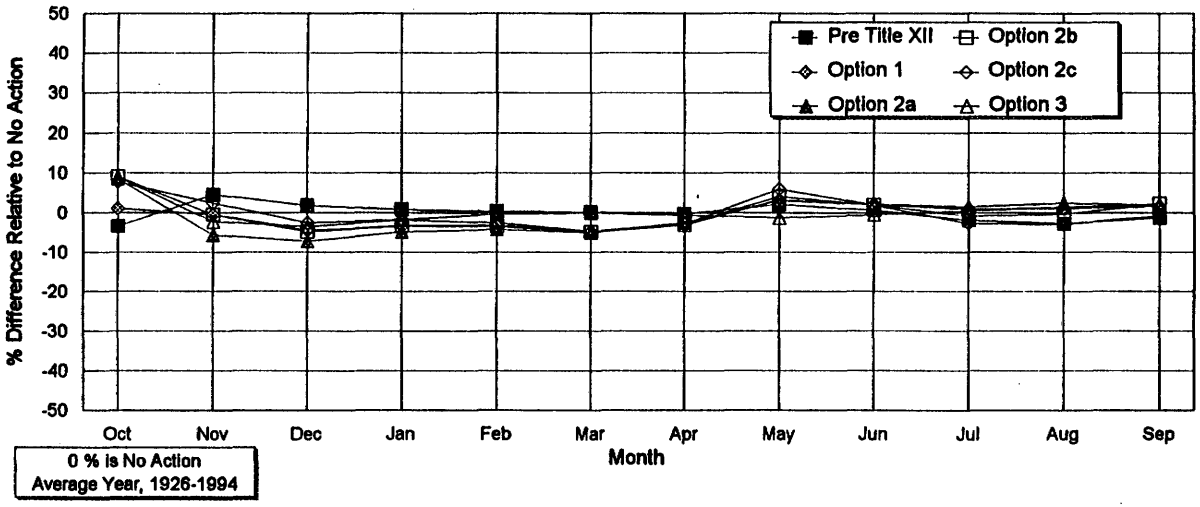


Figure A-11.—Flow impacts compared to no action - Umtanum (average year 1926-1994).

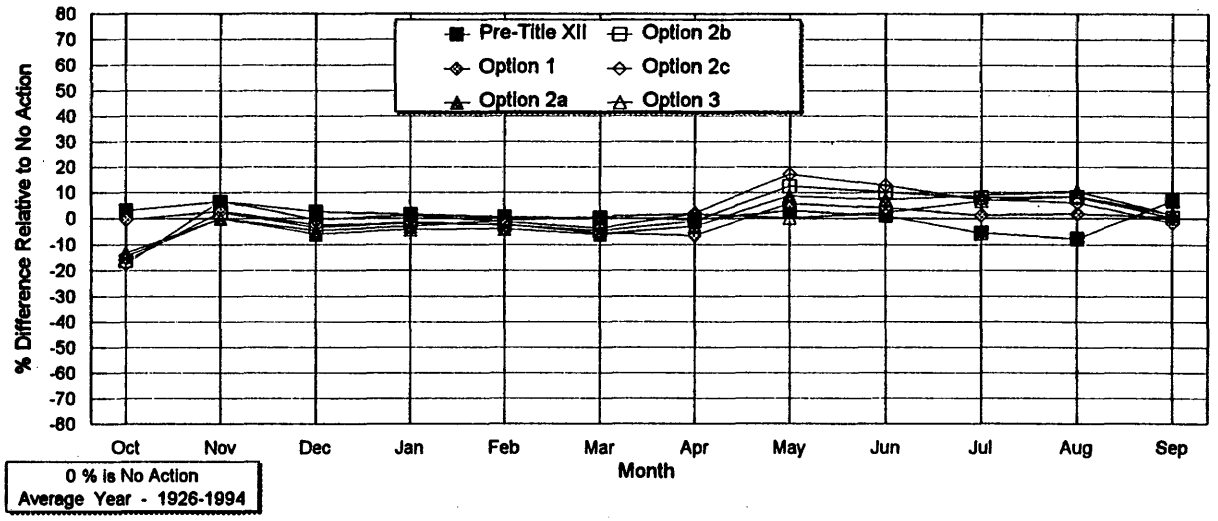


Figure A-12.—Flow impacts compared to no action - Pomona (average year 1926-1994).

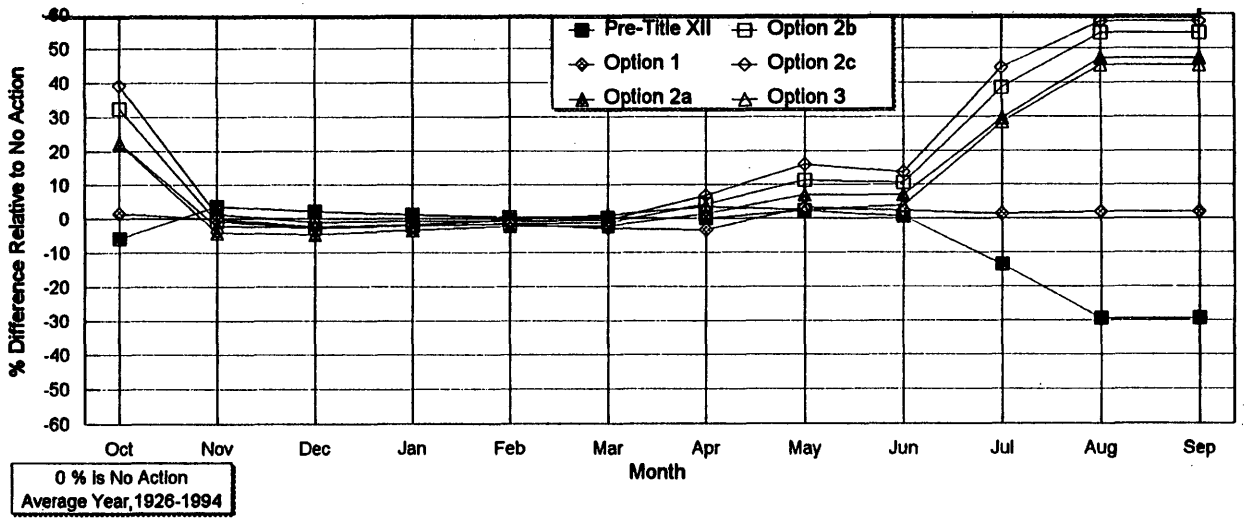


Figure A-13.—Flow impacts compared to no action - Parker (average year 1926-1994).

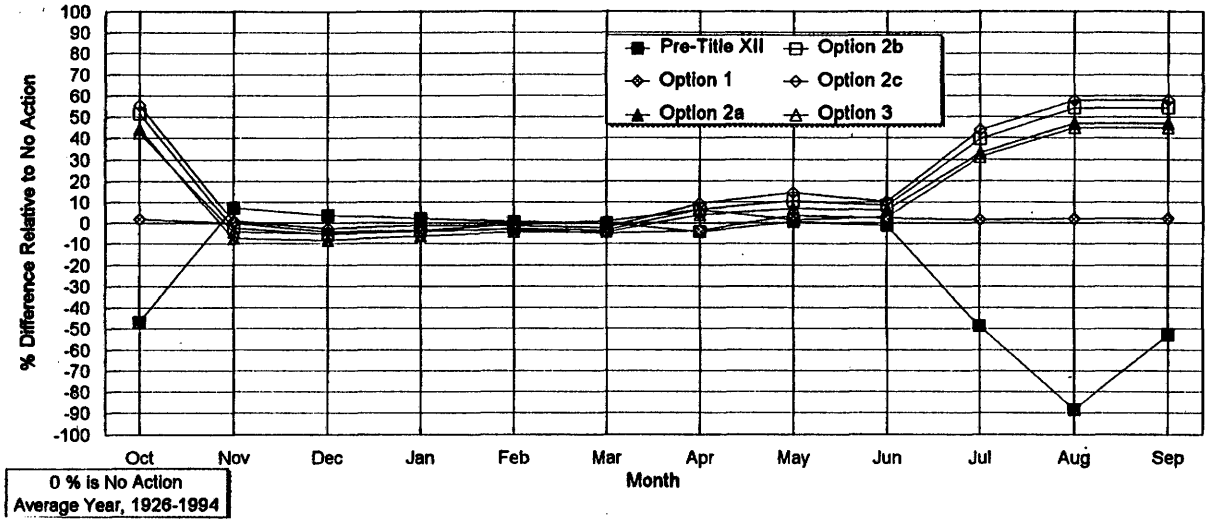


Figure A-14.—Flow impacts compared to no action - Prosser (average year 1926-1994).

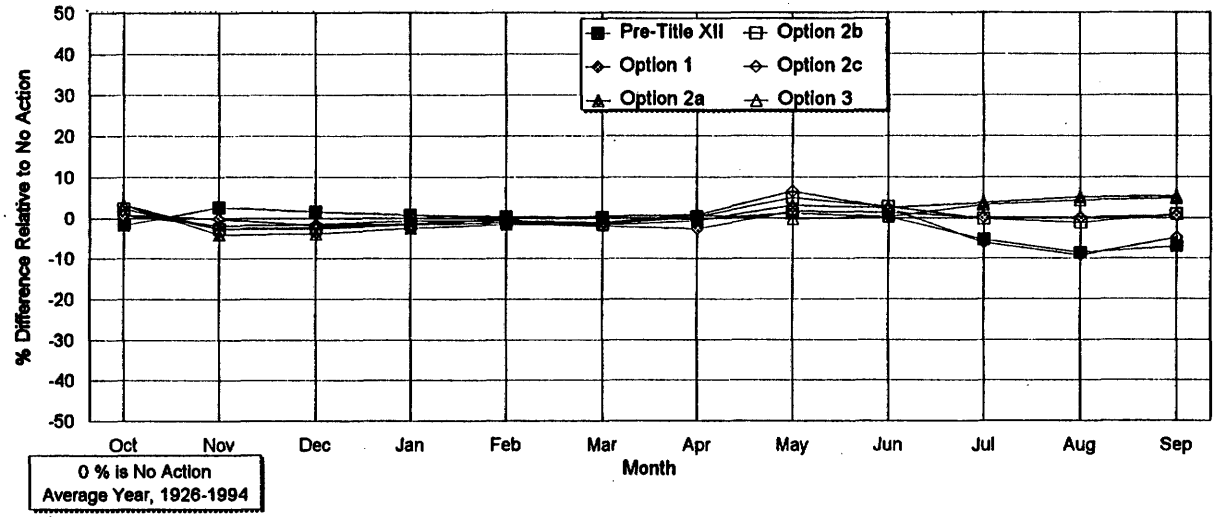


Figure A-15.—Flow impacts compared to no action - Kiona (average year 1926-1994).

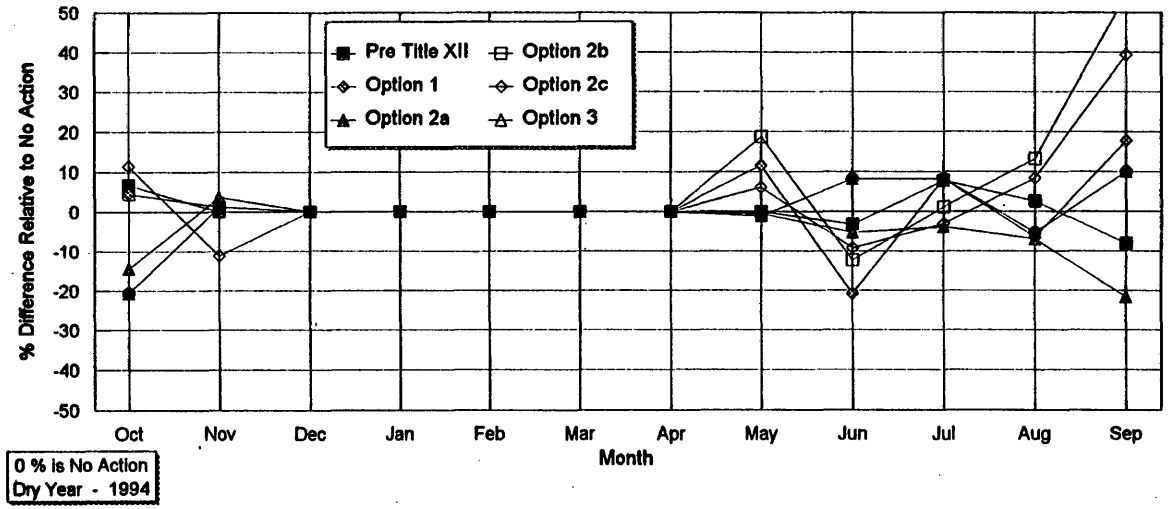


Figure A-16.—Flow impacts compared to no action - Martin (dry year 1994).

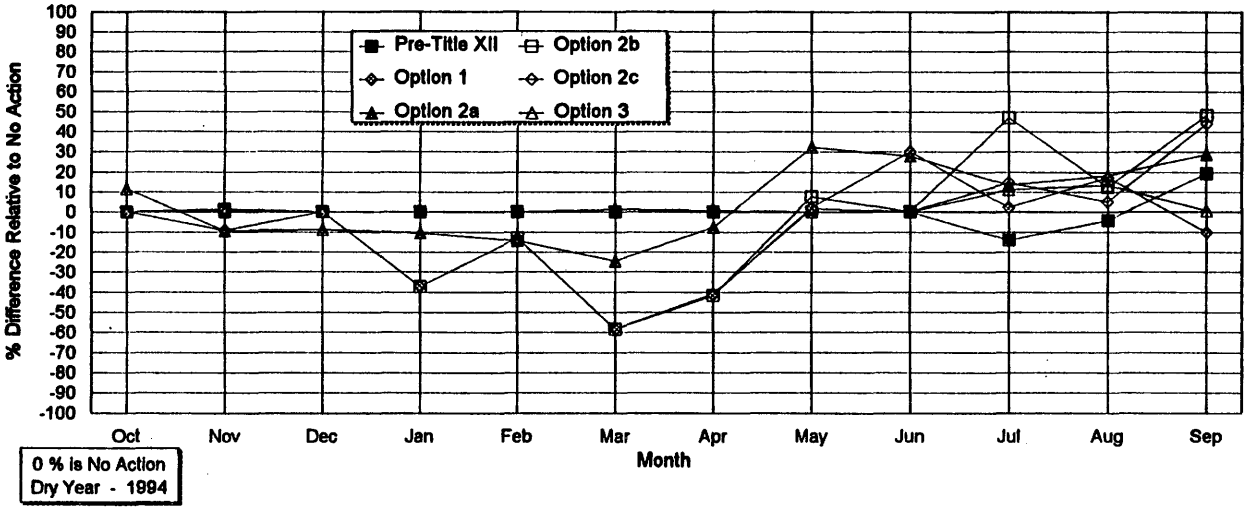


Figure A-17.—Flow impacts compared to no action - Easton (dry year 1994).

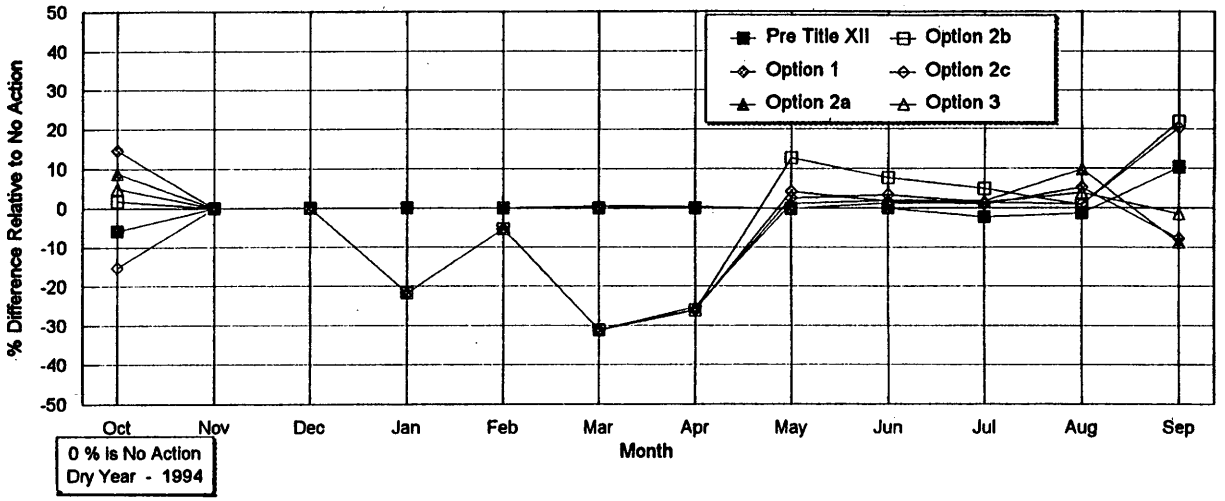


Figure A-18.—Flow impacts compared to no action - Cle Elum (dry year 1994).

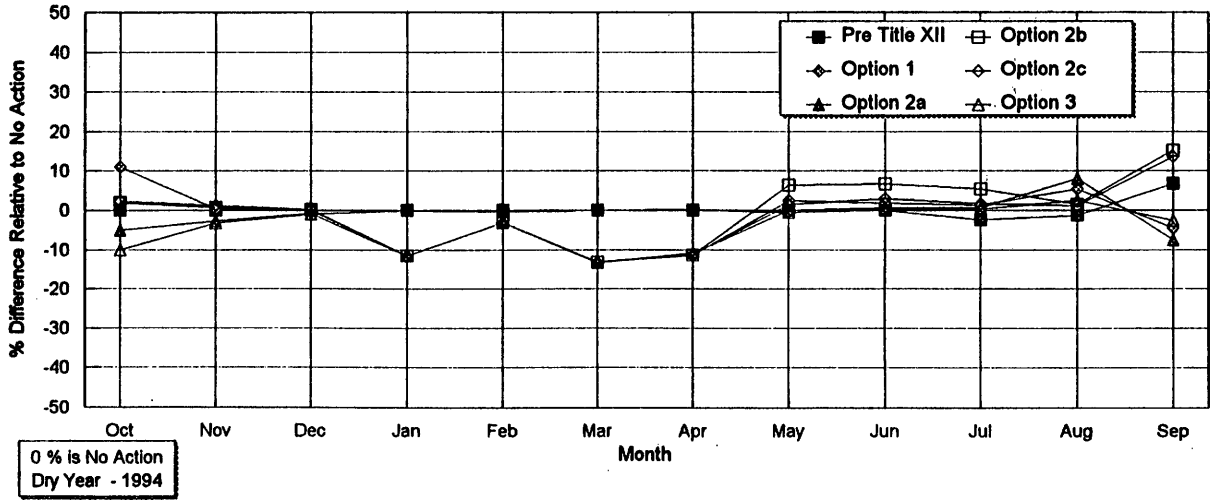


Figure A-19.—Flow impacts compared to no action - Umtanum (dry year 1994).

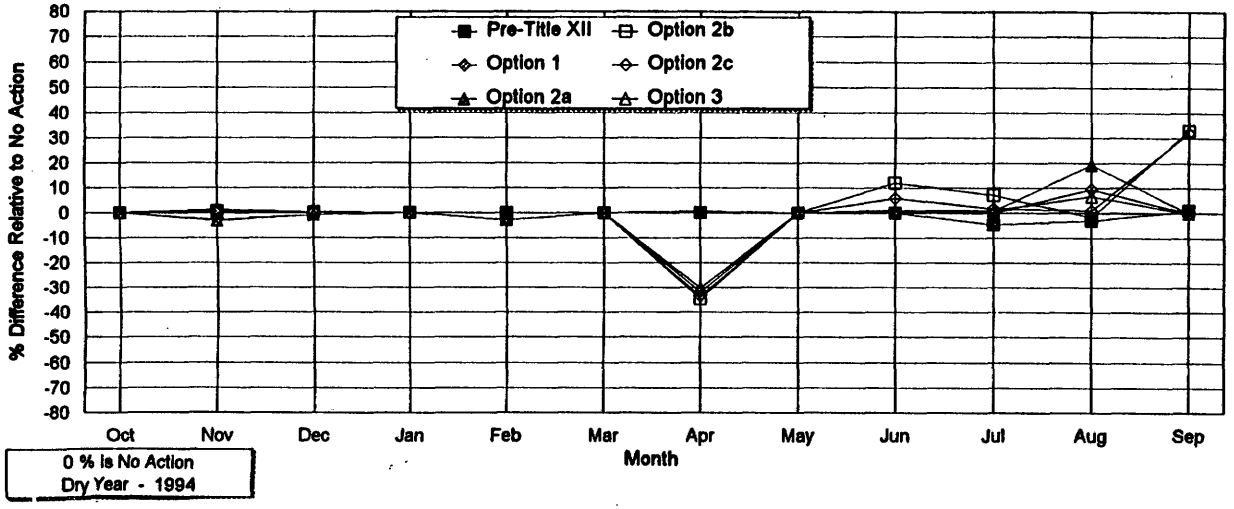


Figure A-20.—Flow impacts compared to no action - Pomona (dry year 1994).

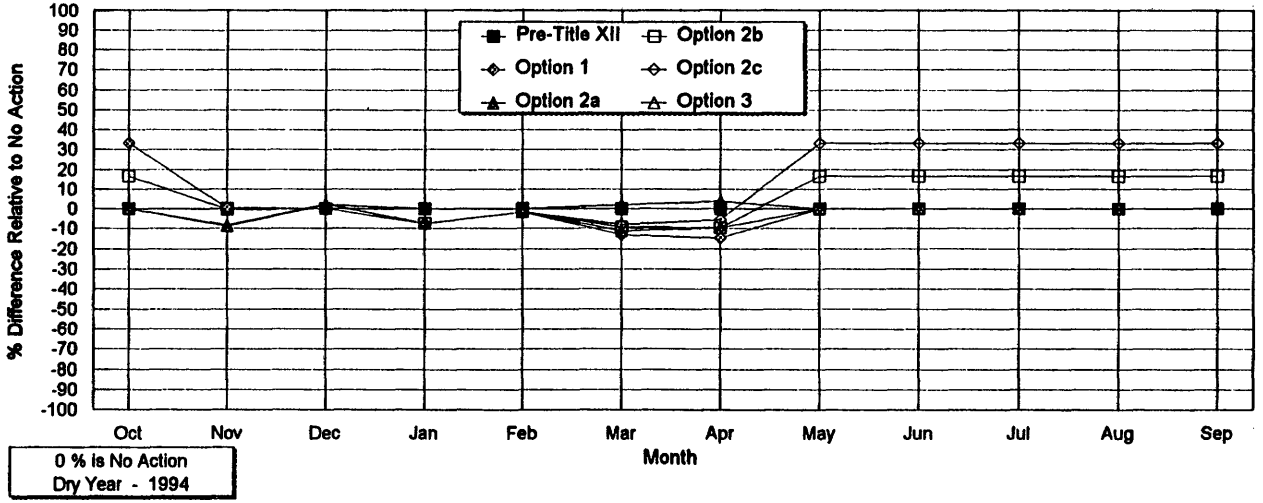


Figure A-21.—Flow impacts compared to no action - Parker (dry year 1994).

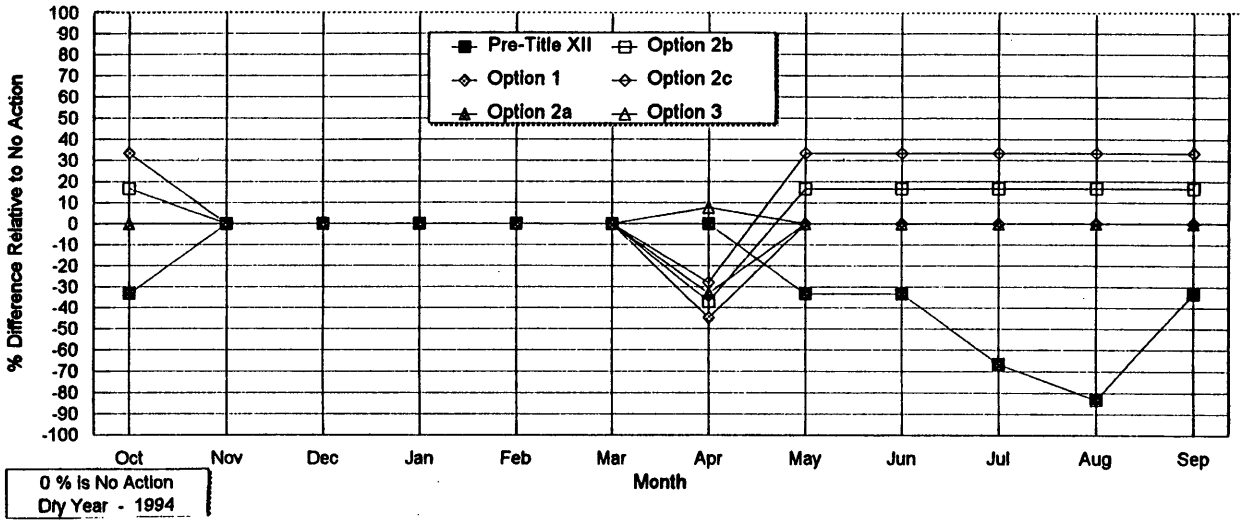


Figure A-22.—Flow impacts compared to no action - Prosser (dry year 1994).

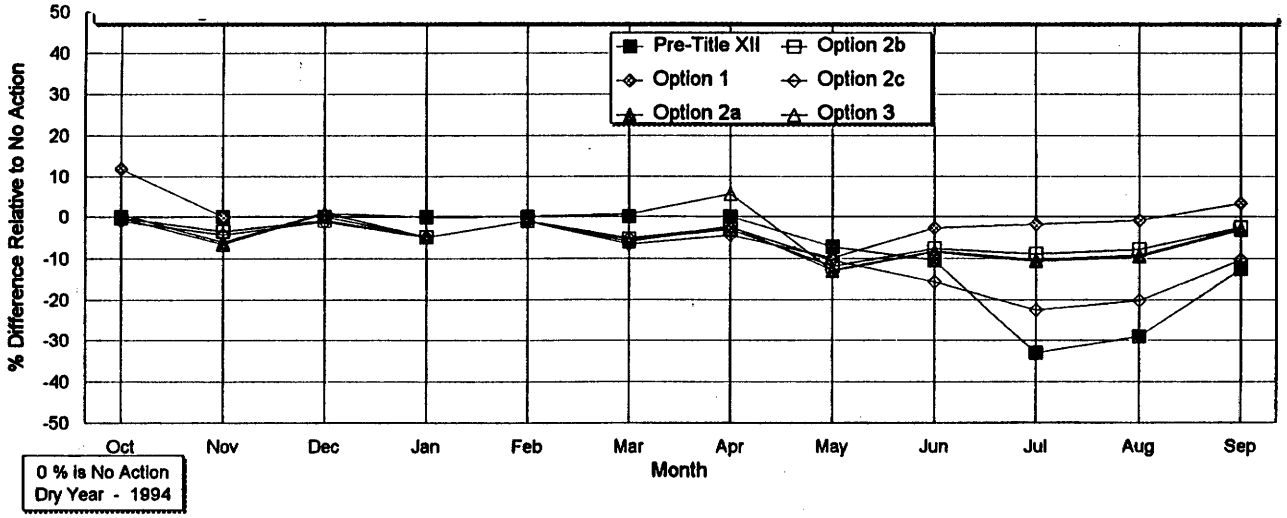


Figure A-23.—Flow impacts compared to no action - Kiona (dry year 1994).

Appendix B

FISH

Table B-1.—Detailed summary of impacts to fish, based on hydrology model results

Fish	Criteria used	Month(s) criteria applied	Pre-Title XII	Alternative					
				No action	1	2A	2B	2C	3
Salmon and steelhead									
Adult migration of spring chinook past Pomona Reach (May-June)	% of time model[1] streamflow > 400 ft^3/s[2]	May - June	Mean flow always above 400 ft^3/s	Mean flow always above 400 ft^3/s	Same as no action	Same as no action	Same as no action	Same as no action	Same as no action
Adult migration of steelhead past Pomona Reach	% of time model streamflow > 400 ft^3/s	Sept	16%	6%	7%	7%	4%	1%	9%
		Oct	65%	57%	52%	28%	23%	20%	30%
Adult migration past Prosser Dam (Fall chinook, coho, and steelhead affected)	% of time model streamflow >400 ft^3/s	Sept	0%	68%	71%	68%	70%	100%	67%
		Oct	3%	70%	72%	70%	71%	100%	68%
Juvenile migration past Prosser Reach (all species)	% of time model streamflow > 1,000 ft^3/s	April	48%	48%	43%	46%	46%	48%	48%
		May	54%	54%	55%	57%	59%	61%	58%
		June	54%	54%	54%	55%	55%	55%	55%
		July	9%	9%	9%	9%	9%	9%	9%
	% of time model streamflow > 800 ft^3/s	April	52%	52%	49%	65%	67%	68%	67%
		May	59%	58%	61%	65%	68%	70%	64%
		June	55%	55%	55%	58%	58%	61%	58%
		July	9%	9%	9%	42%	45%	45%	41%
	% of time model streamflow > 600 ft^3/s	April	55%	67%	65%	78%	81%	81%	81%
		May	65%	67%	70%	71%	72%	75%	70%
		June	55%	55%	55%	74%	75%	75%	71%
		July	10%	19%	22%	68%	70%	70%	67%

[1] % of time means the percentage of model produced entries, for the specified month, where the entry was equal to or greater than the criteria for the period of record (the 69 years used in the model). Thus, 50% for this example means that 35 entries (out of 69 possible) met or exceeded the criteria.
[2] ft^3/s is cubic feet per second.

