Utah Lake Drainage Basin
Water Delivery System
Bonneville Unit, Central Utah Project

Draft Environmental Impact Statement

Draft Surface Water Hydrology Technical Report

Volume 1

March 2004

UTAH RECLAMATION
MITIGATION
AND CONSERVATION
COMMISSION

Utah Lake Drainage Basin Water Delivery System
Environmental Impact Statement

Draft
Surface Water Hydrology Technical Report

March 2004

Prepared by
Central Utah Water Conservancy District

THIS PAGE INTENTIONALLY LEFT BLANK

Surface Water Hydrology Technical Report
Contents

Page

Chapter 1 Introduction 1

1.1 Purpose and Organization 1
1.2 Description of Preferred Alternative and Other Alternatives 1
1.2.1 Spanish Fork Canyon–Provo Reservoir Canal Alternative (Preferred Alternative) 2
1.2.2 Bonneville Unit Water Alternative 4
1.2.3 No Action Alternative 5
1.3 Scoping Issues 6
1.3.1 Issues Raised in Scoping Meetings 6
1.3.1.1 Changes in Stream Flows and River Stages 6
1.3.1.2 Changes in Lake and Reservoir Levels 7
1.3.1.3 Changes in Water Operations, Supplies, or Deliveries 7
1.3.2 Scoping Issues Eliminated From Further Consideration 8
1.3.3 Scoping Issues Addressed in the Technical Report 11
1.4 Impact Topics 12

Chapter 2 Methodology 13

2.1 Background on Utah Lake Operation and the Transbasin Diversion Operation 13
2.1.1 Utah Lake Operation 13
2.1.2 Strawberry Transbasin Diversion Operations 15
2.2 Assumptions 16
2.3 Impact Analysis Methodology 16
2.3.1 Description 16
2.3.1.1 Water Requirements Studies 17
2.3.1.2 Strawberry Reservoir Spreadsheet Operations Model 17
2.3.1.3 Spanish Fork River Model 18
2.3.1.4 Hobble Creek Model 19
2.3.1.5 PROSIM2000 Model 20
2.3.1.6 Provo River Spreadsheet Model 21
2.3.17 Utah Lake Spreadsheet Model 22
2.3.2 Verification and Calibration 23
2.3.2.1 Strawberry Reservoir Spreadsheet Operations Model 23
2.3.2.2 Spanish Fork River Model 23
2.3.2.3 Hobble Creek Model 24
2.3.2.4 PROSIM2000 Model 24
2.3.2.5 Provo River Spreadsheet Model 25
2.3.2.6 Utah Lake Spreadsheet Model 25

Chapter 3 Affected Environment (Baseline Conditions) 27

3.1 Impact Area of Influence 27
3.1.1 Spanish Fork Canyon–Provo Reservoir Canal Alternative (Preferred Alternative) 27
3.1.2 Bonneville Unit Water Alternative and No Action Alternative 31

Page

3.2 Overview ... 31
3.2.1 Comparisons with Previous Environmental Documents ... 31
3.3 Streams ... 33
3.3.1 Upper Provo River ... 33
3.3.2 Middle Provo River ... 33
3.3.3 Lower Provo River ... 34
3.3.4 Hobble Creek ... 34
3.3.5 Spanish Fork River ... 38
3.3.6 Jordan River ... 38
3.4 Reservoirs and Lakes ... 42
3.4.1 Jordanelle Reservoir ... 42
3.4.2 Deer Creek Reservoir ... 43
3.4.3 Utah Lake ... 44
3.4.4 Strawberry Reservoir ... 44

Chapter 4 Environmental Consequences (Impacts) ... 47

4.1 Significance Criteria ... 47
4.2 Potential Impacts Eliminated From Further Analysis ... 47
4.2.1 Potential Impacts on Existing Water Rights ... 47
4.2.2 Potential Impacts on Sixth Water and Diamond Fork Creeks ... 47
4.2.3 Potential Construction Impacts ... 47
4.3 Spanish Fork Canyon–Provo Reservoir Canal Alternative (Preferred Alternative) ... 48
4.3.1 Operations Phase ... 48
4.3.1.1 Provo River From Timpanogos Diversion to River Ditch ... 48
4.3.1.2 Provo River From River Ditch to Snake Creek ... 48
4.3.1.3 Provo River From Snake Creek to Inlet of Deer Creek Reservoir ... 48
4.3.1.4 Provo River From Deer Creek Reservoir Outlet to North Fork of Provo River ... 48
4.3.1.5 Provo River From North Fork of Provo River to Olmsted Diversion Dam ... 48
4.3.1.6 Provo River From Olmsted Diversion Dam to Murdock Diversion Dam ... 49
4.3.1.7 Provo River From Murdock Diversion Dam to Interstate 15 ... 49
4.3.1.8 Provo River From Interstate 15 to Utah Lake ... 49
4.3.1.9 Hobble Creek From Mapleton Springville Lateral to Utah Lake ... 49
4.3.1.10 Spanish Fork River From Diamond Fork Creek to Spanish Fork Diversion Dam (Castilla Gage) ... 50
4.3.1.11 Spanish Fork River From Spanish Fork Diversion Dam to East Bench Diversion ... 50
4.3.1.12 Spanish Fork River From East Bench Diversion to Mill Race Canal ... 50
4.3.1.13 Spanish Fork River From Mill Race Canal to Lakeshore Gage ... 50
4.3.1.14 Spanish Fork River at Lakeshore Gage ... 50
4.3.1.15 Jordan River From Outlet of Utah Lake to Jordan Narrows ... 51
4.3.1.16 Jordan River Downstream From Jordan Narrows ... 51
4.3.1.17 Jordanelle Reservoir ... 51
4.3.1.18 Deer Creek Reservoir ... 51
4.3.1.19 Utah Lake ... 51
4.3.1.20 Strawberry Reservoir ... 52

Page

4.3.2 Summary of Alternative Impacts 52
4.4 Bonneville Unit Water Alternative 52
4.4.1 Operations Phase 52
4.4.1.4 Provo River From Murdock Diversion Dam to Interstate 15 53
4.4.1.5 Provo River From Interstate 15 to Utah Lake 53
4.4.1.6 Hobble Creek From Mapleton Springville Lateral to Utah Lake 53
4.4.1.7 Spanish Fork River From Diamond Fork Creek to Spanish Fork Diversion Dam (Castilla Gage) 53
4.4.1.8 Spanish Fork River From Spanish Fork Diversion Dam to East Bench Diversion 53
4.4.1.9 Spanish Fork River From East Bench Diversion to Mill Race Canal 54
4.4.1.10 Spanish Fork River From Mill Race Canal to Lakeshore Gage 54
4.4.1.11 Spanish Fork River at Lakeshore Gage 54
4.4.1.12 Jordan River From Outlet of Utah Lake to Jordan Narrows 54
4.4.1.14 Utah Lake 54
4.4.1.15 Strawberry Reservoir 55
4.5.2 Summary of Alternative Impacts 55
4.5 No Action Alternative 55
4.5.1 Operations Phase 55
4.5.2 Strawberry Reservoir 55
4.5.3 Summary of Alternative Impacts 56

References Cited R-1
Glossary G-1
Abbreviations and Acronyms ..... A&A-1
Attachment 1 – Background Information and Technical Memoranda ..... Attachment 1

Appendix A – ULS Surface Water Hydrology Results – Simulated Provo River Stream Flows by Ownership (Provided in a Separate Volume) A-1
Appendix B – ULS Surface Water Hydrology Results – Simulated Spanish Fork Stream Flows by Ownership (Provided in a Separate Volume) B-1

Page

Tables

Table Number	Table Title	Page
Table 1-1	Construction Features of Utah Lake Drainage Basin Water Delivery System Alternatives	2
Table 3-1	Major Hydrologic Features in the Impact Area of Influence	32
Table 3-2	Average Monthly, Dry Year, and Wet Year Streamflows (cfs) Under Baseline Conditions	33
Table 3-3	Average Monthly, Dry Year, and Wet Year Reservoir Contents (1000 ac-ft) Under Baseline Conditions	42
Table 4-1	Estimated Average Provo River Flows From Timpanogos Diversion to River Ditch Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline Flows in cfs	57
Table 4-2	Estimated Average Provo River Flows From River Ditch to Snake Creek Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline Flows in cfs	58
Table 4-3	Estimated Average Provo River Flows From Snake Creek to Inlet of Deer Creek Reservoir Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline Flows in cfs	59
Table 4-4	Estimated Average Provo River Flows From Outlet of Deer Creek Reservoir to North Fork of Provo River Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline Flows in cfs	60
Table 4-5	Estimated Average Provo River Flows From North Fork of Provo River to Olmsted Diversion Dam Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline Flows in cfs	61
Table 4-6	Estimated Average Provo River Flows From Olmsted Diversion Dam to Murdock Diversion Dam Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline Flows in cfs	62
Table 4-7	Estimated Average Provo River Flows From Murdock Diversion Dam to Interstate 15 Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline Flows in cfs	63
Table 4-8	Estimated Average Provo River Flows From Interstate 15 to Utah Lake Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline Flows in cfs	64
Table 4-9	Estimated Average Hobble Creek Flows From Mapleton Lateral to Utah Lake Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline Flows in cfs	65
Table 4-10	Estimated Average Spanish Fork Flows From Diamond Fork Creek to Spanish Fork Diversion Dam (Castilla Gage) Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline Flows in cfs	66
Table 4-11	Estimated Average Spanish Fork Flows From Spanish Fork Diversion Dam to East Bench Diversion Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline Flows in cfs	67
Table 4-12	Estimated Average Spanish Fork Flows From East Bench Diversion to Mill Race Canal Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline Flows in cfs	68

Page

Table 4-13 Estimated Average Spanish Fork Flows From Mill Race Canal to Lakeshore Gage
Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative
Compared to Baseline Flows in cfs 69
Table 4-14 Estimated Average Spanish Fork Flows at Lakeshore Gage
Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative
Compared to Baseline Flows in cfs 70
Table 4-15 Estimated Average Jordan River From Outlet of Utah Lake to Jordan Narrows
Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative
Compared to Baseline Flows in cfs 71
Table 4-16 Estimated Average Jordan River Below Jordan Narrows
Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative
Compared to Baseline Flows in cfs 72
Table 4-17 Estimated Average Jordanelle Reservoir
Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative
Compared to Baseline Volume in 1000 acre-feet 73
Table 4-18 Estimated Average Deer Creek Reservoir
Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative
Compared to Baseline Volume in 1000 acre-feet 74
Table 4-19 Estimated Average Utah Lake
Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative
Compared to Baseline Volume in 1000 acre-feet 75
Table 4-20 Estimated Average Strawberry Reservoir
Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative
Compared to Baseline Volume in 1000 acre-feet 76
Table 4-21 Estimated Average Provo River Flows From Outlet of Deer Creek Reservoir to
North Fork of Provo River
Bonneville Unit Water Alternative Compared to Baseline Flows in cfs 77
Table 4-22 Estimated Average Provo River Flows From Interstate 15 to Utah Lake
Bonneville Unit Water Alternative Compared to Baseline Flows in cfs 78
Table 4-23 Estimated Average Hobble Creek Flows From Mapleton Lateral to Utah Lake
Bonneville Unit Water Alternative Compared to Baseline Flows in cfs 79
Table 4-24 Estimated Average Spanish Fork River From Diamond Fork Creek to
Spanish Fork Diversion Dam (Castilla Gate)
Bonneville Unit Water Alternative Compared to Baseline Flows in cfs 80
Table 4-25 Estimated Average Spanish Fork River From Spanish Fork Diversion Dam to
East Bench Diversion
Bonneville Unit Water Alternative Compared to Baseline Flows in cfs 81
Table 4-26 Estimated Average Spanish Fork River From East Bench Diversion to Mill Race Canal
Bonneville Unit Water Alternative Compared to Baseline Flows in cfs 82
Table 4-27 Estimated Average Spanish Fork River From Mill Race Canal to Lakeshore Gage
Bonneville Unit Water Alternative Compared to Baseline Flows in cfs 83
Table 4-28 Estimated Average Spanish Fork River at Lakeshore Gage
Bonneville Unit Water Alternative Compared to Baseline Flows in cfs 84
Table 4-29 Estimated Average Jordan River From Outlet of Utah Lake to Jordan Narrows
Bonneville Unit Water Alternative Compared to Baseline Flows in cfs 85
Table 4-30 Estimated Average Utah Lake
Bonneville Unit Water Alternative Compared to Baseline Volume in 1000 acre-feet 86

Page

Table 4-31 Estimated Average Strawberry Reservoir Bonneville Unit Water Alternative Compared to Baseline Volume in 1000 acre-feet 87

Figures

Figure Number	Table Title	Page
Figure 3-1	Upper Provo River Baseline Stream Flows	27
Figure 3-2	Middle Provo River Baseline Stream Flows	28
Figure 3-3	Lower Provo River Baseline Stream Flows	29
Figure 3-4	Hobble Creek Baseline Stream Flows	30
Figure 3-5a	Spanish Fork River Monthly Flows	31
Figure 3-5b	Spanish Fork River Monthly Flows	32
Figure 3-6	Jordan River Monthly Flows	33
Figure 3-7	Jordanelle Reservoir Baseline Monthly Volumes	35
Figure 3-8	Deer Creek Reservoir Baseline Monthly Volumes	35
Figure 3-9	Utah Lake Monthly Volumes	36
Figure 3-10	Strawberry Reservoir Monthly Volumes	36
Figure 4-1	Estimated Average Provo River Flows From Timpanogos Diversion to River Ditch Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline	88
Figure 4-2	Estimated Average Provo River Flows From River Ditch to Snake Creek Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline	89
Figure 4-3	Estimated Average Provo River Flows From Snake Creek to Inlet of Deer Creek Reservoir Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline	90
Figure 4-4	Estimated Average Provo River Flows From Deer Creek Reservoir Outlet to North Fork of Provo River Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline	91
Figure 4-5	Estimated Average Provo River Flows From North Fork of Provo River to Olmsted Diversion Dam Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline	92
Figure 4-6	Estimated Average Provo River Flows From Olmsted Diversion Dam to Murdock Diversion Dam Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline	93
Figure 4-7	Estimated Average Provo River Flows From Murdock Diversion Dam to Interstate 15 Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline	94
Figure 4-8	Estimated Average Provo River Flows From Interstate 15 to Utah Lake Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline	95
Figure 4-9	Estimated Average Hobble Creek Flows From Mapleton Lateral to Utah Lake Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline	96

Page

Figure 4-10 Estimated Average Spanish Fork Flows From Diamond Fork Creek to Spanish Fork Diversion Dam (Castilla Gage) Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline 97
Figure 4-11 Estimated Average Spanish Fork Flows From Spanish Fork Diversion Dam to East Bench Diversion Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline 98
Figure 4-12 Estimated Average Spanish Fork Flows From East Bench Diversion to Mill Race Canal Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline 99
Figure 4-13 Estimated Average Spanish Fork Flows From Mill Race Canal to Lakeshore Gage Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline 100
Figure 4-14 Estimated Average Spanish Fork Flows at Lakeshore Gage Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline 101
Figure 4-15 Estimated Average Jordan River From Outlet of Utah Lake to Jordan Narrows Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline 102
Figure 4-16 Estimated Average Jordan River Below Jordan Narrows Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline 103
Figure 4-17 Estimated Average Jordanelle Reservoir Contents Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline 104
Figure 4-18 Estimated Average Deer Creek Reservoir Contents Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline 105
Figure 4-19 Estimated Average Utah Lake Contents Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline 106
Figure 4-20 Utah Lake Storage Volume (1000 acre feet) 107
Figure 4-21 Estimated Average Strawberry Reservoir Contents Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline 108
Figure 4-22 Strawberry Reservoir Storage Volume (1000 acre feet) 109
Figure 4-23 Estimated Average Provo River Flows From Murdock Diversion Dam to Interstate 15 Bonneville Unit Water Alternative Compared to Baseline 110
Figure 4-24 Estimated Average Provo River Flows From Interstate 15 to Utah Lake Bonneville Unit Water Alternative Compared to Baseline 111
Figure 4-25 Estimated Average Hobble Creek Flows From Mapleton Lateral to Utah Lake Bonneville Unit Water Alternative Compared to Baseline 112
Figure 4-26 Estimated Average Spanish Fork River From Diamond Fork Creek to Spanish Fork Diversion Dam (Castilla Gate) Bonneville Unit Water Alternative Compared to Baseline 113
Figure 4-27 Estimated Average Spanish Fork River From Spanish Fork Diversion Dam to East Bench Diversion Bonneville Unit Water Alternative Compared to Baseline 114

Page

Figure 4-28 Estimated Average Spanish Fork River From East Bench Diversion to Mill Race Canal Bonneville Unit Water Alternative Compared to Baseline 115
Figure 4-29 Estimated Average Spanish Fork River From Mill Race Canal to Lakeshore Gage Bonneville Unit Water Alternative Compared to Baseline 116
Figure 4-30 Estimated Average Spanish Fork River at Lakeshore Gage Bonneville Unit Water Alternative Compared to Baseline 117
Figure 4-31 Estimated Average Jordan River From Outlet of Utah Lake to Jordan Narrows Bonneville Unit Water Alternative Compared to Baseline 118
Figure 4-32 Estimated Average Utah Lake Contents Bonneville Unit Water Alternative Compared to Baseline 119
Figure 4-33 Utah Lake Storage Volume (1000 acre feet) 120
Figure 4-34 Estimated Average Strawberry Reservoir Contents Bonneville Unit Water Alternative Compared to Baseline 121
Figure 4-3 Strawberry Reservoir Storage Volume (1000 acre feet) 122

Maps

Map Number	Map Title	Page
Map 3-1	Surface Water Hydrology Impact Area of Influence	29

Chapter 1
Introduction

1.1 Purpose and Organization

This *Surface Water Hydrology Technical Report* (TR) analyzes potential impacts on surface water flows and water levels in lakes and reservoirs from the construction, operation and maintenance of the Utah Lake Drainage Basin Water Delivery System (ULS).

This TR addresses issues raised during the public and agency scoping process for the ULS and provides baseline information to support the ULS Draft Environmental Impact Statement (DEIS) being prepared in compliance with the National Environmental Policy Act (NEPA). This TR is incorporated and is part of the ULS DEIS.

This TR is organized by the following chapters:

Chapter 1 – An outline of the TR and a summary description of the Preferred Alternative and other alternatives

Chapter 2 – Methodology used in the analysis of surface water resources

Chapter 3 – Existing Environment (Baseline Conditions)

Chapter 4 – Analysis of environmental consequences (impacts)

This technical report does not contain chapters dealing with mitigation and monitoring, unavoidable adverse impacts, or cumulative impacts. The changes in flows resulting from the operation of the alternatives are used by other resources to determine impacts. There would be no cumulative impacts from a hydrology standpoint since the models used in determining flows included all the water and rights available in the various rivers and streams within the impact area of influence.

This technical report contains the following appendices:

Appendix A ULS Surface Water Hydrology Results – Simulated Provo River Stream Flows by Ownership
Appendix B ULS Surface Water Hydrology Results – Simulated Spanish Fork River Stream Flows by Ownership

Appendix A and B are contained in separate volumes.

1.2 Description of Preferred Alternative and Other Alternatives

This section serves as an overview of the ULS alternatives for this technical report.

1.2.1 Spanish Fork Canyon–Provo Reservoir Canal Alternative (Preferred Alternative)

Table 1-1 presents the Preferred Alternative features. This alternative has a total transbasin diversion of 101,900 acre-feet, which consists of the following amounts of water: 30,000 acre-feet of municipal and industrial (M&I) secondary water to southern Utah County, 30,000 acre-feet of M&I water to Salt Lake County, 1,590 acre-feet of

Table 1-1
Construction Features of Utah Lake Drainage Basin Water Delivery System Alternatives

Feature	Spanish Fork Canyon – Provo Reservoir Canal Alternative (Preferred Alternative)	Bonneville Unit Water Alternative	No Action Alternative
Sixth Water Power Facility and Transmission Line	45 MW generator and 12.9 miles of overhead transmission line upgraded to 138 kV from Sixth Water Power Facility to Highway 6	45 MW generator and 12.9 miles of overhead transmission line upgraded to 138 kV from Sixth Water Power Facility to Highway 6	Not constructed
Upper Diamond Fork Power Facility and Underground Cable	5 MW generator and 1.6 miles of 25 kV underground cable (existing) through Tanner Ridge Tunnel to Sixth Water Transmission Line	5 MW generator and 1.6 miles of 25 kV underground cable (existing) through Tanner Ridge Tunnel to Sixth Water Transmission Line	Not constructed
Spanish Fork Canyon Pipeline	7.0 mile steel pipeline, 84-inches diameter from Spanish Fork Flow Control Structure at mouth of Diamond Fork Creek to Moark Junction	7.0 mile steel pipeline, 72-inches diameter from Spanish Fork Flow Control Structure at mouth of Diamond Fork Creek to Moark Junction	Not constructed
Spanish Fork-Santaquin Pipeline	17.5 mile steel pipeline, ranging from 60- to 36-inches diameter, from terminus of Spanish Fork Canyon Pipeline to Santaquin	17.5 mile steel pipeline, ranging from 48- to 30-inches diameter, from terminus of Spanish Fork Canyon Pipeline to Santaquin (CUPCA Section 207 feature)	Not constructed
Santaquin-Mona Reservoir Pipeline	7.7 mile steel pipeline, 24-inches diameter, from terminus of Spanish Fork-Santaquin Pipeline to Mona Reservoir	Not constructed	Not constructed
Mapleton-Springville Lateral Pipeline (CUPCA Section 207)	5.7 mile steel pipeline, ranging from 48- to 30-inches diameter from terminus of Spanish Fork Canyon Pipeline to Hobble Creek	5.7 mile steel pipeline, ranging from 48- to 30-inches diameter, from terminus of Spanish Fork Canyon Pipeline to Hobble Creek	Not constructed
Spanish Fork – Provo Reservoir Canal Pipeline	19.7 mile steel pipeline, ranging from 60- to 48 inches diameter, from terminus of Spanish Fork Canyon Pipeline to Provo Reservoir Canal and Jordan Valley Aqueduct	Not constructed	Not constructed

M&I water already contracted to the southern Utah County cities, and 40,310 acre-feet of M&I water to Utah Lake for exchange to Jordanelle Reservoir. It would involve constructing five new pipelines: 1) from the mouth of Diamond Fork Canyon to the mouth of Spanish Fork Canyon; 2) from the mouth of Spanish Fork Canyon to Santaquin in southern Utah County; 3) from Santaquin to Mona Reservoir; 4) from the mouth of Spanish Fork Canyon to Hobble Creek along the Mapleton-Springville Lateral alignment; and 5) from the mouth of Spanish Fork Canyon to the Provo Reservoir Canal and Jordan Valley Aqueduct. Under this alternative, the Department of the Interior (DOI) would acquire approximately 57,000 acre-feet of the Central Utah Water Conservancy District's (District) secondary water rights in Utah Lake as part of the project water supply. Two power generating facilities would be constructed in the Diamond Fork System under this alternative.

The following summarizes the Preferred Alternative operation.

- 30,000 acre-feet of M&I water would be conveyed to Salt Lake County through the new pipelines and a combination of existing facilities (Jordan Aqueduct and Provo Reservoir Canal conveyance facilities) to water treatment plants for treatment and culinary supply.

- 30,000 acre-feet of M&I water would be conveyed through the new pipelines to the South Utah Valley Municipal Water Association (SUVMWA) member cities in southern Utah County.

- 1,590 acre-feet of Bonneville Unit water already contracted would continue to be used by SUVMWA member cities as M&I water.

- 40,310 acre-feet of project M&I water would be delivered to Utah Lake for exchange to Jordanelle Reservoir. This water would consist of the following: an average of 16,273 acre-feet would be released for in-stream flows in Sixth Water Creek (8,773 acre-feet through the Strawberry Tunnel) and Diamond Fork Creek (7,500 acre-feet released from the Diamond Fork Flow Control Structure) and flow down the Spanish Fork River to Utah Lake mainly during the winter months; an average of 16,000 acre-feet would be conveyed through the Spanish Fork–Provo Reservoir Canal Pipeline and discharged to the Provo River to assist in meeting in-stream flows when water is being delivered from Strawberry Reservoir to Utah Lake for exchange up to Jordanelle Reservoir; and about 8,037 acre-feet would be conveyed through the Mapleton-Springville Lateral Pipeline and released to Utah Lake via Hobble Creek. All of this water would be subsequently exchanged from Utah Lake to Jordanelle Reservoir.

- Up to 10,200 acre-feet of Strawberry Valley Project (SVP) water shares held by SUVMWA would be conveyed to member cities through the new ULS pipelines in southern Utah County on a space-available basis.

- Hydroelectric project power would be generated and contracted to the Western Area Power Administration (see Table 1-1 for generating capacities).

- By implementing Section 207 Water Conservation Program projects, at least 12,000 acre-feet of project water would be provided for in-stream flow purposes to assist in meeting the flows necessary for recovery of the June sucker. Of this amount, at least 4,000 acre-feet would be obtained from projects in southern Utah County to be released down Hobble Creek, and at least 8,000 acre-feet would be obtained from projects in north Utah County to be released and conveyed through the lower Provo River.

- As allowed under the Jordanelle-Deer Creek Operating Agreement, an average annual 12,165 acre-feet of project water would be provided as flows for June sucker spawning and rearing in the lower Provo River

to assist in meeting the June Sucker Recovery Implementation Program (JSRIP) goals. Of this amount 4,165 acre-feet has already been obtained, and as indicated above, at least an additional 8,000 acre-feet would be obtained from new section 207 projects in north Utah County and released through the lower Provo River.

- Approximately 3,300 acre-feet of lower Provo River water rights already purchased by the Mitigation Commission would flow undiverted to Utah Lake, thereby increasing the summertime flow in the lower Provo River.

- An average of 12,037 acre-feet of water would be available through the Mapleton-Springville Lateral pipeline to Hobble Creek for June sucker spawning and rearing flows to meet JSRIP goals and to provide other fish and wildlife benefits throughout the year. This water would be subsequently exchanged from Utah Lake to Jordanelle Reservoir. Of the 12,037 acre-feet, 4,000 acre-feet would be provided in every year that it is needed. The remaining 8,037 acre-feet only would be provided when water is being delivered from Strawberry Reservoir to Utah Lake for exchange up to Jordanelle Reservoir. Hobble Creek supplemental water would not be delivered during high runoff years when Utah Lake is above compromise level. The high runoff years correspond with years when natural runoff would be sufficient to attract June sucker spawning. The term compromise is used throughout this report. It needs to be defined here or in the definition section.

1.2.2 Bonneville Unit Water Alternative

Table 1-1 presents the features of this alternative. This alternative has a total transbasin diversion of 101,900 acre-feet which consists of which consists of the following amounts of water: 15,800 acre-feet of M&I secondary water to southern Utah County, 1,590 acre-feet of M&I water already contracted to the southern Utah County cities, and 84,510 acre-feet of M&I water to Utah Lake for exchange to Jordanelle Reservoir. It would involve constructing three new pipelines, the same as described for the Preferred Alternative: 1) from the mouth of Diamond Fork Canyon to the mouth of Spanish Fork Canyon; 2) from the mouth of Spanish Fork Canyon to Santaquin in southern Utah County; and 3) from the mouth of Spanish Fork Canyon to Hobble Creek along the Mapleton – Springville Lateral alignment. The Spanish Fork Canyon Pipeline would be a federally funded ULS feature; the other two pipelines would be constructed as combined ULS and Section 207 Water Conservation Program features. Under this alternative, two power generating facilities would be constructed in the Diamond Fork System; the DOI would acquire approximately 15,000 acre-feet of District secondary water rights in Utah Lake as part of the project water supply; and no M&I water would be conveyed to Salt Lake County.

The following summarizes the Bonneville Unit Water Alternative operation:

- 15,800 acre-feet of additional Bonneville Unit M&I water would be delivered to SUVMWA member cities through the Spanish Fork-Santaquin Pipeline in southern Utah County under a contract with SUVMWA.

- 1,590 acre-feet of Bonneville Unit water already contracted would continue to be used by SUVMWA member cities as M&I water.

- 84,510 acre-feet of project M&I water minus conveyance losses would be delivered to Utah Lake for exchange to Jordanelle Reservoir. This water would consist of the following: an average of 16,273 acre-feet would be released for in-stream flows in Sixth Water Creek (8,773 acre-feet through the Strawberry

Tunnel) and Diamond Fork Creek (7,500 acre-feet released from the Diamond Fork Flow Control Structure) and flow down the Spanish Fork River to Utah Lake mainly during the winter months; 48,727 acre-feet would be released from the Spanish Fork Flow Control Structure to be conveyed down the Spanish Fork River to Utah Lake; and 19,510 acre-feet would be conveyed through the Mapleton-Springville Lateral Pipeline and released to Utah Lake via Hobble Creek. All of this water would be subsequently exchanged from Utah Lake to Jordanelle Reservoir.

- Up to 10,200 acre-feet of Strawberry Valley Project (SVP) water shares held by SUVMWA would be conveyed to member cities through the new ULS pipelines in southern Utah County.

- Hydroelectric project power would be generated from the M&I water conveyance and contracted to the Western Area Power Administration (see Table 1-1 for generating capacities).

- By implementing Section 207 Water Conservation Program projects, at least 12,000 acre-feet of project water would be provided for in-stream flow purposes to assist in meeting the flows necessary for recovery of the June sucker. Of this amount, at least 4,000 acre-feet would be obtained from projects in southern Utah County to be released down Hobble Creek, and at least 8,000 acre-feet would be obtained from projects in north Utah County to be released and conveyed through the lower Provo River.

- As allowed under the Jordanelle-Deer Creek Operating Agreement, an average annual 12,165 acre-feet of project water would be provided as flows for June sucker spawning and rearing in the lower Provo River to assist in meeting the June Sucker Recovery Implementation Program (JSRIP) goals. Of this amount 4,165 acre-feet has already been obtained, and as indicated above, at least an additional 8,000 acre-feet would be obtained from new section 207 projects in north Utah County and released through the lower Provo River.

- Approximately 3,300 acre-feet of lower Provo River water rights already purchased by the Mitigation Commission would flow undiverted to Utah Lake, thereby increasing the summertime flow in the lower Provo River.

- An average of 23,510 acre-feet of water would be conveyed through the Mapleton-Springville Lateral pipeline to Hobble Creek for June sucker spawning and rearing flows to meet JSRIP goals and to provide other fish and wildlife benefits throughout the year. This water would be subsequently exchanged from Utah Lake to Jordanelle Reservoir. Of the 23,510 acre-feet, 4,000 acre-feet would be provided in every year that it is needed. The remaining 19,510 acre-feet only would be provided when water is being delivered from Strawberry Reservoir to Utah Lake for exchange up to Jordanelle Reservoir. Hobble Creek supplemental water would not be delivered during high runoff years when Utah Lake is above compromise level The high runoff years correspond with years when natural runoff would be sufficient to attract June sucker spawning.

1.2.3 No Action Alternative

No new water conveyance features would be constructed under the No Action Alternative. The 86,100 acre-feet of Bonneville Unit M&I water, minus the 1,590 acre-feet of Bonneville Unit water already contracted for by SUVMWA member cities, would be conveyed from Strawberry Reservoir through the existing Diamond Fork System and discharged into the Spanish Fork River at the mouth of Diamond Fork Canyon, as described in the 1999 Diamond Fork FS-FEIS. All of this water would be exchanged from Utah Lake to Jordanelle Reservoir.

The following summarizes the No Action Alternative operation.

- 86,100 acre-feet of project M&I water minus conveyance losses would be delivered to Utah Lake for exchange to Jordanelle Reservoir. This water would consist of the following: an average of 16,273 acre-feet would be released for in-stream flows in Sixth Water Creek (8,773 acre-feet through the Strawberry Tunnel) and Diamond Fork Creek (7,500 acre-feet released from the Diamond Fork Flow Control Structure) and flow down the Spanish Fork River to Utah Lake mainly during the winter months; and 69,827 acre-feet would be released from the Spanish Fork Flow Control Structure. Of the 69,827 acre-feet, 1,590 acre-feet would be delivered to SUVMWA member cities under existing contracts, and the remaining 68,237 acre-feet would be conveyed through the Spanish Fork River to Utah Lake throughout the year. All of this water would be subsequently exchanged from Utah Lake to Jordanelle Reservoir.

- 1,590 acre-feet of Bonneville Unit water already contracted would continue to be used by SUVMWA member cities as M&I water.

- As allowed under the Jordanelle-Deer Creek Operating Agreement, an average annual 12,165 acre-feet of project water would be provided as flows for June sucker spawning and rearing in the lower Provo River to assist in meeting the June Sucker Recovery Implementation Program (JSRIP) goals. Of this amount 4,165 acre-feet has already been obtained, and as indicated above, at least an additional 8,000 acre-feet would be obtained from new section 207 projects in north Utah County and released through the lower Provo River.

- Approximately 3,300 acre-feet of lower Provo River water rights already purchased by the Mitigation Commission would flow undiverted to Utah Lake, thereby increasing the summertime flow in the lower Provo River.

1.3 Scoping Issues

1.3.1 Issues Raised in Scoping Meetings

A total of 35 issues that were raised during the public scoping process apply to surface water hydrology and are listed here as recorded at the scoping meetings. The issues are divided into three categories: changes in stream flows and river stages, changes in lake and reservoir levels, and changes in water operations, supplies, and deliveries.

1.3.1.1 Changes in Stream Flows and River Stages

- Would there be an increase or decrease of flooding of streams in wet years?
- How would natural stream flow quantities lower than those used in the planning study affect M&I water supplies and associated resources?
- What would be the impacts on flows and fish habitat in Hobble Creek to Utah Lake?
- What would be the impacts of Concept 1 on Daniels Creek?
- What would be the impacts from Concept 1 on flow levels in the Provo River below Deer Creek Dam?
- What would be the impacts on stream flows in the Provo River from the Olmsted Diversion to Utah Lake?

- What opportunities would exist under each of the ULS concepts to promote Proper Functioning Condition stream flows?
- What would be the impacts on in-stream conditions of tributaries to Deer Creek or Utah Lake reservoirs?
- What would be the potential impacts of higher flows in the Provo River below Deer Creek Reservoir on channel stability, stream habitats and fishability?
- What would be the impacts on Provo River flows between Deer Creek Reservoir and Olmsted Diversion?
- What would be the opportunity to have supplemental stream flows for the June Sucker Recovery Implementation Program mimic historic flows as closely as possible, while not negatively impacting other project purposes?
- What would be the impacts on channel stability, wildlife habitats, and sediment transport?
- What impacts would occur from Concept 3 on operation of any existing Spanish Fork River diversion structures?
- What impacts on wetlands and stream flows would occur because of groundwater pumping?
- What would be the impact on stream channel degradation of Currant Creek?

1.3.1.2 Changes in Lake and Reservoir Levels

- What would be the impacts on Utah Lake from a pipeline rupture, as the area is in a zone of high earthquake risk?
- What would be the impacts from each of the ULS water delivery concepts on water levels in Utah Lake and Deer Creek Reservoir?
- What impacts would occur from each ULS water delivery concept on Utah Lake emergent vegetation, water quality, and evaporation?
- What would be the opportunity under each concept to stabilize Utah Lake?
- What would be the impacts of continued use of surface water in the Salem area?
- What would be the impact on the Jordanelle – Deer Creek Operating Agreement?

1.3.1.3 Changes in Water Operations, Supplies, or Deliveries

- How much water could be conserved for Mapleton and Springville if they could tap into the ULS pipeline in exchange for water in their open canal system?
- How much water could be conserved using sprinkler irrigation versus flood irrigation?
- What would be the impacts of introduction of June sucker on the operation of the Spanish Fork River?
- What is the amount of water potentially available in the Jordan River basin that has not been converted to M&I from agriculture?
- What is the amount of water potentially available in the Utah Lake basin that has not been converted to M&I from agriculture?
- What are the operating constraints on the Provo River related to demands for water and habitat for the June sucker?
- Would the peak flows needed for M&I delivery to Salt Lake County in July and August be met every year?
- How would the intent of the Indian Ford Exchange be fulfilled and what would be the impacts?
- Would all concepts provide the maximum capacity/flow for M&I in combination with Jordanelle and what would be the impacts?
- How much surplus irrigation water exists in Salt Lake and Utah counties?

- What would be the impacts of the ULS on existing water rights in the canals that feed Provo City?
- What would be the impacts of saving ¼ of Mapleton's water?
- What would be the impacts of continued use of surface water in the Salem area?
- What would be the impacts of each of the ULS concepts on SVP water delivery through the Diamond Fork System?

1.3.2 Scoping Issues Eliminated From Further Consideration

Of the 35 issues that were raised during the public scoping process that apply to surface water hydrology, the following 23 issues were eliminated from further consideration for the reasons described.

What would be the impact on stream channel degradation of Currant Creek?

The ULS project does not propose delivery of any Bonneville Unit project water through Currant Creek or through the Santaquin-Mona Reservoir Pipeline. As described in Chapter 1, Section 1.4.2.5, the purpose of the pipeline is to provide an opportunity to develop a June sucker refuge by maintaining a conservation pool in Mona Reservoir if the June Sucker Recovery Implementation Program participants determine that the benefits of the pipeline extension justify the costs. The non-project water supply conveyed through the pipeline would only be stored in Mona Reservoir, and would not be released to Currant Creek. Therefore, Currant Creek would not be affected by any of the ULS alternatives. This EIS addresses only the impacts of constructing the pipeline. The JSRIP will address the water supply and operation of Mona Reservoir in a separate NEPA analysis.

What would be the impacts on Utah Lake from a pipeline rupture, as the area is in a zone of high earthquake risk?

The Spanish Fork-Bluffdale Alternative, the only alternative that would have included a pipeline across Utah Lake, was dropped from further analysis (see Chapter 1, Section 1, Alternatives Considered But Eliminated from Detailed Analysis).

How much water could be conserved using sprinkler irrigation versus flood irrigation?

Water conservation through irrigation practices is not a subject of this ULS DEIS. The basic need for the ULS is to meet some of the M&I demands in the Wasatch Front area and to implement water conservation measures associated with M&I water use.

How would natural streamflow quantities lower than those used in the planning study affect M&I water supplies and associated resources?

The intent of the 50-year period (1950-1999) used for analysis of the project alternatives is to provide a complete hydrologic cycle to test the validity of project assumptions. The period includes both dry (1961, 1977, 1992) and wet (1952, 1983, 1986) years and represents a range of possible future hydrologic conditions.

What would be the impacts of Concept 1 on Daniels Creek?

Concept 1 was renamed the Strawberry Reservoir-Deer Creek Reservoir Alternative. This alternative was eliminated from detail analysis. Please see Chapter 1, Section 1.

What impacts would occur on operation of any existing Spanish Fork River diversion structures?

All of the action alternatives would deliver water to Utah Lake through pipelines that are proposed for construction as part of the ULS project and other tributaries to Utah Lake. Therefore, there would be no impacts on the Spanish Fork River diversion structures under any of the action alternatives.

The No Action Alternative represents baseline conditions where up to 86,100 acre-feet of Bonneville Unit water would flow through the Spanish Fork River to Utah Lake throughout the year. Under the No Action Alternative, the Spanish Fork diversion structures would have to be modified based on commitments in the Diamond Fork Final Supplement (CUWCD 1999).

What would be the impacts of the ULS on existing water rights in the canals that feed Provo City?

The ULS alternatives do not include or alter the water rights and canals that feed Provo City and, therefore, would have no impact on them.

What would be the impacts of each of the ULS concepts on SVP water delivery through the Diamond Fork System?

In 1991, the United States, the District, and SWUA entered into an operating agreement covering in part storage in, and delivery from, Strawberry Reservoir (Reclamation 1991). The operating agreement guaranteed the SWUA 61,000 acre-feet of water each year from Strawberry Reservoir, which provides long-term storage of both CUP and SVP water in a common pool. The 1991 operating agreement provided SWUA with a permanent right to 50,000 acre-feet of holdover storage capacity, with an initial (one-time) allocation of 50,000 acre-feet of stored water. In years when SVP requires more than 61,000 acre-feet, the excess would come from water stored in the 50,000 acre-feet storage space, to the extent that water was available in that space. In years when SVP diversion requirements are less than 61,000 acre-feet, the difference between 61,000 acre-feet and the amount actually released for SVP would be stored in the 50,000 acre-feet storage space to the extent that it contains space to store the water. Pursuant to the 1991 operating agreement, conveyance of up to 600 cfs of SVP water through the natural stream channels and the Diamond Fork System to the confluence with the Spanish Fork River will be provided as described herein and in the Emergency Operations section of the July 1999 Diamond Fork Final Supplement to the Final Environmental Impact Statement.

As a result, the ULS alternatives would have no impact on Strawberry Valley Project water deliveries through the Diamond Fork System, which would continue to operate according to existing operating agreements, procedures, and applicable NEPA compliance documents.

Would all concepts provide the maximum capacity/flow for M&I in combination with Jordanelle and what would be the impacts?

The ULS alternatives would not provide the maximum supply of M&I water in combination with Jordanelle. The M&I supply from the ULS alternatives would be operated independently of the other M&I supplies. The ULS alternatives have not been planned to increase the overall water supply available from Jordanelle under the Bonneville Unit M&I system or from the other existing M&I water supply systems in the Utah Lake Drainage Basin. Additionally, no new conveyance facilities to bring additional capacity to Salt Lake County are included in the ULS alternatives. The Spanish Fork-Bluffdale Alternative, was the only alternative that would have included a new pipeline to Salt Lake County. This alternative was dropped from further analysis (see Chapter 1, Section 1, Alternatives Considered But Eliminated from Detailed Analysis).

What opportunities would exist under each of the ULS concepts to promote Proper Functioning Condition streamflows?

Promoting Proper Functioning Condition streamflows is outside the scope of the ULS project. However the Bonneville Unit has incorporated minimum flows to protect fisheries in streams that previously were subject to total diversion or natural flows that were limiting the fishery. Under the ULS alternatives, specific volumes of flow are allocated to supplement both the Provo River and Hobble Creek. The impact on aquatic and wetland resources is documented in Sections 3.6 Aquatic Resources and 3.7 Wetland Resources.

What would be the opportunity to have supplemental streamflows for the June Sucker Recovery Implementation Program mimic historic flows as closely as possible, while not negatively impacting other project purposes?

What are the operating constraints on the Provo River related to demands for water and habitat for the June sucker?

The June sucker target flow hydrographs on the Provo River and Hobble Creek were developed in cooperation with the June sucker RIP to mimic the natural flow of the streams during the June sucker spawning season. The actions analyzed in this document include the use of 12,165 acre-feet of water to help meet these target flows in the Provo River. In addition, water would be released through Hobble Creek for the June sucker. The degree of success at meeting the target hydrographs is described in the EIS Threatened and Endangered Species section.

What impacts on wetlands and streamflows would occur because of groundwater pumping?

The ULS alternatives do not include any proposals for groundwater pumping and therefore, do not cause any direct impacts on the groundwater. Additional details regarding analysis of wetlands and groundwater impacts are included in the draft EIS sections covering those resources.

What would be the opportunity under each concept to stabilize Utah Lake?

The only opportunities to stabilize Utah Lake would involve altering the inflow to the Lake or altering the outflow from the Lake. Altering the inflow would involve releasing more water from storage (in Deer Creek, Jordanelle, and Strawberry) during dry periods. This would have an extremely adverse effect on M&I water supplies and was not evaluated. Altering the outflow to stabilize the Lake would involve reducing releases from the Lake during extended dry periods so that the Lake level did not fall as low. This would require purchasing Utah Lake rights and not calling for them during dry periods. A brief analysis was conducted to estimate the potential benefits of stabilizing the level of Utah Lake by changing the outflows. The estimated benefits were not significant in that the maximum TDS still exceeded the agricultural standard of 1,200 mg/L, and all or most of the Utah Lake water rights would be required. Because of its highly variable inflow, stabilizing Utah Lake is not possible without drastically changing its volume or surface area. Additional study of Lake stabilization was determined to be unwarranted.

What would be the impacts of introduction of June sucker on the operation of the Spanish Fork River?

Introduction of the June sucker into the Spanish Fork River would require the provision of a suitable water supply and habitat, and modification of the Spanish Fork diversion dams to allow migration. The June sucker recovery team has recommended supplementing Hobble Creek and the Provo River, rather than Spanish Fork. Further analysis of the Spanish Fork River is outside the scope of this EIS. If the No Action alternative is selected, additional analysis may be required.

What is the amount of water potentially available in the Jordan River basin that has not been converted to M&I from agriculture?

What is the amount of water potentially available in the Utah Lake basin that has not been converted to M&I from agriculture?

How much surplus irrigation water exists in Salt Lake and Utah counties?

The ULS Revised Assessment of M&I Water Needs (CUWCD 2003) estimated the available water supplies in the Utah Lake and Jordan River basins. The potential conversion of certain agricultural water was included in those estimates. The State Water Plan for the Jordan River Basin shows a total average supply from Utah Lake/Jordan River of 308,000 acre-feet per year., of which 140,000 acre-feet per year is used for agriculture (in 1995). Agricultural use would drop to 50,000 acre-feet by 2020, and to 5,000 acre-feet by 2050. Some of this agricultural supply would be converted to M&I use, however treatment of Utah Lake water to meet potable water quality requirements is very expensive. Jordan Valley Water Conservancy District long range planning calls for treating up to 50,000 acre-feet of converted Utah Lake/Jordan River agricultural water.

Would the peak flows needed for M&I delivery to Salt Lake County in July and August be met every year?

The ULS alternatives were formulated assuming a peak July water demand equal to 17 percent of the annual demands. This is the average peak water use used for planning M&I water supplies in the study area. Annual demands were assumed constant every year. Surface water hydrologic analyses show that these demands are met every year. The actual peak need for M&I water will be higher than this 17 percent assumption on a daily basis and in certain months. The ULS alternatives were not formulated to meet these full peak needs.

How would the intent of the Indian Ford Exchange be fulfilled and what would be the impacts?

The water supply needs associated with the Indian Ford Exchange are met through the acquisition of 7,900 acre-feet of Utah Lake primary water rights by the U.S. Department of the Interior. This supply was assumed to be held in Utah Lake and was included in the ULS baseline and alternatives. This effectively offsets the supply that could have been realized from the Indian Ford Exchange, which is no longer available to the Bonneville Unit M&I System.

What would be the impacts of saving ¼ of Mapleton's water?

What would be the impacts of continued use of surface water in the Salem area?

Analysis of the impacts of continued use of surface water in the Salem area and of saving Mapleton water is included in this EIS only with respect to the water needs and conservation assumptions and the resulting southern Utah County water demands used to develop the ULS alternatives. Detailed analysis of the impacts of water use and water conservation was also performed as part of the groundwater hydrology impact studies.

1.3.3 Issues Addressed in the Technical Report

All issues identified in Section 1.3.1 are addressed in this technical report except for the issues listed in Section 1.3.2. Issues pertaining to changes in streamflows and river stages and changes in water operations, supplies and deliveries are addressed by evaluating and comparing streamflows throughout the impact area under baseline conditions with streamflows under alternative conditions. Issues pertaining to changes in lake and reservoir levels are addressed by evaluating and comparing the reservoir levels under baseline conditions with those under alternative conditions.

1.4 Impact Topics

The surface water hydrology impact topics include the following:

- Water operations and deliveries
- Stream flows and river stages
- Reservoir and lake levels

Chapter 2
Methodology

This chapter describes the methodology used to evaluate the hydrologic effects of the ULS alternatives (briefly described in Section 1.2). These methods have also been used to establish baseline conditions. Assumptions are discussed first, followed by a discussion of methods of analysis. Finally, results of calibrations used to verify the models are presented. More detailed information on the analyses is given in the appendices, as referenced in this chapter. The hydrologic results presented herein are an approximation using computer models of the actual streamflows and reservoir levels that would result under the ULS alternatives. Actual streamflows and reservoir levels will be different from those shown, based on real-time operations that are variable, based on best engineering judgement.

A simulation period has been used both to establish baseline conditions and to estimate project flows that would result from the operation of the Preferred Alternative and other alternatives. It is standard hydrologic practice to pick a historical period to represent possible future hydrologic conditions, with the assumption that the hydrologic response of future wet and dry periods would be similar to the hydrologic response of past wet and dry periods. For the purposes of this analysis, the 50-year hydrologic period of 1950-1999 was chosen because: 1) it has available historical streamflow and diversion records throughout the affected environment, 2) it is of sufficient length to eliminate residual initial condition bias, 3) it cycles through several wet and dry periods, and 4) it is similar in length to the simulation periods used in other Bonneville Unit documents. Because of the relationship of the ULS to the Bonneville Unit as a whole, a time period overlapping the time period used in the *Final Supplement to FEIS, Diamond Fork System* (CUWCD 1999) was needed to provide compatibility with the previous study.

2.1 Background on Utah Lake Operation and the Transbasin Diversion Operation

To understand how ULS operations might affect Utah Lake, an overview of the operation of the lake and changes in operation caused by the existing M&I System is necessary.

2.1.1 Utah Lake Operation

Utah Lake is a large shallow natural lake. More than a century ago, modifications were made to the outlet to raise the water level of the lake and increase it's storage capacity to approximately 870,000 acre-feet. Rights to divert water from the lake were established through water right filings and two classes of water rights were established, primary and secondary rights. The total of all primary and secondary rights in the lake is 302,046 acre-feet per year. A portion of this water has been moved out of the lake to groundwater points of diversion through water right change applications.

There are five Federal reservoirs on the Provo River, which include three small high mountain reservoirs and two large reservoirs. The two large reservoirs are Deer Creek Reservoir and Jordanelle Reservoir. Deer Creek Reservoir, completed in 1941, is part of the Provo River Project. It is operated and maintained by the Provo River Water Users Association under a contract with the Bureau of Reclamation (Reclamation). The water rights for the Provo River Project provide the water supply for Deer Creek Reservoir by importing water from the Weber and Duchesne river drainages to the Provo River for storage in the reservoir. In addition to these imported amounts, the water rights allow Deer Creek Reservoir to store the natural flows of the Provo River drainage in excess of senior Provo River and Utah Lake water rights.

Jordanelle Reservoir, completed as part of the Bonneville Unit of the CUP in April, 1993, is operated and maintained by the District under a contract with Reclamation. Federal water rights allow Jordanelle Reservoir to store natural flows of the Provo River in excess of senior Provo River and Utah Lake water rights. Reservoir operations of Deer Creek Reservoir and Jordanelle Reservoir are coordinated under the Deer Creek Reservoir/Jordanelle Reservoir Operating Agreement executed in 1994 (Reservoir Operating Agreement). This agreement acknowledges the water rights and water right priorities of both projects, and specifies when each project can store water. The yield of natural flow water in Jordanelle is highly variable and averages much less than the amount of water needed to fulfill contracts for water delivery and for meeting minimum river flow requirements. Municipal and agricultural water contracted from Jordanelle Reservoir totals 107,500 acre-feet per year. To meet the difference, Jordanelle Reservoir stores natural runoff that would otherwise flow into Utah Lake ("system storage") under provisions of the Utah Lake Distribution Plan (ULDP) administered by the State Engineer. The ULDP conversion line curve for Utah Lake is followed to determine when system storage must be held in reserve to meet Utah Lake prior rights or when it can be claimed as water available for use by the CUP without impacting other water right interests. If system storage is determined to belong to Utah Lake water right holders, there are three options available: 1) release the amount of water belonging to Utah Lake water right holders if called for; or 2) import water from Strawberry Reservoir for exchange, or 3) exchange the water utilizing the District's and DOI's Utah Lake water rights.

The parties to the Reservoir Operating Agreement are the United States, the State of Utah, the Provo River Water Users Association, and the Central Utah Water Conservancy District. This agreement provides accounting procedures to allow PRP and CUP water to be held concurrently in each of the reservoirs to optimize reservoir operations. For example, there is a 125 cfs minimum instream flow between Jordanelle and Deer Creek Reservoirs. At times of the year the rate of release from Jordanelle Reservoir to meet the instream flow exceeds the required downstream CUP deliveries. Pursuant to the operating agreement, CUP water not needed for immediate delivery is stored on a space available basis in Deer Creek Reservoir until needed by the CUP petitioners. Conversely, under certain circumstances PRP water may be stored and accumulated in Jordanelle Reservoir. The PRP water is then released from Jordanelle Reservoir to Deer Creek Reservoir, or exchanged for CUP water that has already been stored in Deer Creek Reservoir.

The CUP water supply available from the Provo River depends primarily on the project's ability to exchange water in Utah Lake for system storage stored by the CUP in Jordanelle and Deer Creek reservoirs. Other downstream users may have a call on this water unless their calls can be met from other waters in Utah Lake. In accordance with the ULDP which was adopted and is administered by the State Engineer, excess system storage, stored in Jordanelle and Deer Creek Reservoirs, can be converted to primary CUP storage (that is, water stored can be converted to water usable by the reservoir owner). A plot of this volume-time relationship (known as the conversion line) is shown in Figure 2.1. This conversion line decreases during the irrigation season and is set at a level such that there is enough water in storage to meet all the demands of the Utah Lake water right holders.

The District and the United States are among these water right holders. The District owns 16,863 acre-feet of primary and 57,073 acre-feet of secondary rights. The Department of the Interior (DOI) owns 7,900 acre-feet of primary rights in Utah Lake that are utilized for the exchange to Jordanelle Reservoir to meet existing M&I water contracts. Together, the District and DOI own approximately 82,000 acre-feet of Utah Lake water rights or 27 percent of the total water rights in the lake.

The CUP converts system storage water stored in Jordanelle and/or Deer Creek Reservoirs when the total storage in Utah Lake crosses the conversion line. The District and DOI can also exchange their Utah Lake water rights to Jordanelle and/or Deer Creek Reservoirs even when the conversion line is not crossed, if the State Engineer determines that this can be done without impairing prior rights. Another option is that the District and/or DOI can lower the conversion line by holding their Utah Lake water rights in the Lake, thereby making it possible to convert system storage stored in Jordanelle and/or Deer Creek Reservoirs at a lower Lake level. The lower

conversion line shown on Figure 21. represents a lower operational level in Utah Lake under which conversion of system storage in Jordanelle and/or Deer Creek Reservoirs would be possible. Under the Preferred Alternative, DOI would acquire some of the District's secondary water rights in Utah Lake, which as explained above would be exchanged to Jordanelle Reservoir, thereby reducing the amount of replacement water from Strawberry Reservoir needed for the Jordanelle exchange. As a result, this additional quantity of CUP M&I water from Strawberry Reservoir would now be conveyed and delivered directly through ULS facilities to municipal users.

Each year the District and DOI can decide how to use their water rights in Utah Lake which includes the following options:

1) Release water stored under their rights to water users below Utah Lake; or
2) Hold the water stored under their rights in Utah Lake, in which case the conversion line is lower because the calls on Utah Lake have now been reduced, thereby allowing system storage in Jordanelle and Deer Creek Reservoirs to be converted to CUP primary storage; or
3) Exchange the water stored under their rights in Utah Lake for system storage in Jordanelle and Deer Creek thereby allowing system storage to be converted to CUP primary storage

Under the ULS alternatives, the District would notify the State Engineer in writing as to how the project intends to use its Utah Lake water rights, and the State Engineer via the Jordan River Commissioner would administer these Utah Lake water rights accordingly. Unless the project places a call on these water rights downstream of Utah Lake, the project has no control or impact on how the outflow from the Lake is regulated. The River Commissioner operates the Utah Lake outlet to meet water user calls and to release water when the Lake is above the Compromise elevation. Because Utah Lake is operated by the River Commissioner entirely independent of the project, the ULS alternatives will not affect stream flows on the Jordan River below Jordan Narrows.

2.1.2 Strawberry Transbasin Diversion Operations

Bonneville Unit transbasin diversions from Strawberry Reservoir are released to meet the following project needs and purposes:

1) Meet the minimum instream flows in Sixth Water and Diamond Fork Creeks that are statutorily mandated in CUPCA
2) Provide project water to meet some of the additional M&I demands in the Wasatch Front Area
3) Deliver project water to Utah Lake for exchange up to Jordanelle and Deer Creek Reservoirs to meet existing contracts for M&I water in north Utah and Salt Lake Counties

Under normal operations, the project would be operated to minimize the volume of water delivered from Strawberry Reservoir to Utah Lake while maximizing the project's ability to convert system storage. This means that the project would first exchange, or convert, its Utah Lake rights (under the ULDP or directly) to primary storage in Jordanelle Reservoir. Next, project water released to meet minimum stream flows from Strawberry Reservoir and delivered to Utah Lake would be exchanged to Jordanelle Reservoir. The project would only release additional water from Strawberry Reservoir for delivery to Utah Lake if it had unconverted system storage in Jordanelle and Deer Creek Reservoirs.

Because transbasin water (e.g., water from Strawberry) stored in Utah, but not exchanged to Jordanelle Reservoir, would be the first water spilled out of Utah Lake when it rose above Compromise, the project would be operated to avoid any spills of project water from Utah Lake. As a result, the project would avoid having imported water in Utah Lake in excess of the project's ability to exchange it upstream to Jordanelle Reservoir. Therefore, under the ULS alternatives, the project would avoid spilling project water down the Jordan River, thus eliminating any impacts on Jordan River flows below Jordan Narrows.

2.2 Assumptions

The following assumptions were used in the baseline and alternative analysis modeling and impact analysis.

- The selected fifty-year data period (1950-1999) is representative of the possible future natural hydrologic cycle, including wet and dry years, that may occur over the life of the ULS.
- Operational analysis of water supplies from Utah Lake uses historical deliveries as a basis for estimating demands for Utah Lake water. Historical releases from Utah Lake exceeding the full water right volume of 302,500 acre-feet are assumed to be spills and thus would remain in the Lake in these operations studies.
- Historical releases associated with the 7,900 acre-feet of Indian Ford water acquired as part of the M&I System water supply would remain in the lake and be exchanged to Jordanelle Reservoir.
- Under the ULS alternatives, when CUWCD secondary water rights are part of the water supply of the alternative, historical demands associated with the secondary rights are reduced proportionally to the volume of rights being held in the Lake. If Utah Lake is above compromise elevation or significantly above the baseline level, the full, baseline water right deliveries are assumed.
- The M&I System is under full operation during the entire hydrologic period. The M&I System delivered 56,000 acre-feet of water in 2003 and is projected to reach full operation level of 107,500 acre-feet by 2009
- The Utah Lake Distribution Plan (ULDP), initiated by the State Engineer in 1992 is modeled for the full hydrologic period.

2.3 Impact Analysis Methodology

2.3.1 Description

This section describes in detail the methodology (models, spreadsheets) that were used to estimate the hydrologic impacts of the ULS. In general, PROSIM2000 was used to estimate baseline flows, water deliveries, and reservoir storage on the Provo and Jordan rivers and in Utah Lake. Spreadsheet models were used to estimate alternative condition flows and water deliveries on the Provo, and Jordan rivers, in Utah Lake, and in Deer Creek, and Jordanelle reservoirs. Spreadsheet models were also used to estimate baseline and alternative condition flows and water deliveries on the Diamond Fork and Spanish Fork River System and Hobble Creek based on Strawberry calls estimated with PROSIM2000. A spreadsheet model was used to estimate Strawberry Reservoir levels, using Strawberry inflow data from the Spanish Fork Canyon-Nephi Irrigation System (SFN) analysis, updated by Reclamation. (Reclamation, 2003a)

2.3.1.1 Water Requirements Studies

Water requirements studies were prepared to document the demands for ULS System water. These studies used methodology and results developed through input from a Water Requirements Technical Group that included representatives from Utah State University, Utah Division of Water Resources, Utah Division of Water Rights, Soil Conservation Districts, the Farm Services Agency (FSA) (formerly the Agricultural Stabilization and Conservation Service), the Natural Resources Conservation Service (NRCS) (formerly the Soil Conservation Service), and water users. Water requirement methodology is summarized below in the discussion of the individual models and is described in further detail in the ULS Revised Assessment of M&I Water Needs (CUWCD 2003). The project demands for Salt Lake County and southern Utah County is from the Draft Revised Assessment of M&I Water Needs.

2.3.1.2 Strawberry Reservoir Operations Model

The Strawberry Reservoir operations model is a mass balance spreadsheet based accounting model that tracks water delivered from Strawberry Reservoir through the Syar and Strawberry Tunnels to the Diamond Fork System on a monthly basis for the period of 1950 to 1999. The model utilizes the principle of conservation of mass, in which the inflow is equal to the net outflow plus the change in storage. The mass balance is maintained among the various model components including Strawberry Reservoir inflows, releases through trans-basin tunnels (SVP and CUP release calls), evaporation, and reservoir storage and elevations. Strawberry Reservoir is operated in accordance with specific criteria and constraints that were developed to achieve the following:

- Protect existing water rights and historical deliveries on the Spanish Fork River and Diamond Fork Creek
- Provide a firm annual allocation of 61,000 acre-feet of water to the Strawberry Valley Project (SVP), with 50,000 acre-feet of carryover storage, in accordance with the 1991 Operating Agreement.
- Meet demands for Utah Lake needed to accomplish exchanges for other elements of the Bonneville Unit
- Meet minimum flow requirements in Sixth Water and Diamond Fork creeks and the Uinta Basin
- Supply water for M&I use in Salt Lake County and south Utah County
- Supply water for June sucker attraction flows in Hobble Creek and the Provo River

The Baseline and Alternative analyses of Strawberry Reservoir included the following methodologies and parameters:

- The full Bonneville Unit delivery from Strawberry of 101,900 acre-feet per year is unchanged from previous studies. Only the timing of deliveries are altered by the ULS alternatives. It is these changes in timing that were evaluated in the Strawberry Model to confirm that Strawberry Reservoir operations are not adversely impacted.

- Inflow to Strawberry Reservoir reflects 44,400 acre-feet of flow for fishery bypass required by the Instream Flow Agreement (Reclamation 1988, 7-8). The 44,400 acre-feet includes 6,500 acre-feet for fishery bypasses that were considered in the Bonneville Unit Draft Supplement to DPR (Reclamation 1988) and an additional 37,900 acre-feet subtracted from the inflow estimated in the Bonneville Unit Draft Supplement to DPR (Reclamation 1988). Since the outflow from Strawberry Reservoir has been reduced by 37,900 acre-feet, there is no net effect on the reservoir. Strawberry Reservoir inflows were obtained from operations studies conducted by Reclamation. Inflows to Strawberry Reservoir were

recently updated and extended by Reclamation to include the full 1950 through 1999 period (Reclamation 2003b).

- The development of Baseline CUP calls from Strawberry Reservoir to Utah Lake is described in an October 23, 2001 draft memorandum entitled, "Development of Strawberry to Utah Lake Calls under ULS Baseline Conditions." This document is included in the Attachment 1.

- The full monthly project demands for Salt Lake and South Utah counties M&I (60,000 acre-feet) and SVP (61,000 acre-feet) water are met. In those months when the full project demand would otherwise not be met, the model adjusts the delivery of Bonneville Unit water to Utah Lake to meet the demand.

2.3.1.3 Spanish Fork River Model

The Spanish Fork River Model is a mass balance spreadsheet accounting model designed to track water from Strawberry Reservoir in the Syar Tunnel, Strawberry Tunnel, and Diamond Fork pipeline systems, in Sixth Water and Diamond Fork creeks, and in the Spanish Fork River. The evaluation area ends at the downstream end of the Spanish Fork River, just before it flows into Utah Lake. The inputs to the system are SVP calls from Strawberry Reservoir (developed separately); CUP calls from Strawberry Reservoir (developed using PROSIM2000 and spreadsheet models); natural inflows; and seepage into the Strawberry Tunnel.

Natural flow, CUP water, and SVP water are tracked separately in the model and summed to determine the total flow at any point in the system. The mass balance spreadsheet application accounts for diversions within the river system, including:

- Hayes Ditch
- Levanger Ditch
- WA Pace Ditch
- Clinton Diversion
- Mapleton – Springville Lateral
- Turnout C
- Strawberry Highline Canal
- Salem and South Field Canals
- East Bench Canal
- Mill Race Canal
- Lakeshore Canal

Losses, instream flow requirements, and canal, pipeline and tunnel capacity limitations are accounted for in the model.

The Baseline and Alternative analyses of the Spanish Fork River included the following methodologies and parameters:

- The development of Spanish Fork River natural streamflow and diversion data is documented in an August 13, 2001 draft memorandum entitled, "Hydrologic Adjustment to Develop Diamond Fork and Spanish Fork Data for Use in RiverWare Model and ULS." This document is included in Attachment 1.

- SVP calls on Strawberry Reservoir are the same as under Baseline. Under the Spanish Fork Canyon-Provo Reservoir Canal Pipeline and Bonneville Unit Water alternatives, SVP water that is assumed to be converted to M&I use (10,200 acre-ft/year) is conveyed through ULS facilities on a space available basis. Under the No Action Alternative, no new facilities are available for delivering the converted water.

- Spanish Fork natural flow operations calls and deliveries are the same for all alternatives as under Baseline.

- Under all ULS action alternatives, an average of 101,900 acre-feet per year of CUP water is called from Strawberry Reservoir.

- Under the Preferred Alternative, approximately 12,037 acre-feet per year (4,000 acre-feet of section 207 conserved water, and 8,037 acre-feet Jordanelle exchange water) are released into Hobble Creek primarily in April through June to help achieve target flows associated with June sucker recovery and at other times of the year to improve low flow conditions. Under the Bonneville Unit Water Alternative, additional releases of 11,473 acre-feet of Jordanelle exchange water are made to Hobble Creek, primarily in other months of the year. Hobble Creek supplemental water would not necessarily be delivered during high runoff years when Utah Lake is above compromise level. These typically would be years when natural runoff would be sufficient for the attraction flow. In years when releases from Strawberry to Utah Lake for the Jordanelle Exchange are not being made (other than for instream flow releases in Sixth Water and Diamond Fork creeks), no supplemental flow deliveries would be made to Hobble Creek or the Provo River.

2.3.1.4 Hobble Creek Model

The Hobble Creek Model is a spreadsheet accounting model whose purpose is to evaluate the volume and frequency of ULS supplemental water delivered to Hobble Creek to meet the target flows for June sucker. The target flows were preliminarily estimated as 80 cfs in April, 100 cfs in May, and 40 cfs in June based on recommendations from the June Sucker Recovery Implementation Team..

The model evaluates two bookend scenarios based on two assumptions on the agricultural diversions for the Springville and Mapleton Irrigation Districts. The assumptions were made to avoid the complexity of determining water supply priorities among multiple agricultural water supply sources, while at the same time providing a reasonable range of diversions from Hobble Creek. The model maintains the water balance among flows above the diversions and flows below the diversions on a monthly basis over the 50-year period of 1950-1999. The monthly flows below the diversions are calculated and then compared to the estimated target flows in April, May and June. If flows below the diversions are lower than the target flows, then the ULS supplemental water (if available) is delivered to meet the target flows. The average annual allocated ULS supplemental water was preliminarily estimated as 12,037 acre-feet by the ULS team. Of this, 4,000 acre-feet per year are derived from Section 207 water conservation savings and are available every year if needed. (The 4,000 acre-feet consists of 3,000 acre-feet assumed to be conserved from the ULS supply to southern Utah County, and 1,000 acre-feet already conserved from the 1,590 M&I System supply.) Hobble Creek supplemental water would not be delivered during high runoff years when Utah Lake is above compromise level. These typically would be years when natural runoff would be sufficient for the attraction flow. The remaining 8,037 acre-feet per year are provided from ULS water being delivered from Strawberry to Utah Lake to facilitate the Utah Lake – Jordanelle exchange. This water is only available in years when water is needed to make the exchange. The Hobble Creek spreadsheet model checks the average annual volume of ULS water delivered for flow augmentation purposes to ensure that the annual volume target goal is not exceeded. If the average annual ULS supplemental water is less than 12,037 acre-feet, the remaining water will be delivered and spread evenly among summer months in the years it is available to serve as summer maintenance flow.

In some years, ULS supplemental water may not be available even though Hobble Creek calls for supplemental water. This typically happens when lower than average Strawberry Reservoir releases are required to be made to Utah Lake to facilitate the exchange to Jordanelle Reservoir. The spreadsheet model then checks to see if target flows are achieved in a higher percentage of years (frequency) than the requirement, which was identified as seven out of ten or better. If the target flows aren't being met in seven out of ten years or better, then adjustments are made to the model to achieve that goal.

2.3.1.5 PROSIM2000 Model

The PROSIM2000 Model is a prioritized water balance allocation calculator. It uses a database containing information on hydrology, water rights, facilities, and water requirements (CUWCD 1998). The model provides 50 years of monthly output describing the flows, deliveries, consumptive use, and reservoir storage that would result given the data, assumptions, and operating rules used in simulating a given scenario. The model divides the Provo, Weber, Strawberry Reservoir, Spanish Fork River, and Utah Lake system into stream reaches and model nodes. Simulation results are available at each of the 515-modeled river nodes, inflows, diversion facilities, and reservoir accounts in the modeled area.

The primary function of the model is to estimate the volume of water that, given a set of operational rules, can be allocated and diverted to each water user, stored in each reservoir, or retained in the river. PROSIM2000's prioritized simulation capabilities include the following:

- Water Rights
- Institutional Arrangements
- Hydrological Processes
- Reservoir and Streamflow Operations

PROSIM2000 was used to develop the baseline condition flows and storage in the Provo River, Jordanelle and Deer Creek reservoirs, and Utah Lake. The Provo River Spreadsheet Model, described below, was used to track flow and storage changes resulting from operation of the project alternatives. The following parameters and methodologies are used in the baseline analysis:

- The M&I System is under full operation delivering an average of 107,500 acre-feet during the entire hydrologic period.

- Jordanelle flood control operations are included according to the US Army Corps of Engineers' draft water control diagram. Runoff projections for the years prior to 1996 use computed natural runoff into Deer Creek Reservoir instead of an NRCS projection, because the projection is not available prior to 1996.

- The State Engineer's Utah Lake Distribution Plan is included – the conversion line is modified to account for holding the appropriate level of District secondary rights in the lake.

- Wasatch County Water Efficiency Project is operational. This includes the Daniels Replacement Project, which decreased transbasin diversions from the Strawberry River into the Provo River by 2,900 acre-feet per year.

2.3.1.6 Provo River Model

The Provo River Spreadsheet Model is a mass balance spreadsheet accounting model designed to track water in Jordanelle and Deer Creek Reservoirs and in the Provo River. The simulation ends at the downstream end of the Provo River, just before it flows into Utah Lake. The inputs to the model are the baseline results from the PROSIM2000 baseline simulation and operating changes required for each of the project alternatives. The model provides 50 years of monthly output describing the flows, deliveries, and reservoir storage that would result given the data, assumptions, and operating rules used in simulating a given alternative.

The alternative analyses of the Provo River included the following methodologies and parameters:

- The District is able to directly exchange its Utah Lake rights to Jordanelle Reservoir (Utah State Engineer, Memorandum on Change Application No. 55-77 January 2003).
- ULS operations are performed on a space available basis, in accordance with the Deer Creek-Jordanelle Operating Agreement. There is no impact on the Provo River Project or CUP M&I System operations of Jordanelle and Deer Creek.
- Non-CUP diversions from the lower Provo River are unchanged from the Baseline data except for 3,300 acre-feet of water rights purchased under Section 302 for meeting a portion of the 75 cfs target minimum flow and 12,165 acre-feet of water conserved under Section 207 for June sucker RIP operations.
- Except for modifications associated with June sucker RIP, the alternatives analysis used Baseline Provo River Project (PRP) demands.
- A portion of PRP (15,181 acre-feet) deliveries that are diverted at Murdock in Baseline are diverted on a space available basis at Olmsted in the alternatives.
- CUP M&I deliveries are the same in the alternatives as in Baseline (i.e., all goes through Olmsted). Under the Spanish Fork Canyon-Provo Reservoir Canal Pipeline Alternative, ULS deliveries are made through Provo Reservoir Canal Pipeline (with a capacity of 550 cfs) in the summer when there is insufficient space available capacity in the Jordan Aqueduct and through the Jordan Aqueduct (with a capacity of 270 cfs) at all other times.
- ULS deliveries are only made from Strawberry to Utah Lake when they will facilitate the exchange of water from Utah Lake to Jordanelle. The delivery schedule makes supplemental water available in at least seven out of ten years. These years are associated with large diversions to Utah Lake under Baseline.
- Minimum instream flow requirements are the same under the alternatives as they are under Baseline.
- Transbasin diversions from the Weber and Duchesne rivers to the Provo River Project are the same under all alternatives as under Baseline.
- The Provo River direct flow rights acquired by URMCC under Section 302 are operated to help achieve a 75 cfs minimum flow target in the lower Provo River. Historical diversions associated with the acquired rights are reduced.

- The monthly pattern of CUP M&I System deliveries to North Utah County is modified to reflect utilization of the 20,000 acre-feet per year in secondary water systems.

- Under the Spanish Fork Canyon-Provo Reservoir Canal Pipeline Alternative, 16,000 acre-feet per year is delivered into the Provo River below the West Union/Upper East Union diversion structure, approximately 1 mile below the Murdock Diversion. Winter-time target flows of 75-cfs between Olmsted and Murdock are not by this ULS supplemental water. Target flows between Olmsted and this location are typically satisfied in the summer by irrigation deliveries downstream. These deliveries are only made when necessary to facilitate the exchange from Utah Lake to Jordanelle Reservoir.

- Under all three ULS alternatives the 3,300 acre-feet of Provo River water rights purchased by the Mitigation Commission under Section 302 is left in the River to provide water towards the 75 cfs target flow. This water comes from the following sources:

- It is estimated that the following water quantities and sources comprise the water that would be stored and released to the lower Provo River for June sucker spawning and rearing flows and as an alternate delivery to Utah Lake in lieu of a release from Strawberry Reservoir. This water comes from a combination of storage and direct diversion rights. Because of this, its operation to supplement June sucker spawning and rearing flows also varies. The two elements of storage water (2,875 acre-feet of Northern Utah County Section 207 savings, and 4,000 acre-feet of Provo Reservoir Canal water), would be released from Deer Creek Reservoir every year, as soon as it was needed (and to the extent that it was needed) to meet the appropriate June sucker target flow hydrograph of the Provo River. All of the other supplies are associated with direct diversion water rights. This water is only available as a portion of the overall right to which it is associated. This means that the full volume is available as a part of the natural flow of the River, throughout the entire irrigation season. The water is not necessarily available when needed during the June sucker spawning period. On average, 2,085 of the 5,290 acre-feet of these rights are available when needed, and 3,025 acre-feet are not. To get the most benefit out of these water supplies, when they are available and when they are not needed to meet the spawning and rearing flows, the rights will be used to divert natural flow water at Olmsted to meet CUP M&I System demands. At the same time, an equal amount of CUP water will be held in Jordanelle and Deer Creek, and, subsequently and where possible, used to meeting the spawning and rearing flow targets. Although a portion of this water is spilled or otherwise lost before there is additional need for June sucker flow augmentation, most of it will be released when needed to meet the June sucker or other fishery needs.

  - 2,875 acre-feet Northern Utah County 207 project savings already assigned to DOI
  - 1,000 acre-feet Upper East Union and East River Bottom canals piping to be assigned to DOI
  - 290 acre-feet Timpanogos Canal piping already assigned to DOI
  - 8,000 acre-feet from Provo Reservoir Canal seepage loss savings to be assigned to DOI
  - 12,165 acre-feet total water released to the lower Provo River

2.3.1.7 Utah Lake Model

The Utah Lake Spreadsheet Model is a mass balance spreadsheet accounting model that tracks storage in and outflows from Utah Lake for each of the four project alternatives. Inputs to the model include inflows from the major rivers, the Provo, American Fork, and Spanish Fork rivers, along with other inflows such as return flows and groundwater and demands on the lake. The simulation ends at the Jordan Narrows, downstream from the outlet from Utah Lake. The model provides 50 years of monthly output describing the flows, deliveries, and reservoir storage

'hat would result given the data, assumptions, and operating rules used in simulating a given alternative. The following methodologies and parameters are applied in the Utah Lake Spreadsheet Model:

- The 7,900 acre-feet of CUWCD primary rights transferred to DOI to supply the water associated with the Indian Ford exchange of the M&I System are held in the Lake.
- The CUWCD secondary rights of 57,073 acre-feet are delivered from Utah Lake in the same average pattern as the remainder of Utah Lake rights. In the ULS Spanish Fork Canyon-Provo River Canal Pipeline Alternative approximately 57,000 acre-feet of CUWCD secondary rights are held in Utah Lake when necessary, and water is converted or exchanged to Jordanelle accordingly. In the Bonneville Unit Water Alternative and No Action Alternative, up to 15,000 acre-feet of secondary rights are held in Utah Lake when necessary. Historical calls on Utah Lake are reduced by the proportion associated with the CUWCD secondary rights that are held. If Utah Lake is above Compromise Elevation, or significantly above the baseline level, the full, baseline deliveries associated with the CUWCD secondary rights are assumed.
- The Baseline and alternatives analyses make use of historically-based inflow data, except in the case of transbasin diversions to the Provo River and CUP water from Strawberry Reservoir
- As described in Section 2.1, ULS alternatives will not alter Jordan River flows below Jordan Narrows. Between Utah Lake and Jordan Narrows, Jordan River flow changes are represented at the outlet to Utah Lake.

2.3.2 Verification and Calibration

The analyses and models used to evaluate impacts resulting from the ULS alternatives were verified to demonstrate that they provide a reasonable representation of the physical systems being analyzed. This was accomplished by calibration, in which the models and analyses were used to evaluate historical conditions and the results compared to observed historical values. To the extent that there are uncertainties in parameters used in the models and analyses, these parameters were adjusted to achieve a better match with historical conditions.

2.3.2.1 Strawberry Reservoir Spreadsheet Operations Model

For the southern Utah County area, the Strawberry Reservoir operations model was verified by comparing its output with output from an older Reclamation reservoir model that is the basis for much of the water supply information described in the appendices to the Bonneville Unit Draft Supplement to DPR (Reclamation 1988). The Reclamation models are based, when possible, on historical measured data and on available water supplies. The model-estimated flows are based on these supplies and the demands to be met, so that if historical demand were used in the model, it would reproduce historical flows.

2.3.2.2 Spanish Fork River Model

The Spanish Fork River Model verification consisted of a comparison of simulated and historical streamflows and river diversions, checks of the mass balance in the model, and verification that the baseline model allocates SVP water in the same manner as current operation. All baseline flows and diversions were also checked using a RiverWare model of the Diamond Fork and Spanish Fork system.

2.3.2.3 Hobble Creek Model

The verification of the Hobble Creek Model was based on checks of the mass balance in the model. Because the multiple diversions from Hobble Creek are combined together in the model and not specified explicitly, it was not possible to verify the model against current operations.

2.3.2.4 PROSIM2000 Model

PROSIM, the direct predecessor to PROSIM2000, was calibrated by simulating historical conditions on the Provo River system. Calibration results from PROSIM are applicable to PROSIM2000 and the following discussions are related to PROSIM2000. The objective of the calibration was to make minor adjustments to the input data as necessary, and to verify the accuracy of the model for use in simulating future conditions on the river. The calibration process involved the following steps:

1. Select separate calibration and verification periods for the model.
2. Develop model-input data.
3. Perform initial simulations for the calibration period and compare with historical data.
4. Adjust model-input data for the entire period of hydrological record.
5. Repeat until good agreement is achieved between model output and actual observed conditions during the calibration period.
6. Run calibrated model for the verification period and compare with actual conditions to evaluate the calibration accuracy.

Separate calibration (1960 to 1970) and verification (1971-1984) periods were selected to calibrate the model and to demonstrate the accuracy of the model calibration. These periods were selected because reasonably accurate diversion and reservoir storage data were available, and because they did not include any major operational or facility changes. The results of the calibration process were related to the accuracy of simulated flows, reservoir contents, and river diversions. Each of these is discussed below.

Simulated Provo River flows were compared with historically recorded flows at the streamgages at Woodland, at Hailstone, above Deer Creek, below Deer Creek, and at Provo City. All simulated average annual flows were within one or two percent of the recorded values. Individual annual flows were within four percent at Woodland, Hailstone, and above Deer Creek. Simulated annual flows were within five to seven percent of historic flows below Deer Creek. Simulated annual flows at Provo City were within ten percent in 22 of the 25 years evaluated. Simulated monthly average flows were within one to four percent of historical values at all gages except Provo City, where three out of twelve months had variations of up to 30 percent.

Simulated reservoir volumes compared favorably with historical results with the exception of the mid-1980s, when unmodeled reservoir operational changes occurred. These changes included the Deer Creek/Strawberry Exchange, operations to mitigate high flows, and agricultural water conversions. During the 1960 to 1984 period, the PROSIM2000 Deer Creek Reservoir results were within 10 percent of the historical values, 83 percent of the time. At Utah Lake, simulated results were within 10 percent in 96 percent of all months modeled.

River diversions simulated by PROSIM2000 closely matched historical diversions. On the Provo River above Deer Creek Reservoir, simulated diversions were within one percent of historical values. On the lower river, PROSIM2000 results were within five percent of the historic values more than 93 percent of the time.

The conclusions of the calibration and verification process were that simulated results were in close agreement with recorded values. The PROSIM2000 model and its hydrology and operations logic were judged to be adequately calibrated and ready for use in simulating future Provo River operational scenarios. Additional detail concerning the calibration process is presented in Technical Memorandum - Preliminary Simulation Results, Historical Calibration Scenario (CUWCD, 1994).

