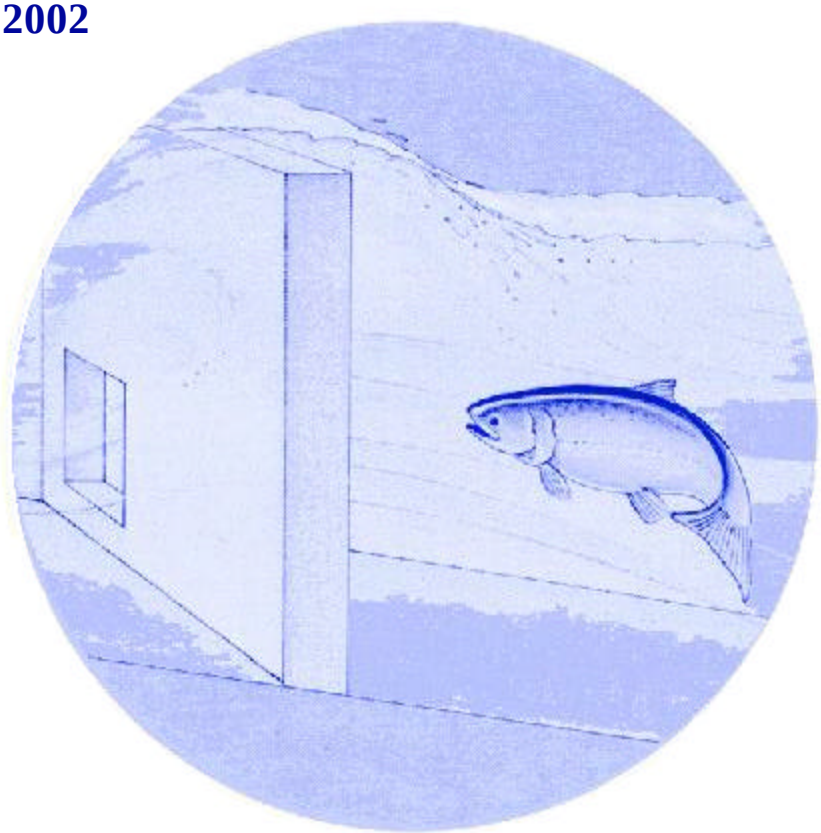
Manastash Water Conservation Study

Final Report
2002



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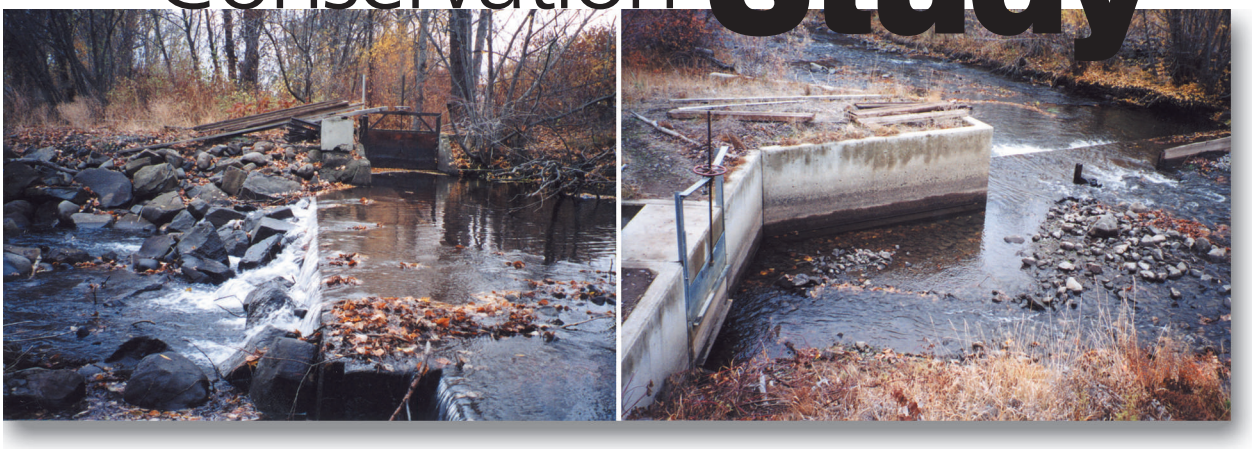
MANASTASH CREEK WATER USERS

Water Conservation Study



DECEMBER 2002

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Water Conservation Study
For
Manastash Creek Water Users
Kittitas County, Washington

Prepared for:

Yakama Nation and
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1.0 INTRODUCTION

Manastash Creek is tributary of the Yakima River and is located southwest and across the Yakima River from the City of Ellensburg (Figure 1). The creek drains mountainous terrain that ranges in elevation from 2,000 feet to over 5,500 feet and is primarily snowmelt fed, with largest flows occurring in spring and early summer. The creek flows through a narrow canyon until reaching a large, open plain that slopes gently toward the Yakima River and enters the main stem of the Yakima River at river mile 154.5. This area, formed by the alluvial fan of the Creek as it leaves the canyon, is the subject of this study. The area is presently dominated by irrigated agriculture, but development pressures are evident as Ellensburg grows and develops as an urban center.