Table B-1.—Detailed summary of impacts to fish, based on hydrology model results (continued)

Fish	Criteria used	Month(s) criteria applied	Pre-Title XII	Alternative					
				No action	1	2A	2B	2C	3
Juvenile migration Flushing flows from Cle Elum			NO	NO	14,600 acre-feet	14,600 acre-feet	14,600 acre-feet	14,600 acre-feet	14,600 acre-feet
Spawning (spring chinook):									
Yakima River at Martin	% of time incubation/ spawning model streamflow > 50%		75%	67%	71%	63%	67%	72%	58%
Yakima River at Easton			78%	72%	67%	51%	67%	74%	52%
Cle Elum river at Roslyn			71%	74%	70%	74%	72%	74%	71%
Spawning (fall chinook) Yakima River at Prosser	% of time model streamflow > 1,000 ft^3/s	Oct	1%	1%	1%	1%	1%	1%	1%
		Nov	32%	29%	29%	28%	26%	28%	28%
	% of time model streamflow > 550 ft^3/s	Oct	3%	17%	20%	70%	71%	71%	68%
		Nov	42%	41%	38%	36%	36%	38%	39%
	% of time model streamflow 450-1,700 ft^3/s	Oct	3%	42%	45%	70%	71%	70%	68%
		Nov	36%	35%	36%	31%	34^	35%	34%
Rearing:									
Yakima River in Parker Reach	% of IFIM-determined model streamflow	July	66%	77%	78%	100%	106%	111%	99%
		Aug	38%	53%	54%	78%	82%	84%	77%
		Sept	38%	53%	54%	78%	82%	84%	77%
		Oct	68%	73%	74%	89%	96^	101%	89%
Yakima River in Pomona Reach	% of time model streamflow is between 400 and 2,000 ft^3/s	Sept	16%	6%	7%	7%	4%	1%	9%
		Oct	65%	57%	52%	28%	23%	20%	30%

Table B-1.—Detailed summary of impacts to fish, based on hydrology model results (continued)

Fish	Criteria used	Month(s) criteria applied	Pre-Title XII	Alternative					
				No action	1	2A	2B	2C	3
Resident Fisheries									
Reservoir fish									
Rimrock Lake	Average content	Sept	52,700 acre-feet	46,300 acre-feet	47,100 acre-feet	43,900 acre-feet	48,000 acre-feet	51,200 acre-feet	42,900 acre-feet
Rimrock Lake over 30,000 acre-feet	% of time content > 30,000 acre-feet	Oct	60%	60%	60%	60%	60%	60%	60%
Rainbow trout	Flow changes at Umtanum	July	3,349 ft^3/s	3,414 ft^3/s	3,444 ft^3/s	3,466 ft^3/s	3,389 ft^3/s	3,323 ft^3/s	3,432 ft^3/s

Appendix C

SOCIOECONOMICS

Table C-1.—Population for cities, towns, and counties in the Yakima River Basin from 1940 to 1990

County and incorporated area	1940	1950	1960	1970	1980	1990
Benton County	**12,053**	**51,370**	**62,070**	**67,540**	**109,444**	**112,560**
Benton City	NA	863	1,210	1,070	2,087	1,806
Kennewick	1,918	10,106	14,244	15,212	34,397	42,152
Prosser	1,719	2,636	2,763	2,954	4,049	4,476
Richland	247	21,809	23,548	26,290	33,578	32,315
West Richland	NA	NA	1,347	1,107	2,938	3,962
Kittitas County	**20,230**	**22,235**	**20,467**	**25,039**	**24,877**	**26,725**
Cle Elum	2,230	2,206	1,816	1,725	1,773	1,778
Ellensburg	5,944	8,430	8,625	13,568	11,755	12,361
Kittitas	501	586	536	637	853	843
Roslyn	NA	NA	NA	NA	938	869
So. Cle Elum	340	442	383	374	449	457
Yakima County	**99,019**	**155,723**	**145,112**	**144,971**	**172,508**	**188,823**
Grandview	1,449	2,503	3,336	3,605	5,615	7,169
Granger	752	1,164	1,424	1,567	1,812	2,053
Harrah	NA	297	284	305	343	352
Mabton	485	831	958	926	1,248	1,482
Moxee City	335	543	499	600	687	825
Naches	536	633	680	666	655	596
Selah	1,130	2,489	2,824	3,311	4,500	5,113
Sunnyside	2,368	4,194	6,208	6,751	9,225	11,238
Tieton	NA	620	479	415	528	693
Toppenish	3,683	5,265	5,667	5,744	6,517	7,419
Union Gap	976	1,766	2,100	2,040	3,184	3,210
Wapato	1,483	3,185	3,137	2,841	3,307	3,795
Yakima	27,221	38,486	43,284	45,588	49,826	54,827
Zillah	803	911	1,059	1,138	1,599	1,911

Appendix D

ENVIRONMENTAL COMMITMENTS

Environmental Commitments

1. Reclamation will comply with environmental statutes when undertaking future site-specific Federal actions which may be tiered from this programmatic environmental impact statement, including the following:

National Environmental Policy Act of 1969
Regulations of the Council on Environmental Quality
Endangered Species Act Section 7
Fish and Wildlife Coordination Act
National Historic Preservation Act
Clean Water Act
Farmland Protection Policy Act
Protection of Indian Trust Assets, taking into consideration all applicable laws, rules, regulations, and Executive orders
Executive Order 12898 on Environmental Justice in Minority Populations and Low-Income Populations
Executive Order 13007 on Indian Sacred Sites
Executive Order 11988 on Floodplain Management
Executive Order 11990 on Protection of Wetlands

2. Reclamation supports the National Wetland Policy, which mandates no net loss of wetlands as a result of any Federal action. As such, Reclamation will take an active role in working with the State and local organizations, other Federal agencies, and the Yakama Indian Nation to identify environmental and other current needs for conserved water, including instream flows for fish and wildlife, environmental restoration, wetlands conservation, etc.

3. As a matter of policy, Reclamation attempts to avoid impacts to *National Register of Historic Places* eligible properties, traditional cultural properties, and paleontological resources; however, proposed projects could adversely affect prehistoric and historic period archeological sites and historical engineering structures. If mitigation of adverse impacts is needed, it would be completed before the start of construction and/or operational changes that would adversely affect significant cultural resources. Cultural resources planning will be completed prior to construction in compliance with the regulations of the Advisory Council on Historic Preservation, 36 CFR Part 800.

4. Reclamation encourages monitoring streamflows in the upper basin and in areas critical to salmon to document improvements in fish production and to identify unanticipated results.

5. Reclamation has initiated or will initiate compliance with the following specific recommendations provided by the U.S. Fish and Wildlife Service as part of the October 3, 1996, Fish and Wildlife Coordination Report for the project:

- Any construction efforts that may affect aquatic resources need to be conducted to prevent any adverse impacts to anadromous and resident fish.

- Opportunities to reduce the introduction of sediments and contaminants into the aquatic system need to be encouraged in the development of the Basin Conservation Program water conservation plans, Yakama Indian Nation projects, and any of the tributary programs.

- Mitigate for any flow changes attributable to implementing Title XII elements which may reduce the effectiveness of fish passage structures and screens.

- Continue efforts to moderate flow fluctuations in the regulated reaches of the river system by adopting more gradual ramping rates.

- Establish an accurate water measurement and accounting system to ensure maximum benefits to fish and wildlife resources.

- Develop a canal/drain right-of-way management plan to improve wildlife habitat associated with irrigation facilities. The management plan should include such things as eliminating, minimizing, and/or better managing mowing, spraying, burning, and grazing; establishing grass cover; and, where possible, maintaining tree and shrub cover along disturbed rights-of-way.

- To improve riparian and wetland habitats, grazed areas along the Yakima River and its tributaries, reservoirs, and wetlands should be fenced to exclude or manage the intensity and timing of livestock grazing.

- Any areas disturbed by future construction of the various project elements need to be revegetated with native vegetation. Plants removed during construction should be replaced with the same or similar species as soon as possible following construction.

- Trees affected by the 3-foot Cle Elum Lake pool rise will not be removed. These trees will die and become snags valuable for perching, feeding, and nesting sites.

- The selection and siting of borrow areas, spoil sites, construction staging areas, etc., need to be analyzed to avoid or minimize impacts to important fish and wildlife habitats.

- Big game protection measures should be installed on existing canals which have been identified as having the potential to trap animals. Fences, bridges, ladders, ramps, and deflectors could be used to prevent trapping or to facilitate escape from the canals. In the future, if canals are modified for water conservation (for example, lining with cement), then fences, bridges, ladders, ramps, and/or deflectors should be incorporated into the construction specifications to prevent the trapping of animals or to facilitate their escape from the canals.

- As an alternative to riprapping, bioengineering techniques (live gabions, brush wattling, and/or willow stakes) can and should be used to reduce construction costs, potentially decrease operation and maintenance costs, and enhance riparian habitat where bank stabilization is proposed.

- To help control or reduce the spread of purple loosestrife, Eurasian milfoil, and other non-native weeds in the Yakima River Basin, appropriate vegetation management activities should be implemented. An active program for control of noxious weeds should be established to ensure program activities do not increase weed problems in the Yakima River Basin.

- Fulfill habitat requirements of certain species in conjunction with project operations, construction, or mitigation and enhancement activities by implementing opportunities to benefit threatened and endangered species, neotropical migratory birds, and other species of concern.

- Wetland and riparian habitats adjacent to irrigation facilities and that would be dried up through water conservation measures should receive water directly for maintenance of those habitats.

- Implement wetland mitigation banking to mitigate wetland losses. Mitigation banking is the restoration, creation, enhancement, and, in exceptional circumstances, preservation of wetlands and/or other aquatic resources expressly for the purpose of providing compensatory mitigation in advance of authorized impacts.

- Combining mitigation efforts with ongoing conservation efforts so that such efforts maximize funding efficiency and facilitate a larger and more ecologically sound project. Furthermore, the potential for long-term success of mitigation efforts can be increased. A larger wetland mitigation project in the Yakima River flood plain will provide important flood control, public recreation, and water quality benefits; tie in with existing protected wetland and riparian areas; improve habitat for wildlife which use wetlands; and, perhaps, benefit anadromous fish by providing rearing areas, reducing water temperatures through shading, and increasing invertebrate production.

- Mitigation activities should not be confined to Reclamation project lands. If mitigation opportunities are better on other lands, then interagency agreements, easements, fee title acquisition, or other mechanisms to accomplish this mitigation should be implemented.

- Mitigation measures for unavoidable project impacts need to be determined for each element and presented and fully evaluated before any program-specific construction begins.

- Set up a comprehensive management plan (similar to the interim comprehensive basin operating plan) and an interagency committee to facilitate coordination between various entities involved in Title XII and to guide mitigation and enhancement efforts throughout the Yakima River Basin. A basin-wide coordinated effort is needed to ensure avoidance and minimization of impacts and to ensure that mitigation measures are soundly developed and implemented. Good coordination across the various boundaries (district, Tribal, Federal, State, private, etc.) is needed to maximize the benefits of water conservation measures to irrigation interests and fish and wildlife resources.

Appendix E

FISH AND WILDLIFE COORDINATION

APR 12 1996

OFFICIAL FILE CO

DATE	SURNAME	CO
4/11		
		LOC

UCA-1607
ENV-4.00

National Marine Fisheries Service
Environmental and Technical Services Division
Attention: Jacqueline Wyland, Chief
525 N.E. Oregon St. Suite 500
Portland, OR 97232

Subject: Request for List of Threatened and Endangered Species for the Yakima River Basin Water Enhancement Project (YRBWEP)

Dear Ms.Wyland:

The Bureau of Reclamation (Reclamation) intends to prepare a Programmatic Environmental Impact Statement (PEIS) for implementing provisions of the legislation authorizing the Yakima River Basin Water Enhancement Project (YRBWEP) under Title XII of the Act of October 31, 1994 (Pub. L. 103-434). The purpose of the YRBWEP is to meet the competing needs for water in the Yakima River basin through improved water conservation and management, and other appropriate means. This may include reducing water diversions by improving conveyance, distribution, and onfarm irrigation facilities; and changing operations, management, and administration of Yakima River basin water. Conserved water would be used to increase instream flows and provide a more stable irrigation supply. The YRBWEP legislation also authorizes actions on the Yakama Indian Reservation to benefit the members of the Yakama Indian Nation.

In accordance with Section 7(c) of the Endangered Species Act of 1973, as amended, Reclamation is requesting information on any listed species or species proposed for listing and any critical habitat that is designated or proposed to be designated, which may occur in the proposed project area. The action presently being considered involves implementing some or all of the provisions of Public Law 103-434. The PEIS will look at two major alternatives, an action alternative implementing the legislation and a no action alternative. The action alternative will be an incremental analysis showing impacts at different levels of implementation of project components. Separate NEPA analyses addressing various alternatives will be conducted for site specific actions not covered in sufficient detail in the PEIS.

The general location of the project is shown on the attached location map. A brief description of the proposed action is also attached for your information. Should you require additional information, please contact Mr. David J. Kaumheimer at 509-575-5848 ext. 232.

Sincerely,

David J. Kaumheimer, Manager
Environmental Programs

Enclosures (2)

bc: D-8210, D-8650, PN-6519, UCA-1202
(w/o attachments to each)

WBR:JTiedeman:jr:04-11-96:(509) 575-5848
(T&ESPNMF.YRB)

PROJECT DESCRIPTION

Federal involvement in the Yakima River basin began in 1905 with authorization of the first facilities of the Yakima Project. The Yakima Project now consists of seven divisions: A storage division consisting of seven reservoirs and six water service divisions with separate diversion, conveyance, and distribution facilities.

Congress first authorized a study of the Yakima River Basin Enhancement Project (YRBWEP) in 1979. Phase one of the YRBWEP was implemented in 1984 when Congress authorized the Secretary of the Interior, through Reclamation, to construct fish passage and protective facilities in the Yakima River basin. The work was performed in partnership with the Bonneville Power Administration, the State of Washington, and others under the auspices of the Fish and Wildlife Program of the Northwest Power Planning Council.

A Columbia River Basin Fish and Wildlife Program adopted by the Northwest Power Planning Council in 1982 identified the Yakima River basin as one of the areas with the greatest potential for the production of salmon and steelhead. With the existing project facilities and operational requirements, maintaining a stable irrigation water supply and instream flows for the maintenance and enhancement of salmon and steelhead in the Yakima River basin is difficult to achieve.

In dry years, the water supply available is allocated among the water users pursuant to entitlements set forth in a Federal District Court Judgment of January 31, 1945 (1945 Consent Decree). The 1945 Consent Decree requires reductions in the water supply available to junior water right holders before any reductions to senior right holders. Additionally, a Federal Court directive on November 28, 1980, requiring Reclamation to make releases from Yakima Project reservoirs to assure adequate instream flows for anadromous fish spawning and rearing further reduces the reliability of irrigation water supplies.

Title XII of the Act of October 31, 1994 (Public Law 103-434), authorized Phase 2 of the YRBWEP and is designed to meet the needs of improved water conservation and management and other appropriate means. As a result of the legislation, a Programmatic Environmental Impact Statement (PEIS) will be developed to evaluate the environmental impacts of implementing Title XII and centers on the Yakima River Basin Water Conservation Program (Basin Conservation Program) as a means of improving water supplies for fish and wildlife and irrigated agriculture.

YRBWEP legislation established the Basin Conservation Program which is central to balancing the competing demands on the basin's water supply. This voluntary program will reduce demands on the available water supply by promoting conservation measures to improve the efficiency of water delivery and use, instream flows for fish and wildlife, and the reliability of irrigation water supplies.

The actual measures that will be adopted depend on the preparation of water conservation plans detailing what can be done. The PEIS will serve as an umbrella document to ensure that the interaction and cumulative effects of all activities proposed for implementation under Title XII of the Act, are addressed. The provisions and measures for the legislation will set the limits on activities to be evaluated in the PEIS. Cost effectiveness will be considered and separate NEPA compliance will be completed when recommending water conservation actions

for implementation. The water conservation measures will occur in steps over a period of years providing the opportunity to monitor, evaluate, and adjust subsequent measures.

The legislation was developed by a consortium of local, tribal, State, and Federal entities involved with water resource activities in the basin and is the result of a consensus building effort to structure an acceptable, comprehensive approach to the basin's water problems. An extensive scoping effort will be conducted by mail along with public scoping sessions which will be scheduled at a later date.

The emphasis of Title XII is on water conservation, therefore, alternative measures such as construction of additional storage facilities or changes in water entitlements and rights not specifically authorized by Title XII will not be considered within the scope of this PEIS. The timing of some of the proposed actions, as mandated by Title XII, may require the preparation of a NEPA compliance document before the PEIS is completed. This will be treated on a case-by-case basis with separate NEPA documents prepared as necessary.

Specific items to be address under this PEIS are:

Item: Basin Conservation Program

Action #1: Implementation of structural and nonstructural water conservation measures to realize by the end of the eighth year of the program 110,000 acre-feet to protect and enhance fish and wildlife resources and 55,000 acre-feet for availability for irrigation.

Action #2: Initial acquisition of water from willing sellers or lessors to provide instream flows for interim periods for flushing of anadromous smolts.

Action #3: Preparation by the Conservation Advisory Group of a Basin Conservation Plan concerning the structure and administration of the Basin Conservation Program and the plan for implementing water conservation measures. The Basin Conservation Plan will also be used for preparing the Interim Comprehensive Basin Operating Plan.

Item: Project Operations

Action #1: Change in the project operational regime for the period of April through September equating total water supply available to "initial" instream target flows to be maintained at Sunnyside and Prosser Diversion Dams. "Initial" target flows over Sunnyside and Prosser Diversion Dams are determined by the total water supply available at specific points in time.

Action #2: Increase the "initial" instream flows levels by an additional 200 cfs at Sunnyside and Prosser Diversion Dams by the reduction of diversion demands resulting from measures implemented through the Basin Conservation Program. *[The water savings of 110,000 cfs roughly equates to 300 cfs in additional instream flows above the "initial" target.]*

Action #3: Preparation of reports on (1) the adequacy of the irrigation water supply to sustain the agricultural economy of the Yakima River basin, and (2) an evaluation of what is necessary to have biologically-based instream target flows.

Item: Cle Elum Dam and Lake

Action #1: Modification of the radial gates to provide 14,600 acre-feet of additional storage capacity to be used for instream flow purposes.
Action #2: Provide for shoreline protection.
Action #3: Construction of a fish passage facility to permit the migration of spring chinook and steelhead.

Item: Tributaries

Action #1: Implementation of nonstorage measures to enhance flows in Taneum Creek for fish, wildlife, and irrigation purposes. *[Note: Implementation is contingent upon completion of a feasibility study, submittal of a report by the Secretary of Interior to Congress and the State, and agreements with appropriate water right owners.]*
Action #2: Water supply enhancement opportunities in other tributaries.

Item: Chandler Pumping Plant and Powerplant

Action #1: Replacement of both or either of the hydraulic turbines with electric motors or construction of a new electric pumping station. This action is to eliminate or reduce diversions now required to operate the hydraulic turbines. The reduced diversions are to remain in the river for instream flow purposes.
Action #2: Subordination of diversions for hydroelectric generation to meet instream target flows over Prosser Diversion Dam.
Action #3: Construction of automated control structures on Chandler Power Canal.

Item: Augmentation of Kachess Reservoir Stored Water

Action #1: Construction of diversion facilities on Cabin and Silver Creeks and pipelines to convey excess flows for storage in Kachess Reservoir. The stored water resulting from this action will be used to enhance the water supply available to the Kittitas Reclamation District and the Roza Irrigation District and to facilitate reservoir operations in the Easton Dam to Keechelus Dam reach of the Yakima River for anadromous fish. *[Note: Implementation is contingent on completion of a feasibility study and an agreement with the two districts for "up-front" payment of the construction costs allocated to irrigation.]*
Action #2: Modifications in the Kachess Reservoir area to expedite the discharge of water at reduced reservoir levels.

Item: Yakama Indian Nation

Action #1: Improvements to the Wapato Irrigation Project with water savings resulting from such improvements to be available for the use of the Yakama Indian Nation for irrigation and other purposes on the reservation and for protection and enhancement of fish and wildlife within the Yakima River basin.
Action #2: Construction and operation of an irrigation demonstration project on the Yakama Indian Reservation.

Action #3: Implementation of a Toppenish Creek Corridor Enhancement Project demonstrating the integration of management of agricultural, fish, wildlife, and cultural resources to meet tribal objectives.

Item: Interim Comprehensive Basin Operating Plan

Action #1: Development of an interim comprehensive operating plan providing a general framework within which the Yakima Project is operated. *[Note: Section 1210 of the legislation requires that a draft plan be developed within 18 months of completing the Basin Conservation Plan which is due within 2-1/2 years of the date the law was enacted.]*

United States Department of the Interior

BUREAU OF RECLAMATION
Upper Columbia Area Office
1917 Marsh Road
P.O. Box 1749
Yakima, Washington 98907-1749

TAKE PRIDE IN AMERICA

EPLY REFER TO:

UCA-1607
ENV-4.00

APR 12 1996

OFFICIAL FILE

DATE	SURNAME

MEMORANDUM

To: Field Supervisor, Fish and Wildlife Service, Upper Columbia River Basin Field Office, 11103 E. Montgomery Drive, Suite 2, Spokane, Washington, 99206

From: Environmental Programs Manager, Bureau of Reclamation, Upper Columbia Area Office, Yakima, Washington

Subject: Request for List of Threatened and Endangered Species for the Yakima River Basin Water Enhancement Project (YRBWEP)

p
The Bureau of Reclamation (Reclamation) intends to prepare a Programmatic Environmental Impact Statement (PEIS) for implementing provisions of the legislation authorizing the Yakima River Basin Water Enhancement Project (YRBWEP) under Title XII of the Act of October 31, 1994 (Pub. L. 103-434). The purpose of the YRBWEP is to meet the competing needs for water in the Yakima River basin through improved water conservation and management, and other appropriate means. This may include reducing water diversions by improving conveyance, distribution, and onfarm irrigation facilities; and changing operations, management, and administration of Yakima River basin water. Conserved water would be used to increase instream flows and provide a more stable irrigation supply. The YRBWEP legislation also authorizes actions on the Yakama Indian Reservation to benefit the members of the Yakama Indian Nation.

In accordance with Section 7(c) of the Endangered Species Act of 1973, as amended, Reclamation is requesting information on any listed species or species proposed for listing and any critical habitat that is designated or proposed to be designated, which may occur in the proposed project area. The action presently being considered involves implementing some or all of the provisions of Public Law 103-434. The PEIS will look at two major alternatives, an action alternative implementing the legislation and a no action alternative. The action alternative will be an incremental analysis showing impacts at different levels of implementation of project components. Separate NEPA analyses addressing various alternatives will be conducted for site specific actions not covered in sufficient detail in the PEIS.

The general location of the project is shown on the attached location map. A brief description of the proposed action is also attached for your information. Should you require additional information, please contact Mr. David J. Kaumheimer at 509-575-5848 ext. 232.

Attachments (2)

oc: D-8210, D-8650, PN-6519, UCA-1202
(w/o attachments to each)

VBR:JTiedeman:jr:04-11-96:(509) 575-5848
(T&ESPFWS.YRB)

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Upper Columbia River Basin Field Office
11103 E. Montgomery Drive, Suite #2
Spokane, WA 99206

29
April 29
Yakima, WA

April 16, 1996

David J. Kaumheimer
Upper Columbia Area Office
Bureau of Reclamation
PO Box 1749
Yakima, WA 98907

FWS Reference: 1-9-96-SP-143 (1355.4000)

Dear Mr. Kaumheimer:

Thank you for your request of April 12, 1996. Enclosed is a list of listed threatened and endangered species, candidate species and species of concern (Enclosure A), that may be present within the area of the proposed Yakima River Basin Water Enhancement Project in Benton, Yakima and Kittitas Counties, Washington. The list fulfills the requirements of the Fish and Wildlife Service (Service) under Section 7(c) of the Endangered Species Act of 1973, as amended (Act). We have also enclosed a copy of the requirements for Bureau of Reclamation (BR) compliance under the Act (Enclosure B).

Should the biological assessment determine that a listed species is likely to be affected (adversely or beneficially) by the project, the (BR) should request Section 7 consultation through this office. If the biological assessment determines that the proposed action is "not likely to adversely affect" a listed species, the (BR) should request Service concurrence with that determination through the informal consultation process. Even if the biological assessment shows a "no effect" situation, we would appreciate receiving a copy for our information.

Candidate species are included simply as advance notice to federal agencies of species which may be proposed and listed in the future. However, protection provided to candidate species now may preclude possible listing in the future. If early evaluation of your project indicates that it is likely to adversely impact a candidate species, the (BR) may wish to request technical assistance from this office.

The Service has revised its list of candidate species, published in the February 28, 1996, Federal Register. Under the new

system, only those species for which the Service has enough information to support a listing proposal will be called "candidates". The list of candidates comprises some of the former Category 1 species. The other Category 1 species and the former Category 2 species remain as species of concern to the Service. The Service anticipates that Federal agencies will remain committed to the concept of addressing conservation needs of both the current list of candidate species and other species of concern. For your information, we have included a list of the species of concern that may occur in the vicinity of your project.

There may be other federally listed species that may occur in the vicinity of your project which are under the jurisdiction of the National Marine Fisheries Service (NMFS). Please contact NMFS at (503) 230-5430 to request a species list.

In addition, please be advised that federal and state regulations may require permits in areas where wetlands are identified. You should contact the Seattle District of the U.S. Army Corps of Engineers for federal permit requirements and the Washington State Department of Ecology for state permit requirements.

Thank you for your efforts to protect our threatened species. If you have additional questions regarding your responsibilities under the Act, please contact Linda Hallock or Michelle Eames of this office at 509-921-0160.

Sincerely,

Robert L Hallock

for Philip Laumeyer
Field Supervisor

Enclosures

FWS 1-9-96-SP-143

ENCLOSURE A

LISTED AND PROPOSED ENDANGERED AND THREATENED SPECIES, CANDIDATE SPECIES AND SPECIES OF CONCERN WHICH MAY OCCUR IN THE VICINITY OF THE BUREAU OF RECLAMATION YAKIMA RIVER BASIN WATER ENHANCEMENT PROJECT BENTON, KITTITAS AND YAKIMA COUNTIES, WASHINGTON T7-20N R11-31E WM

FWS Reference: 1-9-96-SP-143

LISTED

Bald eagle *(Haliaeetus leucocephalus)*- wintering bald eagles may be in the vicinity from November 1 through March 31. Winter concentrations or communal roosts are known in T12N R28E S10, T13N R26E S6, T13N R27E S23, T14N R26E S14, T14N R27E S29 & T17N R18E S25.

Nesting bald eagles may occur in the vicinity from about January 15 through August 15. Nest sites are known in T13N R13E S7, T13N R27E S9 & 10, T14N R27E S29 & T21N R14E S8.

Gray wolf *(Canis lupus)* - may occur in the vicinity

Grizzly bear *(Ursus arctos = U.a. horribilis)* - may occur in the vicinity

Marbled murrelet *(Brachyramphus marmoratus marmoratus)* - may occur in the vicinity

Northern spotted owl *(Strix occidentalis caurina)*- may occur in the vicinity

Peregrine falcon *(Falco peregrinus)*- may occur in the vicinity

Major concerns that should be addressed in your biological assessment of project impacts to these listed species are:

1. Level of use of the project area by listed species.

2. Effect of the project on listed species' primary food stocks and foraging areas in all areas influenced by the project.

3. Impacts from project construction and implementation (e.g. increased noise levels, increased human activity and/or access, loss or degradation of habitat) which may result in disturbance to listed species and/or their avoidance of the project area.

DESIGNATED

Critical habitat for the northern spotted owl

PROPOSED

None

CANDIDATE

The following candidate species may occur in the vicinity:

Bull trout *(Salvelinus confluentus)*

Erigeron basalticus (basalt daisy)- is reported in
T14N R19E T15N R19E T16N R19E

Sidalcea oregana var. *calva* (Oregon checkermallow)- is reported in
T18N R15E T20N R21E T21N R19E

SPECIES OF CONCERN

The following species of concern to the US Fish and Wildlife Service may occur in the vicinity:

<u>Animals</u>

Black tern *(Chlidonias niger)*
California bighorn sheep *(Ovis canadensis californiana)*
California floater (mussel) *(Anodonta californiensis* (Lea, 1852))
California wolverine *(Gulo gulo luteus)*
Cascades frog *(Rana cascadae)*
Columbia pebblesnail *(Fluminicola (=Lithoglyphus) columbianus* (Hemphill in Pilsbry, 1899)) [great Columbia River spire snail]
Ferruginous hawk *(Buteo regalis)*
Fringed myotis (bat) *(Myotis thysanodes)*
Harlequin duck *(Histrionicus histrionicus)*
Larch Mountain salamander *(Plethodon larselli)*
Little willow flycatcher *(Empidonax traillii brewsteri)*
Loggerhead shrike *(Lanius ludovicianus)*
Long-eared myotis (bat) *(Myotis evotis)*
Long-legged myotis (bat) *(Myotis volans)*
Lynn's clubtail (dragonfly) *(Gomphus lynnae)*
Margined sculpin *(Cottus marginatus)*
Northern goshawk *(Accipiter gentilis)*
Northern sagebrush lizard *(Sceloporus graciosus graciosus)*
Olive-sided flycatcher *(Contopus borealis)*
Pacific fisher *(Martes pennanti pacifica)*
Pacific lamprey *(Lampetra tridentata)*
Pale Townsend's (= western) big-eared bat *(Plecotus townsendii pallescens)*
River lamprey *(Lampetra ayresi)*
Small-footed myotis (bat) *(Myotis ciliolabrum)*
Spotted frog *(Rana pretiosa)*
Tailed frog *(Ascaphus truei)*

Western burrowing owl *(Athene cunicularia hypugea)*
Westslope cutthroat trout *(Oncorhynchus (= Salmo) clarki lewisi)*
Yuma myotis (bat) *(Myotis yumanensis)*

Plants

Astragalus columbianus (Columbia milk-vetch)- is reported in
T12N R23E T12N R24E T13N R23E T14N R22E
T14N R23E T15N R22E T15N R23E T16N R22E
T16N R23E T17N R22E

Calochortus longebarbatus var. *longebarbatus* (Long-haired star-tulip)- is reported in
T7N R16E T7N R17E T8N R16E T8N R18E T9N R15E
T9N R16E

Castilleja cryptantha (obscure Indian paintbrush)- is reported in
T16N R11E

Cypripedium fasciculatum (clustered lady's-slipper)- is reported in
T21N R14E T21N R17E T22N R15E

Delphinium viridescens (Wenatchee larkspur)- is reported in
T21N R18E

Lomatium tuberosum (Hoover's desert-parsley)- is reported in
T10N R15E T10N R17E T13N R23E T14N R19E
T15N R19E T16N R18E T16N R19E T17N R21E

Rorippa columbiae (Columbia yellow-cress)- is reported in
T10N R28E T11N R28E

Silene seelyi (Seely's silene)- is reported in
T22N R16E

Tauschia hooveri (Hoover's tauschia)- is reported in
T9N R16E T9N R17E T10N R15E T10N R16E
T10N R17E T12N R15E T12N R16N T13N R16-18
T13N R20E T13N R21E T14N R17E T14N R18E
T15N R19E T17N R20E T17N R21E T18N R20E

ENCLOSURE B

FEDERAL AGENCIES' RESPONSIBILITIES UNDER SECTIONS 7(a) AND 7(c) OF THE ENDANGERED SPECIES ACT OF 1973, AS AMENDED

SECTION 7(a) - Consultation/Conference

Requires:

1. Federal agencies to utilize their authorities to carry out programs to conserve endangered and threatened species;

2. Consultation with FWS when a Federal action may affect a listed endangered or threatened species to ensure that any action authorized, funded, or carried out by a Federal agency is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. The process is initiated by the Federal agency after it has determined that its action may affect (adversely or beneficially) a listed species; and

3. Conference with FWS when a Federal action is likely to jeopardize the continued existence of a proposed species or result in destruction or adverse modification of proposed critical habitat.