2.3.2.5 Provo River Spreadsheet Model

The Provo River spreadsheet model was calibrated and checked by comparing streamflow results with results from preliminary runs of the PROSIM2000 model and by performing simple water-balance checks for continuity.

2.3.2.6 Utah Lake Spreadsheet Model

The Utah Lake spreadsheet model was calibrated and checked by comparing results with independent simulation runs of the LKSIM2000 model. LKSIM2000 produces a time series showing the total volume required to balance the cumulative water balance inputs. By using the Utah Lake spreadsheet model outputs as LKSIM2000 model inputs, the two models are exactly compared for errors in water balance.

THIS PAGE INTENTIONALLY LEFT BLANK

Chapter 3
Affected Environment (Baseline Conditions)

This chapter presents baseline hydrologic conditions for the ULS. Baseline conditions are summarized in this chapter for each of the major hydrologic features. Complete baseline streamflow and reservoir storage results can be found in the appendices.

3.1 Impact Area of Influence

The surface water hydrology impact area of influence includes each of the streams, lakes, and reservoirs that would be affected by the operation of the project alternatives. This can generally be defined by the pathway of the ULS water supply beginning where the ULS water leaves Strawberry Reservoir and ending at the point of use. Map 3-1 shows the overall ULS impact area of influence for surface water hydrology. The impact area includes streams used to convey ULS water upstream and downstream from and including Utah Lake.

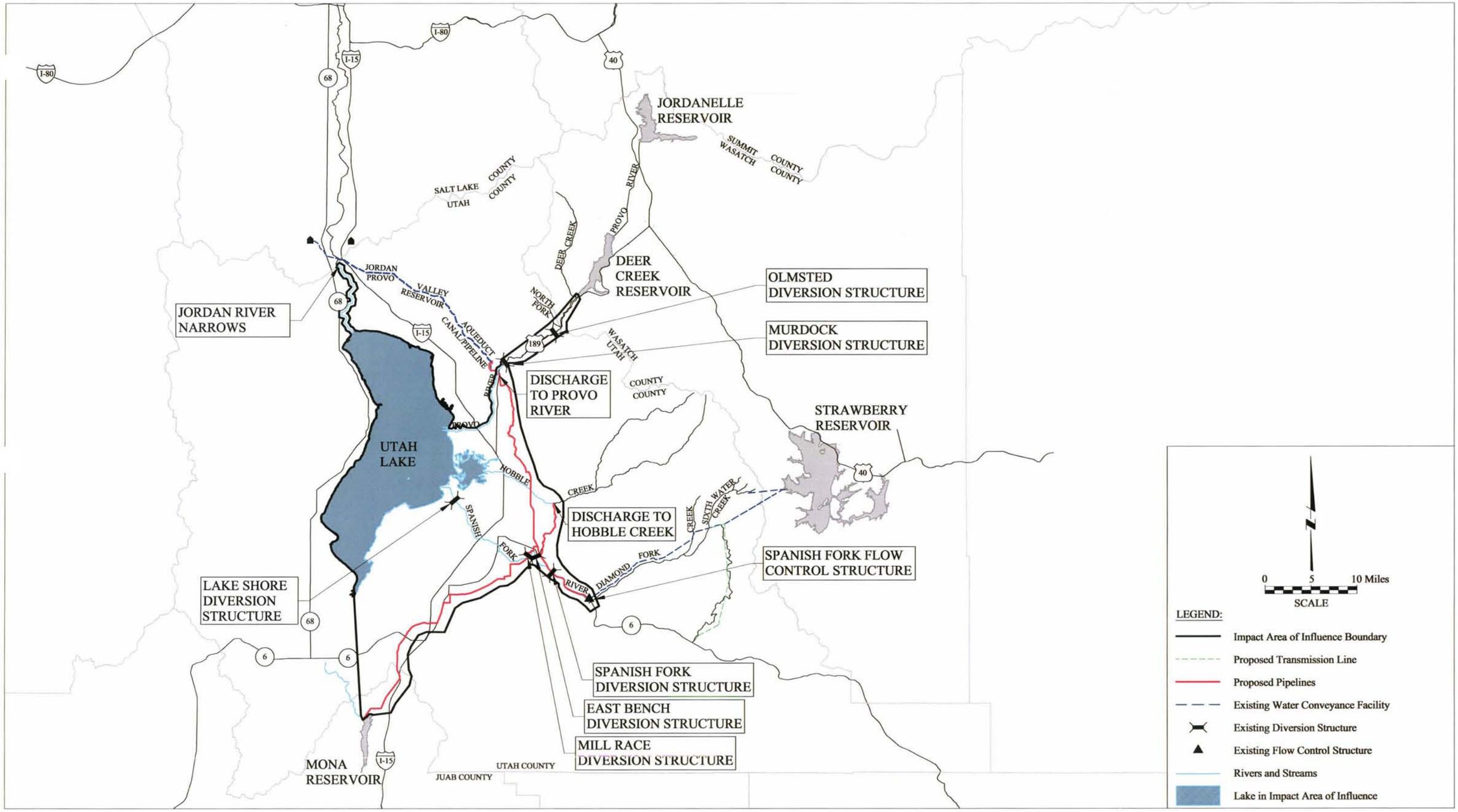
Sixth Water Creek, Diamond Fork Creek, and Strawberry Reservoir are not included in the impact area of influence. However, discussion of surface water hydrology of these features is presented in this chapter (and results are presented in the appendices) to demonstrate that operation impacts would not change significantly from previous analyses in the Bonneville Unit Final EIS (Reclamation 1973) and in the Diamond Fork Final Supplement to the FEIS (CUWCD 1999).

The water bodies included in the impact area of influence for each alternative are summarized below.

3.1.1 Spanish Fork Canyon–Provo Reservoir Canal Alternative (Preferred Alternative)

- Provo River between Jordanelle Reservoir and Utah Lake
- Hobble Creek between Mapleton Lateral and Utah Lake
- Spanish Fork River between Diamond Fork Creek and Utah Lake
- Jordan River from Utah Lake Outlet to the Narrows
- All diversion canals delivering project water
- Deer Creek Reservoir
- Jordanelle Reservoir
- Utah Lake

THIS PAGE INTENTIONALLY LEFT BLANK



Map 3-1
Surface Water Hydrology
Impact Area of Influence

3.1.2 Bonneville Unit Water Alternative and No Action Alternative

- Provo River between Jordanelle Reservoir and Utah Lake
- Hobble Creek between Mapleton Lateral and Utah Lake
- Spanish Fork River between Diamond Fork Creek and Utah Lake
- Jordan River from Utah Lake Outlet to the Narrows
- All diversion canals delivering project water
- Deer Creek Reservoir
- Jordanelle Reservoir
- Utah Lake

3.2 Overview

For the purpose of analysis, the impact area of influence has been divided into major features. Table 3-1 lists the major hydrologic features (reservoirs, ponds, rivers, and creeks) that are considered in the impact analysis and summarizes the potential causes of impacts on these features. Map 3-1 shows the relationship of the ULS to the major hydrologic features in the impact area of influence.

This section presents baseline conditions within the impact area of influence. Baseline conditions are based on the assumption that hydrologic conditions (rainfall, runoff, and climatic conditions) that occurred from 1950 to 1999 would occur again over time. The 50-year period from 1950 to 1999 was selected because 1) it includes at least two wet and dry periods and therefore reflects the potential hydrologic variability and 2) it overlaps the period of analysis used for previous analyses of the Bonneville Unit Systems in related environmental documentation.

Surface water baseline conditions have been developed on a monthly basis. This report generally uses "water years" (which begin in October) rather than calendar years. Water years are commonly used in hydrology to group conditions in a wet season and snow pack accumulation period (generally from October to March) within the same year. Average values over the 50-year baseline period are used as a means to summarize the monthly and annual values. Values for wet and dry years are used to show effects of extreme hydrology. Wet year baseline conditions were developed by averaging flows for 1952, 1983, and 1986. Dry year baseline conditions were developed by averaging flows for 1961, 1977, and 1992. Tables 3-2 and 3-3 present average monthly baseline streamflows and reservoir contents for major streams and reservoirs in the impact area of influence. Baseline details by month for all 50 years are contained in the appendices.

3.2.1 Comparisons with Previous Environmental Documents

ULS baseline surface water hydrology conditions are based upon project operations that were documented in previous environmental documents which are in the process of being implemented. Surface water conditions on the Spanish Fork System are documented in the Diamond Fork Final Supplement (CUWCD 1999) and will be fully implemented in early 2005. Monthly baseline flows only differ from these previously documented operations where more detailed information was available and because ULS baseline conditions have been updated to include the 1950 through 1999 hydrologic period. Surface water hydrologic results for the baseline conditions are compared with Diamond Fork Final Supplement conditions in a draft memorandum entitled "Hydrologic Evaluation of Diamond Fork and Spanish Fork River System for ULS Baseline Conditions", dated April 26, 2003. This document is included in the Attachment 1.

ULS baseline surface water conditions on the Provo River System are based upon project operations that were documented in the 1979 M&I System Final Environmental Statement (FES) (Reclamation, 1979 a&b) and the 1987 Final Supplement (Reclamation 1987) which are in the process of being fully implemented in 2009. The ULS baseline streamflows of the Provo River have been compared in detail with the stream flows that were documented in these environmental documents. The results of this comparison are documented in "ULS Baseline Provo River Flows Compared with CUP M&I System FES Conditions", (CUWCD, 2003), which is included in the Attachment 1. The document concludes, "differences between ...ULS Baseline and the CUP M&I System's post-project condition are relatively minor, and should not affect results of the analysis of ULS impacts."

The baseline flows were also reviewed and analyzed by the Reclamation hydrologist responsible for the M&I System stream flow modeling who compared the flows with previous Reclamation studies. Reclamation concluded that the flows were the essentially the same, given the differences in the hydrologic period and the more detailed methods used in the ULS studies (Reclamation, 2003b).

Baseline surface water conditions for the lakes and reservoirs in the ULS study area are the result of the flows produced by the Spanish Fork and Provo River baseline models and modeling assumptions used in the analysis tools described in Section 2.2.1.

Table 3-1
Major Hydrologic Features in the Impact Area of Influence

Hydrologic Features	Discussion
Upper Provo River	Affected by related action flows from Jordanelle Reservoir (Note: this feature is not included in the overall EIS Impact Area of Influence because it is not affected by ULS operations and the results of surface water hydrology analyses show no impacts)
Middle Provo River	Affected by related action flows from Jordanelle Reservoir and Deer Creek Reservoir (Note: this feature is not included in the overall EIS Impact Area of Influence because it is not affected by ULS operations and the results of surface water hydrology analyses show no impacts)
Lower Provo River	Would receive project flows from middle Provo River and Spanish Fork-Provo Reservoir Canal Pipeline
Hobble Creek	Would receive project flows from Springville-Mapleton Lateral Pipeline
Upper Spanish Fork River	Flows would be modified by operation of Spanish Fork Canyon Pipeline
Lower Spanish Fork River	Flows would be modified by operation of Spanish Fork Canyon Pipeline
Jordan River	Would receive flows from Utah Lake as determined by the State Engineer (Note: this feature is not included in the overall EIS Impact Area of Influence because no project water is released down the Jordan River and the results of the surface water hydrology analyses show no impacts; however, flow data is included to document that there are no impacts)
Jordanelle Reservoir	Would store exchanged M&I System water from Utah Lake (Note: this feature is not included in the overall EIS Impact Area of Influence because the results of surface water hydrology analyses show no impacts)
Deer Creek Reservoir	Would pass through project flows from Jordanelle and Strawberry reservoirs (Note: this feature is not included in the overall EIS Impact Area of Influence because the results of surface water hydrology analyses show no impacts)
Utah Lake	Would receive project surface flows from lower Spanish Fork River, Hobble Creek, and Lower Provo River for exchange to storage in Jordanelle

3.3 Streams

Table 3-2 presents average monthly, wet year, and dry year baseline streamflows for major streams and lakes in the impact area of influence. Complete simulation results by month for all 50 years are contained in the appendices. The following section describes each of the major stream reaches examined for impacts. Baseline average, wet year and dry year flows are presented for each stream reach. Note: When flow results are referenced in this document, they are typically "average annual" results, although the text and tables do not always include these words.

3.3.1 Upper Provo River

The upper Provo River covers the Provo River between Jordanelle and Deer Creek reservoirs and includes three reaches: Timpanogos Diversion to River Ditch, River Ditch to Snake Creek, and Snake Creek to Inlet to Deer Creek Reservoir. Figure 3-1 shows the baseline average, wet year, and dry year flows for the upper Provo River.

3.3.2 Middle Provo River

The middle Provo River encompasses the Provo River between Deer Creek Reservoir and the Murdock diversion structure and includes three reaches: from Deer Creek Reservoir outlet to North Fork of Provo River, North Fork of Provo River to Olmsted Diversion Dam, and Olmsted Diversion Dam to Murdock Diversion Dam. Figure 3-2 shows the baseline average, wet year, and dry year flows for the middle Provo River.

Table 3-2
Average Monthly, Dry Year, and Wet Year Streamflows (cfs) Under Baseline Conditions

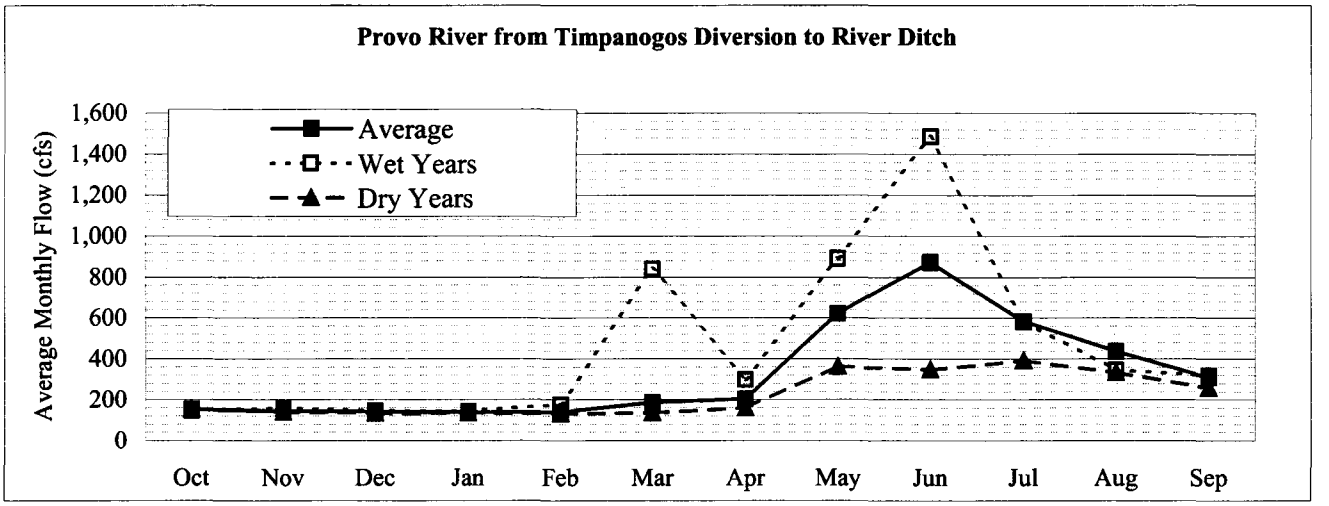
Page 1 of 2

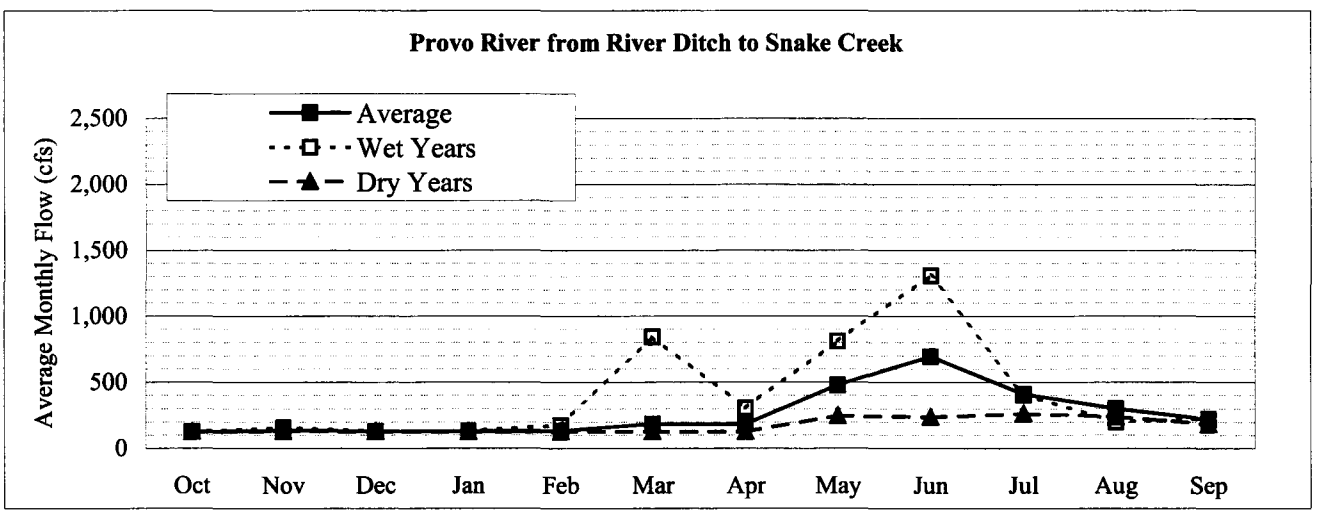
Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual Flow (ac-ft/yr)
Provo River from Timpanogos Diversion to River Ditch													
Average Flow	153	144	140	137	140	186	203	623	873	583	436	307	237,528
Wet Years[1]	147	159	145	143	177	841	299	891	1,487	582	345	319	334,872
Dry Years[2]	153	139	132	135	131	134	158	363	348	391	333	256	161,890
Provo River from River Ditch to Snake Creek													
Average Flow	126	136	129	128	134	184	185	478	694	411	301	219	188,976
Wet Years[1]	125	158	130	132	178	842	307	812	1,309	405	201	226	291,637
Dry Years[2]	126	129	125	125	126	125	126	247	237	261	239	181	123,945
Provo River from Snake Creek to Inlet of Deer Creek Reservoir													
Average Flow	241	268	228	224	231	280	269	557	805	515	428	356	266,021
Wet Years[1]	286	348	246	237	320	982	514	1,003	1,395	524	373	417	401,644
Dry Years[2]	215	242	222	209	214	195	170	302	318	317	342	273	182,517
Provo River from Deer Creek Reservoir Outlet to North Fork of Provo River													
Average Flow	147	110	112	132	138	205	279	743	871	628	568	440	264,774
Wet Years[1]	108	116	106	123	231	1,112	623	1,290	1,598	729	549	469	426,799
Dry Years[2]	125	121	118	140	129	134	206	458	358	456	480	310	183,875
Provo River from North Fork of Provo River to Olmsted Diversion Dam													
Average Flow	161	125	123	143	148	216	300	801	938	674	595	461	283,666
Wet Years[1]	138	128	129	144	259	1,139	671	1,377	1,751	813	603	499	462,997
Dry Years[2]	131	133	128	148	136	141	216	475	368	471	488	327	191,616

Table 3-2
Average Monthly, Dry Year, and Wet Year Streamflows (cfs) Under Baseline Conditions

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual Flow (ac-ft/yr)
Provo River from Olmsted Diversion Dam to Murdock Diversion Dam													
Average Flow	137	70	57	54	68	145	243	740	859	472	386	344	216,482
Wet Years[1]	145	84	88	77	207	1,079	678	1,369	1,712	631	428	415	418,141
Dry Years[2]	94	53	42	39	39	39	90	303	253	154	193	183	89,817
Provo River from Murdock Diversion Dam to Interstate 15													
Average Flow	88	72	59	55	70	147	199	476	527	182	149	134	130,503
Wet Years[1]	95	86	92	80	212	1,083	666	1,189	1,372	280	136	135	327,854
Dry Years[2]	68	55	43	40	40	40	72	105	91	72	115	96	50,687
Provo River from Interstate 15 to Utah Lake													
Average Flow	32	76	56	51	64	142	168	347	374	42	4	6	82,237
Wet Years[1]	79	85	95	81	209	1,082	678	1,124	1,255	131	0	0	291,078
Dry Years[2]	14	49	34	33	34	31	13	0	22	6	52	1	17,293
Hobble Creek from Mapleton Lateral to Utah Lake													
Average Flow	7	25	23	22	26	38	60	109	38	4	1	1	21,379
Wet Years[1]	13	36	33	32	58	78	202	346	183	28	11	10	62,124
Dry Years[2]	0	14	13	14	16	14	9	0	0	0	0	0	4,831
Spanish Fork River from Diamond Fork Creek to Spanish Fork Diversion Dam (Castilla Gage)													
Average Flow	158	191	201	215	248	285	425	740	645	546	457	258	264,195
Wet Years[1]	163	204	276	171	278	326	751	1,351	990	546	454	296	350,881
Dry Years[2]	132	190	174	214	243	259	345	492	544	380	356	188	212,581
Spanish Fork River from Spanish Fork Diversion Dam to East Bench Diversion													
Average Flow	58	109	130	143	163	160	190	339	242	176	134	88	116,656
Wet Years[1]	39	96	181	74	126	90	269	770	414	146	90	65	142,735
Dry Years[2]	73	138	129	167	191	203	275	272	189	120	119	75	117,631
Spanish Fork River from East Bench Dam to Mill Race Canal													
Average Flow	54	109	130	143	163	159	182	295	187	127	93	70	103,308
Wet Years[1]	37	96	181	74	126	90	269	735	332	80	47	28	126,703
Dry Years[2]	69	138	129	167	191	203	260	244	145	95	94	69	108,673
Spanish Fork River from Mill Race Canal to Lakeshore Gage													
Average Flow	131	194	205	219	252	289	389	471	257	149	113	86	166,213
Wet Years[1]	141	207	279	174	283	331	755	1,164	499	87	66	74	245,003
Dry Years[2]	120	193	179	219	248	257	274	258	174	113	115	80	134,505
Spanish Fork River at Lakeshore Gage													
Average Flow	125	195	212	226	260	295	387	448	229	125	92	78	161,126
Wet Years[1]	147	210	285	180	292	341	762	1,153	462	67	46	56	241,565
Dry Years[2]	110	192	188	229	257	266	266	246	157	99	97	75	131,404
Jordan River from Outlet of Utah Lake to Jordan Narrows													
Average Flow	251	155	196	248	314	435	566	849	922	919	792	584	377,033
Wet Years[1]	239	320	686	729	1,085	1,502	1,672	2,027	2,040	1,642	1,256	905	807,538
Dry Years[2]	227	16	16	5	6	6	123	476	565	592	440	228	184,492
Jordan River below Jordan Narrows													
Average Flow	48	83	133	189	239	331	349	252	194	72	40	32	118,146
Wet Years[1]	0	222	591	635	981	1,359	1,426	1,357	1,248	733	436	264	557,026
Dry Years[2]	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes:
[1]The three wettest years (1952, 1983, and 1986) were averaged to calculate the values shown in the table.
[2]The three driest years (1961, 1977, and 1992) were averaged to calculate the values shown in the table.





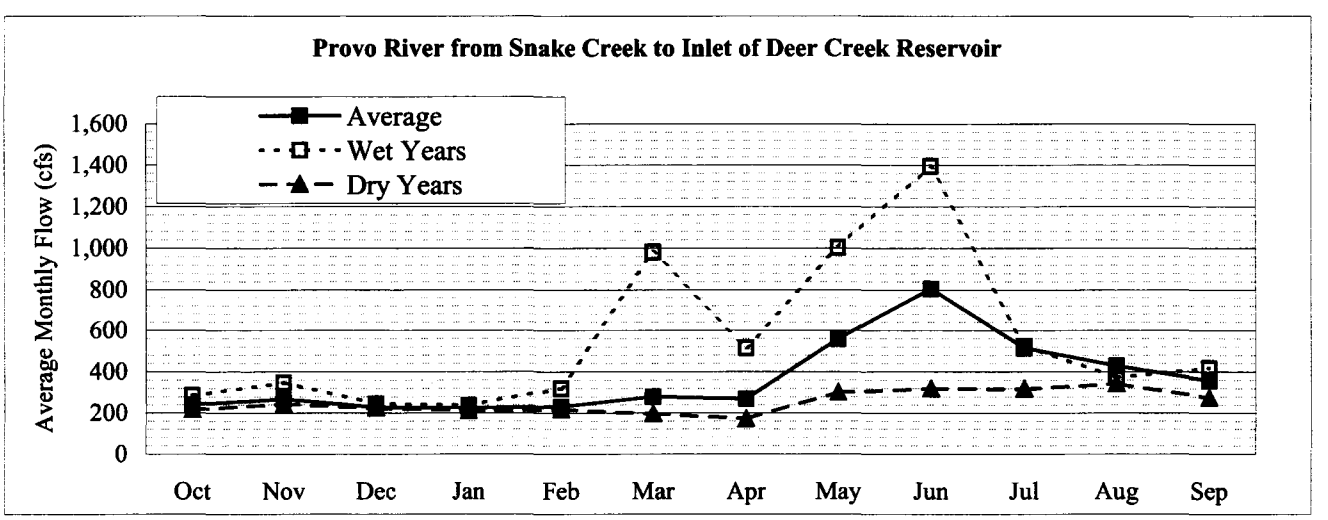
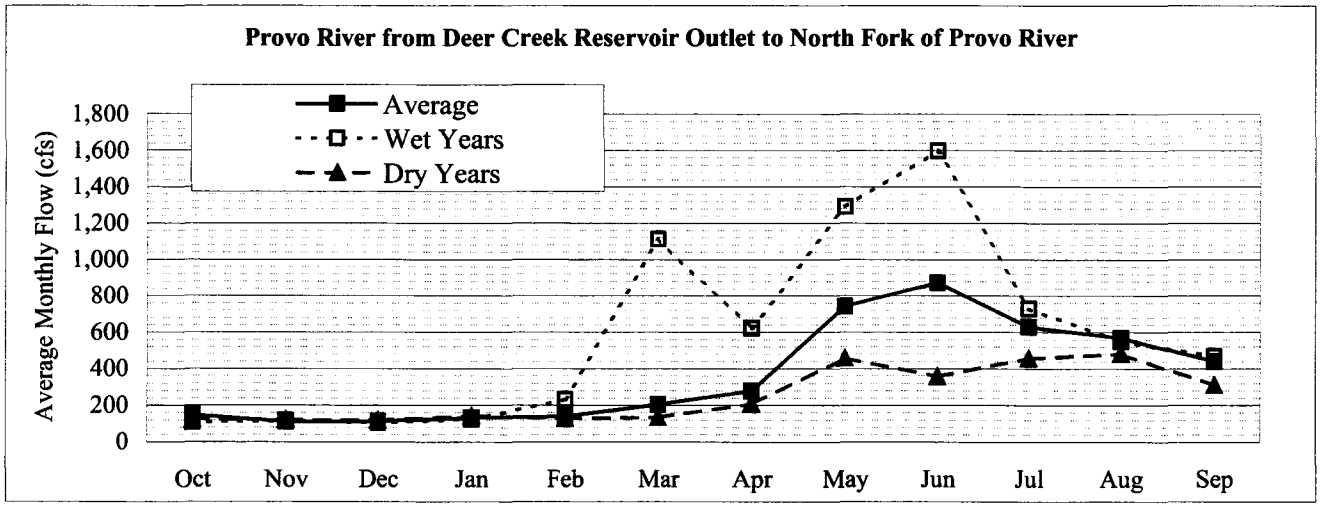
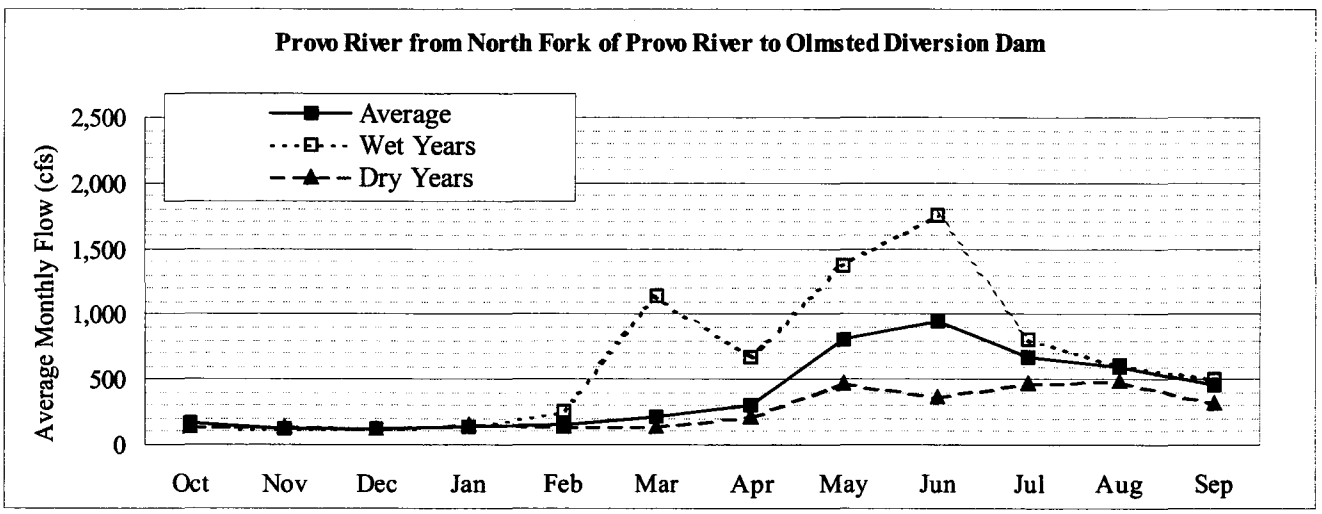


Figure 3-1
Upper Provo River Baseline Stream Flows





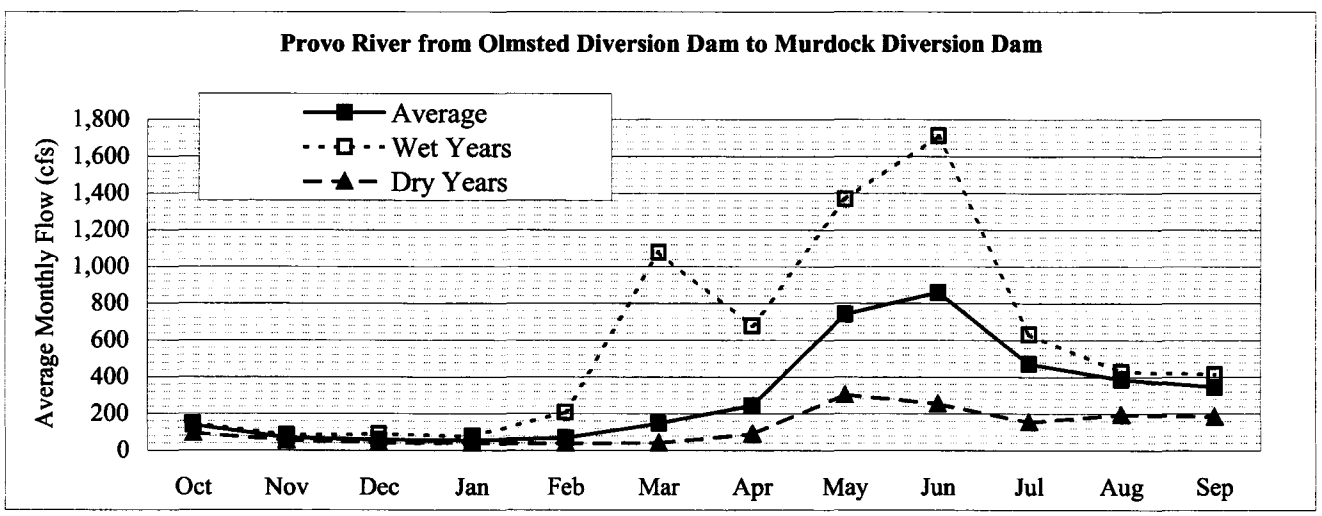
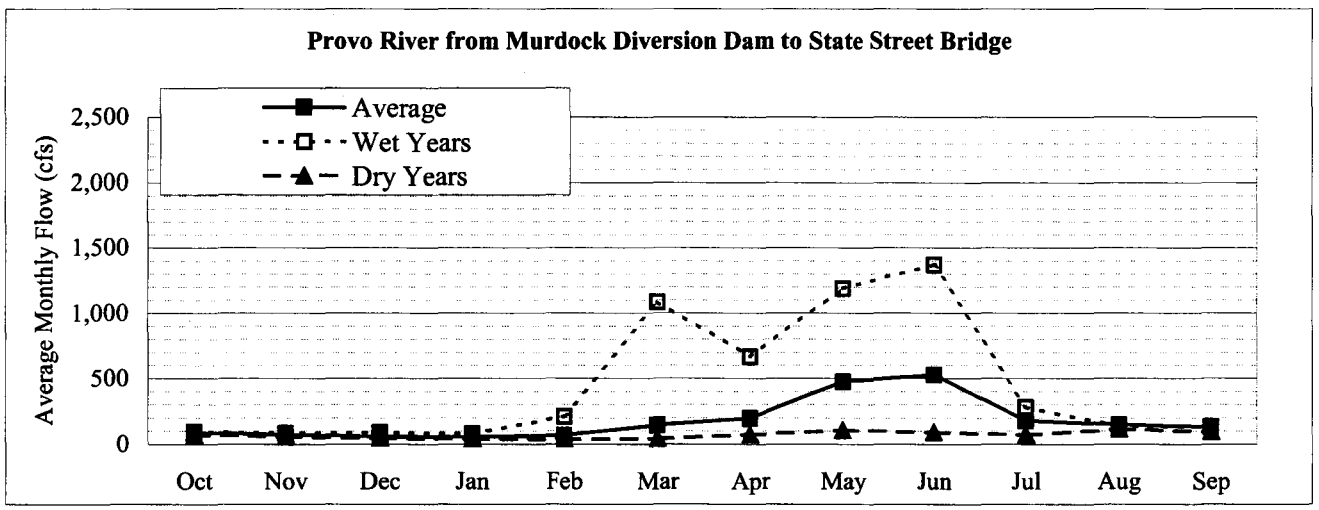


Figure 3-2
Middle Provo River Baseline Stream Flows

3.3.3 Lower Provo River

The lower Provo River runs from the Murdock diversion structure to Utah Lake and includes two reaches: Provo River from Murdock Diversion Dam to Interstate 15 and Provo River from Interstate 15 to Utah Lake. Figure 3-3 shows the baseline average, wet year, and dry year flows for the lower Provo River.



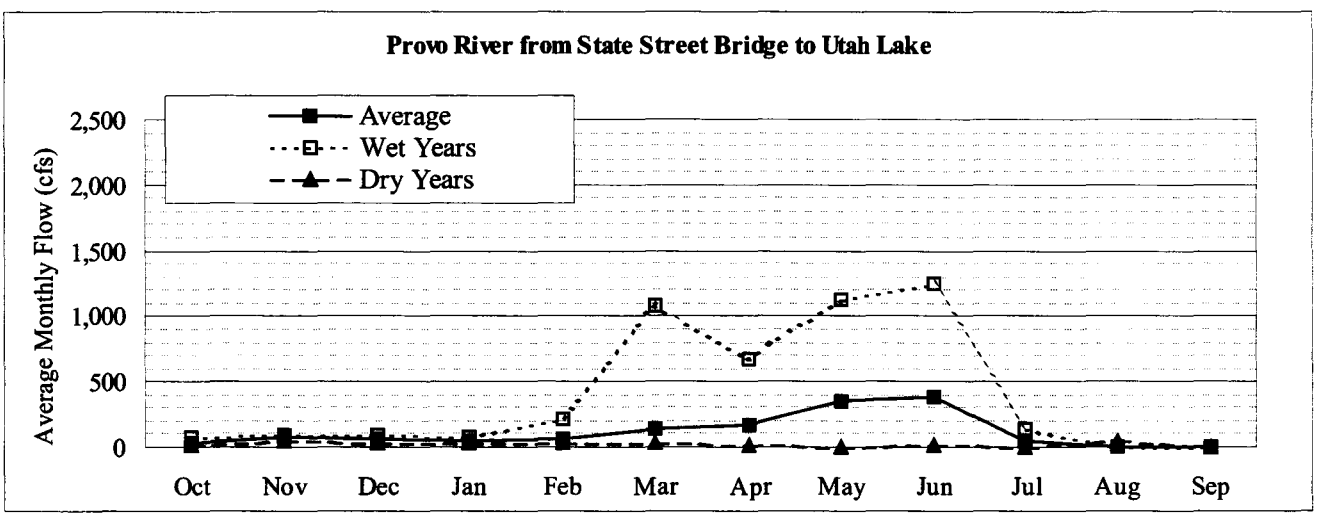


Figure 3-3
Lower Provo River Baseline Stream Flows

3.3.4 Hobble Creek

The Hobble Creek reach runs from the end of the Mapleton-Springville Lateral canal (pipeline) to Utah Lake. Figure 3-4 shows the baseline average, wet year, and dry year flows for Hobble Creek.

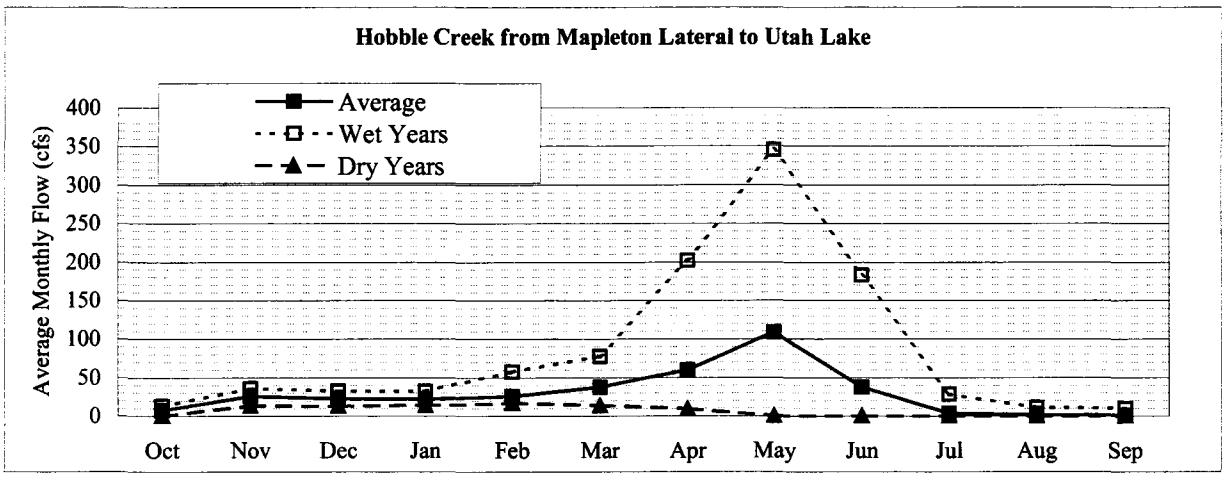


Figure 3-4
Hobble Creek Baseline Stream Flows

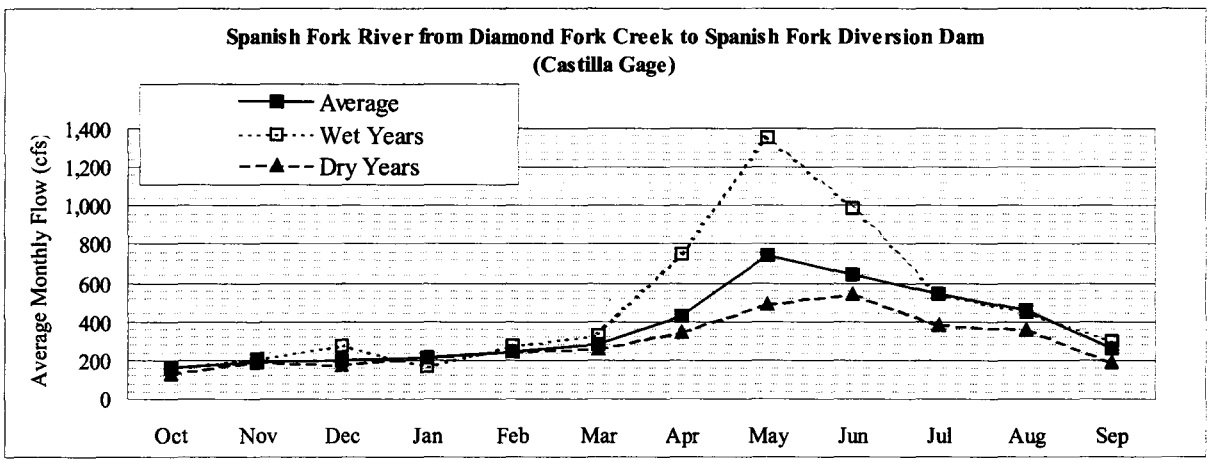
3.3.5 Spanish Fork River

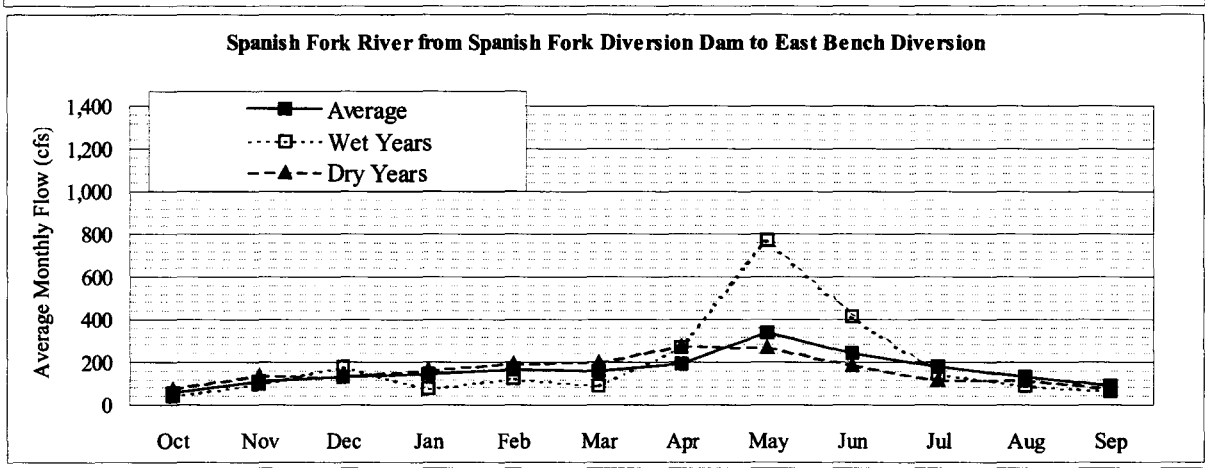
The upper Spanish Fork River covers the reach from the confluence with Diamond Fork Creek to the Spanish Fork Diversion Dam. The lower Spanish Fork River runs from the Spanish Fork Diversion Dam to Utah Lake and includes three reaches and a flow point: Spanish Fork Diversion Dam to East Bench Diversion, East Bench Diversion to Mill Race Canal, Mill Race Canal to Lakeshore Gage, and at Lakeshore Gage. Figures 3-5a and 3-5b show the baseline average, wet year, and dry year flows for the Spanish Fork River.

No flows are reported for Sixth Water or Diamond Fork Creek because flows in these streams are unchanged from those described in the Diamond Fork FS FEIS, and unaffected by operation of the ULS alternatives. ULS alternative operations only affect flows in the pipelines and tunnels bringing water from Strawberry Reservoir, leaving releases to Sixth Water and Diamond Fork unchanged.

3.3.6 Jordan River

The Jordan River begins at the outlet from Utah Lake and continues to the Great Salt Lake. The majority of the water supply diversions from the Jordan River occur at the Jordan Narrows. For the purposes of this analysis, it is assumed that all of the Jordan River diversions occur at the Narrows. The reach of interest lies between the outlet from Utah Lake and the Jordan Narrows. Figure 3-6 shows the baseline average, wet year, and dry year flows for the Jordan River. All releases from Utah Lake are determined by the State Engineer and do not include any project water. Flow data is included to document that the ULS does not impact the Jordan River below Jordan Narrows. The operation of District water rights in Utah Lake could affect flows in the Jordan River above the Narrows. Current District practice is to hold the rights in the Lake and use them to exchange or convert system storage in Jordanelle. Under Baseline operations, the District's Utah Lake rights are assumed to be released down the Jordan River and to be diverted at the Narrows.





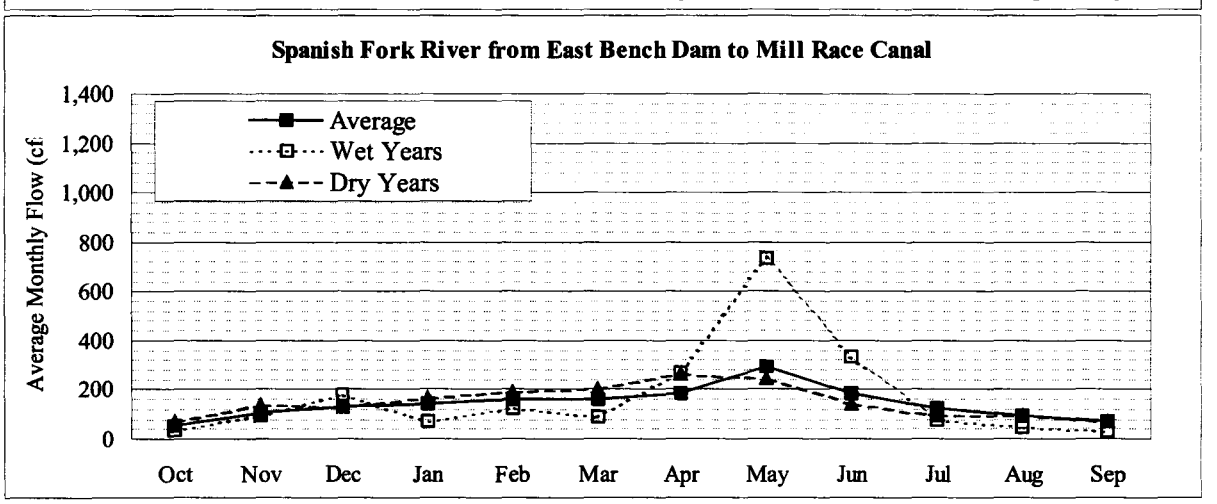
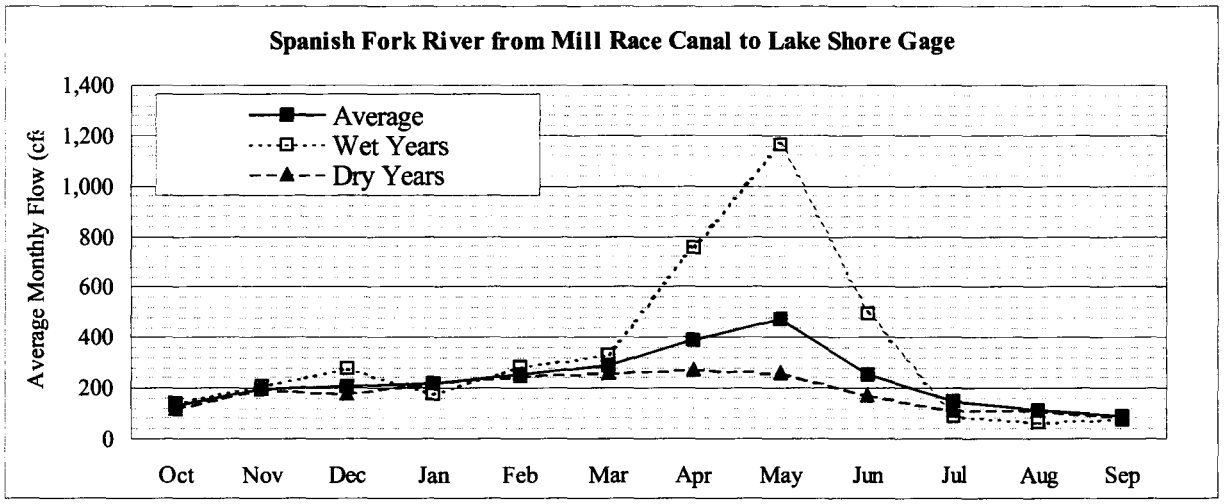


Figure 3-5a
Spanish Fork River Monthly Flows (cfs)



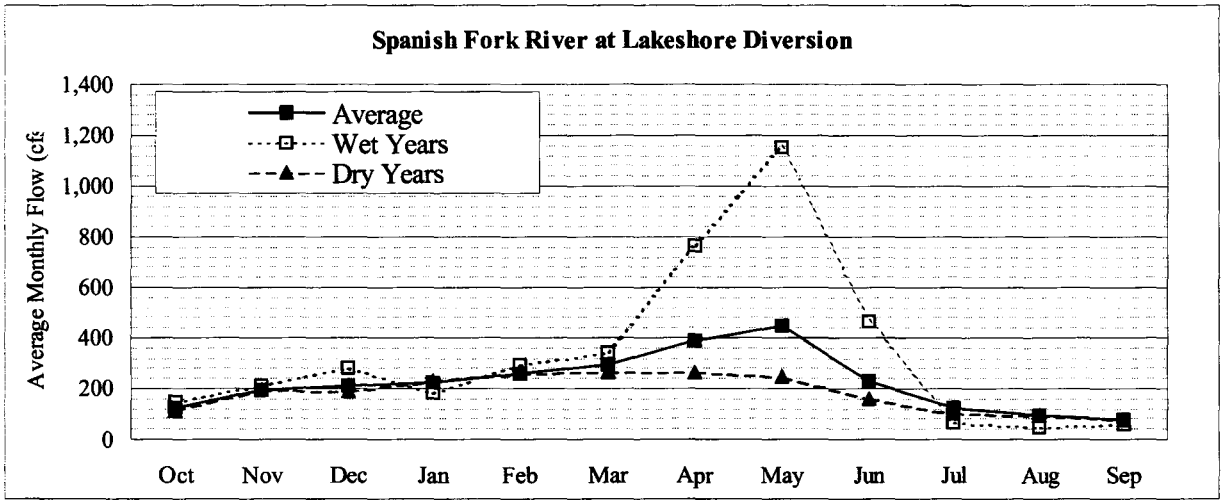
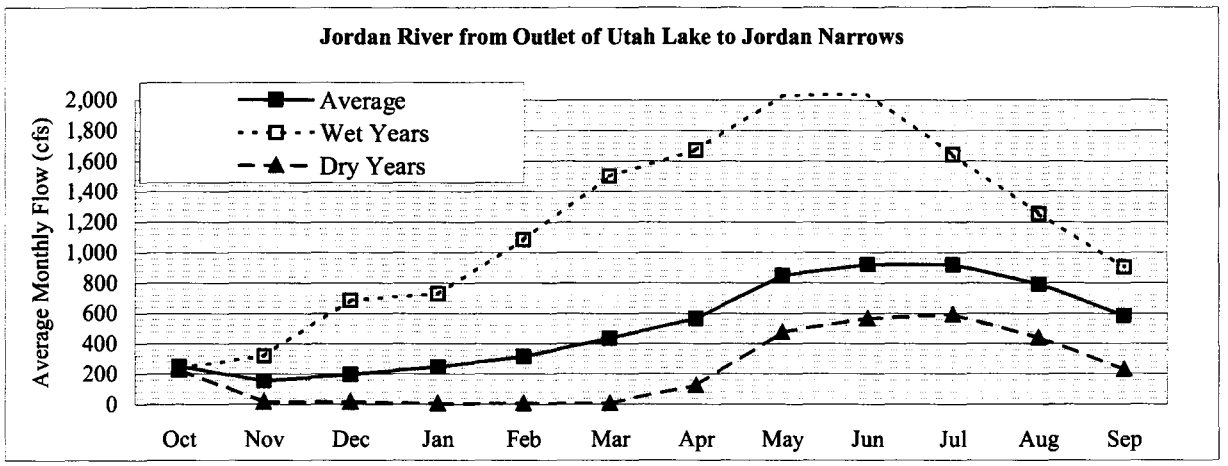


Figure 3-5b
Spanish Fork River Monthly Flows (cfs)



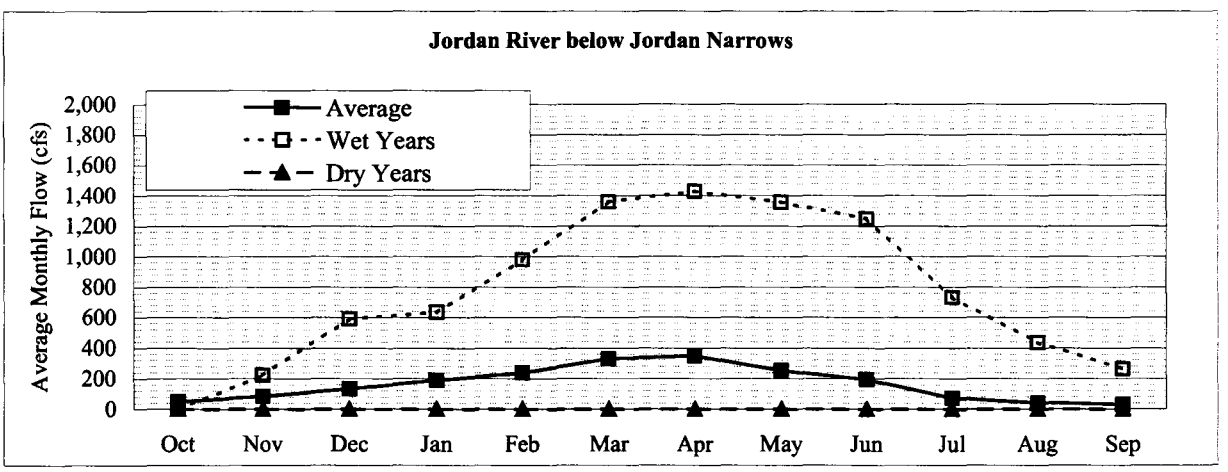


Figure 3-6
Jordan River Monthly Flows (cfs)

3.4 Reservoirs and Lakes

Table 3-3 presents average monthly, wet year, and dry year baseline reservoir contents for major lakes and reservoirs in the impact area of influence. The following sections describe the reservoirs and lakes that might be affected by the alternatives. Baseline average, wet year, and dry year storage volumes are summarized for each facility.

Table 3-3
Average Monthly, Dry Year, and Wet Year Reservoir Contents (1000 ac-ft)
Under Baseline Conditions

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Jordanelle Reservoir												
Average	203.1	204.9	204.9	204.3	204.2	203.2	214.2	245.9	267.5	245.3	219.4	205.1
Wet Years[1]	267.1	272.9	276.0	277.4	280.2	247.1	261.1	285.7	311.4	301.7	285.8	278.1
Dry Years[2]	163.9	164.0	162.0	157.6	153.8	150.8	150.0	156.1	147.1	121.9	100.3	87.8
Deer Creek Reservoir												
Average	82.7	90.1	95.7	100.2	105.1	110.9	114.9	112.3	109.5	100.0	88.2	79.5
Wet Years[1]	117.8	128.7	134.7	140.4	148.5	145.4	149.3	148.6	142.4	130.5	118.3	113.4
Dry Years[2]	35.0	39.4	43.6	47.2	51.9	55.8	52.8	40.4	30.5	19.3	9.0	3.9
Utah Lake												
Average	603	636	672	710	748	778	794	802	771	693	629	596
Wet Years[1]	764	799	834	856	883	949	994	1,079	1,069	975	907	852
Dry Years[2]	478	516	555	591	633	666	667	641	578	504	448	438
Strawberry Reservoir												
Average	727	723	718	713	707	704	710	743	749	738	721	721
Wet Years[1]	849	847	841	843	840	842	869	936	966	972	969	975
Dry Years[2]	680	673	667	658	648	640	633	623	594	573	553	544

Notes:
[1]The three wettest years (1952, 1983, and 1986) were averaged to calculate the values shown in the table.
[2]The three driest years (1961, 1977, and 1992) were averaged to calculate the values shown in the table.

3.4.1 Jordanelle Reservoir

Jordanelle Dam and Reservoir (Map 3-1) are the major features of the CUP M&I System. Water is developed in the reservoir by storing and exchanging Provo River flows that historically flowed into Utah Lake, along with transbasin diversions from the Duchesne and Weber rivers. Figure 3-7 shows the baseline average, wet year, and dry year storage volumes for Jordanelle Reservoir.

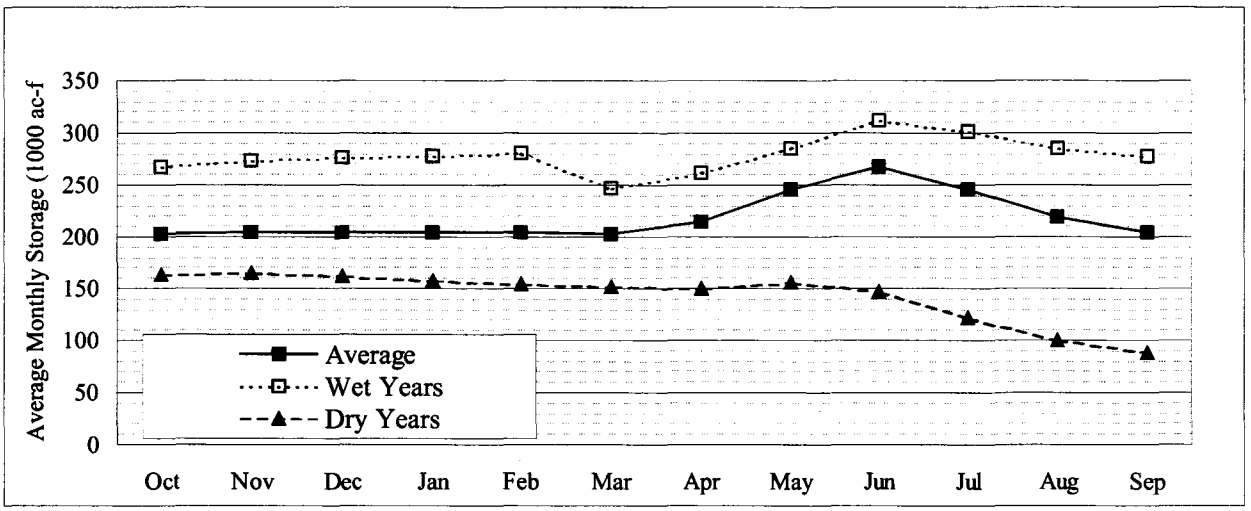


Figure 3-7
Jordanelle Reservoir Baseline Monthly Volumes

3.4.2 Deer Creek Reservoir

The farthest downstream major impoundment on the Provo River is Deer Creek Reservoir, a feature of the Provo River Project. Deer Creek Dam is at the head of the lower Provo Canyon, and the high water line of the reservoir forms the southern boundary of Heber Valley. Lake, Center, Daniels, and Round Valley creeks discharge into Deer Creek Reservoir. Snake Creek and its tributary, Pine Creek, are the only perennial streams that flow from the Wasatch Range to the Provo River above Deer Creek Reservoir. Figure 3-8 shows the baseline average, wet year, and dry year storage volumes for Deer Creek Reservoir.

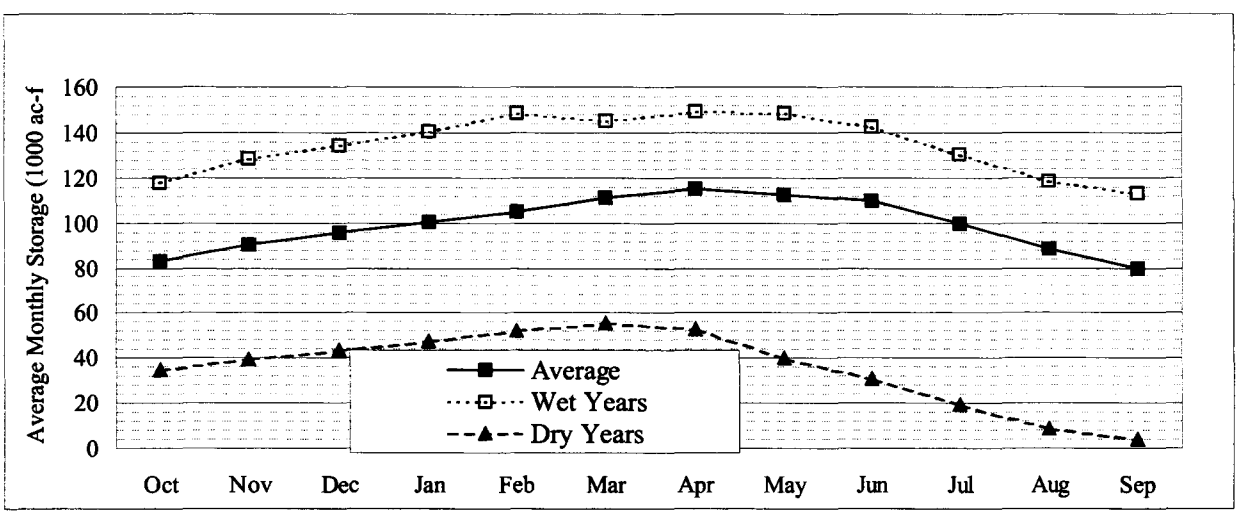


Figure 3-8
Deer Creek Reservoir Monthly Volumes

3.4.3 Utah Lake

Utah Lake is a naturally formed lake with man-made outlet controls that has a surface area of about 150 square miles (96,000 acres), an average depth of 9.2 feet (Jackson and Stevens, 1981), and a total storage capacity of 870,000 acre-feet at the compromise elevation of 4,489.045 feet above msl. Historic seasonal fluctuations in lake level range from 2.4 to 6.1 feet. These variations in depth result from varying inflows, evaporation, and releases for irrigation, domestic, and industrial uses. Major perennial streams that feed Utah Lake are the American Fork River, Provo River, Hobble Creek, and Spanish Fork River. Figure 3-9 shows the baseline average, wet year, and dry year storage volumes for Utah Lake.

3.4.4 Strawberry Reservoir

Strawberry Reservoir is the primary storage facility for the Bonneville Unit of the CUP. The reservoir is a man-made lake formed by the construction of Soldier Creek Dam, completed in 1974. Soldier Creek Dam replaced and inundated the smaller Strawberry Dam, which was constructed as part of the Strawberry Valley Project. The maximum storage in the lake is 1,106,500 acre-feet, associated with a water surface elevation of 7602 feet MSL. The maximum surface area is 17,000 acres. The minimum storage at which water can be diverted to the Bonneville Basin is 7525, associated with storage of 155,000 acre-feet. The majority of the water supply for the reservoir comes from the Strawberry Aqueduct and Collection System (Figure 3-10).

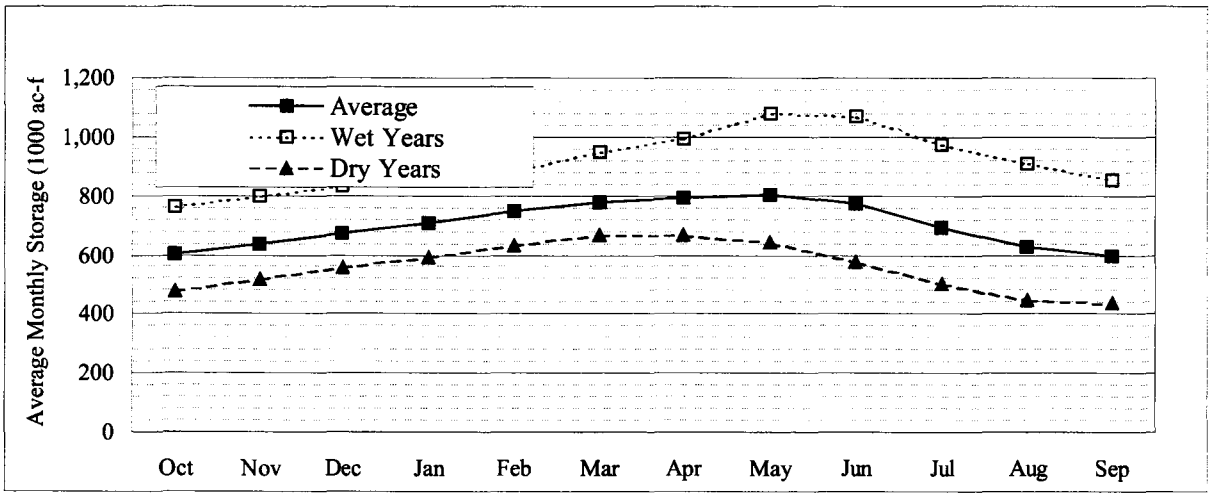


Figure 3-9
Utah Lake Monthly Volumes

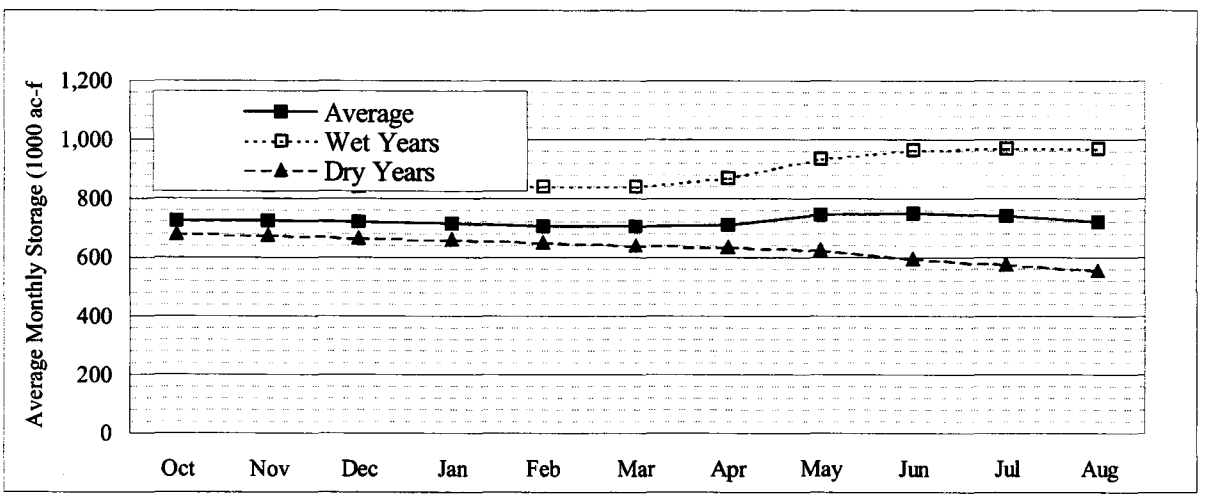


Figure 3-10
Strawberry Reservoir Monthly Volumes

THIS PAGE INTENTIONALLY LEFT BLANK

Chapter 4
Environmental Consequences (Impacts)

4.1 Significance Criteria

Significance criteria are not needed for surface water hydrology because the modeled impacts estimated by this analysis are used by other resource topics to determine the significance of the impacts that flow changes would have on those resources. These other resources include, surface water quality, wetlands, aquatics, vegetation, wildlife, and threatened and endangered species.

The tables and figures referenced in the text are located at the end of the chapter.

4.2 Potential Impacts Eliminated From Further Analysis

4.2.1 Potential Impacts on Existing Water Rights

Protection of these rights was incorporated into the formulation and analysis of the Preferred Alternative and other alternatives. For example, flows in the Provo River are assessed using the PROSIM 2000 model and subsequent spreadsheet models, which included protection of existing water rights as a model constraint.

4.2.2 Potential Impacts on Sixth Water and Diamond Fork Creeks

Potential impacts to Sixth Water and Diamond Fork creeks had been raised under the topic of potential impacts to area streams from the ULS. Model analysis has indicated that flows in Sixth Water and Diamond Fork creeks would not be impacted by operation of the ULS. Unless it is released to provide the statutorily mandated minimum flows or released for other environmental purposes as described in the Final Supplement to the FEIS for the Diamond Fork System, Bonneville Unit water released from Strawberry Reservoir into the Diamond Fork System will be conveyed in the existing pipes and tunnels and therefore there would be no impact on Sixth Water or Diamond Fork creeks.

4.2.3 Potential Construction Impacts

Potential construction impacts on surface water quantities could occur through the use of surface water supplies for construction activities. The water would be used primarily for dust control; water would be used for concrete mixing and backfill compaction as well. Water supplies for construction activities would be obtained from sources approved by the Central Utah Water Conservancy District (District. The total construction water required for any alternative would be less than 1,000 acre-feet over a wide geographic area. Based on the limited amount of construction water required, the potential construction impact of the Preferred Alternative and other alternatives on surface water supplies would not be measurable.

4.3 Spanish Fork Canyon–Provo Reservoir Canal Pipeline Alternative (Preferred Alternative)

4.3.1 Operations Phase

4.3.1.1 Provo River From Timpanogos Diversion to River Ditch

Table 4-1 and Figure 4-1 show estimated flows in Provo River from Timpanogos Diversion to River Ditch resulting from the Preferred Alternative compared to baseline flows. On an annual basis, flows would remain the same as baseline conditions. Monthly flows would also remain essentially the same, with no changes in any month greater than one percent.

4.3.1.2 Provo River From River Ditch to Snake Creek

Table 4-2 and Figure 4-2 show estimated flows in Provo River from River Ditch to Snake Creek resulting from the Preferred Alternative compared to baseline flows. On an annual basis, flows would remain the same as baseline conditions. Monthly flows would also remain essentially the same, with no changes in any month greater than one percent.

4.3.1.3 Provo River From Snake Creek to Inlet of Deer Creek Reservoir

Table 4-3 and Figure 4-3 show estimated flows in Provo River from Snake Creek to Inlet of Deer Creek Reservoir resulting from the Preferred Alternative compared to baseline flows. On an annual basis, flows would remain the same as baseline conditions. Monthly flows would also remain the same, with no changes in any month greater than 0.5 percent.

4.3.1.4 Provo River From Deer Creek Reservoir Outlet to North Fork of Provo River

Table 4-4 and Figure 4-4 show estimated flows in Provo River from Deer Creek Reservoir Outlet to North Fork of Provo River resulting from the Preferred Alternative compared to baseline flows. On an annual basis, flows would increase by 1 percent from baseline conditions in this reach. Monthly flows would increase from April through July and then September and October (from 2 to 12 percent). These higher flows are the result of releases for the endangered June sucker (averaging 3,205 acre-feet during April-July) while also maintaining the minimum flows below Deer Creek Dam (averaging 3,490 acre-feet throughout the year). Maintaining these minimum flows results in a decrease in diversions through the Salt Lake Aqueduct (averaging 3,490 acre-feet) which is provided for under an existing agreement. The reduced diversions into the Salt Lake Aqueduct would be replaced by increased diversions at Olmsted, with the water being moved back into the Salt Lake Aqueduct using the existing Transfer Pipeline. Monthly flows would decrease from November through March and in August (4 to 20 percent), with the resulting flows slightly above the required minimum flows during these months.

4.3.1.5 Provo River From North Fork of Provo River to Olmsted Diversion Dam

Table 4-5 and Figure 4-5 show estimated flows in Provo River from North Fork of Provo River to Olmsted Diversion Dam resulting from the Preferred Alternative compared to baseline flows. On an annual basis, flows would remain essentially the same, increasing by one percent from baseline conditions for the reason described in Section 4.3.1.4. Monthly flows would increase from April through July and September and October (from 2 to 11 percent), with the additional releases resulting from the above described flow changes. Flows would decrease

rom November through March and in August (3 to 20 percent), with the resulting flows slightly above the required minimum flows during these months.

4.3.1.6 Provo River From Olmsted Diversion Dam to Murdock Diversion Dam

Table 4-6 and Figure 4-6 show estimated flows in Provo River from Olmsted Diversion Dam to Murdock Diversion Dam resulting from the Preferred Alternative compared to baseline flows. On an annual basis, flows would remain essentially the same, being reduced by 5 percent from baseline conditions. Monthly flows would increase from January through May (from 2 to 18 percent), with the additional flows resulting from the additional releases resulting from the June sucker attraction operations. Flows would decrease from June through October (5 to 23 percent) because of Provo Reservoir Canal water being conveyed through Olmsted on a space available basis. Flows would not change in November and December.

4.3.1.7 Provo River From Murdock Diversion Dam to Interstate 15

Table 4-7 and Figure 4-7 show estimated flows in Provo River from Murdock Diversion Dam to Interstate 15 resulting from the Preferred Alternative compared to baseline flows. On an annual basis, flows would increase by 20 percent from baseline conditions. Monthly flows would increase in all months of the year (from 7 to 47 percent), with the additional flows resulting from ULS releases and flow changes associated with providing June sucker attraction flows. These changes would be caused by an average annual delivery of 16,000 acre-feet per year of ULS water to supplement minimum flows in the lower Provo River, 12,165 acre-feet released for the June Sucker, and water rights purchased by the Mitigation Commission to help meet the 75 cfs target flow in the lower Provo River..

4.3.1.8 Provo River From Interstate 15 to Utah Lake

Table 4-8 and Figure 4-8 show estimated flows in Provo River from Interstate 15 to Utah Lake resulting from the Preferred Alternative compared to baseline flows. On an annual basis, flows would increase by 38 percent from baseline conditions. Monthly flows would increase in all months of the year (from 8 to 1,425 percent), with the additional releases resulting from supplying water towards the 75-cfs target streamflow, providing June sucker attraction flows, and ULS releases. The very large percentage increases in August and September, 1,425 and 933 percent respectively, are a result of the fact that in the baseline Provo River downstream from Interstate 15 is nearly dry during those two months, so increasing the flow toward the 75-cfs target flow in the reach results in very large percentage increases.

4.3.1.9 Hobble Creek From Mapleton Springville Lateral to Utah Lake

Table 4-9 and Figure 4-9 show estimated flows in Hobble Creek from Mapleton Springville Lateral to Utah Lake resulting from the Preferred Alternative compared to baseline flows. On an annual basis, flows would increase 53 percent from baseline conditions as a result of supplementing the Creek flow under the ULS. Monthly flows would increase in all months of the year (from 21 to 900 percent), with the additional releases resulting from providing June sucker attraction flows and summer-time supplemental flows. The very large percentage increases in July through October (186 to 900 percent) are a result of the fact that in the baseline Hobble Creek downstream from Mapleton Springville Later is nearly dry during those months, so even modest increases of 9 to 13 cfs result in very large percentage increases.

4.3.1.10 Spanish Fork River From Diamond Fork Creek to Spanish Fork Diversion Dam (Castilla Gage)

Table 4-10 and Figure 4-10 show the estimated Spanish Fork River flows from Diamond Fork Creek to Spanish Fork Diversion Dam (Castilla gage) resulting from the Preferred Alternative compared to baseline flows. On an annual basis, flows would decrease an average of 32 percent. Flows would decrease in all months of the year (15 to 44 percent). The reductions in flow occur because most project water and some SVP water would be conveyed in the Spanish Fork Canyon Pipeline and therefore would no longer flow in the Spanish Fork River.

4.3.1.11 Spanish Fork River From Spanish Fork Diversion Dam to East Bench Diversion

Table 4-11 and Figure 4-11 show estimated flows in Spanish Fork River from Spanish Fork Diversion Dam to East Bench Diversion resulting from the Preferred Alternative compared to baseline flows. On an annual basis, flows would decrease 60 percent from baseline conditions. Flows would decrease in all months of the year (from 41 to 71 percent). The reductions in flow occur because project flows that in baseline are conveyed to Utah Lake in Spanish Fork River are now contained in project pipelines (Spanish Fork Canyon – Provo Reservoir Canal Pipeline, Spanish Fork – Santaquin Pipeline, and Mapleton – Springville Lateral Pipeline). Some water conveyed to Utah Lake in the Spanish Fork River would be conveyed to Hobble Creek and the Lower Provo River to supplement flows to Utah Lake in those streams.

4.3.1.12 Spanish Fork River From East Bench Diversion to Mill Race Canal

Table 4-12 and Figure 4-12 show estimated flows in Spanish Fork River from East Bench Diversion to Mill Race Canal resulting from the Preferred Alternative compared to baseline flows. On an annual basis, flows would decrease 66 percent from baseline conditions. Flows would decrease in all months of the year (from 50 to 87 percent). The reductions in flow occur because project flows that in baseline are conveyed to Utah Lake in Spanish Fork River are now contained in project pipelines (Spanish Fork Canyon – Provo Reservoir Canal Pipeline, Spanish Fork – Santaquin Pipeline, and Mapleton Springville Lateral Pipeline).

4.3.1.13 Spanish Fork River From Mill Race Canal to Lakeshore Gage

Table 4-13 and Figure 4-13 show estimated flows in Spanish Fork River from Mill Race Canal to Lakeshore Gage resulting from the Preferred Alternative compared to baseline flows. On an annual basis, flows would decrease 41 percent from baseline conditions. Flows would decrease all months of the year (from 18 to 74 percent). The reductions in flow occur because project flows that in baseline are conveyed to Utah Lake in Spanish Fork River are now contained in project pipelines (Spanish Fork Canyon – Provo Reservoir Canal Pipeline, Spanish Fork – Santaquin Pipeline, and Mapleton Springville Lateral Pipeline).

4.3.1.14 Spanish Fork River at Lakeshore Gage

Table 4-14 and Figure 4-14 show estimated flows in Spanish Fork River at Lakeshore Gage resulting from the Preferred Alternative compared to baseline flows. On an annual basis, flows would decrease 42 percent from baseline conditions. Flows would decrease all months of the year (from 18 to 88 percent). The reductions in flow occur because project flows that in baseline are conveyed to Utah Lake in Spanish Fork River are now contained in project pipelines (Spanish Fork Canyon – Provo Reservoir Canal Pipeline, Spanish Fork – Santaquin Pipeline, and Mapleton Springville Lateral Pipeline). Flows at this location represent the inflow to Utah Lake from the Spanish Fork River. There is one diversion dam below this location with a right to divert up to 10 cfs which is mostly comprised of river gains and local return flows.

4.3.1.15 Jordan River From Outlet of Utah Lake to Jordan Narrows

Table 4-15 and Figure 4-15 show estimated flows in Jordan River from Outlet of Utah Lake to Jordan Narrows resulting from the Preferred Alternative compared to baseline flows. On an annual basis, flows would be reduced by 7 percent from baseline conditions. Monthly flows would decrease in all months of the year (by 2 to 13 percent), because the CUWCD secondary water rights would be held in Utah Lake for exchange up to Jordanelle Reservoir. In some years, the yield of the acquired water rights is greater than the amount needed for the Jordanelle exchange and the water accrues in the Lake or is released, depending upon operation by the River Commissioner.

4.3.1.16 Jordan River Downstream From Jordan Narrows

Table 4-16 and Figure 4-16 show estimated flows in Jordan River downstream from Jordan Narrows resulting from the Preferred Alternative compared to baseline flows. On an annual basis, flows would not change compared with baseline conditions. Variations in monthly flows would also be negligible. Slightly more water would be released in October and November, with differences in all other months being less than 5 percent. These minor flow changes are the result of model-predicted changes in the timing and quantity of spills from Utah Lake, associated with changes in inflows to and diversions from the Lake. Predicted flow changes are small and are confined to periods when Utah Lake is spilling anyway. Even these minor flow changes may or may not occur because all releases from Utah Lake are determined by the State Engineer's representative, do not include any CUP water, and the State Engineer's representative decision process is entirely independent from ULS. Nevertheless, this flow data is included in this EIS to document that the ULS does not impact the Jordan River.

4.3.1.17 Jordanelle Reservoir

Table 4-17 and Figure 4-17 show estimated storage and water surface elevation in Jordanelle Reservoir resulting from the Preferred Alternative compared to baseline flows. Figure 4-17 shows the estimated storage and water surface elevation for the entire study period. The Preferred Alternative would result in a very small decrease in average annual storage volume in Jordanelle Reservoir (two percent) and a decrease in annual water surface elevation of less than two feet. The end of study period storage is 4,000 acre-feet (or 2 percent) less than baseline. These changes are caused by operation of the inter-related actions, most notably the June sucker flows. Based on these changes, the Preferred Alternative has no impacts on storage volume or water surface elevation.

4.3.1.18 Deer Creek Reservoir

Table 4-18 and Figure 4-18 show estimated storage and water surface elevation in Deer Creek Reservoir resulting from the Preferred Alternative compared to baseline flows. Figure 4-18 shows the estimated storage and water surface elevation for the entire study period. On an annual basis, storage and water surface elevations would remain essentially the same with a reduction of only one percent in storage and less than one percent in water surface elevation from baseline conditions. The end of study period storage is 8,000 acre-feet (or 8 percent) less than baseline. These changes are caused by operation of the inter-related actions, most notably the June sucker flows. Based on these changes the Preferred Alternative has no impacts on storage volume or water surface elevation.

4.3.1.19 Utah Lake

Table 4-19 and Figure 4-19 show estimated storage and water surface elevation in Utah Lake resulting from the referred Alternative compared to baseline. Figure 4-20 shows the estimated storage for the entire study period. On an annual basis, storage and water surface elevations would remain essentially the same with a decrease of

only two percent in storage compared with baseline conditions. Differences during wet and dry years skew the average results somewhat. Comparison of median volume and stage shows less difference. Based on these changes, the impacts of the Preferred Alternative on storage volume are negligible.

4.3.1.20 Strawberry Reservoir

Table 4-20 and Figure 4-21 show estimated storage and water surface elevation in Strawberry Reservoir resulting from the Preferred Alternative compared to baseline. Figure 4-22 shows the estimated storage for the entire study period. On an annual basis, storage would decrease 14 percent from baseline conditions as a result of increasing the Bonneville Unit transbasin diversion from an average of 86,100 acre-feet per year to the full 101,900 acre-feet depletion described in the Diamond Fork FS FEIS.