Since the mid to late nineteenth century when irrigated agriculture was established in a significant manner in the Yakima River Basin, Manastash Creek has been used to supply irrigation water for farming in the area. Adjudicated water rights dating back to 1871 for 4,465 acres adjacent to Manastash Creek allow appropriation of up to 26,273 acre-feet of creek water for agricultural irrigation and stock water.

The diversion of water from Manastash Creek for irrigation has created two main problems for fisheries. They are low flows or dewatered reaches of Manastash Creek and fish passage barriers at the irrigation diversion dams. The primary goal of this study, as expressed by Yakama Nation and BPA, is to reestablish safe access in tributaries of the Yakima River by removing physical barriers and unscreened diversions and by adding instream flow where needed for fisheries. The goal expressed by irrigators who would be affected by these projects is to support sustainable and profitable agricultural use of land that currently uses Manastash Creek water for irrigation.

This study provides preliminary costs and recommendations for a range of alternative projects that will partially or fully meet the goal of establishing safe access for fisheries in Manastash Creek by reducing or eliminating diversions and eliminating fish passage barriers. Further study and design will be necessary to more fully develop the alternatives, evaluate their environmental benefits and impacts and determine the effect on Manastash Creek water users. Those studies will be needed to determine which alternative has the best combination of benefits and costs, and meets the goal of the Manastash Creek water users.

Other studies on water conservation in the Manastash Creek area have been performed, most notably by the Kittitas Reclamation District (KRD). This study makes extensive use of the findings and recommendations of the *Kittitas Reclamation District Water Conservation Plan and Addendum #1* (CH2M Hill, 1999, 2001). Those reports identified Manastash Creek as one of the three tributaries of the Yakima River where water savings from irrigation system improvements within the KRD service area could be used to re-establish the natural flow.

The scope of work for this study was formulated following a meeting on June 19, 2001 attended by the consultant team, Yakama Nation, Bonneville Power Administration, Manastash Creek water users, Washington State Department of Fish and Wildlife and Washington Environmental Council which was convened to discuss this study. A public meeting and open house was held in Ellensburg on December 3, 2001 to collect information and comments from interested parties on potential water conservation measures. Other informal meetings were held with Yakama Nation representatives to present potential projects and obtain comments through the process of

preparing this study. No fieldwork was performed for this study other than a brief review of the irrigation facilities. The data presented was collected in 2001 and early 2002, and reflects our understanding of the operations of the irrigation systems at that time.

2.0 BACKGROUND

2.1 Description of Current Water Delivery System

Manastash Creek water users receive water predominately through unlined ditches from six major diversion points on Manastash Creek (see Figures 2-1 and 2-2). Starting from the upstream end, the major diversions are named Manastash Ditch, Keach Ditch, Jensen Ditch, Reed Ditch, Anderson Ditch, and Barnes Road Ditch.

Of these diversions, the Manastash Ditch diversion is the largest, serving over 2,000 acres, and includes more than 3 miles of unlined ditch operated by the Manastash Ditch Association. The Manastash Ditch diversion includes a concrete dam across Manastash Creek, which is a barrier to juvenile fish (Yakama Nation, 2000). The Manastash Ditch runs to the north and crosses three KRD laterals; SB13.8, SB12.8 and SB11.7. It is our understanding that the KRD laterals can be used to convey Manastash Creek water and the Manastash ditch can be used to convey KRD water.

The Keach Ditch and Jensen Ditch diversions have a common concrete dam across Manastash Creek, which is also a barrier to juvenile fish. Both diversions are on the south side of Manastash Creek and divert water to the Keach and Jensen ditches. The Keach and Jensen ditches parallel each other to the south. At the point where the Jensen Ditch crosses the KRD South Branch Canal, it can transfer water to the KRD South Branch canal. The KRD system is used to convey Manastash Creek water to the south half of the Keach and Jensen users. It was stated by the water users that the Jensen ditch only conveys water as far as the Sullivan property. The Keach Ditch Serves 429 acres, and the Jensen Ditch serves 336 acres.

The Reed Ditch diversion also has a concrete dam across Manastash Creek and is considered a barrier to all life stages due to the large concrete slab upstream of the plunge pool (Yakama Nation, 2000). The Reed ditch runs northeast and is on the north side of Manastash Creek. It serves approximately 900 acres of which one property owner, Clarence Harrell, irrigates 700 acres. It crosses the KRD SB13.8 lateral to the west of Cove Road. The KRD diverts water into the Reed ditch at this location to serve landowners along the Reed ditch.