SECTION 7(c) - Biological Assessment for Construction Projects[1]

Requires Federal agencies or their designees to prepare a Biological Assessment (BA) for major construction projects. The BA analyzes the effects of the action, including indirect effects and effects of interrelated or interdepenent actions, on listed and proposed species. The process is initiated by a Federal agency requesting a list of proposed and listed threatened and endangered species. The BA should be completed within 180 days of initiation, or a time period that is mutually agreeable. If the BA is not initiated within 90 days of receipt of the species list, the current accuracy of the list must be verified with the FWS. No irreversible commitment of resources is to be made during the BA process which would foreclose reasonable and prudent alternatives to protect the species. Planning, design, and administrative actions may be taken; however; no construction may begin.

To complete the BA, your agency or its designee should: (1) conduct an onsite inspection of the area to be affected by the proposal, which may include a detailed survey of the area to determine if the species is present and whether suitable habitat exists; (2) review literature and scientific data to determine species distribution, habitat needs, and other biological requirements; (3) interview experts including those within the FWS, state conservation department, universities, and others who may have data not yet published in scientific literature; (4) review and analyze the effects of the proposal on the species in terms of individuals and populations, including consideration of cumulative effects of the proposal on the species and its habitat; (5) analyze alternative actions that may provide conservation measures; and (6) prepare a report documenting the results, including a discussion of study methods used, any problems encountered, and other relevant information. The completed BA should be forwarded to this office.

1." Major construction project" means any major federal action which significantly affects the quality of the human environment (requiring an EIS), designed primarily to result in the building or erection of human-made structures such as dams, buildings, roads, pipelines, channels, and the like. This includes federal action such as permits, grants, licenses, or other forms of federal authorization or approval which may result in construction.

29
APRIL 29
Yakima, Washington

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
ENVIRONMENTAL & TECHNICAL SERVICES DIVISION
525 NE Oregon Street
PORTLAND, OREGON 97232-2737

APR 2 4 1996

F/NWO3

Mr. Dave J. Kaumheimer
Bureau of Reclamation
1917 Marsh Road
P.O. Box 1749
Yakima, Washington 98907-1749

Re: Species List Request for the Yakima River Basin Water Enhancement Project in Central Washington

Dear Mr. Kaumheimer:

The National Marine Fisheries Service (NMFS) has reviewed your April 12, 1996, letter to Jacqueline Wyland requesting a list of threatened and endangered species for the Yakima River Basin Water Enhancement Project in Central Washington.

We have enclosed lists of those anadromous fish species that are listed as endangered or threatened under the Endangered Species Act (ESA), those that are proposed for listing, and those that are candidates for listing. This inventory includes only anadromous species under NMFS' jurisdiction that occur in the Pacific Northwest. The U.S. Fish and Wildlife Service should be contacted regarding the presence of species falling under its jurisdiction.

Available information indicates that three of the anadromous fish species listed under the ESA are known to be downstream of the proposed action area. The species are Snake River sockeye salmon (*Oncorhynchus nerka*), Snake River spring/summer chinook salmon (*O. tshawytscha*), and Snake River fall chinook salmon (*O. tshawytscha*). The designated critical habitat for the listed species (December 28, 1993, 58 FR 68543) does not include the proposed project area.

Two of the seven anadromous fish species that are presently candidates for listing under the ESA are known to be present in the proposed action area; these species are steelhead (*O. mykiss*), and chinook salmon (*O. tshawytscha*). It is important to note that candidates for listing have no status under the ESA. Once a candidate is proposed for listing, or is listed, a conference or consultation may be required.

Please refer to the ESA section 7 implementing regulations, 50 CFR Part 402, for information on the conference and consultation process.

This letter constitutes the required notification of the presence of any Federally listed threatened or endangered species or critical habitat under NMFS' jurisdiction in the permit area that may be affected by the proposed project (Appendix A to Part 330, Section C.13(5)(i)). If you have further questions, please contact Ben Meyer of my staff at (503) 230-5506.

Sincerely,

Elizabeth Holmes Gaar
Habitat Branch Chief

Enclosure

ENDANGERED, THREATENED, PROPOSED AND CANDIDATE SPECIES
UNDER NATIONAL MARINE FISHERIES SERVICE JURISDICTION
THAT OCCUR IN THE PACIFIC NORTHWEST

Listed Species

Snake River Sockeye Salmon	*Oncorhynchus nerka*
Snake River Fall Chinook Salmon	*Oncorhynchus tshawytscha*
Snake River Spring/Summer Chinook Salmon	*Oncorhynchus tshawytscha*

Proposed for Listing

Umpqua River Sea-run Cutthroat Trout	*Oncorhynchus clarki clarki*
Klamath Mountains Province Steelhead	*Oncorhynchus mykiss*
Central California Coastal Coho Salmon	*Oncorhynchus kisutch*
S. Oregon/N. California Coho Salmon	*Oncorhynchus kisutch*
Oregon Coastal Coho Salmon	*Oncorhynchus kisutch*

Candidates for Listing
(all Northwest stocks of the following except coho)

Chinook Salmon	*Oncorhynchus tshawytscha*
Pink Salmon	*Oncorhynchus gorbuscha*
Chum Salmon	*Oncorhynchus keta*
Sockeye Salmon	*Oncorhynchus nerka*
Sea-run Cutthroat Trout	*Oncorhynchus clarki clarki*
Steelhead	*Oncorhynchus mykiss*
Lower Columbia River/SW Washington Coastal Coho Salmon	*Oncorhynchus kisutch*
Puget Sound/Strait of Georgia Coastal Coho Salmon	*Oncorhynchus kisutch*

United States Department of the Interior

BUREAU OF RECLAMATION
Upper Columbia Area Office
1917 Marsh Road
P.O. Box 1749
Yakima, Washington 98907-1749

OFFICIAL FILE

DATE	SURNAME	C
ACTING 12/6	Tiedeman	

IN REPLY REFER TO:
UCA-1607
ENV-4.00

December 6, 1996

MEMORANDUM

To: Fish and Wildlife Service, P.O. Box 1157, Moses Lake, WA 98837
Attn: Mr. Don Haley

From: Environmental Programs Manager, Bureau of Reclamation, Upper Columbia Area Office, Yakima, WA

Subject: Request for Concurrence - Section 7 of the Endangered Species Act (Act) - Biological Evaluation - Yakima River Basin Water Enhancement Project (YRBWEP)

In accordance with the requirements of Section 7 of the Act, Reclamation is providing you a Biological Evaluation for the subject project. This is in reference to your letter dated April 16, 1996, transmitting a list of threatened and endangered species (#1-9-96-SP-143).

Please review this document with our determination that implementation of Title XII will have no affect on threatened and endangered species or critical habitat.

Background

In 1979, Congress authorized an Enhancement Project study to address the needs within the Yakima River basin. Phase I of the Enhancement Project was initiated in 1984 and consisted of the construction of fish passage and protection facilities. Phase II of the Enhancement Project was recently authorized under Title XII of the Act of October 31, 1994, Public Law 03-434 (Title XII). Title XII centers on a voluntary cost-shared Yakima River Basin Water Conservation Program (Basin Conservation Program) to reduce irrigation demands on the available water supply. In addition, other measures providing for the modification of project facilities, water conservation and management on the Yakama Indian Reservation, water leasing and purchasing, and enhancement of tributary water supplies are authorized.

Reclamation is currently evaluating the various elements of Title XII in a Programmatic Environmental Impact Statement (PEIS). The PEIS is an umbrella document in which a diverse list of issues are analyzed in very broad terms with respect to individual and cumulative environmental effects of the various Title XII elements. The purpose of the PEIS evaluation is to decide which Title XII elements Reclamation will further consider for implementation. Alternatives, as described below, will be considered in the PEIS with a goal of identifying a preferred alternative. A decision document called a Record of Decision (or ROD) will likely be issued after all alternatives have been examined and a preferred alternative selected. The actual implementation of individual actions outlined in Title XII and selected for further evaluation in the PEIS will be addressed in future environmental documents on a site-specific basis.

AREA COVERED BY THE EVALUATION

This document addresses those listed species which may occur within the geographic area of the PEIS (see attached location map).

The Yakima River, a tributary to the Columbia River, drains an area of about 6,000 square miles and originates high on the eastern slopes of the central Cascade Mountains east of Seattle. The Yakima River flows for about 200 miles southeast to its confluence with the Columbia River near Richland, Washington. The terrain in the upper basin is rugged, and altitudes range up to 8,200 feet in the Cascade Range. The lower valley, located downstream from the city of Yakima, is much flatter, and altitudes reach only a few hundred feet. The Naches River, the primary tributary to the Yakima, enters the mainstem of the Yakima River at the City of Yakima. Precipitation in the Yakima basin ranges from about 8 inches annually in the lower and eastern valley to over 100 inches annually in the Cascade Range.

The Yakima River and its tributaries support a variety of water related uses. Among these are three hydropower projects, six Federal storage reservoirs, several diversion dams, and various irrigation canals and pumping plants.

SPECIES CONSIDERED IN THE EVALUATION

Reclamation requested a species list from the U.S. Fish and Wildlife Service (Service) on April 12, 1996.

The Service list (#1-9-96-SP-143) included six animal species; bald eagle (*Haliaeetus leucocephalus*), gray wolf

(*Canis lupus*), grizzly bear (*Ursus arctos horribilis*), marbled murrelet (*Brachyramphus marmoratus marmoratus*), northern spotted owl (*Strix occidentalis caurina*), and peregrine falcon (*Falco peregrinus*). The only designated critical habitat noted in the Service's letter is that for the northern spotted owl.

The Service also listed three plant and animal species as candidate species. They are; Oregon checkermallow (*Sidalcea oregana calva*), basalt daisy (*Erigeron basalticus*), and the bull trout (*Salvelinus confluentus*). Thirty-eight plant and animal species were listed as species of concern. However, since it is not a requirement to analyze candidate species, these species will not be addressed in this evaluation. Reclamation is committed to addressing any conservation needs for species of concern when site specific analysis is conducted.

LIMITATIONS OF THIS EVALUATION

As stated previously, the PEIS is only an umbrella document that will evaluate, at a programmatic level, the impacts associated with the various Title XII elements. The goal of the PEIS process is to identify which elements of Title XII will be further considered for implementation. The PEIS will not provide sufficient environmental evaluation to allow the actual implementation of any particular project or element of the Title XII. If any construction projects are initiated, site-specific compliance will be conducted under Section 7 of the ESA.

DESCRIPTION OF ALTERNATIVES

There are basically two actions presently being proposed; the No Action Alternative, which will serve as the baseline, and implementation of Title XII which is the Preferred Action Alternative. The No Action Alternative assumes that none of the elements of Title XII would be implemented except the operational changes necessary to meet the target flows required by Title XII. Those changes have already been implemented, as required. Within the Preferred Action Alternative, there are three sub-elements: 1) Full implementation of Title XII, 2) Implementation of Title XII minus the Basin Conservation Program, and 3) Implementation of Title XII minus the Tributary Program and the Kachess Reservoir Augmentation. For a more detailed description of the elements, see Attachment 1.

DISTRIBUTION, HABITAT AND POTENTIAL AFFECTS TO LISTED SPECIES OR CRITICAL HABITAT

A description of the distribution of listed species and their habitat and critical habitat for the northern spotted owl, is included as part of Attachment 2. The action being evaluated in this biological evaluation is an administrative action and involves identification, through the PEIS, of Title XII elements that Reclamation will further consider for implementation. Implementation of that administrative action will have no direct or indirect affects on listed species or delineated critical habitat. As noted earlier, actual implementation of any of the Title XII elements considered in the PEIS, will be subject to additional environmental compliance review including additional site-specific Section 7 analysis.

INTERRELATED AND INTERDEPENDENT ACTIONS

In accordance with the definition provided in Section 7 of the ESA, interrelated and interdependent actions are actions that have no independent utility apart from the primary action or are actions that are part of the primary action and dependent upon that primary action for their justification.

The primary action associated with this PEIS is to decide which Title XII elements Reclamation will further consider for implementation. The PEIS will not provide sufficient environmental evaluation to allow implementation of any particular project or element of the Title XII. The actual implementation of individual actions outlined in Title XII and selected for further evaluation in the PEIS will be addressed in future environmental documents, including Section 7 analysis, on a site-specific basis. As such, there are no interrelated or interdependent actions which have no independent utility apart from the primary action being considered here.

DETERMINATION

Reclamation has determined that since this is an administrative action and the purpose of this PEIS is to decide which Title XII elements Reclamation will further consider for implementation, the proposed action would have no effect on threatened and endangered species or critical habitat. Site specific Section 7 analysis will be conducted prior to implementation of any Title XII element.

If you agree with our determination, please provide us with written concurrence.

Attachment 2 incorporates a very general assessment of the impacts implementation of various Title XII elements may have on listed species. It is being developed as part of the PEIS. This assessment is not included as part of the biological evaluation, since the action under consideration simply involves selecting those Title XII elements that will be further considered for implementation. This information is being provided for your review and we would appreciate any comments you may have regarding it.

Should you require additional information, please contact Mr. John Tiedeman at 509-575-5848 ext. 238.

Attachment

John Tiedeman
ACTING ENVIR. PROGRAM MANAGER

bc: D8210, D8650, PN6519
WBR: JTIEDEMAN:jr:12-06-96:(509)575-5848
(BELTRWS.YRB)

United States Department of the Interior

BUREAU OF RECLAMATION
Upper Columbia Area Office
1917 Marsh Road
P.O. Box 1749
Yakima, Washington 98907-1749

IN REPLY REFER TO:
UCA-1607
ENV-4.00

December 6, 1996

OFFICIAL FI

DATE	SURNAM
12/16	DJC

National Marine Fisheries Service
Environmental and Technical Services Division
Attention: Mr. Ben Meyer
525 N.E. Oregon St. Suite 500
Portland, OR 97232

Subject: Request for Concurrence - Section 7 of the Endangered Species Act (Act) - Biological Evaluation - Yakima River Basin Water Enhancement Project (YRBWEP)

Dear Mr. Meyer:

In accordance with the requirements of Section 7 of the Act, Reclamation is providing you a copy of a Biological Evaluation for the subject project. This is in reference to your letter dated April 24, 1996, transmitting a list of threatened and endangered species (#F/NW03).

Please review this document with our determination that implementation of Title XII will have no affect on threatened and endangered species or critical habitat.

Background

In 1979, Congress authorized an Enhancement Project study to address the needs within the Yakima River basin. Phase I of the Enhancement Project was initiated in 1984 and consisted of the construction of fish passage and protection facilities. Phase II of the Enhancement Project was recently authorized under Title XII of the Act of October 31, 1994, Public Law 03-434 (Title XII). Title XII centers on a voluntary cost-shared Yakima River Basin Water Conservation Program (Basin Conservation Program) to reduce irrigation demands on the available water supply. In addition, other measures providing for the modification of project facilities, water conservation and management on the Yakama Indian Reservation, water leasing and purchasing, and enhancement of tributary water supplies are authorized.

Reclamation is currently evaluating the various elements of Title XII in a Programmatic Environmental Impact Statement (PEIS). The PEIS is an umbrella document in which a diverse list of issues are analyzed in very broad terms with respect to individual and cumulative environmental effects of the various Title XII elements. The purpose of the PEIS evaluation is to decide which Title XII elements Reclamation will further consider for implementation. Alternatives, as described below, will be considered in the PEIS with a goal of identifying a preferred alternative. A decision document called a Record of Decision (or ROD) will likely be issued after all alternatives have been examined. The actual implementation of individual actions outlined in Title XII and selected for further evaluation in the PEIS will be addressed in future environmental documents on a site-specific basis.

AREA COVERED BY THE EVALUATION

This document addresses those listed species which may occur within the geographic area of the PEIS (see attached location map).

The Yakima River, a tributary to the Columbia River, drains an area of about 6,000 square miles and originates high on the eastern slopes of the central Cascade Mountains east of Seattle. The Yakima River flows for about 200 miles southeast to its confluence with the Columbia River near Richland, Washington. The terrain in the upper basin is rugged, and altitudes range up to 8,200 feet in the Cascade Range. The lower valley, located downstream from the city of Yakima, is much flatter, and altitudes reach only a few hundred feet. The Naches River, the primary tributary to the Yakima, enters the mainstem of the Yakima River at the City of Yakima. Precipitation in the Yakima basin ranges from about 8 inches annually in the lower and eastern valley to over 100 inches annually in the Cascade Range.

The Yakima River and its tributaries support a variety of water related uses. Among these are three hydropower projects, six Federal storage reservoirs, several diversion dams, and various irrigation canals and pumping plants.

SPECIES CONSIDERED IN THE EVALUATION

Reclamation requested a species list from the National Marine Fisheries Service (NMFS) on April 12, 1996.

The NMFS list (#F/NW03) included three anadromous fish species known to be downstream of the proposed action area;

Snake River sockeye salmon (*Oncorhynchus nerka*), Snake River spring/summer chinook salmon (*O. tshawytscha*), and Snake River fall chinook salmon (*O. tshawytscha*). Critical habitat for the listed species does not include the project area.

Two anadromous fish species are listed as candidate species known to be present in the proposed action area, they are; steelhead (*O. mykiss*) and chinook salmon (*O. tshawytscha*). Seven other candidate fish species were also listed. In July 1996, the NMFS proposed to list 15 Evolutionarily Significant Units (ESU) for western steelhead. As a result of that action, NMFS concluded that ESU Number 13 - the Upper Columbia River unit, which includes the Yakima River Basin, warranted candidate status requiring further consideration due to inconclusive data. The other candidate species, except for chinook salmon, will not be addressed in this evaluation since they are not known to be in the project area. In any case, Reclamation will remain committed to addressing any conservation needs for species of concern when site specific analysis is conducted.

LIMITATIONS OF THIS EVALUATION

As stated previously, the PEIS is only an umbrella document that will evaluate, at a programmatic level, the impacts associated with the various Title XII elements. The goal of the PEIS process is to identify which elements of Title XII will be further considered for implementation. The PEIS will not provide sufficient environmental evaluation to allow the actual implementation of any particular project or element of the Title XII. If any construction projects are initiated, site-specific compliance will be conducted under Section 7 of the ESA.

DESCRIPTION OF ALTERNATIVES

There are basically two actions presently being proposed; the No Action Alternative, which will serve as the baseline, and implementation of Title XII which is the Preferred Action Alternative. The No Action Alternative assumes that none of the elements of Title XII would be implemented except the operational changes necessary to meet the target flows required by Title XII. Those changes have already been implemented, as required. Within the Preferred Action Alternative, there are three sub-elements: 1) Full implementation of Title XII, 2) Implementation of Title XII minus the Basin Conservation Program, and 3) Implementation of Title XII minus the Tributary Program and the Kachess Reservoir Augmentation. For a more detailed description of the elements, see Attachment 1.

DISTRIBUTION, HABITAT AND POTENTIAL AFFECTS TO LISTED SPECIES OR CRITICAL HABITAT

Snake River sockeye salmon (*Oncorhynchus nerka*), **Snake River spring/summer chinook salmon** (*O. tshawytscha*), and **Snake River fall chinook salmon** (*O. tshawytscha*) - Listed Snake River stocks do not occur in the Yakima River Basin. Listed stocks, however, do use the Columbia River, to which the Yakima River is a tributary, as a migration corridor. The NMFS has identified Columbia River flow level as a factor affecting the survival and recovery of the listed stocks. Therefore, discharges from the Yakima River could affect listed stocks by affecting the flow levels in the Columbia River. One of the goals of Title XII is to implement activities which will result in the increase to instream flows in the Yakima River during the spring, summer and fall, when flow levels are also a concern in the Columbia River. If implemented, Title XII may result in increased discharges to the Columbia River during adult and smolt migration periods for listed Snake River stocks. Since the action being considered is to identify those Title XII elements that will be further considered for implementation, the action will have no affect on listed Snake River salmon stocks.

Chinook salmon (*O. tshawytscha*) **(Candidate)** - Like the Snake River fall chinook salmon, historical runs of chinook salmon in the Yakima River are not known but were probably a large part of the total chinook runs. The adult spring chinook run in the Yakima Basin is composed of basically two stocks, the Naches stock and the Upper Yakima stock. Peak upstream passage occurs in May at Prosser Dam, which includes both stocks. The peak at Roza Dam, which includes only Upper Yakima stock, occurs in June (Bryant and Parkhurst, 1950). Currently, the majority of fall chinook in the Yakima River spawn below Prosser Dam and peak passage is complete by late October. As in the Snake River stocks, populations of chinook salmon have decreased over time.

Since the proposed action is an administrative action and the purpose of this PEIS is to decide which Title XII elements, or parts of Title XII, Reclamation will further consider for implementation, selection of either the No Action Alternative or Preferred Action Alternative, including any and all of the sub-elements, will have no effect on chinook salmon. However, when any of the sub-elements of Title XII are analyzed for site specific compliance, it may be inferred that implementation of the No Action Alterative will keep the basin and current water status conditions the same as currently in place. Water resources will be negatively affected by current increases

in human encroachment and development; and chinook salmon will continue to be negatively affected through loss of habitat and reduced or polluted river flows. Intense competition for the use of this water is likely to continue, therefore, other species may also be adversely affected by increased human encroachment.

With-in the Preferred Action Alternative, full implementation of Title XII will not adversely affect any chinook salmon. Through water conservation measures, additional water will be made available to increase water supplies with-in the Yakima River and its tributaries enhancing habitat for anadromous fish. There may be a slight affect in species habitat from the reduction in return flows, but that is expected to be off-set by the additional habitat that would be created by the additional water in the watercourses. Implementation of Title XII may alter reservoir water release and storage patterns and water conservation efforts, thus affecting terrestrial and aquatic biological resources. Relatively subtle changes in flow patterns could directly or indirectly affect fish resources. Site specific analysis of any operational changes will be investigated in concurrence with the NMFS when appropriate.

Implementation of Title XII minus the Basin Conservation Program, may impact chinook salmon. By not initiating a conservation program to enhance watercourse flows and supplies, water demands would increase due to current and future requests for public and agricultural development. Site specific analysis of any changes will be investigated in concurrence with the NMFS when appropriate.

Implementation of Title XII minus the Tributary Program and the Kachess Reservoir Augmentation. Like the implementation of Title XII minus the conservation program, chinook salmon may be impacted. Both programs enhance watercourse flows and supplies. While the Tributary Program will slightly affect some species habitat from the reduction in return flows, that is expected to be off-set by the additional habitat that would be created by the additional water in the watercourses. Site specific analysis of any changes will be investigated in concurrence with the NMFS when appropriate.

Steelhead trout *(O. mykiss)* **(Candidate)** - Yakima River steelhead are one of numerous individual stocks of fish proposed for listing by the NMFS. Some of these stocks are considered to be in a depressed state, with spawning escapements being well below the anticipated goals (SASSI, 1993). Steelhead adults enter the Columbia River during late June to early September (ODFW/WDF, 1991). Migration into the Yakima River commences in fall (September) and can continue into the following spring (May) with peak movement at

Prosser dam generally occurring in October and February-March (SSPP, 1990). Steelhead trout spawn mainly in Status Creek, Toppenish Creek, the Naches River and the Yakima River up to Keechelus Dam, where spawning is blocked by the non-existence of a fish ladder for passage. Impediments to fish movement is probably due to cold water temperatures, holding in the Columbia River or low flow conditions in the Yakima River (YRBDC, 1995). The current depressed status of steelhead trout is attributed to a number of factors including habitat degradation, impedance due to Columbia River dams, and mixed-stock from Columbia River fisheries.

Analysis of potential affects are the same as described for the spring/summer chinook salmon.

INTERRELATED AND INTERDEPENDENT ACTIONS

In accordance with the definition provided in Section 7 of the ESA, interrelated and interdependent actions are actions that have no independent utility apart from the primary action or are actions that are part of the primary action and dependent upon that primary action for their justification.

The primary action associated with this PEIS is to decide which Title XII elements Reclamation will further consider for implementation. The PEIS will not provide sufficient environmental evaluation to allow implementation of any particular project or element of the Title XII. The actual implementation of individual actions outlined in Title XII and selected for further evaluation in the PEIS will be addressed in future environmental documents, including Section 7 analysis, on a site-specific basis. As such, there are no interrelated or interdependent actions which have no independent utility apart from the primary action being considered here.

DETERMINATION

Reclamation has determined that since this is an administrative action, and the purpose of this PEIS is to decide which Title XII elements Reclamation will further consider for implementation, the proposed action would have no effect on threatened and endangered species or critical habitat. Site specific Section 7 analysis will be conducted prior to implementation of any Title XII element.

If you agree with our determinations, please provide us with written concurrence.

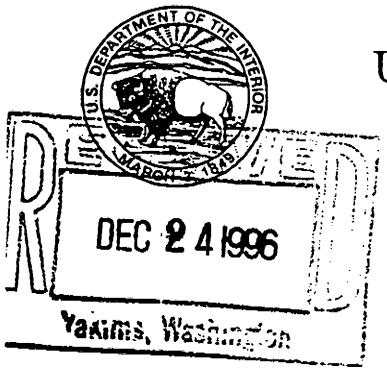
Should you require additional information, please contact Mr. John Tiedeman at 509-575-5848 ext. 238.

Sincerely,

David J. Kaumheimer
Manager
Environmental Programs

Enclosure

bc: D-8210, D-8650, PN-6519
(w/o enclosures to each)
WBR: JTIEDEMAN:jr:12-06-96:(509)575-5848
(BELTRNMF.YRB)



United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
517 South Buchanan
P.O. Box 1157
Moses Lake, Washington 98837
(509)765-6125 Fax: (509)765-9043

December 20, 1996

MEMORANDUM

To: Environmental Programs Manager, Bureau of Reclamation
Upper Columbia Area Office, Yakima, WA

From: Assistant Field Supervisor, Fish and Wildlife Service
Moses Lake Office, Moses Lake, WA

Subject: Section 7 Consultation for the Yakima River Basin Water Enhancement Project (FWS Reference 1-9-97-I-026, 1-9-96-SP-143)

This memorandum is in response to your request for informal consultation on the Yakima River Basin Water Enhancement Project (YRBWEP) proposed by the Bureau of Reclamation (Reclamation). Your memorandum with an attached biological evaluation, dated December 6, 1996, was received in this office on December 9, 1996.

The proposed project is an administrative action involving the identification, through a programmatic Environmental Impact Statement, of elements of Title XII, Phase 2 of the YRBWEP (Public Law 103-434), which Reclamation will further consider for implementation. The U.S. Fish and Wildlife Service (Service) concurs that the proposed project as described in the biological evaluation, will have no effect on bald eagle, gray wolf, grizzly bear, marbled murrelet, northern spotted owl and peregrine falcon.

This concludes informal consultation pursuant to Section 7(a)(2) of the Endangered Species Act of 1973, as amended (Act). This project should be re-analyzed if new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not considered in this consultation; if the action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this consultation; and/or, if a new species is listed or critical habitat is designated that may be affected by this project. We understand that Reclamation will consult with the Service, pursuant to the Act, as each element of Title XII is initiated.

If you have further questions about this letter or your responsibilities under the Act, please contact Don Haley of this office at 509-921-0160.

c: FWS, Spokane

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
Upper Columbia River Basin Field Office
11103 East Montgomery Drive
Spokane, Washington 99206
509) 921-0160 Fax: (509) 891-6748

RECEIVED
YAKIMA, WASHINGTON

UCA
1600

October 3, 1996

To: Environmental Program Manager, Upper Columbia Area Office,
U.S. Bureau of Reclamation, Yakima, Washington

From: For Field Supervisor, Upper Columbia River Basin Field Office, Kurt R Campbell
U.S. Fish and Wildlife Service, Spokane, Washington

Subject: Yakima River Basin Water Enhancement Project (YRBWEP) Final Fish and Wildlife Coordination Act Report.