4.3.2 Summary of Alternative Impacts

Stream flow and river stage impacts associated with the Preferred Alternative are confined to general increases on the lower Provo River below Olmsted and within Hobble Creek and decreases on the Spanish Fork River.

Changes in annual storage and water surface elevation resulting from the operation of the Preferred Alternative are negligible in Jordanelle and Deer Creek reservoirs and Utah Lake.

4.4 Bonneville Unit Water Alternative

4.4.1 Operations Phase

The impact on the following would be the same as described under the Spanish Fork Canyon – Provo Reservoir Canal Alternative (Preferred Alternative).

- Jordanelle Reservoir (Section 4.3.1.16)
- Deer Creek Reservoir (Section 4.3.1.17)

The impacts on the following reaches are exactly the same as under the Spanish Fork Canyon – Provo Reservoir Canal Alternative.

- Provo River from Timpanogos Diversion to River Ditch. (Section 4.3.1.1)
- Provo River from River Ditch to Snake Creek. (Section 4.3.1.2)
- Provo River from Snake Creek to Inlet of Deer Creek Reservoir. (Section 4.3.1.3)
- Provo River from Outlet of Deer Creek Reservoir to North Fork of Provo River (Section 4.3.1.4)
- Provo River from North Fork of Provo River to Olmsted Diversion Dam (Section 4.3.1.5)
- Provo River from Olmsted Diversion Dam to Murdock Diversion Dam (Section 4.3.1.6)
- Jordan River below Jordan Narrows (Section 4.3.1.16)

'.4.1.1 Provo River From Murdock Diversion Dam to Interstate 15

Table 4-21 and Figure 4-23 show estimated flows in Provo River from Murdock Diversion Dam to Interstate 15 resulting from the Bonneville Unit Water Alternative compared to baseline flows. On an annual basis, flows would increase by 8 percent from baseline conditions. Monthly flows would increase in all months of the year (from 0 to 22 percent), resulting from related action rather than ULS operations in this reach. The increases result from Mitigation Commission acquisitions of water rights in the Lower Provo River for the purpose of increasing minimum river flows (75 cfs target) and June sucker RIP attraction flows using Section 207 conserved water.

4.4.1.2 Provo River From Interstate 15 to Utah Lake

Table 4-22 and Figure 4-24 show estimated flows in Provo River from Interstate 15 to Utah Lake resulting from the Bonneville Unit Water Alternative compared to baseline flows. On an annual basis, flows would increase by 18 percent from baseline conditions. Monthly flows would increase in all months of the year (from 0 to 650 percent), with the additional releases resulting from increasing flow toward the 75-cfs target streamflow and providing June sucker attraction flows. The very large percentage increases in August and September, 650 and 333 percent respectively, are a result of the fact that in the baseline Provo River downstream from Interstate 15 is nearly dry during those two months, so increasing toward the 75-cfs target flow in the reach results in very large percentage increases.

4.4.1.3 Hobble Creek From Mapleton Springville Lateral to Utah Lake

Table 4-23 and Figure 4-25 show estimated flows in Hobble Creek from Mapleton Springville Lateral to Utah Lake resulting from the Bonneville Unit Water Alternative compared to baseline flows. On an annual basis, flows would increase 107 percent from baseline conditions. Monthly flows would increase in all months of the year (from 35 to 3,200 percent), with the additional releases resulting from providing June sucker attraction flows and other supplemental water. The very large percentage increases in July through October (443 to 3,200 percent) are a result of the fact that in the baseline Hobble Creek downstream from Mapleton Springville Later is nearly dry during those months, so even increases of around 30 cfs result in very large percentage increases. Under this alternative more water is available to supplement Hobble Creek. A target minimum flow of 35 cfs was assumed, resulting in an additional 11,473 acre-feet of supplemental water, as compared to the Spanish Fork-Provo Reservoir Canal Alternative.

4.4.1.4 Spanish Fork River From Diamond Fork Creek to Spanish Fork Diversion Dam (Castilla Gage)

Table 4-24 and Figure 4-26 show the estimated Spanish Fork River flows from Diamond Fork Creek to Spanish Fork Diversion Dam (Castilla gage) resulting from the Bonneville Unit Water Alternative compared to baseline flows. On an annual basis, flows would decrease an average of 13 percent. Flows from April to September would decrease (2 to 29 percent). The reductions in flow occur because project flows would be conveyed in the Spanish Fork Canyon Pipeline and therefore would not flow in the Spanish Fork River. Flows from October to March would increase (3 to 22 percent) because of bringing water from Strawberry to Utah Lake during the winter months.

4.4.1.5 Spanish Fork River From Spanish Fork Diversion Dam to East Bench Diversion

Table 4-25 and Figure 4-27 show estimated flows in Spanish Fork River from Spanish Fork Diversion Dam to East Bench Diversion resulting from the Bonneville Unit Water Alternative compared to baseline flows. On an annual basis, flows would decrease 19 percent from baseline conditions. Flows from April to September would

decrease (5 to 69 percent). The reductions in flow occur because certain project flows that, under Baseline conditions, would be conveyed to Utah Lake in Spanish Fork River, are now contained in the Mapleton Springville Lateral Pipeline. Flows from October to March would increase (5 to 59 percent).

4.4.1.6 Spanish Fork River From East Bench Diversion to Mill Race Canal

Table 4-26 and Figure 4-28 show estimated flows in Spanish Fork River from East Bench Diversion to Mill Race Canal resulting from the Bonneville Unit Water Alternative compared to baseline flows. On an annual basis, flows would decrease 20 percent from baseline conditions. Flows would decrease in April through September (from 5 to 87 percent). The reductions in flow occur because certain project flows that are conveyed to Utah Lake in Spanish Fork River are now contained in the Mapleton Springville Lateral Pipeline. Flows would increase in October through March (5 to 67 percent).

4.4.1.7 Spanish Fork River From Mill Race Canal to Lakeshore Gage

Table 4-27 and Figure 4-29 show estimated flows in Spanish Fork River from Mill Race Canal to Lakeshore Gage resulting from the Bonneville Unit Water Alternative compared to baseline flows. On an annual basis, flows would decrease 12 percent from baseline conditions. Flows would decrease in April through September (from 3 to 74 percent). The reductions in flow occur because certain project flows that are conveyed to Utah Lake in Spanish Fork River are now contained in the Mapleton Springville Lateral Pipeline. Flows would increase in October through March (3 to 33 percent).

4.4.1.8 Spanish Fork River at Lakeshore Gage

Table 4-28 and Figure 4-30 show estimated flows in Spanish Fork River at Lakeshore Gage resulting from the Bonneville Unit Water Alternative compared to baseline flows. On an annual basis, flows would decrease 12 percent from baseline conditions. Flows would decrease in April through September (from 3 to 88 percent). The reductions in flow occur because certain project flows that are conveyed to Utah Lake in Spanish Fork River are now contained in the Mapleton Springville Lateral Pipeline. Flows would increase in October through March (3 to 33 percent).

4.4.1.9 Jordan River From Outlet of Utah Lake to Jordan Narrows

Table 4-29 and Figure 4-31 show estimated flows in Jordan River from Outlet of Utah Lake to Jordan Narrows resulting from the Bonneville Unit Water Alternative compared to baseline flows. On an annual basis, flows would remain essentially the same with a decrease of less than 1 percent from baseline conditions. Monthly flows would decrease very slightly in certain months (1 percent) and increase very slightly in certain months (5 to 21 percent) because of holding up to 15,000 acre-feet of CUWCD secondary water rights in Utah Lake for exchange to Jordanelle Reservoir. These secondary rights would be used to firm up the dry period yield of the M&I System and ULS. During normal hydrologic periods the yield of the secondary rights is in excess of what is needed to make the Jordanelle Exchange and the water would be released by the Jordan River Commissioner from Utah Lake in the same pattern as Baseline.

4.4.1.10 Utah Lake

Table 4-30 and Figure 4-32 show estimated storage and water surface elevation in Utah Lake resulting from the Bonneville Unit Water Alternative compared to baseline. Figure 33 shows the estimated storage for the entire study period. On an annual basis, storage would remain essentially the same with a decrease of 1 percent from

baseline conditions. Based on these considerations, the impacts of the Bonneville Unit Water Alternative on storage volume and water surface elevation are negligible.

4.4.1.11 Strawberry Reservoir

Table 4-31 and Figure 4-34 show estimated storage and water surface elevation in Strawberry Reservoir resulting from the Bonneville Unit Water Alternative compared to baseline. Figure 35 shows the estimated storage for the entire study period. On an annual basis, storage would decrease 17 percent from baseline conditions.

4.4.2 Summary of Alternative Impacts

Significant stream flow and river stage impacts associated with this alternative are confined to general increases on the lower Provo River below Olmsted and Hobble Creek and decreases on the Spanish Fork River.

Changes in annual storage and water surface elevation resulting from the operation of the Bonneville Unit Water Alternative are negligible in Jordanelle and Deer Creek reservoirs and Utah Lake.

4.5 No Action Alternative

4.5.1 Operations Phase

The impacts on the following reservoirs are the same as described under the Spanish Fork Canyon – Provo Reservoir Canal Alternative.

- Jordanelle Reservoir (Section 4.3.1.16)
- Deer Creek Reservoir (Section 4.3.1.17)

The impacts on the following reaches are exactly the same as under the Spanish Fork Canyon – Provo Reservoir Canal Alternative.

- Provo River from Timpanogos Diversion to River Ditch. (Section 4.3.1.1)
- Provo River from River Ditch to Snake Creek. (Section 4.3.1.2)
- Provo River from Snake Creek to Inlet of Deer Creek Reservoir. (Section 4.3.1.3)
- Provo River from Outlet of Deer Creek Reservoir to North Fork of Provo River (Section 4.3.1.4)
- Provo River from North Fork of Provo River to Olmsted Diversion Dam (Section 4.3.1.5)
- Provo River from Olmsted Diversion Dam to Murdock Diversion Dam (Section 4.3.1.6)
- Jordan River below Jordan Narrows (Section 4.3.1.16)

The impacts on the following reaches are exactly the same as under the Bonneville Unit Water Alternative.

- Provo River from Murdock Diversion Dam to Interstate 15 (Section 4.4.1.4)
- Provo River from Interstate 15 to Utah Lake. (Section 4.4.1.5)

There are no impacts on the following reaches and reservoirs; the following reaches and reservoirs are the same as Baseline.

- Hobble Creek from Mapleton Springville Lateral to Utah Lake (Table 3-2 and Figure 3-4)
- Spanish Fork River from Diamond Fork Creek to Spanish Fork Diversion Dam (Castilla Gage) (Table 3-2 and Figure 3-5a)
- Spanish Fork River from Spanish Fork Diversion Dam to East Bench Diversion (Table 3-2 and Figure 3-5a)
- Spanish Fork River from East Bench Diversion to Mill Race Canal (Table 3-2 and Figure 3-5a)
- Spanish Fork River from Mill Race Canal to Lakeshore Gage (Table 3-2 and Figure 3-5b)
- Spanish Fork River at Lakeshore Gage (Table 3-2 and Figure 3-5b)
- Jordan River from outlet of Utah Lake to Jordan Narrows (Table 3-2 and Figure 3-6)
- Jordan River below Jordan Narrows (Table 3-2 and Figure 3-6)
- Utah Lake (Table 3-3 and Figure 3-9)
- Strawberry Reservoir (Table 3-3 and Figure 3-10)

4.5.2 Summary of Alternative Impacts

Stream flow and river stage changes associated with this alternative would be confined to general increases on the lower Provo River below Olmsted.

Changes in annual storage and water surface elevation resulting from the operation of the No Action Alternative are negligible in Jordanelle, Deer Creek, and Strawberry reservoirs, and in Utah Lake.

Table 4-1
Estimated Average Provo River Flows from Timpanogos Diversion to River Ditch
Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline
Flows in cfs

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
Average													
Baseline	153	144	140	137	140	186	203	623	873	583	436	307	328
Alternative	153	144	141	138	141	186	204	622	872	581	435	307	328
Change	0	0	1	1	1	0	1	-1	-1	-2	-1	0	0
% Change	0%	0%	1%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%
Wet Years[1]													
Baseline	147	159	145	143	177	841	299	891	1,487	582	345	319	462
Alternative	147	159	145	142	177	840	299	891	1,486	580	340	313	461
Change	0	0	0	-1	0	-1	0	0	-1	-2	-5	-6	-1
% Change	0%	0%	0%	-1%	0%	0%	0%	0%	0%	0%	-1%	-2%	0%
Dry Years[2]													
Baseline	153	139	132	135	131	134	158	363	348	391	333	256	223
Alternative	155	142	135	137	134	137	161	367	351	396	339	263	227
Change	2	3	3	2	3	3	3	4	3	5	6	7	4
% Change	1%	2%	2%	1%	2%	2%	2%	1%	1%	1%	2%	3%	2%

Flows in acre-feet

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Average													
Baseline	9,382	8,559	8,636	8,436	7,843	11,416	12,104	38,276	51,936	35,851	26,796	18,293	237,528
Alternative	9,426	8,575	8,676	8,482	7,888	11,453	12,135	38,273	51,897	35,752	26,721	18,249	237,527
Change	44	16	40	46	45	37	31	-3	-39	-99	-75	-44	-1
% Change	0%	0%	0%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%
Wet Years[1]													
Baseline	9,046	9,441	8,926	8,785	9,950	51,693	17,772	54,776	88,452	35,794	21,240	18,997	334,872
Alternative	9,046	9,439	8,925	8,731	9,945	51,645	17,772	54,763	88,395	35,670	20,889	18,631	333,851
Change	0	-2	-1	-54	-5	-48	0	-13	-57	-124	-351	-366	-1,021
% Change	0%	0%	0%	-1%	0%	0%	0%	0%	0%	0%	-2%	-2%	0%
Dry Years[2]													
Baseline	9,396	8,281	8,145	8,286	7,343	8,228	9,403	22,341	20,694	24,067	20,468	15,238	161,890
Alternative	9,546	8,422	8,288	8,453	7,514	8,409	9,576	22,580	20,889	24,353	20,840	15,620	164,490
Change	150	141	143	167	171	181	173	239	195	286	372	382	2,600
% Change	2%	2%	2%	2%	2%	2%	2%	1%	1%	1%	2%	3%	2%

Notes:
[1] The three wettest years (1952, 1983, and 1986) were averaged to calculate the values shown in the table.
[2] The three driest years (1961, 1977, and 1992) were averaged to calculate the values shown in the table.

Table 4-2
Estimated Average Provo River Flows from River Ditch to Snake Creek
Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline
Flows in cfs

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
Average													
Baseline	126	136	129	128	134	184	185	478	694	411	301	219	261
Alternative	127	136	130	129	135	185	185	478	693	410	299	218	261
Change	1	0	1	1	1	1	0	0	-1	-1	-2	-1	0
% Change	1%	0%	1%	1%	1%	1%	0%	0%	0%	0%	-1%	0%	0%
Wet Years[1]													
Baseline	125	158	130	132	178	842	307	812	1,309	405	201	226	403
Alternative	125	158	130	131	178	842	307	812	1,308	403	195	220	401
Change	0	0	0	-1	0	0	0	0	-1	-2	-6	-6	-2
% Change	0%	0%	0%	-1%	0%	0%	0%	0%	0%	0%	-3%	-3%	0%
Dry Years[2]													
Baseline	126	129	125	125	126	125	126	247	237	261	239	181	171
Alternative	128	132	127	128	130	128	129	251	240	266	245	188	175
Change	2	3	2	3	4	3	3	4	3	5	6	7	4
% Change	2%	2%	2%	2%	3%	2%	2%	2%	1%	2%	3%	4%	2%
Flows in acre-feet													
Year Type	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Total**
Average													
Baseline	7,750	8,066	7,936	7,884	7,534	11,313	11,001	29,383	41,291	25,295	18,482	13,040	188,976
Alternative	7,794	8,082	7,975	7,930	7,579	11,349	11,033	29,381	41,253	25,196	18,407	12,997	188,976
Change	44	16	39	46	45	36	32	-2	-38	-99	-75	-43	0
% Change	1%	0%	0%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%
Wet Years[1]													
Baseline	7,686	9,424	7,975	8,133	9,958	51,796	18,238	49,909	77,860	24,875	12,336	13,447	291,637
Alternative	7,686	9,423	7,974	8,079	9,953	51,748	18,238	49,896	77,803	24,751	11,985	13,080	290,617
Change	0	-1	-1	-54	-5	-48	0	-13	-57	-124	-351	-367	-1,020
% Change	0%	0%	0%	-1%	0%	0%	0%	0%	0%	0%	-3%	-3%	0%
Dry Years[2]													
Baseline	7,718	7,689	7,686	7,686	7,109	7,686	7,505	15,184	14,112	16,077	14,702	10,791	123,945
Alternative	7,868	7,830	7,829	7,853	7,280	7,867	7,679	15,423	14,307	16,362	15,075	11,173	126,546
Change	150	141	143	167	171	181	174	239	195	285	373	382	2,601
% Change	2%	2%	2%	2%	2%	2%	2%	2%	1%	2%	3%	4%	2%

Notes:
[1] The three wettest years (1952, 1983, and 1986) were averaged to calculate the values shown in the table.
[2] The three driest years (1961, 1977, and 1992) were averaged to calculate the values shown in the table.

Table 4-3
Estimated Average Provo River Flows from Snake Creek to Inlet of Deer Creek Reservoir
Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline
Flows in cfs

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
Average													
Baseline	241	268	228	224	231	280	269	557	805	515	428	356	367
Alternative	242	268	228	224	232	281	270	557	804	513	427	356	367
Change	1	0	0	0	1	1	1	0	-1	-2	-1	0	0
% Change	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Wet Years[1]													
Baseline	286	348	246	237	320	982	514	1,003	1,395	524	373	417	554
Alternative	286	348	246	237	320	982	514	1,003	1,394	522	368	411	553
Change	0	0	0	0	0	0	0	0	-1	-2	-5	-6	-1
% Change	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-1%	-1%	0%
Dry Years[2]													
Baseline	215	242	222	209	214	195	170	302	318	317	342	273	252
Alternative	218	244	224	211	217	198	173	306	322	322	348	279	255
Change	3	2	2	2	3	3	3	4	4	5	6	6	3
% Change	1%	1%	1%	1%	1%	2%	2%	1%	1%	2%	2%	2%	1%

Flows in acre-feet

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Average													
Baseline	14,826	15,922	13,996	13,744	12,925	17,224	16,032	34,268	47,897	31,672	26,304	21,211	266,021
Alternative	14,870	15,938	14,036	13,790	12,970	17,260	16,064	34,265	47,859	31,573	26,229	21,168	266,021
Change	44	16	40	46	45	36	32	-3	-38	-99	-75	-43	0
% Change	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Wet Years[1]													
Baseline	17,578	20,727	15,102	14,602	17,934	60,399	30,590	61,691	83,028	32,213	22,947	24,834	401,644
Alternative	17,578	20,725	15,102	14,549	17,929	60,351	30,589	61,678	82,971	32,089	22,596	24,467	400,624
Change	0	-2	0	-53	-5	-48	-1	-13	-57	-124	-351	-367	-1,020
% Change	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-2%	-1%	0%
Dry Years[2]													
Baseline	13,245	14,401	13,650	12,822	12,034	11,992	10,105	18,574	18,935	19,515	21,002	16,244	182,517
Alternative	13,395	14,542	13,792	12,989	12,204	12,172	10,279	18,813	19,130	19,801	21,375	16,626	185,118
Change	150	141	142	167	170	180	174	239	195	286	373	382	2,601
% Change	1%	1%	1%	1%	1%	2%	2%	1%	1%	1%	2%	2%	1%

Notes:
[1] The three wettest years (1952, 1983, and 1986) were averaged to calculate the values shown in the table.
[2] The three driest years (1961, 1977, and 1992) were averaged to calculate the values shown in the table.

Table 4-4
Estimated Average Provo River Flows from Outlet of Deer Creek Reservoir to North Fork of Provo River
Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline
Flows in cfs

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
Average													
Baseline	147	110	112	132	138	205	279	743	871	628	568	440	365
Alternative	165	106	105	105	119	186	305	798	904	648	542	448	370
Change	18	-4	-7	-27	-19	-19	26	55	33	20	-26	8	5
% Change	12%	-4%	-6%	-20%	-14%	-9%	9%	7%	4%	3%	-5%	2%	1%
Wet Years[1]													
Baseline	108	116	106	123	231	1,112	623	1,290	1,598	729	549	469	589
Alternative	123	111	104	100	202	1,078	637	1,293	1,610	821	524	473	591
Change	15	-5	-2	-23	-29	-34	14	3	12	92	-25	4	2
% Change	14%	-4%	-2%	-19%	-13%	-3%	2%	0%	1%	13%	-5%	1%	0%
Dry Years[2]													
Baseline	125	121	118	140	129	134	206	458	358	456	480	310	254
Alternative	152	101	100	101	103	108	250	493	396	443	464	321	253
Change	27	-20	-18	-39	-26	-26	44	35	38	-13	-16	11	-1
% Change	22%	-17%	-15%	-28%	-20%	-19%	21%	8%	11%	-3%	-3%	4%	0%
Flows in acre-feet													
Year Type	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Total**
Average													
Baseline	9,066	6,573	6,870	8,140	7,754	12,579	16,589	45,672	51,819	38,612	34,924	26,175	264,774
Alternative	10,117	6,321	6,449	6,459	6,639	11,421	18,150	49,066	53,816	39,840	33,320	26,666	268,263
Change	1,051	-252	-421	-1,681	-1,115	-1,158	1,561	3,394	1,997	1,228	-1,604	491	3,489
% Change	12%	-4%	-6%	-21%	-14%	-9%	9%	7%	4%	3%	-5%	2%	1%
Wet Years[1]													
Baseline	6,650	6,877	6,508	7,561	12,904	68,384	37,055	79,293	95,094	44,826	33,758	27,889	426,799
Alternative	7,544	6,617	6,408	6,149	11,269	66,298	37,877	79,482	95,794	50,489	32,199	28,155	428,282
Change	894	-260	-100	-1,412	-1,635	-2,086	822	189	700	5,663	-1,559	266	1,483
% Change	13%	-4%	-2%	-19%	-13%	-3%	2%	0%	1%	13%	-5%	1%	0%
Dry Years[2]													
Baseline	7,672	7,190	7,277	8,604	7,239	8,224	12,281	28,134	21,300	28,010	29,501	18,444	183,875
Alternative	9,343	6,037	6,149	6,183	5,769	6,624	14,903	30,308	23,554	27,207	28,503	19,079	183,659
Change	1,671	-1,153	-1,128	-2,421	-1,470	-1,600	2,622	2,174	2,254	-803	-998	635	-216
% Change	22%	-16%	-16%	-28%	-20%	-19%	21%	8%	11%	-3%	-3%	3%	0%

Notes:
[1] The three wettest years (1952, 1983, and 1986) were averaged to calculate the values shown in the table.
[2] The three driest years (1961, 1977, and 1992) were averaged to calculate the values shown in the table.

Table 4-5
Estimated Average Provo River Flows from North Fork of Provo River to Olmsted Diversion Dam
Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline
Flows in cfs

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
Average													
Baseline	161	125	123	143	148	216	300	801	938	674	595	461	392
Alternative	178	121	117	115	129	197	327	856	972	694	569	469	396
Change	17	-4	-6	-28	-19	-19	27	55	34	20	-26	8	4
% Change	11%	-3%	-5%	-20%	-13%	-9%	9%	7%	4%	3%	-4%	2%	1%
Wet Years[1]													
Baseline	138	128	129	144	259	1,139	671	1,377	1,751	813	603	499	639
Alternative	153	124	128	121	230	1,105	685	1,380	1,763	905	578	503	641
Change	15	-4	-1	-23	-29	-34	14	3	12	92	-25	4	2
% Change	11%	-3%	-1%	-16%	-11%	-3%	2%	0%	1%	11%	-4%	1%	0%
Dry Years[2]													
Baseline	131	133	128	148	136	141	216	475	368	471	488	327	264
Alternative	158	113	109	109	110	115	260	511	406	458	472	337	264
Change	27	-20	-19	-39	-26	-26	44	36	38	-13	-16	10	0
% Change	21%	-15%	-15%	-26%	-19%	-18%	20%	8%	10%	-3%	-3%	3%	0%
Flows in acre-feet													
Year Type	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Total**
Average													
Baseline	9,891	7,431	7,586	8,774	8,311	13,295	17,868	49,227	55,832	41,416	36,610	27,424	283,666
Alternative	10,942	7,179	7,164	7,093	7,197	12,136	19,429	52,621	57,830	42,644	35,006	27,915	287,155
Change	1,051	-252	-422	-1,681	-1,114	-1,159	1,561	3,394	1,998	1,228	-1,604	491	3,489
% Change	11%	-3%	-6%	-19%	-13%	-9%	9%	7%	4%	3%	-4%	2%	1%
Wet Years[1]													
Baseline	8,511	7,641	7,951	8,881	14,460	70,023	39,937	84,667	104,172	49,980	37,099	29,675	462,997
Alternative	9,405	7,381	7,851	7,469	12,824	67,937	40,759	84,856	104,873	55,643	35,540	29,941	464,479
Change	894	-260	-100	-1,412	-1,636	-2,086	822	189	701	5,663	-1,559	266	1,482
% Change	11%	-3%	-1%	-16%	-11%	-3%	2%	0%	1%	11%	-4%	1%	0%
Dry Years[2]													
Baseline	8,031	7,901	7,846	9,095	7,659	8,685	12,857	29,233	21,925	28,938	30,010	19,435	191,616
Alternative	9,702	6,748	6,718	6,674	6,189	7,085	15,478	31,407	24,180	28,135	29,013	20,070	191,399
Change	1,671	-1,153	-1,128	-2,421	-1,470	-1,600	2,621	2,174	2,255	-803	-997	635	-217
% Change	21%	-15%	-14%	-27%	-19%	-18%	20%	7%	10%	-3%	-3%	3%	0%

Notes:
[1] The three wettest years (1952, 1983, and 1986) were averaged to calculate the values shown in the table.
[2] The three driest years (1961, 1977, and 1992) were averaged to calculate the values shown in the table.

Table 4-6
Estimated Average Provo River Flows from Olmsted Diversion Dam to Murdock Diversion Dam
Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline
Flows in cfs

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
Average													
Baseline	137	70	57	54	68	145	243	740	859	472	386	344	299
Alternative	113	70	57	55	72	148	287	765	813	430	299	281	283
Change	-24	0	0	1	4	3	44	25	-46	-42	-87	-63	-16
% Change	-18%	0%	0%	2%	6%	2%	18%	3%	-5%	-9%	-23%	-18%	-5%
Wet Years[1]													
Baseline	145	84	88	77	207	1,079	678	1,369	1,712	631	428	415	577
Alternative	119	84	88	77	211	1,079	707	1,338	1,642	687	345	343	561
Change	-26	0	0	0	4	0	29	-31	-70	56	-83	-72	-16
% Change	-18%	0%	0%	0%	2%	0%	4%	-2%	-4%	9%	-19%	-17%	-3%
Dry Years[2]													
Baseline	94	53	42	39	39	39	90	303	253	154	193	183	124
Alternative	84	53	42	43	50	37	157	323	213	123	157	155	120
Change	-10	0	0	4	11	-2	67	20	-40	-31	-36	-28	-4
% Change	-11%	0%	0%	10%	28%	-5%	74%	7%	-16%	-20%	-19%	-15%	-3%

Flows in acre-feet

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Average													
Baseline	8,397	4,182	3,494	3,310	3,816	8,945	14,480	45,500	51,101	29,031	23,735	20,491	216,482
Alternative	6,967	4,167	3,488	3,369	4,031	9,112	17,089	47,021	48,369	26,459	18,398	16,725	205,196
Change	-1,430	-15	-6	59	215	167	2,609	1,521	-2,732	-2,572	-5,337	-3,766	-11,286
% Change	-17%	0%	0%	2%	6%	2%	18%	3%	-5%	-9%	-22%	-18%	-5%
Wet Years[1]													
Baseline	8,939	5,009	5,421	4,742	11,554	66,323	40,317	84,201	101,856	38,798	26,300	24,679	418,141
Alternative	7,295	5,009	5,421	4,742	11,735	66,324	42,061	82,271	97,688	42,262	21,182	20,398	406,389
Change	-1,644	0	0	0	181	1	1,744	-1,930	-4,168	3,464	-5,118	-4,281	-11,752
% Change	-18%	0%	0%	0%	2%	0%	4%	-2%	-4%	9%	-19%	-17%	-3%
Dry Years[2]													
Baseline	5,803	3,181	2,558	2,393	2,195	2,412	5,327	18,648	15,073	9,454	11,858	10,916	89,817
Alternative	5,137	3,181	2,559	2,648	2,806	2,254	9,345	19,870	12,663	7,557	9,666	9,225	86,910
Change	-666	0	1	255	611	-158	4,018	1,222	-2,410	-1,897	-2,192	-1,691	-2,907
% Change	-11%	0%	0%	11%	28%	-7%	75%	7%	-16%	-20%	-18%	-15%	-3%

Notes:
[1] The three wettest years (1952, 1983, and 1986) were averaged to calculate the values shown in the table.
[2] The three driest years (1961, 1977, and 1992) were averaged to calculate the values shown in the table.

Table 4-7
Estimated Average Provo River Flows from Murdock Diversion Dam to Interstate 15
Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline
Flows in cfs

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
Average													
Baseline	88	72	59	55	70	147	199	476	527	182	149	134	180
Alternative	129	90	77	74	86	158	251	553	563	231	196	182	216
Change	41	18	18	19	16	11	52	77	36	49	47	48	36
% Change	47%	25%	31%	35%	23%	7%	26%	16%	7%	27%	32%	36%	20%
Wet Years[1]													
Baseline	95	86	92	80	212	1,083	666	1,189	1,372	280	136	135	453
Alternative	100	86	92	80	215	1,083	707	1,204	1,381	347	153	147	467
Change	5	0	0	0	3	0	41	15	9	67	17	12	14
% Change	5%	0%	0%	0%	1%	0%	6%	1%	1%	24%	13%	9%	3%
Dry Years[2]													
Baseline	68	55	43	40	40	40	72	105	91	72	115	96	70
Alternative	108	67	69	65	52	39	137	189	130	104	136	138	103
Change	40	12	26	25	12	-1	65	84	39	32	21	42	33
% Change	59%	22%	60%	63%	30%	-3%	90%	80%	43%	44%	18%	44%	47%
Flows in acre-feet													
Year Type	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Total**
Average													
Baseline	5,419	4,308	3,605	3,403	3,900	9,049	11,830	29,281	31,373	11,170	9,166	7,999	130,503
Alternative	7,914	5,363	4,722	4,524	4,833	9,717	14,926	34,004	33,506	14,174	12,080	10,818	156,582
Change	2,495	1,055	1,117	1,121	933	668	3,096	4,723	2,133	3,004	2,914	2,819	26,079
% Change	46%	24%	31%	33%	24%	7%	26%	16%	7%	27%	32%	35%	20%
Wet Years[1]													
Baseline	5,819	5,122	5,633	4,893	11,789	66,568	39,656	73,132	81,623	17,206	8,364	8,050	327,854
Alternative	6,145	5,122	5,633	4,893	11,970	66,568	42,097	74,011	82,200	21,312	9,423	8,741	338,114
Change	326	0	0	0	181	0	2,441	879	577	4,106	1,059	691	10,260
% Change	6%	0%	0%	0%	2%	0%	6%	1%	1%	24%	13%	9%	3%
Dry Years[2]													
Baseline	4,199	3,287	2,653	2,473	2,263	2,486	4,299	6,426	5,405	4,417	7,076	5,703	50,687
Alternative	6,624	3,957	4,225	3,971	2,924	2,409	8,160	11,629	7,717	6,379	8,361	8,186	74,543
Change	2,425	670	1,572	1,498	661	-77	3,861	5,203	2,312	1,962	1,285	2,483	23,856
% Change	58%	20%	59%	61%	29%	-3%	90%	81%	43%	44%	18%	44%	47%

Notes:
[1] The three wettest years (1952, 1983, and 1986) were averaged to calculate the values shown in the table.
[2] The three driest years (1961, 1977, and 1992) were averaged to calculate the values shown in the table.

Table 4-8
Estimated Average Provo River Flows from Interstate 15 to Utah Lake
Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline
Flows in cfs

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
Average													
Baseline	32	76	56	51	64	142	168	347	374	42	4	6	114
Alternative	77	94	75	69	81	153	222	445	433	110	61	62	157
Change	45	18	19	18	17	11	54	98	59	68	57	56	43
% Change	141%	24%	34%	35%	27%	8%	32%	28%	16%	162%	1425%	933%	38%
Wet Years[1]													
Baseline	79	85	95	81	209	1,082	678	1,124	1,255	131	0	0	402
Alternative	87	85	95	81	212	1,082	719	1,145	1,276	210	27	21	420
Change	8	0	0	0	3	0	41	21	21	79	27	21	18
% Change	10%	0%	0%	0%	1%	0%	6%	2%	2%	60%	N/A	N/A	4%
Dry Years[2]													
Baseline	14	49	34	33	34	31	13	0	22	6	52	1	24
Alternative	56	60	59	57	45	29	82	107	74	46	77	50	62
Change	42	11	25	24	11	-2	69	107	52	40	25	49	38
% Change	300%	22%	74%	73%	32%	-6%	531%	NoCalc	236%	667%	48%	N/A	158%
Flows in acre-feet													
Year Type	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Total**
Average													
Baseline	1,984	4,533	3,464	3,131	3,601	8,753	10,021	21,324	22,225	2,580	251	371	82,237
Alternative	4,735	5,589	4,581	4,252	4,535	9,421	13,223	27,362	25,774	6,791	3,744	3,694	113,702
Change	2,751	1,056	1,117	1,121	934	668	3,202	6,038	3,549	4,211	3,493	3,323	31,465
% Change	139%	23%	32%	36%	26%	8%	32%	28%	16%	163%	1392%	896%	38%
Wet Years[1]													
Baseline	4,862	5,075	5,839	4,957	11,634	66,557	40,315	69,128	74,652	8,034	25	0	291,078
Alternative	5,334	5,075	5,839	4,957	11,815	66,557	42,761	70,381	75,922	12,891	1,676	1,229	304,437
Change	472	0	0	0	181	0	2,446	1,253	1,270	4,857	1,651	1,229	13,359
% Change	10%	0%	0%	0%	2%	0%	6%	2%	2%	60%	N/A	N/A	5%
Dry Years[2]													
Baseline	834	2,890	2,065	2,017	1,893	1,879	796	0	1,292	349	3,210	68	17,293
Alternative	3,466	3,561	3,638	3,516	2,554	1,801	4,879	6,558	4,410	2,833	4,763	2,963	44,944
Change	2,632	671	1,573	1,499	661	-78	4,083	6,558	3,118	2,484	1,553	2,895	27,651
% Change	316%	23%	76%	74%	35%	-4%	513%	N/A	241%	712%	48%	N/A	160%

Notes:
[1] The three wettest years (1952, 1983, and 1986) were averaged to calculate the values shown in the table.
[2] The three driest years (1961, 1977, and 1992) were averaged to calculate the values shown in the table.

Table 4-9
Estimated Average Hobble Creek Flows from Mapleton Lateral to Utah Lake
Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline
Flows in cfs

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
Average													
Baseline	7	25	23	22	26	38	60	109	38	4	1	1	30
Alternative	20	35	32	32	35	46	111	145	65	13	10	10	46
Change	13	10	9	10	9	8	51	36	27	9	9	9	16
% Change	186%	40%	39%	45%	35%	21%	85%	33%	71%	225%	900%	900%	53%
Wet Years[1]													
Baseline	13	36	33	32	58	78	202	346	183	28	11	10	86
Alternative	26	36	33	32	58	78	209	346	183	43	26	25	91
Change	13	0	0	0	0	0	7	0	0	15	15	15	5
% Change	100%	0%	0%	0%	0%	0%	3%	0%	0%	54%	136%	150%	6%
Dry Years[2]													
Baseline	0	14	13	14	16	14	9	0	0	0	0	0	7
Alternative	6	20	19	20	22	20	96	92	40	6	6	6	29
Change	6	6	6	6	6	6	87	92	40	6	6	6	22
% Change	NoCalc	43%	46%	43%	38%	43%	967%	NoCalc	NoCalc	NoCalc	NoCalc	NoCalc	314%
Flows in acre-feet													
Year Type	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Total**
Average													
Baseline	442	1,512	1,402	1,361	1,459	2,332	3,563	6,682	2,248	229	90	58	21,379
Alternative	1,257	2,099	1,978	1,965	1,957	2,815	6,609	8,892	3,841	782	630	590	33,416
Change	815	587	576	604	498	483	3,046	2,210	1,593	553	540	532	12,037
% Change	184%	39%	41%	44%	34%	21%	85%	33%	71%	241%	600%	917%	56%
Wet Years[1]													
Baseline	805	2,139	2,014	1,998	3,217	4,783	11,998	21,262	10,891	1,731	689	595	62,124
Alternative	1,581	2,139	2,014	1,998	3,217	4,783	12,453	21,262	10,891	2,625	1,582	1,460	66,007
Change	776	0	0	0	0	0	455	0	0	894	893	865	3,883
% Change	96%	0%	0%	0%	0%	0%	4%	0%	0%	52%	130%	145%	6%
Dry Years[2]													
Baseline	0	812	819	860	930	864	546	0	0	0	0	0	4,831
Alternative	377	1,177	1,196	1,237	1,271	1,241	5,714	5,631	2,380	377	377	365	21,341
Change	377	365	377	377	341	377	5,168	5,631	2,380	377	377	365	16,510
% Change	NoCalc	45%	46%	44%	37%	44%	947%	NoCalc	NoCalc	NoCalc	NoCalc	NoCalc	342%

Notes:
[1] The three wettest years (1952, 1983, and 1986) were averaged to calculate the values shown in the table.
[2] The three driest years (1961, 1977, and 1992) were averaged to calculate the values shown in the table.

Table 4-10
Estimated Average Spanish Fork River Flows from Diamond Fork Creek to Spanish Fork Diversion Dam (Castilla Gage)
Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline
Flows in cfs

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
Average													
Baseline	158	191	201	215	248	285	425	740	645	546	457	258	365
Alternative	134	130	124	125	138	171	296	578	452	356	305	180	250
Change	-24	-61	-77	-90	-110	-114	-129	-162	-193	-190	-152	-78	-115
% Change	-15%	-32%	-38%	-42%	-44%	-40%	-30%	-22%	-30%	-35%	-33%	-30%	-32%
Wet Years[1]													
Baseline	163	204	276	171	278	326	751	1,351	990	546	454	296	484
Alternative	163	152	144	145	203	272	746	1,338	947	460	376	270	435
Change	0	-52	-132	-26	-75	-54	-5	-13	-43	-86	-78	-26	-49
% Change	0%	-25%	-48%	-15%	-27%	-17%	-1%	-1%	-4%	-16%	-17%	-9%	-10%
Dry Years[2]													
Baseline	132	190	174	214	243	259	345	492	544	380	356	188	293
Alternative	101	104	100	102	111	111	141	209	315	227	210	119	154
Change	-31	-86	-74	-112	-132	-148	-204	-283	-229	-153	-146	-69	-139
% Change	-23%	-45%	-43%	-52%	-54%	-57%	-59%	-58%	-42%	-40%	-41%	-37%	-47%

Flows in acre-feet

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Average													
Baseline	9,693	11,355	12,373	13,211	13,870	17,527	25,299	45,527	38,374	33,569	28,069	15,326	264,195
Alternative	8,238	7,726	7,622	7,703	7,734	10,539	17,589	35,538	26,881	21,907	18,733	10,712	180,921
Change	-1,455	-3,629	-4,751	-5,508	-6,136	-6,988	-7,710	-9,989	-11,493	-11,662	-9,336	-4,614	-83,274
% Change	-15%	-32%	-38%	-42%	-44%	-40%	-30%	-22%	-30%	-35%	-33%	-30%	-32%
Wet Years[1]													
Baseline	10,014	12,125	16,952	10,502	15,562	20,024	44,658	83,050	58,903	33,555	27,913	17,623	350,881
Alternative	10,014	9,019	8,826	8,922	11,347	16,745	44,377	82,288	56,325	28,260	23,106	16,074	315,302
Change	0	-3,106	-8,126	-1,580	-4,215	-3,279	-281	-762	-2,578	-5,295	-4,807	-1,549	-35,579
% Change	0%	-26%	-48%	-15%	-27%	-16%	-1%	-1%	-4%	-16%	-17%	-9%	-10%
Dry Years[2]													
Baseline	8,115	11,318	10,698	13,185	13,701	15,896	20,515	30,275	32,397	23,377	21,910	11,193	212,581
Alternative	6,196	6,190	6,164	6,291	6,231	6,834	8,383	12,833	18,754	13,929	12,922	7,103	111,832
Change	-1,919	-5,128	-4,534	-6,894	-7,470	-9,062	-12,132	-17,442	-13,643	-9,448	-8,988	-4,090	-100,749
% Change	-24%	-45%	-42%	-52%	-55%	-57%	-59%	-58%	-42%	-40%	-41%	-37%	-47%

Notes:
[1] The three wettest years (1952, 1983, and 1986) were averaged to calculate the values shown in the table.
[2] The three driest years (1961, 1977, and 1992) were averaged to calculate the values shown in the table.

Table 4-11
Estimated Average Spanish Fork River Flows from Spanish Fork Diversion Dam to East Bench Diversion
Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline
Flows in cfs

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
Average													
Baseline	58	109	130	143	163	160	190	339	242	176	134	88	161
Alternative	34	48	53	54	53	46	60	189	99	54	43	29	64
Change	-24	-61	-77	-89	-110	-114	-130	-150	-143	-122	-91	-59	-97
% Change	-41%	-56%	-59%	-62%	-67%	-71%	-68%	-44%	-59%	-69%	-68%	-67%	-60%
Wet Years[1]													
Baseline	39	96	181	74	126	90	269	770	414	146	90	65	197
Alternative	39	44	49	49	52	36	264	765	406	115	66	54	162
Change	0	-52	-132	-25	-74	-54	-5	-5	-8	-31	-24	-11	-35
% Change	0%	-54%	-73%	-34%	-59%	-60%	-2%	-1%	-2%	-21%	-27%	-17%	-18%
Dry Years[2]													
Baseline	73	138	129	167	191	203	275	272	189	120	119	75	162
Alternative	40	51	55	54	59	56	72	30	39	24	22	16	43
Change	-33	-87	-74	-113	-132	-147	-203	-242	-150	-96	-97	-59	-119
% Change	-45%	-63%	-57%	-68%	-69%	-72%	-74%	-89%	-79%	-80%	-82%	-79%	-73%

Flows in acre-feet

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Average													
Baseline	3,548	6,470	8,024	8,798	9,130	9,823	11,301	20,827	14,420	10,850	8,250	5,214	116,656
Alternative	2,098	2,841	3,272	3,290	2,994	2,835	3,594	11,631	5,866	3,316	2,668	1,739	46,142
Change	-1,450	-3,629	-4,752	-5,508	-6,136	-6,988	-7,707	-9,196	-8,554	-7,534	-5,582	-3,475	-70,514
% Change	-41%	-56%	-59%	-63%	-67%	-71%	-68%	-44%	-59%	-69%	-68%	-67%	-60%
Wet Years[1]													
Baseline	2,386	5,727	11,119	4,572	7,109	5,514	16,008	47,322	24,640	8,980	5,509	3,851	142,735
Alternative	2,373	2,622	2,992	2,992	2,894	2,235	15,727	47,035	24,182	7,077	4,030	3,192	117,350
Change	-13	-3,105	-8,127	-1,580	-4,215	-3,279	-281	-287	-458	-1,903	-1,479	-659	-25,385
% Change	-1%	-54%	-73%	-35%	-59%	-59%	-2%	-1%	-2%	-21%	-27%	-17%	-18%
Dry Years[2]													
Baseline	4,488	8,184	7,926	10,243	10,777	12,504	16,368	16,731	11,262	7,361	7,328	4,460	117,631
Alternative	2,490	3,056	3,392	3,349	3,307	3,442	4,302	1,818	2,320	1,448	1,325	946	31,194
Change	-1,998	-5,128	-4,534	-6,894	-7,470	-9,062	-12,066	-14,913	-8,942	-5,913	-6,003	-3,514	-86,437
% Change	-45%	-63%	-57%	-67%	-69%	-72%	-74%	-89%	-79%	-80%	-82%	-79%	-73%

Notes:
[1] The three wettest years (1952, 1983, and 1986) were averaged to calculate the values shown in the table.
[2] The three driest years (1961, 1977, and 1992) were averaged to calculate the values shown in the table.

Table 4-12
Estimated Average Spanish Fork River Flows from East Bench Diversion to Mill Race Canal
Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline
Flows in cfs

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
Average													
Baseline	54	109	130	143	163	159	182	295	187	127	93	70	143
Alternative	31	48	53	54	53	46	53	147	51	17	14	15	49
Change	-23	-61	-77	-89	-110	-113	-129	-148	-136	-110	-79	-55	-94
% Change	-43%	-56%	-59%	-62%	-67%	-71%	-71%	-50%	-73%	-87%	-85%	-79%	-66%
Wet Years[1]													
Baseline	37	96	181	74	126	90	269	735	332	80	47	28	175
Alternative	37	44	49	49	52	36	264	732	328	55	29	21	142
Change	0	-52	-132	-25	-74	-54	-5	-3	-4	-25	-18	-7	-33
% Change	0%	-54%	-73%	-34%	-59%	-60%	-2%	0%	-1%	-31%	-38%	-25%	-19%
Dry Years[2]													
Baseline	69	138	129	167	191	203	260	244	145	95	94	69	150
Alternative	38	51	55	54	59	55	58	10	10	7	5	11	34
Change	-31	-87	-74	-113	-132	-148	-202	-234	-135	-88	-89	-58	-116
% Change	-45%	-63%	-57%	-68%	-69%	-73%	-78%	-96%	-93%	-93%	-95%	-84%	-77%

Flows in acre-feet

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Average													
Baseline	3,338	6,470	8,024	8,798	9,130	9,796	10,849	18,108	11,103	7,816	5,713	4,164	103,308
Alternative	1,934	2,841	3,272	3,290	2,994	2,808	3,158	9,046	3,039	1,030	869	914	35,194
Change	-1,404	-3,629	-4,752	-5,508	-6,136	-6,988	-7,691	-9,062	-8,064	-6,786	-4,844	-3,250	-68,114
% Change	-42%	-56%	-59%	-63%	-67%	-71%	-71%	-50%	-73%	-87%	-85%	-78%	-66%
Wet Years[1]													
Baseline	2,252	5,727	11,119	4,572	7,109	5,514	16,008	45,205	19,731	4,934	2,887	1,648	126,703
Alternative	2,252	2,622	2,992	2,992	2,894	2,235	15,727	44,994	19,502	3,368	1,755	1,265	102,597
Change	0	-3,105	-8,127	-1,580	-4,215	-3,279	-281	-211	-229	-1,566	-1,132	-383	-24,106
% Change	0%	-54%	-73%	-35%	-59%	-59%	-2%	0%	-1%	-32%	-39%	-23%	-19%
Dry Years[2]													
Baseline	4,256	8,184	7,926	10,243	10,777	12,474	15,458	15,000	8,650	5,837	5,775	4,093	108,673
Alternative	2,337	3,056	3,392	3,349	3,307	3,412	3,438	612	604	429	302	659	24,897
Change	-1,919	-5,128	-4,534	-6,894	-7,470	-9,062	-12,020	-14,388	-8,046	-5,408	-5,473	-3,434	-83,776
% Change	-45%	-63%	-57%	-67%	-69%	-73%	-78%	-96%	-93%	-93%	-95%	-84%	-77%

Notes:
[1] The three wettest years (1952, 1983, and 1986) were averaged to calculate the values shown in the table.
[2] The three driest years (1961, 1977, and 1992) were averaged to calculate the values shown in the table.

Table 4-13
Estimated Average Spanish Fork River Flows from Mill Race Canal to Lakeshore Gage
Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline
Flows in cfs

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
Average													
Baseline	131	194	205	219	252	289	389	471	257	149	113	86	229
Alternative	108	133	128	130	143	175	260	324	121	38	35	31	135
Change	-23	-61	-77	-89	-109	-114	-129	-147	-136	-111	-78	-55	-94
% Change	-18%	-31%	-38%	-41%	-43%	-39%	-33%	-31%	-53%	-74%	-69%	-64%	-41%
Wet Years[1]													
Baseline	141	207	279	174	283	331	755	1,164	499	87	66	74	338
Alternative	141	155	147	149	208	277	750	1,160	495	61	48	68	305
Change	0	-52	-132	-25	-75	-54	-5	-4	-4	-26	-18	-6	-33
% Change	0%	-25%	-47%	-14%	-27%	-16%	-1%	0%	-1%	-30%	-27%	-8%	-10%
Dry Years[2]													
Baseline	120	193	179	219	248	257	274	258	174	113	115	80	186
Alternative	89	107	105	107	116	110	72	24	39	25	26	22	70
Change	-31	-86	-74	-112	-132	-147	-202	-234	-135	-88	-89	-58	-116
% Change	-26%	-45%	-41%	-51%	-53%	-57%	-74%	-91%	-78%	-78%	-77%	-73%	-62%
Flows in acre-feet													
Year Type	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Total**
Average													
Baseline	8,047	11,555	12,631	13,480	14,124	17,740	23,154	28,966	15,287	9,147	6,972	5,111	166,213
Alternative	6,643	7,925	7,880	7,972	7,987	10,752	15,462	19,903	7,224	2,361	2,128	1,862	98,099
Change	-1,404	-3,630	-4,751	-5,508	-6,137	-6,988	-7,692	-9,063	-8,063	-6,786	-4,844	-3,249	-68,114
% Change	-17%	-31%	-38%	-41%	-43%	-39%	-33%	-31%	-53%	-74%	-69%	-64%	-41%
Wet Years[1]													
Baseline	8,690	12,317	17,178	10,725	15,830	20,325	44,917	71,565	29,679	5,319	4,053	4,405	245,003
Alternative	8,690	9,211	9,052	9,145	11,615	17,046	44,636	71,354	29,451	3,754	2,922	4,022	220,896
Change	0	-3,106	-8,126	-1,580	-4,215	-3,279	-281	-211	-228	-1,565	-1,131	-383	-24,107
% Change	0%	-25%	-47%	-15%	-27%	-16%	-1%	0%	-1%	-29%	-28%	-9%	-10%
Dry Years[2]													
Baseline	7,397	11,499	10,993	13,481	13,969	15,828	16,307	15,884	10,358	6,955	7,062	4,771	134,505
Alternative	5,478	6,371	6,459	6,587	6,499	6,766	4,288	1,496	2,312	1,547	1,589	1,336	50,729
Change	-1,919	-5,128	-4,534	-6,894	-7,470	-9,062	-12,019	-14,388	-8,046	-5,408	-5,473	-3,435	-83,776
% Change	-26%	-45%	-41%	-51%	-53%	-57%	-74%	-91%	-78%	-78%	-77%	-72%	-62%

Notes:
[1] The three wettest years (1952, 1983, and 1986) were averaged to calculate the values shown in the table.
[2] The three driest years (1961, 1977, and 1992) were averaged to calculate the values shown in the table.

Table 4-14
Estimated Average Spanish Fork River Flows at Lakeshore Gage
Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline
Flows in cfs

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
Average													
Baseline	125	195	212	226	260	295	387	448	229	125	92	78	222
Alternative	102	134	135	137	150	182	258	301	93	15	13	23	128
Change	-23	-61	-77	-89	-110	-113	-129	-147	-136	-110	-79	-55	-94
% Change	-18%	-31%	-36%	-39%	-42%	-38%	-33%	-33%	-59%	-88%	-86%	-71%	-42%
Wet Years[1]													
Baseline	147	210	285	180	292	341	762	1,153	462	67	46	56	333
Alternative	147	158	153	154	217	287	758	1,150	459	41	28	50	300
Change	0	-52	-132	-26	-75	-54	-4	-3	-3	-26	-18	-6	-33
% Change	0%	-25%	-46%	-14%	-26%	-16%	-1%	0%	-1%	-39%	-39%	-11%	-10%
Dry Years[2]													
Baseline	110	192	188	229	257	266	266	246	157	99	97	75	181
Alternative	78	106	115	117	125	118	64	12	21	11	8	17	66
Change	-32	-86	-73	-112	-132	-148	-202	-234	-136	-88	-89	-58	-115
% Change	-29%	-45%	-39%	-49%	-51%	-56%	-76%	-95%	-87%	-89%	-92%	-77%	-64%

Flows in acre-feet

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Average													
Baseline	7,682	11,599	13,028	13,915	14,557	18,157	23,014	27,567	13,601	7,706	5,655	4,646	161,126
Alternative	6,278	7,970	8,276	8,407	8,421	11,169	15,322	18,504	5,537	920	811	1,396	93,012
Change	-1,404	-3,629	-4,752	-5,508	-6,136	-6,988	-7,692	-9,063	-8,064	-6,786	-4,844	-3,250	-68,114
% Change	-18%	-31%	-36%	-40%	-42%	-38%	-33%	-33%	-59%	-88%	-86%	-70%	-42%
Wet Years[1]													
Baseline	9,063	12,494	17,527	11,080	16,368	20,937	45,368	70,909	27,512	4,092	2,859	3,356	241,565
Alternative	9,063	9,389	9,401	9,500	12,153	17,658	45,087	70,698	27,284	2,526	1,727	2,974	217,459
Change	0	-3,105	-8,126	-1,580	-4,215	-3,279	-281	-211	-228	-1,566	-1,132	-382	-24,106
% Change	0%	-25%	-46%	-14%	-26%	-16%	-1%	0%	-1%	-38%	-40%	-11%	-10%
Dry Years[2]													
Baseline	6,734	11,450	11,589	14,086	14,503	16,327	15,853	15,108	9,317	6,064	5,939	4,434	131,404
Alternative	4,815	6,322	7,055	7,192	7,034	7,265	3,833	720	1,271	655	465	999	47,628
Change	-1,919	-5,128	-4,534	-6,894	-7,469	-9,062	-12,020	-14,388	-8,046	-5,409	-5,474	-3,435	-83,776
% Change	-28%	-45%	-39%	-49%	-51%	-56%	-76%	-95%	-86%	-89%	-92%	-77%	-64%

Notes:
[1] The three wettest years (1952, 1983, and 1986) were averaged to calculate the values shown in the table.
[2] The three driest years (1961, 1977, and 1992) were averaged to calculate the values shown in the table.

Table 4-15
Estimated Average Jordan River from Outlet of Utah Lake to Jordan Narrows
Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline
Flows in cfs

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
Average													
Baseline	251	155	196	248	314	435	566	849	922	919	792	584	520
Alternative	228	152	192	242	305	412	542	804	867	846	702	508	484
Change	-23	-3	-4	-6	-9	-23	-24	-45	-55	-73	-90	-76	-36
% Change	-9%	-2%	-2%	-2%	-3%	-5%	-4%	-5%	-6%	-8%	-11%	-13%	-7%
Wet Years[1]													
Baseline	239	320	686	729	1,085	1,502	1,672	2,027	2,040	1,642	1,256	905	1,175
Alternative	208	273	645	721	1,045	1,457	1,671	2,009	2,010	1,654	1,265	906	1,155
Change	-31	-47	-41	-8	-40	-45	-1	-18	-30	12	9	1	-20
% Change	-13%	-15%	-6%	-1%	-4%	-3%	0%	-1%	-1%	1%	1%	0%	-2%
Dry Years[2]													
Baseline	227	16	16	5	6	6	123	476	565	592	440	228	227
Alternative	181	14	14	4	5	5	121	448	534	576	430	222	214
Change	-46	-2	-2	-1	-1	-1	-2	-28	-31	-16	-10	-6	-13
% Change	-20%	-13%	-13%	-20%	-17%	-17%	-2%	-6%	-5%	-3%	-2%	-3%	-6%

Flows in acre-feet

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Average													
Baseline	15,406	9,249	12,051	15,266	17,608	26,736	33,680	52,196	54,843	56,517	48,719	34,763	377,033
Alternative	14,017	9,058	11,792	14,867	17,053	25,324	32,221	49,462	51,601	52,027	43,178	30,227	350,828
Change	-1,389	-191	-259	-399	-555	-1,412	-1,459	-2,734	-3,242	-4,490	-5,541	-4,536	-26,205
% Change	-9%	-2%	-2%	-3%	-3%	-5%	-4%	-5%	-6%	-8%	-11%	-13%	-7%
Wet Years[1]													
Baseline	14,711	19,017	42,186	44,840	60,614	92,333	99,516	124,655	121,374	100,930	77,205	53,831	851,213
Alternative	12,813	16,243	39,682	44,306	58,316	89,608	99,398	123,511	119,595	101,698	77,751	53,920	836,840
Change	-1,898	-2,774	-2,504	-534	-2,298	-2,725	-118	-1,144	-1,779	768	546	89	-14,373
% Change	-13%	-15%	-6%	-1%	-4%	-3%	0%	-1%	-1%	1%	1%	0%	-2%
Dry Years[2]													
Baseline	13,970	975	975	295	332	388	7,343	29,290	33,629	36,399	27,058	13,576	164,233
Alternative	11,112	847	847	239	276	304	7,201	27,518	31,799	35,386	26,424	13,206	155,157
Change	-2,858	-128	-128	-56	-56	-84	-142	-1,772	-1,830	-1,013	-634	-370	-9,076
% Change	-20%	-13%	-13%	-19%	-17%	-22%	-2%	-6%	-5%	-3%	-2%	-3%	-6%

Notes:
[1] The three wettest years (1952, 1983, and 1986) were averaged to calculate the values shown in the table.
[2] The three driest years (1961, 1977, and 1992) were averaged to calculate the values shown in the table.

Table 4-16
Estimated Average Jordan River Below Jordan Narrows
Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline
Flows in cfs

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
Average													
Baseline	48	83	133	189	239	331	349	252	194	72	40	32	163
Alternative	55	92	139	190	241	321	348	247	187	71	41	32	163
Change[3]	7	9	6	1	2	-10	-1	-5	-7	-1	1	0	0
% Change[3]	15%	11%	5%	1%	1%	-3%	0%	-2%	-4%	-1%	3%	0%	0%
Wet Years[1]													
Baseline	0	222	591	635	981	1,359	1,426	1,357	1,248	733	436	264	769
Alternative	0	188	557	632	954	1,333	1,456	1,338	1,218	745	445	265	759
Change[3]	0	-34	-34	-3	-27	-26	30	-19	-30	12	9	1	-10
% Change[3]	NoCalc	-15%	-6%	0%	-3%	-2%	2%	-1%	-2%	2%	2%	0%	-1%
Dry Years[2]													
Baseline	0	0	0	0	0	0	0	0	0	0	0	0	0
Alternative	0	0	0	0	0	0	0	0	0	0	0	0	0
Change[3]	0	0	0	0	0	0	0	0	0	0	0	0	0
% Change[3]	NoCalc	NoCalc	NoCalc	NoCalc	NoCalc	NoCalc	NoCalc	NoCalc	NoCalc	NoCalc	NoCalc	NoCalc	NoCalc

Flows in acre-feet

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Average													
Baseline	2,948	4,955	8,208	11,646	13,385	20,348	20,783	15,521	11,545	4,436	2,485	1,886	118,146
Alternative	3,379	5,473	8,534	11,688	13,508	19,756	20,690	15,201	11,103	4,339	2,521	1,895	118,087
Change[3]	431	518	326	42	123	-592	-93	-320	-442	-97	36	9	-59
% Change[3]	15%	10%	4%	0%	1%	-3%	0%	-2%	-4%	-2%	1%	0%	0%
Wet Years[1]													
Baseline	0	13,196	36,365	39,019	54,793	83,547	84,845	83,436	74,269	45,040	26,811	15,704	557,026
Alternative	0	11,172	34,236	38,860	53,245	81,947	86,625	82,292	72,490	45,808	27,357	15,793	549,825
Change[3]	0	-2,024	-2,129	-159	-1,548	-1,600	1,780	-1,144	-1,779	768	546	89	-7,201
% Change[3]	NoCalc	-15%	-6%	0%	-3%	-2%	2%	-1%	-2%	2%	2%	1%	-1%
Dry Years[2]													
Baseline	0	0	0	0	0	0	0	0	0	0	0	0	0
Alternative	0	0	0	0	0	0	0	0	0	0	0	0	0
Change[3]	0	0	0	0	0	0	0	0	0	0	0	0	0
% Change[3]	NoCalc	NoCalc	NoCalc	NoCalc	NoCalc	NoCalc	NoCalc	NoCalc	NoCalc	NoCalc	NoCalc	NoCalc	NoCalc

Notes:
[1] The three wettest years (1952, 1983, and 1986) were averaged to calculate the values shown in the table.
[2] The three driest years (1961, 1977, and 1992) were averaged to calculate the values shown in the table.
[3] Flow changes shown may or may not occur, depending on River Commissioner operation of the Utah Lake outlet.

Table 4-17
Estimated Average Jordanelle Reservoir
Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline
Volume in 1000 acre-feet

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
Average													
Baseline	203.1	204.9	204.9	204.3	204.2	203.2	214.2	245.9	267.5	245.3	219.4	205.1	218.5
Alternative	199.8	201.6	201.5	200.9	200.7	199.7	210.7	242.4	264.0	241.8	216.0	201.7	215.1
Change	-3.3	-3.3	-3.4	-3.4	-3.5	-3.5	-3.5	-3.5	-3.5	-3.5	-3.4	-3.4	-3.4
% Change	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-1%	-1%	-1%	-2%	-2%	-2%
Wet Years[1]													
Baseline	267.1	272.9	276.0	277.4	280.2	247.1	261.1	285.7	311.4	301.7	285.8	278.1	278.7
Alternative	266.0	271.9	275.0	276.4	279.2	246.2	260.2	284.8	310.5	301.0	285.4	278.1	277.9
Change	-1.1	-1.0	-1.0	-1.0	-1.0	-0.9	-0.9	-0.9	-0.9	-0.7	-0.4	0.0	-0.8
% Change	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Dry Years[2]													
Baseline	163.9	164.0	162.0	157.6	153.8	150.8	150.0	156.1	147.1	121.9	100.3	87.8	142.9
Alternative	156.2	156.2	154.1	149.5	145.5	142.4	141.4	147.2	138.0	112.5	90.6	77.7	134.3
Change	-7.7	-7.8	-7.9	-8.1	-8.3	-8.4	-8.6	-8.9	-9.1	-9.4	-9.7	-10.1	-8.6
% Change	-5%	-5%	-5%	-5%	-5%	-6%	-6%	-6%	-6%	-8%	-10%	-12%	-6%
Water Surface Elevation in feet													
Year Type	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Average**
Average													
Baseline	6,118.1	6,119.0	6,118.7	6,117.9	6,117.8	6,117.3	6,123.2	6,139.3	6,148.0	6,138.8	6,127.0	6,119.7	6,127.1
Alternative	6,116.0	6,116.7	6,116.4	6,115.7	6,115.6	6,114.7	6,120.9	6,137.6	6,146.6	6,136.9	6,125.0	6,117.6	6,125.4
Change	-2.1	-2.3	-2.3	-2.2	-2.2	-2.6	-2.3	-1.7	-1.4	-1.9	-2.0	-2.1	-1.7
% Change	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	0%	-1%	-1%	-1%	-1%
Wet Years[1]													
Baseline	6,149.9	6,151.9	6,153.2	6,153.7	6,154.7	6,142.4	6,147.7	6,156.6	6,165.4	6,162.2	6,156.8	6,154.0	6,154.1
Alternative	6,149.5	6,151.7	6,152.8	6,153.4	6,154.3	6,140.3	6,147.3	6,156.3	6,165.0	6,161.9	6,156.6	6,154.0	6,154.0
Change	0	0	0	0	0	-2	0	0	0	0	0	0	0
% Change	0%	0%	0%	0%	0%	-1%	0%	0%	0%	0%	0%	0%	0%
Dry Years[2]													
Baseline	6,101.7	6,102.1	6,101.5	6,099.6	6,098.0	6,096.5	6,096.0	6,099.5	6,093.8	6,077.0	6,057.5	6,045.7	6,091.4
Alternative	6,098.1	6,098.2	6,097.6	6,095.6	6,093.4	6,091.6	6,090.7	6,094.6	6,088.6	6,070.1	6,048.2	6,034.7	6,086.4
Change	-4	-4	-4	-4	-5	-5	-5	-5	-5	-7	-9	-11	-5
% Change	-1%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-3%	-4%	-5%	-2%

Notes:
[1] The three wettest years (1952, 1983, and 1986) were averaged to calculate the values shown in the table.
[2] The three driest years (1961, 1977, and 1992) were averaged to calculate the values shown in the table.

Table 4-18
Estimated Average Deer Creek Reservoir
Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline
Volume in 1000 acre-feet

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
Average													
Baseline	82.7	90.1	95.7	100.2	105.1	110.9	114.9	112.3	109.5	100.0	88.2	79.5	99.1
Alternative	78.8	86.5	93.1	100.3	107.4	115.2	117.6	111.6	106.8	96.0	85.6	76.5	97.9
Change	-3.9	-3.6	-2.6	0.1	2.3	4.3	2.7	-0.7	-2.7	-4.0	-2.6	-3.0	-1.2
% Change	-5%	-4%	-3%	0%	2%	4%	2%	-1%	-2%	-4%	-3%	-4%	-1%
Wet Years[1]													
Baseline	117.8	128.7	134.7	140.4	148.5	145.4	149.3	148.6	142.4	130.5	118.3	113.4	134.8
Alternative	110.9	122.0	128.6	136.7	147.0	145.9	149.0	148.1	141.2	123.4	112.4	107.0	131.0
Change	-6.9	-6.7	-6.1	-3.7	-1.5	0.5	-0.3	-0.5	-1.2	-7.1	-5.9	-6.4	-3.8
% Change	-6%	-5%	-5%	-3%	-1%	0%	0%	0%	-1%	-5%	-5%	-6%	-3%
Dry Years[2]													
Baseline	35.0	39.4	43.6	47.2	51.9	55.8	52.8	40.4	30.5	19.3	9.0	3.9	35.7
Alternative	33.7	39.7	46.1	52.6	59.4	65.8	60.3	46.0	34.0	23.9	15.0	9.7	40.5
Change	-1.3	0.3	2.5	5.4	7.5	10.0	7.5	5.6	3.5	4.6	6.0	5.8	4.8
% Change	-4%	1%	6%	11%	14%	18%	14%	14%	11%	24%	67%	149%	13%
Water Surface Elevation in feet													
Year Type	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Average**
Average													
Baseline	5,378.8	5,383.4	5,386.9	5,389.6	5,392.4	5,395.8	5,397.6	5,396.0	5,394.6	5,389.8	5,382.5	5,376.0	5,389.7
Alternative	5,377.1	5,382.2	5,386.3	5,390.5	5,394.3	5,398.4	5,399.6	5,396.2	5,394.0	5,388.7	5,382.2	5,375.4	5,389.9
Change	-1.7	-1.2	-0.6	0.9	1.9	2.6	2.0	0.2	-0.6	-1.1	-0.3	-0.6	0.2
% Change	-2%	-1%	-1%	1%	2%	2%	2%	0%	-1%	-1%	0%	-1%	0%
Wet Years[1]													
Baseline	5,402.0	5,406.7	5,409.3	5,411.7	5,415.0	5,413.7	5,415.0	5,415.0	5,412.7	5,407.7	5,402.3	5,400.0	5,409.3
Alternative	5,398.7	5,404.0	5,407.0	5,410.3	5,414.3	5,414.0	5,415.0	5,414.7	5,412.0	5,404.7	5,399.7	5,397.0	5,408.3
Change	-3.3	-2.7	-2.3	-1.4	-0.7	0.3	0.0	-0.3	-0.7	-3.0	-2.6	-3.0	-1.0
% Change	-3%	-2%	-2%	-1%	-1%	0%	0%	0%	-1%	-2%	-2%	-3%	-1%
Dry Years[2]													
Baseline	5,341.3	5,347.3	5,351.7	5,355.3	5,360.3	5,363.3	5,360.0	5,346.3	5,334.0	5,325.7	5,316.3	5,308.0	5,345.7
Alternative	5,341.3	5,349.3	5,355.7	5,361.7	5,367.3	5,371.7	5,367.7	5,355.0	5,344.0	5,337.7	5,328.7	5,319.7	5,352.7
Change	0.0	2.0	4.0	6.4	7.0	8.4	7.7	8.7	10.0	12.0	12.4	11.7	7.0
% Change	0%	3%	6%	8%	9%	10%	10%	13%	19%	26%	34%	42%	11%

Notes:
[1] The three wettest years (1952, 1983, and 1986) were averaged to calculate the values shown in the table.
[2] The three driest years (1961, 1977, and 1992) were averaged to calculate the values shown in the table.

Table 4-19
Estimated Average Utah Lake
Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline
Volume in 1000 acre-feet

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
Average													
Baseline	602.8	636.0	671.7	710.1	747.8	778.4	794.1	801.6	771.0	693.3	628.7	596.1	702.6
Alternative	597.0	628.3	660.9	695.6	729.0	755.1	770.2	781.2	750.7	676.0	615.3	587.5	687.2
Change	-5.8	-7.7	-10.8	-14.5	-18.8	-23.3	-23.9	-20.4	-20.3	-17.3	-13.4	-8.6	-15.4
% Change	-1%	-1%	-2%	-2%	-3%	-3%	-3%	-3%	-3%	-2%	-2%	-1%	-2%
Wet Years[1]													
Baseline	764.0	799.4	833.9	855.7	883.0	949.1	993.7	1,079.2	1,069.2	974.9	907.4	852.3	913.5
Alternative	763.9	798.8	827.4	847.9	873.3	938.5	985.0	1,072.3	1,064.6	976.8	908.9	854.5	909.3
Change	-0.1	-0.6	-6.5	-7.8	-9.7	-10.6	-8.7	-6.9	-4.6	1.9	1.5	2.2	-4.2
% Change	0%	0%	-1%	-1%	-1%	-1%	-1%	-1%	0%	0%	0%	0%	0%
Dry Years[2]													
Baseline	477.7	515.8	555.0	591.1	632.8	666.4	666.6	641.0	578.4	504.1	447.6	438.1	559.6
Alternative	458.2	492.0	528.5	559.4	594.3	620.0	617.2	594.0	530.7	455.3	396.3	387.5	519.5
Change	-19.5	-23.8	-26.5	-31.7	-38.5	-46.4	-49.4	-47.0	-47.7	-48.8	-51.3	-50.6	-40.1
% Change	-4%	-5%	-5%	-5%	-6%	-7%	-7%	-7%	-8%	-10%	-11%	-12%	-7%
Water Surface Elevation in feet													
Year Type	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Average**
Average													
Baseline	4,486.0	4,486.4	4,486.8	4,487.2	4,487.7	4,488.0	4,488.2	4,488.2	4,487.9	4,487.0	4,486.3	4,485.9	4,487.2
Alternative	4,485.9	4,486.3	4,486.7	4,487.1	4,487.4	4,487.7	4,487.9	4,488.0	4,487.7	4,486.8	4,486.1	4,485.8	4,487.0
Change	-0.1	-0.1	-0.1	-0.1	-0.3	-0.3	-0.3	-0.2	-0.2	-0.2	-0.2	-0.1	-0.2
% Change	-1%	-1%	-1%	-1%	-3%	-3%	-2%	-2%	-2%	-2%	-2%	-1%	-2%
Wet Years[1]													
Baseline	4,487.9	4,488.2	4,488.6	4,488.9	4,489.2	4,489.8	4,490.3	4,491.2	4,491.1	4,490.1	4,489.4	4,488.8	4,489.5
Alternative	4,487.9	4,488.3	4,488.6	4,488.8	4,489.1	4,489.7	4,490.2	4,491.1	4,491.0	4,490.1	4,489.4	4,488.9	4,489.4
Change	0.0	0.1	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.1	-0.1
% Change	0%	1%	0%	-1%	-1%	-1%	-1%	-1%	-1%	0%	0%	1%	-1%
Dry Years[2]													
Baseline	4,484.5	4,485.0	4,485.5	4,485.9	4,486.4	4,486.8	4,486.8	4,486.5	4,485.7	4,484.8	4,484.2	4,484.0	4,485.5
Alternative	4,484.3	4,484.7	4,485.2	4,485.5	4,485.9	4,486.2	4,486.2	4,485.9	4,485.2	4,484.2	4,483.5	4,483.4	4,485.1
Change	-0.2	-0.3	-0.3	-0.4	-0.5	-0.6	-0.6	-0.6	-0.5	-0.6	-0.7	-0.6	-0.4
% Change	-2%	-3%	-3%	-4%	-5%	-6%	-6%	-6%	-5%	-7%	-9%	-8%	-4%

Notes:
[1] The three wettest years (1952, 1983, and 1986) were averaged to calculate the values shown in the table.
[2] The three driest years (1961, 1977, and 1992) were averaged to calculate the values shown in the table.

Table 4-20
Estimated Average Strawberry Reservoir
Preferred Alternative: Spanish Fork Canyon – Provo Reservoir Canal Alternative Compared to Baseline
Volume in 1000 acre-feet

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
Average													
Baseline	727.2	722.7	718.2	713.1	707.1	703.5	710.3	743.0	748.9	737.9	720.6	721.4	722.8
Alternative	617.9	614.8	612.6	610.3	608.0	608.7	618.5	656.1	661.9	645.4	618.9	611.2	623.7
Change	-109.3	-107.9	-105.6	-102.8	-99.1	-94.8	-91.8	-86.9	-87.0	-92.5	-101.7	-110.2	-99.1
% Change	-15%	-15%	-15%	-14%	-14%	-13%	-13%	-12%	-12%	-13%	-14%	-15%	-14%
Wet Years[1]													
Baseline	849.4	847.3	841.4	843.2	840.4	842.3	868.7	935.6	965.8	972.3	969.2	974.9	895.9
Alternative	729.4	729.1	730.2	732.6	733.0	737.0	761.9	843.9	871.9	875.9	861.3	862.8	789.1
Change	-120.0	-118.2	-111.2	-110.6	-107.4	-105.3	-106.8	-91.7	-93.9	-96.4	-107.9	-112.1	-106.8
% Change	-14%	-14%	-13%	-13%	-13%	-13%	-12%	-10%	-10%	-10%	-11%	-11%	-12%
Dry Years[2]													
Baseline	679.6	673.3	666.9	657.9	648.5	640.3	633.1	623.1	594.4	573.4	553.1	543.6	623.9
Alternative	616.9	613.7	609.5	605.4	601.5	599.7	596.6	585.4	552.0	523.4	495.6	477.8	573.1
Change	-62.7	-59.6	-57.4	-52.5	-47.0	-40.6	-36.5	-37.7	-42.4	-50.0	-57.5	-65.8	-50.8
% Change	-9%	-9%	-9%	-8%	-7%	-6%	-6%	-6%	-7%	-9%	-10%	-12%	-8%
Water Surface Elevation in feet													
Year Type	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Average**
Average													
Baseline	7,576.4	7,576.1	7,575.8	7,575.4	7,575.0	7,574.7	7,575.2	7,577.7	7,578.1	7,577.3	7,576.0	7,576.0	7,576.2
Alternative	7,569.1	7,568.9	7,568.7	7,568.5	7,568.3	7,568.4	7,569.2	7,572.1	7,572.5	7,571.3	7,569.2	7,568.6	7,569.6
Change	-7.3	-7.2	-7.1	-6.9	-6.7	-6.3	-6.0	-5.6	-5.6	-6.0	-6.8	-7.4	-6.6
% Change	-14%	-14%	-14%	-14%	-13%	-13%	-12%	-11%	-11%	-11%	-13%	-15%	-13%
Wet Years[1]													
Baseline	7,585.0	7,584.8	7,584.5	7,584.6	7,584.4	7,584.5	7,586.3	7,591.0	7,593.1	7,593.6	7,593.4	7,593.8	7,588.3
Alternative	7,577.3	7,577.3	7,577.4	7,577.5	7,577.6	7,577.9	7,579.6	7,585.4	7,587.4	7,587.7	7,586.7	7,586.8	7,581.7
Change	-7.7	-7.5	-7.1	-7.1	-6.8	-6.6	-6.7	-5.6	-5.7	-5.9	-6.7	-7.0	-6.6
% Change	-13%	-13%	-12%	-12%	-11%	-11%	-11%	-8%	-8%	-9%	-10%	-10%	-10%
Dry Years[2]													
Baseline	7,573.1	7,572.6	7,572.1	7,571.4	7,570.7	7,570.0	7,569.4	7,568.6	7,566.3	7,564.7	7,563.1	7,562.3	7,568.8
Alternative	7,569.8	7,569.5	7,569.2	7,568.9	7,568.6	7,568.4	7,568.2	7,567.3	7,564.7	7,562.4	7,560.1	7,558.6	7,566.4
Change	-3.3	-3.1	-2.9	-2.5	-2.1	-1.6	-1.2	-1.3	-1.6	-2.3	-3.0	-3.7	-2.4
% Change	-7%	-7%	-6%	-5%	-5%	-4%	-3%	-3%	-4%	-6%	-8%	-10%	-5%

Notes:
[1] The three wettest years (1952, 1983, and 1986) were averaged to calculate the values shown in the table.
[2] The three driest years (1961, 1977, and 1992) were averaged to calculate the values shown in the table.

Table 4-21
Estimated Average Provo River Flows from Murdock Diversion Dam to Interstate 15
Bonneville Unit Water Alternative Compared to Baseline
Flows in cfs

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
Average													
Baseline	88	72	59	55	70	147	199	476	527	182	149	134	180
Alternative	93	72	59	56	73	150	242	512	544	213	166	145	194
Change	5	0	0	1	3	3	43	36	17	31	17	11	14
% Change	6%	0%	0%	2%	4%	2%	22%	8%	3%	17%	11%	8%	8%
Wet Years[1]													
Baseline	95	86	92	80	212	1,083	666	1,189	1,372	280	136	135	453
Alternative	100	86	92	80	215	1,083	707	1,204	1,381	347	153	147	467
Change	5	0	0	0	3	0	41	15	9	67	17	12	14
% Change	5%	0%	0%	0%	1%	0%	6%	1%	1%	24%	13%	9%	3%
Dry Years[2]													
Baseline	68	55	43	40	40	40	72	105	91	72	115	96	70
Alternative	70	55	43	44	51	38	113	125	99	78	122	101	78
Change	2	0	0	4	11	-2	41	20	8	6	7	5	8
% Change	3%	0%	0%	10%	28%	-5%	57%	19%	9%	8%	6%	5%	11%
Flows in acre-feet													
Year Type	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Total**
Average													
Baseline	5,419	4,308	3,605	3,403	3,900	9,049	11,830	29,281	31,373	11,170	9,166	7,999	130,503
Alternative	5,688	4,292	3,599	3,462	4,116	9,217	14,403	31,467	32,388	13,101	10,203	8,645	140,582
Change	269	-16	-6	59	216	168	2,573	2,186	1,015	1,931	1,037	646	10,079
% Change	5%	0%	0%	2%	6%	2%	22%	7%	3%	17%	11%	8%	8%
Wet Years[1]													
Baseline	5,819	5,122	5,633	4,893	11,789	66,568	39,656	73,132	81,623	17,206	8,364	8,050	327,854
Alternative	6,145	5,122	5,633	4,893	11,970	66,568	42,097	74,011	82,200	21,312	9,423	8,741	338,114
Change	326	0	0	0	181	0	2,441	879	577	4,106	1,059	691	10,260
% Change	6%	0%	0%	0%	2%	0%	6%	1%	1%	24%	13%	9%	3%
Dry Years[2]													
Baseline	4,199	3,287	2,653	2,473	2,263	2,486	4,299	6,426	5,405	4,417	7,076	5,703	50,687
Alternative	4,311	3,287	2,653	2,728	2,874	2,329	6,720	7,659	5,917	4,820	7,496	5,982	56,776
Change	112	0	0	255	611	-157	2,421	1,233	512	403	420	279	6,089
% Change	3%	0%	0%	10%	27%	-6%	56%	19%	9%	9%	6%	5%	12%

Notes:
[1] The three wettest years (1952, 1983, and 1986) were averaged to calculate the values shown in the table.
[2] The three driest years (1961, 1977, and 1992) were averaged to calculate the values shown in the table.

Table 4-22
Estimated Average Provo River Flows from Interstate 15 to Utah Lake
Bonneville Unit Water Alternative Compared to Baseline
Flows in cfs

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
Average													
Baseline	32	76	56	51	64	142	168	347	374	42	4	6	114
Alternative	41	76	56	52	68	145	213	404	414	93	30	26	135
Change	9	0	0	1	4	3	45	57	40	51	26	20	21
% Change	28%	0%	0%	2%	6%	2%	27%	16%	11%	121%	650%	333%	18%
Wet Years[1]													
Baseline	79	85	95	81	209	1,082	678	1,124	1,255	131	0	0	402
Alternative	87	85	95	81	212	1,082	719	1,145	1,276	210	27	21	420
Change	8	0	0	0	3	0	41	21	21	79	27	21	18
% Change	10%	0%	0%	0%	1%	0%	6%	2%	2%	60%	NoCalc	NoCalc	4%
Dry Years[2]													
Baseline	14	49	34	33	34	31	13	0	22	6	52	1	24
Alternative	19	49	34	37	44	28	58	42	44	21	63	13	37
Change	5	0	0	4	10	-3	45	42	22	15	11	12	13
% Change	36%	0%	0%	12%	29%	-10%	346%	NoCalc	100%	250%	21%	NoCalc	54%
Flows in acre-feet													
Year Type	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Total**
Average													
Baseline	1,984	4,533	3,464	3,131	3,601	8,753	10,021	21,324	22,225	2,580	251	371	82,237
Alternative	2,510	4,518	3,458	3,191	3,817	8,921	12,700	24,825	24,657	5,718	1,867	1,521	97,702
Change	526	-15	-6	60	216	168	2,679	3,501	2,432	3,138	1,616	1,150	15,465
% Change	27%	0%	0%	2%	6%	2%	27%	16%	11%	122%	644%	310%	19%
Wet Years[1]													
Baseline	4,862	5,075	5,839	4,957	11,634	66,557	40,315	69,128	74,652	8,034	25	0	291,078
Alternative	5,334	5,075	5,839	4,957	11,815	66,557	42,761	70,381	75,922	12,891	1,676	1,229	304,437
Change	472	0	0	0	181	0	2,446	1,253	1,270	4,857	1,651	1,229	13,359
% Change	10%	0%	0%	0%	2%	0%	6%	2%	2%	60%	NoCalc	NoCalc	5%
Dry Years[2]													
Baseline	834	2,890	2,065	2,017	1,893	1,879	796	0	1,292	349	3,210	68	17,293
Alternative	1,153	2,891	2,066	2,272	2,504	1,721	3,439	2,588	2,610	1,274	3,898	759	27,176
Change	319	1	1	255	611	-158	2,643	2,588	1,318	925	688	691	9,883
% Change	38%	0%	0%	13%	32%	-8%	332%	NoCalc	102%	265%	21%	NoCalc	57%

Notes:
[1] The three wettest years (1952, 1983, and 1986) were averaged to calculate the values shown in the table.
[2] The three driest years (1961, 1977, and 1992) were averaged to calculate the values shown in the table.

Table 4-23
Estimated Average Hobble Creek Flows from Mapleton Lateral to Utah Lake
Bonneville Unit Water Alternative Compared to Baseline
Flows in cfs

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
Average													
Baseline	7	25	23	22	26	38	60	109	38	4	1	1	30
Alternative	38	55	53	52	56	68	102	147	72	35	33	32	62
Change	31	30	30	30	30	30	42	38	34	31	32	31	32
% Change	443%	120%	130%	136%	115%	79%	70%	35%	89%	775%	3200%	3100%	107%
Wet Years[1]													
Baseline	13	36	33	32	58	78	202	346	183	28	11	10	86
Alternative	24	39	36	35	60	81	202	346	187	45	28	23	92
Change	11	3	3	3	2	3	0	0	4	17	17	13	6
% Change	85%	8%	9%	9%	3%	4%	0%	0%	2%	61%	155%	130%	7%
Dry Years[2]													
Baseline	0	14	13	14	16	14	9	0	0	0	0	0	7
Alternative	34	47	47	48	50	53	80	95	40	33	33	34	49
Change	34	33	34	34	34	39	71	95	40	33	33	34	42
% Change	NoCalc	236%	262%	243%	213%	279%	789%	NoCalc	NoCalc	NoCalc	NoCalc	NoCalc	600%

Flows in acre-feet

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Average													
Baseline	442	1,512	1,402	1,361	1,459	2,332	3,563	6,682	2,248	229	90	58	21,379
Alternative	2,339	3,290	3,238	3,198	3,118	4,170	6,098	9,034	4,266	2,164	2,028	1,906	44,849
Change	1,897	1,778	1,836	1,837	1,659	1,838	2,535	2,352	2,018	1,935	1,938	1,848	23,470
% Change	429%	118%	131%	135%	114%	79%	71%	35%	90%	845%	2153%	3186%	110%
Wet Years[1]													
Baseline	805	2,139	2,014	1,998	3,217	4,783	11,998	21,262	10,891	1,731	689	595	62,124
Alternative	1,463	2,311	2,190	2,175	3,377	4,960	11,998	21,262	11,127	2,759	1,712	1,369	66,703
Change	658	172	176	177	160	177	0	0	236	1,028	1,023	774	4,579
% Change	82%	8%	9%	9%	5%	4%	0%	0%	2%	59%	148%	130%	7%
Dry Years[2]													
Baseline	0	812	819	860	930	864	546	0	0	0	0	0	4,831
Alternative	2,073	2,818	2,892	2,933	2,803	3,268	4,758	5,817	2,380	2,042	2,058	2,006	35,848
Change	2,073	2,006	2,073	2,073	1,873	2,404	4,212	5,817	2,380	2,042	2,058	2,006	31,017
% Change	NoCalc	247%	253%	241%	201%	278%	771%	NoCalc	NoCalc	NoCalc	NoCalc	NoCalc	642%

Notes:
[1] The three wettest years (1952, 1983, and 1986) were averaged to calculate the values shown in the table.
[2] The three driest years (1961, 1977, and 1992) were averaged to calculate the values shown in the table.

Table 4-24
Estimated Average Spanish Fork River from Diamond Fork Creek to Spanish Fork Diversion Dam (Castilla Gage)
Bonneville Unit Water Alternative Compared to Baseline
Flows in cfs

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
Average													
Baseline	158	191	201	215	248	285	425	740	645	546	457	258	365
Alternative	192	255	245	246	271	293	415	579	453	357	305	182	316
Change	34	64	44	31	23	8	-10	-161	-192	-189	-152	-76	-49
% Change	22%	34%	22%	14%	9%	3%	-2%	-22%	-30%	-35%	-33%	-29%	-13%
Wet Years[1]													
Baseline	163	204	276	171	278	326	751	1,351	990	546	454	296	484
Alternative	182	191	181	183	243	310	784	1,339	947	460	376	270	456
Change	19	-13	-95	12	-35	-16	33	-12	-43	-86	-78	-26	-28
% Change	12%	-6%	-34%	7%	-13%	-5%	4%	-1%	-4%	-16%	-17%	-9%	-6%
Dry Years[2]													
Baseline	132	190	174	214	243	259	345	492	544	380	356	188	293
Alternative	164	240	232	234	255	248	264	210	315	227	211	122	227
Change	32	50	58	20	12	-11	-81	-282	-229	-153	-145	-66	-66
% Change	24%	26%	33%	9%	5%	-4%	-23%	-57%	-42%	-40%	-41%	-35%	-23%

Flows in acre-feet

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Average													
Baseline	9,693	11,355	12,373	13,211	13,870	17,527	25,299	45,527	38,374	33,569	28,069	15,326	264,195
Alternative	11,816	15,174	15,070	15,152	15,182	18,023	24,689	35,619	26,926	21,931	18,769	10,838	229,190
Change	2,123	3,819	2,697	1,941	1,312	496	-610	-9,908	-11,448	-11,638	-9,300	-4,488	-35,005
% Change	22%	34%	22%	15%	9%	3%	-2%	-22%	-30%	-35%	-33%	-29%	-13%
Wet Years[1]													
Baseline	10,014	12,125	16,952	10,502	15,562	20,024	44,658	83,050	58,903	33,555	27,913	17,623	350,881
Alternative	11,166	11,350	11,156	11,252	13,678	19,075	46,631	82,328	56,347	28,260	23,106	16,074	330,422
Change	1,152	-775	-5,796	750	-1,884	-949	1,973	-722	-2,556	-5,295	-4,807	-1,549	-20,459
% Change	12%	-6%	-34%	7%	-12%	-5%	4%	-1%	-4%	-16%	-17%	-9%	-6%
Dry Years[2]													
Baseline	8,115	11,318	10,698	13,185	13,701	15,896	20,515	30,275	32,397	23,377	21,910	11,193	212,581
Alternative	10,092	14,288	14,263	14,390	14,328	15,262	15,681	12,928	18,754	13,929	12,968	7,285	164,168
Change	1,977	2,970	3,565	1,205	627	-634	-4,834	-17,347	-13,643	-9,448	-8,942	-3,908	-48,413
% Change	24%	26%	33%	9%	5%	-4%	-24%	-57%	-42%	-40%	-41%	-35%	-23%

Notes:
[1] The three wettest years (1952, 1983, and 1986) were averaged to calculate the values shown in the table.
[2] The three driest years (1961, 1977, and 1992) were averaged to calculate the values shown in the table.

Table 4-25
Estimated Average Spanish Fork River from Spanish Fork Diversion Dam to East Bench Diversion
Bonneville Unit Water Alternative Compared to Baseline
Flows in cfs

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
Average													
Baseline	58	109	130	143	163	160	190	339	242	176	134	88	161
Alternative	92	173	174	175	186	168	180	190	99	54	44	31	130
Change	34	64	44	32	23	8	-10	-149	-143	-122	-90	-57	-31
% Change	59%	59%	34%	22%	14%	5%	-5%	-44%	-59%	-69%	-67%	-65%	-19%
Wet Years[1]													
Baseline	39	96	181	74	126	90	269	770	414	146	90	65	197
Alternative	57	83	87	87	92	74	302	766	407	115	66	54	183
Change	18	-13	-94	13	-34	-16	33	-4	-7	-31	-24	-11	-14
% Change	46%	-14%	-52%	18%	-27%	-18%	12%	-1%	-2%	-21%	-27%	-17%	-7%
Dry Years[2]													
Baseline	73	138	129	167	191	203	275	272	189	120	119	75	162
Alternative	104	187	187	186	203	193	195	31	39	24	22	19	115
Change	31	49	58	19	12	-10	-80	-241	-150	-96	-97	-56	-47
% Change	42%	36%	45%	11%	6%	-5%	-29%	-89%	-79%	-80%	-82%	-75%	-29%
Flows in acre-feet													
Year Type	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Total**
Average													
Baseline	3,548	6,470	8,024	8,798	9,130	9,823	11,301	20,827	14,420	10,850	8,250	5,214	116,656
Alternative	5,676	10,289	10,721	10,739	10,442	10,319	10,694	11,711	5,911	3,340	2,704	1,864	94,411
Change	2,128	3,819	2,697	1,941	1,312	496	-606	-9,116	-8,509	-7,509	-5,547	-3,350	-22,245
% Change	60%	59%	34%	22%	14%	5%	-5%	-44%	-59%	-69%	-67%	-64%	-19%
Wet Years[1]													
Baseline	2,386	5,727	11,119	4,572	7,109	5,514	16,008	47,322	24,640	8,980	5,509	3,851	142,735
Alternative	3,525	4,952	5,323	5,322	5,225	4,565	17,981	47,074	24,205	7,077	4,030	3,192	132,471
Change	1,139	-775	-5,796	750	-1,884	-949	1,973	-248	-435	-1,903	-1,479	-659	-10,264
% Change	48%	-14%	-52%	16%	-27%	-17%	12%	-1%	-2%	-21%	-27%	-17%	-7%
Dry Years[2]													
Baseline	4,488	8,184	7,926	10,243	10,777	12,504	16,368	16,731	11,262	7,361	7,328	4,460	117,631
Alternative	6,387	11,154	11,491	11,448	11,404	11,870	11,599	1,913	2,320	1,448	1,371	1,127	83,531
Change	1,899	2,970	3,565	1,205	627	-634	-4,769	-14,818	-8,942	-5,913	-5,957	-3,333	-34,100
% Change	42%	36%	45%	12%	6%	-5%	-29%	-89%	-79%	-80%	-81%	-75%	-29%

Notes:
[1] The three wettest years (1952, 1983, and 1986) were averaged to calculate the values shown in the table.
[2] The three driest years (1961, 1977, and 1992) were averaged to calculate the values shown in the table.

Table 4-26
Estimated Average Spanish Fork River from East Bench Diversion to Mill Race Canal
Bonneville Unit Water Alternative Compared to Baseline
Flows in cfs

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
Average													
Baseline	54	109	130	143	163	159	182	295	187	127	93	70	143
Alternative	90	173	174	175	186	167	172	148	52	17	15	17	115
Change	36	64	44	32	23	8	-10	-147	-135	-110	-78	-53	-28
% Change	67%	59%	34%	22%	14%	5%	-5%	-50%	-72%	-87%	-84%	-76%	-20%
Wet Years[1]													
Baseline	37	96	181	74	126	90	269	735	332	80	47	28	175
Alternative	55	83	87	87	92	74	302	732	328	55	29	21	162
Change	18	-13	-94	13	-34	-16	33	-3	-4	-25	-18	-7	-13
% Change	49%	-14%	-52%	18%	-27%	-18%	12%	0%	-1%	-31%	-38%	-25%	-7%
Dry Years[2]													
Baseline	69	138	129	167	191	203	260	244	145	95	94	69	150
Alternative	101	187	187	186	203	193	180	12	10	7	6	14	107
Change	32	49	58	19	12	-10	-80	-232	-135	-88	-88	-55	-43
% Change	46%	36%	45%	11%	6%	-5%	-31%	-95%	-93%	-93%	-94%	-80%	-29%

Flows in acre-feet

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Average													
Baseline	3,338	6,470	8,024	8,798	9,130	9,796	10,849	18,108	11,103	7,816	5,713	4,164	103,308
Alternative	5,511	10,289	10,721	10,739	10,442	10,292	10,258	9,126	3,084	1,054	905	1,040	83,463
Change	2,173	3,819	2,697	1,941	1,312	496	-591	-8,982	-8,019	-6,762	-4,808	-3,124	-19,845
% Change	65%	59%	34%	22%	14%	5%	-5%	-50%	-72%	-87%	-84%	-75%	-19%
Wet Years[1]													
Baseline	2,252	5,727	11,119	4,572	7,109	5,514	16,008	45,205	19,731	4,934	2,887	1,648	126,703
Alternative	3,404	4,952	5,323	5,322	5,225	4,565	17,981	45,033	19,525	3,368	1,755	1,265	117,717
Change	1,152	-775	-5,796	750	-1,884	-949	1,973	-172	-206	-1,566	-1,132	-383	-8,986
% Change	51%	-14%	-52%	16%	-27%	-17%	12%	0%	-1%	-32%	-39%	-23%	-7%
Dry Years[2]													
Baseline	4,256	8,184	7,926	10,243	10,777	12,474	15,458	15,000	8,650	5,837	5,775	4,093	108,673
Alternative	6,234	11,154	11,491	11,448	11,404	11,840	10,736	708	604	429	348	840	77,233
Change	1,978	2,970	3,565	1,205	627	-634	-4,722	-14,292	-8,046	-5,408	-5,427	-3,253	-31,440
% Change	46%	36%	45%	12%	6%	-5%	-31%	-95%	-93%	-93%	-94%	-79%	-29%

Notes:
[1] The three wettest years (1952, 1983, and 1986) were averaged to calculate the values shown in the table.
[2] The three driest years (1961, 1977, and 1992) were averaged to calculate the values shown in the table.

Table 4-27
Estimated Average Spanish Fork River from Mill Race Canal to Lakeshore Gage
Bonneville Unit Water Alternative Compared to Baseline
Flows in cfs

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
Average													
Baseline	131	194	205	219	252	289	389	471	257	149	113	86	229
Alternative	166	258	249	251	276	297	379	325	122	39	35	33	202
Change	35	64	44	32	24	8	-10	-146	-135	-110	-78	-53	-27
% Change	27%	33%	21%	15%	10%	3%	-3%	-31%	-53%	-74%	-69%	-62%	-12%
Wet Years[1]													
Baseline	141	207	279	174	283	331	755	1,164	499	87	66	74	338
Alternative	160	194	185	187	248	315	788	1,161	495	61	48	68	326
Change	19	-13	-94	13	-35	-16	33	-3	-4	-26	-18	-6	-12
% Change	13%	-6%	-34%	7%	-12%	-5%	4%	0%	-1%	-30%	-27%	-8%	-4%
Dry Years[2]													
Baseline	120	193	179	219	248	257	274	258	174	113	115	80	186
Alternative	152	243	237	239	259	247	195	26	39	25	27	26	142
Change	32	50	58	20	11	-10	-79	-232	-135	-88	-88	-54	-44
% Change	27%	26%	32%	9%	4%	-4%	-29%	-90%	-78%	-78%	-77%	-68%	-24%

Flows in acre-feet

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Average													
Baseline	8,047	11,555	12,631	13,480	14,124	17,740	23,154	28,966	15,287	9,147	6,972	5,111	166,213
Alternative	10,220	15,374	15,328	15,421	15,436	18,236	22,563	19,984	7,269	2,386	2,164	1,987	146,368
Change	2,173	3,819	2,697	1,941	1,312	496	-591	-8,982	-8,018	-6,761	-4,808	-3,124	-19,845
% Change	27%	33%	21%	14%	9%	3%	-3%	-31%	-52%	-74%	-69%	-61%	-12%
Wet Years[1]													
Baseline	8,690	12,317	17,178	10,725	15,830	20,325	44,917	71,565	29,679	5,319	4,053	4,405	245,003
Alternative	9,841	11,542	11,382	11,475	13,946	19,376	46,890	71,394	29,473	3,754	2,922	4,022	236,017
Change	1,151	-775	-5,796	750	-1,884	-949	1,973	-171	-206	-1,565	-1,131	-383	-8,986
% Change	13%	-6%	-34%	7%	-12%	-5%	4%	0%	-1%	-29%	-28%	-9%	-4%
Dry Years[2]													
Baseline	7,397	11,499	10,993	13,481	13,969	15,828	16,307	15,884	10,358	6,955	7,062	4,771	134,505
Alternative	9,375	14,469	14,558	14,686	14,596	15,193	11,585	1,591	2,312	1,547	1,635	1,518	103,066
Change	1,978	2,970	3,565	1,205	627	-635	-4,722	-14,293	-8,046	-5,408	-5,427	-3,253	-31,439
% Change	27%	26%	32%	9%	4%	-4%	-29%	-90%	-78%	-78%	-77%	-68%	-23%

Notes:
[1] The three wettest years (1952, 1983, and 1986) were averaged to calculate the values shown in the table.
[2] The three driest years (1961, 1977, and 1992) were averaged to calculate the values shown in the table.

Table 4-28
Estimated Average Spanish Fork River Flows at Lakeshore Gage
Bonneville Unit Water Alternative Compared to Baseline
Flows in cfs

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
Average													
Baseline	125	195	212	226	260	295	387	448	229	125	92	78	222
Alternative	160	259	256	258	283	303	377	302	94	15	14	26	195
Change	35	64	44	32	23	8	-10	-146	-135	-110	-78	-52	-27
% Change	28%	33%	21%	14%	9%	3%	-3%	-33%	-59%	-88%	-85%	-67%	-12%
Wet Years[1]													
Baseline	147	210	285	180	292	341	762	1,153	462	67	46	56	333
Alternative	166	197	191	192	258	325	796	1,150	459	41	28	50	321
Change	19	-13	-94	12	-34	-16	34	-3	-3	-26	-18	-6	-12
% Change	13%	-6%	-33%	7%	-12%	-5%	4%	0%	-1%	-39%	-39%	-11%	-4%
Dry Years[2]													
Baseline	110	192	188	229	257	266	266	246	157	99	97	75	181
Alternative	142	242	246	249	269	255	187	13	21	11	8	20	138
Change	32	50	58	20	12	-11	-79	-233	-136	-88	-89	-55	-43
% Change	29%	26%	31%	9%	5%	-4%	-30%	-95%	-87%	-89%	-92%	-73%	-24%
Flows in acre-feet													
Year Type	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Total**
Average													
Baseline	7,682	11,599	13,028	13,915	14,557	18,157	23,014	27,567	13,601	7,706	5,655	4,646	161,126
Alternative	9,856	15,419	15,725	15,856	15,869	18,653	22,423	18,585	5,582	945	847	1,522	141,281
Change	2,174	3,820	2,697	1,941	1,312	496	-591	-8,982	-8,019	-6,761	-4,808	-3,124	-19,845
% Change	28%	33%	21%	14%	9%	3%	-3%	-33%	-59%	-88%	-85%	-67%	-12%
Wet Years[1]													
Baseline	9,063	12,494	17,527	11,080	16,368	20,937	45,368	70,909	27,512	4,092	2,859	3,356	241,565
Alternative	10,215	11,719	11,731	11,830	14,484	19,988	47,341	70,738	27,307	2,526	1,727	2,974	232,580
Change	1,152	-775	-5,796	750	-1,884	-949	1,973	-171	-205	-1,566	-1,132	-382	-8,985
% Change	13%	-6%	-33%	7%	-12%	-5%	4%	0%	-1%	-38%	-40%	-11%	-4%
Dry Years[2]													
Baseline	6,734	11,450	11,589	14,086	14,503	16,327	15,853	15,108	9,317	6,064	5,939	4,434	131,404
Alternative	8,712	14,420	15,154	15,291	15,130	15,693	11,131	815	1,271	655	511	1,181	99,965
Change	1,978	2,970	3,565	1,205	627	-634	-4,722	-14,293	-8,046	-5,409	-5,428	-3,253	-31,439
% Change	29%	26%	31%	9%	4%	-4%	-30%	-95%	-86%	-89%	-91%	-73%	-24%

Notes:
[1] The three wettest years (1952, 1983, and 1986) were averaged to calculate the values shown in the table.
[2] The three driest years (1961, 1977, and 1992) were averaged to calculate the values shown in the table.

Table 4-29
Estimated Average Jordan River from Outlet of Utah Lake to Jordan Narrows
Bonneville Unit Water Alternative Compared to Baseline
Flows in cfs

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
Average													
Baseline	251	155	196	248	314	435	566	849	922	919	792	584	520
Alternative	251	154	196	248	314	433	573	842	919	913	796	584	520
Change	0	-1	0	0	0	-2	7	-7	-3	-6	4	0	0
% Change	0%	-1%	0%	0%	0%	0%	1%	-1%	0%	-1%	1%	0%	0%
Wet Years[1]													
Baseline	239	320	686	729	1,085	1,502	1,672	2,027	2,040	1,642	1,256	905	1,175
Alternative	239	311	683	726	1,076	1,493	1,673	2,032	2,052	1,650	1,309	905	1,179
Change	0	-9	-3	-3	-9	-9	1	5	12	8	53	0	4
% Change	0%	-3%	0%	0%	-1%	-1%	0%	0%	1%	0%	4%	0%	0%
Dry Years[2]													
Baseline	227	16	16	5	6	6	123	476	565	592	440	228	227
Alternative	227	16	16	5	6	6	123	476	565	592	440	228	227
Change	0	0	0	0	0	0	0	0	0	0	0	0	0
% Change	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Flows in acre-feet

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Average													
Baseline	15,406	9,249	12,051	15,266	17,608	26,736	33,680	52,196	54,843	56,517	48,719	34,763	377,033
Alternative	15,431	9,181	12,057	15,244	17,590	26,651	34,121	51,775	54,670	56,129	48,918	34,769	376,534
Change	25	-68	6	-22	-18	-85	441	-421	-173	-388	199	6	-499
% Change	0%	-1%	0%	0%	0%	0%	1%	-1%	0%	-1%	0%	0%	0%
Wet Years[1]													
Baseline	14,711	19,017	42,186	44,840	60,614	92,333	99,516	124,655	121,374	100,930	77,205	53,831	851,213
Alternative	14,711	18,513	42,007	44,623	60,106	91,826	99,546	124,961	122,119	101,449	80,491	53,878	854,230
Change	0	-504	-179	-217	-508	-507	30	306	745	519	3,286	47	3,017
% Change	0%	-3%	0%	0%	-1%	-1%	0%	0%	1%	1%	4%	0%	0%
Dry Years[2]													
Baseline	13,970	975	975	295	332	388	7,343	29,290	33,629	36,399	27,058	13,576	164,233
Alternative	13,970	975	975	295	332	388	7,343	29,290	33,629	36,399	27,058	13,576	164,233
Change	0	0	0	0	0	0	0	0	0	0	0	0	0
% Change	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Notes:
[1] The three wettest years (1952, 1983, and 1986) were averaged to calculate the values shown in the table.
[2] The three driest years (1961, 1977, and 1992) were averaged to calculate the values shown in the table.

Table 4-30
Estimated Average Utah Lake
Bonneville Unit Water Alternative Compared to Baseline
Volume in 1000 acre-feet

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
Average													
Baseline	602.8	636.0	671.7	710.1	747.8	778.4	794.1	801.6	771.0	693.3	628.7	596.1	702.6
Alternative	592.6	629.6	667.4	707.0	744.9	775.4	792.1	796.4	761.9	682.3	615.8	582.7	695.7
Change	-10.2	-6.4	-4.3	-3.1	-2.9	-3.0	-2.0	-5.2	-9.1	-11.0	-12.9	-13.4	-6.9
% Change	-2%	-1%	-1%	0%	0%	0%	0%	-1%	-1%	-2%	-2%	-2%	-1%
Wet Years[1]													
Baseline	764.0	799.4	833.9	855.7	883.0	949.1	993.7	1,079.2	1,069.2	974.9	907.4	852.3	913.5
Alternative	758.4	800.2	831.6	854.9	880.9	946.8	995.6	1,081.2	1,071.1	979.9	909.9	855.8	913.9
Change	-5.6	0.8	-2.3	-0.8	-2.1	-2.3	1.9	2.0	1.9	5.0	2.5	3.5	0.4
% Change	-1%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%
Dry Years[2]													
Baseline	477.7	515.8	555.0	591.1	632.8	666.4	666.6	641.0	578.4	504.1	447.6	438.1	559.6
Alternative	430.0	472.4	516.6	555.5	599.6	634.2	636.2	604.4	537.4	460.8	401.8	391.9	520.1
Change	-47.7	-43.4	-38.4	-35.6	-33.2	-32.2	-30.4	-36.6	-41.0	-43.3	-45.8	-46.2	-39.5
% Change	-10%	-8%	-7%	-6%	-5%	-5%	-5%	-6%	-7%	-9%	-10%	-11%	-7%
Water Surface Elevation in feet													
Year Type	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Average**
Average													
Baseline	4,486.0	4,486.4	4,486.8	4,487.2	4,487.7	4,488.0	4,488.2	4,488.2	4,487.9	4,487.0	4,486.3	4,485.9	4,487.2
Alternative	4,485.9	4,486.3	4,486.7	4,487.2	4,487.6	4,488.0	4,488.1	4,488.2	4,487.8	4,486.9	4,486.1	4,485.8	4,487.1
Change	-0.1	-0.1	-0.1	0.0	-0.1	0.0	-0.1	0.0	-0.1	-0.1	-0.2	-0.1	-0.1
% Change	-1%	-1%	-1%	0%	-1%	0%	-1%	0%	-1%	-1%	-2%	-1%	-1%
Wet Years[1]													
Baseline	4,487.9	4,488.2	4,488.6	4,488.9	4,489.2	4,489.8	4,490.3	4,491.2	4,491.1	4,490.1	4,489.4	4,488.8	4,489.5
Alternative	4,487.8	4,488.3	4,488.6	4,488.9	4,489.1	4,489.8	4,490.3	4,491.2	4,491.1	4,490.2	4,489.4	4,488.9	4,489.5
Change	-0.1	0.1	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0
% Change	-1%	1%	0%	0%	-1%	0%	0%	0%	0%	1%	0%	1%	0%
Dry Years[2]													
Baseline	4,484.5	4,485.0	4,485.5	4,485.9	4,486.4	4,486.8	4,486.8	4,486.5	4,485.7	4,484.8	4,484.2	4,484.0	4,485.5
Alternative	4,484.0	4,484.5	4,485.0	4,485.5	4,486.0	4,486.4	4,486.4	4,486.0	4,485.2	4,484.3	4,483.6	4,483.5	4,485.0
Change	-0.5	-0.5	-0.5	-0.4	-0.4	-0.4	-0.4	-0.5	-0.5	-0.5	-0.6	-0.5	-0.5
% Change	-6%	-6%	-5%	-4%	-4%	-4%	-4%	-5%	-5%	-6%	-7%	-6%	-5%

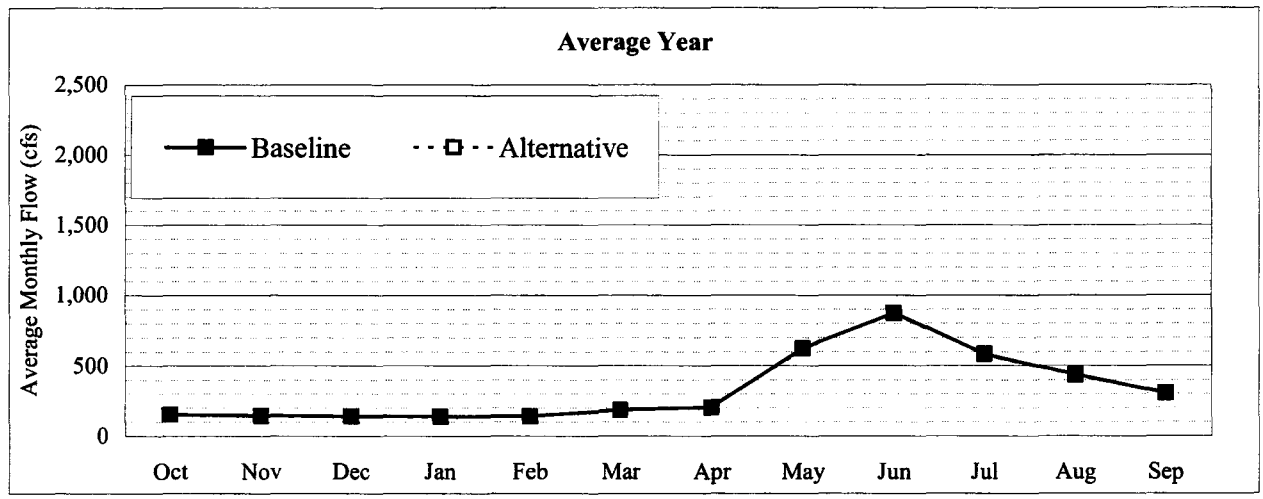
Notes:
[1] The three wettest years (1952, 1983, and 1986) were averaged to calculate the values shown in the table.
[2] The three driest years (1961, 1977, and 1992) were averaged to calculate the values shown in the table.

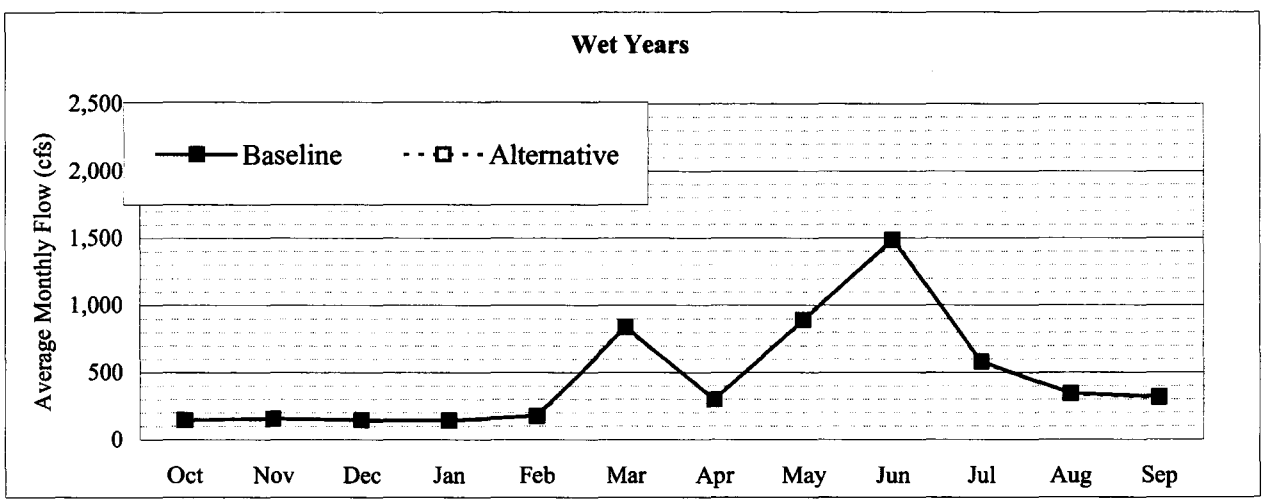
Table 4-31
Estimated Average Strawberry Reservoir
Bonneville Unit Water Alternative Compared to Baseline
Volume in 1000 acre-feet

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
Average													
Baseline	727.2	722.7	718.2	713.1	707.1	703.5	710.3	743.0	748.9	737.9	720.6	721.4	722.8
Alternative	612.1	601.8	592.7	583.8	574.8	568.9	574.4	618.0	630.9	622.8	605.3	605.2	599.2
Change	-115.1	-120.9	-125.5	-129.3	-132.3	-134.6	-135.9	-125.0	-118.0	-115.1	-115.3	-116.2	-123.6
% Change	-16%	-17%	-17%	-18%	-19%	-19%	-19%	-17%	-16%	-16%	-16%	-16%	-17%
Wet Years[1]													
Baseline	849.4	847.3	841.4	843.2	840.4	842.3	868.7	935.6	965.8	972.3	969.2	974.9	895.9
Alternative	696.1	694.6	694.3	695.1	694.0	696.7	721.4	796.4	828.8	838.3	832.1	840.1	752.3
Change	-153.3	-152.7	-147.1	-148.1	-146.4	-145.6	-147.3	-139.2	-137.0	-134.0	-137.1	-134.8	-143.6
% Change	-18%	-18%	-17%	-18%	-17%	-17%	-17%	-15%	-14%	-14%	-14%	-14%	-16%
Dry Years[2]													
Baseline	679.6	673.3	666.9	657.9	648.5	640.3	633.1	623.1	594.4	573.4	553.1	543.6	623.9
Alternative	617.9	606.7	594.5	582.2	570.3	560.6	553.2	550.8	526.0	505.6	485.5	474.8	552.3
Change	-61.7	-66.6	-72.4	-75.7	-78.2	-79.7	-79.9	-72.3	-68.4	-67.8	-67.6	-68.8	-71.6
% Change	-9%	-10%	-11%	-12%	-12%	-12%	-13%	-12%	-12%	-12%	-12%	-13%	-11%
Water Surface Elevation in feet													
Year Type	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Average**
Average													
Baseline	7,576.4	7,576.1	7,575.8	7,575.4	7,575.0	7,574.7	7,575.2	7,577.7	7,578.1	7,577.3	7,576.0	7,576.0	7,576.2
Alternative	7,568.7	7,567.9	7,567.1	7,566.4	7,565.6	7,565.1	7,565.6	7,569.1	7,570.2	7,569.5	7,568.2	7,568.2	7,567.7
Change	-7.7	-8.2	-8.7	-9.0	-9.4	-9.6	-9.6	-8.6	-7.9	-7.8	-7.8	-7.8	-8.5
% Change	-15%	-16%	-17%	-18%	-19%	-19%	-19%	-16%	-15%	-15%	-15%	-15%	-17%
Wet Years[1]													
Baseline	7,585.0	7,584.8	7,584.5	7,584.6	7,584.4	7,584.5	7,586.3	7,591.0	7,593.1	7,593.6	7,593.4	7,593.8	7,588.3
Alternative	7,574.6	7,574.5	7,574.5	7,574.5	7,574.4	7,574.6	7,576.4	7,582.0	7,584.4	7,585.1	7,584.7	7,585.2	7,578.9
Change	-10.4	-10.3	-10.0	-10.1	-10.0	-9.9	-9.9	-9.0	-8.7	-8.5	-8.7	-8.6	-9.4
% Change	-17%	-17%	-17%	-17%	-17%	-17%	-16%	-14%	-13%	-12%	-13%	-13%	-15%
Dry Years[2]													
Baseline	7,573.1	7,572.6	7,572.1	7,571.4	7,570.7	7,570.0	7,569.4	7,568.6	7,566.3	7,564.7	7,563.1	7,562.3	7,568.8
Alternative	7,569.9	7,569.1	7,568.2	7,567.2	7,566.3	7,565.5	7,564.9	7,564.7	7,562.7	7,561.1	7,559.4	7,558.5	7,564.9
Change	-3.2	-3.5	-3.9	-4.2	-4.4	-4.5	-4.5	-3.9	-3.6	-3.6	-3.7	-3.8	-3.9
% Change	-7%	-7%	-8%	-9%	-10%	-10%	-10%	-9%	-9%	-9%	-10%	-10%	-9%

Notes:
[1] The three wettest years (1952, 1983, and 1986) were averaged to calculate the values shown in the table.
[2] The three driest years (1961, 1977, and 1992) were averaged to calculate the values shown in the table.

Figure 4-1
Estimated Average Provo River Flows from Timpanogos Diversion to River Ditch
Preferred Alternative: Spanish Fork Canyon - Provo Reservoir Canal Alternative Compared to Baseline





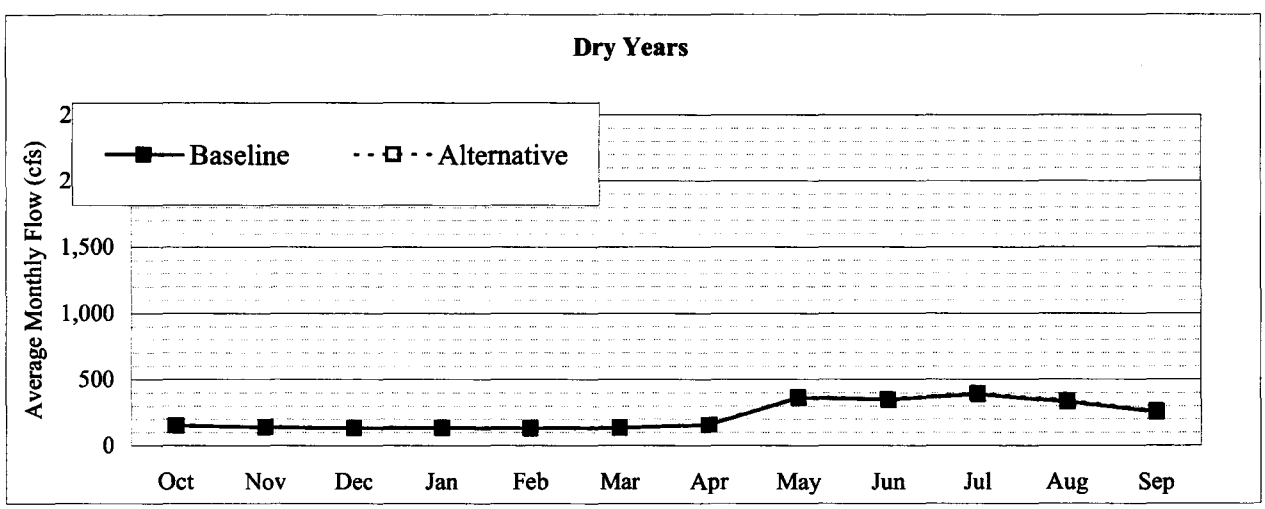
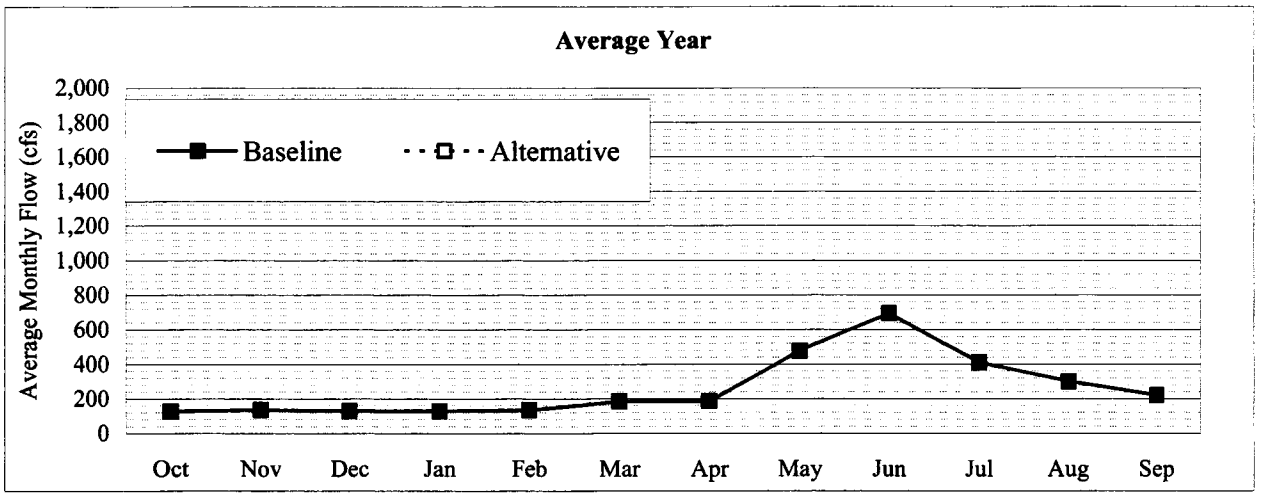
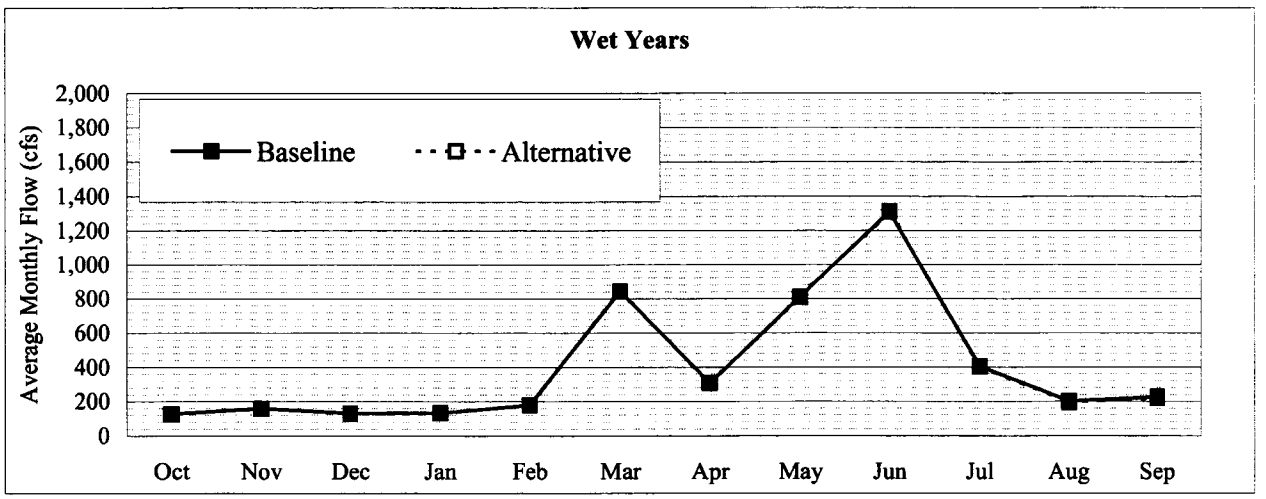


Figure 4-2
Estimated Average Provo River Flows from River Ditch to Snake Creek
Preferred Alternative: Spanish Fork Canyon - Provo Reservoir Canal Alternative Compared to Baseline





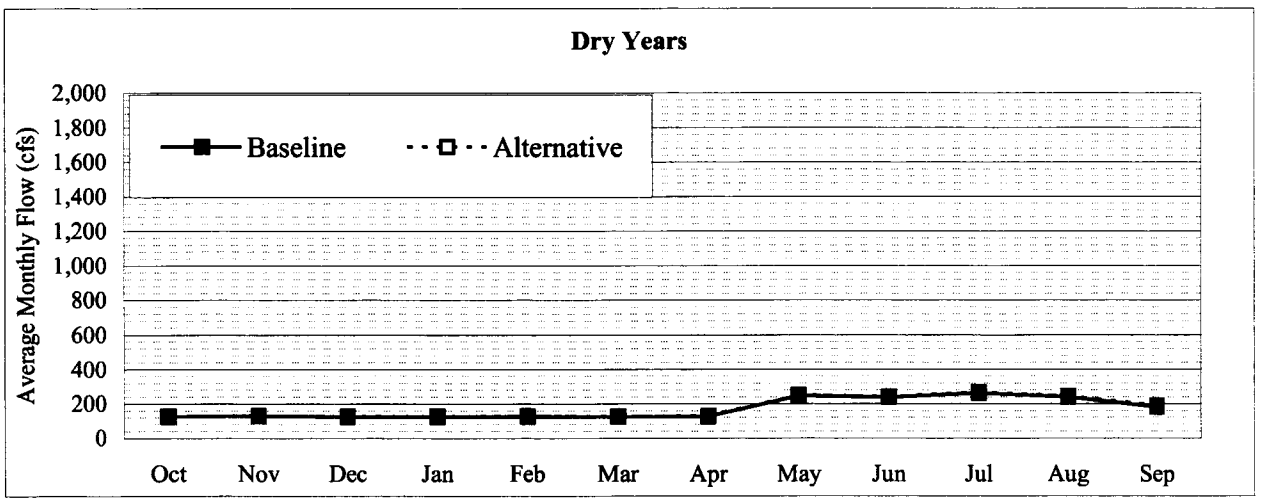
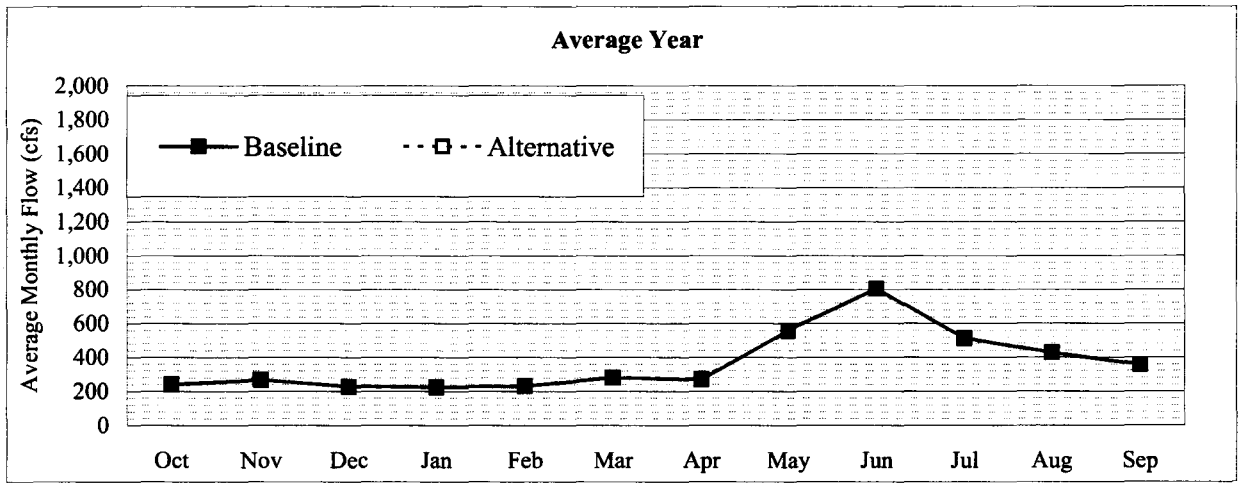
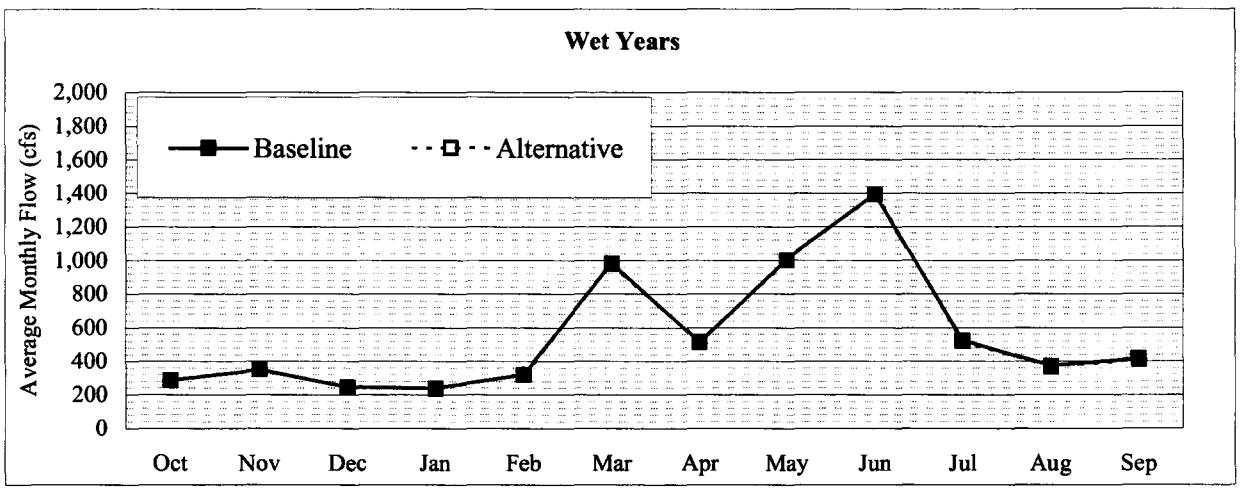


Figure 4-3
Estimated Average Provo River Flows from Snake Creek to Inlet of Deer Creek Reservoir
Preferred Alternative: Spanish Fork Canyon - Provo Reservoir Canal Alternative Compared to Baseline





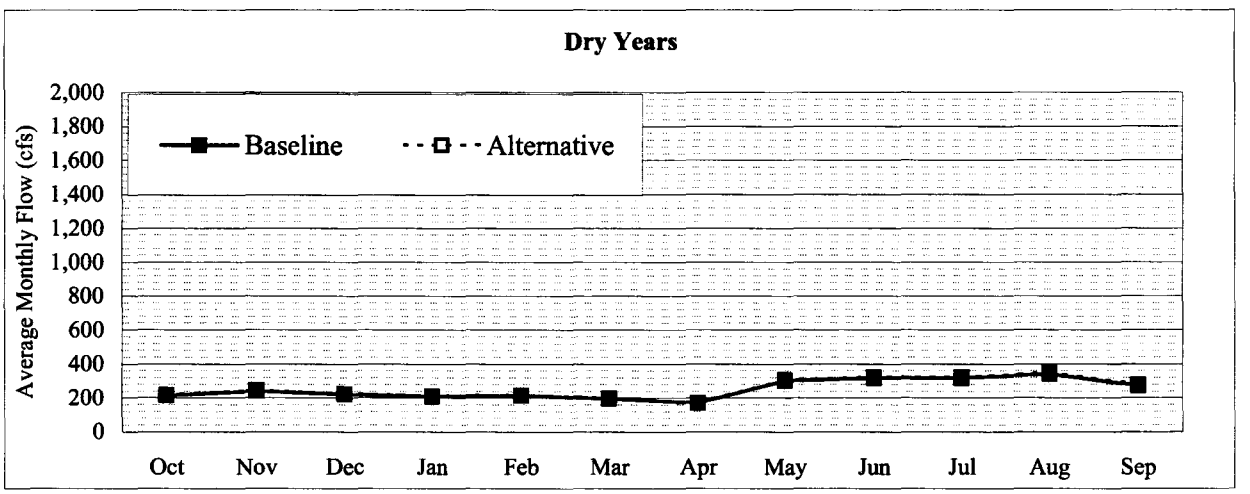
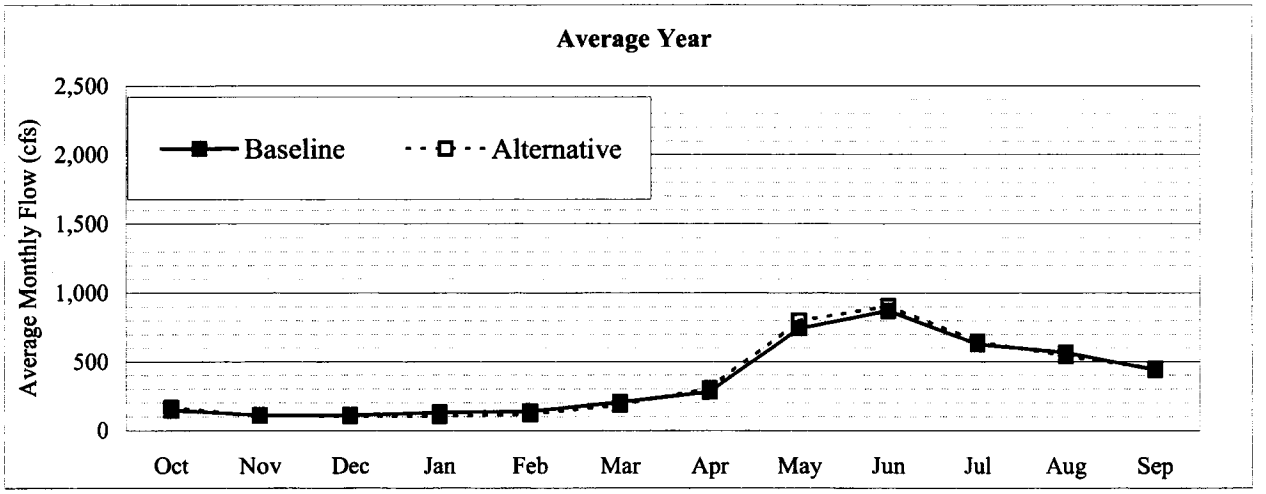
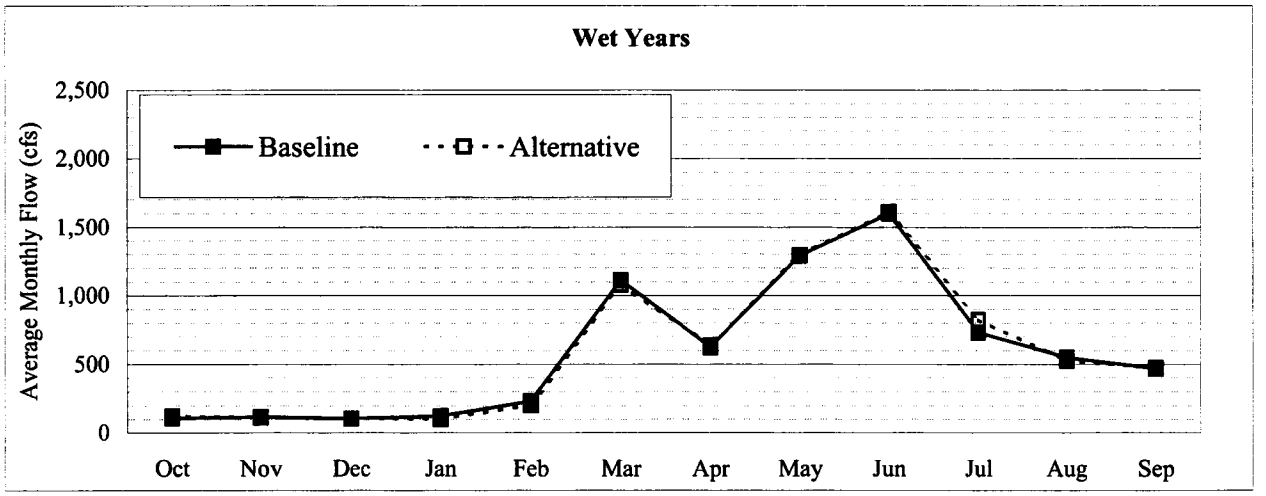


Figure 4-4
Estimated Average Provo River Flows from Outlet of Deer Creek Reservoir to North Fork of Provo River
Preferred Alternative: Spanish Fork Canyon - Provo Reservoir Canal Alternative Compared to Baseline





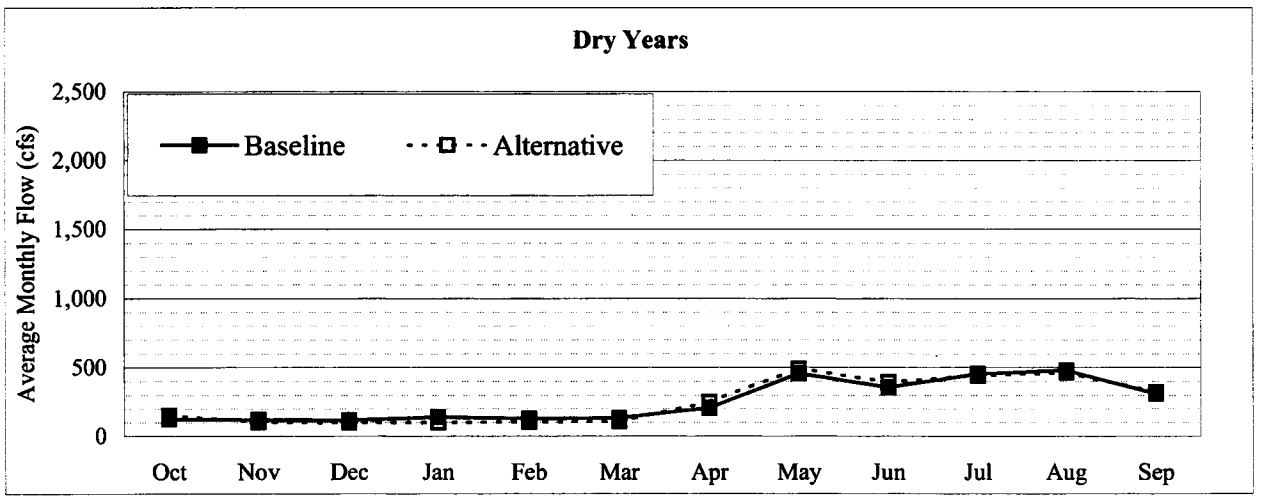


Figure 4-5
Estimated Average Provo River Flows from North Fork of Provo River to Olmsted Diversion Dam
Preferred Alternative: Spanish Fork Canyon - Provo Reservoir Canal Alternative Compared to Baseline

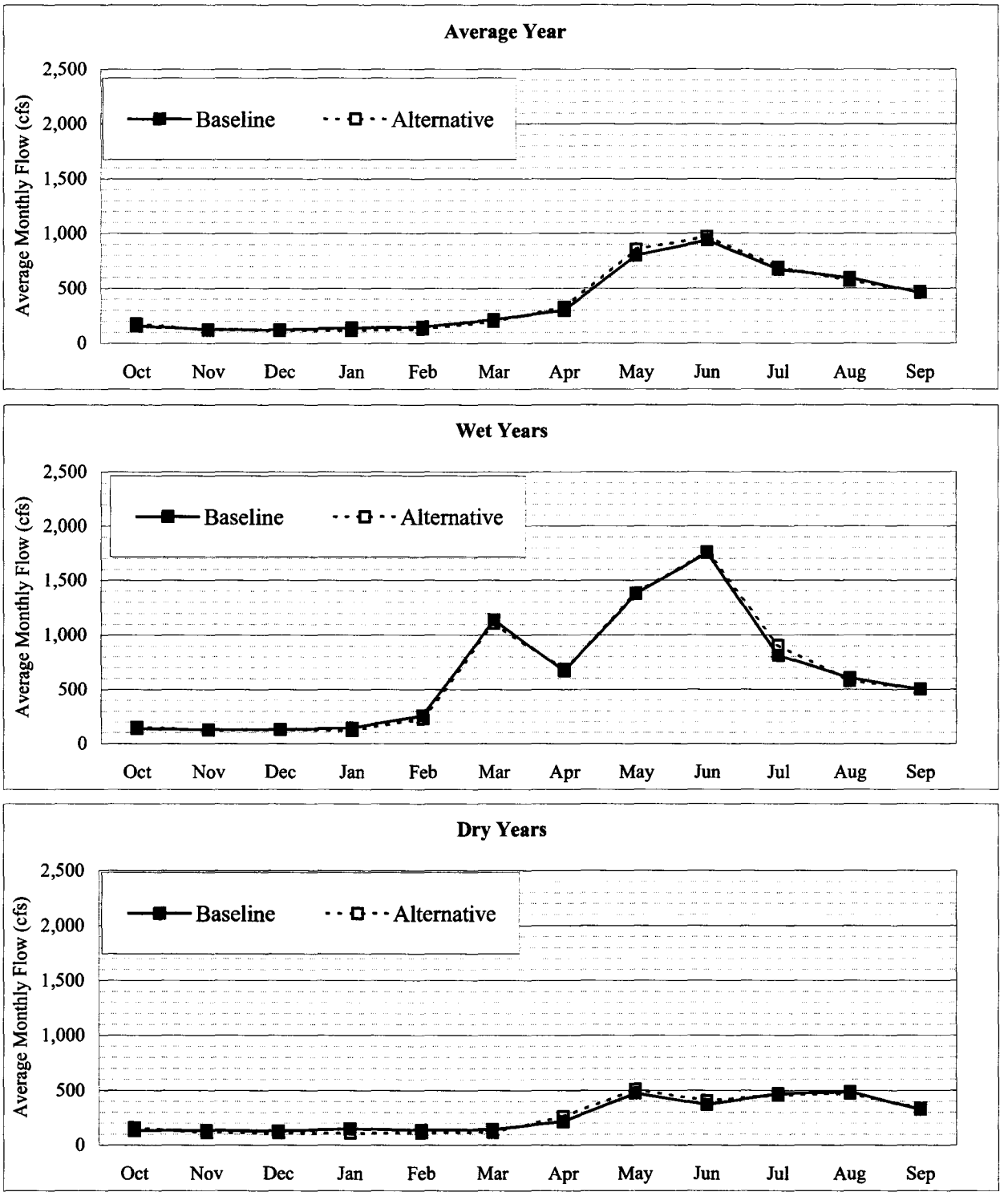
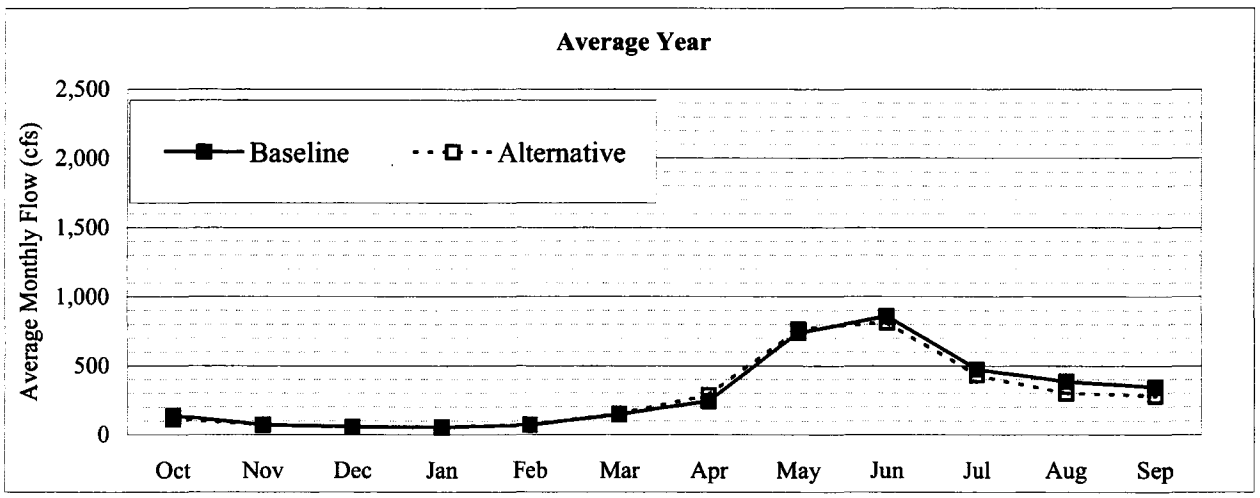
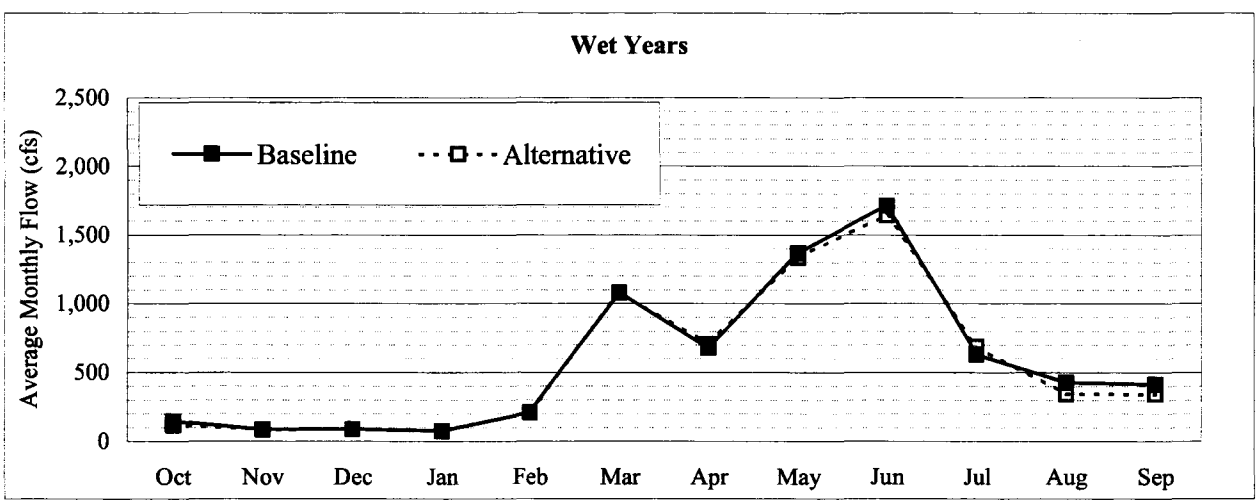


Figure 4-6
Estimated Average Provo River Flows from Olmsted Diversion Dam to Murdock Diversion Dam
Preferred Alternative: Spanish Fork Canyon - Provo Reservoir Canal Alternative Compared to Baseline





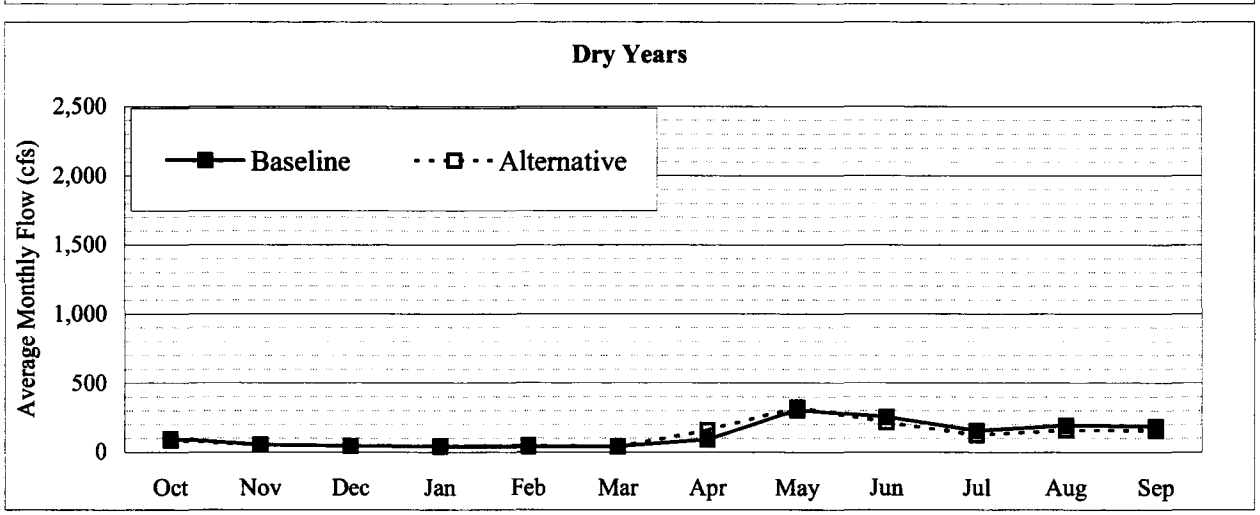


Figure 4-7
Estimated Average Provo River Flows from Murdock Diversion Dam to I-15
Preferred Alternative: Spanish Fork Canyon - Provo Reservoir Canal Alternative Compared to Baseline

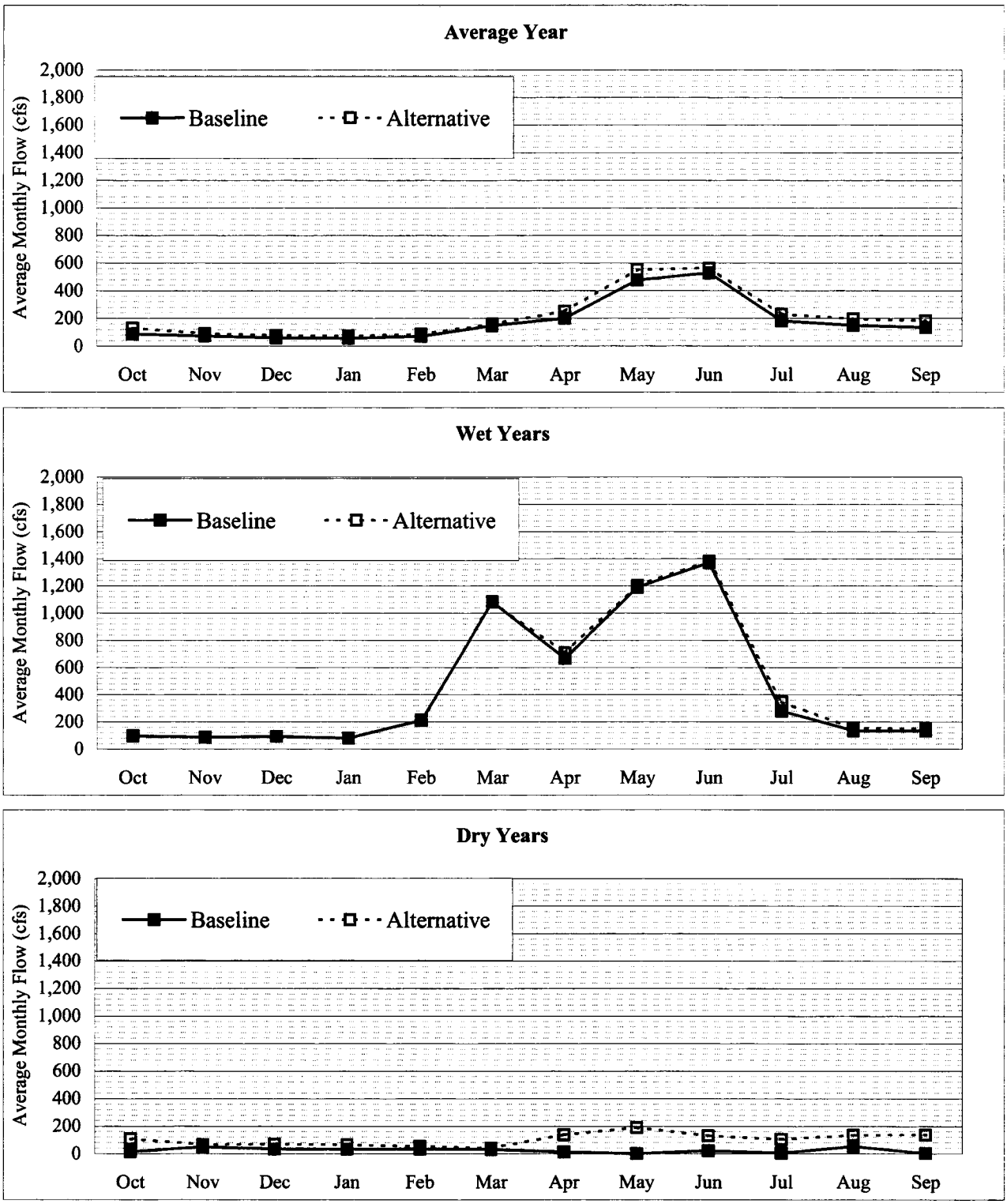
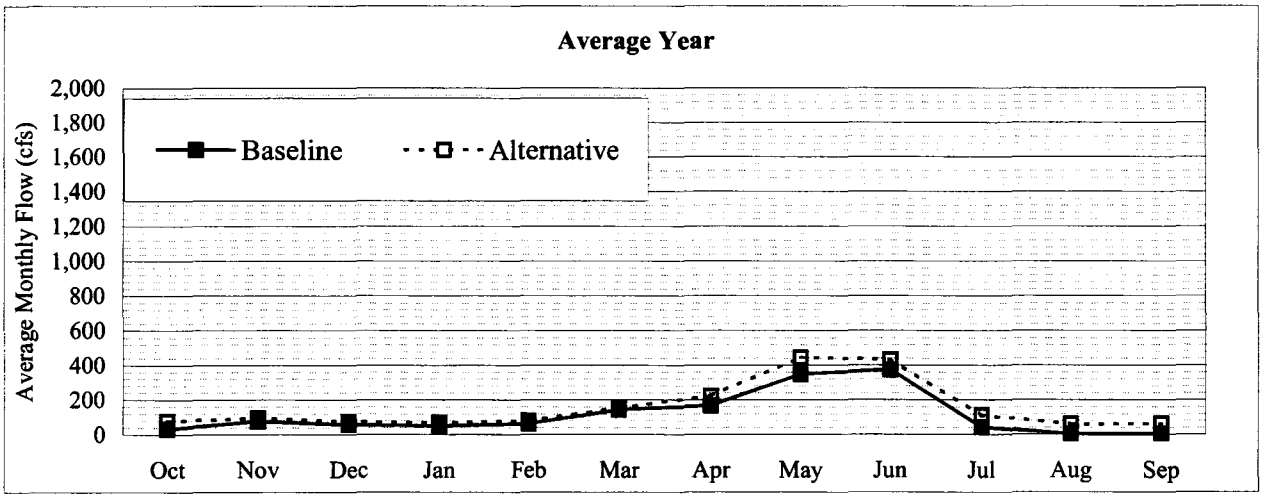
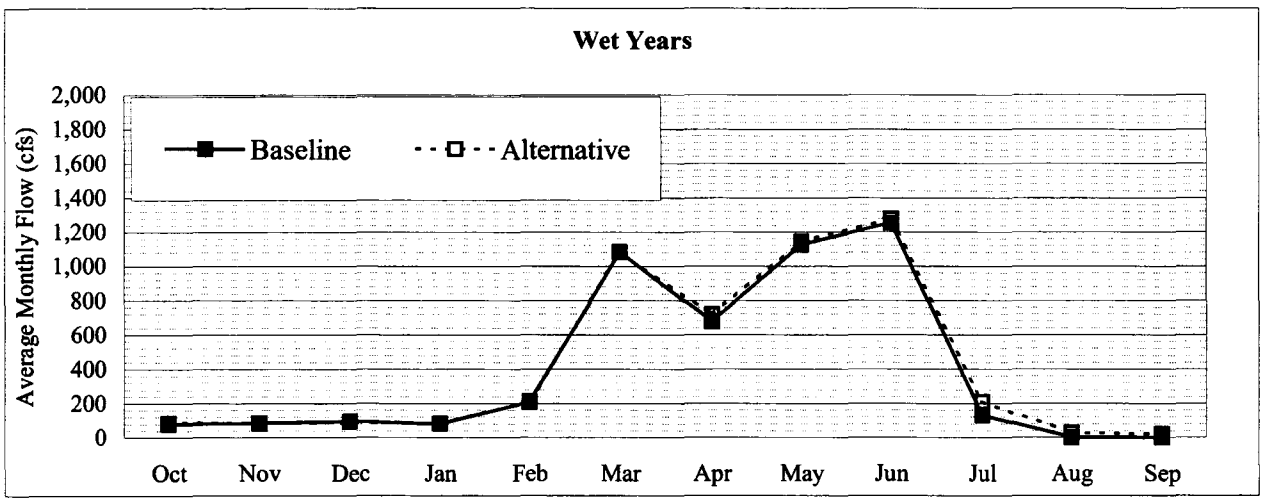


Figure 4-8
Estimated Average Provo River Flows from Interstate 15 to Utah Lake
Preferred Alternative: Spanish Fork Canyon - Provo Reservoir Canal Alternative Compared to Baseline





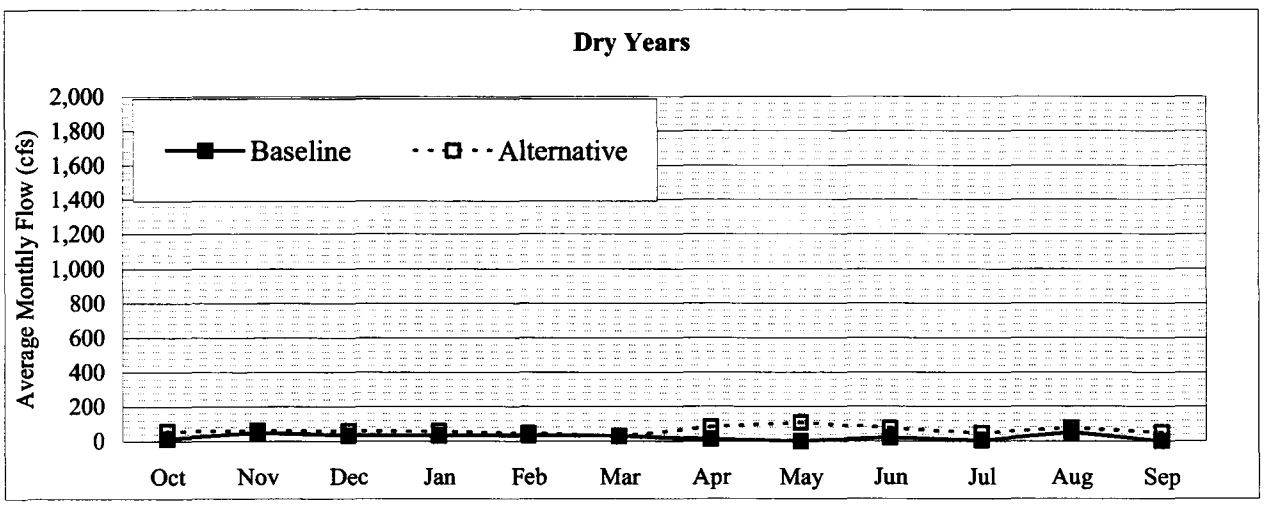


Figure 4-9
Estimated Average Hobble Creek Flows from Mapleton Lateral to Utah Lake
Preferred Alternative: Spanish Fork Canyon - Provo Reservoir Canal Alternative Compared to Baseline