Attached is our final Fish and Wildlife Coordination Act Report (Report) for the YRBWEP elements included in Title XII, Phase 2 of the YRBWEP, in Public Law 103-434, which was passed on October 31, 1994. The purpose of the proposed project is to protect, mitigate and enhance fish and wildlife and to improve the reliability of the water supply for irrigation through improved water conservation and management and other appropriate means.

This final Report was prepared under the authority of and in accordance with the provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended, 16 U.S.C. 661 et seq.). It was prepared as per the 1996 Scope-of-work between the Bureau of Reclamation (Bureau) and the Fish and Wildlife Service (Service). Our analysis was based on information provided by the Bureau, site visits, observations and prior knowledge of staff, resource information readily available from our files and information contained in several Fish and Wildlife Coordination Act and Planning Aid Reports completed in the Yakima River Basin (Basin) for the Bureau over the last 30 years. The Report contains a description of the fish and wildlife resources and habitats of the Basin, description of the project elements, impacts from implementing the project elements and recommendations for avoiding and mitigating adverse impacts and enhancing resources in the Basin.

We have received Bureau comments and have addressed them where appropriate. If you have any questions or comments regarding the attached report, please contact Don Haley in our Moses Lake Office at (509) 765-6125.

Attachment

c: USBR, Boise (Lola Sept)
USFWS, Vancouver (Simmons)
USFWS, Leavenworth (Cates)
USFWS, Olympia (Campbell)
NMFS, Portland (Carlon)
WDFW, Yakima (Easterbrooks, Clausing, Renfrow)
YIN, Toppenish (Tuck)

YAKIMA RIVER BASIN WATER ENHANCEMENT PROJECT

FINAL

FISH AND WILDLIFE COORDINATION ACT REPORT

Prepared for
Pacific Northwest Region
Bureau of Reclamation
U.S. Department of the Interior

Prepared by
Donald Haley, Fish and Wildlife Biologist
Upper Columbia River Basin Field Office
U.S. Fish and Wildlife Service
Spokane, Washington

October 1996

TABLE OF CONTENTS

INTRODUCTION 1

DESCRIPTION OF THE PROJECT 4

AQUATIC AND TERRESTRIAL RESOURCES IN THE BASIN 6
Anadromous fish 6
Resident fish 9
Wetlands 10
Riparian 13
Coniferous forest 15
Shrub-steppe 16
Agricultural land 17
Neotropical migratory birds 17
Federal listed threatened, endangered species, candidates and other species of concern . 19
State listed threatened, endangered and sensitive species and candidates for listing 24
Environmental contaminants 25

POTENTIAL CHANGES TO AQUATIC AND TERRESTRIAL RESOURCES FROM IMPLEMENTING THE VARIOUS YRBWEP ELEMENTS 26
Anadromous fish 26
Resident fish 27
Terrestrial resources 27

RECOMMENDATIONS 31

LITERATURE CITED 35

APPENDIX A - Neotropical Migratory Birds Found Within the Yakima River Basin Grouped by Habitat Association 40

INTRODUCTION

The purpose of this U.S. Fish and Wildlife Service (Service) Fish and Wildlife Coordination Act Report (Report), is to identify important fish and wildlife resources in the Yakima River Basin (Basin), generally describe the environmental effects of implementing various elements of the Bureau of Reclamation's (Reclamation) Yakima River Basin Water Enhancement Project (YRBWEP) and make recommendations to avoid, minimize and/or mitigate for adverse impacts.

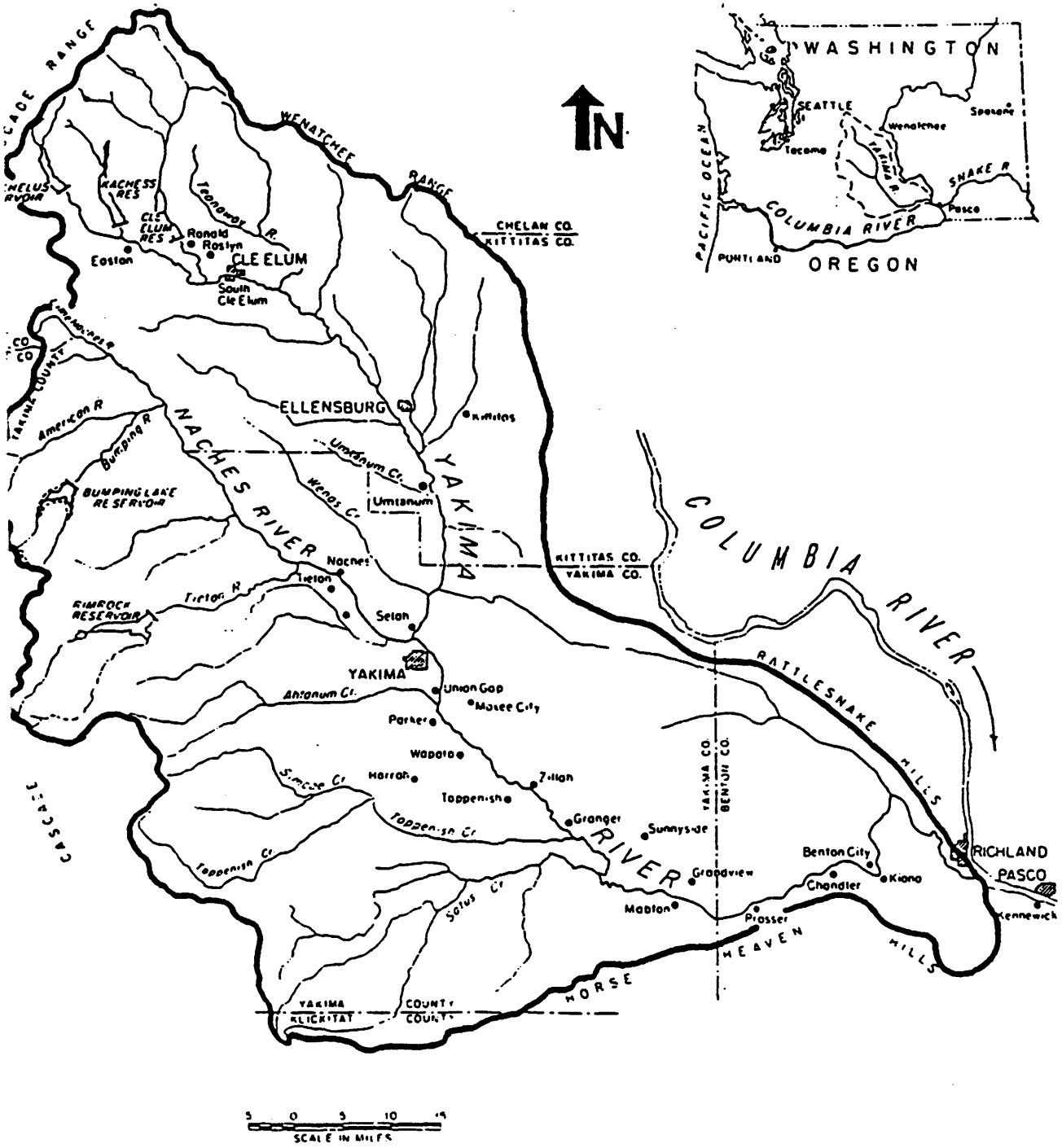
The Yakima River is the largest tributary to the Columbia River located entirely within the State of Washington. The river drains a portion of the eastern slope of Washington's Cascade Mountains and the semi-arid mountains and lowlands within Kittitas, Yakima, Klickitat and Benton Counties. The watershed area includes over 6,150 square miles and is geographically diverse. The Basin extends from the crest of the Cascade Mountains on the west to the Columbia Basin on the east and from the Wenatchee Mountains on the north to within 30 miles of the Washington-Oregon border on the south (Figure 1).

The common hydrologic pattern in the region is the result of most water originating in higher mountains, often as snow. Snowmelt feeds streams and rivers and recharges groundwater aquifers. This hydrologic system has been greatly modified by man, mostly to provide more dependable dry-season surface water supplies. While the Yakima River historically experienced nearly annual flooding due to spring snowmelt and runoff, this has been considerably reduced due to the development of various irrigation-related projects.

The Yakima River has a very low gradient, averaging less than one tenth of one percent, from its mouth at the Columbia River, 214 miles up to the base of Reclamation's dam at Keechelus Lake (USGS 1991). Estimated average annual runoff is about 3.4 million acre-feet per year. The river drains most of Kittitas and Yakima Counties and smaller portions of Benton and Klickitat Counties. Important tributaries in the upper basin include Kachess, Cle Elum, Teanaway and Naches Rivers. Ahtanum, Toppenish and Satus Creeks join the river in the lower Basin.

In the Basin, streams are rated either Class AA (extraordinary), Class A (excellent) and Class B (good) (USGS 1992). Class AA streams must markedly and uniformly exceed water quality standards for all, or substantially all, designated water uses; Class A streams must meet or exceed standards established for all, or substantially all, designated water uses; and Class B streams must meet or exceed the requirements for most uses (except for domestic water supplies, salmonid spawning and primary-contact recreation). Class AA streams in the Basin include the Yakima River from its confluence with the Cle Elum River to its headwaters, the Cle Elum and Tieton Rivers, the Naches River from River Mile (RM) 35.7 to its headwaters, tributaries to the Class AA waters and all streams lying within national forests and/or wilderness areas. Class A streams include all other streams in the Basin except Sulphur Creek, a tributary to the Yakima River at RM 61, which is Class B.

The Yakima River meanders across the lower valley, often in a well-incised channel, except for 20 miles downstream of Sunnyside Irrigation Dam where the channel is braided. The lower Yakima River valley is a fairly broad, flat, ancient floodplain of rich soils, where irrigated agriculture has



URCE: U.S. Department of Health, Education, and Welfare, Public Health Service. *Irrigation return flow study, Wapato irrigation district, Yakima River Basin, Washington.* Working Paper No. 47. (May 1964).

Figure 1 - Yakima River Basin

flourished. In 1992, USGS stated that the Basin is one of the most intensively irrigated areas in the country. The irrigated lands primarily produce fruits, vegetables, hops and livestock feed. The Basin has about 500,000 irrigated acres of cropland, which is about 75 % of the total cropland acreage.

Large seasonal flow variations in the Yakima River have been modified since the late 19th century by development and operation of irrigation projects, hydropower projects and storage reservoirs on the mainstem Yakima, Kachess, Cle Elum, Bumping and Tieton Rivers. The six storage reservoirs, operated by Reclamation, capture and store a portion of the spring runoff (about 1,070,000 acre-feet maximum storage) and release it in summer and early autumn for irrigation. These reservoirs include Keechelus Lake (157,800 acre-feet), Kachess Lake (239,000 acre-feet), Cle Elum Lake (436,900 acre-feet), Bumping Lake (33,700 acre-feet) Rimrock Lake (198,000 acre-feet) and Clear Lake (5,300 acre-feet). While these reservoirs are managed primarily for irrigation uses; since 1981, some of the stored water has been used to benefit anadromous fish. Water releases are now made from these reservoirs in the winter to protect anadromous fish redds in the upper Yakima River (USBR 1996). Also, some reservoir releases during the summer are being managed to enhance spring chinook spawning activities in September and October. The operation of these reservoirs and many other irrigation facilities in the Basin is the responsibility of Reclamation's Yakima Project.

There has been a variety of efforts to improve conditions in the Basin for anadromous fish, while other efforts have targeted improving irrigation with indirect benefits to anadromous fish. The Northwest Power Planning Council's Columbia River Basin Fish and Wildlife Program (Program) includes several elements which address Yakima River anadromous fish issues. For example, a large amount of work has taken place on fish screens and adult fish passage facilities. Also, considerable fishery research has been conducted, with the proposed Yakima Fisheries Project targeted at constructing, operating and maintaining anadromous fish production facilities to increase knowledge of supplementation techniques and rebuild naturally spawning anadromous fish stocks. Under the Program, Reclamation has initiated a flow reregulation project upstream of the Sunnyside Diversion Dam (USFWS 1995a). The project purpose is to improve and stabilize Yakima River flows to facilitate downstream juvenile migration and upstream adult migration.

The Columbia River Fish Management Program is an effort involving fishery mitigation activities resulting from the *United States v Oregon* treaty fishing rights case. This program directs fishery mitigation activities by rebuilding upper Columbia River chinook, coho, sockeye and steelhead runs. Current plans include release of fall chinook and coho into the Basin. North Yakima Conservation District and Natural Resource Conservation Service (NRCS) developed a watershed agreement to reduce sediment discharges from the Moxee Drain into the Yakima River by 70 percent (North Yakima Conservation District and SCS 1994). One of the goals of this project is to improve conditions for fall chinook salmon for a 21-mile reach of the Yakima River through improved water quality. Improved instream flows may also result. There have also been considerable efforts to protect and enhance wetland and riparian areas in the Basin, most of which provide benefits to anadromous fish.

DESCRIPTION OF THE PROJECT

The YRBWEP was initially authorized by Congress with Public Law 96-162 on December 28, 1979 (USBR 1996a). This initiated a feasibility study for the proposed YRBWEP. It involved preliminary identification of water needs, available resources and potential plan elements to meet those needs. It also included detailed studies of the best plan elements, formulations of alternative plans and detailed evaluation of the selected plan. Since those initial efforts, progress has been made in addressing some of the important elements identified. Much of the remaining elements, plus some additional ones, were included in Title XII, Phase 2 of the YRBWEP (Title XII), in Public Law 103-434, which was passed on October 31, 1994. Eight major elements were included in Title XII and are described below:

1. Basin Conservation Program This element involves developing water conservation plans, implementing selected measures and post-implementation monitoring and evaluation. A Conservation Advisory Group will prepare a Basin Conservation Plan for implementing water conservation measures and will administer the Basin Conservation Program. The implementation of structural and nonstructural water conservation measures are to result in 110,000 acre-feet of water to protect and enhance fish and wildlife resources and 55,000 acre-feet to be available for irrigation by the eighth year of the program. Measures to be considered include automating water conveyance systems, water measuring or metering facilities, lining and piping of water systems, electrification of hydraulic turbines and improvement of onfarm water application systems. The Basin Conservation Program also allows purchase or lease of land, water or water rights from willing sellers or lessors to limit or forego water use on a temporary or permanent basis.

2. Yakima Project Operations Title XII established new Yakima River target flows for the period from April through October for instream flow purposes to be maintained past Sunnyside and Prosser Diversion Dams. Flows will be determined using criteria based on the total water supply available. The new target flows range from 300 cubic feet per second (cfs) to 600 cfs depending on the total water supply available. This new operational regime took effect in 1995. As conservation measures are implemented under the Basin Conservation Program, and diversions are reduced, target flows will be increased by 50 cfs for each 27,000 acre-feet of diversion reduction. Water acquired by purchase or lease will be used to provide streamflows for short-term needs such as flushing flows to speed migration of anadromous fish smolts or longer-term needs such as increasing instream flows above current Yakima Project operational criteria. Additionally, studies will be done to determine both biologically-based target flows and whether the current water supply available for irrigation is adequate to sustain the Basin's agricultural economy.

3. Cle Elum Dam and Lake There would be a three-foot rise in the height of the dam's radial gates to provide an additional 14,600 acre-feet of storage. This extra water will be dedicated to instream flow improvements above the targets established by Title XII and subsequent flow increases from the Basin Conservation Program. Erosion control work will be accomplished to provide shoreline protection. This would involve riprap along 6,700 feet of noncontiguous sections of shoreline on the east side of the lake. Also, a fish passage facility to permit the migration of anadromous fish past the dam has been authorized.

4. Chandler Pumping and Powerplant With this element, electric pumps would be used to pump about 300 cfs of water into the Kennewick Irrigation District Canal, which is currently served by hydraulic pumps at the Chandler Powerhouse and Pumping Plant. This would eliminate diverting up to about 450 cfs of water from the Yakima River at Prosser Diversion Dam to run the hydraulic pumps. The hydraulic pumps would remain functional to allow their use if sufficient flows are deemed present in the Yakima River, in the future. Additionally, automated control structures would be constructed on the Chandler Power Canal and diversions for hydroelectric generation at Chandler would be subordinated to meet instream target flows. The flow increase provided by this element would be in addition to other elements of Title XII.

5. Kachess Dam and Lake One activity involves modifying facilities at Kachess Dam to improve discharges at low reservoir levels. This would include removing silt from the existing channel and replacing a tunnel with a new channel, both of which connect the former natural lake with the Kachess Dam spillway. The other activity includes constructing diversion facilities on Cabin and Silver Creeks and pipelines to augment the stored water supply of Kachess Lake. Up to 45,000 acre-feet annually may be diverted to help fill Kachess Lake and provide flows for irrigation and improve reservoir operations in the upper Yakima River to benefit anadromous fish.

6. Tributaries This element will involve investigating and implementing nonstorage measures to enhance tributary water supplies for fish, wildlife and irrigation on Taneum Creek. Enhancement programs similar to that on Taneum Creek can be investigated and implemented on other tributaries in the Basin upon agreement of appropriate tributary water rights owners.

7. Yakama Indian Nation One activity within this element includes improvements to the Wapato Irrigation Project. Water savings would be available for additional irrigation and other purposes within the Yakama Indian Reservation and for protection and enhancement of fish and wildlife within other areas of the Basin. Another activity involves developing a demonstration project to help illustrate cost effective, state-of-the-art irrigation water management and conservation measures and train tribal members in irrigation methods, operation and management. The implementation of this project is the tribe's discretion. The final activity is the Toppenish Creek Corridor Enhancement Project. This project should demonstrate integration of management of agricultural, fish, wildlife and cultural resources to meet tribal objectives. These activities will not require additional diversions from the Yakima River.

8. Interim Comprehensive Basin Operating Plan A draft plan is to be developed by October 31, 1999. This will be the framework for Reclamation's operation of the Yakima Project reservoirs and facilities. Measures implemented as part of YRBWEP will be included. This plan will identify how water supply and water need calculations will be made, identify operating capabilities and constraints, and set forth operating and streamflow objectives.

Most of the elements are relatively general and will be or are in the process of being developed more fully. Some of the elements will involve the development of additional details before implementation can take place; such as, the Basin Conservation Program. However, the tributary enhancement project for tributaries other than Taneum Creek will require additional study and then will require additional authorization to implement measures.

AQUATIC AND TERRESTRIAL RESOURCES IN THE BASIN

Anadromous fish

The fisheries resources of the Yakima River system evolved with the Basin's geology, climate, and dynamic hydrologic cycle. About 600,000 salmon and steelhead migrated annually into the Basin prior to 1890 (USBR and USFWS 1968). These included spring, summer and fall chinook salmon, sockeye salmon, coho salmon and summer steelhead (BPA 1996a). By the 1920's, there were only about 11,000 returning adults each year (USBR 1990). Factors within the Basin contributing to this initial decline include: 1) total blockage of a substantial amount of spawning and rearing habitat, 2) dewatering of spawning and rearing habitat, 3) overharvest of returning adults, 4) construction of diversion dams without fish ladders, 5) construction of diversion canals without adequate fish protection measures, and 6) elimination of braids and natural floodways by diking and channelization. While some of these factors have been addressed, numbers have continued to decline. In 1986, the USFWS (1986) estimated that about 6,500 adult chinook salmon and steelhead were returning to spawn in the Basin annually. The mean annual return of salmon and steelhead returning to the Basin from 1989 to 1994 was only about 5,100 adults (BPA 1996a). Furthermore, wild sockeye, summer chinook and coho salmon are now apparently extinct in the Basin.

Outside of the Basin, access to and from the sea is adversely affected by four mainstem dams on the Columbia River (McNary, John Day, the Dalles and Bonneville). Additionally, harvest levels in the lower Columbia River and Pacific Ocean have affected anadromous fish numbers in the Basin. Currently, anadromous fish production in the Basin is limited by regulated low flows, poor water quality and habitat destruction, all due primarily to irrigation development.

Anadromous fish are distributed throughout the Yakima River and its accessible tributaries. Each species utilizes specific areas within the Basin for its respective life history stages. Characteristics of viable anadromous fish habitat have been identified, including:

> access to and from the sea
> suitable gravel for spawning
> food
> an adequate supply of good quality water
> sufficient shelter

In the past, inadequate fish passage and protective facilities at many diversion sites was a major factor in anadromous fish declines in the Basin. Upstream passage may have been blocked by structures, inadequate attraction flows in passageways, diversion into wasteways, and insufficient diversion screening. In general, Reclamation believes that after completing Phase I and II, the passage problem has improved all major fish passage problems in the basin with modified irrigation diversion structures (David Kaumheimer, Reclamation, personal communication). Spawning gravel is abundant throughout most of the basin, but is less common in the lower mainstem. Food is usually not limiting for salmonid production in the Basin (USFWS 1995b). Water quality degradation in the Basin seriously affects anadromous and resident fish.

Sedimentation from irrigation practices, other land use development and degradation of riparian corridors and streambanks have increased silt loads in the river. Sediments can directly or indirectly reduce salmon production by: suffocating or encasing incubating eggs, causing gill abrasions which result in fungal infections, reducing primary productivity by limiting light penetration, reducing aquatic invertebrate production and causing significant increases in water temperature due to greater absorbance and retention of solar radiation.

Another water quality issue of significance for both anadromous and resident fish is high water temperatures in the 20-mile reach just downstream of Prosser. This section of the Yakima River is relatively wide and shallow with much of the substrate rubble and bedrock basalt. The substrate composition, channel morphology, low water velocity associated with low streamflows, silt load in the water and limited woody riparian vegetation are all conducive to heat accumulation in the summer in the lower Yakima River valley. USGS (1992) listed the low flows of this reach as one of the reasons for high summer water temperatures. They also state that the water temperature at Prosser is more closely correlated to air temperature than upstream reaches.

Dauble et al. (1994) reported relatively high mortalities of juvenile chinook salmon and rainbow trout during studies on the Yakima River at Prosser in late May and June. They attributed this mortality to stress from crowding and high water temperatures (greater than 72° F or 22° C). This water temperature is higher than the 21° C maximum established by the Washington State Water Quality Standards for Class A streams. Water temperatures in the reach below Prosser have been recorded as high as 82 ° F (WDFW, unpublished data). Aside from direct mortality, temperatures in these ranges can create a thermal block to migration, increase stress on adults and juveniles, increase susceptibility to disease and increase activity of predator fish (Tuck 1989).

Decreased flows, especially during critical late spring and summer periods has also affected anadromous fish. Aside from ensuring adequate spawning and rearing habitat, certain flows are needed by upstream migrating adult fish to meet minimum depth requirements. Also, flows help determine quality of water, operating efficiency of fish passage and protective facilities, degree of attraction of inflow from wasteways and drains and other factors important to the life cycle of fish (USBR and WDOE 1985). Rapid daily fluctuations below storage reservoirs may have a detrimental effect on anadromous fish production (USBR and WDOE 1985). Rapid dewatering may strand fish and dewater redds, while rapid increases in flow during spawning can displace rearing and spawning fish to less suitable habitat. High flows that occur during the May-June freshet are valuable to anadromous fish for several reasons including: providing smolts rapid transport to the sea, decreasing smolt vulnerability to predation, decreasing impacts of dams and screens and cleaning accumulated silts from spawning gravels.

Fish habitat in the Basin primarily includes upper and lower perennial streams and large oligotrophic lakes. Upper perennial streams are defined as having high gradients and water velocities; rock, cobble or gravel substrate; high dissolved oxygen concentrations and very little floodplain development (Cowardin et al. 1979). Prime examples of this habitat type include the American, Bumping, Tieton, Teanaway and Naches Rivers and the upper portion of the Yakima River. Lower perennial streams have low gradient and low water velocity, mainly sand and mud substrate and a well-developed floodplain. Much of the lower Yakima River can be classified as

lower perennial, although significant areas with gravel substrate exists in that reach.

The large reservoirs in the Basin are classified almost entirely as limnetic habitat with very little littoral habitat occurring along the steep embankments. The existing reservoirs are considerably less productive than the original lakes they inundated (USFWS 1986).

Spring chinook salmon There are three distinct sub-stocks of spring chinook salmon in the Basin: the American River, Naches River and upper Yakima River stocks (Fast et al. 1991). Spring chinook enter the Yakima River system in peak numbers in the months of April and May. They ascend the mainstem and disperse to spawn in the upper Yakima, Cle Elum, American, Bumping and Naches Rivers, spawning from late July through mid-October. Egg incubation lasts through the winter, with peak juvenile emergence from mid-April to mid-May. The young fish usually rear for one year, but some juveniles outmigrate as sub-yearlings (Fast et al. 1991). Current constraints on natural production in the Basin include both too high and too low instream flows at the wrong times of the year, lack of passage in some tributaries, degraded riparian and instream habitat and high water temperatures in the lower Basin (BPA 1996a).

From 1983 to 1987, total run size for spring chinook ranged from 1,324 to 9,452 fish and averaged 4,472 fish per year (Watson 1989). In 1986, the Service estimated an average annual run of 2,500 spring chinook (USFWS 1986). However, runs of spring chinook are currently extremely depressed, with only 665 spring chinook returning in 1995 (Bob Tuck, fishery biologist, Yakama Indian Nation, personal communication).

Fall chinook salmon Two substocks of fall chinook occur in the Yakima River system: the mainstem Yakima River and Marion Drain stocks. The mainstem stock comprise the majority of fall chinook in the Basin, with the majority spawning downstream of Benton City (BPA 1996a). Fall chinook enter the Yakima River from late August through October with peak spawning from late October through November. Spawning occurs in the mainstem from the river mouth upstream to near Sunnyside Dam. Fry emerge from late February through April and most juveniles undergo smoltification and outmigration in their first spring and summer as sub-yearlings. Since fall chinook spawn mainly in the lower Basin, they have been affected less with construction of diversion dams and more by water quality degradation. Factors currently limiting fall chinook production in the Basin include smolt and presmolt mortality due to sedimentation in spawning areas downstream of Sunnyside Dam, poor water quality and high water temperatures (BPA 1996a). The Service (1986) estimated returning fall chinook adults at about 2,000 fish. Watson (1989) estimated that the total run size from 1983 to 1988 ranged from 943 to 4,440 fish.

Coho salmon Natural coho salmon spawning is probably the result of hatchery fish outplantings in the Basin or hatchery releases outside of the Basin (BPA 1996a). They enter the Yakima River from September through November, with peak runs in October. Coho salmon spawn primarily in tributaries downstream of Roza Dam with peak spawning in November. Peak emergence is in April, with juveniles rearing for one year. Outmigration peaks in April and May. Since summer water quality conditions in the lower Yakima River are not conducive to rearing juvenile salmon, it is likely they rear in tributaries or in the Yakima River upstream of Sunnyside Dam. Recently, 700,000 coho smolts have been released into the Basin annually (BPA 1996a). In 1995, 600,000

pre-smolts were also released. However, from 1989 to 1992 the average number of adult coho observed at Prosser Dam was 140.

Sockeye salmon Sockeye salmon were historically present in the accessible natural lakes in the system such as Cle Elum, Kachess, Keechelus, and Bumping before their outlets were dammed. The National Marine Fisheries Service (NMFS) began a feasibility study in 1989 to determine if species restoration was possible. Juvenile sockeye usually rear in lakes and they were reared in Cle Elum Lake for one year before being allowed to emigrate. The study determined that existing physical and operational parameters limits the number of juveniles that outmigrated from the lake. A final report on the study is anticipated to be completed by NMFS in 1996.

Steelhead Both wild and hatchery-origin steelhead occur in the Basin, with the vast majority of wild origin. Most wild summer run steelhead enter the system in September through November, or in February through April. Spawning usually occurs between February and May. Hatchery summer run steelhead exhibit similar run and spawning times. Steelhead spawning is distributed throughout much of the upper Yakima River system and in Satus and Toppenish Creeks on the Yakama Indian Reservation. However, the majority of spawning occurs below Roza Dam and the largest number of steelhead to pass the dam in the past five years was estimated to be 125 (BPA 1996a). Steelhead fry emerge from April and July and rear throughout the Basin for usually one or two years, before smolting. Most smolts emigrate from mid-April through May. Historically, summer steelhead runs were estimated to range between 80,000 and 100,000 fish (BPA 1996a). In recent years, total returns have averaged about 1,700 fish with 10 to 20 percent composed of hatchery fish. Yakima River summer steelhead have been petitioned for listing under the Endangered Species Act. However, the recent proposed listings for several evolutionary significant units (ESU's) of steelhead as endangered (August 9, 1996, 61 FR 41541) does not include the Middle Columbia River ESU, which contains Yakima River Basin steelhead. The Middle Columbia River ESU is still listed as a candidate for listing.

Resident fish

Several resident fish species are common to the Basin. The mainstem and many tributaries support resident rainbow and cutthroat trout, mountain whitefish, sculpins, large-scale, longnose, and bridgelip suckers, chiselmouth and peamouth chubs, redside shiner, northern squawfish and longnose dace. Bull trout, a candidate for federal listing as a threatened or endangered species, is found within the Basin, but not downstream of the city of Yakima. Introduced species include brook trout, large and smallmouth bass, black crappie, bluegill, channel catfish, carp and yellow perch.

Important resident fish species present in upper perennial streams include rainbow trout, cutthroat trout, bull trout, whitefish and several species of dace, sculpins and suckers. In the lower perennial streams, species present include rainbow trout, whitefish, smallmouth bass, carp, northern squawfish, yellow perch, longnose dace, northern squawfish, redside shiner, chiselmouth and peamouth chubs, largescale, bridgelip and longnose suckers and several species of sculpins and dace. Only a few indigenous trout occur in the lower Yakima River; with high summer water temperature a likely limiting factor.

Resident fish species present in the large oligotrophic reservoirs in the Basin include rainbow, cutthroat, brook and bull trout, kokanee, whitefish and several species of dace, sculpins and suckers.