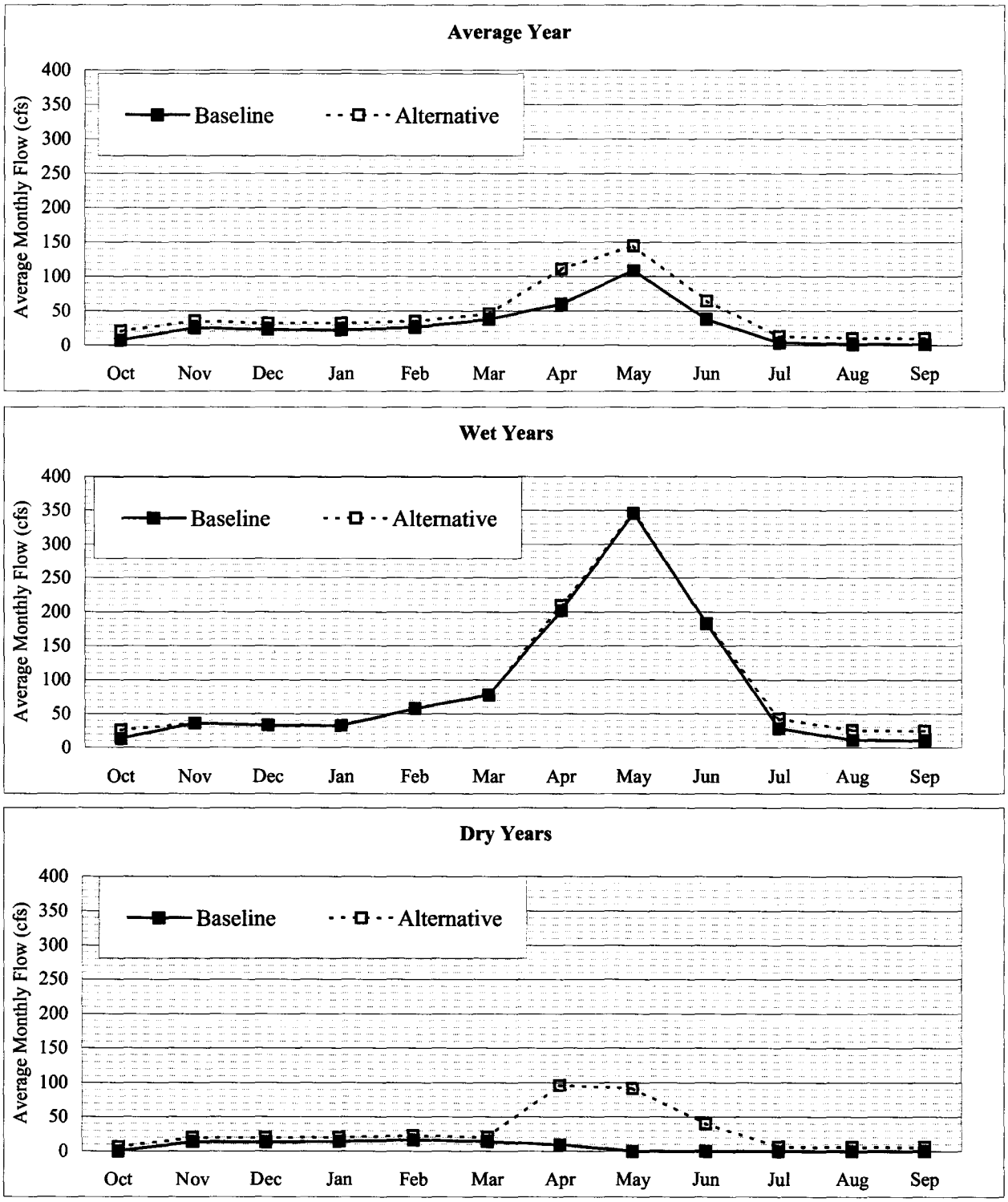
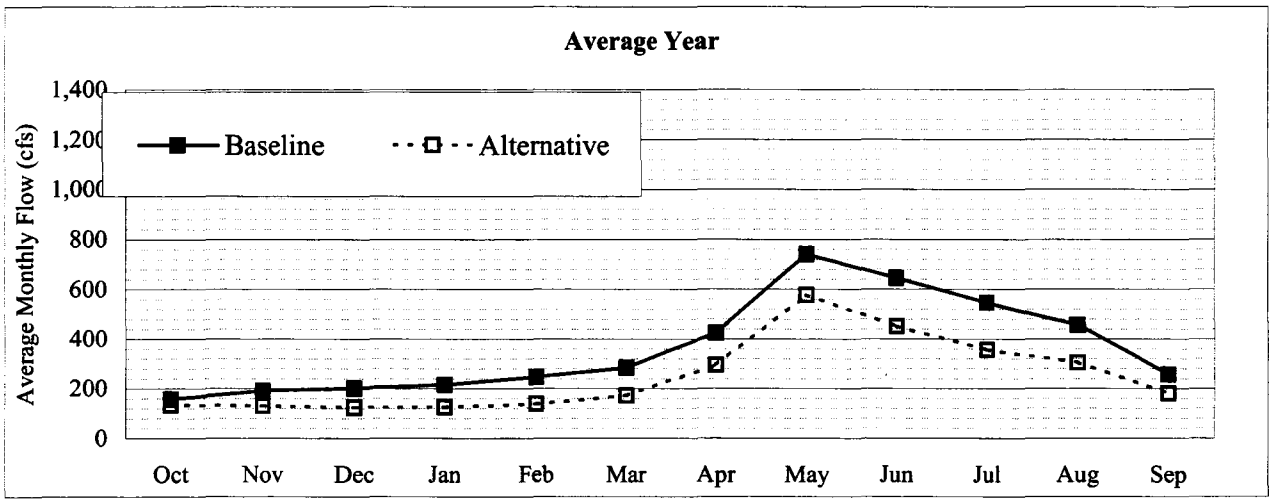
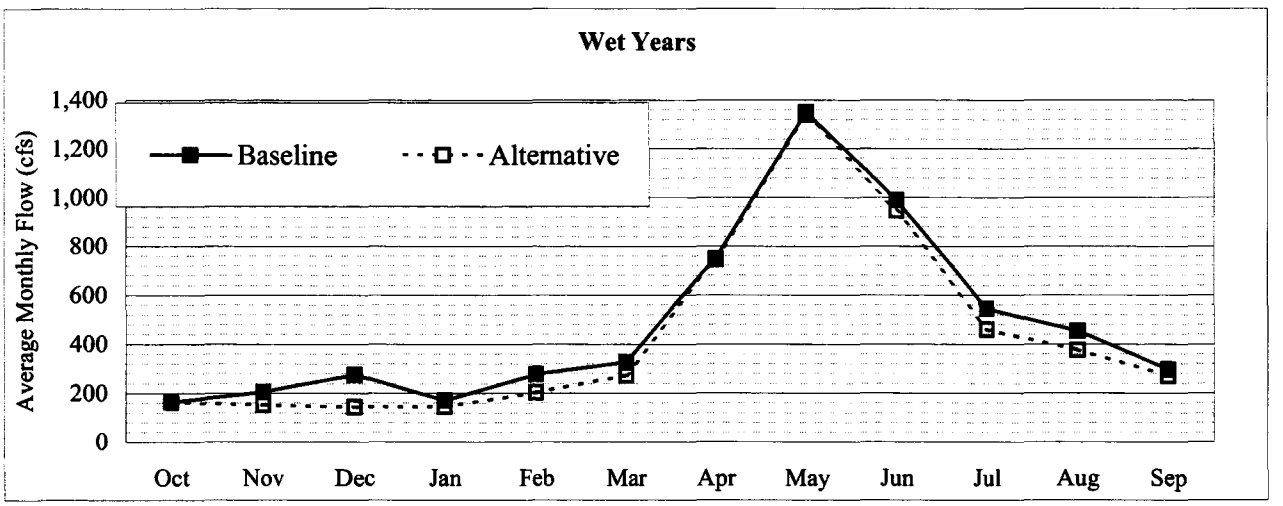


Figure 4-10

Estimated Average Spanish Fork River Flows from Diamond Fork Creek to Spanish Fork Diversion Dam (Castilla gage)

Preferred Alternative: Spanish Fork Canyon - Provo Reservoir Canal Alternative Compared to Baseline





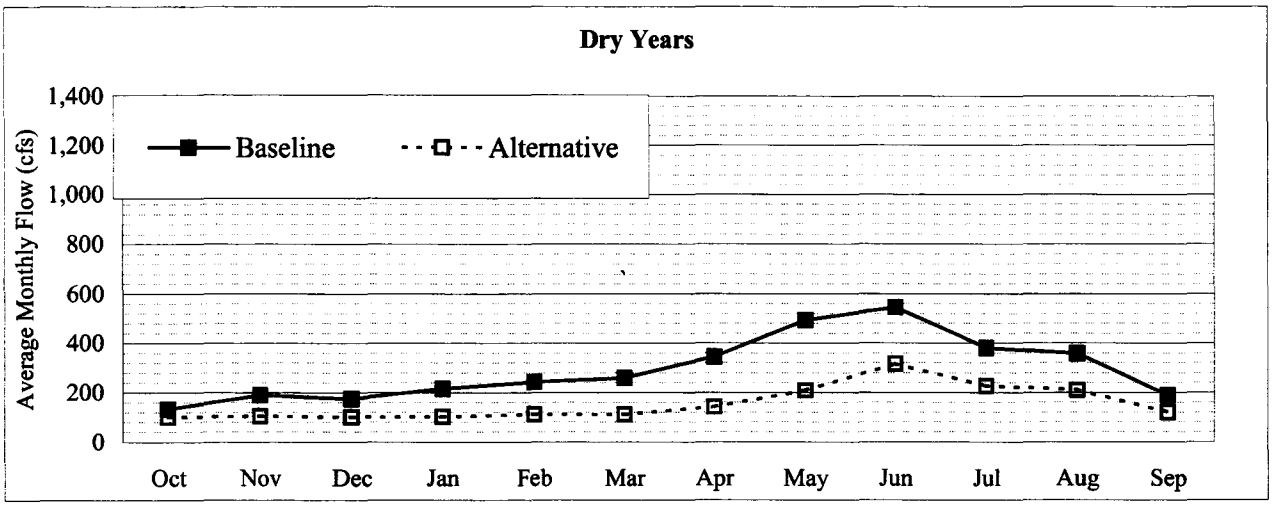
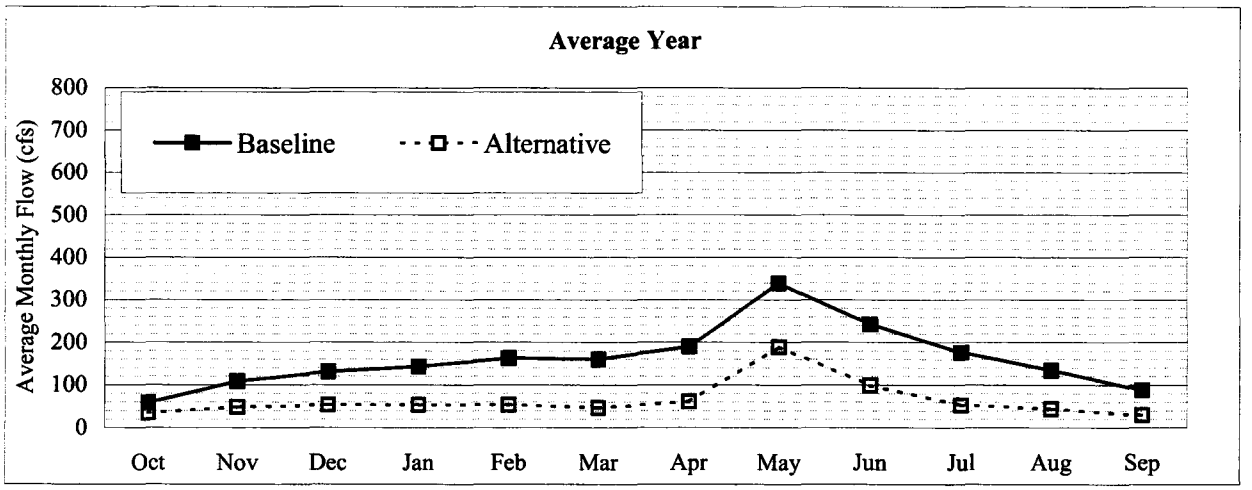
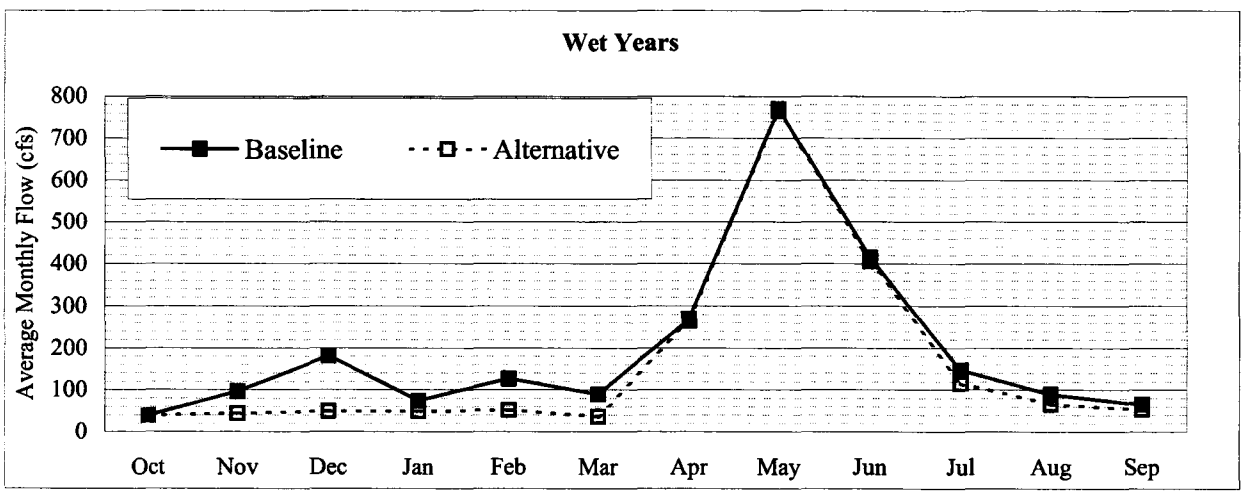


Figure 4-11
Estimated Average Spanish Fork River Flows from Spanish Fork Diversion Dam to East Bench Diversion
Preferred Alternative: Spanish Fork Canyon - Provo Reservoir Canal Alternative Compared to Baseline





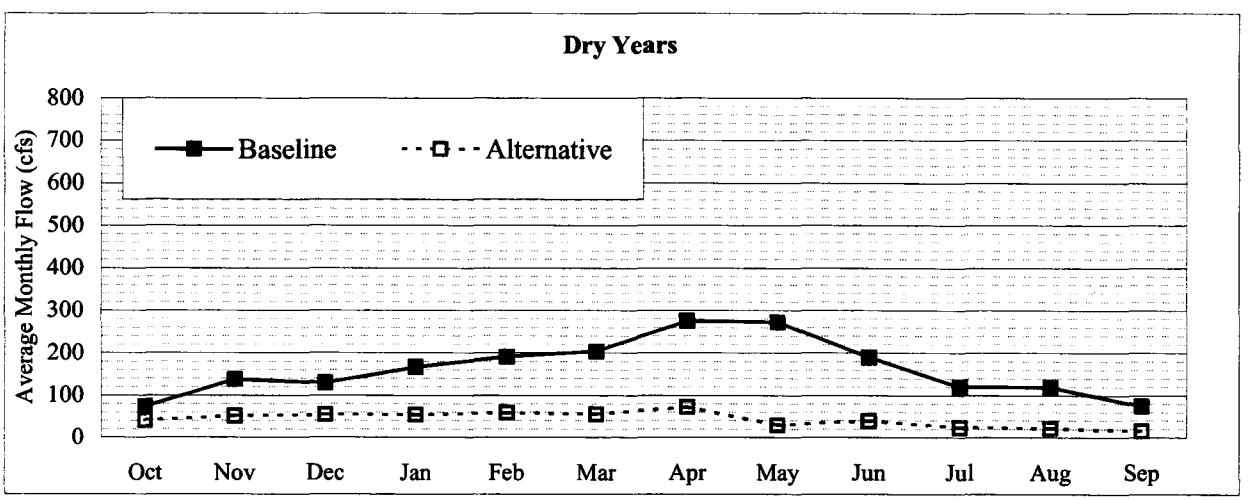
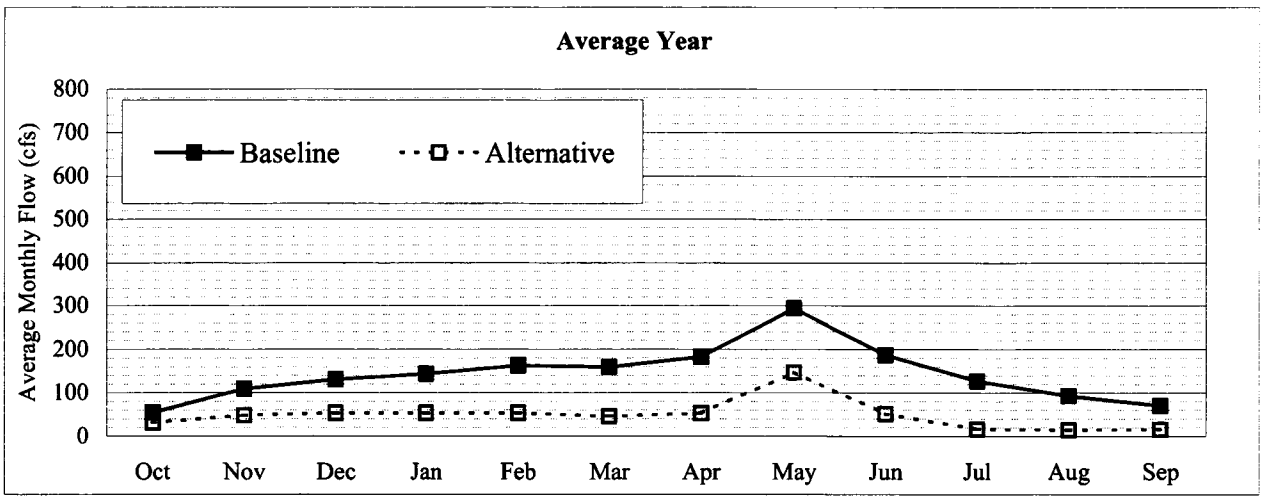
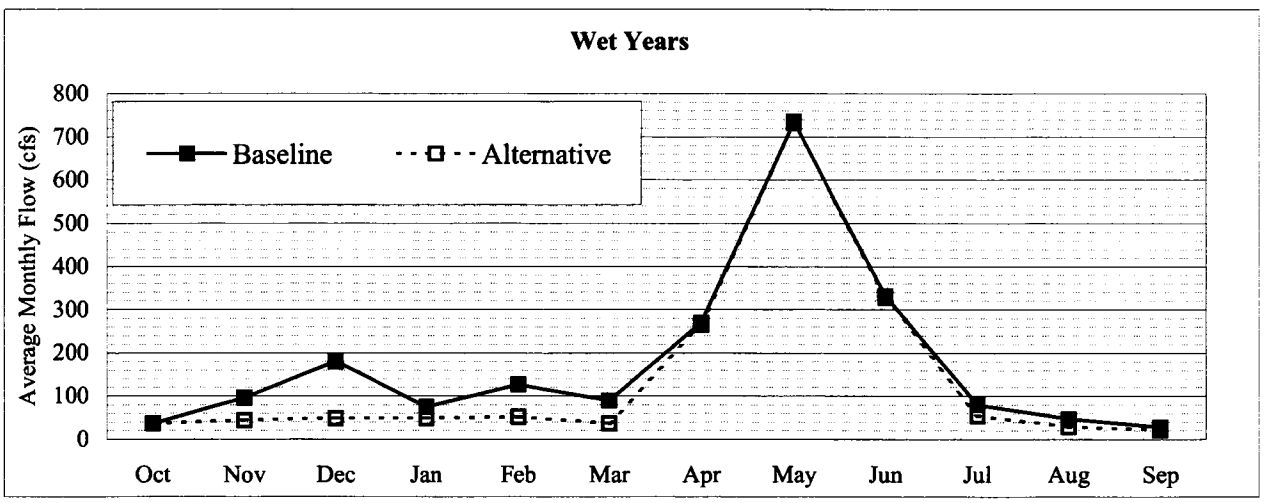


Figure 4-12
Estimated Average Spanish Fork River Flows from East Bench Diversion to Mill Race Canal
Preferred Alternative: Spanish Fork Canyon - Provo Reservoir Canal Alternative Compared to Baseline





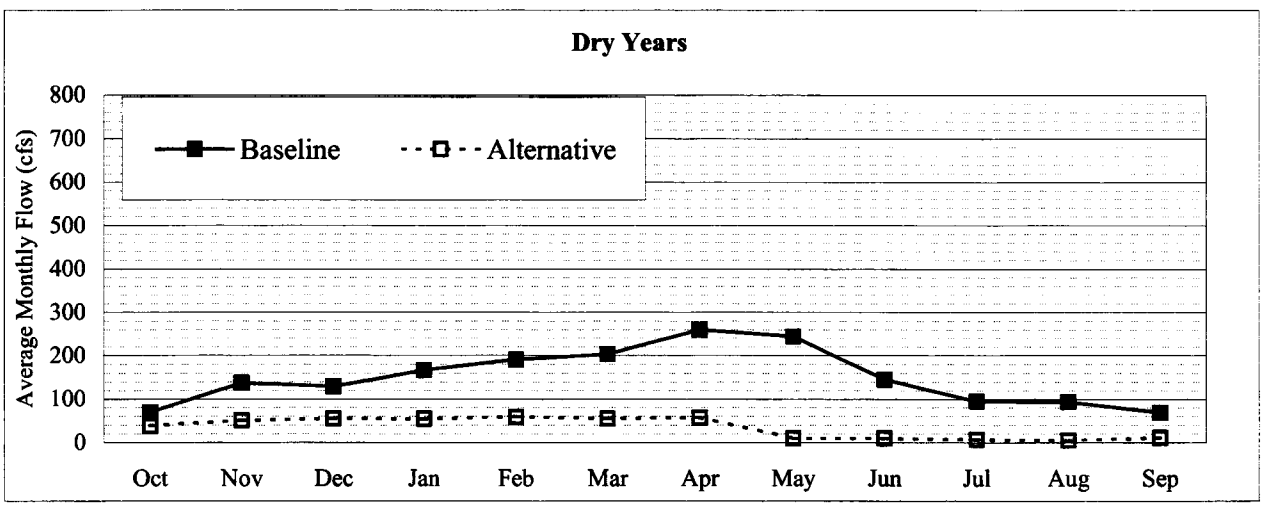
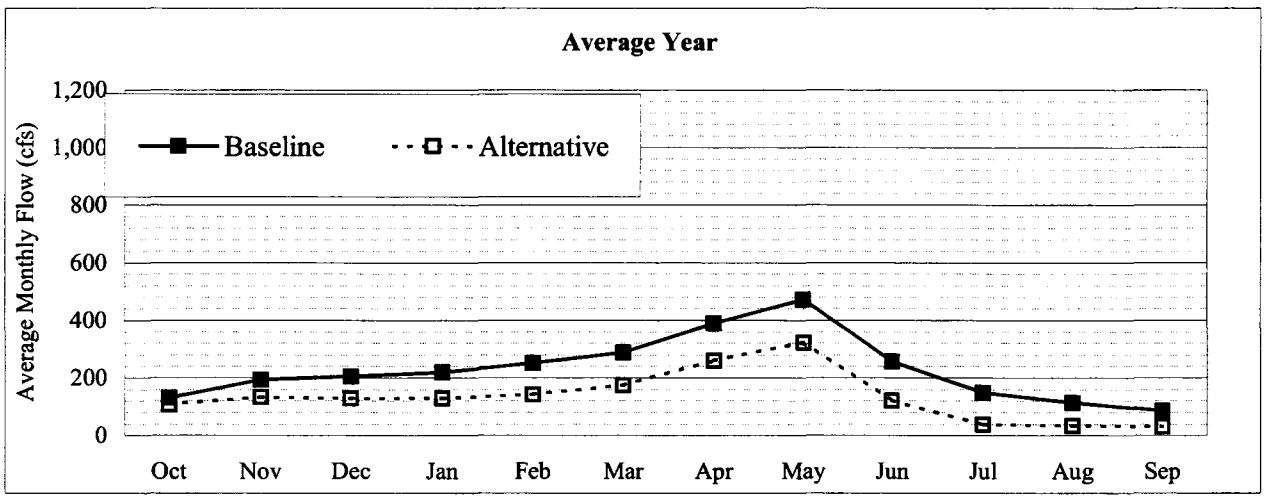
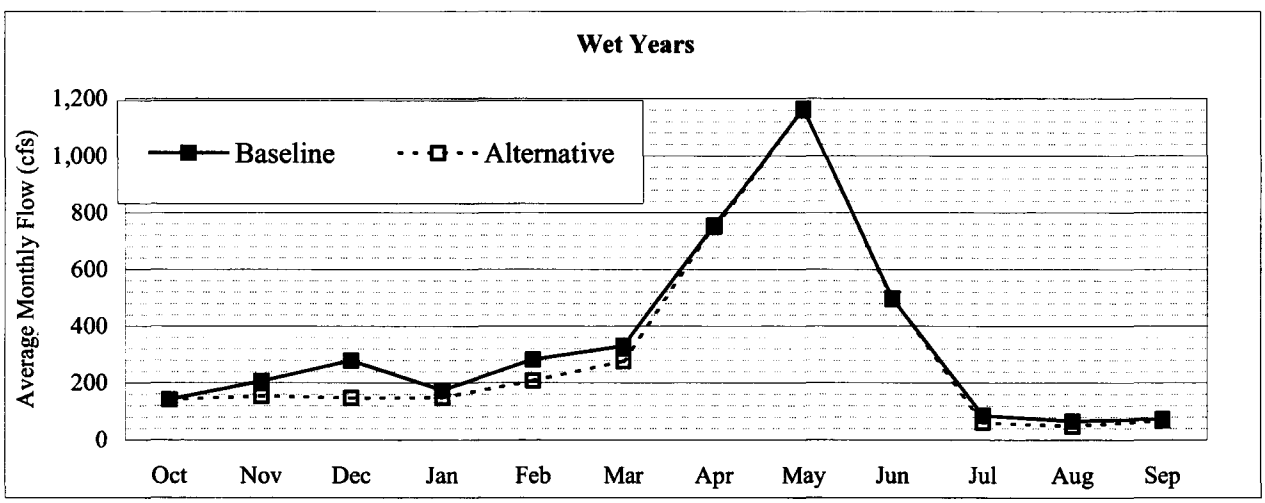


Figure 4-13
Estimated Average Spanish Fork River Flows from Mill Race Canal to Lakeshore Gage
Preferred Alternative: Spanish Fork Canyon - Provo Reservoir Canal Alternative Compared to Baseline





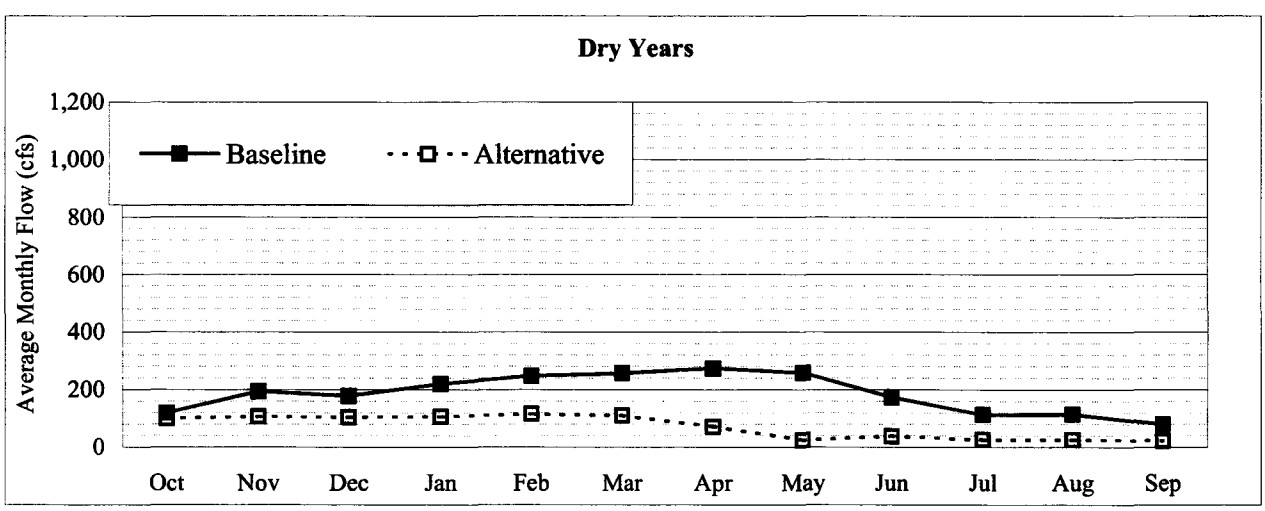
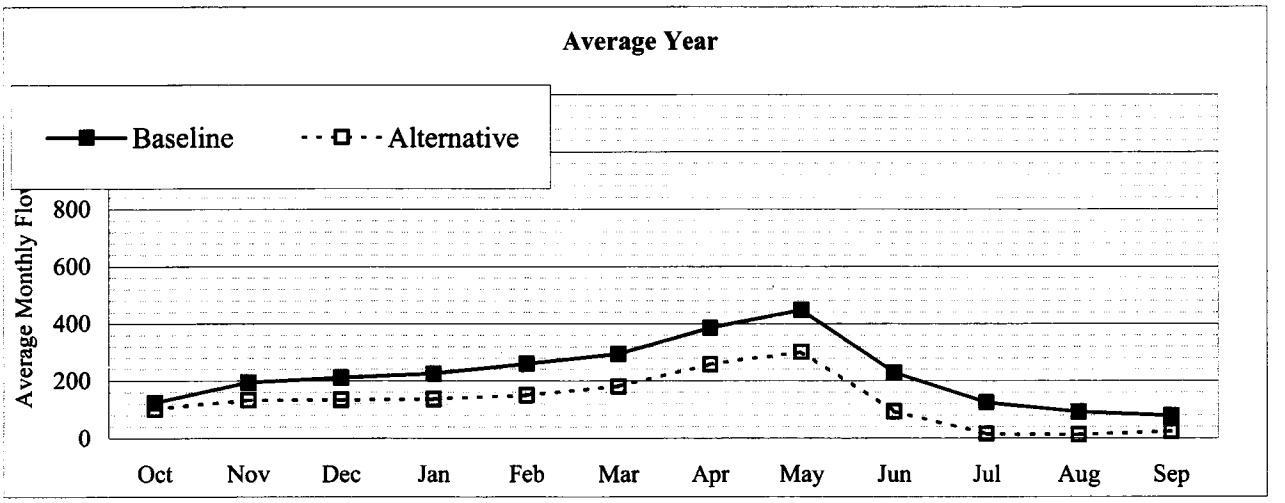
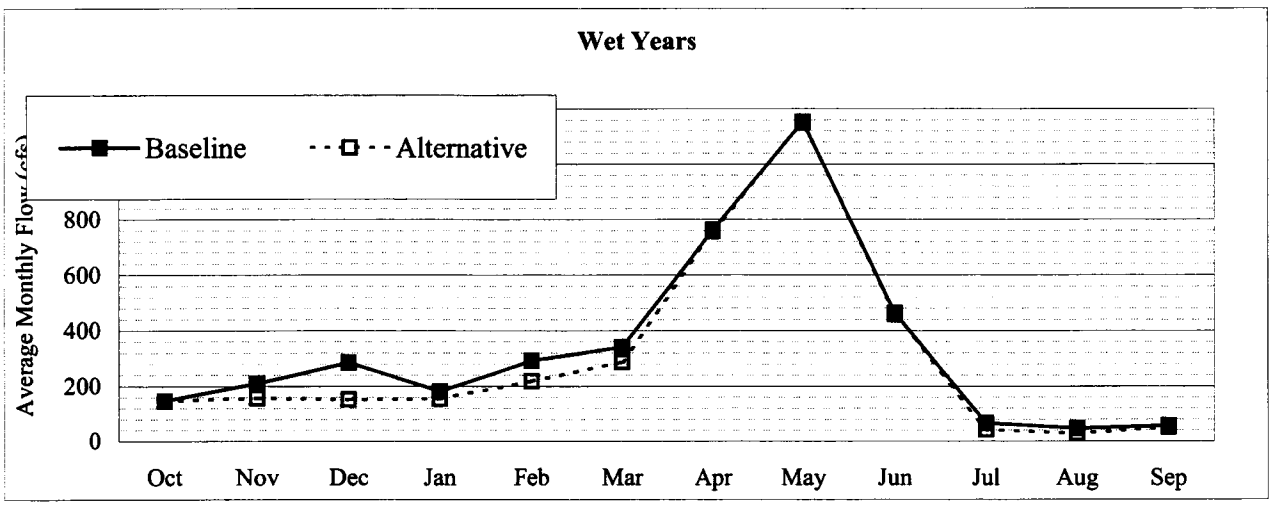


Figure 4-14
Estimated Average Spanish Fork River Flows at Lakeshore Gage
Preferred Alternative: Spanish Fork Canyon - Provo Reservoir Canal Alternative Compared to Baseline





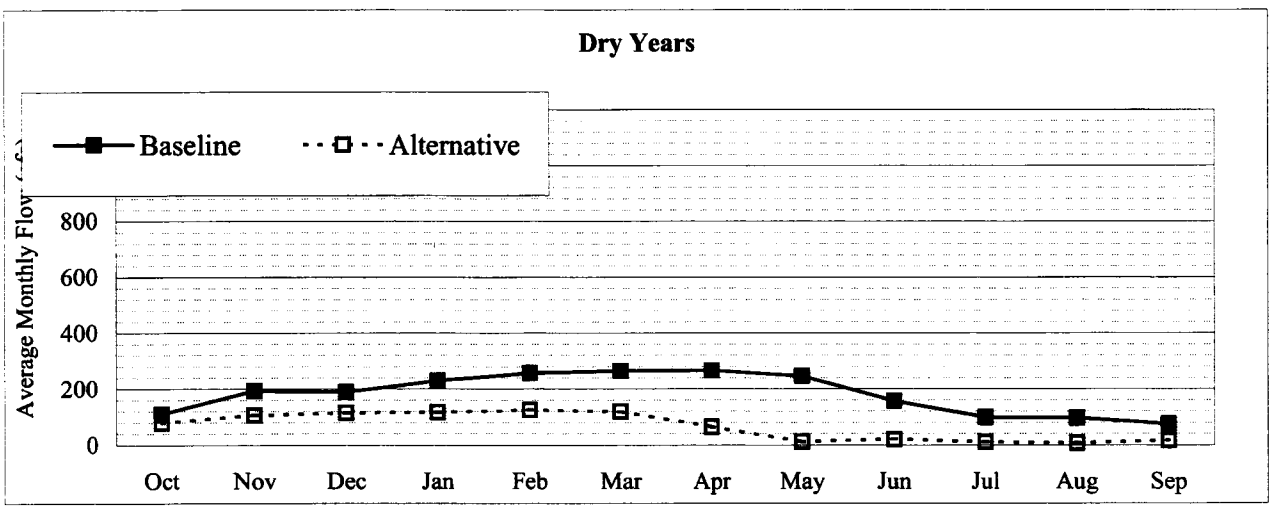


Figure 4-15
Estimated Average Jordan River Flows from Outlet of Utah Lake to Jordan Narrows
Preferred Alternative: Spanish Fork Canyon - Provo Reservoir Canal Alternative Compared to Baseline

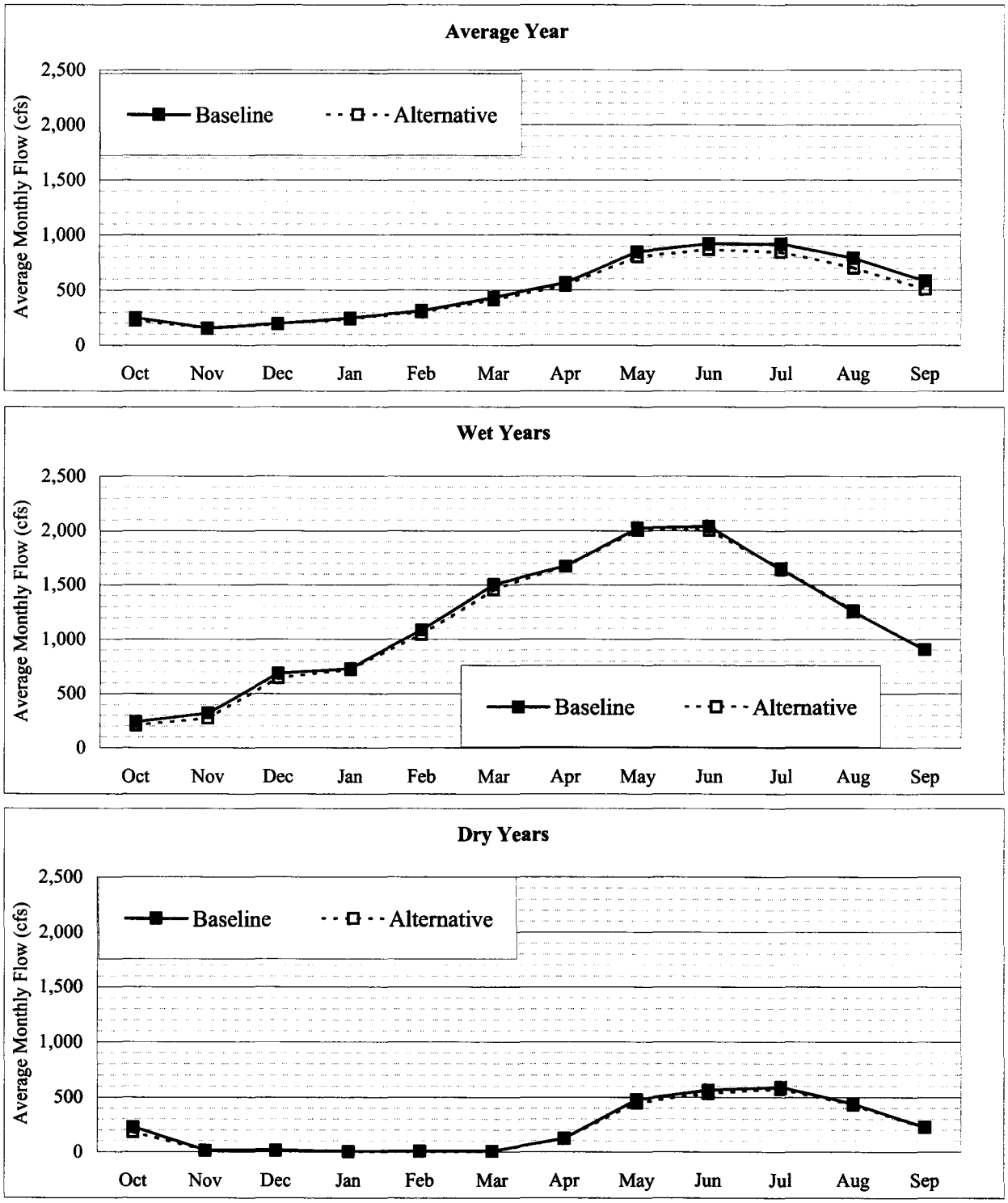


Figure 4-16
Estimated Average Jordan River Flows Below Jordan Narrows
Preferred Alternative: Spanish Fork Canyon - Provo Reservoir Canal Alternative Compared to Baseline

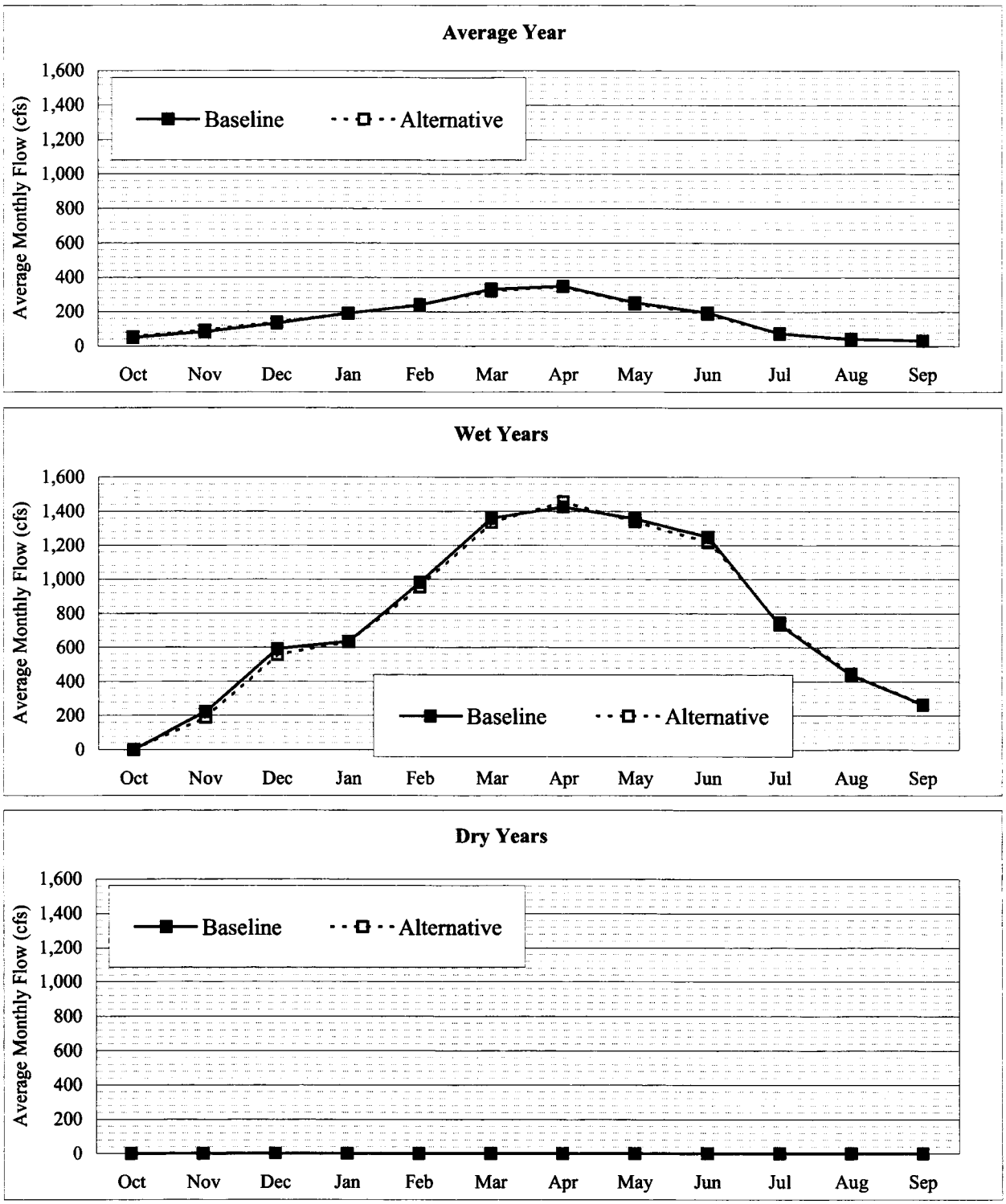


Figure 4-17
Estimated Average Jordanelle Reservoir Contents
Preferred Alternative: Spanish Fork Canyon - Provo Reservoir Canal Alternative Compared to Baseline

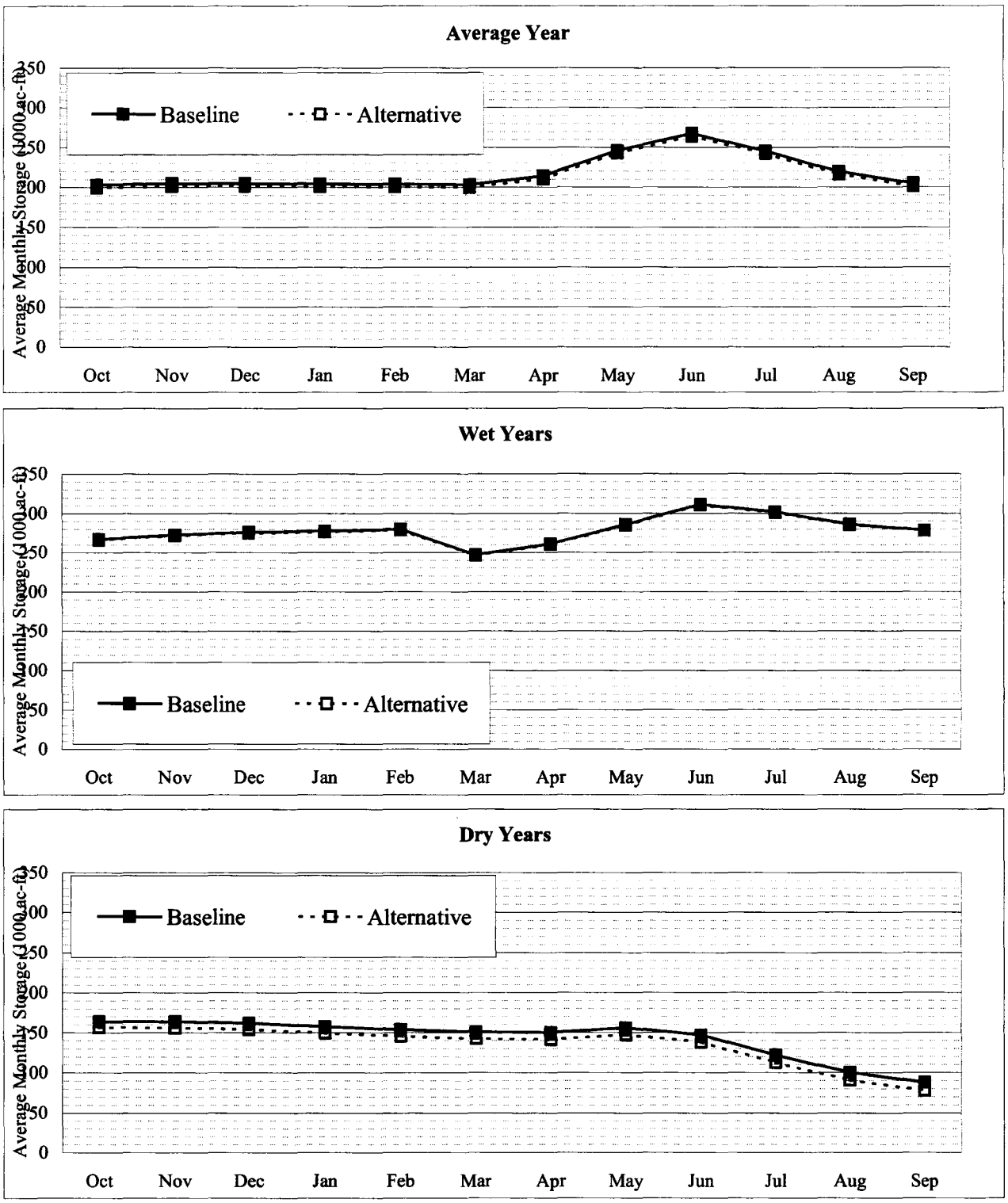
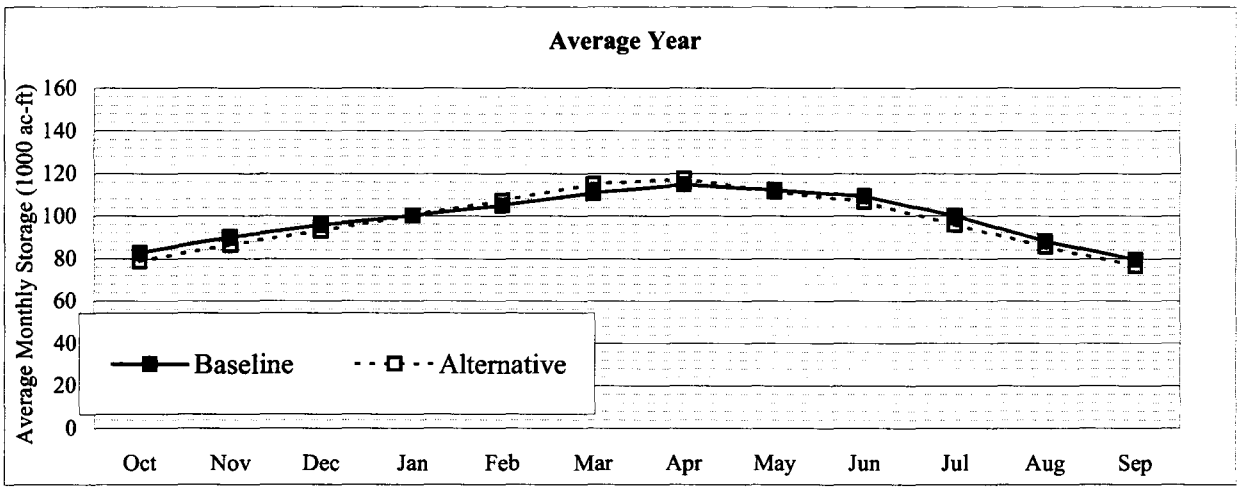
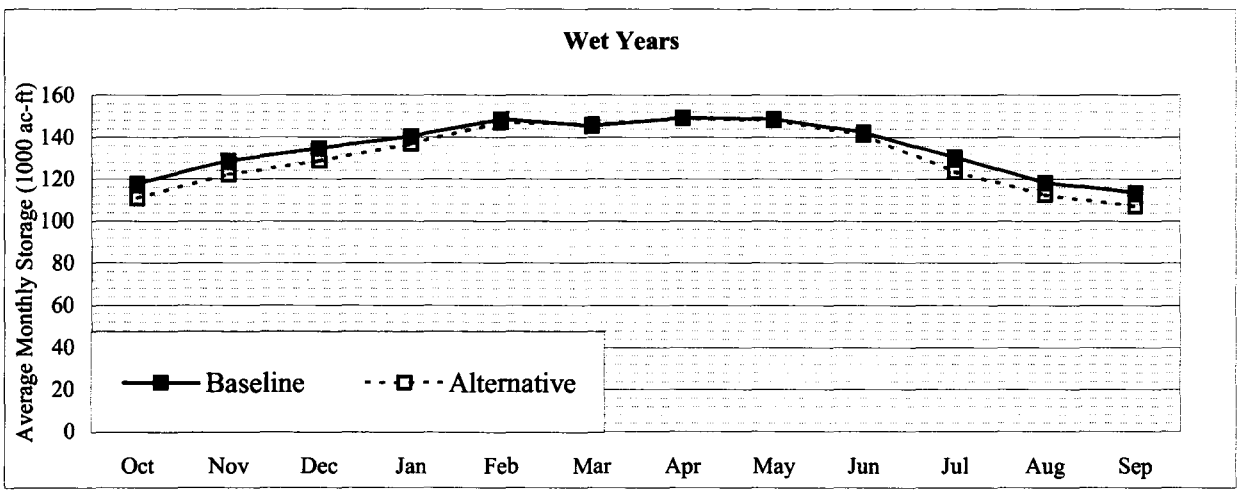


Figure 4-18
Estimated Average Deer Creek Reservoir Contents
Preferred Alternative: Spanish Fork Canyon - Provo Reservoir Canal Alternative Compared to Baseline





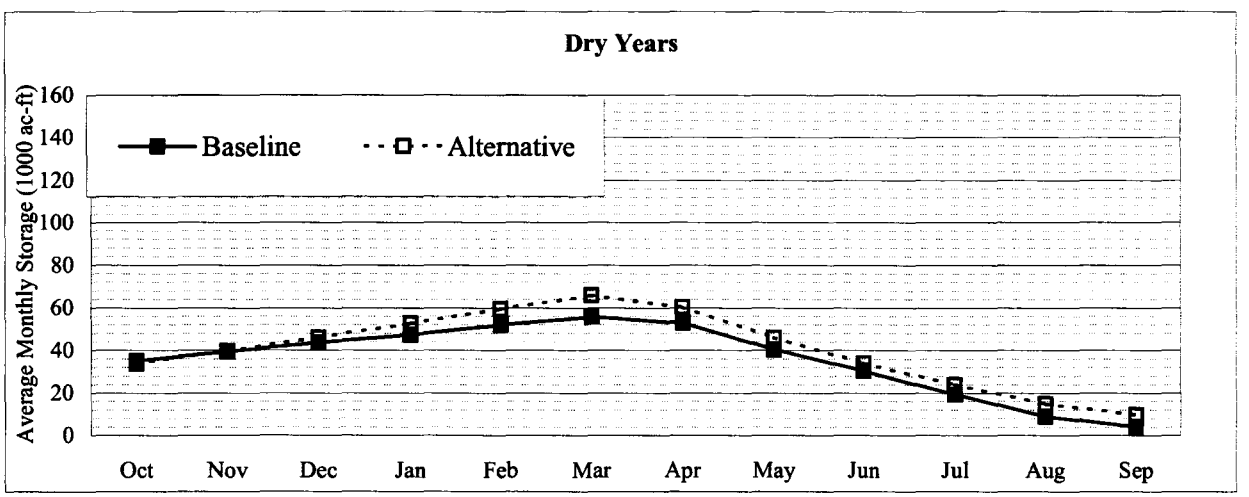
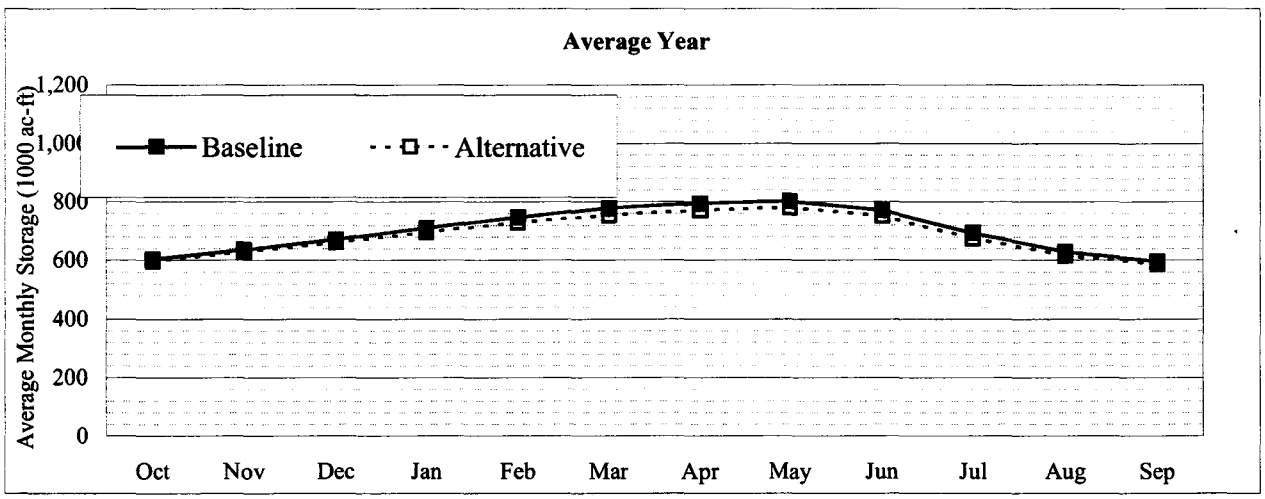
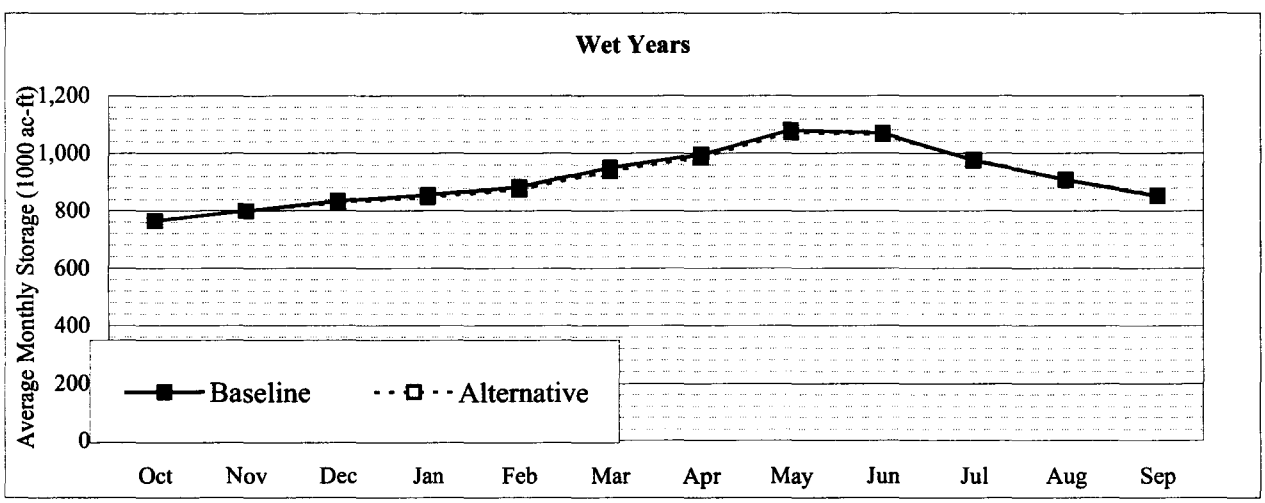


Figure 4-19
Estimated Average Utah Lake Contents
Preferred Alternative: Spanish Fork Canyon - Provo Reservoir Canal Alternative Compared to Baseline





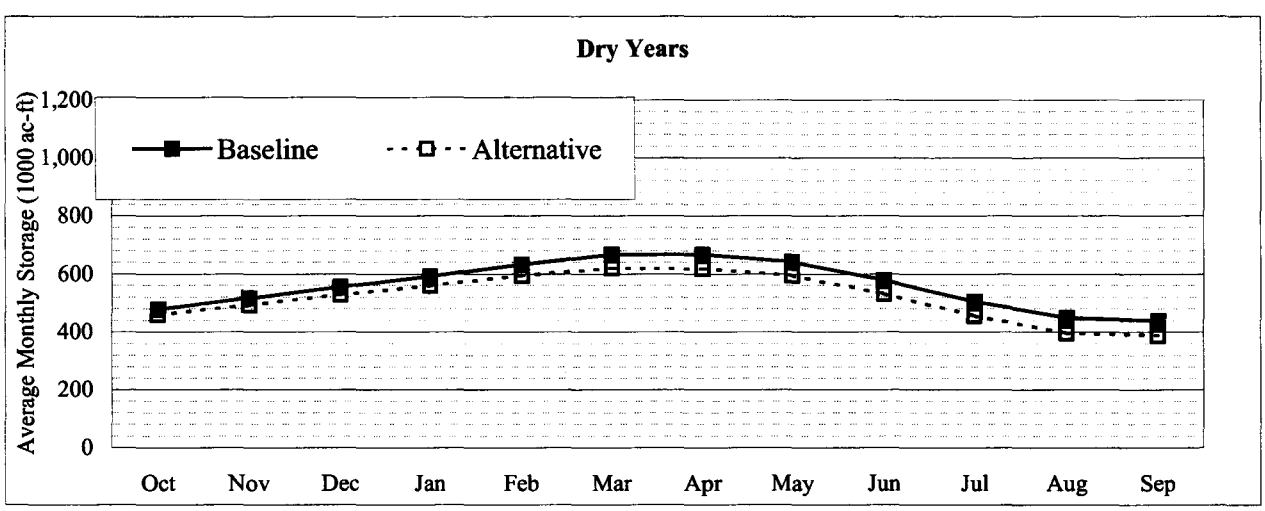


Figure 4-20
Utah Lake Storage Volume (1000 acre feet)

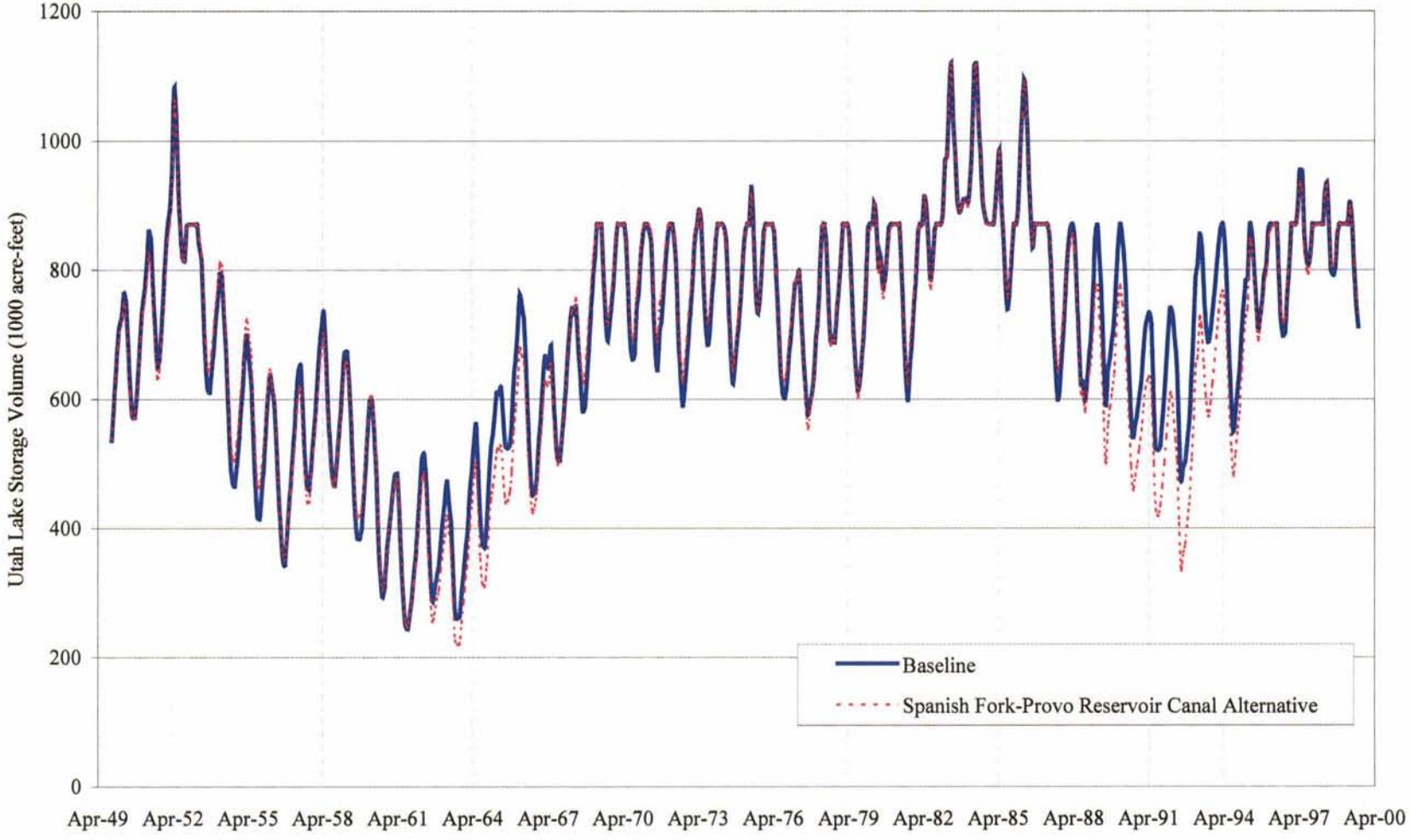
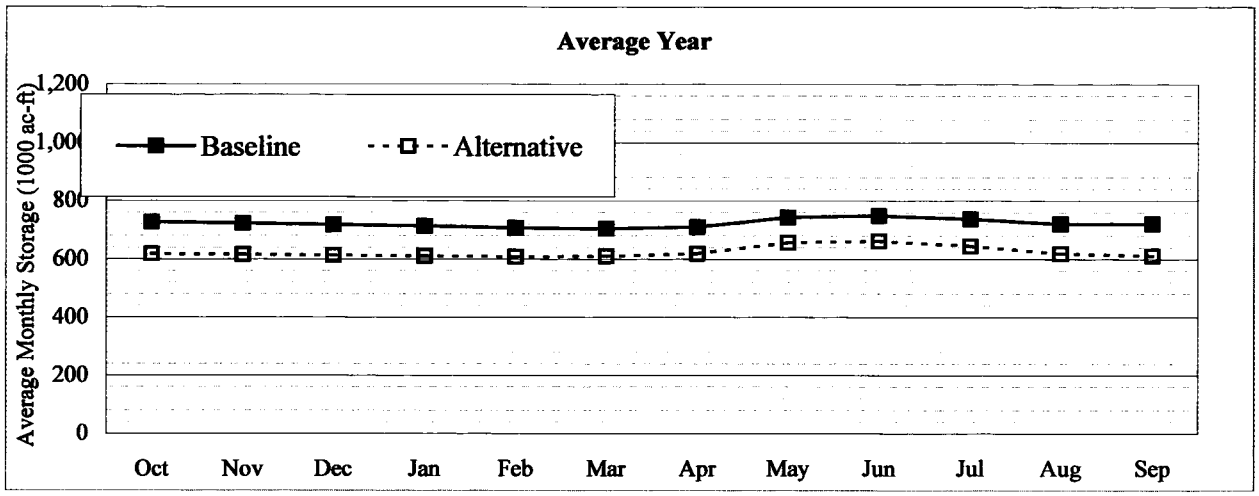
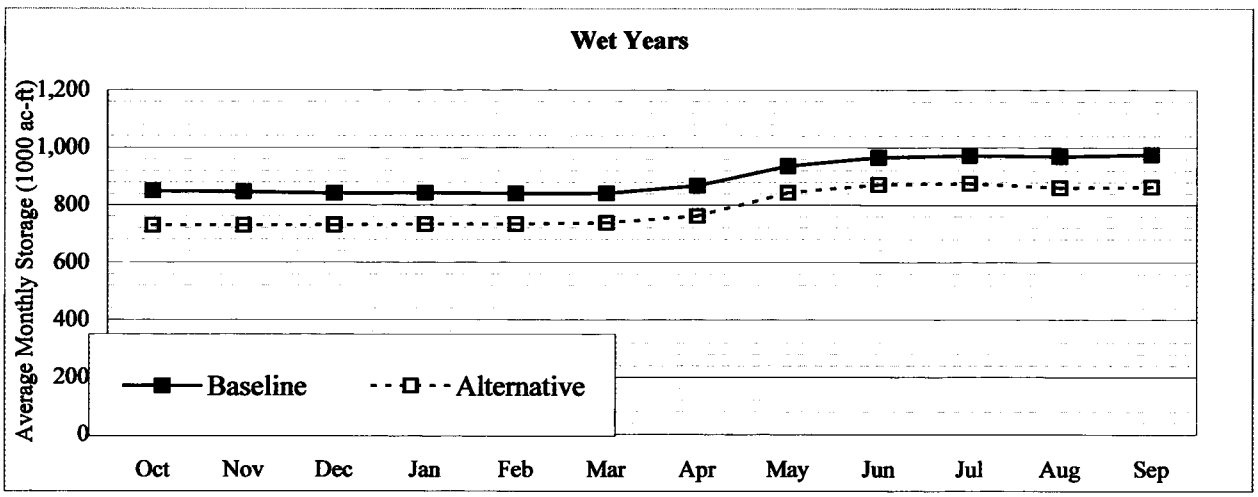


Figure 4-21
Estimated Average Strawberry Reservoir Contents
Preferred Alternative: Spanish Fork Canyon - Provo Reservoir Canal Alternative Compared to Baseline





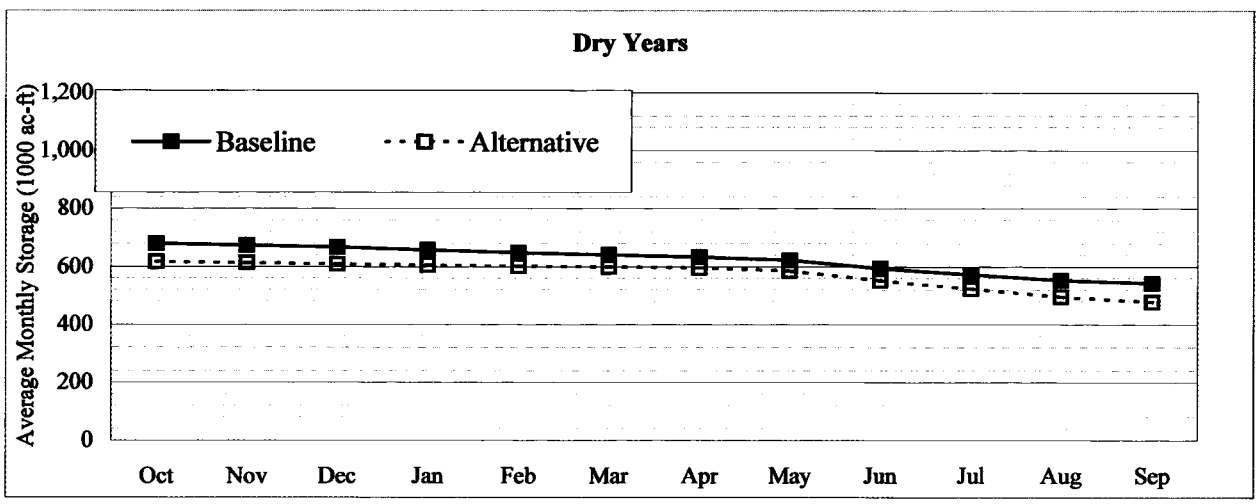


Figure 4-22
Strawberry Reservoir Storage Volume (1000 acre feet)

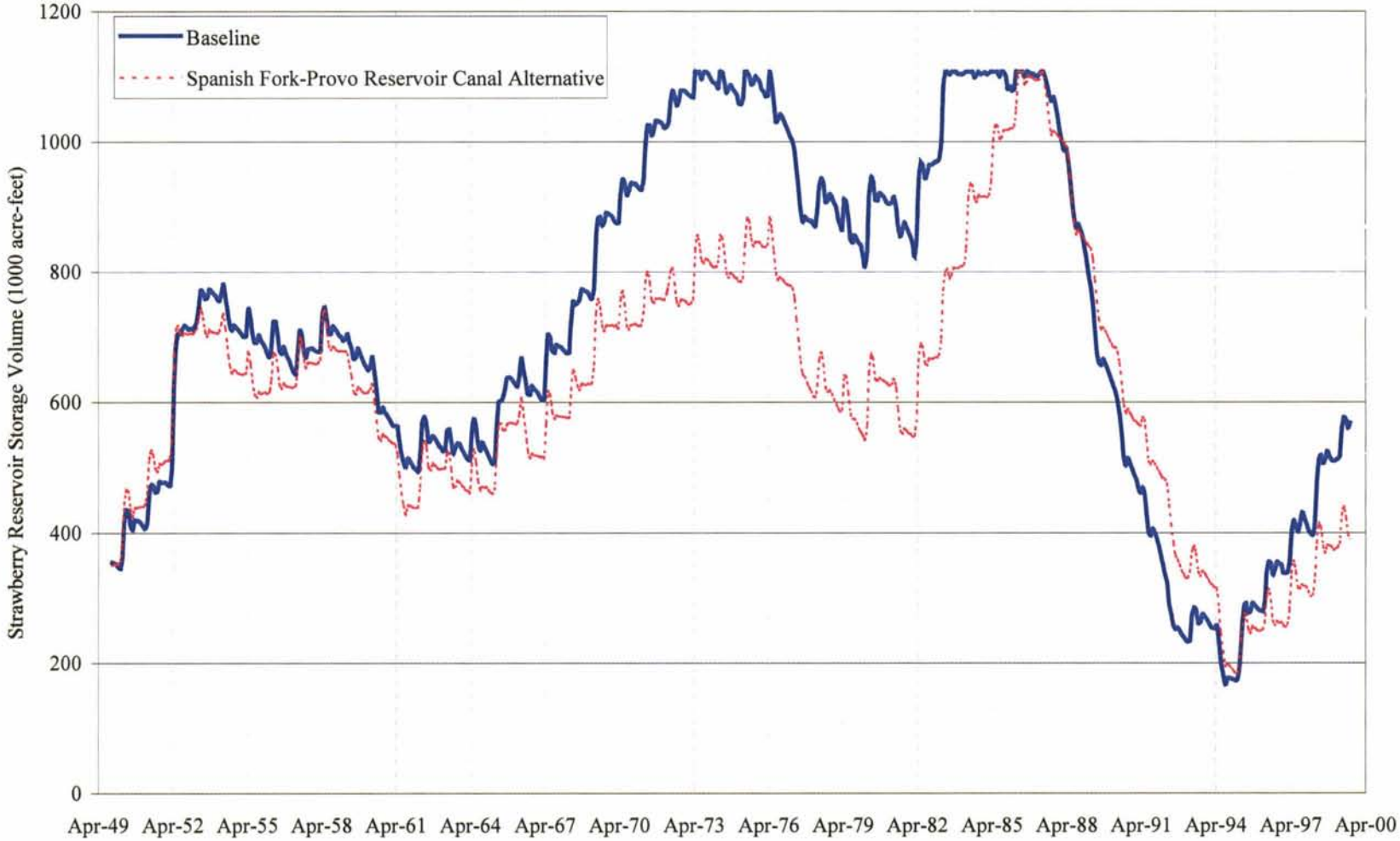
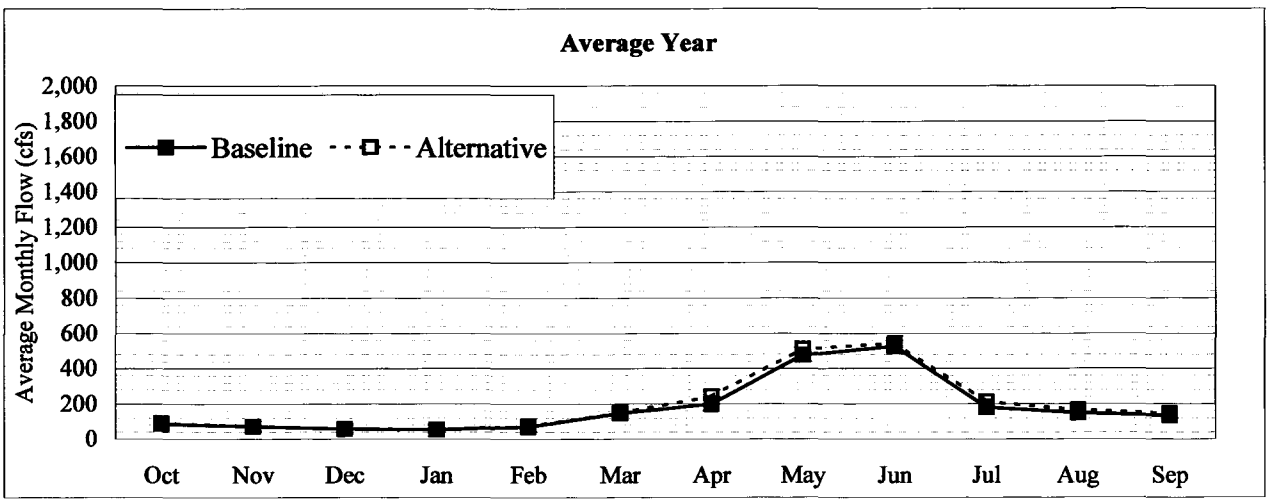
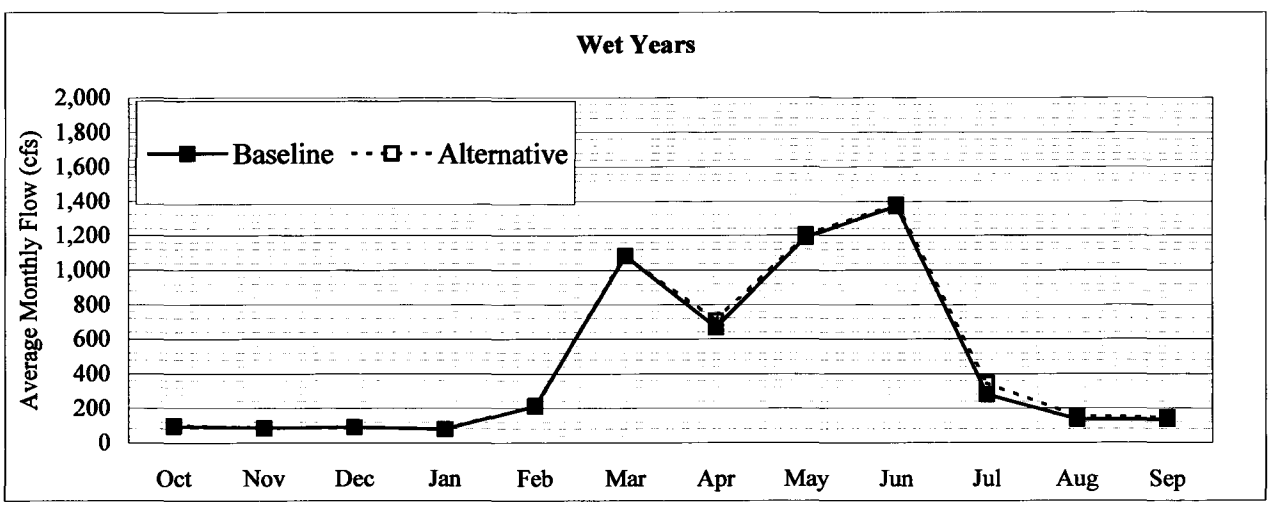


Figure 4-23
Estimated Average Provo River Flows from Murdock Diversion Dam to Interstate 15
Bonneville Unit Water Alternative Compared to Baseline





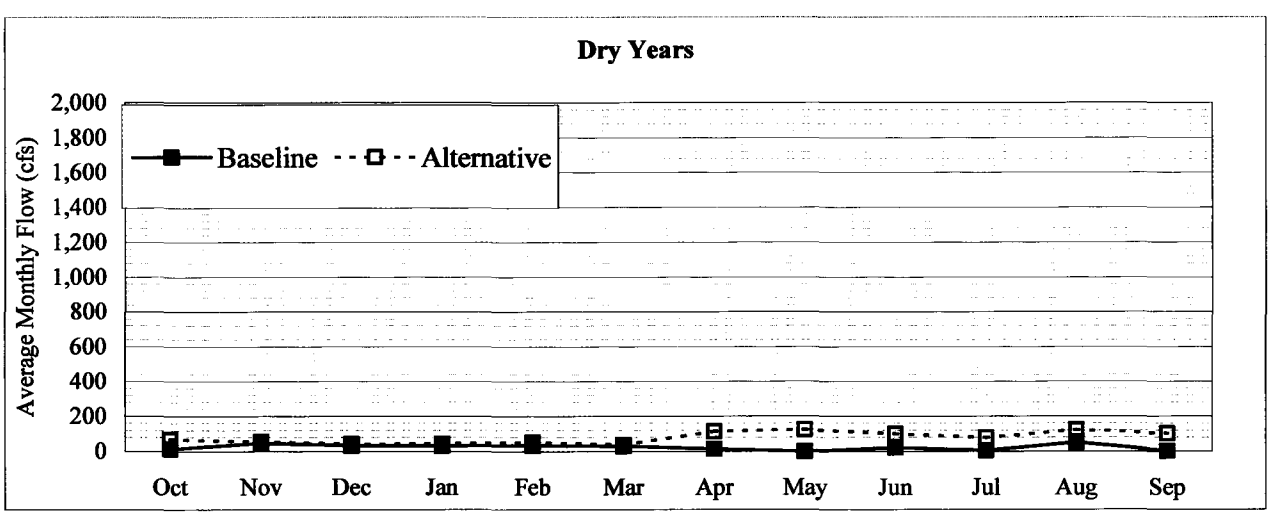
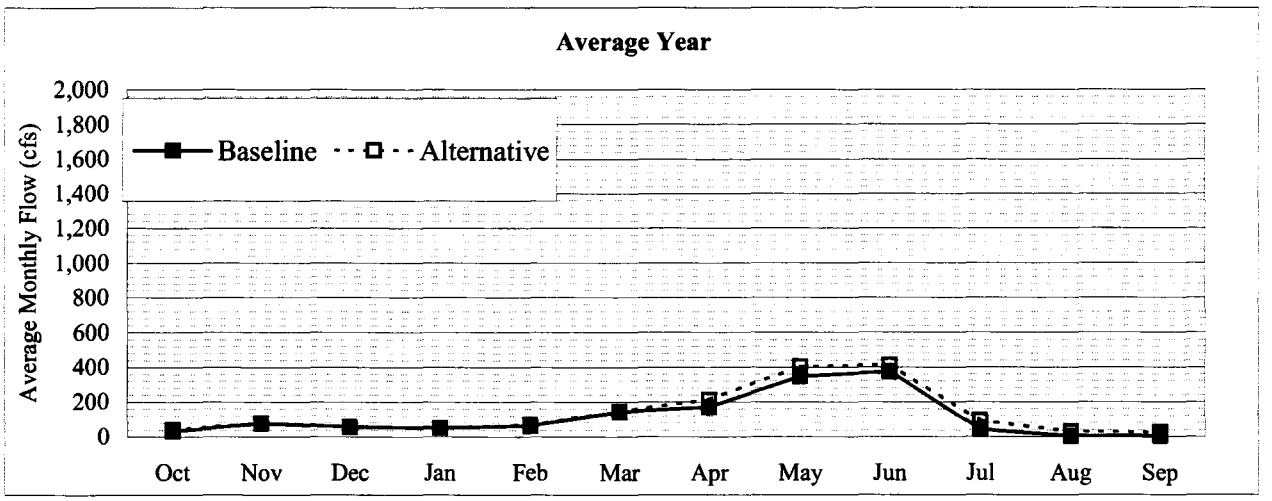
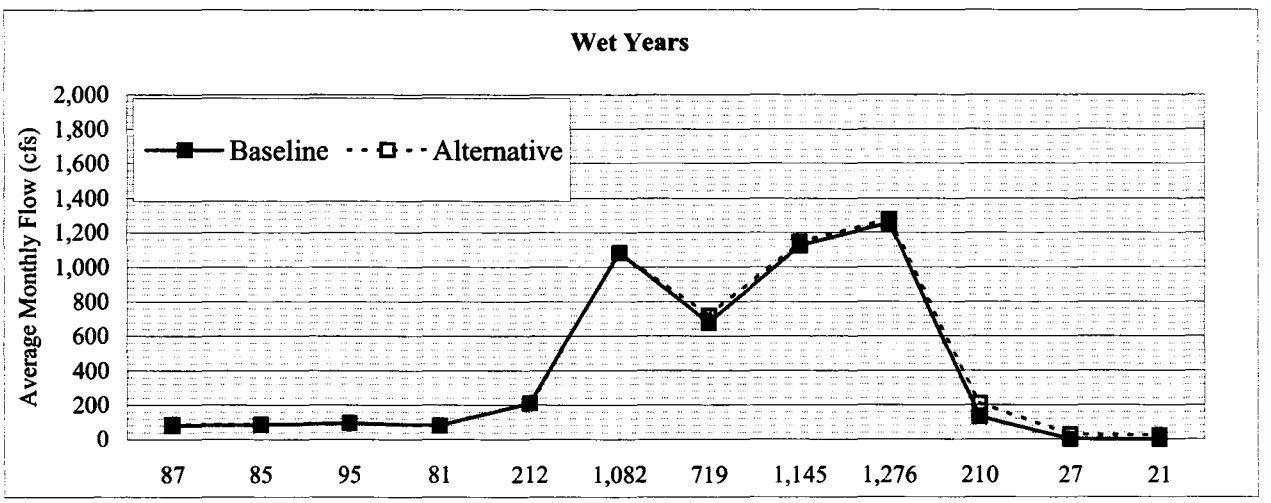


Figure 4-24
Estimated Average Provo River Flows from Interstate 15 to Utah Lake
Bonneville Unit Water Alternative Compared to Baseline





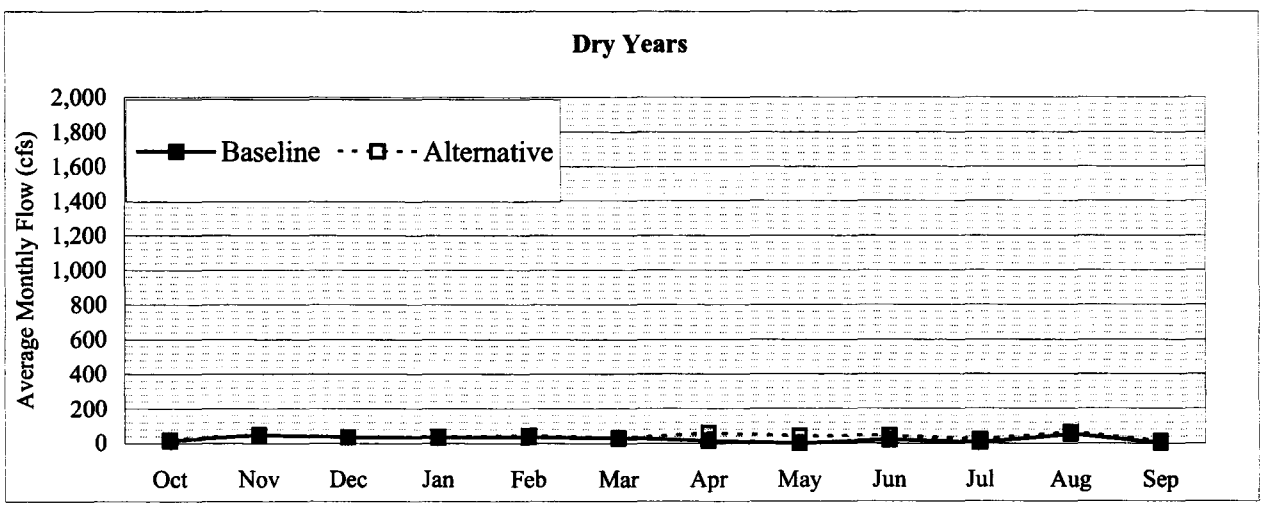


Figure 4-25
Estimated Average Hobble Creek Flows from from Mapleton Lateral to Utah Lake
Bonneville Unit Water Alternative Compared to Baseline

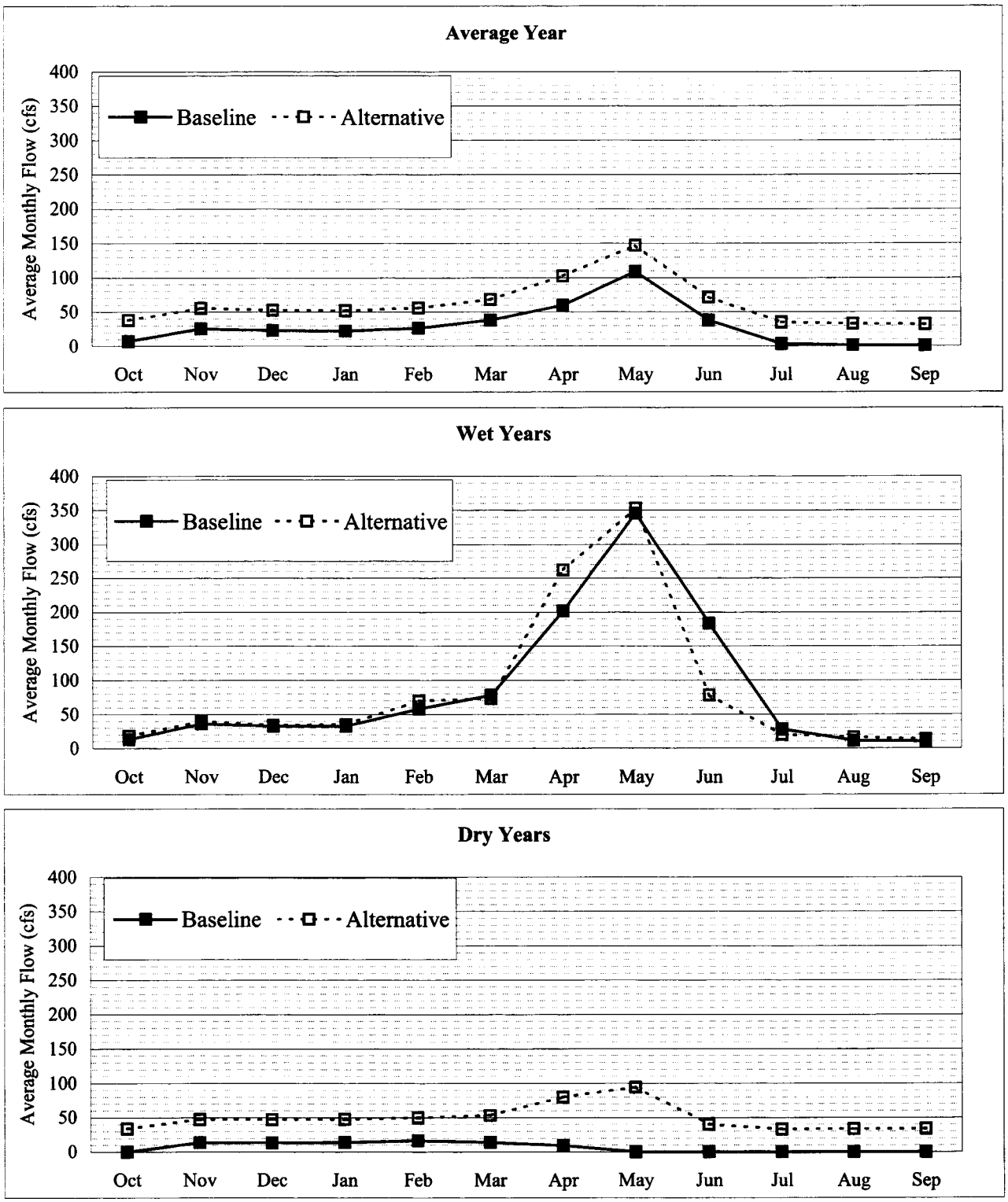
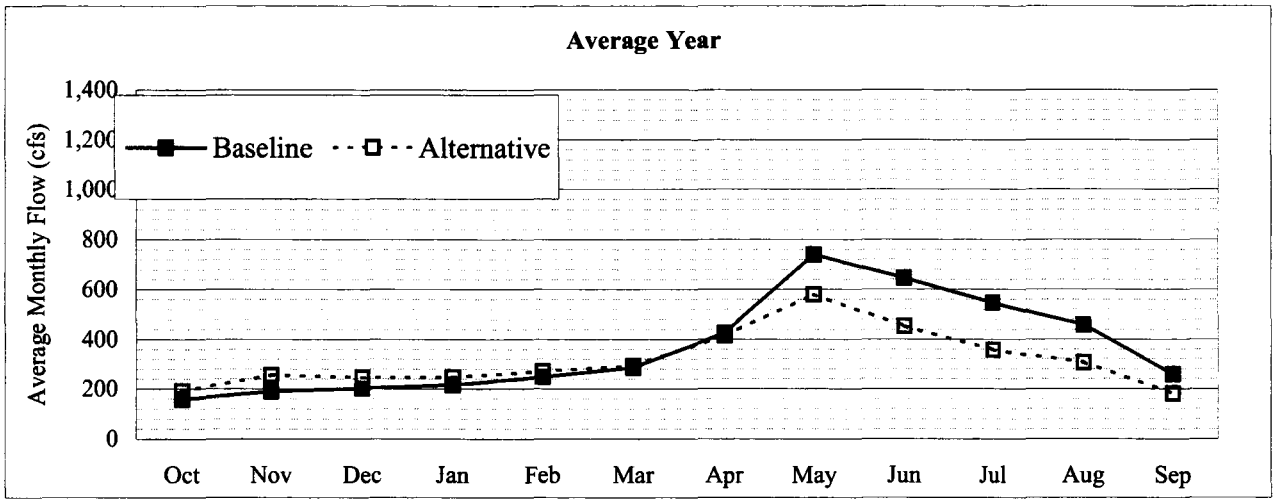
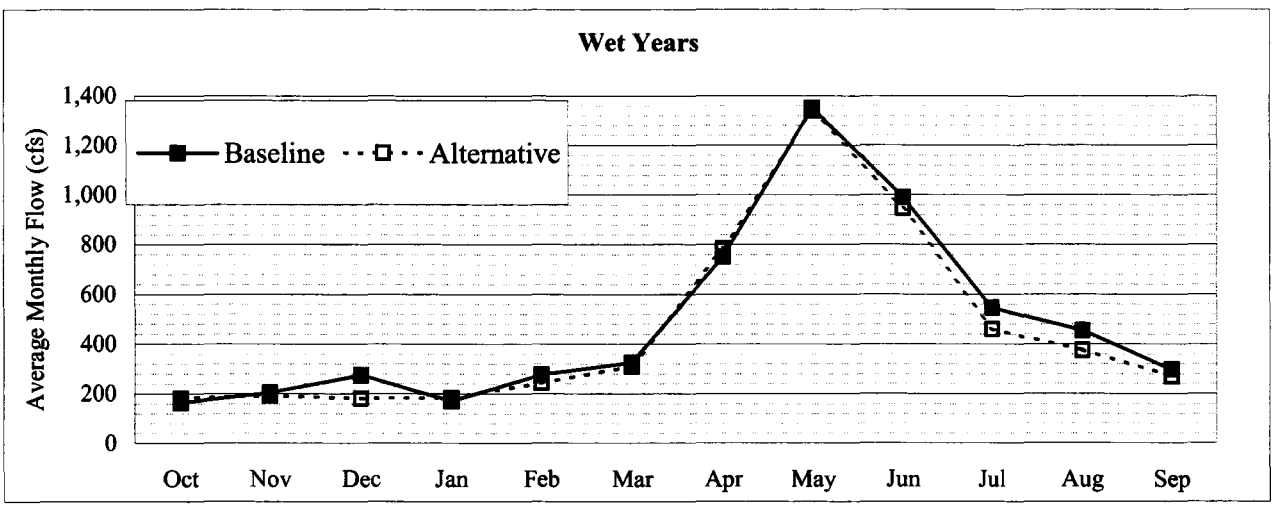


Figure 4-26

Estimated Average Spanish Fork River Flows from Diamond Fork Creek to Spanish Fork Diversion Dam (Castilla gage)

Bonneville Unit Water Alternative Compared to Baseline





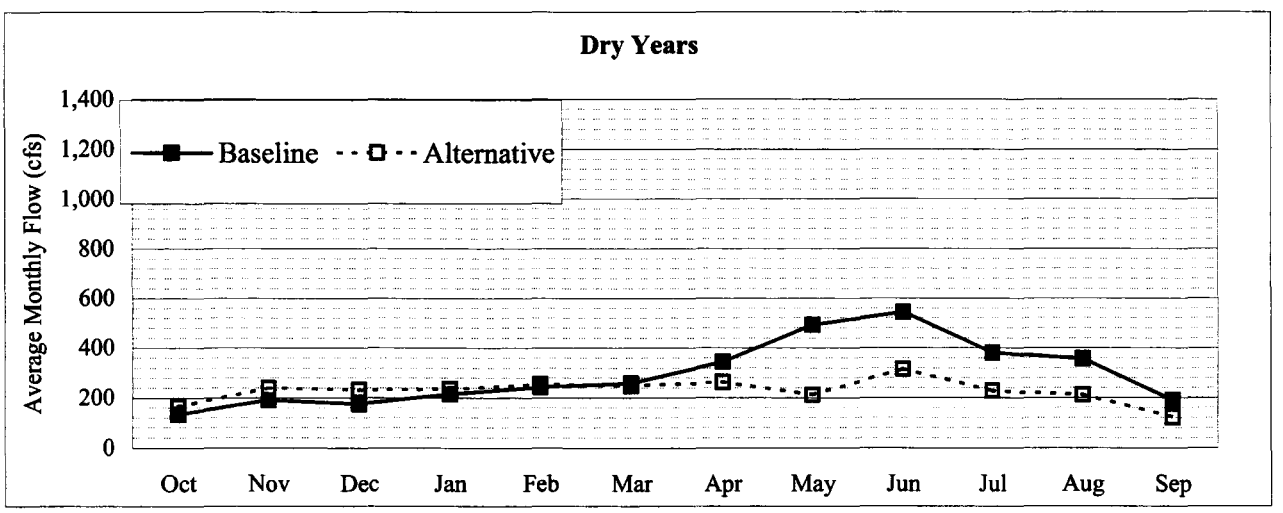
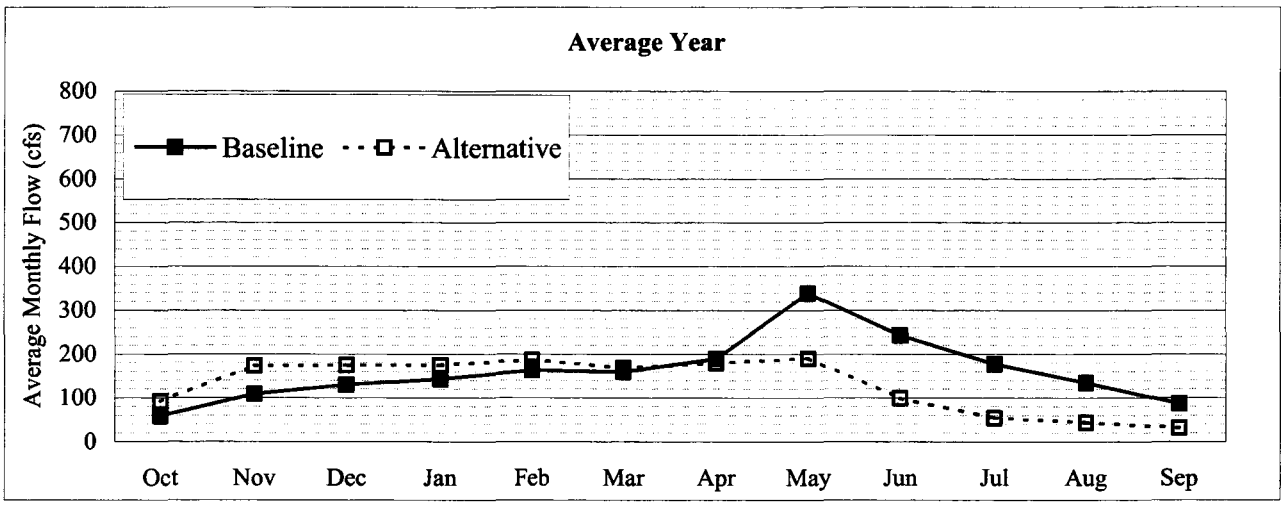
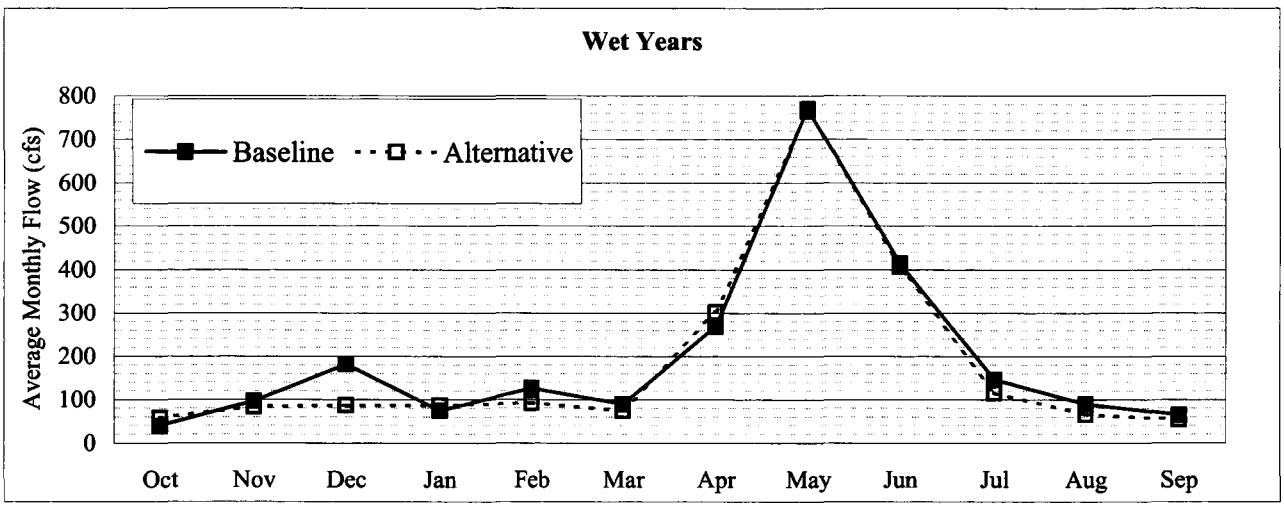


Figure 4-27
Estimated Average Spanish Fork River Flows from Spanish Fork Diversion Dam to East Bench Diversion
Bonneville Unit Water Alternative Compared to Baseline





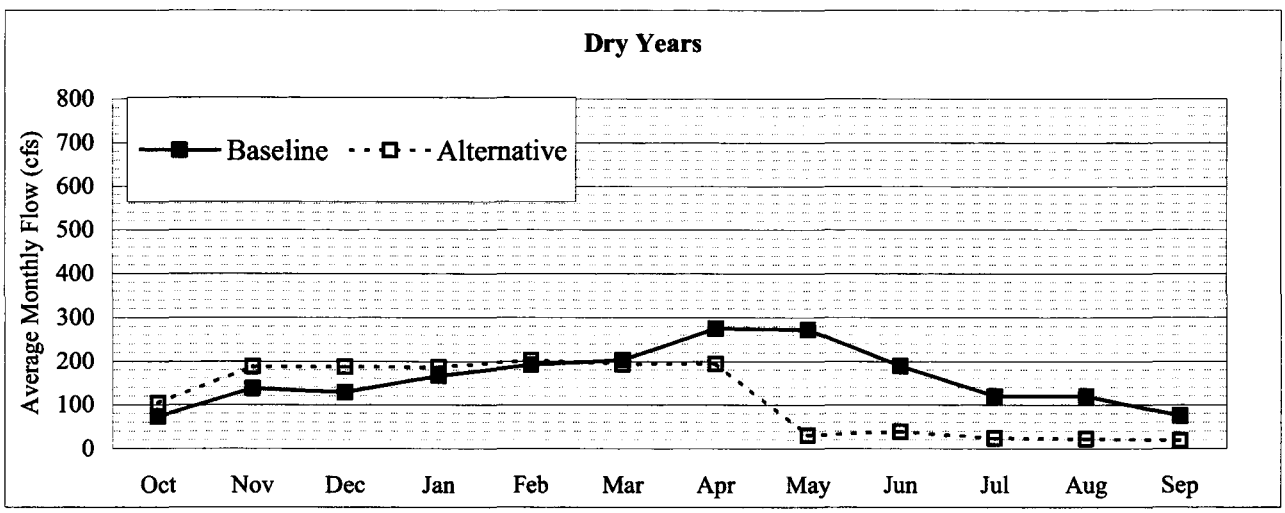
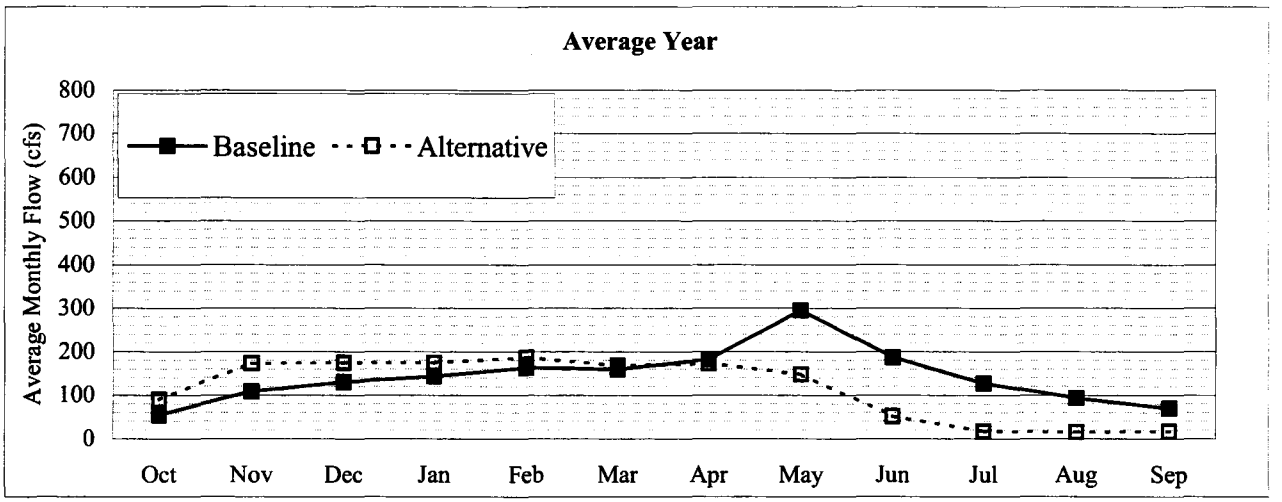
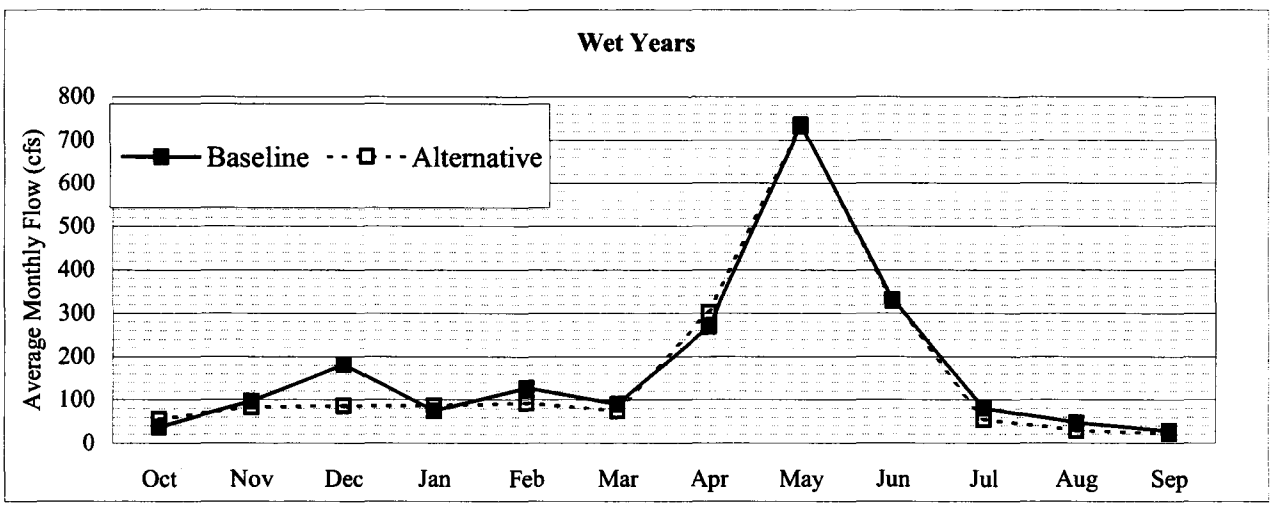


Figure 4-28
Estimated Average Spanish Fork River Flows from East Bench Diversion to Mill Race Canal
Bonneville Unit Water Alternative Compared to Baseline





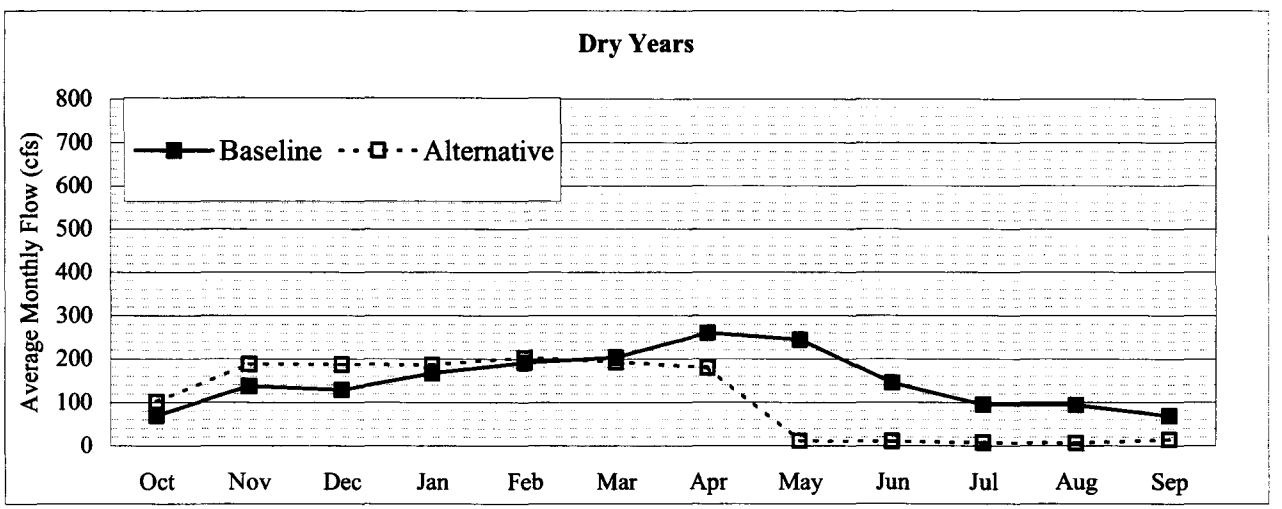
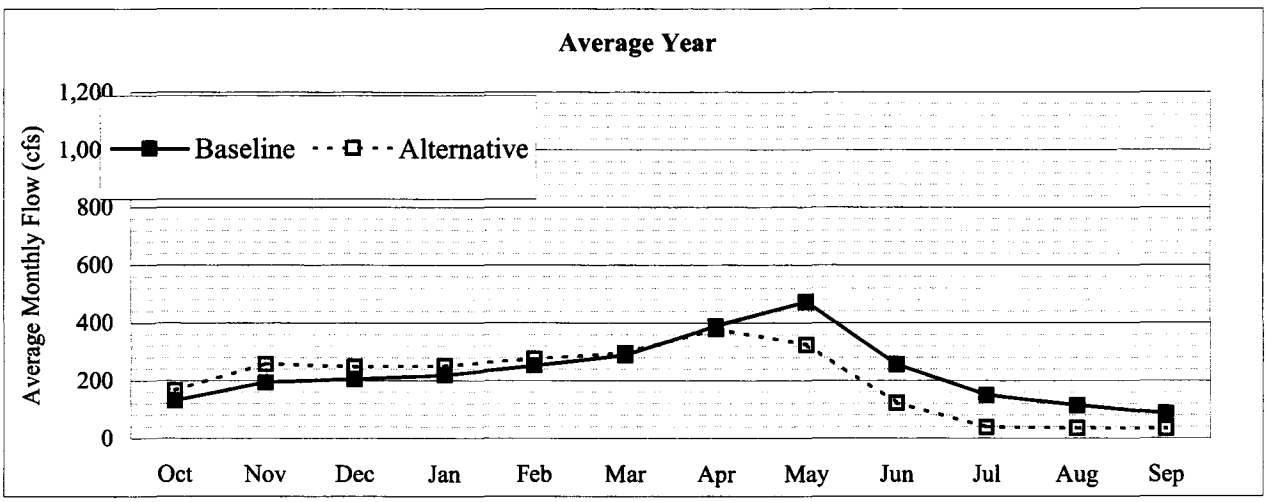
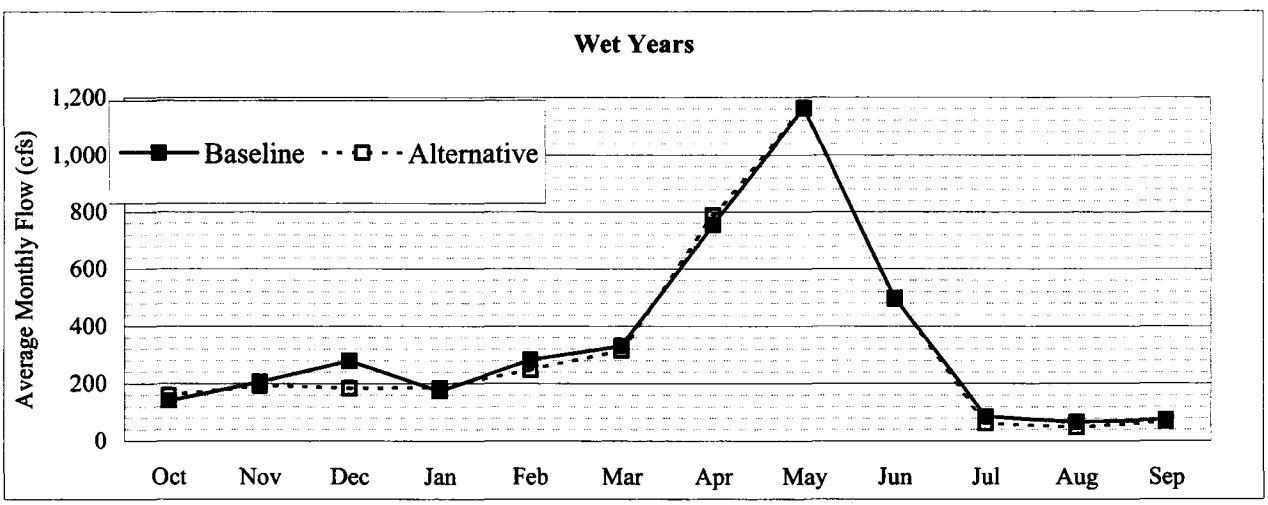


Figure 4-29
Estimated Average Spanish Fork River Flows from Mill Race Canal to Lakeshore Gage
Bonneville Unit Water Alternative Compared to Baseline





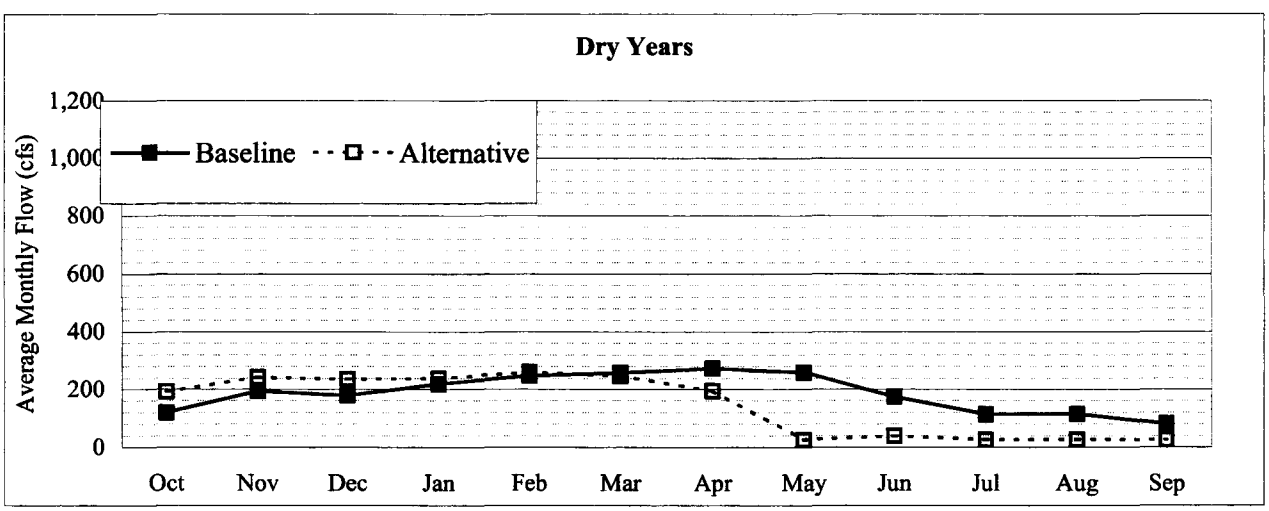
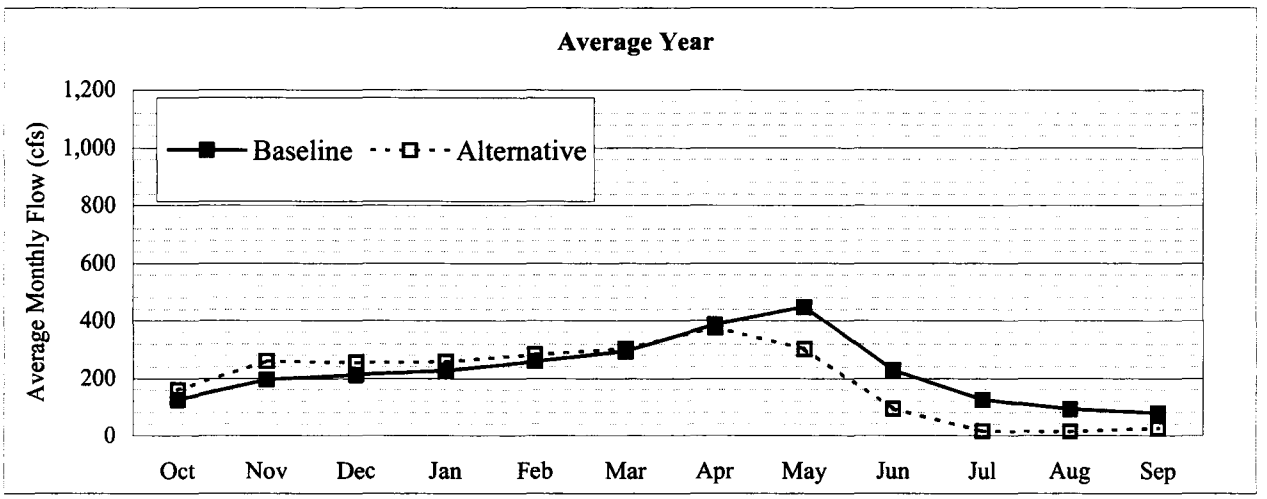
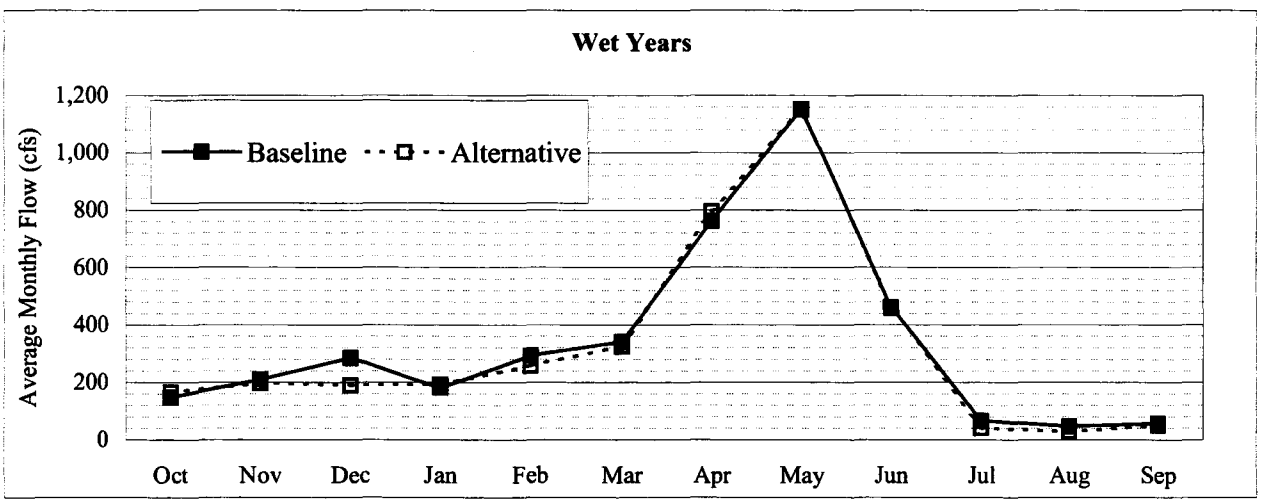


Figure 4-30
Estimated Average Spanish Fork River Flows at Lakeshore Gage
Bonneville Unit Water Alternative Compared to Baseline





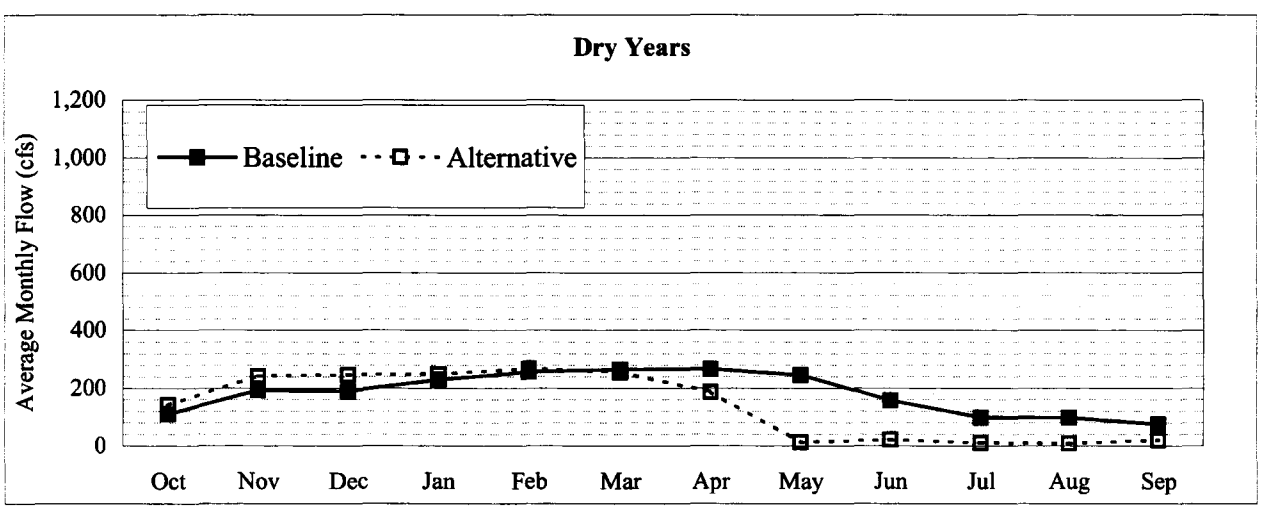


Figure 4-31
Estimated Average Jordan River Flows from Outlet of Utah Lake to Jordan Narrows
Bonneville Unit Water Alternative Compared to Baseline

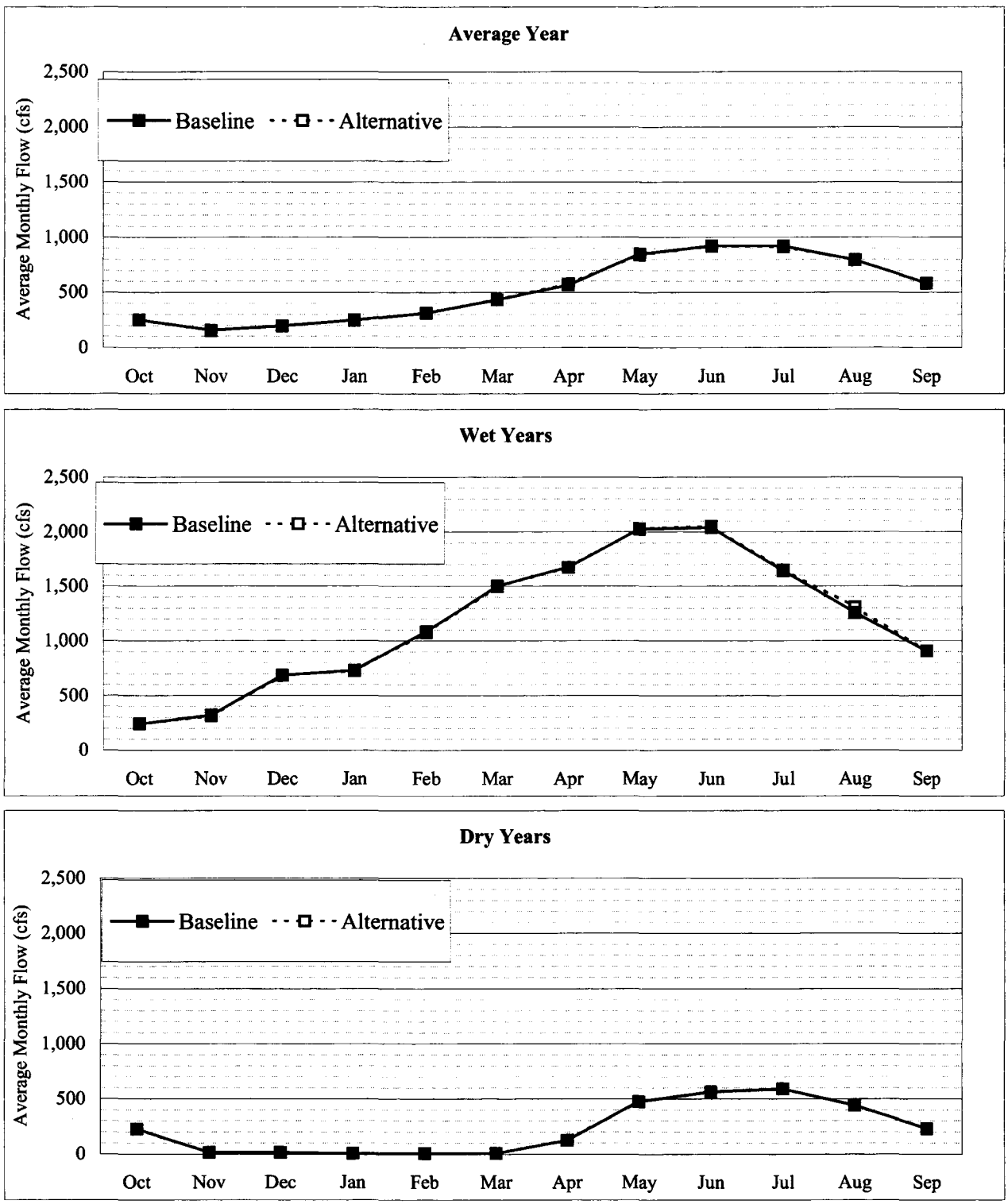
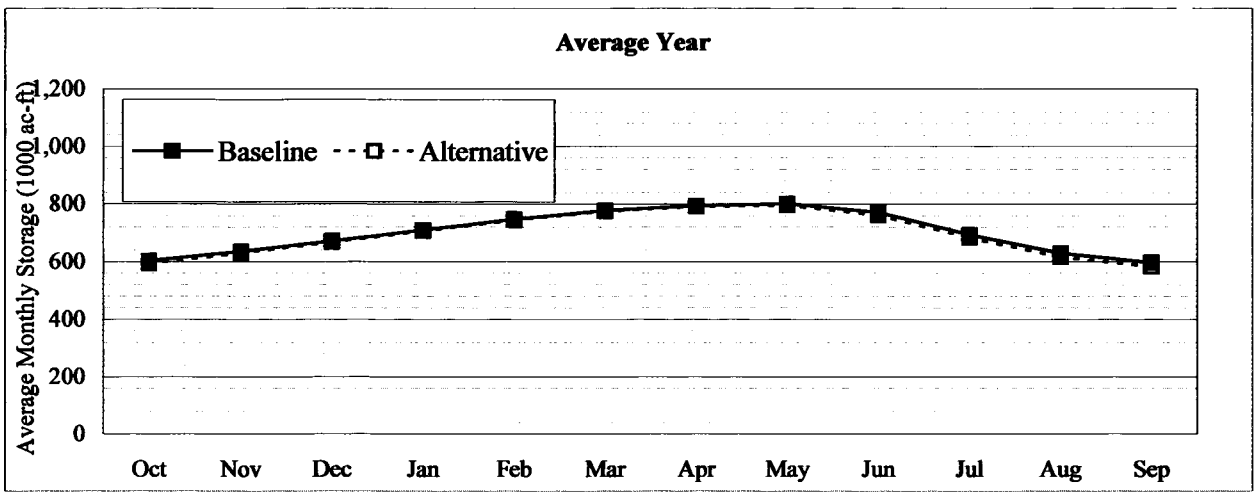
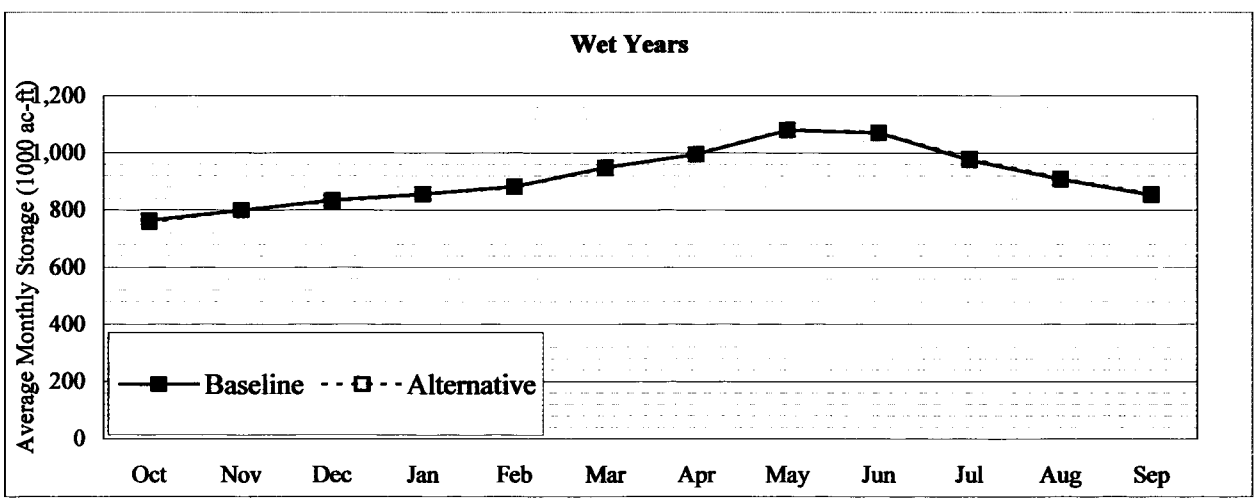


Figure 4-32
Estimated Average Utah Lake Contents
Bonneville Unit Water Alternative Compared to Baseline





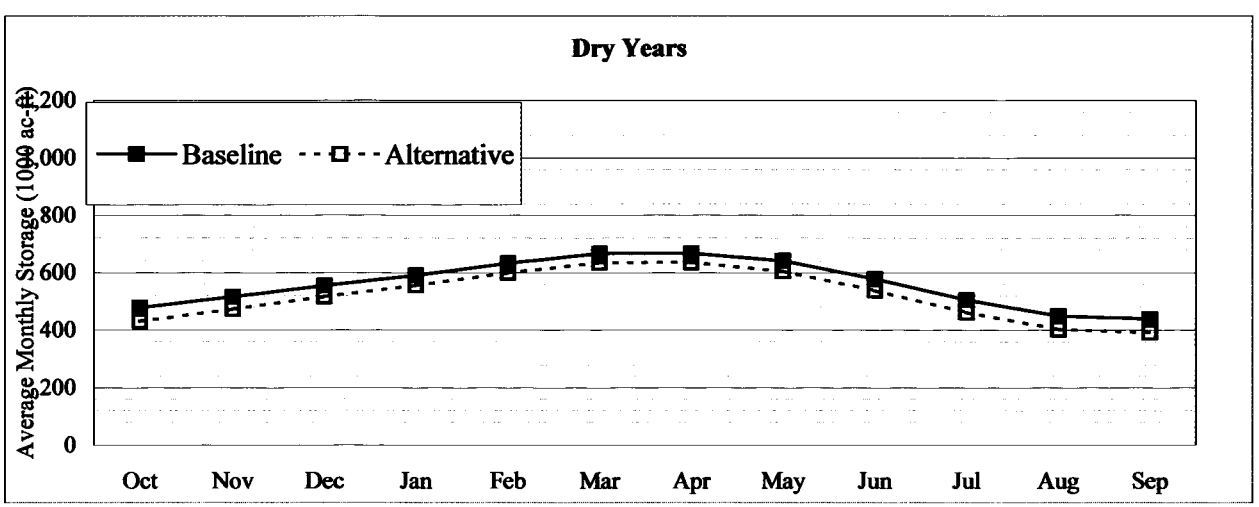


Figure 4-33
Utah Lake Storage Volume (1000 acre feet)

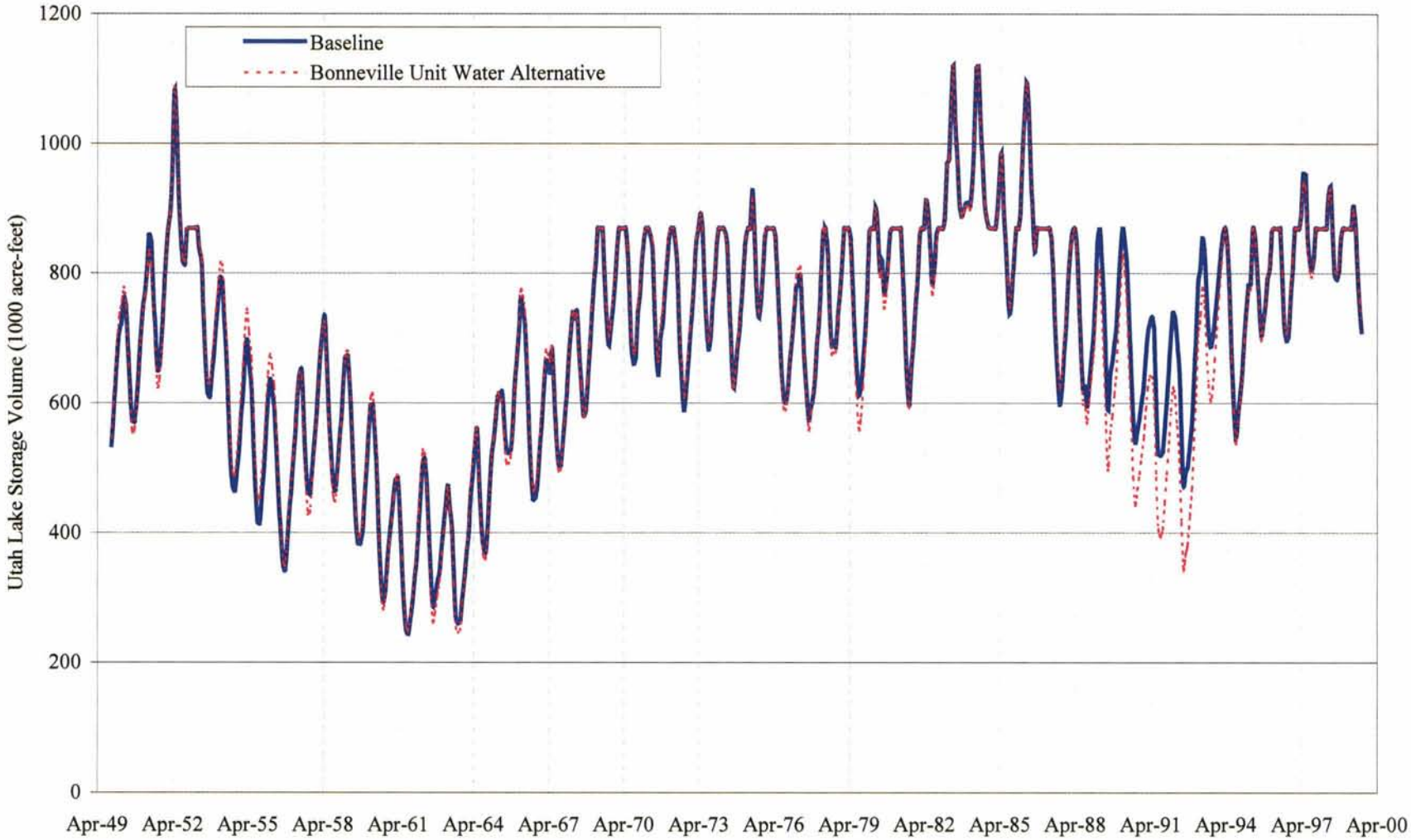
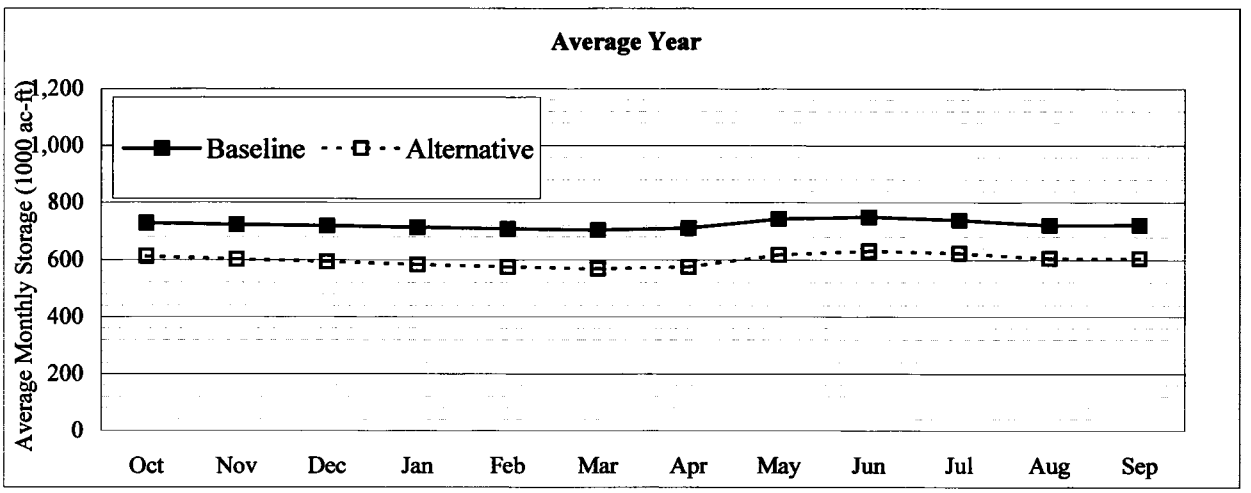
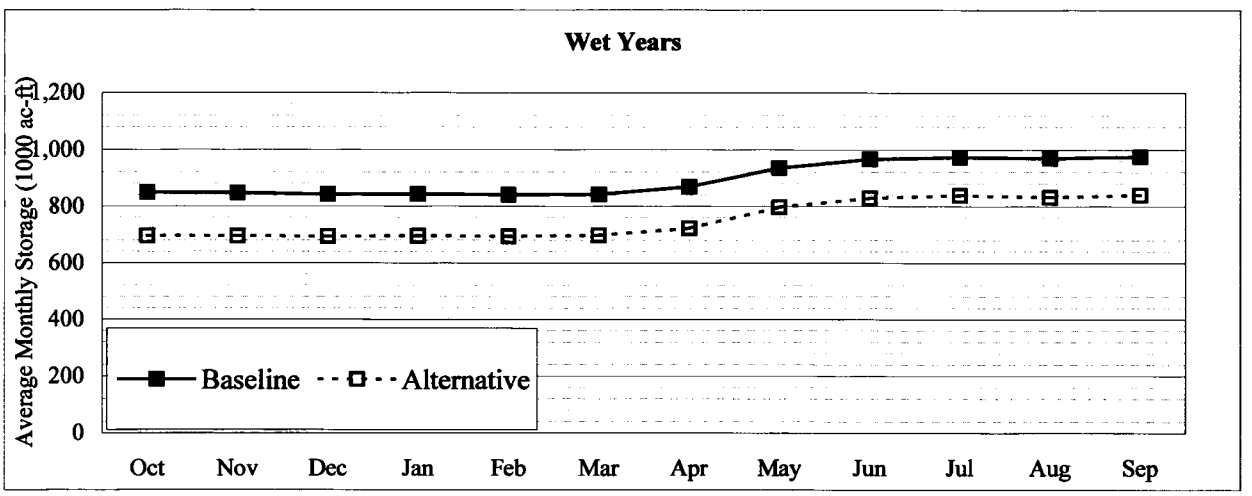


Figure 4-34
Estimated Average Strawberry Reservoir Contents
Bonneville Unit Water Alternative Compared to Baseline





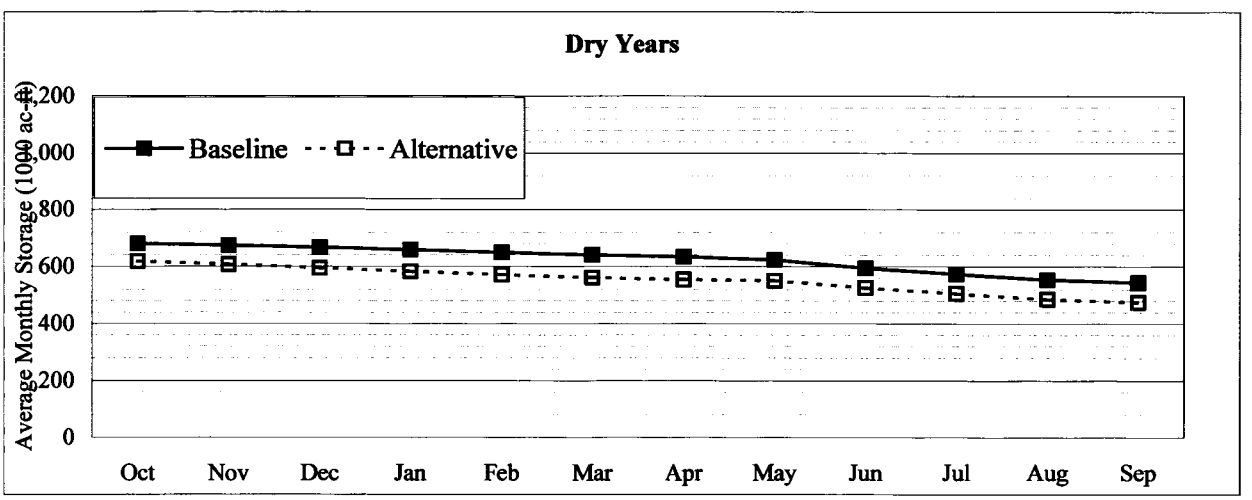
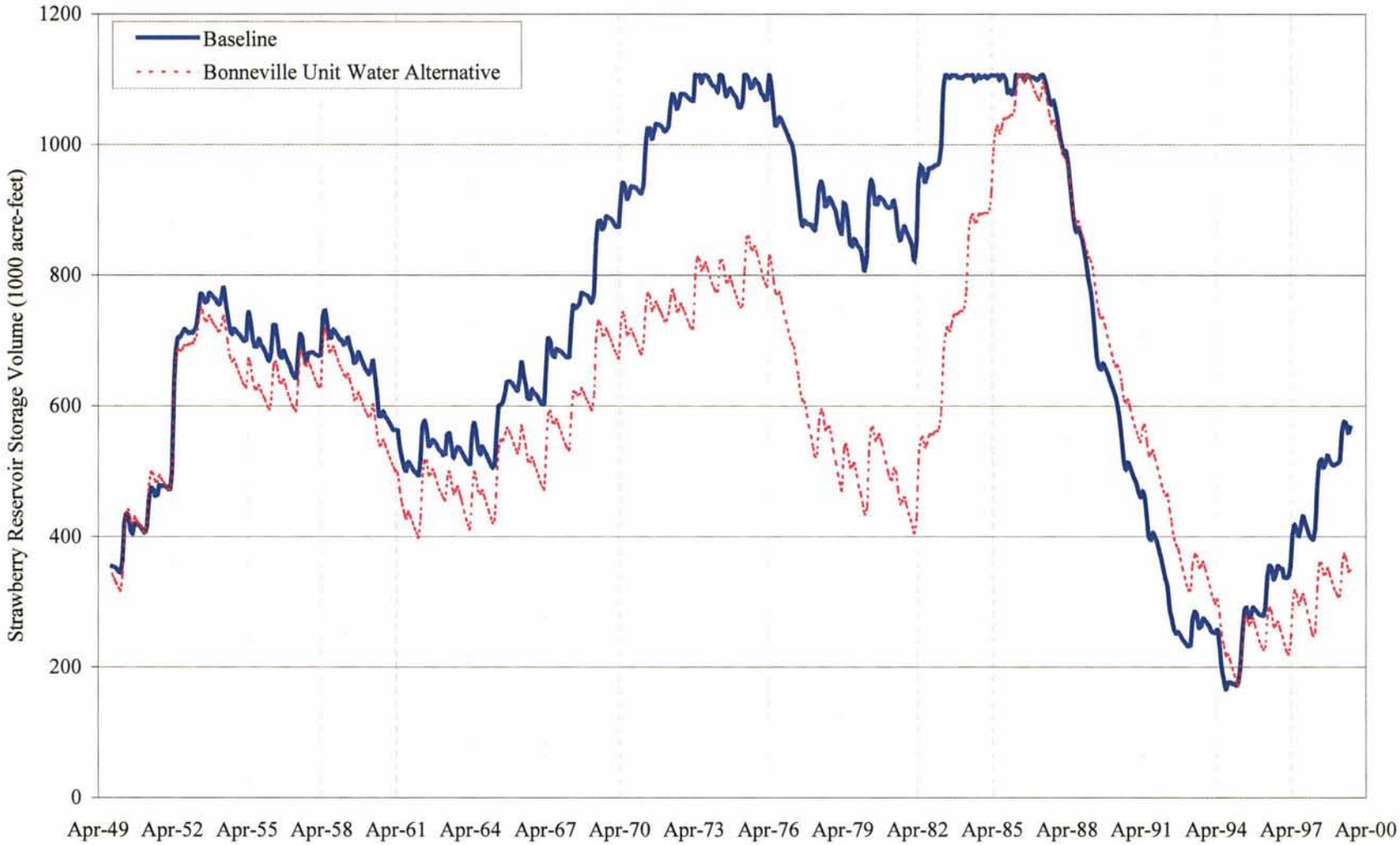


Figure 4-35
Strawberry Reservoir Storage Volume (1000 acre feet)



References Cited

Central Utah Water Conservancy District (CUWCD). 1994. *PROSIM Hydrological modeling of the historical demands scenario.*

_____. 1998. *Final Report on the hydrologic model analysis of the Provo River Basin.*

_____. 1999. *Diamond Fork System, final supplement to the final environmental impact statement.*

_____. 2003. *Revised assessment of M&I water needs, supplement to plan formulation report of February 2002, Utah Lake Drainage Basin Water Delivery System.*

Thurin, S. 2003. *ULS Baseline Provo River Flows Compared with CUP M&I System FES Conditions.*

U.S. Bureau of Reclamation (Reclamation). 1973. *Bonneville Unit final environmental impact statement, Central Utah Project, Utah.*

_____. *1979a. Final environmental impact statement on the Central Utah Project, Municipal and Industrial System, Bonneville Unit.*

_____. *1979b. Draft environmental impact statement on the Central Utah Project, Municipal and Industrial System, Bonneville Unit.*

_____. 1987. *Final supplement to the M&I system's final environmental impact statement on the Central Utah Project, Municipal and Industrial System, Bonneville Unit.*

_____. 1988. Central Utah Project *Bonneville Unit-Utah, Supplement to Definite Plan Report, Draft Water Supply Appendix.*

_____. 2003a. *"Alt99", Extended input dataset for Strawberry Reservoir Model.*

_____. 2003b. *Personal Communication. Comparison between USBR and PROSIM2000 flows at Jordanelle Reservoir August 29.*

THIS PAGE INTENTIONALLY LEFT BLANK

Glossary

Accretion. The gradual accumulation of water in a surface or subsurface body of water.

Acre-foot. A volume of water 1 foot deep and 1 acre in area, or 43,560 cubic feet.

Affected Environment. Parts of the environment that would be impacted by a change in operation or management.

Alternative. A proposition or situation offering a choice between two or more proposals, only one of which may be chose. An opportunity for deciding between two or more courses or propositions.

Aquifer. A subsurface body of water.

Bankfull. Water flowing in a channel at the elevation of the channel banks. Any additional discharge would cause water to begin overflowing from the channel.

Base Flows. Most commonly refers to the component of stream flow that is relatively constant from year to year, in contrast to the total flow that is affected by snowmelt and rainfall.

Baseline. The set of starting conditions from which changes and impacts are quantified.

Compromise (or Compromise Elevation). The elevation of Utah Lake at which the outlet gates must be fully opened to avoid inundation of lands around the Lake. Established as 4,489.045 feet above mean sea level.

Confluence. The location where two or more streams come together.

Conversion. The water rights process under the Utah Lake Distribution Plan by which system storage becomes priority storage.

Conversion Line. The total volume of system storage in Utah Lake, Jordanelle, and Deer Creek at which system storage may be converted to priority storage.

Cubic feet per second. A measurement of flow: volume/time, in English units.

Cumulative Impacts. As defined in Section 1508.7 of the Council on Environmental Quality (CEQ) Regulations (CEQ 1978), cumulative impacts are "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."

Distribution Plan. The Utah State Engineer's interim operation plan for Utah lake which allows surplus system storage to be stored in Jordanelle and Deer Creek reservoirs and to be subsequently converted to priority storage when the total system storage is above the conversion line.

Diversion. A place where water is diverted from a river or reservoir.

Diversion Dam. A structure across a main river channel that maintains the channel bottom elevation and increases the water surface elevation just to improve the performance of the diversion.

Endangered Species. Any species of plant or animal that is in danger of extinction throughout all or a

significant portion of its range. Plant or animal species identified by the Secretary of the Interior as endangered in accordance with the 1973 Endangered Species Act (ESA).

Environmental Impact Statement (EIS). A document that discusses the likely significant impacts of a proposal, methods to lessen the significance of impacts, and alternatives to a proposed action. This documentation is required by the National Environmental Policy Act.

Erosion. The carrying away of surface material by wind or water.

Eutrophication. The process of over-enrichment of water bodies by nutrients often typified by the development of algal blooms.

Exchange. The water rights process under which water in one location or under one owner's control is traded for water in another location or under another owner's control.

Floodplain. The area covered by floodwaters from channel overflows; generally associated with a particular recurrence interval (e.g. the 100-year floodplain is the area covered by floodwaters from the 100-year flood).

Forebay. The area of a reservoir from which water is withdrawn.

Gaging Station. A permanent facility on a stream which measures the depth (also called stage) of the water in the river. Depths are then converted to flows using a stage-discharge equation that has been developed for that particular site.

Gradient. The slope of a streambed or groundwater level.

Groundwater. Water beneath the surface that feeds wells and springs and maintains the level of rivers and lakes in dry weather.

Groundwater Discharge. The movement (usually laterally or upward) of water from a body of groundwater to its emergence into a surface water system such as a spring, seep or stream channel.

Groundwater Recharge. The process of adding water to the zone of saturation; also, the amount of water added.

High Flow. The annual average maximum flow observed in a stream.

Hydroelectric. The production of electricity by water power.

Instream Flow. The volume of water per unit of time (usually cubic feet per second) flowing within a stream channel.

Low Flow. The annual average minimum flow observed in a stream.

Mitigate, Mitigation. Cause to become less severe or harmful; reduce impacts; actions to avoid, minimize, reduce, eliminate, compensate, or rectify impacts to resources.

Municipal and Industrial Water (M&I). A water use classification that designates water to be used for domestic, commercial, or industrial purposes.

National Environmental Policy Act. A congressional act requiring an environmental impact statement on all major federal actions significantly affecting the quality of the human environment. [42 U.S.C. 4332 2(2)(C).]

Nutrients. Essential chemicals required by all living forms (plants and animals) for growth and health, such as

ıitrogen or phosphorus. Excessive amounts of nutrients can lead to degradation of water quality by promoting nigh growth rates of certain species, such as algae. Some nutrients can even be toxic in high concentrations.

Peak Discharge. Maximum flow rate, such as maintained by a canal or pipeline. Usually measured in cubic feet per second (cfs).

Phosphorus. A nonmetallic element of the nitrogen family that occurs widely as phosphates.

Portal. A tunnel's entrance and exit points from the ground.

Preferred Alternative. Of the alternatives proposed by the joint lead agencies in the environmental impact statement (EIS), this is the favored course of action, by the joint lead agencies.

Prime Farmland. Lands that have the best combination of physical and chemical characteristics for food production, feed, forage, fiber and seed crops. In Utah, to be officially considered prime farmland, they must meet certain criteria, as defined by the Soil Conservation Service (now the Natural Resource Conservation Service).

Priority Storage. Legal storage under a water right. Such water is not subject to call by other rights and can be used in accordance with the right.

Reaches. A specified section of a stream or a pipeline.

Return Flow. The flow of unconsumed water back to the stream, river or reservoir after delivery; often to describe groundwater discharge to surface water.

Scour. Erosion that occurs on the bottom of a river.

Sedimentation. The introduction of sediment material from an erosion source into a stream or lake.

Sediment. Material suspended in or settled to the bottom of a liquid from natural sources such as soil erosion or rock weathering or from human activity such as forest or agricultural practices or construction.

Spillway. The portion of a dam where water can flow over the top and into the channel below.

Standard Operating Procedures (SOPs). A process followed during construction, operation or maintenance of a project to avoid, minimize or rectify adverse impacts on natural resources and people.

Storage. The volume of water in a reservoir or aquifer.

System Storage. The total active storage in Utah Lake, excluding the primary storage, plus water stored in upstream reservoirs under junior priority water rights. System storage is subject to call to satisfy the diversion requirements of primary and secondary Utah Lake storage rights.

Temporary Impact. An impact that lasts for a limited time, such as only during the construction phase of a project.

Threatened Species. Any animal or plant species likely to become endangered within the foreseeable future throughout all or a significant portion of its range. Plant or animal species identified by the Secretary of the Interior as threatened in accordance with the 1973 Endangered Species Act (ESA).

Total Dissolved Solids(TDS). The mass of dissolved ionic compounds in water per volume of water, usually expressed in mg/L or equivalently parts per million.

Transbasin Diversion. A water diversion from one hydrologic drainage basin to another.

Tributary. A stream that flows into a large stream, river or other body of water.

Turbidity. The ability of water to transmit light. Suspended solids, organics, and dissolved species which color the water contribute to turbidity.

Water Rights. A legal right to take water and put it to beneficial use.

Water Table. The upper surface of groundwater or the level below which the soil is saturated with water.

Water Year. The water year starts October 1 and ends September 30. For example, the 1995 water year started October 1, 1994, and ended September 30, 1995.

Weir. A grade control feature extending across a channel or reservoir, designed for water to flow over the top.

Wetted Channel. The portion of the streambed that conveys water.

Abbreviations and Acronyms

Abbreviation/Acronym	Meaning/Description
AF	Acre-Feet
B.U.	Bonneville Unit
Cfs	Cubic Feet Per Second
COE	U.S. Army Corps of Engineers
CRSP	Colorado River Storage Project
CUP	Central Utah Project
CUPCA	Central Utah Project Completion Act
CUWCD	Central Utah Water Conservancy District
DEIS	Draft Environmental Impact Statement
DOI	U.S. Department of the Interior
DPR	Definite Plan Report
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ESA	1973 Endangered Species Act
FEIS	Final Environmental Impact Statement
Fps	Foot per Second
FS-FEIS	Final Supplement to the Final Environmental Impact Statement
Ft	Foot
Ft^3	Cubic Foot
HEC-RAS	Hydrologic Engineering Center – River Analysis System
IFIM	Instream Flow Incremental Methodology
In	Inch/inches
Lb	Pound
M&I	Municipal and Industrial
Mg/L	Milligrams per Liter
Mitigation Commission	Utah Reclamation Mitigation and Conservation Commission
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service, formerly SCS
O&M	Operations and Maintenance
SCS	Soil Conservation Service, now known as NRCS
SFN	Spanish Fork Canyon – Nephi Irrigation System
SVP	Strawberry Valley Project
SWUA	Strawberry Water Users Association
TDS	Total Dissolved Solids
URMCC	Utah Reclamation, Mitigation and Conservation Commission
Reclamation	U.S. Bureau of Reclamation
USGS	U.S. Geological Survey
1999 FS-FEIS	Diamond Fork System 1999 Final Supplement to the 1984 Diamond Fork Power System Final Environmental Impact Statement

THIS PAGE INTENTIONALLY LEFT BLANK

Utah Lake Drainage Basin Water Delivery System

Draft Surface Water Hydrology Technical Report

Attachment 1 Background Information and Technical Memoranda

DRAFT MEMORANDUM

TO: Mark Breitenbach

FROM: Steven M. Thurin, Montgomery Watson Harza

SUBJECT: Development of Strawberry to Utah Lake Calls Under ULS Baseline Conditions

PROJECT: Utah Lake Drainage Basin Water Delivery System
District Code: 1B02029

DATE: October 23, 2001

The attached tables and charts display our initial cut at the development of a set of Baseline data to represent the calls of water from Strawberry Reservoir to Utah Lake to make the M&I Exchange under ULS Baseline conditions. The data were developed using the following steps:

1. Use Baseline Diamond Fork/Spanish Fork hydrology data and Baseline SVP calls to determine when Sixth Water IFRs are not satisfied above Sixth Water Aqueduct or in lower Diamond Fork. Whenever these IFRs are not met, release CUP water to fully satisfy. The resulting dataset is shown as the lower, light-colored columns on Figure 1.
2. During the Diamond Fork Final Supplement overlap period (1950 – 1973), take the annual volumes released under that study (less the IFR releases described above), as the annual amounts to be released under ULS Baseline conditions. These are the darker columns under the heavy black line on Figure 1.
3. During the non-overlap period, use PROSIM2000's rules to determine the amount of release required to satisfy the M&I exchange. Adjust the resulting annual volumes to obtain an average of 86,100 acre-feet per year for the entire 1950-1999 study period.
   A. Monthly calls were developed from the annual volumes with the objective of matching the monthly pattern used in the Diamond Fork Final Supplement calls.

The resulting releases are shown on Table 1. The previously developed FS FEIS releases are shown on Table 2. The average monthly patterns associated with the two datasets are displayed on Figure 2.