Angler use in the Basin is concentrated in the more productive reservoirs, such as Rimrock and Bumping Lakes, and in the mainstem Yakima and Naches Rivers (USFWS 1986). Mongillo and Falconer (1980) estimated that resident fish resources in the Basin provided about 64,000 angler-days of use in reservoirs and 190,000 angler-days of use on streams.

Wetlands

Wetlands are lands where saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and in its surface. The single feature that most wetlands share is soil or substrate that is at least periodically saturated with or covered by water. The water creates severe physiological problems for all plants and animals except those that are adapted for life in water or in saturated soil (Dahl and Johnson 1991).

The National Wetlands Inventory (NWI) classification system (Cowardin et al. 1979) identifies wetlands and deepwater habitats. The NWI has identified 43,695 acres of wetlands within the Basin. This included 41,513 acres mapped as polygons and 2,182 acres mapped as linear wetlands. Acreages of linear wetlands were determined by using the miles of mapped linear wetland (1,800 total miles) and an average width of ten feet. There was 20,040 acres of herbaceous wetlands, 20,044 acres of woody (shrubs and/or trees) wetlands and 3,611 acres of unvegetated wetlands. In addition, deepwater habitat was also determined with lakes and reservoirs accounting for 19,458 acres and rivers accounting for 9,732 acres. Because NWI mapping for Washington was completed using aerial photography taken from 1980 to 1984, the data reflects early 1980's wetland and deepwater habitat conditions. Two attached maps identify the location of wetlands in the upper and lower Basin based on NWI data (Attachments).

There are three broad categories or systems within the Basin including palustrine, riverine and lacustrine. Palustrine wetlands include nontidal wetlands dominated by trees, shrubs, persistent emergents and emergent mosses or lichens. They also include wetlands lacking such vegetation but less than 20 acres in size and with water depth shallower than 6.6 feet at low water. Palustrine wetlands include emergent wetlands (characterized by erect, rooted, herbaceous hydrophytes which are usually dominated by perennial plants); scrub-shrub wetlands (characterized by woody vegetation less than 20 feet tall); forested wetlands (characterized by woody vegetation 20 feet tall or taller); and aquatic bed (dominated by plants that grow principally on or below the surface of the water for most of the growing season). Palustrine wetlands in the Basin include wet meadows, seeps, small shallow ponds, marshes, and riparian wetlands along streams, rivers and other waterways. Aside from natural wetlands, there are many wetlands which have formed and been maintained from artificial water sources, such as reservoirs, sewage lagoons, stock ponds, irrigation canals and drainage ditches and irrigated cropland runoff.

The riverine system includes deepwater habitats (permanently flooded land deeper than 6.6 feet)

contained within a channel. Riverine habitat in the Basin includes upper perennial high gradient streams; broad, lower perennial river reaches; and, irrigation canals and drains. Wildlife species that depend on the upper perennial riverine habitat for feeding, nesting and escape cover include beaver, mink, raccoon, dipper, belted kingfisher, common merganser, harlequin duck and tailed frog. Lower perennial river reaches support such species or species groups as beaver, muskrat, osprey, bald eagle, several species of waterfowl, great blue heron, great egret and bank swallow. Irrigation canals and drains are used by beaver, muskrat, raccoon, ducks (mainly mallards), great blue heron, killdeer, pied-billed grebe, red-winged blackbird, barn swallow and bank swallow.

The lacustrine system includes deepwater habitats with all of the following characteristics: situated in a topographic depression or a dammed river channel; lacking trees, shrubs, persistent emergents or emergent mosses or lichens; and total area exceeds 20 acres. Lacustrine habitat in the Basin includes Reclamation's storage reservoirs and some gravel pits along the Yakima River. The reservoirs are deep, cold and have large drawdown zones. Some wildlife species that utilize the reservoirs for feeding, resting and/or escape cover include bald eagle, osprey, great blue heron, common loon, common merganser, harlequin duck, black swift, belted kingfisher, violet-green swallow and spotted sandpiper. The gravel pits are shallower and water levels are more stable. They are used by similar species, except for the black swift and harlequin duck, and also include many more duck species, ring-billed gull, common tern, American coot, pied-billed grebe, mink, muskrat, beaver, western painted turtle and bullfrog.

Some of the more common wetland plants in emergent wetlands include cattail, bulrush, spikerush, sedges, rushes, scouring rush, and various grasses such as reed canarygrass, meadow foxtail and common reed. In forested wetlands, black cottonwood usually dominates, with an understory of willows, red-osier dogwood, alder and/or birch. Scrub-shrub wetlands commonly contain willows, alder, red-osier dogwood, chokecherry and/or young cottonwood. Aquatic beds can include pondweeds, coontail, milfoil and/or duckweeds.

Because of the Basin's semi-arid environment, wetlands are extremely important to many species of wildlife as they provide some of the best vegetative growth for food and cover, invertebrate production and water. Recognition of the value of wetlands has historically focused on waterfowl populations. Oliver (1983) estimated that up to 300,000 ducks wintered on the Yakama Indian Reservation in the 1960's. Tens of thousands of waterfowl can still be found in the lower Basin in winter and during migration. These wetlands are also used for nesting by mallard, gadwall, blue-winged teal, cinnamon teal, redhead, American widgeon, northern shoveler and Canada goose. Most of the wood ducks produced in eastern Washington are produced along the Yakima and Naches Rivers. Waterfowl produced within the Wapato Irrigation Project account for about 20 percent of the production in eastern Washington (Tracy Hames, waterfowl biologist, Yakama Indian Nation, personal communication). Also, as many as 40,000 Canada geese use areas flooded by Toppenish and Simcoe Creeks in the spring (BPA 1994). Furthermore, sandhill cranes and swans historically nested in the Basin and could return if wetland restoration and enhancement efforts were to continue (Parker 1989).

There are a variety of other wildlife species which also use wetlands. Some species, such as sora rail, American coot, red-winged blackbird, yellow-headed blackbird, Wilson's phalarope, lesser

yellowlegs, American avocet, black-necked stilt, black-crowned night-heron, American bittern, great blue heron, common snipe, bobolink, common yellowthroat, marsh wren, muskrat, mink, western painted turtle, spotted frog, Cascades frog and bullfrog are wetland-dependent species. Other species do not require wetlands, but definitely use them, including: peregrine falcon, bald eagle, northern harrier, California quail, ring-necked pheasant, killdeer, American crow, song sparrow, yellow warbler, swallows, raccoon, coyote, striped skunk, mule deer, elk, black bear and ruffed grouse.

Wetlands in the Basin provide functions beyond fish and wildlife habitat. They provide both consumptive and non-consumptive recreational uses, groundwater recharge, flood control and improvement of water quality as important functions.

Washington's wetlands have declined 30 percent (about 940,000 acres remaining from about 1,350,000 acres originally), with the loss of freshwater wetlands estimated at 25 percent (USFWS 1990). Losses have been attributed to agriculture conversion (drainage and leveling for crop production); filling for solid waste disposal, road construction and commercial, residential and urban development; construction of dikes, levees and dams for flood control, water supply and irrigation; discharges of materials (for example pesticides, herbicides, nutrient loading from domestic sewage and agricultural runoff and sediments from agriculture and other land development) hydrologic alteration by canals, drains, spoil banks, roads and other structures; and groundwater withdrawal. Aside from the direct loss of wetlands, many wetlands have been reduced in quality from the above factors.

Ongoing wetland threats include overgrazing, intensive adverse agricultural practices (including increased chemical uses, buffer removal, feedlots and dairy operations in and near wetlands), erosion, poor water quality of irrigation return flow, exotic species (for example, carp and purple loosestrife) and fairly recently, the changes in many older irrigation systems which have reduced associated wetlands (for example, lining canals and changing to piped and pressurized systems).

The majority of wetlands in the Basin were along the major streams and rivers, especially the lower Yakima River and Toppenish and Satus Creeks. Other wetlands were along smaller tributaries, seeps and springs, high elevation wet meadows and along lakes. Many of these wetlands have been lost or degraded. Efforts have been made to protect remaining wetlands at Sunnyside Wildlife Area (WA), Toppenish National Wildlife Refuge (NWR), Yakima Greenway and the Yakama Indian Reservation. Over 300 acres of wetland and riparian areas along the Yakima and Naches Rivers were recently acquired by the Corps of Engineers and are being managed by WDFW to help fulfill mitigation for construction of Lower Snake River dams and reservoirs. Also, several other Federal, state, tribal and local agencies, private groups and individuals are restoring and enhancing wetlands in the Basin.

One wetland conservation effort is the Intermountain West Joint Venture. This is part of the North American Waterfowl Management Plan, which is a broad framework agreement developed in 1986 to protect and enhance waterfowl and wetland values. The Intermountain West Joint Venture was established in 1994 and includes eleven states. One of the five focus areas identified in Washington was the Lower Yakima River Basin, which helps highlight the importance of this

area to waterfowl and other wetland dependent wildlife species. Since it is a focus area, it will benefit from a consolidated effort from many Federal, state, local, tribal and private interests to identify important goals and objectives and conserve, protect and enhance wetlands. It will also help facilitate partnerships and securing funding to carry out various conservation activities.

The Yakama Indian Nation recently completed a nearly 500-acre wetland restoration project along Toppenish Creek, in cooperation with Ducks Unlimited (Tracy Hames, waterfowl biologist, Yakama Indian Nation, personal communication). They plan to continue restoring and improving hundreds of acres of wetlands and riparian areas along Toppenish and Satus Creeks. With funding largely provided by the BPA, they propose to secure property and conduct wildlife management activities in and along the Yakima River (BPA 1994). The project area includes over 50,000 acres with a variety of wetland and riparian habitat types, lacustrine and riverine habitats, as well as agricultural lands and shrub-steppe. Habitat management activities would include fencing, weed control, establishment of native vegetation, sediment removal, shoreline protection, and water development and control. BPA also intends to fund additional habitat improvement work at Sunnyside WA which contains wetland and riverine habitats (BPA 1996b). There are also several private waterfowl hunting clubs located in the lower Basin. Many of these clubs actively manage wetlands and do provide some wetland benefits.

Aside from acquiring and managing wetlands, a variety of regulations also benefit wetlands. Some of the major regulations pertaining to wetlands include: Sections 401 and 404 of the Federal Clean Water Act; Executive Order 11990 - Protection of Wetlands; Executive Order 11988 - Floodplain Management; "Swampbuster" provisions of the Food Security Act of 1985, as amended by the Food, Agriculture, Conservation and Trade Act of 1990; State Shoreline Management Act; State Hydraulic Code; and State and local Floodplain Management Programs.

Riparian

Riparian habitat is defined as the area adjacent to flowing water that contain elements of both aquatic and terrestrial ecosystems which mutually benefit each other (WDFW 1995). They generally occur as relatively narrow linear units along aquatic habitats. Some riparian areas are also wetlands, such as, palustrine forested and palustrine scrub-shrub wetlands. Riparian areas also include forested and scrub-shrub too dry to be classified as wetlands, gravel bars, wet meadows, flood scoured areas, and other stream related habitats and vegetation.

Riparian areas are estimated to provide less than one percent of the land base in the Pacific Northwest yet support the greatest diversity and abundance of wildlife that exist in the arid portions of the region (USFWS 1990). Although riparian areas make up a small portion of the landscape, they are an important resource because they are very productive, diverse and provide critical components to both aquatic and upland ecosystems. WDFW (1995) states that about 90 percent of Washington's land-based vertebrate species use riparian habitat for essential life activities. They further point out that the high wildlife value of these areas is derived from the structural complexity of vegetation, connectivity with other ecosystems, high edge-to-area ratio, abundant food, water and a moist and mild microclimate.

Riparian forests in the Basin typically contain black cottonwood, but may also contain alder, willow, silver maple, mulberry and hackberry. Higher elevation riparian forests are used by elk, deer, beaver, mink, river otter, longtail vole, osprey, Cooper's hawk, sharp-shinned hawk, ruffed grouse, red-naped sapsucker, red-breasted sapsucker, black swift, Vaux's swift, rufous hummingbird, calliope hummingbird, Pacific-slope flycatcher, Hammond's flycatcher, dusky flycatcher, veery, Swainson's thrush, western tanager, solitary vireo, MacGillivray's warbler, fox sparrow, red-breasted nuthatch and Cassin's finch. And at lower elevations they may contain deer, beaver, raccoon, river otter, mink, striped skunk, cottontail, western harvest mouse, several bat species, bald eagle, Swainson's hawk, American kestrel, western screech owl, great horned owl, great blue heron, black-crowned night-heron, ring-necked pheasant, California quail, belted kingfisher, black-headed grosbeak, gray catbird, Northern oriole, eastern kingbird, northern flicker, downy woodpecker, hairy woodpecker, Lewis' woodpecker, ash-throated flycatcher, yellow warbler, song sparrow, Lincoln's sparrow and American goldfinch.

Riparian scrub-shrub areas typically contain willow, chokecherry, red-osier dogwood, sumac, wild rose, Rocky Mountain maple, current, snowberry and young cottonwood trees. Many of the wildlife species which use riparian forests also use this habitat, except for those species which rely on large trees and snags, such as woodpeckers and owls. Some additional species using this habitat include Wilson's warbler, willow flycatcher and lazuli bunting.

Riparian herbaceous habitat is common along many of the irrigation canals and drains, mainly because of regular disturbance (mowing, burning and pesticide use) to destroy weeds and maintain a manicured appearance (Oakerman 1979). Perennial grasses make up the largest percentage of cover along the main canals. These grasses include reed canarygrass, redtop, bluegrass species, crested wheatgrass, quackgrass and saltgrass and are most typical on slopes along the canals. Further out in the rights-of-way, the sparse vegetation is composed of perennial grasses along with annual species such as cheatgrass, Russian thistle, mustards, lambsquarter, bassia and flixweed. Woody vegetation makes up a very small percentage of the total plant cover along canals. Oakerman (1979) also found that unlined canal/drain systems had much more value as wildlife habitat than lined canal/drain systems. Within the Wapato Irrigation Project, unlined canals and drains provide habitat (nesting, brood-rearing, feeding, thermal and escape cover) for upland game, waterfowl, furbearers and many nongame birds (Yakima Indian Nation 1992). Some specific wildlife which may use this riparian habitat includes mallard, cinnamon teal, Canada goose, ring-necked pheasant, California quail, common snipe, black-billed magpie, Brewer's blackbird, western meadowlark, American robin, mourning dove, belted kingfisher, brown-headed cowbird, red-winged blackbird, American goldfinch, song sparrow, white-crowned sparrow, house sparrow and common yellowthroat.

Many additional wildlife species may be found in these and other riparian habitat types because they often are interspersed with and/or adjacent to a variety of other habitats (such as agricultural, urban, shrub-steppe, coniferous forest and deepwater habitats).

Efforts are being made to preserve, restore and enhance riparian areas in the Basin. BPA has funded or intends to fund projects benefitting riparian areas at Sunnyside WA, Wenas WA and the Yakama Indian Reservation (BPA 1994, 1996b). The Yakama Indian Nation is protecting and

enhancing riparian areas along the Yakima River and plans to conserve additional areas as well (Tracy Hames, waterfowl biologist, Yakama Indian Nation, personal communication). WDFW is protecting and managing riparian areas along the Yakima, Tieton and Naches Rivers and Taneum, Manastash, Umtanum, Wenas, Oak and South Fork of Cowiche Creeks. The Bureau of Land Management manages land along the Yakima River northwest of Yakima and is attempting to improve wildlife habitats, including riparian areas (BLM 1991). The Yakima Greenway Foundation protects and manages riparian areas along the Yakima River near Yakima.

Coniferous forest

Young (1976) estimated that over 1,500,000 acres within the Basin are forest lands. Franklin and Trappe (1963) determined that there were five forest zones along the eastern Cascade Mountains which would be included within the Basin boundaries. The zones start with ponderosa pine, then move up into the Douglas fir zone, then to the grand fir zone, on to the western hemlock and/or Pacific silver fir zone and end with the subalpine fir and/or mountain hemlock zone. The ponderosa pine and western hemlock and/or Pacific silver fir zones may be absent or fragmentally represented in some areas (Franklin and Dyrness 1973).

The ponderosa pine zone occupies the driest forested zone. On xeric sites, ponderosa pine may be intermingled with shrub-steppe habitat. Other trees in the ponderosa pine zone include lodgepole pine, Oregon white oak, quaking aspen and western juniper. Aspen occurs in wetter sites within the zone (Franklin and Dyrness 1973).

The Douglas fir zone is next and is usually well-defined between the ponderosa pine and grand fir zones. Dominant trees in this zone may include the following species, depending on the fire history: Douglas fir, ponderosa pine, lodgepole pine and western larch (Franklin and Dyrness 1973).

The most extensive zone in the southern Washington Cascade Mountains is the grand fir zone. This zone is the most diverse zone and major tree species include grand fir, ponderosa pine, lodgepole pine, western larch and Douglas fir. Other species present in limited numbers or in localized areas include Engelmann spruce, subalpine fir, western white pine and mountain hemlock. Mountain meadows found on relatively gentle topography along and near heads of stream courses make up the most important group of permanent nonforest communities in the grand fir zone (Franklin and Dyrness 1973).

The western hemlock and/or Pacific silver fir zone is most common between 2,500 and 3,800 feet above sea level. Most of this zone in the Basin is occupied by relatively youthful stands in which grand fir, Douglas fir, western white pine, western larch, lodgepole pine and Engelmann spruce are dominant and western hemlock and Pacific silver fir are very young trees in the understory (Franklin and Dyrness 1973).

Climax forests of the subalpine fir zone start at about 4,000 and 5,800 feet. In many areas the upper limit extends to the subalpine-alpine ecotone and typically includes forest-meadow parkland. Cool summers, cold winters and deep snowpacks are important factors in separating

this zone from lower forested zones. Major forest trees in this zone include subalpine fir, Engelmann spruce and lodgepole pine. Whitebark pine and subalpine larch are abundant higher in the zone and Douglas fir, grand fir, western larch and western white pine may be abundant lower in the zone (Franklin and Dyrness 1973).

Several big game species inhabit the coniferous forest and associated areas including elk, mule deer, black bear, California bighorn sheep and mountain lion. Black bear and mountain lion are normally found in higher elevations within the Basin. Deer and elk are found in higher elevations in the summer, but migrate to the foothills in winter. Bighorn sheep use open forested areas, grassland and grassland/shrub communities near steep, rugged terrain. Additional mammals present include marten, beaver, bobcat, shorttail weasel, longtail weasel, bushy-tailed woodrat, Douglas squirrel, yellow pine chipmunk, snowshoe hare, porcupine, vagrant shrew and heather vole. Some of the birds found in the coniferous forest habitat within the Basin include northern goshawk, Cooper's hawk, spotted owl, northern pygmy owl, blue grouse, ruffed grouse, Steller's jay, gray jay, Vaux's swift, calliope hummingbird, red-naped sapsucker, Williamson's sapsucker, pileated woodpecker, white-headed woodpecker, olive-sided flycatcher, western wood-pewee, Pacific-slope flycatcher, Hammond's flycatcher, varied thrush, hermit thrush, western bluebird, Townsend's solitaire, mountain chickadee, black-capped chickadee, pygmy nuthatch, red-breasted nuthatch, solitary vireo, Townsend's warbler, western tanager, red crossbill and Cassin's finch. The Cascades frog, Pacific treefrog, roughskin newt and long-toed salamander are some amphibians which may be found in this habitat.

Shrub-steppe

Daubenmire (1970) differentiated the Basin into two vegetation zones: forest and Artemesia tridentata - Agropyron (big sagebrush - wheatgrass). The big sagebrush - wheatgrass zone (hereafter referred to as shrub-steppe) has undergone drastic changes. Young (1976) calculated that this zone covers over 2,000,000 acres within the Basin. However, this habitat has undergone significant losses and degradation and is now listed as an endangered ecosystem in Washington (Noss et al. 1995). Dobler (1990) calculated that roughly 60 percent of the historical, native shrub-steppe habitat in Washington has been converted to other uses. Most urban development in the Basin has occurred within this zone. Also, there are now 500,000 acres of irrigated cropland within this zone. Additionally, changes have occurred to much of the remaining habitat including heavy grazing from livestock, altered fire frequencies, exotic species invasion and off-road vehicle use. As an example, much of the 320,000-acre Department of the Army Yakima Training Center, located mainly within the Basin, is composed primarily of shrub-steppe and has been degraded by overgrazing and training exercises. Some areas show only minor impacts to the native vegetation, whereas others have been permanently altered and now represent new plant associations.

Undisturbed vegetation in this shrub-steppe habitat is dominated by big sagebrush as the principal shrub and bluebunch wheatgrass as the principal grass (Daubenmire 1970). Much smaller amounts of gray and green rabbitbrush, spiny hopsage, three-tip sage and horsebrush may occur in the shrub layer. Additional grasses include needle-and-thread, Thurber's needlegrass, bottlebrush squirreltail and Cusick's bluegrass. Some forbs include arrowleaf balsamroot, silky lupine and longleaf phlox. Cheatgrass, an exotic annual, has become widespread throughout the region. In

some areas it has replaced the native grass species amid the native shrubs and forbs. In other areas, shrubs are completely absent and cheatgrass is essentially the only grass species that occurs.

Some mammals using shrub-steppe habitat include mule deer, coyote, badger, black-tailed jackrabbit, bobcat, Washington ground squirrel, northern grasshopper mouse, Ord's kangaroo rat and Merriam shrew. Birds using shrub-steppe habitat within the Basin include prairie falcon, golden eagle, burrowing owl, long-billed curlew, chukar, sage grouse, common nighthawk, common poorwill, rock wren, horned lark, loggerhead shrike, sage thrasher, western meadowlark, mourning dove, green-tailed towhee, western kingbird, vesper sparrow, black-throated sparrow, Brewer's sparrow, lark sparrow and sage sparrow. Some reptiles and amphibians using this habitat include western rattlesnake, striped whipsnake, Great Basin spadefoot toad, short-horned lizard and northern sagebrush lizard.

Agricultural land

Agricultural land in the southern two-thirds of the Basin contains large tracts of orchards, vineyards and hop fields, in addition to a wide variety of other crops. Pasture, hay, corn and wheat are the primary uses of agricultural land in the northern portion of the basin. Historically, croplands provided much higher quality habitat than exists in most places today. However, more efficient irrigation practices, larger fields, changes in crops, removal of fencerows, increased herbicide use and other practice changes removed much of the wildlife habitat. Cropland and pasture in the Lower Yakima River Basin can still be very important to large numbers of wintering waterfowl (especially mallard and Canada geese); however, their numbers no longer approach the 300,000's recorded in the 1960's (Oliver 1983).

Orchards, vineyards and hop fields provide only marginal habitat for some wildlife including American robin, mourning dove, California quail, western meadowlark and gopher snake. Typical wildlife species that occur in other cropland areas include Great Basin pocket mouse, deer mouse, northern pocket gopher, striped skunk, turkey vulture, American kestrel, common crow, ring-necked pheasant, mourning dove, rock dove, western meadowlark, American robin, red-winged blackbird, brown-headed cowbird, horned lark, barn swallow and gopher snake.

Some typical bird species in irrigated pasture and hayfields include northern harrier, American kestrel, red-tailed hawk, ring-necked pheasant, western meadowlark, American robin, black-billed magpie, western and eastern kingbirds, barn and violet-green swallows, western bluebird, savannah sparrow, white-crowned sparrow, red-winged blackbird and Brewer's blackbird. Other species found in pasture and hayfields include mule deer, coyote, striped skunk, Pacific mole, deer mouse, garter snake and gopher snake.

Neotropical migratory birds

There is widespread concern about the future of neotropical migratory birds (NTMBs) (Andelman and Stock 1994). These are species which breed in the United States and Canada and then fly south to Mexico, Central or South America or the Caribbean. Many of these species have experienced large population declines due to habitat destruction on the breeding grounds,

wintering areas and along migration routes.

In Washington there are 118 NTMB with all but four species found within the Basin. Those which may be found in the Basin are listed in Appendix A and are organized by habitat type. For 87 (74 percent) of the NTMB in Washington, information is lacking to determine long-term population trends. However 15 species (12 percent) are known to have experienced long-term declines within Washington. All of these species, except the upland sandpiper can be found in the Basin and include the following:

ferruginous hawk
golden eagle
killdeer
upland sandpiper
band-tailed pigeon
rufous hummingbird
eastern kingbird
barn swallow
golden-crowned kinglet
gray catbird
solitary vireo
orange-crowned warbler
yellow warbler
Wilson's warbler
chipping sparrow

Protecting these species' habitats to halt their downward population trend, before they become in serious trouble, is both ecologically and economically responsible. If sufficient conservation actions do not take place to stop their downward population trends, the species may become listed as threatened or endangered. History has shown that some of these species have continued declining into extinction (for example, dusky seaside sparrow), while large amounts of money have been spent on others to try and recover their ailing populations (for example, whooping crane, black-footed ferret and California condor) with limited success.

Eight of the NTMB species with declining trends depend on riparian habitats, which helps illustrate the value of this important habitat type. Furthermore, 57 percent of the NTMB in Washington are associated with riparian habitats. If sufficient data were available on all of the NTMB species, it is likely that additional riparian-dependent and other species would also be demonstrating downward population trends.

There are some NTMB species which are listed as threatened and endangered or species of concern to the Service which are not included in the list of species with long-term population declines. These include peregrine falcon, northern goshawk, western burrowing owl, loggerhead shrike, least willow flycatcher and olive-sided flycatcher. The reason long-term declines were not detected for these birds could be that little quantitative monitoring information was available for the species in Washington, survey sample sizes were too small or the declining trends were not

statistically significant for enough of the survey routes.

Federal listed threatened and endangered species, candidates and other species of concern

Threatened and endangered species

> Marbled murrelet (*Brachyramphus marmoratus*) - Marbled murrelets are mostly a marine bird, but they nest in inland old-growth forests. At present, their range extend into a small portion of the Basin in extreme western Kittitas and Yakima Counties. Keechelus and Kachess Lakes are within marbled murrelet range; however, Cle Elum Lake is just outside the range.

> Northern spotted owl (*Strix occidentalis caurina*) - Spotted owls occur in the later seral coniferous forests of all of the counties along the east side of the Cascade Range. Within the Basin, Critical Habitat has been designated in western Klickitat, Yakima and Kittitas Counties. Critical Habitat is adjacent to Kachess, Keechelus, Rimrock, Clear, Bumping and Cle Elum Lakes.

> Peregrine falcon (*Falco peregrinus*) - Preferred habitat of peregrine falcons is open country with rocky cliffs for nesting, nearby rivers and lakes, and a significant prey base. Nest sites are usually fairly small ledges on cliff faces. Cliffs and bluffs used for nesting range average about 150 feet tall. Waterfowl usually make up the bulk of the prey, but peregrines take virtually all bird species of smaller size. Peregrines nesting in eastern Washington appear to winter near their nest sites or move to lower areas with a more abundant winter prey base. Peregrines are expanding their range to use high buildings in some urban areas, with rock doves as the prey base.

> Gray wolf (*Canis lupus*) - The Northern Rocky Mountain Recovery Plan (NRMRP) (USFWS 1987b) identifies three areas for gray wolf recovery, none of which are in the Basin; however, wolves are regularly reported in eastern Washington. Although many reports are unverified, it is accepted that at least transient wolves occur; however, no pack activity has been documented.

Gray wolves occupy a broad spectrum of habitats. Key components of habitat as listed in the NRMRP include a sufficient year-round prey base of ungulates (mainly deer and elk within the Basin) and alternate prey; suitable and somewhat secluded denning and rendezvous sites; and sufficient space with minimal exposure to humans.

A current Service Research Information Bulletin recommends a revision in thinking about the requirements for wolf recovery (USFWS 1993). If wolves are fully or partially protected and prey remains adequate, wolves adapt to human development and expand their range. Necessary habitat or human-use restrictions are primarily "those on activities that actually destroy wolf or prey habitat or that clearly hinder wolf dispersal"(USFWS 1993).

> Grizzly bear (*Ursus arctos = U.a. horribilis*) - Grizzly bears have been reported throughout the Cascade Mountains. Their habitat use is determined by isolation from human disturbance, food distribution, food availability and denning security. Denning occurs most commonly on north slopes above 6,000 feet elevation. (U.S. Forest Service 1994). After emerging from dens in early spring, the bears move quickly to low elevation areas and feed on new growth and winter-

killed ungulates. Later in spring, bears generally feed on emerging grasses, forbs and budding shrubs. In late summer and fall, bears forage on berries such as huckleberry, serviceberry, rose and strawberry plants, then move to high elevations and denning sites. They may concentrate their use in mixed shrub fields, snow chutes, old burns, meadows and cutting units. Human disturbance, usually increased with road access into grizzly bear habitat, is known to affect bear use of otherwise suitable habitat. In general, roads increase the probability of bear-human encounters and human-induced mortality (USFS 1994).

> Bald eagle *(Haliaeetus leucocephalus)* - Suitable habitat includes those areas that are close to water and provide a substantial food base such as along rivers with anadromous fish, good populations of resident fish, abundant waterfowl and good mammal populations. In the Basin, bald eagles are found along the shores of reservoirs and rivers. Territory size and configuration are influenced by availability of perch trees for foraging, quality of foraging habitat and distance of nests from water supporting adequate food supplies. Human disturbance must be kept to a minimum during the nesting season.

The location of bald eagle nests in the Pacific recovery area is influenced by factors such as relative tree height, diameter, species, form, position on the surrounding topography, distance from water and distance from disturbance (Anthony and Isaacs 1989). Bald eagles usually nest in the same territories each year and often use the same nests repeatedly. Nest trees usually provide an unobstructed view of an associated waterbody and are often prominent locations on the topography. Snags, and trees with exposed lateral limbs or those with dead tops are often present in nesting territories and are used as roosts, perch sites or access points to and from the nest.