Table 1
Baseline Flow - CUP Calls on Strawberry (acre-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1950	2,465	4,445	5,590	7,003	7,370	8,622	11,021	14,093	17,421	15,090	8,068	7,150	108,338
1951	2,316	4,175	6,465	7,674	7,898	8,880	12,962	17,210	9,451	4,515	2,186	2,408	86,140
1952	793	4,270	5,932	7,101	6,997	8,452	1,498	2,041	101	79	0	0	37,266
1953	259	4,031	6,184	2,809	2,499	2,509	1,526	10	0	0	0	0	19,827
1954	485	4,202	5,383	6,667	7,438	8,363	6,573	8,107	6,351	4,939	4,501	4,820	67,829
1955	1,177	4,214	5,499	6,338	6,535	8,050	7,469	9,555	8,955	6,991	4,930	4,137	73,850
1956	1,661	9,288	10,338	10,850	10,725	10,519	10,107	16,399	13,169	13,297	9,966	8,089	124,408
1957	2,963	8,640	9,624	10,432	11,037	11,823	10,690	13,144	17,969	12,632	12,807	10,227	131,988
1958	85	2,565	3,190	4,436	5,310	7,355	8,497	18,588	10,325	8,272	6,908	6,527	82,058
1959	1,281	5,144	6,200	6,939	7,315	8,164	6,392	5,771	5,761	4,747	3,247	3,674	64,635
1960	1,865	8,607	8,835	8,848	8,478	9,473	7,960	9,557	7,710	8,892	20,127	6,279	106,631
1961	6,549	9,236	5,089	6,199	6,858	8,164	7,016	4,788	1,140	3,356	5,304	3,230	66,929
1962	5,741	7,765	8,683	7,059	5,766	7,756	11,720	21,076	18,903	17,645	9,692	2,570	124,376
1963	8,448	4,338	5,927	6,705	7,467	8,732	9,072	10,761	12,483	6,906	4,961	2,121	87,921
1964	6,062	4,795	6,926	7,758	7,526	8,249	12,126	13,137	19,247	7,385	12,173	9,695	115,078
1965	1,901	8,685	9,757	9,825	9,726	9,576	10,164	15,477	15,457	14,492	697	0	105,757
1966	1,439	4,533	6,470	7,352	7,468	8,855	7,941	10,514	5,688	6,614	4,565	3,762	75,201
1967	1,088	6,036	7,337	7,888	7,817	8,974	9,254	12,032	16,592	13,328	8,199	6,437	104,981
1968	2,663	3,756	5,458	6,432	7,129	8,236	8,482	9,547	10,009	7,885	10	0	69,607
1969	78	4,419	5,770	8,239	8,820	9,863	17,817	10,195	0	0	0	70	65,271
1970	1,893	4,202	5,853	7,328	7,951	8,736	7,377	13,156	1,352	7	0	0	57,855
1971	2,077	4,105	5,867	6,702	6,976	7,699	12,089	801	95	0	0	1,880	48,291
1972	3,099	4,262	6,193	7,513	7,763	10,792	14,207	0	0	0	100	0	53,929
1973	2,887	3,924	5,548	6,463	6,817	8,066	10,543	3,045	1,508	40	0	0	48,841
1974	5,605	4,249	7,326	7,404	7,484	7,823	18,168	5,000	8,000	7,000	0	0	78,058
1975	7,932	7,247	8,545	8,582	14,966	7,020	8,639	10,747	14,362	13,593	0	0	101,633
1976	3,058	6,427	7,601	13,174	6,940	12,047	10,061	11,629	11,816	11,710	11,722	0	106,185
1977	3,277	6,122	7,189	8,874	9,622	9,997	13,289	18,771	10,581	13,545	11,800	9,135	122,203
1978	2,616	4,712	5,385	5,957	6,296	8,284	1,190	14,214	11,402	7,096	9,134	7,472	83,759
1979	3,644	7,461	8,886	10,919	19,730	14,214	17,594	22,394	15,685	14,230	16,435	12,724	163,917
1980	4,043	7,465	8,882	10,104	19,244	20,412	4,393	4,578	7,113	14,856	12,940	10,018	124,048
1981	2,332	5,469	6,391	7,688	5,457	6,765	13,158	17,111	14,079	6,895	0	3,287	88,632
1982	4,001	9,212	11,152	12,820	14,630	23,139	7,018	1,509	10,610	11,444	9,866	3,777	119,179
1983	2,475	2,411	2,508	2,678	2,713	2,025	1,760	278	612	3,713	2,381	2,620	26,175
1984	2,007	2,970	6,174	5,354	4,218	3,448	1,190	0	0	7,232	976	636	34,206
1985	3,163	5,038	2,648	2,828	4,832	4,347	1,190	1,923	1,449	0	0	0	27,419
1986	2,174	9,634	23,537	2,678	8,980	3,867	1,190	1,660	0	1,100	1,154	0	55,976
1987	8,921	4,654	2,155	2,515	4,619	2,065	7,500	1,908	0	0	0	0	34,337
1988	6,177	13,692	17,691	22,316	15,603	15,692	4,595	16,747	9,641	9,641	9,641	6,748	148,183
1989	4,895	8,918	10,773	19,202	21,844	22,412	24,674	25,099	15,422	16,595	675	2,012	172,521
1990	3,570	7,136	8,480	9,702	10,772	11,176	18,099	23,460	17,212	15,319	15,358	11,890	152,174
1991	3,614	7,534	8,981	10,353	11,566	15,845	17,461	23,478	19,047	12,442	10,889	13,011	154,222
1992	3,745	8,300	10,056	14,311	13,835	17,290	20,458	21,403	13,423	0	0	0	122,820
1993	3,394	6,075	7,148	7,948	8,660	8,664	12,335	4,485	8,539	7,997	6,894	5,337	87,474
1994	2,947	4,647	5,323	6,122	6,393	6,551	8,783	10,798	6,139	6,376	6,894	3,525	74,497
1995	2,798	3,578	3,945	4,153	3,970	3,342	4,376	1,660	359	8,232	7,097	5,494	49,003
1996	2,806	4,208	4,849	5,261	5,490	5,923	1,355	2,255	4,626	753	0	0	37,525
1997	2,546	5,720	5,808	14,815	4,538	4,757	10,339	17,378	11,541	5,290	0	0	82,733
1998	2,178	13,196	12,987	12,689	7,441	7,839	6,097	5,855	4,528	1,261	0	0	74,071
1999	3,978	9,633	7,608	4,053	3,519	4,140	9,232	8,783	6,096	0	0	0	57,041
Average	3,143	6,107	7,403	8,141	8,461	9,100	9,333	10,243	8,439	7,069	5,046	3,615	86,100
Maximum	8,921	13,692	23,537	22,316	21,844	23,139	24,674	25,099	19,247	17,645	20,127	13,011	172,521
Minimum	78	2,411	2,155	2,515	2,499	2,025	1,190	0	0	0	0	0	19,827

Table 2

Diamond Fork Final Supplement FEIS CUP Utah Lake Calls

In acre-feet

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Sum
1950	184	4,495	5,663	7,114	7,502	8,785	11,261	14,438	17,847	15,459	8,265	7,325	**108,338**
1951	2,308	4,175	6,465	7,675	7,899	8,881	12,963	17,212	9,452	7,849	2,186	2,408	**89,473**
1952	632	4,284	5,957	7,135	7,032	8,500	1,500	2,044	102	80	-	-	**37,266**
1953	259	4,031	6,184	2,809	2,499	2,509	1,526	10	-	-	-	-	**19,827**
1954	485	4,202	5,383	6,667	7,438	8,363	6,573	8,107	6,351	4,939	4,501	4,820	**67,829**
1955	1,177	4,214	5,499	6,338	6,535	8,050	7,469	9,555	8,955	6,991	4,930	4,137	**73,850**
1956	1,661	9,288	10,338	10,850	10,725	10,519	10,107	16,399	16,502	13,297	9,966	8,089	**127,741**
1957	2,963	8,640	9,624	10,432	11,037	11,823	10,690	13,144	17,969	15,965	12,807	10,227	**135,321**
1958	85	2,565	3,190	4,436	5,310	7,355	8,497	18,588	10,325	8,272	6,908	6,527	**82,058**
1959	1,281	5,144	6,200	6,939	7,315	8,164	6,392	5,771	5,761	4,747	3,247	3,674	**64,635**
1960	1,865	8,607	8,835	8,848	8,478	9,473	7,960	9,557	9,043	6,892	24,127	6,278	**109,963**
1961	6,549	9,236	5,089	6,199	6,858	8,164	7,016	4,788	1,140	3,356	5,304	3,231	**66,930**
1962	5,741	7,765	8,683	7,059	5,766	7,756	11,720	18,576	21,403	17,645	13,025	2,570	**127,709**
1963	8,449	4,338	5,927	6,705	7,467	8,732	9,072	10,761	12,483	10,239	4,961	2,121	**91,255**
1964	6,062	4,795	6,926	7,758	7,526	8,249	8,626	13,137	19,247	14,218	12,173	9,695	**118,412**
1965	1,901	8,685	9,757	9,825	9,726	9,576	10,164	15,477	15,457	14,492	697	-	**105,757**
1966	1,283	4,538	6,479	7,363	7,480	8,871	7,960	10,540	9,043	6,630	4,576	3,771	**78,534**
1967	986	6,040	7,342	7,894	7,823	8,981	9,262	12,044	16,610	16,680	8,208	6,444	**108,314**
1968	2,610	3,757	5,461	6,436	7,134	8,242	8,489	9,555	10,020	7,893	10	-	**69,607**
1969	78	4,419	5,770	8,239	8,820	9,863	17,817	10,195	-	-	-	70	**65,271**
1970	1,893	4,202	5,853	7,328	7,951	8,736	7,377	13,156	1,352	7	-	-	**57,855**
1971	2,126	4,199	6,033	6,919	7,230	8,006	12,628	825	100	-	-	225	**48,291**
1972	3,099	4,262	6,193	7,513	7,763	10,792	14,207	-	-	-	100	-	**53,929**
1973	2,887	3,924	5,548	6,463	6,817	8,066	10,543	3,045	1,508	40	-	-	**48,841**
	2,357	**5,409**	**6,600**	**7,289**	**7,505**	**8,602**	**9,159**	**9,872**	**8,778**	**7,320**	**5,250**	**3,401**	**81,542**

Average for 1930-73 period is 86,100

Figure 1
86,100 Acre-Feet CUP Calls on Strawberry Reservoir

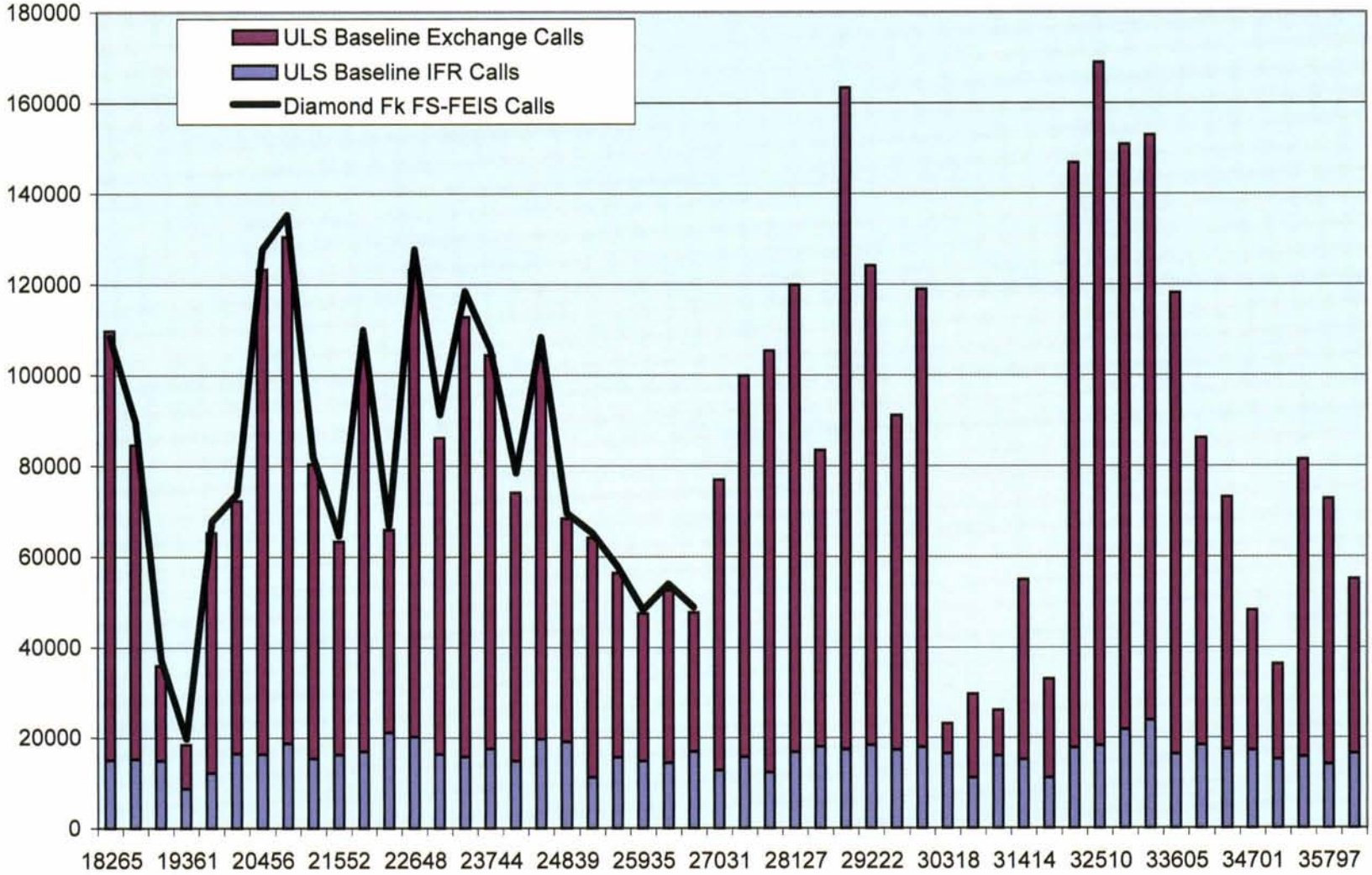
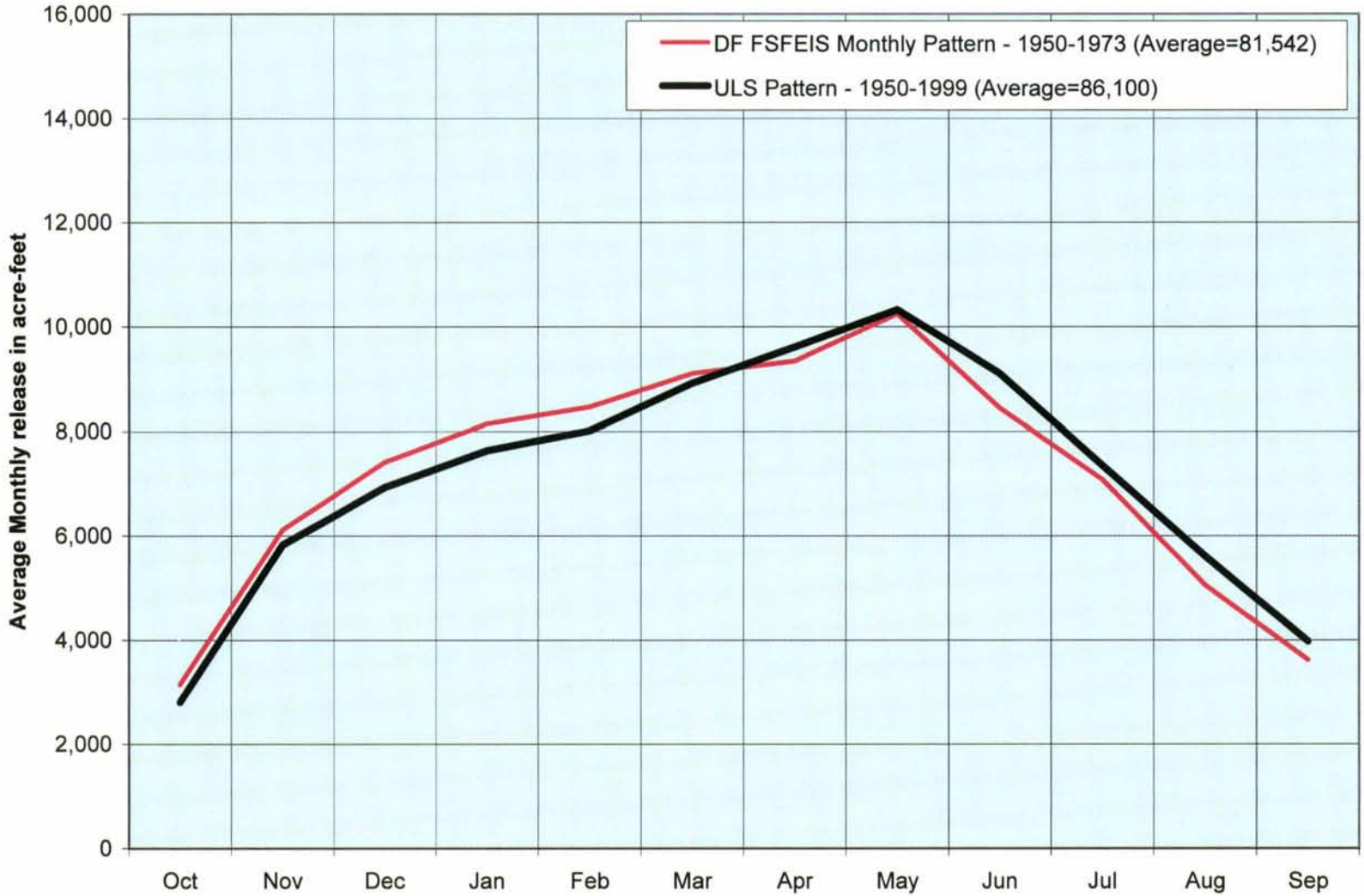


Figure 2
Release Patterns for 86,100



DRAFT MEMORANDUM

TO: Mark Breitenbach

FROM: Steven M. Thurin, Montgomery Watson Harza

SUBJECT: Hydrologic Adjustment to Develop Diamond Fork and Spanish Fork Data for Use in RiverWare Model and ULS

PROJECT: Utah Lake Drainage Basin Water Delivery System
District Code: 1B02029

DATE: September 12, 2001

Franson-Noble and Associates prepared a Historical Operation Study of Diamond Fork and Spanish Fork River data (Franson-Noble, January, 2001). At your request, a hydrologic adjustment has been completed of these Franson-Noble and Associates data (FN Data) for use in the new RiverWare Spanish Fork Model (SFSIM) and in the Utah Lake Drainage Basin Water Delivery System studies. This memorandum documents and summarizes the results of the hydrologic adjustment.

Careful review of the FN Data revealed two minor problems. First, while mainly consistent, several significant discrepancies existed in selected datasets. In particular, mass balance errors were found in certain months between the Diamond Fork at Mouth and the Spanish Fork at Castilla data, and between the Millrace and Lakeshore data. While relatively minor, the effect of these errors was to make it impossible in certain months to consistently track water balances from upstream to downstream. Second, after discussions with the Spanish Fork River Commissioner, it was found that the gains and losses assumed below East Bench Canal did not accurately estimate the observed gain in this reach.

In addition to these two problems, ULS project team members requested three specific adjustments to the data. The requested adjustments were:

1. Strawberry Tunnel seepage flows should be assumed to be a constant 5 cfs, throughout the study period. The FN Data had used some measured seepage data and some

estimated data that ranged from 4.5 to 6.0 cfs.

2. Strawberry seepage should accrue to Strawberry Valley project (SVP) only during months when SVP was bringing water through one of the tunnels. FN Data assumed a variable seepage and that all seepage was SVP water, then assumed that it was lost in Diamond Fork.
3. Losses assigned to SVP deliveries should be capped at a maximum of 10 percent. FN Data used losses estimated from Spanish Fork River Commissioner's Annual Reports.

The hydrologic adjustment was conducted primarily to correct these problems, and to develop a more consistent database of historical hydrology for use in future planning studies.

In adjusting the FN Data, the following series of steps were followed, in priority:

1) Where possible, utilize the FN Data without adjustment. This includes using their stream gage regression results and adjusted diversions and individual components of flow.
2) Assume Strawberry Tunnel seepage water is equal to 5 cfs and accrues to natural flow except when SVP is diverting water from Strawberry.
3) Use FN Data for historical losses to Strawberry water in Diamond Fork, except where the losses exceed 10 percent or the change in calculation of natural seepage versus SVP water makes this impossible.
4) Adjust Spanish Fork gains and losses below East Bench to be greater than or equal to 3 cfs (181 acre-feet) and less than or equal to 5 cfs, in all months.
5) Adjust natural inflows and gains and losses at each inflow point (Sixth Water at Aqueduct, Diamond Fork at Red Hollow and at Mouth, and Spanish Fork below East Bench and above Lakeshore) to achieve a consistent mass balance.
6) Eliminate negative flows at all diversion points, including negative components of flow (i.e., SVP water, CUP water, or natural flow).
7) Adjust gains and losses to produce agreement with FN total flows at Castilla, Thistle, and Lakeshore gages, unless FN Data violates conservation of mass.
8) Whenever possible, retain all historical diversion data without adjustment. When necessary due to loss adjustments, decrease natural flow diversions at Millrace and Lakeshore, and increase SVP diversions at the same locations to better account for the revised allocation of water.

The hydrologic adjustments resulted in an internally consistent water balance throughout the

Diamond Fork/Spanish Fork system. The results of the hydrologic adjustment are summarized on Table 1. Critical adjusted datasets are discussed below and summarized in the tables that follow.

There are no negative historical flows, and very good agreement with all stream gage and diversion data. On a percentage basis, the largest changes to individual data sets are to the gains and losses at East Bench and above Lakeshore (increased by 63 percent and decreased by 53 percent, respectively). These changes are the direct result of the change in assumptions referred to in item 4), above. The largest change to flow at a node is a 58 percent increase in flow below the East Bench diversion. This is considered acceptable, particularly because this flow is a computed, not a measured value. The largest changes at measured gage locations are a 5 percent increase in the flow at the Thistle gage, and a 3 percent increase in the flow below Lakeshore. These adjustments were made in order to smooth out the calculated gains and losses below the East Bench and above the Lakeshore diversions. The adjusted gains and losses below East Bench and above Lakeshore are displayed on Tables 2 and 3. The resulting adjusted flow below Lakeshore is compared with the recorded and FN calculated flow at the same location on Figure 1.

Because the changes in tracking and accounting of Strawberry Tunnel seepage and SVP losses tend to decrease the calculated natural flow in the river slightly, the natural flow in Diamond Fork and Sixth Water is somewhat smaller in the adjusted hydrology. Due to the capping of SVP losses at 10 percent, the calculated natural flows are reduced somewhat further, and a small amount of natural flow diversions at Millrace and Lakeshore were changed to SVP diversions. The volume of this change averaged less than 800 acre-feet per year. The adjustments are shown in Tables 4 through 6. The annual values for all of the variables in the hydrologic adjustment are summarized in Table 7.

Figure 1
SPANISH FORK HYDROLOGIC ADJUSTMENT - Flows at Lakeshore

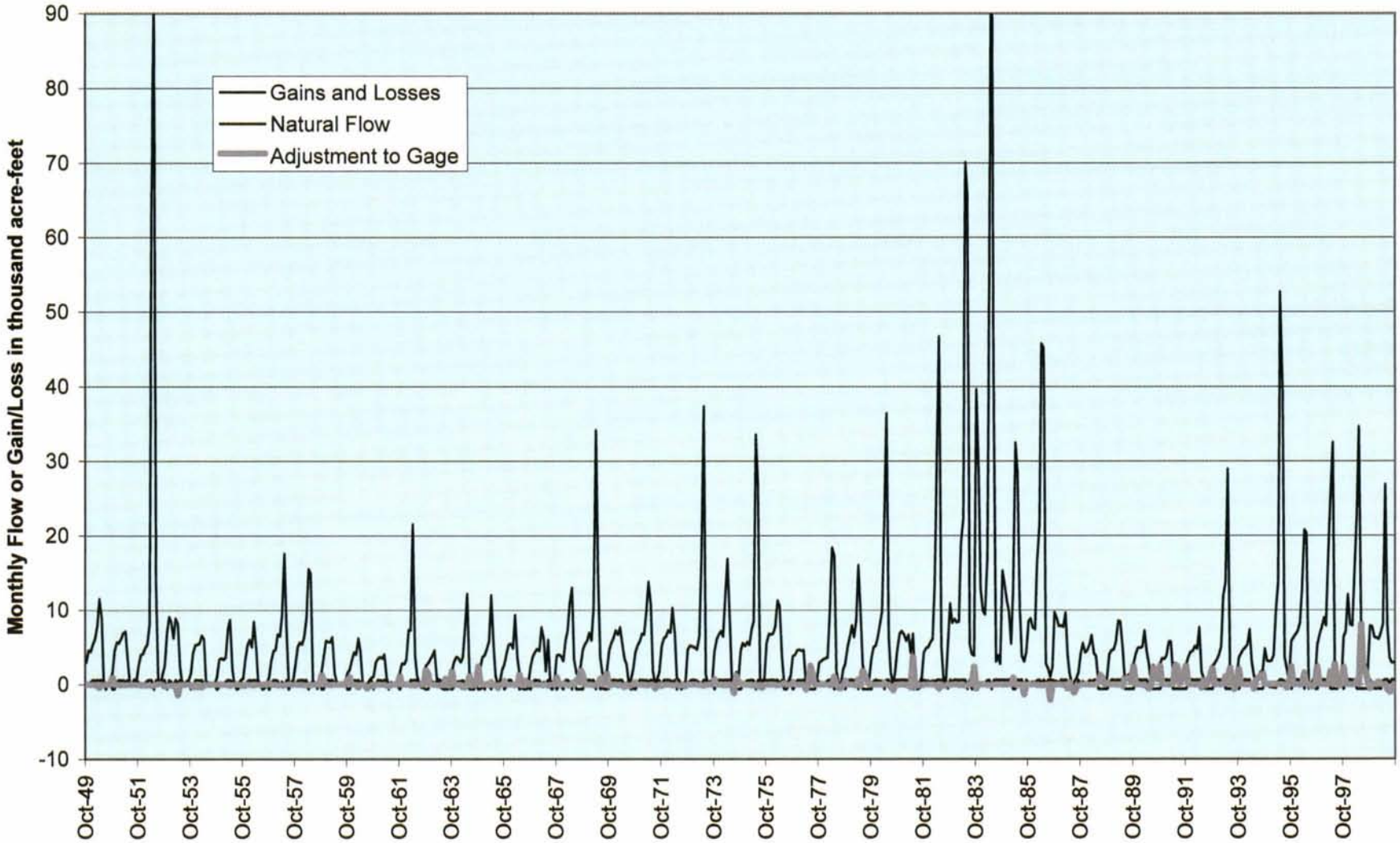


Table 1

Summary of Hydrologic Adjustment Adjusted Flows Compared with FN Data

Description	Franson-Noble Average Annual Flow	Adjusted Average Annual Flow
Total Losses above Red Hollow	4.22	2.41
Natural Inflow above Red Hollow	27.47	25.61
Total Flow at Red Hollow	93.50	93.49
Total Losses above Mouth	4.22	2.41
Hayes Ditch (River Loss)	0.05	0.05
Levanger Ditch (River Loss)	0.06	0.06
Natural Inflow above Mouth	17.87	16.04
Total Flow at Mouth	107.03	107.02
Spanish Fork @ Thistle Inflow*	72.49	76.45
SVP Irrig Clinton Losses	0.90	0.90
WA Pace Ditch Diversion	0.04	0.04
Total Flow above Strawberry Div Dam	179.31	182.53
Total Mapleton Diversion	9.39	9.40
Total Turnout C Diversion	0.21	0.20
Total Highline Diversion	41.05	41.05
Total Salem Diversion	19.36	19.36
Total Flow below Strawberry Div Dam	28.07	36.72
Total East Bench Diversion	13.10	13.11
Total Flow below E Bench	14.98	23.61
Gains & Losses Below East Bench	1.79	2.92
Total Power Canal Return flow	81.49	75.80
Total Flow above Mill Race	98.25	102.32
Total Mill Race Diversion	15.45	15.45
Flow below Mill Race	82.80	86.87
Gains & Losses above Lakeshore	3.00	1.41
Flow above Lakeshore	85.80	88.28
Total Lakeshore Diversion	6.51	6.53
Flow below Lakeshore	79.29	81.75
Total SVP Diversions	56.01	56.80
Total River Diversions	48.27	47.50
Total Diversions	104.28	104.30

Table 2

Spanish Fork Hydrologic Adjustment

Spanish Fork Gains below East Bench

Monthly Volume in Acre-feet

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1950	181	181	192	307	278	297	298	307	243	181	307	298	3,070
1951	181	181	181	307	278	307	209	307	181	181	307	298	2,919
1952	237	181	181	181	248	307	298	181	298	181	307	298	2,898
1953	307	181	307	208	181	296	181	307	296	307	307	298	3,178
1954	181	181	290	307	278	307	181	307	298	307	181	181	3,000
1955	181	181	181	181	214	307	298	260	298	181	181	298	2,760
1956	181	181	237	307	278	307	298	307	298	307	181	298	3,180
1957	181	181	307	307	278	181	213	181	298	181	307	298	2,913
1958	181	258	307	306	278	307	181	181	298	307	181	298	3,083
1959	181	181	307	307	278	307	181	307	203	181	181	298	2,913
1960	181	181	196	307	251	278	209	181	298	307	307	298	2,994
1961	181	181	307	297	248	307	298	181	298	307	181	181	2,967
1962	181	181	181	181	181	307	298	307	298	307	181	181	2,784
1963	181	181	181	216	181	225	298	181	181	224	181	181	2,411
1964	181	181	188	211	222	248	191	181	181	307	181	261	2,532
1965	181	181	181	181	186	181	181	181	181	181	181	262	2,258
1966	181	181	307	307	181	181	181	181	298	307	181	181	2,668
1967	181	181	307	284	278	181	184	181	298	181	181	181	2,618
1968	181	181	181	181	278	306	194	181	298	181	181	181	2,523
1969	181	188	307	307	278	307	181	307	181	181	181	181	2,781
1970	181	298	307	307	278	307	298	181	181	307	181	181	3,007
1971	181	181	307	307	278	281	203	307	298	307	307	298	3,256
1972	181	298	307	307	278	189	298	181	263	307	307	181	3,098
1973	181	245	300	307	239	181	181	307	298	307	307	298	3,152
974	181	181	307	307	278	307	298	307	298	307	181	181	3,134
975	181	181	181	264	278	307	261	181	298	307	307	298	3,044
1976	307	298	307	307	278	307	181	307	298	307	181	298	3,377
1977	181	181	272	284	278	307	181	181	298	307	181	298	2,949
1978	237	181	181	181	250	307	298	181	298	307	307	298	3,026
1979	181	181	307	307	278	307	181	256	181	307	181	181	2,849
1980	181	210	307	258	245	230	181	307	298	181	307	298	3,005
1981	307	298	307	307	278	307	298	181	298	307	181	298	3,367
1982	307	246	239	196	241	214	298	307	298	278	307	181	3,112
1983	307	213	307	307	278	307	298	307	181	307	181	181	3,176
1984	181	181	181	181	181	271	298	181	298	307	307	298	2,864
1985	307	298	307	307	181	181	181	307	298	307	181	298	3,154
1986	181	181	190	181	278	289	181	307	181	307	307	298	2,881
1987	241	217	181	307	278	307	204	181	298	307	181	298	3,000
1988	181	220	181	181	278	205	298	307	298	307	307	181	2,944
1989	181	181	307	307	278	307	298	307	298	307	307	181	3,260
1990	181	188	307	307	278	307	298	181	298	181	181	181	2,888
1991	181	181	307	307	278	307	181	181	181	181	181	181	2,648
1992	181	181	307	307	278	307	298	243	184	307	181	181	2,957
1993	181	181	307	307	278	307	181	181	181	181	307	181	2,774
1994	181	181	272	307	278	307	181	181	181	181	181	181	2,613
1995	237	181	181	181	181	181	192	307	298	211	181	298	2,628
1996	181	181	307	307	278	307	181	307	181	307	307	181	3,027
1997	181	181	307	307	278	307	181	181	181	181	307	262	2,855
1998	181	181	307	307	278	307	181	181	181	181	181	181	2,648
1999	267	181	181	181	181	181	248	307	298	181	281	298	2,785
Average	**202**	**200**	**258**	**269**	**254**	**274**	**232**	**241**	**257**	**258**	**234**	**242**	**2,919**
Maximum	**307**	**298**	**307**	**307**	**278**	**307**	**298**	**307**	**298**	**307**	**307**	**298**	**3,377**
Minimum	**181**	**181**	**181**	**181**	**181**	**181**	**181**	**181**	**181**	**181**	**181**	**181**	**2,258**
Percent	**7%**	**7%**	**9%**	**9%**	**9%**	**9%**	**8%**	**8%**	**9%**	**9%**	**8%**	**8%**	

Table 3

Spanish Fork Hydrologic Adjustment

Adjusted Gains/Losses above Lakeshore*

Monthly Volume in Acre-feet

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1950	(36)	149	338	615	555	615	595	615	397	(615)	49	312	3,588
1951	(615)	(595)	289	615	555	615	378	615	(207)	(121)	615	290	2,434
1952	387	(141)	102	227	503	615	595	(615)	595	409	609	595	3,882
1953	615	(595)	615	402	(91)	615	203	615	483	185	1	435	3,482
1954	(615)	(251)	600	615	555	615	89	510	223	142	35	7	2,526
1955	(615)	(301)	(131)	(1)	406	615	595	424	240	(615)	(453)	515	678
1956	(375)	(341)	473	615	555	615	595	615	-	(608)	(412)	(116)	1,616
1957	(615)	(91)	615	615	555	(201)	411	(353)	595	(615)	322	595	1,833
1958	(272)	522	615	615	555	615	(595)	(20)	595	74	(538)	391	2,558
1959	(615)	(595)	615	615	555	615	239	421	138	(252)	36	447	2,220
1960	(615)	(595)	354	615	499	602	341	179	(415)	(0)	162	595	1,723
1961	(615)	59	615	613	492	615	595	(615)	344	139	55	(258)	2,040
1962	(615)	179	79	119	(241)	615	595	615	595	(225)	(369)	(403)	944
1963	(615)	(595)	139	414	229	448	595	(376)	(595)	(615)	(615)	(426)	(2,011)
1964	(615)	(311)	322	399	428	532	339	24	(595)	(615)	(615)	83	(622)
1965	(615)	(595)	(251)	(615)	314	(231)	(595)	222	(451)	(615)	(527)	550	(3,409)
1966	(615)	(231)	615	615	99	169	290	(615)	(373)	(615)	(615)	(414)	(1,690)
1967	(615)	259	615	586	555	69	317	199	595	(393)	(615)	97	1,670
1968	(615)	(251)	(211)	(615)	555	615	346	(615)	595	(615)	(615)	(595)	(2,020)
1969	(615)	322	615	615	555	615	(595)	615	(595)	(431)	(615)	(595)	(108)
1970	(526)	595	615	615	555	615	595	(205)	(114)	(138)	(615)	(467)	1,525
1971	(615)	(61)	615	615	555	589	420	615	595	231	2	595	4,155
1972	(200)	595	615	615	555	331	595	(615)	595	(615)	(125)	258	2,604
1973	3	492	615	615	471	266	108	615	595	12	432	595	4,820
1974	(615)	209	615	615	555	615	595	615	595	(50)	(615)	(595)	2,539
1975	(615)	(95)	204	540	555	615	530	(615)	595	615	462	595	3,387
1976	536	595	615	615	555	615	115	588	(595)	(615)	(241)	595	3,378
1977	(615)	(311)	558	586	555	615	4	(615)	(595)	(615)	(615)	477	(570)
1978	387	(141)	102	227	501	615	595	(615)	595	(0)	(0)	595	2,861
1979	(615)	259	615	615	555	615	(595)	537	(595)	(615)	(615)	(595)	(433)
1980	(615)	397	615	526	489	462	(595)	615	595	208	(0)	595	3,292
1981	589	595	615	615	555	615	595	(615)	(595)	(615)	(446)	595	2,503
1982	575	493	477	354	475	415	595	615	595	615	286	(535)	4,960
1983	615	407	615	615	555	615	595	615	(595)	615	(615)	(595)	3,441
1984	(238)	202	(153)	197	169	565	595	(615)	595	615	615	595	3,142
1985	615	595	615	615	142	(615)	(595)	615	595	615	(615)	595	3,177
1986	271	268	331	222	555	606	164	615	141	615	615	595	4,997
1987	472	415	192	615	555	615	492	(615)	(595)	(311)	(615)	595	1,816
1988	2	422	(228)	122	555	378	595	615	(595)	(615)	(615)	(595)	41
1989	(615)	(32)	615	615	555	615	595	615	(595)	(615)	(615)	(595)	543
1990	(615)	316	615	615	555	615	595	(221)	(595)	(615)	(615)	(595)	55
1991	(615)	(67)	615	615	555	615	(595)	(615)	(595)	(615)	(615)	(595)	(1,911)
1992	(615)	105	615	615	555	615	595	615	(595)	(599)	(615)	(595)	696
1993	(615)	128	615	615	555	615	(595)	(615)	(595)	(615)	(615)	(119)	(1,240)
1994	(615)	(10)	558	615	555	615	(595)	(615)	(595)	(615)	(615)	(595)	(1,912)
1995	468	(210)	(349)	(380)	(429)	(489)	337	615	595	370	137	595	1,260
1996	(615)	102	615	615	555	615	(595)	615	(595)	(422)	611	(595)	907
1997	(615)	132	615	615	555	615	(595)	(615)	(595)	(615)	110	378	(15)
1998	(615)	175	615	615	555	615	(595)	(615)	(595)	(615)	(615)	(595)	(1,670)
1999	615	(342)	(582)	(615)	(555)	(615)	443	615	595	210	615	595	979
Average	**(279)**	**45**	**396**	**435**	**433**	**459**	**195**	**88**	**(4)**	**(216)**	**(205)**	**66**	**1,413**
Maximum	**615**	**595**	**615**	**615**	**555**	**615**	**595**	**615**	**595**	**615**	**615**	**595**	**4,997**
Minimum	**(615)**	**(595)**	**(582)**	**(615)**	**(555)**	**(615)**	**(595)**	**(615)**	**(595)**	**(615)**	**(615)**	**(595)**	**(3,409)**
Percent	**-20%**	**3%**	**28%**	**31%**	**31%**	**32%**	**14%**	**6%**	**0%**	**-15%**	**-15%**	**5%**	

Table 4

Spanish Fork Hydrologic Adjustment

SVP Losses in Sixth Water and Diamond Fork*

Monthly Volume in Acre-feet

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1950	-	-	-	-	-	-	43	-	-	979	1,455	950	3,427
1951	51	-	-	-	-	-	56	115	511	1,527	989	300	3,548
1952	35	-	-	-	-	-	-	-	-	-	-	-	35
1953	767	226	-	-	-	-	156	-	1,163	1,733	1,337	653	6,034
1954	247	40	-	41	-	44	59	249	1,846	1,083	1,077	145	4,831
1955	251	-	-	-	-	-	-	-	1,916	1,337	766	485	4,755
1956	181	-	-	-	-	-	-	-	2,113	1,757	1,327	639	6,017
1957	101	-	-	-	-	-	-	-	507	436	697	591	2,332
1958	218	-	-	-	-	-	43	77	426	1,192	471	14	2,441
1959	221	-	-	-	-	-	-	237	1,258	213	-	112	2,040
1960	151	-	-	-	-	41	45	-	2,393	1,954	1,591	321	6,496
1961	91	-	-	-	-	-	-	1,347	1,791	1,101	163	-	4,492
1962	-	-	-	-	-	-	-	-	906	1,054	914	333	3,206
1963	141	-	-	-	-	-	-	-	570	1,548	1,208	357	3,823
1964	221	-	-	-	-	44	43	-	-	2,581	1,197	653	4,739
1965	121	-	-	-	-	-	-	-	-	1,444	1,118	610	3,292
1966	78	-	-	-	-	-	-	413	2,220	1,611	1,494	442	6,257
1967	181	-	-	-	-	-	-	-	106	1,913	1,777	711	4,687
1968	-	-	-	-	-	-	-	-	885	2,114	301	726	4,026
1969	226	-	-	-	-	-	-	-	-	1,717	1,812	731	4,485
1970	178	-	-	-	-	-	-	40	491	2,056	1,885	323	4,972
1971	150	-	-	-	-	-	-	-	1,357	2,252	2,122	-	5,881
1972	36	-	-	-	-	-	-	880	1,667	2,069	1,573	415	6,640
1973	-	-	-	-	-	-	-	-	-	2,065	1,816	-	3,881
1974	-	-	-	-	-	-	-	-	1,660	1,753	1,951	540	5,904
1975	156	-	-	-	-	-	-	-	118	1,729	2,257	725	4,985
976	-	-	-	-	-	-	-	-	2,149	2,273	1,949	178	6,549
)77	84	-	-	-	-	-	261	822	2,150	1,875	1,467	381	7,039
1978	2	-	-	-	-	-	-	-	1,209	2,449	2,042	346	6,048
1979	-	-	-	-	-	-	-	56	1,960	2,220	340	1,165	5,741
1980	210	-	-	-	-	-	-	-	731	1,878	2,090	-	4,909
1981	260	-	-	-	-	-	111	672	1,831	2,139	2,045	549	7,607
1982	-	-	-	-	-	-	-	64	-	1,732	2,010	-	3,806
1983	-	-	-	-	-	-	-	-	-	-	-	52	52
1984	61	-	-	-	-	-	-	-	-	-	-	-	61
1985	-	-	-	-	-	-	-	65	-	526	2,123	-	2,714
1986	-	-	-	-	-	-	-	-	-	1,111	1,793	-	2,904
1987	-	-	-	-	-	-	272	1,042	2,364	1,861	1,783	1,061	8,381
1988	137	-	-	-	-	-	-	655	2,348	2,569	2,048	863	8,620
1989	-	-	-	-	-	-	130	1,454	2,401	2,429	1,522	261	8,196
1990	-	-	-	-	-	-	30	938	1,368	2,517	2,128	1,021	8,001
1991	-	-	-	-	-	-	-	-	607	2,189	1,940	-	4,736
1992	-	-	-	-	-	-	-	1,273	2,067	1,503	1,724	416	6,983
1993	-	-	-	-	-	-	-	-	401	1,708	2,029	14	4,153
1994	56	-	-	-	-	-	-	722	2,206	2,260	1,364	992	7,601
1995	-	-	-	-	-	-	-	-	-	870	1,809	-	2,679
1996	-	-	-	-	-	-	-	-	415	1,731	2,037	-	4,183
1997	-	-	-	-	-	-	-	-	-	1,381	1,444	-	2,825
1998	-	-	-	-	-	-	-	-	132	1,939	2,075	-	4,146
1999	96	-	-	-	-	-	-	-	1,145	2,296	1,968	304	5,809
Average	**94**	**5**	**-**	**1**	**-**	**3**	**25**	**222**	**988**	**1,613**	**1,421**	**368**	**4,739**
Maximum	**767**	**226**	**-**	**41**	**-**	**44**	**272**	**1,454**	**2,401**	**2,581**	**2,257**	**1,165**	**8,620**
Minimum	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**35**
Percent	**2%**	**0%**	**0%**	**0%**	**0%**	**0%**	**1%**	**5%**	**21%**	**34%**	**30%**	**8%**	

*** Historical losses limited to a maximum of 10 percent**

Table 5

Spanish Fork Hydrologic Adjustment

Adjusted SVP Diversions at Lakeshore and Mill Race

Monthly Volume in Acre-feet

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1950	1,080	-	-	-	-	-	-	-	443	717	1,915	1,474	5,630
1951	-	-	-	-	-	-	-	-	634	1,893	1,627	1,220	5,373
1952	104	-	-	-	-	-	-	-	-	561	479	767	1,910
1953	248	-	-	-	-	-	-	-	147	1,417	1,638	1,442	4,892
1954	146	-	-	-	-	-	14	99	1,257	1,915	2,080	351	5,860
1955	176	-	-	-	-	-	-	-	1,206	2,936	1,543	453	6,316
1956	90	-	-	-	-	-	-	-	2,134	1,988	1,865	835	6,911
1957	234	-	-	-	-	-	-	-	134	1,350	1,367	831	3,916
1958	88	-	-	-	-	-	-	-	291	2,111	2,128	560	5,179
1959	73	-	-	-	-	-	-	586	1,550	886	886	500	4,481
1960	2	-	-	-	-	-	-	-	2,606	2,189	1,570	402	6,769
1961	71	-	-	-	-	-	-	744	1,610	895	237	137	3,693
1962	-	-	-	-	-	-	-	-	742	1,199	1,653	261	3,855
1963	76	-	-	-	-	-	-	-	-	1,570	1,377	331	3,355
1964	370	-	-	-	-	-	-	-	-	2,628	1,428	1,191	5,615
1965	112	-	-	-	-	-	-	-	-	178	533	272	1,095
1966	96	-	-	-	-	-	-	-	1,346	2,040	1,902	668	6,053
1967	351	-	-	-	-	-	-	-	-	849	1,265	590	3,054
1968	-	-	-	-	-	-	-	-	30	615	648	523	1,816
1969	124	-	-	-	-	-	-	-	-	487	1,645	870	3,127
1970	124	-	-	-	-	-	-	-	-	1,004	2,307	244	3,679
1971	182	-	-	-	-	-	-	-	-	1,151	1,319	-	2,653
1972	-	-	-	-	-	-	-	-	274	2,802	2,402	104	5,582
1973	-	-	-	-	-	-	-	-	-	897	603	208	1,708
1974	24	-	-	-	-	-	-	-	507	848	2,271	495	4,145
1975	217	-	-	-	-	-	-	-	-	958	909	1,263	3,347
1976	278	-	-	-	-	-	-	-	2,966	3,766	2,432	465	9,906
1977	60	-	-	-	-	-	30	572	2,673	3,062	2,384	922	9,701
1978	87	-	-	-	-	-	-	-	345	3,014	1,658	321	5,425
1979	39	-	-	-	-	-	-	-	439	2,871	1,969	1,534	6,852
1980	344	-	-	-	-	-	-	-	-	-	1,496	258	2,099
1981	108	-	-	-	-	-	-	-	894	3,125	2,449	142	6,717
1982	69	-	-	-	-	-	-	-	-	-	1,275	46	1,390
1983	-	-	-	-	-	-	-	-	-	-	-	-	-
1984	-	-	-	-	-	-	-	-	-	-	-	-	-
1985	-	-	-	-	-	-	-	-	-	-	650	1,129	1,779
1986	54	-	-	-	-	-	-	-	-	-	-	-	54
1987	-	-	-	-	-	-	-	-	1,986	2,003	1,898	849	6,735
1988	172	-	-	-	-	-	-	591	2,480	3,369	2,353	272	9,238
1989	100	-	-	-	-	-	113	135	2,867	3,567	2,157	753	9,691
1990	-	-	-	-	-	-	-	141	567	4,570	3,101	1,345	9,724
1991	-	-	-	-	-	-	-	-	1,143	2,003	2,543	55	5,744
1992	-	-	-	-	-	-	1,222	1,238	1,737	637	1,838	423	7,095
1993	-	-	-	-	-	-	-	-	-	961	1,373	150	2,485
1994	-	-	-	-	-	-	-	250	1,550	2,593	1,031	522	5,945
1995	-	-	-	-	-	-	-	-	-	83	1,189	649	1,921
1996	-	-	-	-	-	-	-	-	-	1,165	1,259	266	2,690
1997	-	-	-	-	-	-	-	-	-	1,042	444	202	1,688
1998	-	-	-	-	-	-	-	-	-	728	1,687	1,760	4,175
1999	-	-	-	-	-	-	-	-	260	1,110	1,290	420	3,080
Average	**106**	**-**	**-**	**-**	**-**	**-**	**28**	**87**	**696**	**1,515**	**1,481**	**570**	**4,483**
Maximum	**1,080**	**-**	**-**	**-**	**-**	**-**	**1,222**	**1,238**	**2,966**	**4,570**	**3,101**	**1,760**	**9,906**
Minimum	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Percent	**2%**	**0%**	**0%**	**0%**	**0%**	**0%**	**1%**	**2%**	**16%**	**34%**	**33%**	**13%**	

Table 6

Spanish Fork Hydrologic Adjustment

Change to SVP Diversions at Lakeshore and Mill Race

Monthly Volume in Acre-feet

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1950	-	-	-	-	-	-	-	-	-	-	-	-	-
1951	-	-	-	-	-	-	-	-	-	-	-	-	-
1952	-	-	-	-	-	-	-	-	-	-	-	-	-
1953	-	-	-	-	-	-	-	-	-	0	-	-	0
1954	-	-	-	-	-	-	-	-	-	-	0	-	0
1955	0	-	-	-	-	-	-	-	752	-	-	-	752
1956	-	-	-	-	-	-	-	-	1,683	-	0	-	1,683
1957	-	-	-	-	-	-	-	-	-	-	-	-	-
1958	-	-	-	-	-	-	-	-	-	0	-	-	0
1959	-	-	-	-	-	-	-	-	0	-	-	0	0
1960	-	-	-	-	-	-	-	-	1,063	238	-	-	1,301
1961	-	-	-	-	-	-	-	-	-	0	-	-	0
1962	-	-	-	-	-	-	-	-	-	-	-	-	-
1963	-	-	-	-	-	-	-	-	-	543	-	-	543
1964	0	-	-	-	-	-	-	-	-	155	-	0	155
1965	41	-	-	-	-	-	-	-	-	178	-	-	220
1966	-	-	-	-	-	-	-	-	458	405	-	-	863
1967	0	-	-	-	-	-	-	-	-	0	-	-	0
1968	-	-	-	-	-	-	-	-	-	-	-	-	-
1969	-	-	-	-	-	-	-	-	-	-	-	0	0
1970	-	-	-	-	-	-	-	-	-	-	-	-	-
1971	-	-	-	-	-	-	-	-	-	-	-	-	-
1972	-	-	-	-	-	-	-	-	-	2,256	-	-	2,256
1973	-	-	-	-	-	-	-	-	-	897	444	-	1,341
1974	-	-	-	-	-	-	-	-	-	116	-	-	116
1975	-	-	-	-	-	-	-	-	-	-	-	-	-
1976	-	-	-	-	-	-	-	-	2,433	1,561	-	-	3,995
1977	-	-	-	-	-	-	30	367	1,762	2,334	-	-	4,492
1978	-	-	-	-	-	-	-	-	-	889	62	-	951
1979	-	-	-	-	-	-	-	-	-	2,124	-	-	2,124
1980	-	-	-	-	-	-	-	-	-	-	194	-	194
1981	-	-	-	-	-	-	-	-	220	1,598	-	-	1,818
1982	-	-	-	-	-	-	-	-	-	-	603	-	603
1983	-	-	-	-	-	-	-	-	-	-	-	-	-
1984	-	-	-	-	-	-	-	-	-	-	-	-	-
1985	-	-	-	-	-	-	-	-	-	-	-	-	-
1986	-	-	-	-	-	-	-	-	-	-	-	-	-
1987	-	-	-	-	-	-	-	-	620	-	0	-	620
1988	-	-	-	-	-	-	-	-	1,318	914	824	-	3,056
1989	-	-	-	-	-	-	-	-	703	1,128	1,001	651	3,484
1990	-	-	-	-	-	-	-	-	-	3,167	351	519	4,037
1991	-	-	-	-	-	-	-	-	1,143	-	0	-	1,143
1992	-	-	-	-	-	-	-	-	558	229	32	-	818
1993	-	-	-	-	-	-	-	-	-	423	483	-	906
1994	-	-	-	-	-	-	-	-	388	521	613	-	1,522
1995	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	-	-	-	-	-	-	-	-	-	625	-	-	625
1997	-	-	-	-	-	-	-	-	-	-	-	-	-
1998	-	-	-	-	-	-	-	-	-	0	-	-	0
1999	-	-	-	-	-	-	-	-	-	0	-	-	0
Average	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**7**	**262**	**406**	**92**	**23**	**792**
Maximum	**41**	**-**	**-**	**-**	**-**	**-**	**30**	**367**	**2,433**	**3,167**	**1,001**	**651**	**4,492**
Minimum	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Percent	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**1%**	**33%**	**51%**	**12%**	**3%**	

Table 7

SPANISH FORK HYDROLOGIC ADJUSTMENT - Annual Results

NODE:	Sixth Water at Strawberry Tunnel Outlet		Diamond Fork at Red Hollow				Diamond Fork at Mouth						Spanish Fork at Castilla				
Year	Natural Inflow - 6th Water	TOTAL FLOW at 6th Water	Losses	Nat. Inflow-Diamond Fork	TOTAL FLOW at Red Hollow	FN Flow at Red Hollow	Losses	Hayes Ditch (Total Loss)	Levanger Ditch (Total Loss)	Nat. Inflow	TOTAL FLOW at Mouth	FN Flow at Mouth	SF @ Thistle Inflow	SVP Irrig Clinton Losses	WA Pace Ditch	TOTAL FLOW above Div Dam	FN Flow above Dam
1950	3.18	75.06	1.71	17.16	90.50	90.39	1.71	0.03	0.10	19.00	107.65	107.55	64.50	1.07	0.05	171.04	167.30
1951	3.07	71.65	1.77	16.43	86.31	86.13	1.77	0.06	0.15	22.35	106.67	106.49	50.45	0.94	0.06	156.13	153.40
1952	9.10	59.13	0.02	51.96	111.07	111.39	0.02	0.00	0.24	37.86	148.68	149.00	168.20	1.15	0.00	315.73	310.60
1953	3.11	86.43	3.02	16.45	99.86	99.95	3.02	0.10	0.14	18.14	114.74	114.83	59.66	1.03	0.02	173.35	169.90
1954	1.73	80.97	2.42	9.07	87.63	87.38	2.42	0.07	0.13	8.62	93.64	93.38	40.68	1.27	0.05	133.00	131.80
1955	1.40	75.35	2.38	7.20	80.17	80.20	2.38	0.05	0.16	10.84	88.42	88.45	47.48	1.02	0.05	134.83	133.90
1956	2.47	79.84	3.01	12.56	89.39	89.30	3.01	0.03	0.08	8.17	94.44	94.35	48.71	1.04	0.05	142.06	137.50
1957	3.33	61.23	1.17	18.50	78.56	78.80	1.17	0.04	0.08	14.28	91.56	91.80	72.92	1.08	0.10	163.31	161.00
1958	3.13	70.17	1.22	16.88	85.82	85.73	1.22	0.05	0.06	17.76	102.26	102.16	77.61	0.99	0.06	178.82	177.00
1959	1.21	70.82	1.02	6.05	75.85	75.70	1.02	0.10	0.07	10.05	84.71	84.56	35.38	1.14	0.06	118.89	117.50
1960	1.44	81.00	3.25	6.30	84.06	83.88	3.25	0.08	0.12	6.39	89.01	88.83	37.38	1.04	0.05	125.30	122.30
1961	1.19	56.45	2.25	5.67	59.87	59.83	2.25	0.06	0.07	7.61	65.10	65.07	19.47	0.75	0.04	83.79	83.10
1962	3.37	49.54	1.60	18.52	66.45	66.61	1.60	0.06	0.07	10.95	75.67	75.82	65.71	0.70	0.02	140.66	137.00
1963	2.19	47.33	1.91	11.35	56.77	56.90	1.91	0.08	0.15	13.65	68.28	68.41	31.53	0.59	0.01	99.22	100.80
1964	2.91	63.76	2.37	15.41	76.80	76.70	2.37	0.07	0.11	13.77	88.03	87.92	37.99	0.84	0.02	125.15	125.40
1965	4.76	47.63	1.65	26.06	72.05	72.20	1.65	0.11	0.12	21.65	91.83	91.98	61.14	0.73	0.08	152.15	153.40
1966	2.51	75.89	3.13	13.11	85.87	85.90	3.13	0.11	0.12	13.61	96.12	96.15	43.55	0.92	0.05	138.70	138.50
1967	3.03	63.33	2.34	16.28	77.27	77.30	2.34	0.11	0.16	16.41	91.06	91.09	62.07	0.72	0.09	152.32	152.20
1968	3.98	60.18	2.01	21.61	79.77	79.80	2.01	0.12	0.11	14.93	92.46	92.49	71.17	0.87	0.09	162.67	163.70
1969	5.92	69.33	2.24	32.94	100.03	100.06	2.24	0.13	0.17	28.19	125.68	125.71	95.95	0.83	0.11	220.69	221.40
1970	3.43	66.28	2.49	18.47	82.26	82.29	2.49	0.12	0.13	9.52	89.04	89.07	70.40	1.00	0.05	158.49	154.40
1971	3.90	69.41	2.94	21.12	87.59	87.62	2.94	0.11	0.08	15.47	99.93	99.96	79.36	0.85	0.07	178.37	169.60
1972	3.02	76.63	3.32	15.10	88.41	88.49	3.32	0.13	0.15	14.85	99.66	99.74	52.26	1.02	0.04	150.86	147.80
1973	4.65	61.21	1.94	24.88	84.16	84.18	1.94	0.10	0.11	9.39	91.40	91.43	101.02	0.73	0.09	191.59	183.60
1974	4.21	73.64	2.95	22.60	93.28	93.31	2.95	0.12	0.06	16.79	106.94	106.97	83.92	1.04	0.03	189.79	180.00
1975	5.21	66.95	2.49	28.30	92.76	92.79	2.49	0.07	0.01	16.23	106.42	106.45	99.46	0.68	0.00	204.20	197.10
1976	3.19	87.70	3.27	15.31	99.73	99.75	3.27	0.04	0.01	14.01	110.41	110.43	58.13	0.52	0.01	168.02	163.10
1977	1.86	80.09	3.52	6.66	83.23	83.17	3.52	0.04	0.00	12.01	91.68	91.62	23.28	0.87	0.07	114.01	115.10
1978	3.62	72.16	3.02	18.85	87.98	88.00	3.02	0.04	0.01	14.49	99.40	99.42	71.37	0.99	0.10	169.68	160.20
1979	7.76	82.14	2.87	41.91	121.18	121.12	2.87	0.13	0.00	7.52	125.70	125.64	61.06	1.03	0.09	185.63	181.40
1980	7.08	67.84	2.45	38.69	104.08	104.10	2.45	0.07	0.00	12.62	114.17	114.19	107.88	0.89	0.10	221.07	214.90
1981	2.36	82.52	3.80	11.34	90.06	90.02	3.80	0.02	0.00	15.55	101.78	101.75	44.55	0.88	0.06	145.39	142.40
1982	7.64	61.50	1.90	41.97	101.56	101.50	1.90	0.05	0.00	14.84	114.44	114.38	125.14	0.72	0.11	238.75	234.80
1983	7.91	27.98	0.03	44.39	72.35	72.73	0.03	0.00	0.00	37.97	110.29	110.67	200.81	0.00	0.00	311.10	301.90
1984	14.17	44.53	0.03	79.67	124.17	124.28	0.03	0.00	0.00	15.34	139.48	139.59	279.42	0.28	0.00	418.62	412.80
1985	8.62	64.88	1.36	36.00	99.52	99.46	1.36	0.00	0.00	33.71	131.87	131.81	127.15	0.92	0.00	258.10	251.50
1986	8.82	63.64	1.45	48.51	110.70	110.85	1.45	0.04	0.00	17.30	126.51	126.66	147.34	0.69	0.00	273.16	269.27
1987	3.24	88.89	4.19	15.68	100.39	100.35	4.19	0.05	0.00	9.67	105.81	105.78	55.43	1.37	0.00	159.87	159.27
1988	2.30	94.68	4.31	10.15	100.52	100.54	4.31	0.03	0.00	10.29	106.47	106.49	45.85	1.38	0.00	150.94	151.92
1989	1.77	122.10	4.10	6.77	124.77	124.77	4.10	0.05	0.00	16.74	137.36	137.36	41.98	1.13	0.00	178.21	174.81
1990	1.72	121.42	4.00	5.82	123.24	123.24	4.00	0.03	0.00	16.51	135.72	135.72	37.62	1.07	0.00	172.28	170.69
1991	1.56	94.77	2.37	6.95	99.35	99.35	2.37	0.01	0.00	15.07	112.05	112.04	39.90	1.00	0.00	150.94	150.93
1992	0.90	141.99	3.62	3.18	141.55	141.55	3.62	0.00	0.00	11.21	149.14	149.14	33.56	1.12	0.00	181.58	174.61
1993	4.29	109.16	2.33	22.08	128.91	128.91	2.33	0.00	0.00	16.55	143.13	143.13	78.28	0.99	0.00	220.42	221.08
1994	2.49	98.89	3.81	11.54	106.61	106.62	3.81	0.00	0.00	13.26	116.06	116.06	35.32	1.27	0.00	150.11	153.09
1995	5.84	59.46	1.34	31.65	89.77	89.77	1.34	0.00	0.00	16.72	105.15	105.14	116.28	0.81	0.00	222.61	213.13
1996	4.13	73.12	2.70	21.93	92.35	91.98	2.70	0.00	0.00	21.03	110.69	110.69	90.59	1.08	0.00	200.21	198.26
1997	7.25	66.20	2.17	39.75	103.78	103.78	2.17	0.00	0.00	12.61	114.22	114.22	110.74	0.59	0.00	224.37	223.92
1998	5.92	67.50	2.13	31.96	97.34	97.34	2.13	0.00	0.00	23.97	119.18	119.18	124.19	0.61	0.00	242.77	239.00
1999	3.36	85.17	2.91	16.69	98.96	98.95	2.91	0.00	0.00	24.63	120.68	120.68	87.84	0.96	0.00	207.56	197.48
MAX	**14.17**	**141.99**	**4.31**	**79.67**	**141.55**	**141.55**	**4.31**	**0.13**	**0.24**	**37.97**	**149.14**	**149.14**	**279.42**	**1.38**	**0.11**	**418.62**	**412.80**
MIN	**0.90**	**27.98**	**0.02**	**3.18**	**56.77**	**56.90**	**0.02**	**0.00**	**0.00**	**7.52**	**65.10**	**65.07**	**19.47**	**0.00**	**0.00**	**83.79**	**83.10**
SUM	**203.24**	**3717.52**	**120.30**	**1077.44**	**4674.66**	**4674.95**	**120.30**	**2.70**	**2.96**	**802.07**	**5350.77**	**5351.43**	**3822.69**	**45.18**	**1.85**	**9126.43**	**8965.74**
AVE Annual	**4.06**	**74.35**	**2.41**	**21.55**	**93.49**	**93.50**	**2.41**	**0.05**	**0.06**	**16.04**	**107.02**	**107.03**	**76.45**	**0.90**	**0.04**	**182.53**	**179.31**

Table 7 (continued)

SPANISH FORK HYDROLOGIC ADJUSTMENT - Annual Results

NODE:	Power Canal					East Bench				Spanish Fork at Mill Race					Spanish Fork at Lakeshore					
Year	Total Mapleton	Total Turnout C	Total Highline	Total Salem	Total Total Return	TOTAL FLOW below Div Dam	FN below Power Canal	Total East Bench	TOTAL FLOW below E Bench	Gains & Losses Below EB	TOTAL FLOW above Mill race	FN Total at Node	Total Mill Race	Flow below Mill Race	Gains & Losses	Flow above Lakeshore	FN above Lakeshore	Lakeshore Diver	Flow below Lakeshore	FN Below Lakeshore
1950	10.81	0.26	49.07	23.09	67.79	20.01	12.84	12.84	7.17	3.07	78.02	75.48	18.90	59.13	3.59	62.71	62.68	9.24	53.48	53.45
1951	10.16	0.25	46.32	21.41	57.41	20.59	14.15	14.15	6.43	2.92	66.76	64.17	18.43	48.33	2.43	50.76	49.26	7.78	42.99	41.48
1952	6.08	0.13	46.80	24.20	105.97	132.54	123.84	15.49	117.06	2.90	225.92	222.46	18.43	207.49	3.88	211.37	211.47	9.16	202.21	202.30
1953	11.01	0.18	46.68	24.02	67.59	23.87	13.50	13.50	10.37	3.18	81.13	77.96	18.86	62.27	3.48	65.76	64.02	7.51	58.25	56.51
1954	11.26	0.23	40.46	17.63	46.59	16.83	12.00	12.00	4.84	3.00	54.42	53.02	14.95	39.47	2.53	42.00	41.81	5.02	36.98	36.79
1955	10.47	0.16	38.65	18.73	48.98	17.84	12.48	12.48	5.36	2.76	57.10	55.37	16.88	40.22	0.68	40.90	40.82	6.59	34.31	34.24
1956	10.73	0.28	41.30	21.50	45.49	22.76	12.87	12.87	9.88	3.18	58.55	54.40	17.83	40.72	1.62	42.34	42.33	7.75	34.59	34.58
1957	9.05	0.19	35.05	23.44	75.68	19.91	12.90	12.90	7.01	2.91	85.60	83.43	16.29	69.32	1.83	71.15	70.88	8.62	62.53	62.26
1958	9.77	0.27	44.38	23.33	77.58	23.49	17.73	14.84	8.64	3.08	89.31	87.37	18.09	71.22	2.56	73.78	73.41	7.99	65.79	65.42
1959	9.67	0.12	39.33	15.53	39.14	15.10	9.05	9.05	6.05	2.91	48.11	45.89	14.44	33.67	2.22	35.89	33.86	3.65	32.24	30.21
1960	10.28	0.17	40.76	18.22	36.21	19.67	10.98	10.98	8.68	2.99	47.88	44.77	15.42	32.46	1.72	34.19	32.27	5.37	28.82	26.91
1961	7.29	0.11	28.43	11.14	24.24	12.57	7.61	7.61	4.96	2.97	32.18	30.92	9.95	22.23	2.04	24.27	24.13	3.09	21.18	21.05
1962	7.66	0.17	33.88	17.80	62.86	18.28	11.34	11.34	6.94	2.78	72.59	68.61	14.63	57.96	0.94	58.90	57.99	6.59	52.31	51.40
1963	5.68	0.11	25.23	17.74	37.77	12.68	9.97	9.97	2.70	2.41	42.89	40.06	14.12	28.77	-2.01	26.76	22.67	6.02	20.74	16.65
1964	8.27	0.17	33.95	15.68	53.36	13.72	10.30	10.30	3.41	2.53	59.30	56.57	12.14	47.16	-0.62	46.54	43.54	5.26	41.28	38.28
1965	6.88	0.26	42.54	20.15	66.22	16.09	12.91	12.91	3.17	2.26	71.66	68.55	15.10	56.56	-3.41	53.15	50.04	7.83	45.32	42.21
1966	9.95	0.11	38.84	18.84	53.93	17.04	12.27	12.27	4.77	2.67	61.36	58.09	15.55	45.82	-1.69	44.13	41.88	6.08	38.04	35.80
1967	10.16	0.14	46.75	19.98	58.25	17.05	13.12	13.12	3.93	2.62	64.80	63.62	16.20	48.60	1.67	50.27	49.98	7.18	43.09	42.80
1968	8.54	0.15	42.26	18.33	77.12	16.27	13.19	13.19	3.09	2.52	82.73	79.49	13.34	69.39	-2.02	67.37	63.30	6.48	60.89	56.82
1969	11.28	0.35	48.82	23.70	101.95	34.59	32.19	15.88	18.70	2.78	123.43	120.40	18.93	104.50	-0.11	104.39	99.90	7.84	96.55	92.06
1970	9.53	0.28	41.90	19.85	65.22	21.61	13.24	13.24	8.37	3.01	76.59	72.88	16.78	59.82	1.53	61.34	61.47	7.48	53.86	53.99
1971	11.26	0.33	43.54	21.14	72.73	29.38	15.72	15.72	13.67	3.26	89.65	83.98	16.78	72.87	4.15	77.02	76.77	8.07	68.95	68.70
1972	10.11	0.16	37.89	21.31	57.95	23.44	13.21	13.21	10.23	3.10	71.28	68.51	15.72	55.56	2.60	58.17	58.32	6.14	52.02	52.18
1973	10.84	0.25	41.21	21.77	70.22	47.31	34.36	14.74	32.57	3.15	105.93	100.60	16.19	89.75	4.82	94.57	94.63	7.07	87.50	87.56
1974	11.80	0.12	45.28	22.93	78.92	30.73	15.46	15.46	15.28	3.13	97.34	89.48	19.54	77.80	2.54	80.34	78.22	7.50	72.84	70.72
1975	7.44	0.12	44.94	18.74	93.04	39.93	29.06	12.88	27.05	3.04	123.13	118.83	14.86	108.27	3.39	111.66	111.42	6.34	105.32	105.07
1976	10.45	0.08	43.30	20.59	64.81	28.79	14.93	14.93	13.86	3.38	82.04	77.96	16.24	65.80	3.38	69.18	68.60	6.89	62.29	61.71
1977	9.77	0.07	35.96	12.87	37.63	17.72	8.74	8.74	8.98	2.95	49.56	46.09	10.85	38.71	-0.57	38.14	32.07	4.11	34.03	28.58
1978	10.21	0.13	46.92	18.03	65.69	28.69	12.81	12.81	15.88	3.03	84.60	78.10	14.97	69.63	2.86	72.49	71.55	5.29	67.20	66.25
1979	11.23	0.06	49.14	19.13	77.86	28.23	16.22	16.22	12.01	2.85	92.71	86.03	16.39	76.32	-0.43	75.89	70.28	5.90	69.99	64.38
1980	9.18	0.04	49.39	20.56	96.11	45.79	34.15	16.75	29.04	3.00	128.16	123.54	15.36	112.80	3.29	116.09	115.63	7.68	108.41	107.94
1981	10.87	0.05	39.78	17.41	54.66	22.63	12.42	12.42	10.21	3.37	68.23	63.78	14.78	53.45	2.50	55.96	52.10	4.30	51.66	47.80
1982	8.62	0.07	43.98	22.76	109.93	53.38	45.07	16.34	37.04	3.11	150.09	147.59	15.81	134.28	4.96	139.24	139.22	8.57	130.67	130.65
1983	5.57	0.03	30.11	17.16	147.14	111.10	99.24	13.58	97.51	3.18	247.83	240.51	8.94	238.89	3.44	242.33	239.83	6.23	236.10	233.60
1984	7.90	0.10	30.71	20.18	204.49	155.24	147.87	13.80	141.45	2.86	348.80	344.67	12.47	336.32	3.14	339.47	339.64	7.74	331.73	331.90
1985	9.52	0.06	39.39	21.22	140.39	47.52	36.41	16.83	30.69	3.15	174.23	169.04	16.18	158.06	3.18	161.23	160.30	8.71	152.53	151.60
1986	10.08	0.27	38.00	20.60	148.48	55.73	47.36	16.62	39.11	2.88	190.47	188.26	16.86	173.61	5.00	178.61	178.84	6.74	171.87	172.10
1987	12.04	0.32	38.25	17.99	69.79	21.48	12.04	12.03	9.45	3.00	82.24	80.58	17.16	65.08	1.82	66.90	66.57	4.08	62.82	62.50
1988	12.70	0.40	41.72	20.10	53.38	22.65	15.17	14.02	8.62	2.94	64.95	62.46	16.54	48.41	0.04	48.45	45.08	5.06	43.39	40.02
1989	11.05	0.34	44.78	18.12	51.18	52.74	39.67	12.73	40.01	3.26	94.45	88.92	15.39	79.05	0.54	79.60	75.38	5.25	74.35	70.13
1990	10.78	0.27	39.59	17.86	47.14	56.64	45.00	10.70	45.94	2.89	95.96	90.43	16.04	79.93	0.06	79.98	72.67	3.75	76.23	69.06
1991	9.73	0.24	37.05	17.29	48.33	38.31	33.06	12.47	25.84	2.65	76.82	70.76	14.01	62.81	-1.91	60.90	51.20	4.24	56.66	46.96
1992	11.39	0.27	43.35	16.37	40.08	70.12	56.39	10.97	59.15	2.96	102.19	94.42	13.99	88.21	0.70	88.90	83.95	5.38	83.52	78.57
1993	8.36	0.21	43.44	18.49	79.78	70.14	64.38	13.92	56.22	2.77	138.77	134.56	14.38	124.39	-1.24	123.15	116.75	6.20	116.95	110.55
1994	10.39	0.32	45.33	17.14	55.26	21.68	16.37	11.80	9.87	2.61	67.75	64.48	14.22	53.53	-1.91	51.62	44.32	5.59	46.03	38.73
1995	5.44	0.20	33.00	15.47	114.93	53.57	39.91	10.94	42.63	2.63	160.19	153.11	11.37	148.82	1.26	150.08	150.11	4.87	145.21	145.24
1996	8.13	0.48	46.39	20.41	100.05	24.73	16.24	14.08	10.65	3.03	113.73	109.51	16.55	97.18	0.91	98.09	94.05	7.85	90.24	86.20
1997	6.45	0.55	43.81	20.70	115.96	36.90	31.72	12.92	23.98	2.86	142.80	138.58	16.13	126.67	-0.02	126.65	119.93	7.33	119.32	112.60
1998	6.34	0.43	44.42	20.36	129.11	42.12	33.14	13.69	28.43	2.65	160.18	149.38	15.81	144.37	-1.67	142.70	126.42	10.03	132.68	116.40
1999	7.56	0.19	40.52	17.16	95.49	46.64	28.84	13.17	33.47	2.78	131.74	125.00	13.99	117.76	0.98	118.74	118.46	6.95	111.78	111.51
MAX	**12.70**	**0.55**	**49.39**	**24.20**	**204.49**	**155.24**	**147.87**	**16.83**	**141.45**	**3.38**	**348.80**	**344.67**	**19.54**	**336.32**	**5.00**	**339.47**	**339.64**	**10.03**	**331.73**	**331.90**
MIN	**5.44**	**0.03**	**25.23**	**11.14**	**24.24**	**12.57**	**7.61**	**7.61**	**2.70**	**2.26**	**32.18**	**30.92**	**8.94**	**22.23**	**-3.41**	**24.27**	**22.67**	**3.09**	**20.74**	**16.65**
SUM	**469.76**	**10.23**	**2052.63**	**968.17**	**3789.84**	**1835.81**	**1403.41**	**655.43**	**1180.38**	**145.93**	**5116.15**	**4912.67**	**772.73**	**4343.42**	**70.66**	**4414.08**	**4290.03**	**326.38**	**4087.70**	**3964.40**
AVE Annual	**9.40**	**0.20**	**41.05**	**19.36**	**75.80**	**36.72**	**28.07**	**13.11**	**23.61**	**2.92**	**102.32**	**98.25**	**15.45**	**86.87**	**1.41**	**88.28**	**85.80**	**6.53**	**81.75**	**79.29**

MWH
MONTGOMERY WATSON HARZA

MEMORANDUM

To: Mark Breitenbach
Central Utah Water Conservancy District

From: Ryan C. Murdock and Steven M. Thurin

Date: April 26, 2003

Subject: Hydrologic Evaluation of Diamond Fork and Spanish Fork River System for ULS Baseline Conditions

BACKGROUND

An evaluation of the hydrology of the Diamond Fork and Spanish Fork River system has been performed for baseline conditions for the Utah Lake Drainage Basin Water Delivery System (ULS). The purpose of this memorandum is to document the methodology and assumptions used in the evaluation and to present a summary of the results.

In the hydrologic evaluations, natural flow water, SVP (Strawberry Valley Project) water, and CUP (Central Utah Project) water are tracked separately, and are summed to get the total flow. Strawberry Reservoir is the source of SVP water and CUP water in the Diamond Fork and Spanish Fork system. Baseline SVP calls from Strawberry Reservoir to the Diamond Fork and Spanish Fork System average 61,000 acre-feet (AF) per year. Baseline CUP calls from Strawberry Reservoir to the Diamond Fork and Spanish Fork system average 86,100 AF per year. The Baseline model was developed to provide a representation of flows in the Diamond Fork and Spanish Fork River system under Baseline ULS conditions, and to provide a framework against which to compare ULS alternatives.

EVALUATION METHODOLOGY

The hydrologic evaluation was done using a mass balance spreadsheet application. The Baseline model uses the same natural flow data and diversions as are included in the Historical model ("Hydrologic Evaluation of Diamond Fork Creek and Spanish Fork River System for Historical Conditions", April 21, 2003), but it includes operating rules and SVP and CUP data sets that represent anticipated, long-term baseline conditions. The process of testing the Baseline model was essentially identical to that used on the Historical model, except that more time was spent in adjusting and verifying the correct operation of the more extensive operating rules, and in revising Baseline datasets to achieve certain operational objectives. These objectives include

satisfying minimum instream flow requirements and matching certain, established mean annual flow volumes.

Inflows to the Diamond Fork and Spanish Fork System

Baseline SVP Water Deliverable Calls from Strawberry

A set of data was developed for use in simulating Strawberry Valley Project (SVP) operations under Baseline conditions. The data represent anticipated SVP releases from Strawberry Reservoir and anticipated deliveries of this SVP water at each of the canals on the Spanish Fork River. Adjustments were necessary to the historical SVP releases to account for changes in operating policies, most notably the 1991 agreement between CUWCD and the Strawberry Water Users Association. The following methods were utilized in developing the Baseline SVP release data:

1. Historical SVP releases from Strawberry Reservoir were used as the basis for estimating future (Baseline) SVP operations. The data used to represent historical SVP releases were developed from flow measurements made at the Strawberry Tunnel at West Portal station, on the Utah Division of Water Rights database, for the period 1950 through 1988 (less estimated tunnel seepage), and from measurements reported in the Spanish Fork River Commissioner's reports for the period after 1988. Data from the period after 1988 were adjusted by removing CUWCD supplemental irrigation deliveries, which were included in the Commissioner's reported SVP releases. The CUWCD supplemental irrigation releases were developed from the Commissioner's reported CUWCD deliveries, plus losses that were assumed to be similar to those charged on SVP deliveries from Strawberry.

   These historical SVP releases average 59,205 acre-ft/yr (based on calendar year) for the 1950-1999 period. This data is shown in Column 1 on Table 1.

2. Not all of these historical calls were made under the current operating agreement (signed in 1991) between CUWCD and the Strawberry Water Users Association. During the early portions of the study period, the reservoir was much smaller, and was operated differently than it is now. For this reason, in developing the Baseline releases, the historical releases were checked against the CUWCD operating policies under which SVP deliveries are currently made.

3. The monthly series of historical releases were routed through a reservoir water balance operation with the following parameters:

a. 50,000 acre-ft of maximum carryover storage

b. Storage above 50,000 acre-feet at the end of March of each year is lost to SVP

c. No evaporation losses or precipitation gains are charged on the carryover storage

d. 61,000 acre-ft/year firm water allocation is added each April 1st

   (Note: the historical operational analysis was reset at the beginning of 1989 to reflect the historical initiation of operations under these policies.)

DRAFT

4. The results of this reservoir operational analysis are displayed in Columns 2 through 6 of Table 1. The beginning of year storage (Column 2) shows how much total water is available for delivery in each year. This value is always at least 61,000 acre-feet because that volume is added in on April 1, the assumed beginning of year.

5. Table 1, Column 3 shows the volume of water that is deliverable to SVP each year. This is the lesser of the historical volume of releases and the beginning of year storage. The analysis shows five years in Table 1, Column 6 where the full historical releases could not be made under current operational policies.

6. The end of year storage volume (Table 1, Column 5) shows how much of the available water was left in the SVP account in the lake, after making that year's releases. On March 31 of each year when this volume exceeds 50,000 acre-feet, the excess reverts to the Bonneville Unit CUP storage account. Therefore, Column 5 is not allowed to exceed 50,000 acre-feet. The SVP account reductions are shown in Column 4.

7. The historical releases are compared with the deliverable releases on Figure 1. This graphic also shows the end of operational year carryover or end of year storage (Table 1, Column 5) from the analysis described above.

8. The next portion of the analysis is shown in Table 1, Column 3. Here, the deliverable SVP calls have been adjusted slightly, to better approximate how the SVP water would likely have been called if the entire period had been operated under current CUWCD operation procedures. The deliveries in 1961, 1962, 1963, and 1964 were each increased to 61,000 (the firm SVP yield). This adjustment is reasonable, given the difference between the historical operation and the current operations. In historical 1961, Strawberry Reservoir was drawn down below 10,000 acre-feet. Over the next few years (which were all historically dry) the reservoir continued to be drawn down to a low level. Under current operating procedures, the SVP is not responsible for refilling the enlarged reservoir, and it is reasonable to expect that, under similar hydrologic conditions, the SVP would take their full allotment. For this reason, the SVP releases were set at 61,000 acre-feet per year in 1961 through 1964.

9. The prolonged over-allocations of SVP water that occurred in the late 1980s would not be possible under the 1991 Agreement. Historically, during the period 1987 through 1992, the SVP calls averaged more than 77,000 acre-feet per year. This would result in a drawdown of the SVP carryover of almost 100,000 acre-feet. To reduce the drawdown in this period to the maximum (50,000 acre-feet) the historical calls in 1987 through 1990 were reduced by 12%.

10. Historical deliveries for water years 1952, 1983, 1984, 1997, 1998, and 1999 were also adjusted upwards. This was done for two basic reasons. First, without this adjustment the SVP storage in Strawberry would exceed the maximum of 111,000 acre-feet, resulting in their water being lost to SVP. Secondly, without these adjustments, the longterm average SVP releases would be less than the SVP's

DRAFT

guaranteed yield of 61,000 acre-feet. The adjustments were designed to be as small as possible while avoiding the loss of SVP water supply.

11. The resulting Baseline SVP calls average 61,000 acre-feet per year, slightly more than both the historical calls and the deliverable historical calls. The Baseline calls are shown graphically on Figure 1.

Table 1. Baseline SVP Strawberry Reservoir Releases

	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Operating Year (Apr 1 - Mar 31)	Historical SVP Calls (acre-ft)	Beginning of Year Storage-April 1 (acre-ft)	Adjusted BASELINE Deliverable Calls (acre-ft)	SVP Storage Account Reduction (acre-ft)	End of Year Storage-March 31 (acre-ft)	Adjustment to Historical Release (acre-ft)
1950	62,906	111,000	62,906	-	48,094	-
1951	66,556	109,094	66,556	-	42,538	-
1952	49,479	103,538	53,538	-	50,000	4,059
1953	70,001	111,000	70,001	-	40,999	-
1954	74,762	101,999	74,762	-	27,237	-
1955	66,858	88,237	66,858	-	21,379	-
1956	69,373	82,379	69,373	-	13,006	-
1957	56,062	74,006	56,062	-	17,944	-
1958	62,242	78,944	62,242	-	16,702	-
1959	64,484	77,702	64,484	-	13,218	-
1960	73,710	74,218	73,710	-	508	-
1961	50,932	61,508	61,000	-	508	10,068
1962	43,469	61,508	61,000	-	508	17,531
1963	41,418	61,508	61,000	-	508	19,582
1964	55,066	61,508	61,000	-	508	5,934
1965	38,149	61,508	38,149	-	23,359	-
1966	69,847	84,359	69,847	-	14,512	-
1967	55,108	75,512	55,108	-	20,404	-
1968	54,427	81,404	54,427	-	26,977	-
1969	58,627	87,977	58,627	-	29,350	-
1970	58,757	90,350	58,757	-	31,593	-
1971	59,665	92,593	59,665	-	32,928	-
1972	69,830	93,928	69,830	-	24,098	-
1973	51,598	85,098	51,598	-	33,500	-
1974	65,550	94,500	65,550	-	28,950	-
1975	58,952	89,950	58,952	-	30,998	-
1976	77,891	91,998	77,891	-	14,107	-
1977	75,064	75,107	75,064	-	43	-

DRAFT

1978	64,292	61,043	61,043	-	-	(3,249)
1979	71,132	61,000	61,000	-	-	(10,132)
1980	57,261	61,000	57,261	-	3,739	-
1981	74,555	64,739	64,739	-	-	(9,816)
1982	47,325	61,000	47,325	-	13,675	-
1983	9,848	74,675	45,181	-	29,494	35,333
1984	15,974	90,494	61,000	-	29,494	45,026
1985	53,101	90,494	53,101	-	37,393	-
1986	48,393	98,393	48,393	-	50,000	-
1987	83,182	111,000	72,965	-	38,035	(10,217)
1988	89,138	99,035	78,189	-	20,846	(10,949)
1989	79,590	81,846	69,814	-	12,032	(9,776)
1990	77,496	73,032	67,978	-	5,055	(9,519)
1991	56,759	66,055	56,759	-	9,295	-
1992	70,296	70,295	70,295	-	-	-
1993	49,611	61,000	49,611	-	11,389	-
1994	71,919	72,389	71,919	-	469	-
1995	36,225	61,469	36,225	-	25,245	-
1996	50,788	86,245	50,788	-	35,456	-
1997	40,859	96,456	46,456	-	50,000	5,597
1998	51,047	111,000	61,000	-	50,000	9,953
1999	60,658	111,000	61,000	-	50,000	342
Average	**59,205**	**82,522**	**61,000**	**-**	**21,522**	**1,795**
Minimum	**9,848**	**61,000**	**36,225**	**-**	**-**	**(10,949)**
Maximum	**89,138**	**111,000**	**78,189**	**-**	**50,000**	**45,026**
Historical Calls Adjusted Up: 1952, 1961-1964, 1983-1984, 1997- 1999						
Historical Calls Adjusted Down: 1987, 1988, 1989, 1990						

DRAFT

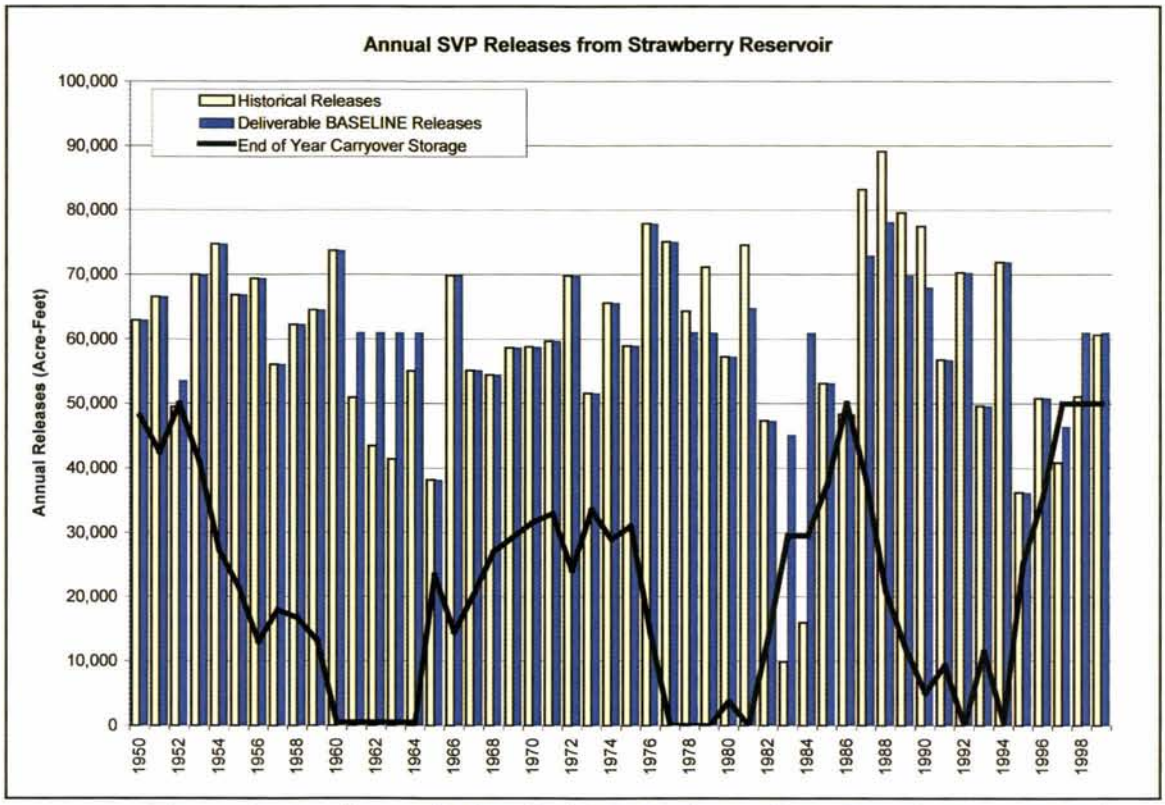


Figure 1. Baseline and Historical SVP Releases from Strawberry Reservoir

DRAFT

Baseline CUP Water Deliverable Calls from Strawberry

A set of Baseline data was developed to represent the calls of water from Strawberry Reservoir to Utah Lake to make the M&I Exchange under ULS Baseline conditions. The data were developed using the following steps:

1. Use the Riverware model with Baseline Diamond Fork/Spanish Fork hydrology data and Baseline SVP releases to determine when minimum instream flow requirements (IFRs) are not satisfied above the Sixth Water Aqueduct or in lower Diamond Fork Creek. Whenever these IFRs are not met, release CUP water (either through Strawberry Tunnel or from the Diamond Fork Tunnel outlet) to fully satisfy the minimum flow requirement. The resulting datasets of CUP IFR releases are presented in Tables C3, C4, C9, and C10 (at the end of this memo) and shown as the lower, light-colored columns on Figure 2. The average annual volume of the CUP water minimum flow releases is 16,273 acre-feet, with 8,773 acre-feet released through the Strawberry Tunnel into Sixth Water and 7,500 acre-feet released through the Diamond Fork Outlet Structure into Diamond Fork.
2. During the Diamond Fork Final Supplement to the Final EIS (FS FEIS) overlap period (1950 – 1973), take the annual volumes released under that study (less the IFR releases described above), as the annual amounts to be released for the M&I Exchange under ULS Baseline conditions. These are the darker columns under the heavy black line (which represents the FS FEIS releases) on Figure 2.