Bald eagle winter habitat is mostly associated with areas of open, ice-free water where fish are available and/or waterfowl congregate (Stalmaster 1987). Additionally, eagles may be scattered through upland areas feeding on ungulate carrion, game birds and rabbits (Swenson et al. 1981). In areas where waterways do not freeze, adult eagles tend to remain on the territory year-round. A majority of the bald eagles wintering in central and eastern Washington are winter migrants (Fielder 1992). Some move relatively short distances to lower elevations or inland for food sources. Most eagles that breed in the Pacific recovery area winter in the vicinity of their nests.

Candidate species

> Bull trout (*Salvelinus confluentus*) is a wide ranging, non-anadromous species that formerly inhabited most of the cold lakes, rivers and streams throughout the western states and British Columbia. It exhibits two life forms, resident and migratory. The resident forms inhabit streams and grows to about six to 12 inches. The migratory forms commonly exceed 12 inches in length and spawn in streams where the juveniles live for some time before migrating to rivers and lakes. Bull trout are piscivorous and require an abundant supply of forage fish for vigorous populations.

Bull trout require cold water, with 7-8° C appearing optimal and 15° C maximum. Spawning occurs in cooling water below 9° C. Optimal incubating temperature seems to be 2-4° C. Spawning occurs from August through November and eggs hatch in late winter or early spring. Emergence occurs in early April through May, commonly following spring peak flows. Because

of extended time in the substrate, bull trout are susceptible to mortality in unstable conditions. Successful reproduction requires channel and substrate stability and adequate winter water flow to prevent the substrate from freezing. Bull trout require complex forms of instream cover. Adults use pools, large woody debris, large boulders and undercut banks for resting and foraging. Juveniles also use side channels and smaller wood in the water. Channels for moving between safe wintering areas and summer foraging areas are also necessary.

> *Erigeron basalticus* (basalt daisy)- is reported in
T14N R19E T15N R19E T16N R19E

Reported sites in Yakima and Kittitas Counties are along the Yakima River and Selah Creek. Found in cliff crevices in basaltic canyons at low elevations.

> *Sidalcea oregana* var. *calva* (Oregon checkermallow)- is reported in
T18N R15E T20N R21E T21N R19E

Reported sites in Kittitas and Chelan Counties are near streams in mountainous areas.

Other species of concern

> Black tern (*Chlidonias niger*) - Black terns are small terns which eat primarily insects and can occur statewide, in or near wetlands and sloughs. They usually nest in marshy wetlands in June.

> California bighorn sheep (*Ovis canadensis californiana*) - This sheep has been reintroduced in various areas around the state in suitable habitat, including L.T. Murray and Oak Creek Wildlife Areas within the Basin.

> California floater (mussel) (*Anodonta californiensis*) (Lea, 1852)) - This mussel is found in unpolluted fresh water, except small creeks. They prefer lakes and slow streams with areas less than 6.6 feet deep having sandy bottoms. Adults will also live on mud bottoms. Juveniles are parasitic on gills, fins and barbels of host fish.

> California wolverine (*Gulo gulo luteus*) and Pacific fisher (*Martes pennanti pacifica*) - The wolverine and fisher prefer mountainous areas of the Cascade Mountains. They are generally found in the northern areas of the State, but extend sparsely as far as southern Yakima County.

> Cascades frog (*Rana cascadae*) - The Cascades frog is generally found above 3,000 feet in the Cascades and may only be active from May to August. They prefer montane and subalpine streams and ponds. Slow clear water with a substrate of silt, sand or gravel provides good breeding habitat. They may move to permanent streams when ponds dry up.

> Columbia pebblesnail (*Fluminicola (=Lithoglyphus) columbianus* (Hemphill in Pilsbry, 1899)) [great Columbia River spire snail] - This snail is found in the main channels and free-flowing parts of the Columbia River. They live on diatom-covered rocks.

> Ferruginous hawk (*Buteo regalis*) - This large hawk prefers open plains and brushy open country and avoids forested areas. They nest in trees along streams, bluffs, rock piles and artificial structures. Ferruginous hawks feed primarily on ground squirrels, rabbits and other small mammals.

> Fringed myotis (*Myotis thysanodes*)
> Long-eared myotis (*Myotis evotis*)
> Long-legged myotis (*Myotis volans*)
> Pale Townsend's (= western) big-eared bat (*Plecotus townsendii pallescens*)
> Small-footed myotis (*Myotis ciliolabrum*)
> Yuma myotis (*Myotis yumanensis*) - These bat species tend to forage over water, especially the Yuma myotis. They need to have roost areas near foraging areas, especially in winter, to minimize energy expenditure. They roost in caves, buildings, under bridges, rock crevices and under tree bark.

> Harlequin duck (*Histrionicus histrionicus*) - In the Cascade Mountains, harlequin ducks rely generally on fast, turbulent streams as breeding habitat. They would be present in the Basin from late March to early August. They nest on the ground near streams or in holes in trees or rocks.

> Larch Mountain salamander (*Plethodon larselli*) - This small salamander is found primarily near the Columbia River Gorge, but was recently found just south of Mt. Ranier National Park. They live in rock rubble, scree slopes and in rocky road fills up to 3,400 feet in elevation.

> Little willow flycatcher (*Empidonax traillii brewsteri*) - This flycatcher is primarily found west of the Basin, but comes as far east as the foothills of the Cascade Mountains, and the nearby flats. They use open brushy areas, especially scrub-shrub wetlands comprised of willow.

> Loggerhead shrike (*Lanius ludovicianus*) - Loggerhead shrikes are robin-sized birds which feed mainly on insects, with small birds and mammals taken in winter. Preferred habitat includes shrub-steppe and any semi-open area with shrubs, fences, powerlines or small trees for perches.

> Lynn's clubtail (*Gomphus lynnae*) - This dragonfly uses large, slow rivers with mud to small cobble substrate and shrubs and dense grass on the banks. They have been reported along the Yakima River between Kiona and Richland, but probably could be found elsewhere with additional surveys.

> Margined sculpin (*Cottus marginatus*) - This sculpin primarily inhabits the Walla Walla, Touchet and Tucannon Rivers in Washington. They are a benthic species whose requirements are poorly known. However, without competition, they seem to prefer cool (55-66° F) water, moderate to rapid current and rubble or gravel substrate.

> Northern goshawk (*Accipiter gentilis*) - This large hawk prefers mature and old-growth forests in the Cascade Mountains. Goshawks are aerial hunters, flying between trees and under canopy in search of grouse, smaller birds and other prey. Nest sites are in older trees within the forest stand.

> Northern sagebrush lizard (*Sceloporus graciosus graciosus*) - This lizard is primarily a shrub-steppe dweller, but also uses bouldered regions and forested slopes. They are typically a ground lizard and rarely climbs into shrubs. They prefers fine gravel soils, but are also found on sandy or rocky soil. They need rock crevices, mammal holes and similar cover for refuge.

> Olive-sided flycatcher (*Contopus borealis*) - This bird seems to prefer mixed and broken forests with wooded streams and some wetland. The diet consists entirely of flying insects which they search for from high snags and perches. They nest high in conifer trees.

> Pacific lamprey (*Lampetra tridentata*) - These fish have spawning habitat requirements similar to those of salmonids, including clean gravel and cold water. They spend about five years as ammocoetes; blind filter feeders that burrow in mud and fine sediments in pools, quiet backwaters and eddies, downstream from spawning riffles. The ammocoetes migrate slowly downstream, with their movement apparently triggered by high water flow. Between four and six years, ammocoetes start metamorphosing into adults and becoming parasitic on soft scaled fishes. The adults migrate to sea, where they remain until they return to spawn and die.

> River lamprey (*Lampetra ayresi*) - Not much is known about the river lamprey; however, it is assumed that its life history and requirements are similar to those of the Pacific lamprey. Both lampreys are known throughout the Columbia River system.

> Spotted frog (*Rana pretiosa*) - Spotted frogs are found in warmwater marshes, overflow wetlands and bogs with non-woody wetland vegetation. They are found in most of eastern Washington and within the basin occur in western Kittitas, Yakima and Klickitat Counties .

> Tailed frog (*Ascaphus truei*) - This frog occurs in higher elevations in the Cascades. It is the most aquatic frog in the Pacific Northwest and occurs in cold, rocky streams. It clings to rocks or other bottom features during the day and feeds along the stream or adjacent moist woodlands at night. Sedimentation and high water temperatures are likely causes of reductions of this species.

> Western burrowing owl (*Athene cunicularia hypugea*) - This owl is generally found in open, broken or flat areas of the Basin including shrub-steppe and agricultural areas. An opportunistic feeder, it preys primarily on insects and small mammals, but also birds, fishes and amphibians when available. They use ground squirrel or other mammal burrows for shelter and nesting.

> Westslope cutthroat trout (*Oncorhynchus (= Salmo) clarki lewisi*) - This trout requires cold, clean water of streams and lakes that are free from barriers to allow for migration. Disjunct populations are present throughout Washington with some of these native.

> *Astragalus columbianus* (Columbia milk-vetch) This is a short-lived perennial with a sprawling growth habit and brilliant white flowers, changing to yellow. It occurs in shrub-steppe and is most common in early seral stages (for example, following fire). They flower in March and April and germination and seedling establishment are enhanced by fire.

> *Calochortus longebarbatus* var. *longebarbatus* (Long-haired star-tulip)- This is a regional

endemic found in Klickitat and Yakima Counties.

> *Castilleja cryptantha* (obscure Indian paintbrush)- This plant is found primarily between 4,500 and 6,500 feet in elevation in the vicinity of Mount Ranier National Park (Smith-Kuebel and Lillybridge 1993). It is found in grass-dominated subalpine meadows, generally on level ground with stabilized, well-developed soils.

> *Cypripedium fasciculatum* (clustered lady's-slipper)- This perennial orchid grows on rocky soils in open coniferous forest (U.S. Forest Service 1995). In Washington, it is often associated with Douglas-fir and ponderosa pine. It is found at elevations of 450 feet to 4,500 feet.

> *Delphinium viridescens* (Wenatchee larkspur)- This is a local endemic found in the Wenatchee Mountains in Kittitas and Chelan Counties at 1,800 to 4,200 feet in elevation (Smith-Kuebel and Lillybridge 1993). It is found in or at the edge of meadows in areas which are more or less moist (springs, seeps, riparian areas)(Hitchcock and Cronquist 1973).

> *Lomatium tuberosum* (Hoover's desert-parsley)- This plant is found on rocky hillsides in the Cascade foothills in western Yakima County (Hitchcock and Cronquist 1973).

> *Rorippa columbiae* (Columbia yellow-cress) This species grows in damp to wet soils and has been observed near all types of water bodies including the Columbia River, streams, permanent lakes, wet meadows, irrigation ditches and roadside ditches (Gehring 1992). Populations in Washington are known along the Columbia River's Hanford Reach and near Bonneville Dam.

> *Silene seelyi* (Seely's silene)- This local endemic is found in crevices on basalt and granite rock outcrops and cliffs, usually in the absence of other species (Smith-Kuebel and Lillybridge 1993). It is found in the Wenatchee Mountains of Kittitas and Chelan Counties at elevations between 2,000 and 7,000 feet.

> *Tauschia hooveri* (Hoover's tauschia)- This species is found in shrub-steppe scablands in Yakima County (Hitchcock and Cronquist 1973).

State listed threatened, endangered and sensitive species and candidates for listing[1]

State listed threatened and endangered species

> Pygmy rabbit (*Brachylagus idahoensis*)
> Western gray squirrel (*Sciurus griseus*)
> Lynx (*Lynx canadensis*)
> Gray wolf
> Grizzly bear
> Marbled murrelet
> Northern spotted owl
> Peregrine falcon
> Bald eagle

> Ferruginous hawk
> Sandhill crane (*Grus canadensis*)

State sensitive species

> Larch Mountain salamander

State candidate species

> Merriam's shrew (*Sorex merriami*)
> Townsend's big-eared bat
> Washington ground squirrel (*Spermophilus washingtoni*)
> Fisher (*Martes pennanti*)
> Common loon (*Gavia immer*)
> Northern goshawk (*Accipiter gentilis*)
> Golden eagle (*Aquila chrysaetos*)
> Merlin (*Falco columbianus*)
> Sage grouse (*Centrocercus urophasianus*)
> Flammulated owl (*Otus flammeolus*)
> Burrowing owl (*Athene cunicularia*)
> Vaux's swift (*Chaetura vauxi*)
> Lewis' woodpecker (*Melanerpes lewis*)
> White-headed woodpecker (*Picoides albolarvatus)*
> Black-backed woodpecker (*Picoides arcticus*)
> Pileated woodpecker (*Dryocopus pileatus*)
> Sage thrasher (*Oreoscoptes montanus*)
> Loggerhead shrike (*Lanius ludoviciamus*)
> Sage sparrow (*Amphispiza belli*)
> Cascades spotted frog
> Northern leopard frog (*Rana pipiens*)
> Pygmy whitefish (*Prosopium coulteri*)
> Margined sculpin
> Silver-bordered bog fritillary (*Boloria selene atrocostalis*)
> Basin hairstreak (*Mitoura barryi*)
> Johnson's (Mistletoe) hairstreak (*Mitoura johnsoni*)
> Juniper hairstreak (*Mitoura siva ssp.*)
> Yuma skipper (*Ochlodes yuma*)

[1] (Leray Stream, wildlife biologist, WDFW, personal communication)

Environmental contaminants

Water quality degradation in the Yakima River is among the highest of all monitored streams in

Washington, with constituent concentrations increased in a downstream direction (USGS 1992). BPA (1990) noted water quality problems in the Basin restricted largely downstream of Sunnyside Dam to the river's mouth. The quality of agricultural return flow determines water quality in lower reaches of the Yakima River since return flows comprise as much as 80 percent of the lower mainstem flow during the irrigation season.

There were increases in ammonia, nitrite-plus-nitrate and orthophosphate concentrations in the Yakima River from water years 1974 to 1981 (USGS 1992). This may be due to increasing use of nitrogen and phosphorous fertilizers and increasing livestock populations in the Basin. About two percent of the ammonia determinations exceeded the Environmental Protection Agency (EPA) chronic-toxicity criteria for the protection of salmonids or other sensitive fish species.

Concentrations of several organic compounds exceeded State water standards for chronic toxicity of freshwater aquatic life, including aldrin/dieldrin, endosulfan, DDT and its metabolites, endrin, parathion and polychlorinated biphenyls (PCBs). USGS (1992) found the largest concentrations of hydrophobic compounds (DDT and its metabolites, dieldrin and others) in agricultural return flows that also contained the largest suspended sediment concentrations. This suggests that these contaminants could be reduced in streams by controlling erosion of contaminated soils.

Annual statewide analyses by WDOE revealed the consistent presence of DDT and its metabolites in fish, with the highest concentrations from Yakima River fish. In 1985, these levels were below Food and Drug Administration action levels, but slightly exceeded the National Academy of Science (NAS) recommended levels for protection of aquatic life in fish from the lower Yakima River. In July, 1993, Washington Department of Health issued a fish consumption advisory for fish in the Yakima River due to DDT and DDE levels. The advisory is still in effect and includes the river from just above Yakima to its mouth and also some tributaries such as Moxee Drain, Marion Drain and Sulphur Creek. The advisory recommends people limit consumption of bottom fish from these sources to one meal per week.

USGS (1992) also found nearly 50 percent of the fecal-coliform bacteria determinations made in the Basin exceeded the State standards. Most exceedances occurred downstream of Granger (RM 82.7). They also noted that fecal-coliform concentrations were increasing from 1977-85 water years in the lower Yakima River at Parker (RM 104.6) and Kiona (RM 29.9) by six and 14 percent per year, respectively. Their data suggest that nonpoint sources are controlling bacterial quality of the streams and increases in fecal-coliform concentrations could be attributed to increases in livestock numbers in the Basin.

POTENTIAL CHANGES TO AQUATIC AND TERRESTRIAL RESOURCES FROM IMPLEMENTING THE VARIOUS YRBWEP ELEMENTS

Anadromous fish

Potential adverse impacts may accrue to downstream fisheries from changes in the coordinated flow releases from storage reservoirs to facilitate construction. For example, Kachess Dam modifications would result in the lowering of the reservoir during construction and the loss of one

season of manipulating storage releases between Kachess and Keechelus Lakes to benefit spring chinook spawning. Modifications at Cle Elum Dam may also require lowered reservoir levels during construction with potentially reduced storage available for supplementing Yakima River flows. Also, high flow releases made early in the season to drawdown reservoirs may scour redds and newly emerged fry and juvenile salmon and trout could be flushed out of suitable habitat. Close coordination with the Systems Operating Advisory Committee (SOAC) would help ensure flow requirements are met to the maximum extent possible in spite of reduced flexibility due to construction requirements.

With Title XII fully implemented, at least 250,000 more acre-feet of water per year would be available for instream uses. This is about 7.5 percent of the average annual runoff for the Basin. This is a significant amount of water that can be made available during critical times of the year. Furthermore, this does not include the following potential sources for flow improvement: additional storage at Kachess Lake; water conserved on the Yakama Indian Nation projects; and, water conserved on the Taneum Creek and other tributary streams which have no required water savings determined.

The Title XII elements collectively would have the effect of decreasing water diversions from the river; decreasing flow fluctuations (especially below some diversion points); increasing instream flow levels; increasing the effectiveness of fish screens; and decreasing the input of sediments, pesticides, herbicides and nutrients into the Yakima River. The improved instream flows realized through implementation of the proposed project would increase spawning, incubation and rearing habitat for anadromous fish. It would also facilitate upstream migration of adults and downstream migration of juvenile anadromous fish. The number of returning fish would increase over a period of years as successive generations of anadromous fish went through their three to five year cycle from incubation down to the ocean and back up to spawn.

Resident fish

The improved streamflows throughout the Basin should improve most resident fish populations. USFWS (1987b) determined that improved instream flows in the upper Yakima River would improve conditions for rainbow trout juvenile and adult rearing; whitefish spawning, incubation and rearing; and possibly for brook trout spawning, incubation and rearing. Decreases in flows in some drains and wasteways due to water conservation measures may adversely impact resident fish present in those systems. Resident fish may be adversely or beneficially impacted by operational changes in the Project depending on whether or not flow fluctuations are increased or moderated, respectively. Rapid flow changes force fish to abandon niches and established territories, can cause stranding (especially of juveniles), and can strand or flush out benthic invertebrates that serve as an important food base for most of the fish species present in the Basin.

Terrestrial resources

In general, many improvements in water delivery, application and use can have an adverse impact on wildlife in the Basin. Leakage in water transport facilities and inefficient irrigation techniques have resulted in the maintenance and creation of riparian, wetland and other habitats. Oakerman (1979) found that the largest wildlife populations along canals occurred in these areas. As water

delivery efficiency is increased, through canal lining, piping, etc., habitat dependent on water loss will disappear. Aside from the loss of vegetative habitat, some water conservation measures would also reduce or eliminate water currently available for drinking, resting, or feeding. The majority of terrestrial impacts from title XII, both positive and adverse, would involve wetlands and riparian areas. However, additional habitats would also be impacted, depending on the implementation measures finally used.

Shallow groundwater wells may be used for irrigation in some areas as a measure to conserve surface waters. This measure would lower the water table to a greater or lesser extent (depending on soil and substrate conditions) and could dry up wetland and riparian areas throughout the pumping field and its zone of influence.

The effects of the YRBWEP on wetlands would be both beneficial and adverse. Beneficial affects could accrue from elements such as the Toppenish Creek Corridor Enhancement and Irrigation Demonstration Project on the Yakama Indian Reservation and the Yakima Basin Tributaries elements, depending on their final designs. Furthermore, with some additional flows in the Yakima River following implementation of the various elements, wetland acreages may improve in the lower reach. Since the increased flows would generally remain within the river channel, wetland restoration or enhancement would be minimal from additional Yakima River flow. Wetland losses would accrue due to full implementation of the YRBWEP. Using irrigation water more efficiently with nonstructural means may result in less water available for wetland maintenance. For example, improved water measurement and automation should result in less water moving through a system and reduced hydrology for associated wetlands, as well as less water contributed to the groundwater which feeds some wetlands. Additional wetland information should be gathered once YRBWEP project elements are further developed. As directed by Title XII, an inventory of wetland resources will be conducted by Reclamation in coordination with WDFW (USBR 1996a). This information would help assess impacts (both adverse and beneficial) from project implementation. Also, attempts should be made to minimize wetland loss during project development. Projected wetland benefits from YRBWEP should be determined more closely and net wetland losses should be mitigated.

Changing cropping patterns as a method to conserve water may also have adverse impacts to wildlife in the Basin. For example, significant declines in cereal grains in the Kittitas Valley was found to decrease pheasant numbers by over 70 percent (USFWS 1982). Also, increasing cropfield size, which is sometimes accomplished to accommodate irrigation techniques, reduces the value of this habitat to most wildlife which use it.

Basin Conservation Program Impacts from this element basically depend on water conservation measures used. Potential measures include canal lining; converting open ditch systems to closed pipe systems; converting furrow irrigation to drip or sprinkler irrigation; increased precision in water application; and different cropping patterns. A potential adverse impact to fishery resources from this element could occur from lowering water tables near streams with less water available for infiltration and/or groundwater withdrawal. This could reduce groundwater return flows into streams such as lower Toppenish and Satus Creeks, which could potentially raise water temperatures and reduce habitat. However, water conservation measures should also result in less water being withdrawn from the Yakima River itself, with potentially cooler water and more

aquatic habitat available.

Measures involving lining canals will harm big game and other animals by causing them to be trapped if they enter canals. Highline and Tieton Canals have already been identified as having trapping problems, with estimated losses at the Highline Canal of 80 deer and elk annually (Merker 1985).

Some of the benefits of this element include reducing sediments, pesticides, herbicides and nutrients in the Yakima River and its tributaries. At least in the Moxee Watershed, 95 percent of the sediment loading occurs during the irrigation season (North Yakima Conservation District and SCS 1994). Also, poor water management has been listed as a major cause for soil erosion in the Basin (Dawson 1987). This indicates improvements in irrigation systems for water conservation, for example, converting from furrow to drip irrigation, could reduce a significant source of sediments and other contaminants in the aquatic system.

Impacts from implementation of the Basin Conservation Program can be better determined when Water Conservation Plans have been prepared, specific measures identified and locations of areas to be affected by those measures determined.

Yakima Project Operations Some Project elements primarily benefit irrigation (for example, Kachess Lake augmented storage); however, this element allows irrigation benefits to also benefit fisheries. Since the operational regime is now based on total water supply available in the Basin, as this water supply increases, target flows at Sunnyside and Prosser Dams would be increased, benefitting aquatic resources using the lower Yakima River. With the potential for over twice as much flow in the Yakima River at Prosser and Sunnyside as the current minimum target flow (300 cfs), adjacent riparian areas and wetlands should be at least maintained and may be improved in quality and quantity. Higher and more dependable flows will improve adjacent soil moisture during critical low flow periods when rainfall is also limiting and trees, shrubs and other plants are stressed. This element also includes the development of biologically-based target flows, which should further benefit anadromous fish by fine tuning flow requirements and hopefully improving habitat conditions.

Cle Elum Dam and Lake Terrestrial habitat would be adversely impacted by the proposed project through inundation (USFWS 1987a). The approximately 70 acres of uplands which would be inundated by raising the pool level three feet is sparsely vegetated with coniferous trees and little or no understory vegetation. Additionally, the required relocation of the Forest Service Wish Poosh Campground could result in adverse impacts from construction and increased human activity at the new location. Enlargement of the reservoir would have little impact on aquatic resources (USFWS 1985), except for benefits provided by the 14,600 acre-feet of additional storage to be used to increase instream flow. While areas to receive shoreline protection have already experienced erosion problems, adverse impacts may result by constructing access roads and stockpile areas for riprap, and disturbance of wildlife during construction activities. Adverse impacts from the fish passage facility portion of this element would be determined when project details are further developed. Positive impacts of this measure include reestablishing spring chinook salmon and steelhead migration to and from the lake. Furthermore, the reintroduction of sockeye salmon may also be feasible.

Chandler Pumping and Powerplant With the project fully implemented, diversions from the Yakima River would be reduced by an average of 342 cfs during the irrigation season based on flow and diversion records from 1985 to 1994 (USFWS 1996b). The project would help moderate some acute and unpredictable decreases in streamflows. More dependable and higher flows should also lower water temperatures in this reach, especially during warm summer months. Any decrease in summer water temperatures should benefit anadromous and resident fish, since they can currently exceed critical thermal thresholds. More detailed information on impacts of this element can be found in the Service's Fish and Wildlife Coordination Act Report on this proposed element (USFWS 1996b).

Kachess Dam and Lake Modifying the outlet works and discharge channel at Kachess Dam would allow for over 80,000 acre-feet of available stored water (about one-third of Kachess Lake storage), which is currently stranded annually, to be made available (USBR 1996b). This would increase the number of "mini flip-flop" operations which take place from about five in every ten years to eight or nine in every ten years (John Tiedeman, biologist, Reclamation, personal communication). "Mini flip-flop" involves manipulating storage releases from Kachess and Keechelus Lakes to enhance spring chinook spawning. The additional "mini flip-flops" would increase the maintenance of preferred spawning and incubation conditions by 30 to 40 percent within an 11-mile reach of the Yakima River. Potential adverse impacts include the loss of one year of "mini flip-flop" operations and water quality impacts during construction. Water quality impacts should be minor if mitigation measures in Reclamation's Final Environmental Assessment for the project (1996b) are implemented. Additional information on potential impacts from this procedure is addressed in the Service's Planning Aid Memorandum (USFWS 1996a).

Impacts from augmenting Kachess Lake storage with water from Cabin and Silver Creeks include loss of terrestrial habitat along the pipeline alignments (primarily coniferous forest), construction activities associated with crossing the Yakima River with pipelines and the addition of potentially 45,000 acre-feet or more of stored water annually (CH2M Hill 1989). This stored water may be dedicated for both irrigation and anadromous fish. Additional impacts may be determined during the feasibility study for this project.

Tributaries Positive impacts may accrue from this element since it should result in enhanced water supplies for fish and wildlife. However, the actual implementation measures and timing of water availability would need to be examined to determine beneficial and adverse impacts of this element.

Yakama Indian Nation The Toppenish Creek Corridor Enhancement element of YRBWEP would likely involve wetland restoration and enhancement components. However, a more complete determination of potential impacts from the three projects included with this element should be made once implementation measures are determined.

Interim Comprehensive Basin Operating Plan A draft plan will not be developed until October 31, 1999. Determination of potential adverse and beneficial impacts should be made at that time.

In conclusion, the Service supports full implementation of Title XII provisions. However, while we recognize there are many benefits from the various proposed elements, primarily for

anadromous fish, there are some adverse impacts that need to be addressed. The Service should continue to be involved as project plans for each element become better developed to help better determine impacts. This information would be provided in Supplemental Fish and Wildlife Coordination Act Reports.

RECOMMENDATIONS

The following are the Service's recommendations to avoid or mitigate potential adverse impacts to fish and wildlife resources or enhance those resources. These recommendations may change, become more detailed or entirely new recommendations may be made as project elements become further developed. The Service would develop more detailed recommendations in the future through supplemental Fish and Wildlife Coordination Act Reports.

1. Construction efforts that may affect aquatic resources need to be conducted to prevent adverse impacts to anadromous and resident fish. Consideration needs to be given to such things as timing; conducting work in reservoirs, streams, rivers and irrigation facilities at low flows or in the dry, and use of best management practices to prevent the introduction of sediments and contaminants into the aquatic system.

2. Other opportunities to reduce the introduction of sediments and contaminants into the aquatic system need to be encouraged in the development of the Basin Conservation Program's water conservation plans, Yakama Indian Nation projects, and potentially the Tributary element.

3. If flow changes due to implementing Title XII elements reduce the effectiveness of fish passage structures and screens, these impacts would need to be fully mitigated.

4. Continuing efforts need to be made to moderate flow fluctuations in the regulated reaches of the system by adopting more gradual ramping rates.

5. An accurate water measurement and accounting system needs to be a key part of this venture to ensure maximum benefits to fish and wildlife resources.

6. A canal/drain right-of-way management plan needs to be developed to improve wildlife habitat associated with irrigation facilities. It needs to include such things as eliminating, minimizing and/or better managing mowing, spraying, burning and grazing (for example, delay mowing, spraying and burning operations until after birds have nested and young have fledged and refrain from burning canals and drains in winter when they often provide important cover to many species of wildlife). It also needs to include establishing grass cover, and where possible, tree and shrub cover, along disturbed rights-of-way. Aside from improving wildlife habitat, establishment of a healthy vegetative cover will reduce weed problems.

7. Fencing of grazed areas along some waterways, reservoirs and wetlands to exclude or manage the intensity and timing of livestock grazing, needs to be implemented to improve riparian and wetland habitats and mitigate for riparian and wetland losses. Watering gaps, piping and watering troughs outside of exclosures, can be used in concert with fencing.

8. Areas disturbed by constructing various project elements; such as, pipeline corridors from Cabin and Silver Creeks to Kachess Lake, borrow sites, corridors for new water lines or similar activities, need to be revegetated with native vegetation. Plants removed during construction needs to be replaced with the same or similar species as soon as possible following construction. It may be necessary to use temporary cover crops, mulches or various fabrics to quickly stabilize some sites.

9. Trees affected by the Cle Elum Lake pool rise should not be removed, unless they pose a safety problem. These trees would die and become snags that would be valuable as perching, feeding and nesting sites.

10. The siting of borrow areas, spoil sites, construction staging areas, Wish Poosh Campground, etc., needs to be selected to avoid or minimize impacts to important habitats.

11. Big game protection measures need to be installed on canals with identified problems trapping animals. Fences, bridges, ladders, ramps and deflectors can be used to prevent trapping or to facilitate escape from the canals (Merker 1985). If canals are modified for water conservation (for example, lining with cement), with an increasing likelihood of trapping big game animals, then fences, bridges, ladders, ramps and/or deflectors need to be incorporated to prevent the trapping of animals or to facilitate their escape from the canals.

12. The use of bioengineering techniques (for example, live gabions, brush wattling and/or willow stakes) as an alternative to strictly riprapping can and should be used to reduce construction costs, potentially decrease operation and maintenance costs, and enhance riparian habitat along the shoreline of Cle Elum Lake or other areas where bank stabilization is proposed.

13. Vegetation management activities to help control or reduce the spread of purple loosestrife, Eurasian milfoil and other non-native weeds in the Basin need to be implemented. We recommend an active program for control be established and monitored to ensure Project activities do not increase noxious weed problems in the Basin.

14. We encourage the use of buffers, which can be important for improving the quality of adjacent habitats. They also improve the success of habitats development through mitigation or enhancement activities.

15. Opportunities to benefit threatened and endangered species, neotropical migratory birds and other species of concern need to be implemented. Reclamation can fulfill the habitat requirements of certain species in conjunction with Project operations, construction or mitigation and enhancement activities.

16. One measure that can be very effective, is public outreach (information/education). The public needs to understand what is being proposed and how it may affect them and possibly future generations, before they will fully accept a particular program. We recommend a public outreach strategy be developed to help the public accept the implementation measures and help maximize potential benefits of Title XII, especially with the elements which directly affect private landowners, such as the Basin Conservation Program.

17. Wetland and riparian habitats adjacent to irrigation facilities and would be dried up through water conservation measures, need to be provided water directly for maintenance of those habitats.

18. We recommend wetland mitigation banking be implemented as a means to mitigate wetland losses. Mitigation banking is the restoration, creation, enhancement, and in exceptional circumstances, preservation of wetlands and/or other aquatic resources expressly for the purpose of providing compensatory mitigation in advance of authorized impacts. Some advantages of mitigation banks over individual mitigation projects include: 1) It may be advantageous for maintaining aquatic ecosystem integrity by consolidating mitigation into a single large parcel or contiguous parcels. 2) Compensatory mitigation is typically implemented and functioning in advance of project impacts. 3) It may provide more cost-effective mitigation opportunities. 4) A mitigation bank can bring together financial resources, planning and scientific expertise, which can increase the potential for the establishment and long-term management of successful mitigation that maximizes opportunities for contributing to biodiversity. 5) The consolidation of compensatory mitigation within a mitigation bank increases the efficiency of limited agency resources in review and compliance monitoring of mitigation projects.

19. Consideration needs to be given to combining mitigation efforts with ongoing conservation efforts in the Basin. For example, for wetland/riparian areas lost due to conversion to trickle irrigation with the Moxee Watershed Project, vegetation restoration activities will take place with ongoing wetland/riparian restoration efforts by other entities such as the Yakima Greenway Foundation, WDFW, etc. (Mike Tobin, Manager, North Yakima Conservation District, personal communication). Combining conservation efforts with such partnerships maximizes funding efficiency, accessing expertise and facilitating a larger and more ecologically sound project. Furthermore, it can increase the potential for long-term success of mitigation efforts. Also, there may be opportunities to mitigate the losses of small degraded wetlands along canals, for example, by restoring valuable larger blocks of wetlands with many benefits. A larger wetland mitigation project in the Yakima River floodplain will provide important flood control, public recreation and water quality benefits, tie in with existing protected wetland and riparian areas, improve habitat for wildlife which use wetlands and perhaps benefit anadromous fish by providing rearing areas, reducing water temperatures through shading and increasing invertebrate production.

20. Mitigation activities should not be confined to Reclamation project lands. If mitigation opportunities are better on other lands, then interagency agreements, easements, fee title acquisition or other mechanisms to accomplish this mitigation needs to be implemented.

21. Mitigation measures for unavoidable project impacts needs to be determined for each element and presented and fully evaluated before construction begins. This plan needs to contain several features, such as: mitigation objectives, mitigation project design, standards for success, monitoring, reporting requirements, permanent protection measures, contingencies if mitigation measures are unsuccessful and a description of long-term maintenance activities (probable practices and responsible parties). Amounts of required mitigation will become clearer as project design develops.

22. A basin-wide coordinated effort is needed to ensure avoidance and minimization of impacts is

maximized and mitigation measures are soundly developed and implemented. For example, close coordination between Reclamation, the SOAC, the Basin Conservation Program CAG, Yakama Indian Nation and other entities affecting the use of Basin irrigation water under Title XII, is important to reduce potential adverse impacts, ensure losses are adequately mitigated and reduce conflicts with other priorities. A comprehensive management plan (similar to the Interim Comprehensive Basin Operating Plan) and possibly set up an interagency committee is needed to help facilitate coordination between the various entities involved in Title XII and guide mitigation and enhancement efforts throughout the Basin. Good coordination across various boundaries (district, tribal, federal, state, private, etc) is needed to maximize the benefits of water conservation measures to irrigation interests and fish and wildlife resources.

LITERATURE CITED

Andelman, S.J. and A. Stock. 1994. Management, Research and Monitoring Priorities for the Conservation of Neotropical Migratory Landbirds that Breed in Washington State. Washington Natural Heritage Program. Washington Department of Natural Resources, Olympia, WA 25 pp.

Anthony, R.G. and F.B. Isaacs. 1989. Characteristics of Bald Eagle Nest Sites in Oregon. J. Wildl. Manage. 53(1):148-159.

BLM (Bureau of Land Management). 1991. Draft Spokane Resource Management Plan Amendment/Environmental Impact Statement Supplement. BLM-OR-ES-91-33-1792. U.S. Department of the Interior, Bureau of Land Management, Spokane, WA 163 pp.

BPA (Bonneville Power Administration). 1990. Yakima-Klickitat Production Project Environmental Assessment and Finding of No Significant Impact. DOE/EA-0392, Bonneville Power Administration, Portland, OR

BPA. May, 1994. Lower Yakima Valley Wetlands and Riparian Restoration Project Final Environmental Assessment and Finding of No Significant Impact. DOE No. 0941, U.S. Department of Energy, Bonneville Power Administration, Portland, OR 58 pp.

BPA. 1996a. Yakima Fisheries Project Final Environmental Impact Statement. In cooperation with Washington Department of Fish and Wildlife and Yakama Indian Nation. DOE/EIS-0169, U.S. Department of Energy, Bonneville Power Administration, Portland, OR 204 pp.

BPA. 1996b. Washington Wildlife Mitigation Projects Draft Programmatic Environmental Assessment. DOE/EA-10962, U.S. Department of Energy, Bonneville Power Administration, Portland, OR 89 pp.

CH2M Hill. 1989. Appraisal Assessment of Augmenting Kachess Reservoir Stored Waters by Gravity Feed from Cabin Creek and Silver Creek. Prepared for: U.S. Department of the Interior, Bureau of Reclamation, Boise, ID 30 pp.

Cowardin, L.M., V. Carter, F.C. Golet and E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. 131 pp.

Dahl, T.E. and C.E. Johnson. 1991. Status and Trends of Wetlands in the Conterminous United States, Mid-1970's to Mid-1980's. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. 28 pp.

Daubenmire, R. 1970. Steppe Vegetation of Washington. Washington State University Cooperative Extension, EB1446. 131 pp.

Dauble, D., R. Mueller, and G. Martinson. 1994. Evaluation of Water Quality Conditions near Proposed Fish Production Sites Associated with the Yakima Fisheries Project. Prepared for:

U.S. Department of Energy, Bonneville Power Administration.

Dawson, R.H. and Associates Inc. 1987. Onfarm Conservation Practices in the Yakima Basin - Phase II. Prepared for U.S. Department of the Interior, Bureau of Reclamation, Boise, ID 53 pp.

Dobler, F. 1990. Shrub Steppe Ecosystem Studies: Phase I Completion Report for 1988-1990. Washington Department of Wildlife, unpublished draft on file.

Fast, D., J. Hubble, M. Kohn and B. Watson. 1991. Yakima River Spring Chinook Enhancement Study. Prepared for: U.S. Department of Energy, Bonneville Power Administration.

Fielder, P.C. 1992. Effects of Recreational Use on Bald Eagles Along the Rock Island Project. PUD Annual Report. Wenatchee, WA 17 pp.

Franklin, J.F. and C.T. Dyrness. 1973. Natural Vegetation of Oregon and Washington. Gen. Tech. Rep. PNW-8. U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, OR 417 pp.

Franklin, J.F. and J.M. Trappe. 1963. Plant Communities of the Northern Cascade Range: A Reconnaissance. Northwest Science 37(4): 163-164.

Gehring, J. 1992. Element Stewardship Abstract: *Rorippa columbiae* (Robinson) Howell. Unpublished report prepared for The Nature Conservancy, Washington Field Office, Seattle, WA 26 pp.

Hitchcock, C.L. and A. Cronquist. 1973. Flora of the Pacific Northwest. University of Washington Press, Seattle, WA 730 pp.

Johnson, A., D. Norton and B. Yake. 1986. Occurrence and Significance of DDT Compounds and Other Contaminants in Fish, Water, and Sediment from the Yakima River Basin. Washington Department of Ecology, Olympia, WA 89 pp.

Merker, C.R. 1985. Big Game Mortality in the Highline Canal of the Yakima Project. Prepared by Washington Department of Game. Prepared for U.S. Department of the Interior, Bureau of Reclamation, Boise, ID 42 pp.

Mongillo, P. and L. Falconer. 1980. Yakima Fisheries Enhancement Study Final Report. Washington Department of Game, Yakima, WA 171 pp.

North Yakima Conservation District and SCS (Soil Conservation Service). 1994. Moxee Watershed Plan and Environmental Assessment for Moxee Watershed, Yakima County, Washington. North Yakima Conservation District in cooperation with Soil Conservation Service, Yakima, WA 38 pp.

Noss, R.F., E.T. LaRoe III and J. M. Scott. 1995. Endangered Ecosystems of the United States: A Preliminary Assessment of Loss and Degradation. Biological Report 28, U.S. Department of

the Interior, National Biological Service, Washington, D.C. 58 pp.

Oakerman, G. 1979. Yakima River Basin Wildlife Enhancement Study. Contract No. 7-07010-SS038. Washington Department of Game for U.S. Department of Interior, Bureau of Reclamation, Yakima, WA 146 pp.

Oliver, W.H. 1983. Farm - Wildlife History, Relationships and Problems on Yakima Indian Reservation. Contract # 82-7134, Yakima Indian Nation, Toppenish, WA 181 pp.

Parker, R.C. 1989. Draft Southcentral Waterfowl Management Plan. Unpublished report on file. Washington Department of Wildlife, Moses Lake, WA

Smith-Kuebel, C. and T.R. Lillybridge. 1993. Sensitive Plants and Noxious Weeds of the Wenatchee National Forest. U.S. Department of Agriculture, Forest Service, in cooperation with U.S. Department of Energy, Bonneville Power Administration, Portland, OR

Stalmaster, M.V. 1987. The Bald Eagle. Universe Books, New York, New York. 227 pp.

Stemple, J.M. 1985. Conversion of Weighted Usable Area to Potential Fish Production in the Yakima Basin. Unpublished report. U.S. Department of the Interior, Fish and Wildlife Service, Olympia, WA

Swenson, J.E., T.C. Hinz, S.J. Knapp, H.J. Wentland and J.T. Herbert. 1981. A Survey of Bald Eagles in Southeastern Montana. Raptor Res. 15(4):113-120.

Tuck, B. 1989. Memorandum from Bob Tuck, Eco-Northwest to Larry Vinsonhaler, Yakima River Basin Water Enhancement Project Study Leader.

USBR (U.S. Bureau of Reclamation). 1986. Preliminary Evaluation of Nonstorage Elements Being Considered for Early Implementation. U.S. Department of the Interior, Bureau of Reclamation, Boise, ID 35 pp.

USBR. 1990. Fish Passage and Protective Facilities, Phase II, Yakima River Basin, Washington. Planning report by U.S. Department of the Interior, Bureau of Reclamation, Boise, ID 31 pp.

USBR. 1996a. Yakima River Basin Water Enhancement Project Plan of Study for the Preparation of a Programmatic Environmental Impact Statement. Planning report by U.S. Department of the Interior, Bureau of Reclamation, Boise, ID 45 pp.

USBR. 1996b. Finding of No Significant Impact and Final Environmental Assessment; Modifications to Kachess Dam, Yakima River Basin Water Enhancement Project, Washington. U.S. Department of the Interior, Bureau of Reclamation, Yakima, WA

USBR and USFWS (U.S. Fish and Wildlife Service). 1968. Bumping Lake Enlargement. Joint report. U.S. Department of the Interior, Bureau of Reclamation, Boise, ID 77 pp.

USBR and WDOE (Washington Department of Ecology). 1985. Yakima River Basin Water Enhancement Project Phase 2 Status Report. U.S. Department of Interior, Bureau of Reclamation in cooperation with Washington Department of Ecology, Boise, ID

USBR and WDOE. 1987. Yakima River Basin Early Implementation Program. Draft Report prepared by U.S. Department of Interior, Bureau of Reclamation in cooperation with Washington Department of Ecology, Boise, ID

USFWS (U.S. Fish and Wildlife Service). 1986a. Potential Fish and Wildlife Impacts of Alternative Plans proposed for the Yakima River Basin Water Enhancement Project. Planning Aid Report prepared by the U.S. Department of Interior, Fish and Wildlife Service Olympia, WA for the Bureau of Reclamation, Boise, ID

USFWS 1986b. Recovery Plan for the Pacific Bald Eagle. U.S. Department of the Interior, Fish and Wildlife Service, Portland, OR 160 pp.

USFWS. 1987a. Fish and Wildlife Coordination Act Report for the Early Implementation Measures of YRBWEP. U.S. Department of the Interior, Fish and Wildlife Service, Olympia, WA 22 pp.

USFWS. 1987b. Northern Rocky Mountain Wolf Recovery Plan. U.S. Fish and Wildlife Service, Denver, CO 119 pp.

USFWS. 1990. Regional Wetlands Concept Plan. U.S. Department of the Interior, Fish and Wildlife Service, Portland, OR 18 pp.

USFWS. 1993. Updating Our Thinking on the Role of Human Activity in Wolf Recovery. U.S. Fish and Wildlife Service Information Bulletin, St. Paul, MN 2 pp.

USFWS. 1995a. Supplemental Fish and Wildlife Coordination Act Report, Yakima River Water Conservation Demonstration Project. U.S. Department of the Interior, Fish and Wildlife Service, Olympia, WA 8 pp.

USFWS. 1995b. Planning Aid Report for the Chandler Pumping Plan Electrification Reconnaissance Study. U.S. Department of the Interior, Fish and Wildlife Service, Olympia, WA 18 pp.

USFWS. 1996a. Planning Aid Memorandum for the Proposed Modifications to the Kachess Dam. U.S. Department of the Interior, Fish and Wildlife Service, Moses Lake, WA 5 pp.

USFWS. 1996b. Fish and Wildlife Coordination Act Report, Yakima River, Chandler Pumping Plant Electrification. U.S. Department of the Interior, Fish and Wildlife Service, Moses Lake, WA 24 pp.

U.S. Forest Service. 1994. United Eagle Timber Sale Biological Evaluation. U.S. Forest Service, Colville, WA 17 pp.

U.S. Forest Service. 1995. Draft Environmental Impact Statement Snoqualmie Pass Adaptive Management Area Plan. Wenatchee and Mt. Baker-Snoqualmie National Forests. Available from Wenatchee National Forest, Wenatchee, WA or Mt. Baker-Snoqualmie National Forest Mountlake Terrace, WA.

USGS (U.S. Geological Survey). 1991. Water Resources Data, Washington, Water Year 1991.

USGS. 1992. Surface Water Quality Assessment of the Yakima River Basin, Washington: Analysis of Available Water Quality Data Though 1985 Water Year. Open-File Report 91-453. U.S. Geological Survey, Portland, OR 244 pp.

Watson, B. 1989. Draft Columbia Basin System Planning- Yakima Sub-basin. Unpublished draft report, Yakima Indian Nation, Toppenish, WA 267 pp.

WDFW (Washington Department of Fish and Wildlife). 1995. Draft Priority Habitat Management Recommendations - Riparian. Washington Department of Fish and Wildlife, Olympia, WA 196 pp.

Yakima Indian Nation. 1992. Integration of Cultural, Agricultural, Wildlife, and Fisheries Resources in the Toppenish Creek corridor: a Tribal Enhancement Project. Department of Natural Resources, Toppenish, WA 87 pp.

Young, C. 1976. Areas of High Ecological Value in Yakima Watershed. Unpublished final report on file. Washington Department of Game.

APPENDIX A - Neotropical Migratory Birds Found Within the Yakima River Basin Grouped by Habitat Association[1]-

freshwater marshes, lakes and ponds

osprey
northern harrier
killdeer
short-eared owl
black swift
belted kingfisher
eastern kingbird
purple martin
tree swallow
violet-green swallow
northern rough-winged swallow
bank swallow
cliff swallow
barn swallow
marsh wren
common yellowthroat
red-winged blackbird
yellow-headed blackbird

wet meadows (excluding hay fields)

northern harrier
red-tailed hawk
American kestrel
long-eared owl
short-eared owl
calliope hummingbird
rufous hummingbird
horned lark
tree swallow
cliff swallow
American robin
American pipit
common yellowthroat
savannah sparrow
Lincoln's sparrow
bobolink
western meadowlark
Brewer's blackbird

subalpine parkland

American kestrel
calliope hummingbird
rufous hummingbird
northern flicker
olive-sided flycatcher
golden-crowned kinglet
ruby-crowned kinglet
mountain bluebird
Townsend's solitaire
hermit thrush
yellow-rumped warbler
lazuli bunting
chipping sparrow
fox sparrow
Lincoln's sparrow
dark-eyed junco
Cassin's finch

cliffs

turkey vulture
red-tailed hawk
ferruginous hawk
golden eagle
American kestrel
peregrine falcon
prairie falcon
black swift
white-throated swift
cliff swallow
rock wren

[1] based on Andelman and Stock (1994)

APPENDIX A - continued.

Riparian

osprey
sharp-shinned hawk
Cooper's hawk
Swainson's hawk
red-tailed hawk
American kestrel
merlin
mourning dove
long-eared owl
common nighthawk
black swift
Vaux's swift
black-chinned hummingbird
calliope hummingbird
rufous hummingbird
belted kingfisher
Lewis's woodpecker
red-naped sapsucker
red-breasted sapsucker
northern flicker
western wood-pewee
willow flycatcher
least flycatcher
Hammond's flycatcher
dusky flycatcher
Pacific-slope flycatcher
ash-throated flycatcher
western kingbird
eastern kingbird
tree swallow
violet-green swallow
northern rough-winged swallow

Riparian

bank swallow
cliff swallow
barn swallow
house wren
veery
Swainson's thrush
American robin
gray catbird
cedar waxwing
solitary vireo
warbling vireo
red-eyed vireo
orange-crowned warbler
Nashville warbler
yellow warbler
American redstart
MacGillivray's warbler
common yellowthroat
Wilson's warbler
yellow-breasted chat
black-throated gray warbler
western tanager
black-headed grosbeak
lazuli bunting
rufous-sided towhee
Lincoln's sparrow
white-crowned sparrow
fox sparrow
Brewer's blackbird
red-winged blackbird
northern oriole
American goldfinch
brown-headed cowbird

APPENDIX A - continued.

old growth/ mature coniferous forest	young coniferous forest
sharp-shinned hawk	sharp-shinned hawk
Cooper's hawk	Cooper's hawk
northern goshawk	red-tailed hawk
red-tailed hawk	American kestrel
golden eagle	mourning dove
American kestrel	long-eared owl
mourning dove	common nighthawk
flammulated owl	common poorwill
long-eared owl	calliope hummingbird
common nighthawk	red-naped sapsucker
common poorwill	northern flicker
Vaux's swift	olive-sided flycatcher
calliope hummingbird	western wood-pewee
Lewis's woodpecker	Hammond's flycatcher
red-naped sapsucker	dusky flycatcher
Williamson's sapsucker	cordilleran flycatcher
northern flicker	violet-green swallow
olive-sided flycatcher	house wren
western wood-pewee	golden-kinglet
Hammond's flycatcher	ruby-crowned kinglet
dusky flycatcher	western bluebird
cordilleran flycatcher	Townsend's solitaire
violet-green swallow	hermit thrush
house wren	American robin
golden-crowned kinglet	solitary vireo
ruby-crowned kinglet	yellow-rumped warbler
western bluebird	Townsend's warbler
mountain bluebird	western tanager
Townsend's solitaire	chipping sparrow
hermit thrush	dark-eyed junco
American robin	Cassin's finch
solitary vireo	
yellow-rumped warbler	
Townsend's warbler	
western tanager	
chipping sparrow	
dark-eyed junco	
Cassin's finch	

APPENDIX A - continued.

clearcut/seedling/shrub coniferous forest

turkey vulture
red-tailed hawk
golden eagle
American kestrel
mourning dove
common nighthawk
common poorwill
black-chinned hummingbird
calliope hummingbird
northern flicker
olive-sided flycatcher
dusky flycatcher
gray flycatcher
house wren
western bluebird
mountain bluebird
Townsend's solitaire
hermit thrush
American robin
Nashville warbler
MacGillivray's warbler
chipping sparrow
dark-eyed junco
brown-headed cowbird

Urban

killdeer
mourning dove
rufous hummingbird
northern flicker
purple martin
violet-green swallow
cliff swallow
barn swallow
house wren
American robin
rufous-sided towhee
chipping sparrow
white-crowned sparrow
dark-eyed junco

shrub-steppe

turkey vulture
northern harrier
Swainson's hawk
red-tailed hawk
ferruginous hawk
golden eagle
American kestrel
prairie falcon
mourning dove
burrowing owl
common nighthawk
common poorwill
white-throated swift
gray flycatcher
Say's phoebe
western kingbird
horned lark
rock wren
sage thrasher
loggerhead shrike
Brewer's sparrow
vesper sparrow
lark sparrow
black-throated sparrow
sage sparrow
grasshopper sparrow
western meadowlark
Brewer's blackbird
long-billed curlew

Urban (continued)

red-winged blackbird
Brewer's blackbird
brown-headed cowbird
American goldfinch

APPENDIX A - continued.

agricultural/pastureland

turkey vulture
northern harrier
Swainson's hawk
red-tailed hawk
golden eagle
American kestrel
killdeer
mourning dove
short-eared owl
Say's phoebe
eastern kingbird
western kingbird
horned lark
violet-green swallow
cliff swallow
barn swallow
house wren
western bluebird
American robin
rufous-sided towhee
chipping sparrow
savannah sparrow
white-crowned sparrow
bobolink
Brewer's blackbird
brown-headed cowbird
American goldfinch

dry grassland

turkey vulture
northern harrier
Swainson's hawk
red-tailed hawk
ferruginous hawk
golden eagle
American kestrel
prairie falcon
long-billed curlew
mourning dove
burrowing owl
short-eared owl
common nighthawk
common poorwill
white-throated swift
western kingbird
horned lark
mountain bluebird
vesper sparrow
lark sparrow
savannah sparrow
grasshopper sparrow
bobolink
western meadowlark

Appendix F

TITLE XII—YAKIMA RIVER BASIN WATER ENHANCEMENT PROJECT

TITLE XII--YAKIMA RIVER BASIN WATER ENHANCEMENT PROJECT

SEC. 1201. PURPOSES.

The purposes of this title are--

(1) to protect, mitigate, and enhance fish and wildlife through improved water management; improved instream flows; improved water quality; protection, creation and enhancement of wetlands; and by other appropriate means of habitat improvement;

(2) to improve the reliability of water supply for irrigation;

(3) to authorize a Yakima River basin water conservation program that will improve the efficiency of water delivery and use; enhance basin water supplies; improve water quality; protect, create and enhance wetlands; and determine the amount of basin water needs that can be met by water conservation measures;

(4) to realize sufficient water savings from the Yakima River Basin Water Conservation Program so that not less than 40,000 acre-feet of water savings per year are achieved by the end of the fourth year of the Basin Conservation Program, and not less than 110,000 acre-feet of water savings per year are achieved by the end of the eighth year of the program, to protect and enhance fish and wildlife resources; and not less than 55,000 acre feet of water savings per year are achieved by the end of the eighth year of the program for availability for irrigation;

(5) to encourage voluntary transactions among public and private entities which result in the implementation of water conservation measures, practices, and facilities; and

(6) to provide for the implementation by the Yakama Indian Nation at its sole discretion of (A) an irrigation demonstration

project on the Yakama Indian Reservation using water savings from system improvements to the Wapato Irrigation Project, and (B) a Toppenish Creek corridor enhancement project integrating agricultural, fish, wildlife, and cultural resources.

SEC. 1202. DEFINITIONS.

As used in this title:

(1) The term 'Basin Conservation Plan' means a plan for implementing water conservation measures found in the various water conservation plans developed under the Basin Conservation Program.

(2) The term 'Basin Conservation Program' means the Yakima River Basin Water Conservation Program established under section 1203(a).

(3) The term 'comprehensive basin operating plan' means a plan that will provide guidance to the Yakima Project Superintendent for operation of the existing Yakima Project as modified by actions taken pursuant to this title.

(4) The term 'Conservation Advisory Group' means the Yakima River Basin Conservation Advisory Group established under section 1203(c).

(5) The term 'conserved water' means water saved and attributable to the program established under the Basin Conservation Program.

(6) The term 'Irrigation Demonstration Project' means the Yakama Indian Reservation Irrigation Demonstration Project authorized in section 1204(b).

(7) The term 'nonproratable water' means that portion of the total water supply available under provisions of sections 18 and 19 of Civil Action No. 21 (Federal District Court Judgment of January 31, 1945) that is not subject to proration in times of

water shortage.

(8) The term 'on-district storage' means small water storage facilities located within the boundaries of an irrigation entity, including reregulating reservoirs, holding ponds, or other new storage methods which allow for efficient water use.

(9) The term 'proratable water' means that portion of the total water supply available under provisions of sections 18 and 19 of Civil Action No. 21 (Federal District Court Judgment of January 31, 1945) that is subject to proration in times of water shortage.

(10) The term 'Secretary' means the Secretary of the Interior.

(11) The term 'System Operations Advisory Committee' means a group of fishery biologists--

(A) created by the Yakima Project Superintendent in response to the supplemental instructions entitled 'Supplementary Instructions to the Water Master', and dated November 28, 1980, in the case of Kittitass Reclamation District, et al. vs. the Sunnyside Valley Irrigation District, et al. (E.D. Wash., Civil No. 21.);

(B) who advise the Yakima Project Superintendent on operations of the Yakima Project for fish and wildlife purposes; and

(C) who, together with others, were identified for consultation on November 29, 1990, in the amended partial summary judgment entered in the basin adjudication (Yakima County Superior Court No. 77-2-01484-5).

(12) The term 'Toppenish Enhancement Project' means the Toppenish Creek corridor enhancement project authorized by section 1204(c).

(13) The term 'Yakama Indian Nation' means the Confederated Tribes and Bands of the Yakama Indian Nation as redesignated

under section 1204(g).

(14) The term 'Yakima Project Superintendent' means the individual designated by the Regional Director, Pacific Northwest Region, Bureau of Reclamation, to be responsible for the operation and management of the Yakima Federal Reclamation Project, Washington.

SEC. 1203. YAKIMA RIVER BASIN WATER CONSERVATION PROGRAM.

(a) ESTABLISHMENT- (1) The Secretary, in consultation with the State of Washington, the Yakama Indian Nation, Yakima River basin irrigators, and other interested parties, shall establish and administer a Yakima River Basin Water Conservation Program for the purpose of evaluating and implementing measures to improve the availability of water supplies for irrigation and the protection and enhancement of fish and wildlife resources, including wetlands, while improving the quality of water in the Yakima Basin. The Secretary may make grants to eligible entities for the purposes of carrying out this title under such terms and conditions as the Secretary may require. Such terms and conditions shall include requirement that all water districts, irrigation districts, individuals, or other entities eligible to participate in the Basin Conservation Program must equip all surface water delivery systems within their boundaries with volumetric water meters or equally effective water measuring methods within 5 years of the date of enactment of this Act.

(2) Conserved water resulting in whole or in part from the expenditure of Federal funds shall not be used to expand irrigation in the Yakima Basin, except as specifically provided in section 1204(a)(3) on the Yakama Indian Reservation.

(3) The provisions of this section shall not apply to the Yakama

Indian Nation except as to any funds specifically applied for from the Basin Conservation Program.

(b) FOUR PHASES OF PROGRAM- The Basin Conservation Program shall encourage and provide funding assistance for four phases of water conservation, which shall consist of the following:

(1) The development of water conservation plans, consistent with applicable water conservation guidelines of the Secretary, by irrigation districts, conservation districts, water purveyors, other areawide entities, and individuals not included within an areawide entity.

(2) The investigation of the feasibility of specific potential water conservation measures identified in conservation plans.

(3) The implementation of measures that have been identified in conservation plans and have been determined to be feasible.

(4) Post implementation monitoring and evaluation of implemented measures.

(c) CONSERVATION ADVISORY GROUP- (1) Not later than 12 months after the date of enactment of this Act, the Secretary, in consultation with the State of Washington, the Yakama Indian Nation, Yakima River basin irrigators, and other interested and related parties, shall establish the Yakima River Basin Conservation Advisory Group.

(2) Members of the Conservation Advisory Group shall be appointed by the Secretary and shall be comprised of--

(A) one representative of the Yakima River basin nonproratable irrigators,

(B) one representative of the Yakima River basin proratable irrigators,

(C) one representative of the Yakama Indian Nation,

(D) one representative of environmental interests,

(E) one representative of the Washington State University Agricultural Extension Service,

(F) one representative of the Department of Wildlife of the State of Washington, and

(G) one individual who shall serve as the facilitator.