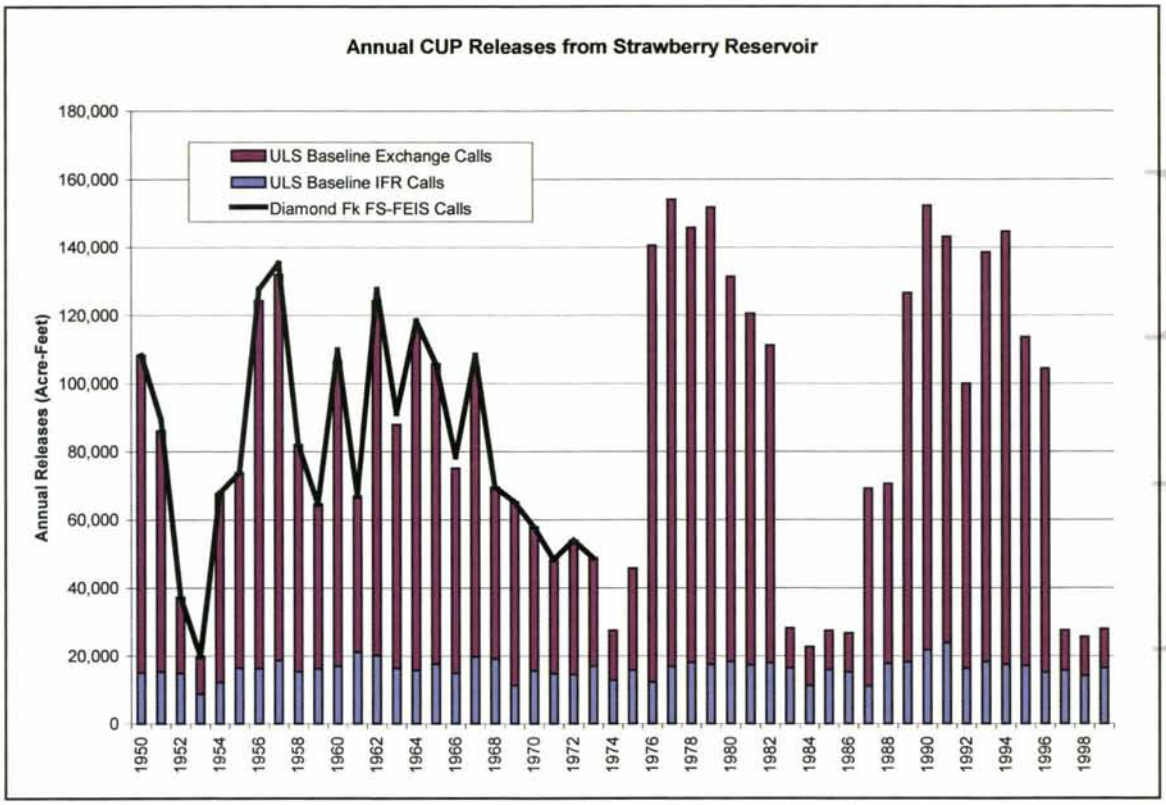


Figure 2. Annual Volumes of CUP Calls on Strawberry Reservoir

3. During the non-overlap period, use a similar annual pattern of releases. Adjust the resulting (1974-1999) annual volumes to obtain an average of 86,100 acre-feet per year for the entire 1950-1999 study period.

   Monthly calls for this period were developed from the annual volumes using a pattern fitting spreadsheet, as described below:

   Monthly Pattern Objective: Develop a 50-year dataset that mimics the monthly pattern of releases used in the Final Supplement to the Diamond Fork Final EIS. Use the FS FEIS monthly releases during the overlap period. The post-1973 monthly calls were developed using the following steps:

   a. During the period 1950-1973, use the FS FEIS monthly releases exactly, except when required minimum flow releases exceed the total FS FEIS releases. In these years, adjust all FS FEIS monthly values so that the Baseline releases are as close as possible to the FS FEIS releases, and the annual totals are the same.

   b. During the non-overlap period, release Exchange water at an initial rate of 100 cfs on October 16, ramping up to a rate of 160 cfs in January. Release at 190 cfs in February, 180 cfs in March, and 270 cfs in April and May. Release at up to 320 cfs in June, 290 cfs in July, 250 cfs in August and 200 cfs in September, if necessary. Releases were limited when they would cause high flows (greater than

DRAFT

600 cfs) below the Lakeshore Diversion, and adjustments were made for the flows not to exceed the pipeline and tunnel system capacity.

The resulting CUP releases from Strawberry under Pattern 3 are shown on Table B6 and B21 (at the end of this memo). The average monthly patterns associated with the Pattern 3 datasets are compared with the FS FEIS patterns on Figure 3.

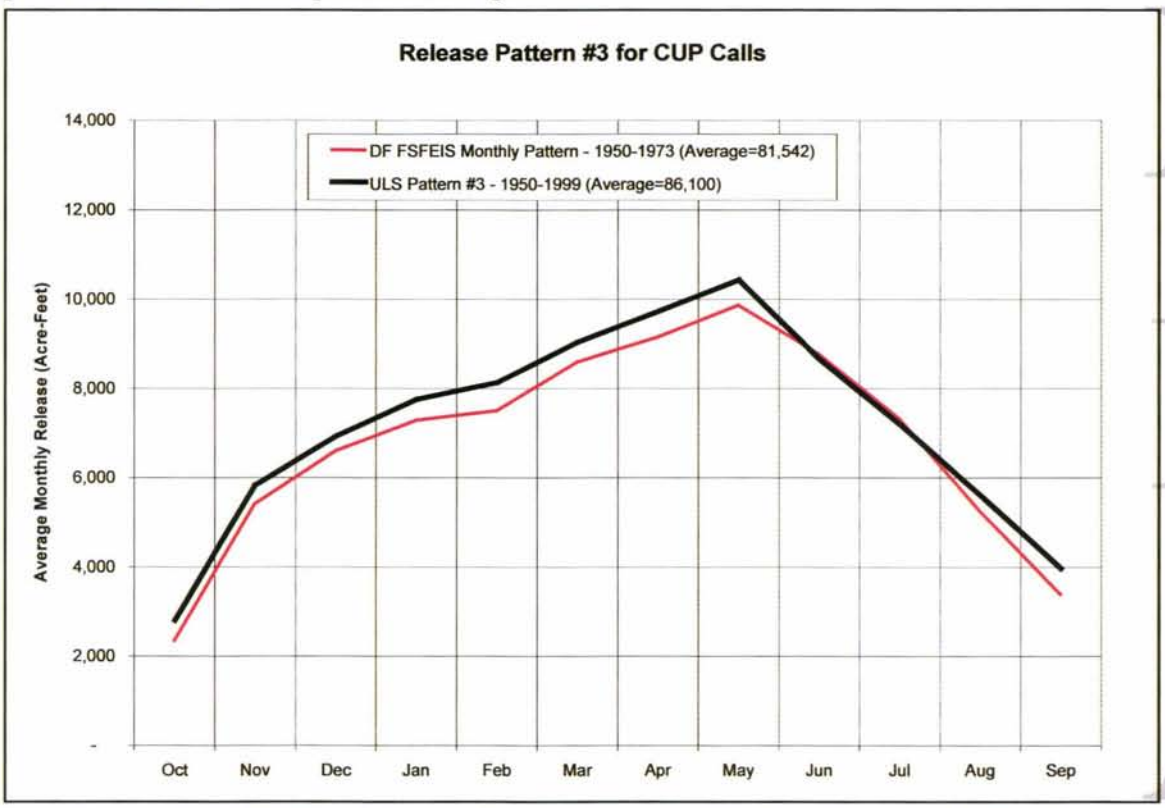


Figure 3. CUP Water Release Patterns- Diamond Fork FS FEIS and Pattern 3

Natural Inflows

The Natural inflows under Baseline conditions are the same as those in the historical data.

Seepage Water

In months when the SVP deliverable calls were greater than 5 cfs, the Strawberry Tunnel seepage water is credited to SVP. In all other months the Strawberry Tunnel seepage was credited to the natural flow. Under these guidelines, SVP only gets the seepage water when their calls are greater than the volume of the seepage water. Otherwise, SVP may be credited with seepage water for a given month when they may have only been delivering water in a few days or less during that month.

Losses

DRAFT

Water transferred during the irrigation season was charged loss rates, based upon where it was discharged into the natural stream channel. Losses were applied to SVP and CUP water conveyed in the stream channels according the following:

a.	Strawberry Tunnel to Sixth Water Aqueduct	2.5 Percent
b.	Sixth Water Aqueduct to Red Hollow	2.0 Percent
c.	Red Hollow to Mouth of Diamond Fork	1.5 Percent
d.	Spanish Fork below Diamond Fork	4.0 Percent

These losses are cumulative, i.e., water transferred through multiple reaches would be charged the sum of the individual reach losses. No losses are charged on deliveries in the non-irrigation season.

Instream Flow Requirements (IFRs)

Section 303(c) of the Central Utah Project Completion Act (CUPCA) gives a required minimum in-stream flow in Diamond Fork Creek from the beginning of the Diamond Fork Pipeline to the Spanish Fork River of 60 cfs from October to April and 80 cfs from May to September. The IFR in Sixth Water Creek downstream of the Strawberry Tunnel is 25 cfs November to April and 32 cfs May to October.

Capacity Checks

The spreadsheet model accounted for the capacity of the pipelines, tunnels, and canals in the Diamond Fork and Spanish Fork system.

Baseline SVP Water in the System

The Baseline SVP calls were used to estimate Baseline SVP diversions for each of the canals delivering Strawberry water. Because the estimated losses associated with the delivery of water under Baseline conditions will be different than historical losses, the amount of water that will be delivered under Baseline will be different, even in years when there is no difference between Historical and Baseline SVP releases from Strawberry. This analysis shows that the average volume of the historical releases that could be delivered under current operating policies is 59,468 acre-feet, which is the baseline calls from Strawberry Reservoir plus Strawberry Tunnel seepage minus losses.

After accounting for losses, depending upon where and when the water was discharged into the stream, the remaining SVP water was distributed to the individual SVP diversions in such a way as to match the historical pattern of the diversions as closely as possible.

Baseline SVP diversions were calculated based on both the Baseline SVP water available for diversion and the historical SVP diversions. In months when the total historical SVP diversions were greater than zero, the SVP Baseline diversion at each facility was calculated as the historical diversion for that facility multiplied by the ratio of the total baseline SVP water available for diversion to the total historical diversion. In months when Baseline SVP water was available for diversion and the historical SVP diversion was zero, the Baseline SVP diversion at each facility was calculated as the total Baseline SVP water available for diversion (after losses)

DRAFT

multiplied by the ratio of the average historical diversion at that facility for that month to the average total historical SVP diversion amount for that month. In months where the calculated Baseline SVP diversion amount for any canal exceeded the canal capacity, the excess SVP water was moved to other canals with capacity available, first to the canal(s) that diverted the largest percentages of SVP water historically.

In the evaluation, all of the available baseline SVP water was taken by the SVP diversions, so no SVP water flows to Utah Lake. The Spanish Fork Diversion Dam diverts water into the Power Canal, which normally takes all SVP and Natural water except East Bench Canal demands up to the canal's 550 cfs capacity. In the baseline scenario, the Power Canal diverted all SVP water except the East Bench Canal demands, and diverted all natural water minus East Bench demands, except when the capacity was exceeded.

Baseline SVP diversions average 59,468 acre-feet per year, almost eight percent more than the historical diversions. The annual average Historical and Baseline SVP diversion volumes are shown in Table 2.

Table 2. Comparison of Historical and Baseline SVP Diversions

SVP Diversions	Historical Diversion (AFA)	Baseline Diversion (AFA)
Clinton	901	966
Mapleton and Springville Lateral	8,121	8,831
Turn Out C	140	153
Highline Canal	32,344	34,856
Salem and Southfield Canal	3,377	3,581
East Bench Canal	5,914	6,367
Mill Race Canal	2,169	2,272
Lake Shore Canal	2,314	2,442

Baseline CUP Water in the System

In the Baseline evaluation, all of the CUP water flows to Utah Lake after losses are taken. No CUP water is diverted in the Diamond Fork and Spanish Fork system.

Natural Water in the System

The flow of Natural water in the system under Baseline conditions is the same as in the Historical data.

DRAFT

RESULTS

Table 3 summarizes the average annual volumes of inflows, diversions, losses, and outflows for the CUP, SVP, and Natural Flow water in the Diamond Fork and Spanish Fork System under Baseline conditions.

Table 3. Flow Summary for CUP, SVP, and Natural Flow Water

BASELINE SUMMARY	Volume (AF)
CUP Water	
Inflow from Strawberry Reservoir	86,100
Losses	2,112
Flows to Utah Lake	83,988
SVP Water	
Inflow from Strawberry Reservoir	61,000
Strawberry Tunnel Seepage	1,602
Losses	3,134
SVP Diversions	59,468
Flows to Utah Lake	0
Natural Flow Water	
Natural Net Inflow	124,125
Strawberry Tunnel Seepage	2,020
Diversions	49,068
Flows to Utah Lake	77,077

The results of flows at selected points in the Diamond Fork and Spanish Fork stream system and pipeline/tunnel system are presented in the following tables:

Baseline Flows at Selected Points in the Stream System: Tables A1-A72

Baseline Flows at Selected Points in the Pipeline/Tunnel System: Tables B1-B30

Baseline Releases to Meet Instream Flow Requirements: Tables C1-C6

DRAFT

Figure 1
SPANISH FORK HYDROLOGIC ADJUSTMENT - Flows at Lakeshore

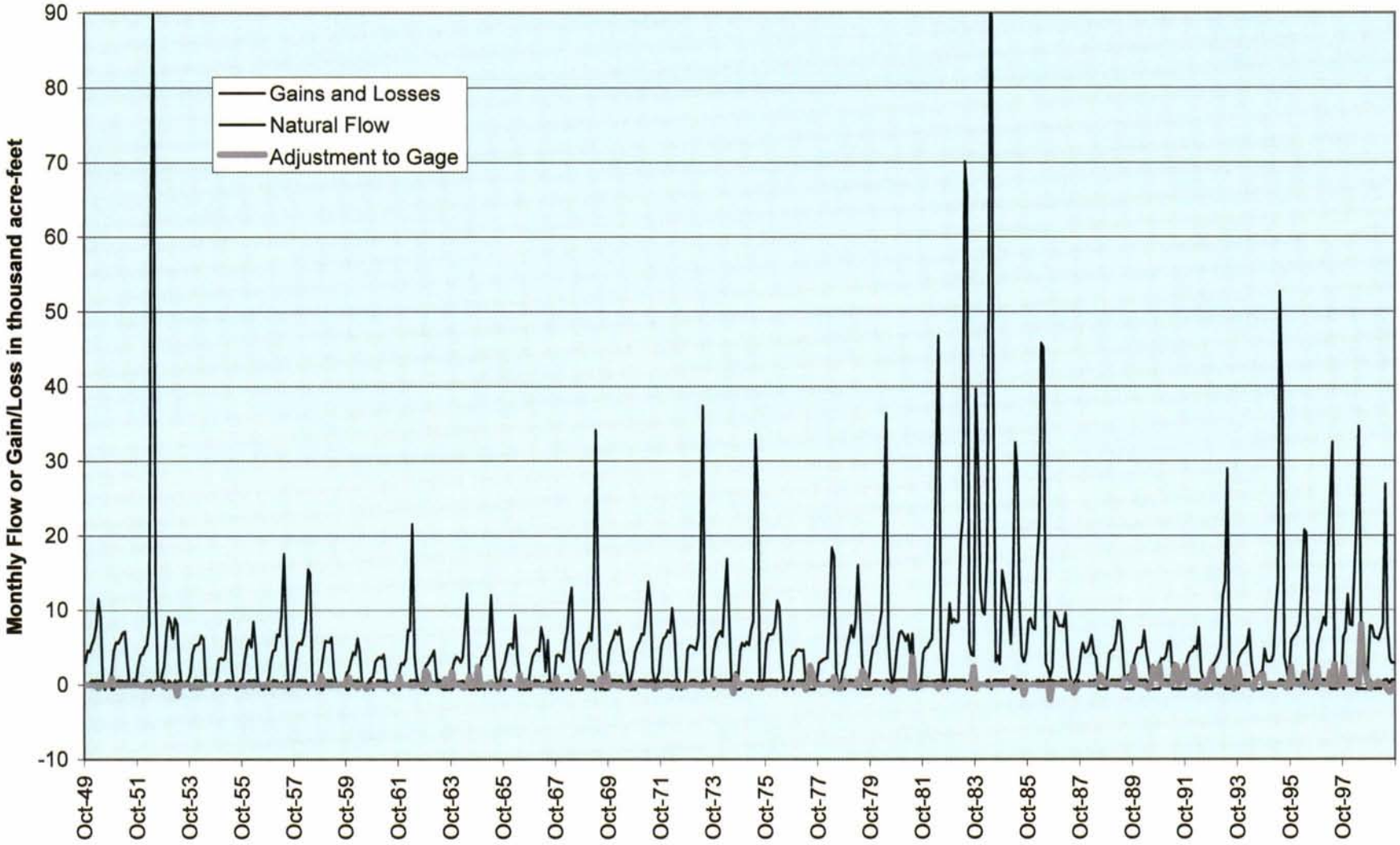


Table 1

Summary of Hydrologic Adjustment
Adjusted Flows Compared with FN Data

Description	Franson-Noble Average Annual Flow	Adjusted Average Annual Flow
Total Losses above Red Hollow	4.22	2.41
Natural Inflow above Red Hollow	27.47	25.61
Total Flow at Red Hollow	93.50	93.49
Total Losses above Mouth	4.22	2.41
Hayes Ditch (River Loss)	0.05	0.05
Levanger Ditch (River Loss)	0.06	0.06
Natural Inflow above Mouth	17.87	16.04
Total Flow at Mouth	107.03	107.02
Spanish Fork @ Thistle Inflow*	72.49	76.45
SVP Irrig Clinton Losses	0.90	0.90
WA Pace Ditch Diversion	0.04	0.04
Total Flow above Strawberry Div Dam	179.31	182.53
Total Mapleton Diversion	9.39	9.40
Total Turnout C Diversion	0.21	0.20
Total Highline Diversion	41.05	41.05
Total Salem Diversion	19.36	19.36
Total Flow below Strawberry Div Dam	28.07	36.72
Total East Bench Diversion	13.10	13.11
Total Flow below E Bench	14.98	23.61
Gains & Losses Below East Bench	1.79	2.92
Total Power Canal Return flow	81.49	75.80
Total Flow above Mill Race	98.25	102.32
Total Mill Race Diversion	15.45	15.45
Flow below Mill Race	82.80	86.87
Gains & Losses above Lakeshore	3.00	1.41
Flow above Lakeshore	85.80	88.28
Total Lakeshore Diversion	6.51	6.53
Flow below Lakeshore	79.29	81.75
Total SVP Diversions	56.01	56.80
Total River Diversions	48.27	47.50
Total Diversions	104.28	104.30

Table 2

Spanish Fork Hydrologic Adjustment

Spanish Fork Gains below East Bench

Monthly Volume in Acre-feet

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1950	181	181	192	307	278	297	298	307	243	181	307	298	3,070
1951	181	181	181	307	278	307	209	307	181	181	307	298	2,919
1952	237	181	181	181	248	307	298	181	298	181	307	298	2,898
1953	307	181	307	208	181	296	181	307	296	307	307	298	3,178
1954	181	181	290	307	278	307	181	307	298	307	181	181	3,000
1955	181	181	181	181	214	307	298	260	298	181	181	298	2,760
1956	181	181	237	307	278	307	298	307	298	307	181	298	3,180
1957	181	181	307	307	278	181	213	181	298	181	307	298	2,913
1958	181	258	307	306	278	307	181	181	298	307	181	298	3,083
1959	181	181	307	307	278	307	181	307	203	181	181	298	2,913
1960	181	181	196	307	251	278	209	181	298	307	307	298	2,994
1961	181	181	307	297	248	307	298	181	298	307	181	181	2,967
1962	181	181	181	181	181	307	298	307	298	307	181	181	2,784
1963	181	181	181	216	181	225	298	181	181	224	181	181	2,411
1964	181	181	188	211	222	248	191	181	181	307	181	261	2,532
1965	181	181	181	181	186	181	181	181	181	181	181	262	2,258
1966	181	181	307	307	181	181	181	181	298	307	181	181	2,668
1967	181	181	307	284	278	181	184	181	298	181	181	181	2,618
1968	181	181	181	181	278	306	194	181	298	181	181	181	2,523
1969	181	188	307	307	278	307	181	307	181	181	181	181	2,781
1970	181	298	307	307	278	307	298	181	181	307	181	181	3,007
1971	181	181	307	307	278	281	203	307	298	307	307	298	3,256
1972	181	298	307	307	278	189	298	181	263	307	307	181	3,098
1973	181	245	300	307	239	181	181	307	298	307	307	298	3,152
1974	181	181	307	307	278	307	298	307	298	307	181	181	3,134
1975	181	181	181	264	278	307	261	181	298	307	307	298	3,044
1976	307	298	307	307	278	307	181	307	298	307	181	298	3,377
1977	181	181	272	284	278	307	181	181	298	307	181	298	2,949
1978	237	181	181	181	250	307	298	181	298	307	307	298	3,026
1979	181	181	307	307	278	307	181	256	181	307	181	181	2,849
1980	181	210	307	258	245	230	181	307	298	181	307	298	3,005
1981	307	298	307	307	278	307	298	181	298	307	181	298	3,367
1982	307	246	239	196	241	214	298	307	298	278	307	181	3,112
1983	307	213	307	307	278	307	298	307	181	307	181	181	3,176
1984	181	181	181	181	181	271	298	181	298	307	307	298	2,864
1985	307	298	307	307	181	181	181	307	298	307	181	298	3,154
1986	181	181	190	181	278	289	181	307	181	307	307	298	2,881
1987	241	217	181	307	278	307	204	181	298	307	181	298	3,000
1988	181	220	181	181	278	205	298	307	298	307	307	181	2,944
1989	181	181	307	307	278	307	298	307	298	307	307	181	3,260
1990	181	188	307	307	278	307	298	181	298	181	181	181	2,888
1991	181	181	307	307	278	307	181	181	181	181	181	181	2,648
1992	181	181	307	307	278	307	298	243	184	307	181	181	2,957
1993	181	181	307	307	278	307	181	181	181	181	307	181	2,774
1994	181	181	272	307	278	307	181	181	181	181	181	181	2,613
1995	237	181	181	181	181	181	192	307	298	211	181	298	2,628
1996	181	181	307	307	278	307	181	307	181	307	307	181	3,027
1997	181	181	307	307	278	307	181	181	181	181	307	262	2,855
1998	181	181	307	307	278	307	181	181	181	181	181	181	2,648
1999	267	181	181	181	181	181	248	307	298	181	281	298	2,785
Average	**202**	**200**	**258**	**269**	**254**	**274**	**232**	**241**	**257**	**258**	**234**	**242**	**2,919**
Maximum	**307**	**298**	**307**	**307**	**278**	**307**	**298**	**307**	**298**	**307**	**307**	**298**	**3,377**
Minimum	**181**	**181**	**181**	**181**	**181**	**181**	**181**	**181**	**181**	**181**	**181**	**181**	**2,258**
Percent	**7%**	**7%**	**9%**	**9%**	**9%**	**9%**	**8%**	**8%**	**9%**	**9%**	**8%**	**8%**	

Table 3

Spanish Fork Hydrologic Adjustment

Adjusted Gains/Losses above Lakeshore*

Monthly Volume in Acre-feet

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1950	(36)	149	338	615	555	615	595	615	397	(615)	49	312	**3,588**
1951	(615)	(595)	289	615	555	615	378	615	(207)	(121)	615	290	**2,434**
1952	387	(141)	102	227	503	615	595	(615)	595	409	609	595	**3,882**
1953	615	(595)	615	402	(91)	615	203	615	483	185	1	435	**3,482**
1954	(615)	(251)	600	615	555	615	89	510	223	142	35	7	**2,526**
1955	(615)	(301)	(131)	(1)	406	615	595	424	240	(615)	(453)	515	**678**
1956	(375)	(341)	473	615	555	615	595	615	-	(608)	(412)	(116)	**1,616**
1957	(615)	(91)	615	615	555	(201)	411	(353)	595	(615)	322	595	**1,833**
1958	(272)	522	615	615	555	615	(595)	(20)	595	74	(538)	391	**2,558**
1959	(615)	(595)	615	615	555	615	239	421	138	(252)	36	447	**2,220**
1960	(615)	(595)	354	615	499	602	341	179	(415)	(0)	162	595	**1,723**
1961	(615)	59	615	613	492	615	595	(615)	344	139	55	(258)	**2,040**
1962	(615)	179	79	119	(241)	615	595	615	595	(225)	(369)	(403)	**944**
1963	(615)	(595)	139	414	229	448	595	(376)	(595)	(615)	(615)	(426)	**(2,011)**
1964	(615)	(311)	322	399	428	532	339	24	(595)	(615)	(615)	83	**(622)**
1965	(615)	(595)	(251)	(615)	314	(231)	(595)	222	(451)	(615)	(527)	550	**(3,409)**
1966	(615)	(231)	615	615	99	169	290	(615)	(373)	(615)	(615)	(414)	**(1,690)**
1967	(615)	259	615	586	555	69	317	199	595	(393)	(615)	97	**1,670**
1968	(615)	(251)	(211)	(615)	555	615	346	(615)	595	(615)	(615)	(595)	**(2,020)**
1969	(615)	322	615	615	555	615	(595)	615	(595)	(431)	(615)	(595)	**(108)**
1970	(526)	595	615	615	555	615	595	(205)	(114)	(138)	(615)	(467)	**1,525**
1971	(615)	(61)	615	615	555	589	420	615	595	231	2	595	**4,155**
1972	(200)	595	615	615	555	331	595	(615)	595	(615)	(125)	258	**2,604**
1973	3	492	615	615	471	266	108	615	595	12	432	595	**4,820**
974	(615)	209	615	615	555	615	595	615	595	(50)	(615)	(595)	**2,539**
J75	(615)	(95)	204	540	555	615	530	(615)	595	615	462	595	**3,387**
1976	536	595	615	615	555	615	115	588	(595)	(615)	(241)	595	**3,378**
1977	(615)	(311)	558	586	555	615	4	(615)	(595)	(615)	(615)	477	**(570)**
1978	387	(141)	102	227	501	615	595	(615)	595	(0)	(0)	595	**2,861**
1979	(615)	259	615	615	555	615	(595)	537	(595)	(615)	(615)	(595)	**(433)**
1980	(615)	397	615	526	489	462	(595)	615	595	208	(0)	595	**3,292**
1981	589	595	615	615	555	615	595	(615)	(595)	(615)	(446)	595	**2,503**
1982	575	493	477	354	475	415	595	615	595	615	286	(535)	**4,960**
1983	615	407	615	615	555	615	595	615	(595)	615	(615)	(595)	**3,441**
1984	(238)	202	(153)	197	169	565	595	(615)	595	615	615	595	**3,142**
1985	615	595	615	615	142	(615)	(595)	615	595	615	(615)	595	**3,177**
1986	271	268	331	222	555	606	164	615	141	615	615	595	**4,997**
1987	472	415	192	615	555	615	492	(615)	(595)	(311)	(615)	595	**1,816**
1988	2	422	(228)	122	555	378	595	615	(595)	(615)	(615)	(595)	**41**
1989	(615)	(32)	615	615	555	615	595	615	(595)	(615)	(615)	(595)	**543**
1990	(615)	316	615	615	555	615	595	(221)	(595)	(615)	(615)	(595)	**55**
1991	(615)	(67)	615	615	555	615	(595)	(615)	(595)	(615)	(615)	(595)	**(1,911)**
1992	(615)	105	615	615	555	615	595	615	(595)	(599)	(615)	(595)	**696**
1993	(615)	128	615	615	555	615	(595)	(615)	(595)	(615)	(615)	(119)	**(1,240)**
1994	(615)	(10)	558	615	555	615	(595)	(615)	(595)	(615)	(615)	(595)	**(1,912)**
1995	468	(210)	(349)	(380)	(429)	(489)	337	615	595	370	137	595	**1,260**
1996	(615)	102	615	615	555	615	(595)	615	(595)	(422)	611	(595)	**907**
1997	(615)	132	615	615	555	615	(595)	(615)	(595)	(615)	110	378	**(15)**
1998	(615)	175	615	615	555	615	(595)	(615)	(595)	(615)	(615)	(595)	**(1,670)**
1999	615	(342)	(582)	(615)	(555)	(615)	443	615	595	210	615	595	**979**
Average	**(279)**	**45**	**396**	**435**	**433**	**459**	**195**	**88**	**(4)**	**(216)**	**(205)**	**66**	**1,413**
Maximum	**615**	**595**	**615**	**615**	**555**	**615**	**595**	**615**	**595**	**615**	**615**	**595**	**4,997**
Minimum	**(615)**	**(595)**	**(582)**	**(615)**	**(555)**	**(615)**	**(595)**	**(615)**	**(595)**	**(615)**	**(615)**	**(595)**	**(3,409)**
Percent	**-20%**	**3%**	**28%**	**31%**	**31%**	**32%**	**14%**	**6%**	**0%**	**-15%**	**-15%**	**5%**	

Table 4

Spanish Fork Hydrologic Adjustment

SVP Losses in Sixth Water and Diamond Fork*

Monthly Volume in Acre-feet

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1950	-	-	-	-	-	-	43	-	-	979	1,455	950	**3,427**
1951	51	-	-	-	-	-	56	115	511	1,527	989	300	**3,548**
1952	35	-	-	-	-	-	-	-	-	-	-	-	**35**
1953	767	226	-	-	-	-	156	-	1,163	1,733	1,337	653	**6,034**
1954	247	40	-	41	-	44	59	249	1,846	1,083	1,077	145	**4,831**
1955	251	-	-	-	-	-	-	-	1,916	1,337	766	485	**4,755**
1956	181	-	-	-	-	-	-	-	2,113	1,757	1,327	639	**6,017**
1957	101	-	-	-	-	-	-	-	507	436	697	591	**2,332**
1958	218	-	-	-	-	-	43	77	426	1,192	471	14	**2,441**
1959	221	-	-	-	-	-	-	237	1,258	213	-	112	**2,040**
1960	151	-	-	-	-	41	45	-	2,393	1,954	1,591	321	**6,496**
1961	91	-	-	-	-	-	-	1,347	1,791	1,101	163	-	**4,492**
1962	-	-	-	-	-	-	-	-	906	1,054	914	333	**3,206**
1963	141	-	-	-	-	-	-	-	570	1,548	1,208	357	**3,823**
1964	221	-	-	-	-	44	43	-	-	2,581	1,197	653	**4,739**
1965	121	-	-	-	-	-	-	-	-	1,444	1,118	610	**3,292**
1966	78	-	-	-	-	-	-	413	2,220	1,611	1,494	442	**6,257**
1967	181	-	-	-	-	-	-	-	106	1,913	1,777	711	**4,687**
1968	-	-	-	-	-	-	-	-	885	2,114	301	726	**4,026**
1969	226	-	-	-	-	-	-	-	-	1,717	1,812	731	**4,485**
1970	178	-	-	-	-	-	-	40	491	2,056	1,885	323	**4,972**
1971	150	-	-	-	-	-	-	-	1,357	2,252	2,122	-	**5,881**
1972	36	-	-	-	-	-	-	880	1,667	2,069	1,573	415	**6,640**
1973	-	-	-	-	-	-	-	-	-	2,065	1,816	-	**3,881**
1974	-	-	-	-	-	-	-	-	1,660	1,753	1,951	540	**5,904**
1975	156	-	-	-	-	-	-	-	118	1,729	2,257	725	**4,985**
976	-	-	-	-	-	-	-	-	2,149	2,273	1,949	178	**6,549**
977	84	-	-	-	-	-	261	822	2,150	1,875	1,467	381	**7,039**
1978	2	-	-	-	-	-	-	-	1,209	2,449	2,042	346	**6,048**
1979	-	-	-	-	-	-	-	56	1,960	2,220	340	1,165	**5,741**
1980	210	-	-	-	-	-	-	-	731	1,878	2,090	-	**4,909**
1981	260	-	-	-	-	-	111	672	1,831	2,139	2,045	549	**7,607**
1982	-	-	-	-	-	-	-	64	-	1,732	2,010	-	**3,806**
1983	-	-	-	-	-	-	-	-	-	-	-	52	**52**
1984	61	-	-	-	-	-	-	-	-	-	-	-	**61**
1985	-	-	-	-	-	-	-	65	-	526	2,123	-	**2,714**
1986	-	-	-	-	-	-	-	-	-	1,111	1,793	-	**2,904**
1987	-	-	-	-	-	-	272	1,042	2,364	1,861	1,783	1,061	**8,381**
1988	137	-	-	-	-	-	-	655	2,348	2,569	2,048	863	**8,620**
1989	-	-	-	-	-	-	130	1,454	2,401	2,429	1,522	261	**8,196**
1990	-	-	-	-	-	-	30	938	1,368	2,517	2,128	1,021	**8,001**
1991	-	-	-	-	-	-	-	-	607	2,189	1,940	-	**4,736**
1992	-	-	-	-	-	-	-	1,273	2,067	1,503	1,724	416	**6,983**
1993	-	-	-	-	-	-	-	-	401	1,708	2,029	14	**4,153**
1994	56	-	-	-	-	-	-	722	2,206	2,260	1,364	992	**7,601**
1995	-	-	-	-	-	-	-	-	-	870	1,809	-	**2,679**
1996	-	-	-	-	-	-	-	-	415	1,731	2,037	-	**4,183**
1997	-	-	-	-	-	-	-	-	-	1,381	1,444	-	**2,825**
1998	-	-	-	-	-	-	-	-	132	1,939	2,075	-	**4,146**
1999	96	-	-	-	-	-	-	-	1,145	2,296	1,968	304	**5,809**
Average	**94**	**5**	**-**	**1**	**-**	**3**	**25**	**222**	**988**	**1,613**	**1,421**	**368**	**4,739**
Maximum	**767**	**226**	**-**	**41**	**-**	**44**	**272**	**1,454**	**2,401**	**2,581**	**2,257**	**1,165**	**8,620**
Minimum	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**35**
Percent	**2%**	**0%**	**0%**	**0%**	**0%**	**0%**	**1%**	**5%**	**21%**	**34%**	**30%**	**8%**	

*** Historical losses limited to a maximum of 10 percent**

Table 5

Spanish Fork Hydrologic Adjustment

Adjusted SVP Diversions at Lakeshore and Mill Race

Monthly Volume in Acre-feet

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1950	1,080	-	-	-	-	-	-	-	443	717	1,915	1,474	5,630
1951	-	-	-	-	-	-	-	-	634	1,893	1,627	1,220	5,373
1952	104	-	-	-	-	-	-	-	-	561	479	767	1,910
1953	248	-	-	-	-	-	-	-	147	1,417	1,638	1,442	4,892
1954	146	-	-	-	-	-	14	99	1,257	1,915	2,080	351	5,860
1955	176	-	-	-	-	-	-	-	1,206	2,936	1,543	453	6,316
1956	90	-	-	-	-	-	-	-	2,134	1,988	1,865	835	6,911
1957	234	-	-	-	-	-	-	-	134	1,350	1,367	831	3,916
1958	88	-	-	-	-	-	-	-	291	2,111	2,128	560	5,179
1959	73	-	-	-	-	-	-	586	1,550	886	886	500	4,481
1960	2	-	-	-	-	-	-	-	2,606	2,189	1,570	402	6,769
1961	71	-	-	-	-	-	-	744	1,610	895	237	137	3,693
1962	-	-	-	-	-	-	-	-	742	1,199	1,653	261	3,855
1963	76	-	-	-	-	-	-	-	-	1,570	1,377	331	3,355
1964	370	-	-	-	-	-	-	-	-	2,628	1,428	1,191	5,615
1965	112	-	-	-	-	-	-	-	-	178	533	272	1,095
1966	96	-	-	-	-	-	-	-	1,346	2,040	1,902	668	6,053
1967	351	-	-	-	-	-	-	-	-	849	1,265	590	3,054
1968	-	-	-	-	-	-	-	-	30	615	648	523	1,816
1969	124	-	-	-	-	-	-	-	-	487	1,645	870	3,127
1970	124	-	-	-	-	-	-	-	-	1,004	2,307	244	3,679
1971	182	-	-	-	-	-	-	-	-	1,151	1,319	-	2,653
1972	-	-	-	-	-	-	-	-	274	2,802	2,402	104	5,582
1973	-	-	-	-	-	-	-	-	-	897	603	208	1,708
1974	24	-	-	-	-	-	-	-	507	848	2,271	495	4,145
1975	217	-	-	-	-	-	-	-	-	958	909	1,263	3,347
76	278	-	-	-	-	-	-	-	2,966	3,766	2,432	465	9,906
977	60	-	-	-	-	-	30	572	2,673	3,062	2,384	922	9,701
1978	87	-	-	-	-	-	-	-	345	3,014	1,658	321	5,425
1979	39	-	-	-	-	-	-	-	439	2,871	1,969	1,534	6,852
1980	344	-	-	-	-	-	-	-	-	-	1,496	258	2,099
1981	108	-	-	-	-	-	-	-	894	3,125	2,449	142	6,717
1982	69	-	-	-	-	-	-	-	-	-	1,275	46	1,390
1983	-	-	-	-	-	-	-	-	-	-	-	-	-
1984	-	-	-	-	-	-	-	-	-	-	-	-	-
1985	-	-	-	-	-	-	-	-	-	-	650	1,129	1,779
1986	54	-	-	-	-	-	-	-	-	-	-	-	54
1987	-	-	-	-	-	-	-	-	1,986	2,003	1,898	849	6,735
1988	172	-	-	-	-	-	-	591	2,480	3,369	2,353	272	9,238
1989	100	-	-	-	-	-	113	135	2,867	3,567	2,157	753	9,691
1990	-	-	-	-	-	-	-	141	567	4,570	3,101	1,345	9,724
1991	-	-	-	-	-	-	-	-	1,143	2,003	2,543	55	5,744
1992	-	-	-	-	-	-	1,222	1,238	1,737	637	1,838	423	7,095
1993	-	-	-	-	-	-	-	-	-	961	1,373	150	2,485
1994	-	-	-	-	-	-	-	250	1,550	2,593	1,031	522	5,945
1995	-	-	-	-	-	-	-	-	-	83	1,189	649	1,921
1996	-	-	-	-	-	-	-	-	-	1,165	1,259	266	2,690
1997	-	-	-	-	-	-	-	-	-	1,042	444	202	1,688
1998	-	-	-	-	-	-	-	-	-	728	1,687	1,760	4,175
1999	-	-	-	-	-	-	-	-	260	1,110	1,290	420	3,080
Average	**106**	**-**	**-**	**-**	**-**	**-**	**28**	**87**	**696**	**1,515**	**1,481**	**570**	**4,483**
Maximum	**1,080**	**-**	**-**	**-**	**-**	**-**	**1,222**	**1,238**	**2,966**	**4,570**	**3,101**	**1,760**	**9,906**
Minimum	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Percent	**2%**	**0%**	**0%**	**0%**	**0%**	**0%**	**1%**	**2%**	**16%**	**34%**	**33%**	**13%**	

Table 6

Spanish Fork Hydrologic Adjustment

Change to SVP Diversions at Lakeshore and Mill Race

Monthly Volume in Acre-feet

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1950	-	-	-	-	-	-	-	-	-	-	-	-	-
1951	-	-	-	-	-	-	-	-	-	-	-	-	-
1952	-	-	-	-	-	-	-	-	-	-	-	-	-
1953	-	-	-	-	-	-	-	-	-	0	-	-	0
1954	-	-	-	-	-	-	-	-	-	-	0	-	0
1955	0	-	-	-	-	-	-	-	752	-	-	-	752
1956	-	-	-	-	-	-	-	-	1,683	-	0	-	1,683
1957	-	-	-	-	-	-	-	-	-	-	-	-	-
1958	-	-	-	-	-	-	-	-	-	0	-	-	0
1959	-	-	-	-	-	-	-	-	0	-	-	0	0
1960	-	-	-	-	-	-	-	-	1,063	238	-	-	1,301
1961	-	-	-	-	-	-	-	-	-	0	-	-	0
1962	-	-	-	-	-	-	-	-	-	-	-	-	-
1963	-	-	-	-	-	-	-	-	-	543	-	-	543
1964	0	-	-	-	-	-	-	-	-	155	-	0	155
1965	41	-	-	-	-	-	-	-	-	178	-	-	220
1966	-	-	-	-	-	-	-	-	458	405	-	-	863
1967	0	-	-	-	-	-	-	-	-	0	-	-	0
1968	-	-	-	-	-	-	-	-	-	-	-	-	-
1969	-	-	-	-	-	-	-	-	-	-	-	0	0
1970	-	-	-	-	-	-	-	-	-	-	-	-	-
1971	-	-	-	-	-	-	-	-	-	-	-	-	-
1972	-	-	-	-	-	-	-	-	-	2,256	-	-	2,256
1973	-	-	-	-	-	-	-	-	-	897	444	-	1,341
1974	-	-	-	-	-	-	-	-	-	116	-	-	116
1975	-	-	-	-	-	-	-	-	-	-	-	-	-
1976	-	-	-	-	-	-	-	-	2,433	1,561	-	-	3,995
1977	-	-	-	-	-	-	30	367	1,762	2,334	-	-	4,492
1978	-	-	-	-	-	-	-	-	-	889	62	-	951
1979	-	-	-	-	-	-	-	-	-	2,124	-	-	2,124
1980	-	-	-	-	-	-	-	-	-	-	194	-	194
1981	-	-	-	-	-	-	-	-	220	1,598	-	-	1,818
1982	-	-	-	-	-	-	-	-	-	-	603	-	603
1983	-	-	-	-	-	-	-	-	-	-	-	-	-
1984	-	-	-	-	-	-	-	-	-	-	-	-	-
1985	-	-	-	-	-	-	-	-	-	-	-	-	-
1986	-	-	-	-	-	-	-	-	-	-	-	-	-
1987	-	-	-	-	-	-	-	-	620	-	0	-	620
1988	-	-	-	-	-	-	-	-	1,318	914	824	-	3,056
1989	-	-	-	-	-	-	-	-	703	1,128	1,001	651	3,484
1990	-	-	-	-	-	-	-	-	-	3,167	351	519	4,037
1991	-	-	-	-	-	-	-	-	1,143	-	0	-	1,143
1992	-	-	-	-	-	-	-	-	558	229	32	-	818
1993	-	-	-	-	-	-	-	-	-	423	483	-	906
1994	-	-	-	-	-	-	-	-	388	521	613	-	1,522
1995	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	-	-	-	-	-	-	-	-	-	625	-	-	625
1997	-	-	-	-	-	-	-	-	-	-	-	-	-
1998	-	-	-	-	-	-	-	-	-	0	-	-	0
1999	-	-	-	-	-	-	-	-	-	0	-	-	0
Average	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**7**	**262**	**406**	**92**	**23**	**792**
Maximum	**41**	**-**	**-**	**-**	**-**	**-**	**30**	**367**	**2,433**	**3,167**	**1,001**	**651**	**4,492**
Minimum	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Percent	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**1%**	**33%**	**51%**	**12%**	**3%**	

Table 7

SPANISH FORK HYDROLOGIC ADJUSTMENT - Annual Results

NODE:	Sixth Water at Strawberry Tunnel Outlet		Diamond Fork at Red Hollow				Diamond Fork at Mouth						Spanish Fork at Castilla				
Year	Natural Inflow - 6th Water	TOTAL FLOW at 6th Water	Losses	Nat. Inflow-Diamond Fork	TOTAL FLOW at Red Hollow	FN Flow at Red Hollow	Losses	Hayes Ditch (Total Loss)	Levanger Ditch (Total Loss)	Nat. Inflow	TOTAL FLOW at Mouth	FN Flow at Mouth	SF @ Thistle Inflow	SVP Irrig Clinton Losses	WA Pace Ditch	TOTAL FLOW above Div Dam	FN Flow above Dam
1950	3.18	75.06	1.71	17.16	90.50	90.39	1.71	0.03	0.10	19.00	107.65	107.55	64.50	1.07	0.05	171.04	167.30
1951	3.07	71.65	1.77	16.43	86.31	86.13	1.77	0.06	0.15	22.35	106.67	106.49	50.45	0.94	0.06	156.13	153.40
1952	9.10	59.13	0.02	51.96	111.07	111.39	0.02	0.00	0.24	37.86	148.68	149.00	168.20	1.15	0.00	315.73	310.60
1953	3.11	86.43	3.02	16.45	99.86	99.95	3.02	0.10	0.14	18.14	114.74	114.83	59.66	1.03	0.02	173.35	169.90
1954	1.73	80.97	2.42	9.07	87.63	87.38	2.42	0.07	0.13	8.62	93.64	93.38	40.68	1.27	0.05	133.00	131.80
1955	1.40	75.35	2.38	7.20	80.17	80.20	2.38	0.05	0.16	10.84	88.42	88.45	47.48	1.02	0.05	134.83	133.90
1956	2.47	79.84	3.01	12.56	89.39	89.30	3.01	0.03	0.08	8.17	94.44	94.35	48.71	1.04	0.05	142.06	137.50
1957	3.33	61.23	1.17	18.50	78.56	78.80	1.17	0.04	0.08	14.28	91.56	91.80	72.92	1.08	0.10	163.31	161.00
1958	3.13	70.17	1.22	16.88	85.82	85.73	1.22	0.05	0.06	17.76	102.26	102.16	77.61	0.99	0.06	178.82	177.00
1959	1.21	70.82	1.02	6.05	75.85	75.70	1.02	0.10	0.07	10.05	84.71	84.56	35.38	1.14	0.06	118.89	117.50
1960	1.44	81.00	3.25	6.30	84.06	83.88	3.25	0.08	0.12	8.39	89.01	88.83	37.38	1.04	0.05	125.30	122.30
1961	1.19	56.45	2.25	5.67	59.87	59.83	2.25	0.06	0.07	7.61	65.10	65.07	19.47	0.75	0.04	83.79	83.10
1962	3.37	49.54	1.60	18.52	66.45	66.61	1.60	0.06	0.07	10.95	75.67	75.82	65.71	0.70	0.02	140.66	137.00
1963	2.19	47.33	1.91	11.35	56.77	56.90	1.91	0.08	0.15	13.65	68.28	68.41	31.53	0.59	0.01	99.22	100.80
1964	2.91	63.76	2.37	15.41	76.80	76.70	2.37	0.07	0.11	13.77	88.03	87.92	37.99	0.84	0.02	125.15	125.40
1965	4.76	47.63	1.65	26.06	72.05	72.20	1.65	0.11	0.12	21.65	91.83	91.98	61.14	0.73	0.08	152.15	153.40
1966	2.51	75.89	3.13	13.11	85.87	85.90	3.13	0.11	0.12	13.61	96.12	96.15	43.55	0.92	0.05	138.70	138.50
1967	3.03	63.33	2.34	16.28	77.27	77.30	2.34	0.11	0.16	16.41	91.06	91.09	62.07	0.72	0.09	152.32	152.20
1968	3.98	60.18	2.01	21.61	79.77	79.80	2.01	0.12	0.11	14.93	92.46	92.49	71.17	0.87	0.09	162.67	163.70
1969	5.92	69.33	2.24	32.94	100.03	100.06	2.24	0.13	0.17	28.19	125.68	125.71	95.95	0.83	0.11	220.69	221.40
1970	3.43	66.28	2.49	18.47	82.26	82.29	2.49	0.12	0.13	9.52	89.04	89.07	70.40	1.00	0.05	158.40	154.40
1971	3.90	69.41	2.94	21.12	87.59	87.62	2.94	0.11	0.08	15.47	99.93	99.96	79.36	0.85	0.07	178.37	169.60
1972	3.02	76.63	3.32	15.10	88.41	88.49	3.32	0.13	0.15	14.85	99.66	99.74	52.26	1.02	0.04	150.86	147.80
1973	4.65	61.21	1.94	24.88	84.16	84.18	1.94	0.10	0.11	9.39	91.40	91.43	101.02	0.73	0.09	191.59	183.60
1974	4.21	73.64	2.95	22.60	93.28	93.31	2.95	0.12	0.06	16.79	106.94	106.97	83.92	1.04	0.03	189.79	180.00
1975	5.21	66.95	2.49	28.30	92.76	92.79	2.49	0.07	0.01	16.23	106.42	106.45	98.46	0.68	0.00	204.20	197.10
1976	3.19	87.70	3.27	15.31	99.73	99.75	3.27	0.04	0.01	14.01	110.41	110.43	58.13	0.52	0.01	168.02	163.10
1977	1.86	80.09	3.52	6.66	83.23	83.17	3.52	0.04	0.00	12.01	91.68	91.62	23.28	0.87	0.07	114.01	115.10
1978	3.62	72.16	3.02	18.85	87.98	88.00	3.02	0.04	0.01	14.49	99.40	99.42	71.37	0.99	0.10	169.68	160.20
1979	7.76	82.14	2.87	41.91	121.18	121.12	2.87	0.13	0.00	7.52	125.70	125.64	61.06	1.03	0.09	185.63	181.40
1980	7.08	67.84	2.45	38.69	104.08	104.10	2.45	0.07	0.00	12.62	114.17	114.19	107.88	0.89	0.10	221.07	214.90
1981	2.36	82.52	3.80	11.34	90.06	90.02	3.80	0.02	0.00	15.55	101.78	101.75	44.55	0.88	0.06	145.39	142.40
1982	7.64	61.50	1.90	41.97	101.56	101.50	1.90	0.05	0.00	14.84	114.44	114.38	125.14	0.72	0.11	238.75	234.80
1983	7.91	27.98	0.03	44.39	72.35	72.73	0.03	0.00	0.00	37.97	110.29	110.67	200.81	0.00	0.00	311.10	301.90
1984	14.17	44.53	0.03	79.67	124.17	124.28	0.03	0.00	0.00	15.34	139.48	139.59	279.42	0.28	0.00	418.62	412.80
1985	6.62	64.88	1.36	36.00	99.52	99.46	1.36	0.00	0.00	33.71	131.87	131.81	127.15	0.92	0.00	258.10	251.50
1986	8.82	63.64	1.45	48.51	110.70	110.85	1.45	0.04	0.00	17.30	126.51	126.66	147.34	0.69	0.00	273.16	269.27
1987	3.24	88.89	4.19	15.68	100.39	100.35	4.19	0.05	0.00	9.67	105.81	105.78	55.43	1.37	0.00	159.87	159.27
1988	2.30	94.68	4.31	10.15	100.52	100.54	4.31	0.03	0.00	10.29	106.47	106.49	45.85	1.38	0.00	150.94	151.92
1989	1.77	122.10	4.10	6.77	124.77	124.77	4.10	0.05	0.00	16.74	137.36	137.36	41.98	1.13	0.00	178.21	174.81
1990	1.72	121.42	4.00	5.82	123.24	123.24	4.00	0.03	0.00	16.51	135.72	135.72	37.62	1.07	0.00	172.28	170.69
1991	1.56	94.77	2.37	6.95	99.35	99.35	2.37	0.01	0.00	15.07	112.05	112.04	39.90	1.00	0.00	150.94	150.93
1992	0.90	141.99	3.62	3.18	141.55	141.55	3.62	0.00	0.00	11.21	149.14	149.14	33.56	1.12	0.00	181.58	174.61
1993	4.29	109.16	2.33	22.08	128.91	128.91	2.33	0.00	0.00	16.55	143.13	143.13	78.28	0.99	0.00	220.42	221.08
1994	2.49	98.89	3.81	11.54	106.61	106.62	3.81	0.00	0.00	13.26	116.06	116.06	35.32	1.27	0.00	150.11	153.09
1995	5.84	59.46	1.34	31.65	89.77	89.77	1.34	0.00	0.00	16.72	105.15	105.14	118.28	0.81	0.00	222.61	213.13
1996	4.13	73.12	2.70	21.93	92.35	91.98	2.70	0.00	0.00	21.03	110.69	110.69	90.59	1.08	0.00	200.21	198.26
1997	7.25	66.20	2.17	39.75	103.78	103.78	2.17	0.00	0.00	12.61	114.22	114.22	110.74	0.59	0.00	224.37	223.92
1998	5.92	67.50	2.13	31.96	97.34	97.34	2.13	0.00	0.00	23.97	119.18	119.18	124.19	0.61	0.00	242.77	239.00
1999	3.36	85.17	2.91	16.69	98.96	98.95	2.91	0.00	0.00	24.63	120.68	120.68	87.84	0.96	0.00	207.56	197.48
MAX	**14.17**	**141.99**	**4.31**	**79.67**	**141.55**	**141.55**	**4.31**	**0.13**	**0.24**	**37.97**	**149.14**	**149.14**	**279.42**	**1.38**	**0.11**	**418.62**	**412.80**
MIN	**0.90**	**27.98**	**0.02**	**3.18**	**56.77**	**56.90**	**0.02**	**0.00**	**0.00**	**7.52**	**65.10**	**65.07**	**19.47**	**0.00**	**0.00**	**83.79**	**83.10**
SUM	**203.24**	**3717.52**	**120.30**	**1077.44**	**4674.66**	**4674.95**	**120.30**	**2.70**	**2.96**	**802.07**	**5350.77**	**5351.43**	**3822.69**	**45.18**	**1.85**	**9126.43**	**8965.74**
AVE Annual	**4.06**	**74.35**	**2.41**	**21.55**	**93.49**	**93.50**	**2.41**	**0.05**	**0.06**	**16.04**	**107.02**	**107.03**	**76.45**	**0.90**	**0.04**	**182.53**	**179.31**

Table 7 (continued)

SPANISH FORK HYDROLOGIC ADJUSTMENT - Annual Results

NODE:	Power Canal					East Bench				Spanish Fork at Mill Race					Spanish Fork at Lakeshore					
Year	Total Mapleton	Total Turnout C	Total Highline	Total Salem	Total Total Return	TOTAL FLOW below Div Dam	FN below Power Canal	Total East Bench	TOTAL FLOW below E Bench	Gains & Losses Below EB	TOTAL FLOW above Mill race	FN Total at Node	Total Mill Race	Flow below Mill Race	Gains & Losses	Flow above Lakeshore	FN above Lakeshore	Lakeshore Diver	Flow below Lakeshore	FN Below Lakeshore
1950	10.81	0.26	49.07	23.09	67.79	20.01	12.84	12.84	7.17	3.07	78.02	75.48	18.90	59.13	3.59	62.71	62.68	9.24	53.48	53.45
1951	10.16	0.25	46.32	21.41	57.41	20.59	14.15	14.15	6.43	2.92	66.76	64.17	18.43	48.33	2.43	50.76	49.26	7.78	42.99	41.48
1952	6.08	0.13	46.80	24.20	105.97	132.54	123.84	15.49	117.06	2.90	225.92	222.46	18.43	207.49	3.88	211.37	211.47	9.16	202.21	202.30
1953	11.01	0.18	46.68	24.02	67.59	23.87	13.50	13.50	10.37	3.18	81.13	77.96	18.86	62.27	3.48	65.76	64.02	7.51	58.25	56.51
1954	11.26	0.23	40.46	17.63	46.59	16.83	12.00	12.00	4.84	3.00	54.42	53.02	14.95	39.47	2.53	42.00	41.81	5.02	36.98	36.79
1955	10.47	0.16	38.65	18.73	48.98	17.84	12.48	12.48	5.36	2.76	57.10	55.37	16.88	40.22	0.68	40.90	40.82	6.59	34.31	34.24
1956	10.73	0.28	41.30	21.50	45.49	22.76	12.87	12.87	9.88	3.18	58.55	54.40	17.83	40.72	1.62	42.34	42.33	7.75	34.59	34.58
1957	9.05	0.19	35.05	23.44	75.68	19.91	12.90	12.90	7.01	2.91	85.60	83.43	16.29	69.32	1.83	71.15	70.88	8.62	62.53	62.26
1958	9.77	0.27	44.38	23.33	77.58	23.49	17.73	14.84	8.64	3.08	89.31	87.37	18.09	71.22	2.56	73.78	73.41	7.99	65.79	65.42
1959	9.67	0.12	39.33	15.53	39.14	15.10	9.05	9.05	6.05	2.91	48.11	45.89	14.44	33.67	2.22	35.89	33.86	3.65	32.24	30.21
1960	10.28	0.17	40.76	18.22	36.21	19.67	10.98	10.98	8.68	2.99	47.88	44.77	15.42	32.46	1.72	34.19	32.27	5.37	28.82	26.91
1961	7.29	0.11	28.43	11.14	24.24	12.57	7.61	7.61	4.96	2.97	32.18	30.92	9.95	22.23	2.04	24.27	24.13	3.09	21.18	21.05
1962	7.66	0.17	33.88	17.80	62.86	18.28	11.34	11.34	6.94	2.78	72.59	68.61	14.63	57.96	0.94	58.90	57.99	6.59	52.31	51.40
1963	5.68	0.11	25.23	17.74	37.77	12.68	9.97	9.97	2.70	2.41	42.89	40.06	14.12	28.77	-2.01	26.76	22.67	6.02	20.74	16.65
1964	8.27	0.17	33.95	15.68	53.36	13.72	10.30	10.30	3.41	2.53	59.30	56.57	12.14	47.16	-0.62	46.54	43.54	5.26	41.28	38.28
1965	6.88	0.26	42.54	20.15	66.22	16.09	12.91	12.91	3.17	2.26	71.66	68.55	15.10	56.56	-3.41	53.15	50.04	7.83	45.32	42.21
1966	9.95	0.11	38.84	18.84	53.93	17.04	12.27	12.27	4.77	2.67	61.36	58.09	15.55	45.82	-1.69	44.13	41.88	6.08	38.04	35.80
1967	10.16	0.14	46.75	19.98	58.25	17.05	13.12	13.12	3.93	2.62	64.80	63.62	16.20	48.60	1.67	50.27	49.98	7.18	43.09	42.80
1968	8.54	0.15	42.26	18.33	77.12	16.27	13.19	13.19	3.09	2.52	82.73	79.49	13.34	69.39	-2.02	67.37	63.30	6.48	60.89	56.82
1969	11.28	0.35	48.82	23.70	101.95	34.59	32.19	15.88	18.70	2.78	123.43	120.40	18.93	104.50	-0.11	104.39	99.90	7.84	96.55	92.06
1970	9.53	0.28	41.90	19.85	65.22	21.61	13.24	13.24	8.37	3.01	76.59	72.88	16.78	59.82	1.53	61.34	61.47	7.48	53.86	53.99
1971	11.26	0.33	43.54	21.14	72.73	29.38	15.72	15.72	13.67	3.26	89.65	83.98	16.78	72.87	4.15	77.02	76.77	8.07	68.95	68.70
1972	10.11	0.16	37.89	21.31	57.95	23.44	13.21	13.21	10.23	3.10	71.28	68.51	15.72	55.56	2.60	58.17	58.32	6.14	52.02	52.18
1973	10.84	0.25	41.21	21.77	70.22	47.31	34.36	14.74	32.57	3.15	105.93	100.60	16.19	89.75	4.82	94.57	94.63	7.07	87.50	87.56
1974	11.80	0.12	45.28	22.93	78.92	30.73	15.46	15.46	15.28	3.13	97.34	89.48	19.54	77.80	2.54	80.34	78.22	7.50	72.84	70.72
1975	7.44	0.12	44.94	18.74	93.04	39.93	29.06	12.88	27.05	3.04	123.13	118.83	14.86	108.27	3.39	111.66	111.42	6.34	105.32	105.07
1976	10.45	0.08	43.30	20.59	64.81	28.79	14.93	14.93	13.86	3.38	82.04	77.96	16.24	65.80	3.38	69.18	68.60	6.89	62.29	61.71
1977	9.77	0.07	35.96	12.87	37.63	17.72	8.74	8.74	8.98	2.95	49.56	46.09	10.85	38.71	-0.57	38.14	32.07	4.11	34.03	28.58
1978	10.21	0.13	46.92	18.03	65.69	28.69	12.81	12.81	15.88	3.03	84.60	78.10	14.97	69.63	2.86	72.49	71.55	5.29	67.20	66.25
1979	11.23	0.06	49.14	19.13	77.86	28.23	16.22	16.22	12.01	2.85	92.71	86.03	16.39	76.32	-0.43	75.89	70.28	5.90	69.99	64.38
1980	9.18	0.04	49.39	20.56	96.11	45.79	34.15	16.75	29.04	3.00	128.16	123.54	15.36	112.80	3.29	116.09	115.63	7.68	108.41	107.94
1981	10.87	0.05	39.78	17.41	54.66	22.63	12.42	12.42	10.21	3.37	68.23	63.78	14.78	53.45	2.50	55.96	52.10	4.30	51.66	47.80
1982	8.62	0.07	43.98	22.76	109.93	53.38	45.07	16.34	37.04	3.11	150.09	147.59	15.81	134.28	4.96	139.24	139.22	8.57	130.67	130.65
1983	5.57	0.03	30.11	17.16	147.14	111.10	99.24	13.58	97.51	3.18	247.83	240.51	8.94	238.89	3.44	242.33	239.83	6.23	236.10	233.60
1984	7.90	0.10	30.71	20.18	204.49	155.24	147.87	13.80	141.45	2.86	348.80	344.67	12.47	336.32	3.14	339.47	339.64	7.74	331.73	331.90
1985	9.52	0.06	39.39	21.22	140.39	47.52	36.41	16.83	30.69	3.15	174.23	169.04	16.18	158.06	3.18	161.23	160.30	8.71	152.53	151.60
1986	10.08	0.27	38.00	20.60	148.48	55.73	47.36	16.62	39.11	2.88	190.47	188.26	16.86	173.61	5.00	178.61	178.84	6.74	171.87	172.10
1987	12.04	0.32	38.25	17.99	69.79	21.48	12.04	12.03	9.45	3.00	82.24	80.58	17.16	65.08	1.82	66.90	66.57	4.08	62.82	62.50
1988	12.70	0.40	41.72	20.10	53.38	22.65	15.17	14.02	8.62	2.94	64.95	62.46	16.54	48.41	0.04	48.45	45.08	5.06	43.39	40.02
1989	11.05	0.34	44.78	18.12	51.18	52.74	39.67	12.73	40.01	3.26	94.45	88.92	15.39	79.05	0.54	79.60	75.38	5.25	74.35	70.13
1990	10.78	0.27	39.59	17.86	47.14	56.64	45.00	10.70	45.94	2.89	95.96	90.43	16.04	79.93	0.06	79.98	72.67	3.75	76.23	69.06
1991	9.73	0.24	37.05	17.29	48.33	38.31	33.06	12.47	25.84	2.65	76.82	70.76	14.01	62.81	-1.91	60.90	51.20	4.24	56.66	46.96
1992	11.39	0.27	43.35	16.37	40.08	70.12	56.39	10.97	59.15	2.96	102.19	94.42	13.99	88.21	0.70	88.90	83.95	5.38	83.52	78.57
1993	8.36	0.21	43.44	18.49	79.78	70.14	64.38	13.92	56.22	2.77	138.77	134.56	14.38	124.39	-1.24	123.15	116.75	6.20	116.95	110.55
1994	10.39	0.32	45.33	17.14	55.26	21.68	16.37	11.80	9.87	2.61	67.75	64.48	14.22	53.53	-1.91	51.62	44.32	5.59	46.03	38.73
1995	5.44	0.20	33.00	15.47	114.93	53.57	39.91	10.94	42.63	2.63	160.19	153.11	11.37	148.82	1.26	150.08	150.11	4.87	145.21	145.24
1996	8.13	0.48	46.39	20.41	100.05	24.73	16.24	14.08	10.65	3.03	113.73	109.51	16.55	97.18	0.91	98.09	94.05	7.85	90.24	86.20
1997	6.45	0.55	43.81	20.70	115.96	36.90	31.72	12.92	23.98	2.86	142.80	138.58	16.13	126.67	-0.02	126.65	119.93	7.33	119.32	112.60
1998	6.34	0.43	44.42	20.36	129.11	42.12	33.14	13.69	28.43	2.65	160.18	149.38	15.81	144.37	-1.67	142.70	126.42	10.03	132.68	116.40
1999	7.56	0.19	40.52	17.16	95.49	46.64	28.84	13.17	33.47	2.78	131.74	125.00	13.99	117.76	0.98	118.74	118.46	6.95	111.78	111.51
MAX	**12.70**	**0.55**	**49.39**	**24.20**	**204.49**	**155.24**	**147.87**	**16.83**	**141.45**	**3.38**	**348.80**	**344.67**	**19.54**	**336.32**	**5.00**	**339.47**	**339.64**	**10.03**	**331.73**	**331.90**
MIN	**5.44**	**0.03**	**25.23**	**11.14**	**24.24**	**12.57**	**7.61**	**7.61**	**2.70**	**2.26**	**32.18**	**30.92**	**8.94**	**22.23**	**-3.41**	**24.27**	**22.67**	**3.09**	**20.74**	**16.65**
SUM	**469.76**	**10.23**	**2052.63**	**968.17**	**3789.84**	**1835.81**	**1403.41**	**655.43**	**1180.38**	**145.93**	**5116.15**	**4912.67**	**772.73**	**4343.42**	**70.66**	**4414.08**	**4290.03**	**326.38**	**4087.70**	**3964.40**
AVE Annual	**9.40**	**0.20**	**41.05**	**19.36**	**75.80**	**36.72**	**28.07**	**13.11**	**23.61**	**2.92**	**102.32**	**98.25**	**15.45**	**86.87**	**1.41**	**88.28**	**85.80**	**6.53**	**81.75**	**79.29**

MWH
MONTGOMERY WATSON HARZA

MEMORANDUM

To: Mark Breitenbach
Central Utah Water Conservancy District

From: Steven M. Thurin

Date: April 10, 2003

Subject: ULS Baseline Provo River Flows Compared with CUP M&I System FES Conditions

BACKGROUND

The impacts of the CUP M&I System on average monthly stream flows of the Provo River were estimated and documented in the 1979 M&I System Final Environmental Statement (FES) and the 1987 Final Supplement. The pre- and post-project flows were estimated using a USBR-developed model called the Jordanelle Operations Study (JOPS), which included the period 1930-1973. The pre- and post-project monthly flows reported in those documents are presented in Table 1.

As part of the Utah Lake Drainage Basin Water Delivery System Project (ULS), new studies of Provo River flows with and without the ULS Alternatives are being conducted. These ULS studies make use of a new study period (1950 through 1999) and a new hydrologic analysis model (PROSIM2000). The new study period was selected because it included more recent conditions, and because the available hydrologic data during this period were significantly more plentiful and more accurate. The new model was specifically required under the Central Utah Completion Act. Its objectives included developing a comprehensive understanding of the hydrology, water rights, and operation of the Provo River system, and the capability to compare stream flows under varying water development options. The underlying purpose for the model was to allow more effective planning and decision-making concerning new and existing facilities, operational procedures, and policies. The primary differences in operational conditions are summarized in Appendix A.

Except for these primarily non-Federal actions that have modified conditions on the Provo River, the Baseline condition for ULS is the same as the post-project condition associated with the CUP M&I System. Because PROSIM2000 is being used to estimate flows associated with ULS pre-project and alternative conditions, it is reasonable to compare the results generated using PROSIM, with results reported in the previous environmental documents, and to determine whether its use is appropriate.

EVALUATION METHODOLOGY

Because PROSIM2000 and JOPS estimate stream flows for different hydrologic periods, only the 24-year overlap period (1950-1973) will be used for direct comparison of results. Although Table 1 (Table C-5 of the FES) only reported average monthly results, print-outs of the monthly data used to develop the JOPS average flows were obtained, so that more detailed comparisons could be made. The JOPS monthly data and results were digitized and transferred into an Excel spreadsheet for ease of comparison.

REVIEW OF AVERAGE RESULTS

Table 2 shows the average monthly flows from JOPS and the average monthly flows from PROSIM for the overlapping period, below Deer Creek Dam and below Olmsted Diversion Dam. Figures 1 and 2 display the same results graphically.

Examination of these figures and tables shows very close agreement. At Deer Creek, the total average flow is within 6 cfs (2 percent). Below Olmsted, the total flow is within 19 cfs (8 percent). Because the original streamgage measurements upon which the studies are based are only accurate to about 10 percent, this agreement is extremely close. The individual monthly averages are similarly close. The overall pattern of the water agrees remarkably well at both locations, considering that the two models used completely independent analyses.

To examine areas of agreement and disagreement between the two models in closer detail, individual monthly values for the below Deer Creek location are compared in Table 3. More variation can be seen in this table, than in the long-term average values. Some individual months vary by as much as plus 600 cfs and minus 800 cfs. In order to focus on the most significant differences, only those months with a flow difference of more than 20 percent are shown on Table 4. This table also highlights with different colors the months where the variation was more than plus or minus 50 cfs. After seeing the magnitude of the individual monthly variations, detailed explanations were developed for the larger differences.

REVIEW OF INDIVIDUAL MONTHLY VARIATIONS AT DEER CREEK

Many different factors influence the calculated flows in each of the models. For JOPS, flows below Deer Creek are calculated by adding or subtracting more than 80 different values. For PROSIM, the calculations are even more complicated, with each flow value representing the summation of nearly 200 factors. Despite this complexity, many of the largest differences between the two sets of flows can be explained using a few of the most significant factors.

One major factor that influences flow on the lower Provo River is the transfer of foreign (transbasin) water from the Weber River to Utah Lake. Under certain conditions, the Provo River Project may directly move as much as 1,000 cfs from the Weber-Provo Diversion to Utah Lake. Under other conditions, Weber River water that has been previously stored in Deer Creek or Jordanelle reservoirs may be spilled and allowed to flow down to Utah Lake. PROSIM and JOPS both model these operations, although in a significantly different way. The different methods of modeling result in these transfers and spills to Utah Lake occurring in different months. Because the volumes associated with these operations tend to be quite large, the resulting variation in flow below Deer Creek can be equally large.

DRAFT

Detailed examination of the differences in the timing for these Weber River transfers reveals that they cause 12 of the largest flow differences shown in Table 4. The flow differences that can be explained by the variation in timing of transfers from the Weber to the Provo River are highlighted in Table 5. Because this factor is so important in affecting modeled flow in the Provo River, consideration was given to setting the Weber River transbasin diversions in PROSIM to equal those used in JOPS. Unfortunately, PROSIM's water rights calculation methods do not permit this variable to be directly locked. Additionally, the methodology used in PROSIM for simulating Weber to Provo River diversions is more sophisticated than that used in JOPS, so that model accuracy could be lost by so doing.

The next factor considered in explaining the differences between the results from the two models was differences in storage of surplus Provo River flow. JOPS made use of results from a previous study (the Provo River Surplus Flow Study) to determine when water was above the needs of the prior water right holders and could be stored. PROSIM calculates each water right on the Provo River for each month in the simulation. It is possible that the two programs might have generated more similar results, if PROSIM did not have two additional sets of operational rules to consider in determining the timing and amount of Provo River storage in Deer Creek and Jordanelle: the Utah Lake Distribution Plan, and the draft Jordanelle Flood Control Operations Rules.

The Utah Lake Distribution Plan was developed in and implemented by the Utah State Engineer in 1992, to allow storage of water, out of priority with regard to Utah Lake rights, in Deer Creek and Jordanelle reservoirs. The Plan has specific requirements for when water can be stored and converted by the two reservoirs, and when the stored water must be released to Utah Lake. PROSIM simulates each provision of the Plan. The Plan was not included in JOPS, because at the time of the JOPS it had not yet been implemented.

The draft Jordanelle Flood Control Operations Rules require that a specific volume of storage space remain available in Jordanelle to allow a portion of the expected snowmelt runoff to be held in the reservoir to help protect downstream areas from flooding. The volume of storage space required to be left empty varies by month and depending upon the projected runoff of the watershed. The flood control rules are in place from February through June and have a minimum space available of 10,000 acre-feet. The flood control rules are included in PROSIM but not in JOPS.

The net effect of these two operational rules is that Jordanelle tends to have slightly less water in storage when modeled with PROSIM than when modeled with JOPS. This tends to make streamflows below Deer Creek in PROSIM slightly larger during the month of April, and sometimes March. In months when the Utah Lake Distribution Plan requires surplus water to be released from Jordanelle and/or Deer Creek, PROSIM's modeled flows may be somewhat higher than those predicted by JOPS. This tends to happen in the summer and fall of very dry years. Detailed examination of results indicates that these two differences between the models explain the flow differences observed in 25 months. These months are highlighted in Table 6.

The final factor that explains differences between the individual monthly flows predicted for the below Deer Creek location involves variations in the underlying models' methods for predicting surplus flow. The JOPS is based on earlier studies and models. In many months, releases from Deer Creek are made in JOPS (or are larger) because those studies require that a certain volume of water be released to satisfy earlier water rights, including water rights in Utah Lake. PROSIM

DRAFT

examines the specific rights and water demands of each higher priority downstream user, and releases the precise quantity of water necessary to satisfy them. In the 21 months highlighted on Table 7, there is disagreement between PROSIM and JOPS in terms of how much water must be released to satisfy prior water rights, with PROSIM calculating that less water is necessary. Most of these months are probably times when JOPS assumes that water needs to be added to Utah Lake. Because PROSIM simulates Utah Lake's calls on the Provo River under the provisions of the Distribution Plan, it is to be expected that there would be some significant differences in this calculation.

The preceding three tables have explained the majority (58) of the flow differences observed between the results from the two models below Deer Creek. The remaining (unexplained) differences are displayed on Table 8. Many of these differences could probably be explained as well, if additional analysis was determined to be worthwhile.

REVIEW OF INDIVIDUAL MONTHLY FLOW DIFFERENCES AT OLMSTED

The final location of modeled flow in the Jordanelle Operations Study is below the Olmsted Diversion Dam. Table 9 highlights the differences (greater than 20 percent) between the two models' predicted flow at this location. Between this station and the Deer Creek location, there are only two changes in the flow: those associated with inflows and gains to the Provo River, and those associated with diversions to the Olmsted flowline. For this reason, all of the explanations of differences that applied below Deer Creek also apply below Olmsted, and the only new explanations required deal with differences in gains to the Provo River or in the Olmsted diversions. Additionally, the Olmsted diversions used in the two models are almost identical, leaving gains between the two stations as the only major issue to be considered. After removing the differences explained at Deer Creek, remaining differences at Olmsted are shown in Table 10.

In developing the Provo River Simulation Model, a great deal of effort was expended to accurately quantify the contribution from each tributary to the Provo River. In the reach between the Deer Creek station and Olmsted, there are three of these tributaries, plus the ungaged runoff directly into the River. Each of these streams has a short gaged record. The average annual (gaged) flow for these streams totals 41,000 acre-feet. PROSIM estimates the runoff directly into the stream as an additional 12,000 acre-feet per year. In contrast, JOPS used a single, total gain between Deer Creek and Olmsted of 35,000 acre-feet per year. The average monthly gains used in each model are displayed graphically on Figure 3. The difference between these two datasets is explanation for almost all of the flow differences not explained at Deer Creek. In particular, because the average flow is so much higher, PROSIM's much higher gains in September and in November through March, show up as visible differences in Table 10 and in Figure 2.

Because of the effort put into the hydrologic analysis used in developing PROSIM, and because its results are confirmed by the available streamgage data, it is assumed that PROSIM's gains between the two locations are more nearly correct, and that this is sufficient explanation for the majority of the flow differences shown in Table 10.

CONCLUSIONS

DRAFT

Hydrologic analysis and operations modeling of a complicated system like the Provo River is difficult. Experience shows that no two independently developed models or independently conducted studies are likely to arrive at exactly the same results. Careful examination of the results developed in the Jordanelle Operations Study's CUP M&I System evaluation and in the Provo River Simulation Model's analysis of the ULS Baseline condition, shows very good agreement. Individual monthly flow differences below Deer Creek and below Olmsted are explainable by clear differences between the methods, assumptions, or data used in the two studies. Furthermore, neither study shows a significant overall bias towards higher or lower flows. The average flows are within 2 percent at Deer Creek and within 7 percent at Olmsted. Because the PROSIM2000 model has greater capabilities for simulating recent, complex changes in the operations of the system, and because it has been developed specifically for this purpose, it has been determined that it is the better tool for use in simulating the Baseline condition and the effects of the ULS Alternatives on surface water hydrological conditions. The differences between PROSIM's ULS Baseline and the CUP M&I System's post-project condition are relatively minor, and should not affect results of the analysis of ULS impacts.

DRAFT

APPENDIX D

Utah Lake Drainage Basin Water Delivery System
Definition of ULS Baseline Conditions

DRAFT

ULS Baseline Provo River Flows Compared with CUP M&I System FES Conditions

Baseline Conditions (1987 FS M&I FEIS)	ULS Baseline Conditions	Notes and Sources
Water Supplies	**Water Supplies**	
Strawberry to Utah Lake delivery 30,000 acre-feet	Strawberry to Utah Lake delivery 86,100 acre-feet	FS to M&I EIS says 30,000 comes from Strawberry on an interim basis. 1988 DPR says 48,600 acre-feet from Strawberry. 86,100 pattern from Diamond Fk Final Supplement.
Return flows to Utah Lake from I&D System deliveries plus diking evap savings ~50,000 acre-feet	Return flows to Utah Lake from 1,590 acre-feet Strawberry deliveries 560 acre-feet	As an alternative, Baseline could use 50,000 acre-feet of supply from purchased rights (88 DPR), rather than from diking benefits and return flows
Use of Jacob-Welby or Indian Ford 8,700 acre-feet (88 DPR)	Purchase of Utah Lake primary water rights 7,900 acre-feet	Jacob-Welby not mentioned in 1987 FS to M&I EIS
CUP Return flows from CUP deliveries on Provo River 20,100 acre-feet (Francis 1,200, Heber Ag 4,400, Heber M&I 1,500, No Utah County 13,000) (88 DPR)	Non-CUP Return flows from CUP deliveries on Provo River 14,100 acre-feet (Francis 1,200, Heber Ag 4,400, Heber M&I 1,500, No Utah County 7,000)	Current assumption is that return flows from No. Utah Co. will be lower (35% vs. 65%) due to use of water for secondary irrigation. (Note: return flows under Modified Baseline and No Action do not accrue to CUP)
Use of available surplus Provo River flows 10,100 acre-feet	Use of available surplus Provo River flows 10,100 acre-feet	Additional surplus flow may be available in Modified Baseline and No Action because additional conversion of System Storage is possible under the UL Distribution Plan
Total of Bonneville Unit supplies listed above 118,900 acre-feet	Total of Bonneville Unit supplies listed above 118,760 acre-feet	Supplies are not necessarily equivalent nor additive
Deliveries and Losses	**Deliveries and Losses**	Equivalent to depletions from the system
M&I System deliveries to Salt Lake Co. 70,000 acre-feet	M&I System deliveries to Salt Lake Co. 70,000 acre-feet	
M&I System deliveries to No. Utah Co. 19,000 acre-feet	M&I System deliveries to No. Utah Co. 20,000 acre-feet	FS to M&I EIS added 2,400 acre-feet to Heber M&I, reduced No. Utah Co. by 1,000 acre-feet from previous plan. ULS Baseline uses same monthly pattern as 1987 FS FEIS
M&I System deliveries to Wasatch Co. M&I 2,400 acre-feet	M&I System deliveries to Wasatch Co. M&I 2,400 acre-feet	
M&I System agric. deliveries to Wasatch and Summit counties 15,100 acre-feet	M&I System agric. deliveries to Wasatch and Summit counties 15,100 acre-feet	
Bonneville Unit deliveries to So. Utah Co. 1,500 acre-feet (88 DPR)	Bonneville Unit deliveries to So. Utah Co. 1,590 acre-feet	
M&I System losses 6,700 acre-feet from Jordanelle evaporation and storage	M&I System losses 6,700 acre-feet from Jordanelle evaporation and storage	
Total Bonneville Unit deliveries and losses 114,700 acre-feet	Total Bonneville Unit deliveries and losses 115,790 acre-feet	Net Provo River depletion is 98,500 acre-feet

ULS Baseline Provo River Flows Compared with CUP M&I System FES Conditions

Institutional Arrangements	Institutional Arrangements	Notes and Sources
Utah Lake Distribution Plan is not in effect	Utah Lake Distribution Plan is in effect	
Jordanelle-Deer Creek Operating Agreement not included	Jordanelle-Deer Creek Operating Agreement is included	
Wasatch County Water Efficiency Project is not included	Wasatch County Water Efficiency Project is included, but no effect	
Daniel Replacement Project inflow of 2,900 acre-feet stays in Strawberry River System	Daniel Replacement Project inflow of 2,900 acre-feet stays in Strawberry River System	
Minimum streamflows as documented in previous EIS's	Minimum streamflows as documented in previous EIS's	10 cfs Upper Provo,125 cfs Heber Valley, 100 cfs below Deer Cr, 25 cfs (winter) below Olmsted. 25/32 cfs Sixth Water, 60/80 cfs Diamond Fork.
June Sucker RIP is not in effect	June Sucker RIP is not in effect	Releases made to mimic spring runoff
Utah Lake demands reduced by purchase of rights	Utah Lake demands are set at full historical levels	
Development level is as shown in M&I EIS	Development level is as shown in M&I EIS	
Groundwater pumping at historical levels	Groundwater pumping is adjusted for completed change applications	
Water conservation (207 and other programs) is not included	Water conservation (207 and other programs) is included	
Utah Lake water quality modeled with Baseline flows (not historical)	Utah Lake water quality modeled with modified Baseline flows	
	Jordanelle operated to provide flood control protection	Operations are in accordance with COE's Water Control Diagram
SVP supply averages 61,000 acre-feet, none is converted to M&I use	SVP supply averages 61,000 acre-feet, none is converted to M&I use	
High Flows Study not included	High Flows Study not included	
Study period is 1930 - 1973	Study period is 1950 - 1999	

DRAFT