(3) The Conservation Advisory Group shall--

(A) provide recommendations to the Secretary and to the State of Washington regarding the structure and implementation of the Basin Conservation Program,

(B) provide recommendations to the Secretary and to the State of Washington regarding the establishment of a permanent program for the measurement and reporting of all natural flow and contract diversions within the basin,

(C) structure a process to prepare a basin conservation plan as specified in subsection (f),

(D) provide annual review of the implementation of the applicable water conservation guidelines of the Secretary, and

(E) provide recommendations consistent with statutes of the State of Washington on rules, regulations, and administration of a process to facilitate the voluntary sale or lease of water.

(4) The facilitator shall arrange for meetings of the Conservation Advisory Group, provide logistical support, and serve as moderator for the meetings.

(5) The Conservation Advisory Group shall consult an irrigation district when considering actions specifically affecting that district. For the purposes of this paragraph, an irrigation district includes the Yakima Reservation Irrigation

District.

(6) The Conservation Advisory Group shall be nonvoting, seeking consensus whenever possible. If disagreement occurs, any member may submit independent comments to the Secretary. The Conservation Advisory Group shall terminate 5 years after the date of its establishment unless extended by the Secretary.

(d) COST SHARING- (1) Except as otherwise provided by this title, costs incurred in the four phases of the Basin Conservation Program shall be shared as follows:

Program Phase	Non-Federal		Federal Grant
	State Grant	Local	
1. Development of water conservation plans	50% but not more than $200,000 per recipient	(Residual amount if any)	50%
2. Investigation of specific water conservation measures	50% but sum of 1 and 2 not greater than $200,000 per recipient	20% after deducting State funds for Item 2	Residual amount after deducting State and local funds for Item 2
3. and 4. Implementation and post implementation monitoring and evaluation	17.5%	17.5%	65.0%

(2) The Yakima River Basin Water Enhancement Project is a Federal action to improve streamflow and fish passage conditions and shall be considered part of a comprehensive program to restore the Yakima River basin anadromous fishery resource. Related fishery resource improvement facilities which utilize funding sources under the Pacific Northwest Electric Power Planning and Conservation Act of 1989 (94 Stat. 2697) and independent water-related improvements of

the State of Washington and other public and private entities to improve irrigation water use, water supply, and water quality, shall be treated as non-Federal cost share expenditures and shall be consolidated in any final calculation of required cost sharing. Within one year of the date of enactment of this Act, the Secretary shall enter into a binding cost sharing agreement with the State of Washington. The agreement shall describe the terms and conditions of specific contributions and other activities that may, subject to approval by the Secretary, qualify as non-Federal cost share expenditures.

(3) Costs of the Basin Conservation Program related to projects on the Yakama Indian Reservation are a Federal responsibility and shall be nonreimbursable and not subject to the cost-sharing provisions of this subsection.

(e) ENTITY WATER CONSERVATION PLANS- To participate in the Conservation Basin Program an entity must submit a proposed water conservation plan to the Secretary. The Secretary shall approve a water conservation plan submitted under this subsection if the Secretary determines that the plan meets the applicable water conservation guidelines of the Secretary.

(f) BASIN CONSERVATION PLAN- The Conservation Advisory Group shall, within 2 1/2 years after the date of enactment of this Act, submit a draft basin conservation plan to the Secretary.

(g) PUBLIC COMMENT- The Secretary shall distribute the draft basin conservation plan and the entity water conservation plans submitted under subsections (e) and (f), respectively, for public comment for a 60-day period.

(h) PUBLICATION OF BASIN CONSERVATION PLAN- Within 60 days after the close of the comment period under subsection (g), the Secretary shall publish the Basin Conservation Plan which

plan will provide the basis--

(1) for prioritizing and allocating funds to implement conservation measures under this title; and

(2) for preparing an interim comprehensive basin operating plan under section 1210 of this title as provided for in Public Law 96-162 (93 Stat. 1241).

(i) CONSERVATION MEASURES- (1) Measures considered for implementation in the Basin Conservation Program may include, among others, conveyance and distribution system monitoring, automation of water conveyance systems, water measuring or metering devices and equipment, lining and piping of water conveyance and distribution systems, on-district storage, electrification of hydraulic turbines, tail-water recycling, consolidation of irrigation systems, irrigation scheduling, and improvement of on-farm water application systems. Basin Conservation Program funds may also be used throughout all four phases of the Basin Conservation Program to mitigate for adverse impacts of program measures.

(2) In addition to implementing existing technologies, the Secretary shall encourage the testing of innovative water conservation measures. The Secretary shall, to the maximum extent possible under applicable Federal, State, and tribal law, cooperate with the State of Washington to facilitate water and water right transfers, water banking, dry year options, the sale and leasing of water, and other innovative allocation tools used to maximize the utility of existing Yakima River basin water supplies.

(3) The Secretary may, consistent with applicable law, use funds appropriated to carry out this section for the purchase or lease of land, water, or water rights from any entity or

individual willing to limit or forego water use on a temporary or permanent basis. Funds used for purchase or lease under this paragraph are not subject to the cost sharing provisions of subsection (d). Efforts to acquire water should be made immediately upon availability of funds to meet the three-year goal specified in section 1205(a)(4) to provide water to be used by the Yakima Project Superintendent under the advisement of the System Operations Advisory Committee for instream flow purposes. The use of Basin Conservation Program funds under this paragraph are in addition to those specifically authorized to be appropriated by subsection (j)(4).

(4) On-farm water management improvements shall be coordinated with programs administered by the Secretary of Agriculture and State conservation districts.

(j) AUTHORIZATION OF APPROPRIATIONS- There is hereby authorized to be appropriated to the Secretary, at September 1990 prices, plus or minus such amounts as may be justified by reason of ordinary fluctuations of applicable cost indexes, the following amounts for the Basin Conservation Program:

(1) $1,000,000 for the development of water conservation plans.

(2) $4,000,000 for investigation of specific potential water conservation measures identified in conservation plans for consideration for implementing through the Basin Conservation Program.

(3) Up to $67,500,000 for design, implementation, post-implementation monitoring and evaluation of measures, and addressing environmental impacts.

(4) Up to $10,000,000 for the initial acquisition of water from willing sellers or lessors specifically to provide instream

flows for interim periods to facilitate the outward migration of anadromous fish flushing flows. Such funds shall not be subject to the cost sharing provisions of subsection (d).

(5) $100,000 annually for the establishment and support of the Conservation Advisory Group during its duration. Such funds shall be available for travel and per diem, rental of meeting rooms, typing, printing and mailing, and associated administrative needs. The Secretary and the State of Washington shall provide appropriate staff support to the Conservation Advisory Group.

SEC. 1204. YAKAMA INDIAN NATION.

(a) WAPATO IRRIGATION PROJECT IMPROVEMENTS AND APPROPRIATIONS-

(1) The Yakama Indian Nation's proposed system improvements to the Wapato Irrigation Project, as well as the design, construction, operation, and maintenance of the Irrigation Demonstration Project and the Toppenish Creek corridor enhancement project, pursuant to this title shall be coordinated with the Bureau of Indian Affairs.

(2) There is authorized to be appropriated to the Secretary not more than $23,000,000 for the preparation of plans, investigation of measures, and following the Secretary's certification that such measures are consistent with the water conservation objectives of this title, the implementation of system improvements to the Wapato Irrigation Project. Funding for further improvements within the Wapato Irrigation Project may be acquired under the Basin Conservation Program or other sources identified by the Yakama Indian Nation.

(3) Water savings resulting from irrigation system

improvements shall be available for the use of the Yakama Indian Nation for irrigation and other purposes on the reservation and for protection and enhancement of fish and wildlife within the Yakima River basin. The conveyance of such water through irrigation facilities other than the Wapato Irrigation Project shall be on a voluntary basis and shall not further diminish the amount of water that otherwise would have been delivered by an entity to its water users in years of water proration.

(b) IRRIGATION DEMONSTRATION PROJECT APPROPRIATIONS- (1)(A) There is hereby authorized to be appropriated to the Secretary--

(i) at September 1990 prices, plus or minus such amounts as may be justified by reason of ordinary fluctuations of applicable cost indexes, $8,500,000 for the design and construction of the Yakama Indian Reservation Irrigation Demonstration Project; and

(ii) such sums as may be necessary for the operation and maintenance of the Irrigation Demonstration Project, including funds for administration, training, equipment, materials, and supplies for the period specified by the Secretary, which sums are in addition to operation and maintenance funds for wildlife and cultural purposes appropriated to the Secretary under other authorization.

(B) Funds may not be made available under this subsection until the Yakama Indian Nation obtains the concurrence of the Secretary in the construction, management, and administrative aspects of the Irrigation Demonstration Project.

(C) After the end of the period specified under subparagraph (A)(ii), costs for the operation and maintenance of the

Irrigation Demonstration Project, including funds for administration, training, equipment, materials, and supplies referred to in that subparagraph, shall be borne exclusively by the lands directly benefitting from the Irrigation Demonstration Project.

(2) The Irrigation Demonstration Project shall provide for the construction of distribution and on-farm irrigation facilities to use all or a portion of the water savings, as determined by the Yakama Indian Nation, resulting from the Wapato Irrigation Project system improvements for--

(A) demonstrating cost-effective state of the art irrigation water management and conservation,

(B) the training of tribal members in irrigation methods, operation, and management, and

(C) upgrading existing hydroelectric facilities and construction of additional hydroelectric facilities on the reservation to meet irrigation pumping power needs.

(c) TOPPENISH CREEK CORRIDOR ENHANCEMENT PROJECT APPROPRIATIONS-There is hereby authorized to be appropriated to the Secretary $1,500,000 for the further investigation by the Yakama Indian Nation of measures to develop a Toppenish Creek corridor enhancement project to demonstrate integration of management of agricultural, fish, wildlife, and cultural resources to meet tribal objectives and such amount as the Secretary subsequently determines is necessary for implementation. There is also authorized to be appropriated to the Secretary such sums as may be necessary for the operation and maintenance of the Toppenish Enhancement Project.

(d) REPORT- Within 5 years of the implementation of the Irrigation Demonstration Project and the Toppenish Enhancement

Project, the Secretary, in consultation with the Yakama Indian Nation, shall report to the Committee on Energy and Natural Resources of the Senate, the Committee on Natural Resources of the House of Representatives, and the Governor of the State of Washington on the effectiveness of the conservation, training, mitigation, and other measures implemented.

(e) STATUS OF IMPROVEMENTS AND FACILITIES- The Wapato Irrigation Project system improvements and any specific irrigation facility of the Irrigation Demonstration Project (excluding on-farm irrigation facilities) and the Toppenish Enhancement Project shall become features of the Wapato Irrigation Project.

(f) TREATMENT OF CERTAIN COSTS- Costs related to Wapato Irrigation Project improvements, the Irrigation Demonstration Project, and the Toppenish Enhancement Project shall be a Federal responsibility and are nonreimbursable and nonreturnable.

(g) REDESIGNATION OF YAKIMA INDIAN NATION TO YAKAMA INDIAN NATION-

(1) REDESIGNATION- The Confederated Tribes and Bands of the Yakima Indian Nation shall be known and designated as the 'Confederated Tribes and Bands of the Yakama Indian Nation'.

(2) REFERENCES- Any reference in a law, map, regulation, document, paper, or other record of the United States to the Confederated Tribes and Bands of the Yakima Indian Nation referred to in subsection (a) shall be deemed to be a reference to the 'Confederated Tribes and Bands of the Yakama Indian Nation'.

SEC. 1205. OPERATION OF YAKIMA BASIN PROJECTS.

(a) WATER SAVINGS FROM BASIN CONSERVATION

PROGRAM- (1) The Basin Conservation Program is intended to result in reductions in water diversions allowing for changes in the present operation of the Yakima Project to improve stream flow conditions in the Yakima River basin. Except as provided by paragraph (5) of this subsection and section 1209, commencing with the enactment of this title, and notwithstanding that anticipated water savings are yet to be realized, the Secretary, upon the enactment of this title and acting through the Yakima Project Superintendent, shall (A) continue to estimate the water supply which is anticipated to be available to meet water entitlements; and (B) provide instream flows in accordance with the following criteria:

Water Supply Estimate for Period (million acre feet):				Target Flow from Date of Estimate thru October Downstream of (cubic feet per second):	
April thru September	May thru September	June thru September	July thru September	Sunnyside Diversion Dam	Prosser Diversion Dam
(1) 3.2	2.9	2.4	1.9	600	600
(2) 2.9	2.65	2.2	1.7	500	500
(3) 2.65	2.4	2.0	1.5	400	400
Less than line 3 water supply				300	300

(2) The initial target flows represent target flows at the respective points. Reasonable fluctuations from these target flows are anticipated in the operation of the Yakima Project, except that for any period exceeding 24 hours--

(A) actual flows at the Sunnyside Diversion Dam may not decrease to less than 65 percent of the target flow at the Sunnyside Diversion Dam; and

(B) actual flows at the Prosser Diversion Dam may not decrease by more than 50 cubic feet per second from the target flow.

(3) The instream flows shall be increased for interim periods during any month of April through October to facilitate when necessary the outward migration of anadromous fish. Increased instream flows for such interim periods shall be obtained through voluntary sale and leasing of water or water rights or from conservation measures taken under this title.

(4)(A)(i) Within the three-year period beginning when appropriations are first provided to carry out the Basin Conservation Program, the instream flow goal in the Yakima River is as follows: to secure water which is to be used for instream flows to facilitate meeting recommendations of the System Operations Advisory Committee for flushing flows or other instream uses.

(ii) In addition to any other authority of the Secretary to provide water for flushing flows, the water required to meet the goal specified in clause (i) shall be acquired through the voluntary purchase or lease of land, water, or water rights and from the development of additional storage capability at Lake Cle Elum provided for in section 1206(a).

(iii) In addition to water required to meet the instream flow goal specified in clause (i), the System Operations Advisory Committee may recommend additional water to meet instream flow goals pursuant to judicial actions.

(B) After the period referred to in subparagraph (A), such instream flow goal is modified as follows:

(i) The goal increases so that the instream target flows

specified in the table in paragraph (1) increase by 50 cubic feet per second for each 27,000 acre-feet of reduced annual water diversions achieved through implementation of measures under the Basin Conservation Program. Such increases do not apply to actions taken pursuant to section 1204. Such increases shall not further diminish the amount of water that otherwise would have been delivered by an entity to its water users in years of water proration.

(ii) The goal changes directly with the availability of water resulting from Federal expenditures under this title for purchase or lease of water under this title.

(C) The Yakima Project Superintendent shall maintain an account of funded and completed conservation measures taken under the Basin Conservation Program.

(D) No later than March 31 of each calendar year, the Yakima Project Superintendent shall meet with the State of Washington, Yakama Indian Nation, and Yakima River basin irrigators to mutually determine total diversion reductions and respective adjustments to the target flows referred to in this subsection. The Yakima Project Superintendent shall announce such adjustments with the announcements of Total Water Supply Available. For the purposes of this subparagraph, conserved water will be considered available for adjusting target flows in the first year following completion of a measure or following a result from the post implementation monitoring and evaluation program, as the case may be.

(5) Operational procedures and processes in the Yakima River basin which have or may be implemented through

judicial actions shall not be impacted by this title.

(6)(A) Within three years after the date of enactment of this Act, the Secretary shall conduct a study and submit a report with recommendations to the appropriate committees of the Congress on whether the water supply available for irrigation is adequate to sustain the agricultural economy of the Yakima River basin.

(B) The target flows provided for under this subsection shall be evaluated within three years after the date of enactment of this Act by the Systems Operations Advisory Committee for the purpose of making a report with recommendations to the Secretary and the Congress evaluating what is necessary to have biologically-based target flows.

(C) The recommendations and reports under subparagraphs (A) and (B) shall provide a basis for the third phase of the Yakima River Basin Water Enhancement Project.

(b) WATER FROM LAKE CLE ELUM- Water accruing from the development of additional storage capacity at Lake Cle Elum, made available pursuant to the modifications authorized in section 1206(a), shall not be part of the Yakima River basin's water supply as provided in subsection (a)(1). Water obtained from such development is exclusively dedicated to instream flows for use by the Yakima Project Superintendent as flushing flows or as otherwise advised by the System Operations Advisory Committee. Water may be carried over from year-to-year in the additional capacity to the extent that there is space available. Releases may be made from other Yakima Project storage facilities to most effectively utilize this additional water, except that water

deliveries to holders of existing water rights shall not be impaired.

(c) STATUS OF BASIN CONSERVATION PROGRAM FACILITIES- Measures of the Basin Conservation Program which are implemented on facilities currently under the administrative jurisdiction of the Secretary, except as provided in section 1204, shall be considered features of the Yakima River Basin Water Enhancement Project, and their operation and maintenance shall be integrated and coordinated with other features of the existing Yakima Project. The responsibility for operation and maintenance and the related costs shall remain with the current operating entity. As appropriate, the Secretary shall incorporate the operation and maintenance of such facilities into existing agreements. The Secretary shall assure that such facilities are operated in a manner consistent with Federal and State law and in accordance with water rights recognized pursuant to State and Federal law.

(d) WATER ACQUIRED BY PURCHASE AND LEASE- Water acquired from voluntary sellers and lessors shall be administered as a block of water separate from the Total Water Supply Available, in accordance with applicable Federal and State law.

(e) YAKIMA PROJECT PURPOSE- (1) An additional purpose of the Yakima Project shall be for fish, wildlife, and recreation.

(2) The existing storage rights of the Yakima Project shall include storage for the purposes of fish, wildlife, and recreation.

(3) The purposes specified in paragraphs (1) and (2) shall not impair the operation of the Yakima Project to provide water for irrigation purposes nor impact existing contracts.

SEC. 1206. LAKE CLE ELUM AUTHORIZATION OF APPROPRIATIONS.

(a) MODIFICATIONS AND IMPROVEMENTS- There is hereby authorized to be appropriated to the Secretary--

(1) at September 1990 prices, plus or minus such amounts as may be justified by reason of ordinary fluctuation of applicable indexes, $2,934,000 to--

(A) modify the radial gates at Cle Elum Dam to provide an additional 14,600 acre-feet of storage capacity in Lake Cle Elum,

(B) provide for shoreline protection of Lake Cle Elum, and

(C) construct juvenile fish passage facilities at Cle Elum Dam, plus

(2) such additional amounts as may be necessary which may be required for environmental mitigation.

(b) OPERATION AND MAINTENANCE APPROPRIATIONS- There is hereby authorized to be appropriated to the Secretary such sums as may be necessary for that portion of the operation and maintenance of Cle Elum Dam determined by the Secretary to be a Federal responsibility.

SEC. 1207. ENHANCEMENT OF WATER SUPPLIES FOR YAKIMA BASIN TRIBUTARIES.

(a) GENERAL PROVISIONS- The following shall be applicable to the investigation and implementation of measures to enhance water supplies for fish and wildlife and irrigation purposes on tributaries of the Yakima River basin:

(1) An enhancement program authorized by this section undertaken in any tributary shall be contingent upon the agreement of appropriate water right owners to participate.

(2) The enhancement program authorized by this section shall not be construed to affect (A) the water rights of any

water right owners in the tributary or other water delivering entities; (B) the capability of tributary water users to divert, convey, and apply water; and (C) existing water and land uses within the tributary area.

(3) The water supply for tributary enhancement shall be administered in accordance with applicable State and Federal laws.

(4) Any enhancement program authorized by this section shall be predicated upon the availability of a dependable water supply.

(b) STUDY- (1) The Secretary, following consultation with the State of Washington, the tributary water right owners, and the Yakama Indian Nation, and agreement of appropriate water right owners to participate, shall conduct a study concerning the measures that can be implemented to enhance water supplies for fish and wildlife and irrigation purposes on Taneum Creek, including (but not limited to)--

(A) water use efficiency improvements;

(B) the conveyance of water from the Yakima Project through the facilities of any irrigation entity willing to contract with the Secretary without adverse impact to water users;

(C) the construction, operation, and maintenance of ground water withdrawal facilities;

(D) contracting with any entity that is willing to voluntarily limit or forego present water use through lease or sale of water or water rights on a temporary or permanent basis;

(E) purchase of water rights from willing sellers; and

(F) other measures compatible with the purposes of this title, including restoration of stream habitats.

(2) In conducting the Taneum Creek study, the Secretary shall

consider--

(A) the hydrologic and environmental characteristics;

(B) the engineering and economic factors relating to each measure; and

(C) the potential impacts upon the operations of present water users in the tributary and measures to alleviate such impacts.

(3) The Secretary shall make available to the public for a 45-day comment period a draft report describing in detail the findings, conclusions, and recommendations of the study. The Secretary shall consider and include any comment made in developing a final report. The Secretary's final report shall be submitted to the Committee on Energy and Natural Resources of the Senate, the Committee on Natural Resources of the House of Representatives, and the Governor of the State of Washington, and made available to the public.

(c) IMPLEMENTATION OF NONSTORAGE MEASURES- After securing the necessary permits the Secretary may, in cooperation with the Department of Ecology of the State of Washington and in accordance with the laws of the State of Washington, implement nonstorage measures identified in the final report under subsection (b) upon fulfillment of the following conditions:

(1) The Secretary shall enter into an agreement with the appropriate water right owners who are willing to participate, the State of Washington, and the Yakama Indian Nation, for the use and management of the water supply to be provided by proposed tributary measures pursuant to this section.

(2) The Secretary and the State of Washington find that the implementation of the proposed tributary measures will not impair the water rights of any person or entity in the affected

tributary.

(d) OTHER YAKIMA RIVER BASIN TRIBUTARIES- Enhancement programs similar to the enhancement program authorized by this section may be investigated and implemented by the Secretary in other tributaries contingent upon the agreement of the appropriate tributary water right owners to participate. The provisions set forth in this section shall be applicable to such programs.

(e) AUTHORIZATION OF APPROPRIATIONS- (1) There is hereby authorized to be appropriated to the Secretary $500,000 for the study of the Taneum Creek Project and such amount as the Secretary subsequently determines is necessary for implementation of tributary measures pursuant to this section.

(2) There is also authorized to be appropriated to the Secretary such funds as are necessary for the investigation of enhancement programs similar to the enhancement program authorized by this section in other Yakima River basin tributaries contingent upon the agreement of the appropriate water right owners to participate. Funds for the implementation of any such similar enhancement program may not be appropriated until after the Secretary submits an investigation report to the appropriate congressional committees.

SEC. 1208. CHANDLER PUMPING PLANT AND POWERPLANT-OPERATIONS AT PROSSER DIVERSION DAM.

(a) AUTHORIZATION OF APPROPRIATIONS FOR ELECTRIFICATION- In order to provide for electrification to enhance instream flows by eliminating the need to divert water to operate the hydraulic turbines which pump water to the Kennewick Irrigation District, there is authorized to be

appropriated--

(1) $50,000 to conduct an assessment of opportunities for alternative pumping plant locations;

(2) $4,000,000 for construction; and

(3) such sums as may be necessary for the prorata share of the operation and maintenance allocated to fish and wildlife as determined by the Secretary.

(b) POWER FOR PROJECT PUMPING- (1) The Administrator of the Bonneville Power Administration shall provide for project power needed to effect the electrification as provided in subsection (a).

(2)(A) There is authorized to be appropriated for the Bureau of Reclamation for each fiscal year in which the Administrator provides power under this subsection an amount equal to the cost to the Bonneville Power Administration of providing power under this subsection during such fiscal year. The rate to be utilized by the Administrator in determining the cost of power under this paragraph in a fiscal year shall be the rate for priority firm power charged by the Bonneville Power Administration in that fiscal year under section 7(b) of the Pacific Northwest Electric Power Planning and Conservation Act (16 U.S.C. 839e(b)).

(B) The Bureau of Reclamation shall, using funds appropriated pursuant to the authorization of appropriations in subparagraph (A), reimburse the Bonneville Power Administration for the costs of the project power provided under this subsection. Such funds shall be available for such purpose without fiscal year limitation.

(c) SUBORDINATION- Any diversions for hydropower generation at the Chandler Powerplant shall be subordinated to

meet the flow targets determined under subsection (f).

(d) WATER SUPPLY FOR KENNEWICK IRRIGATION DISTRICT- The Secretary shall ensure that the irrigation water supply for the Kennewick Irrigation District shall not be affected by conservation, electrification, or subordination pursuant to this title and any reduction in its irrigation water supply resulting from conservation measures adopted or implemented by other entities pursuant to this title shall be replaced by water developed through subordination, electrification, or a combination of the two.

(e) TREATMENT OF CERTAIN FUNDS- Funds appropriated and project power provided pursuant to this section shall be nonreimbursable since such funds are used for fish and wildlife purposes and such funds are not subject to cost share under section 1203(d).

(f) TARGET FLOWS- Target flows measured at appropriate biological and hydrological location or locations shall be determined by the Yakima Project Superintendent in consultation with the System Operations Advisory Committee.

SEC. 1209. AUGMENTATION OF KACHESS RESERVOIR STORED WATER.

(a) AUTHORIZATION OF APPROPRIATIONS- In order to augment Kachess Reservoir stored water supplies from flows of Cabin Creek and Silver Creek which are excess to system demands, there is authorized to be appropriated--

(1) such sums as may be necessary to carry out a feasibility study, including the benefits, costs, and environmental aspects, of the facility described in paragraph (2);

(2) for the construction of facilities to convey such flows to Kachess Reservoir, $20,000,000; and

(3) such sums as may be necessary for the pro rata share of the operation and maintenance allocated to fish and wildlife determined by the Secretary.

(b) LIMITATION- Construction of the facilities described in subsection (a)(1) is contingent on the completion of the feasibility study referred to in subsection (a)(2).

(c) USE OF ADDITIONAL WATER- The stored water supply resulting from the construction of facilities under this section shall be used by the Secretary to--

(1) enhance the water supply available to the Kittitas Reclamation District and the Roza Irrigation District in years of proration; and

(2) facilitate reservoir operations in the Easton Dam toKeechelus Dam reach of the Yakima River for the propagation of anadromous fish.

(d) TREATMENT OF COSTS- The construction and operation and maintenance costs of the facilities under this section shall be allocated to irrigation and fishery enhancement, as follows:

(1) The portion of such costs allocated to irrigation is reimbursable, with the construction costs to be paid prior to initiation of construction by the Kittitas Reclamation District and the Roza Irrigation District.

(2) The portion of such costs allocated to fishery enhancement is nonreimbursable.

(e) KACHESS DAM MODIFICATIONS- There is authorized to be appropriated $2,000,000 for the modification of the discharge facilities of Kachess Dam to improve reservoir operations for anadromous fish enhancement. Amounts appropriated under this subsection are nonreimbursable.

SEC. 1210. INTERIM COMPREHENSIVE BASIN OPERATING

PLAN.

(a) DEVELOPMENT- The Secretary shall, in consultation with the State of Washington, Yakama Indian Nation, Yakima River Basin irrigation districts, Bonneville Power Administration, and other entities as determined by the Secretary, develop an interim comprehensive operating plan for providing a general framework within which the Yakima Project Superintendent operates the Yakima Project, including measures implemented under the Yakima River Basin Water Enhancement Project, including (but not limited to)--

(1) operating capability and constraints of the system;

(2) information on water supply calculations and water needs;

(3) system operations and stream flow objectives; and

(4) the System Operations Advisory Committee activities.

(b) PROCESS REQUIREMENTS- A draft of the interim comprehensive basin operating plan shall be completed within 18 months after the completion of the Basin Conservation Plan under section 1203(f) and, upon completion, published for a 90-day public review period. The Secretary shall complete and publish the final interim comprehensive operating plan within 90 days after the close of the public review period. The Secretary shall update the plan as needed to respond to decisions from water adjudications relating to the Yakima River basin.

(c) AUTHORIZATION OF APPROPRIATIONS- There is authorized to be appropriated $100,000 to carry out this section.

SEC. 1211. ENVIRONMENTAL COMPLIANCE.

There are hereby authorized to be appropriated to the Secretary $2,000,000 for environmental compliance activities including the

conduct, in cooperation with the State of Washington, of an inventory of wildlife and wetland resources in the Yakima River basin and an investigation of measures, including 'wetland banking', which could be implemented to address potential impacts which could result from the activities taken under this title.

SEC. 1212. SAVINGS AND CONTINGENCIES.

(a) IN GENERAL- Nothing in this title shall be construed to--

(1) affect or modify any treaty or other right of the Yakama Indian Nation;

(2) authorize the appropriation or use of water by any Federal, State, or local agency, the Yakama Indian Nation, or any other entity or individual;

(3) impair the rights or jurisdictions of the United States, the States, the Yakama Indian Nation, or other entities over waters of any river or stream or over any ground water resource;

(4) alter, amend, repeal, interpret, modify, or be in conflict with any interstate compact made by the States;

(5) alter, establish, or impair the respective rights of States, the United States, the Yakama Indian Nation, or any other entity or individual with respect to any water or water-related right;

(6) alter, diminish, or abridge the rights and obligations of any Federal, State, or local agency, the Yakama Indian Nation, or other entity, public or private;

(7) affect or modify the rights of the Yakama Indian Nation or its successors in interest to, and management and regulation of, those water resources arising or used, within the external boundaries of the Yakama Indian Reservation;

(8) affect or modify the settlement agreement between the United States and the State of Washington filed in Yakima County Superior Court with regard to Federal reserved water rights other than those rights reserved by the United States for the benefit of the Yakama Indian Nation and its members;

(9) affect or modify the rights of any Federal, State, or local agency, the Yakama Indian Nation, or any other entity, public or private with respect to any unresolved and unsettled claims in any water right adjudications, or court decisions, including State against Acquavella, or constitute evidence in any such proceeding in which any water or water related right is adjudicated; or

(10) preclude other planning studies and projects to accomplish the purposes of this title by other means: funded publicly, privately, or by a combination of public and private funding.

(b) CONTINGENCY BASED ON APPROPRIATIONS- The performance of any activity under this title which requires accomplishment within a specified period that may require appropriation of money by Congress or the allotment of funds shall be contingent upon such appropriation or allotment being made.

MISSION STATEMENTS

The Mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to tribes.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.