The Anderson diversion serves properties owned by Anderson and Dean. The diversion consists of a temporary straw bale dam across Manastash Creek that is a seasonal barrier to juveniles. The diversion is just downstream from the KRD SB13.8 siphon. The ditch is on the south side of Manastash Creek and serves approximately 170 acres.

The Barnes Road diversion serves properties owned by Anderson and Mellergaard, which are within the Westside Canal service area. The diversion is located on the downstream side of the Barnes Road Bridge and is a seasonal barrier to juveniles. The diversion is piped for about 50-feet before entering an open unlined ditch (Yakama Nation, 2000).

Other small diversions located on the lower Manastash Creek include Hatfield, Evans, Schwab, and Neilson as referred to in this report. The Hatfield Ditch diversion consists of a pre-cast vault

with a 12-inch PVC pipe. However, the channel delivering water to the diversion structure was breached during June 2000 (Yakama Nation, 2000). The Evans, Schwab and Neilson diversions serve single properties and do not to have dams that span Manastash Creek.

2.2 Project Area Description

The farms that use Manastash Creek water are located along the lower reach of Manastash Creek on an alluvial fan between Manastash Ridge and the Yakima River. There are 4,465 acres that use Manastash Creek water. Timothy hay, pasture and wheat are the predominant crops. Timothy hay comprises of approximately 41% of the total irrigated area; pasture 23% and wheat 11%. Table 2-1 presents the breakdown of crop type and acreage by point of diversion for Manastash Creek users. These areas were estimated using Kittitas County Conservation District (KCCD) Geographic Information System (GIS) maps overlaid onto Manastash Creek adjudicated water rights boundaries digitized from the *Yakima River Basin Water Rights Adjudication Second Supplemental Report of Referee* (Yakima County Superior Court, 1998). Acreages may vary due to slight differences in coordinate system conversion.

Table 2-1
Crop Type and Acreage by Point of Diversion

Crop Type	Diversion							Total (ac)	% of Total
	Anderson (ac)	Barnes (ac)	Jensen (ac)	Keach (ac)	Manastash (ac)	Reed (ac)	Other (ac)		
Mint	-	24	-	-	34	-	-	58	1%
Mixed Hay	-	-	-	-	48	-	-	48	1%
Pasture	1	-	65	80	806	62	3	1,017	23%
Potatoes	-	-	-	-	37	-	-	37	1%
Sweet Corn	-	-	39	-	141	-	-	180	4%
Timothy Hay	117	140	16	298	845	391	11	1,819	41%
Timothy/Alfalfa	-	-	81	38	-	-	-	119	3%
Wheat	-	-	18	-	134	339	-	491	11%
Not Mapped/Other	53	3	117	13	147	128	238	698	16%
Total	171	167	336	429	2,191	919	252	4,465	100%

Irrigation methods were also estimated using the KCCD GIS maps. Table 2-2 presents the irrigation method and acreage by point of diversion. It should be noted that almost half of the total land irrigated has not been mapped. Most of the mapped farmland is irrigated by gravity irrigation methods such as gated pipe and ditches. There are approximately 200 acres on the Keach diversion that uses wheel line and linear move pressurized sprinklers.

Table 2-2
Irrigation Method and Acreage by Point of Diversion

Irrigation Method	Diversion							Total (ac)	% of Total
	Anderson (ac)	Barnes (ac	Jensen (ac)	Keach (ac)	Manastash (ac)	Reed (ac)	Other (ac)		
Cement Ditch	-	-	-	-	77	-	-	77	2%
Earthen Ditch	-	-	-	-	553	11	13	577	13%
Gated Pipe	117	99	34	70	734	16	0	1,070	24%
Gated Pipe/Siphon Tubes	-	-	-	150	-	-	-	150	3%
Hand/Wheel Line	-	14	-	-	-	-	-	14	>1%
Hand Line	-	-	44	13	-	-	1	58	1%
Linear Move	-	-	-	53	-	-	-	53	1%
Surface	-	-	-	-	118	-	-	118	3%
Wheel Line	-	29	-	140	-	5	-	174	4%
Not Mapped/Other	54	25	258	3	709	888	238	2,174	49%
Total	171	167	336	429	2,191	919	252	4,465	100%

2.3 Water Rights and Water Use

Manastash Creek water rights quantities are listed in the *Yakima River Basin Water Rights Adjudication* (Yakima County Superior Court, 1998). Table 2-3 provides information on Manastash Creek water rights holders, including name, priority date, point of diversion, acreage and quantity allowed. The water rights holders in Table 2-3 are sorted by point of diversion. There are a total 4,465 acres (71 defined areas) that have adjudicated water rights on Manastash Creek. The peak allowable diversions occur during the months of April, May and June, and total 88 cfs. In July through October, the allowed diversion reduces by one-half to 45 cfs. Stock water accounts for an additional 2 cfs. The total adjudicated volume of water for Manastash Creek is approximately 26,000 acre-feet annually.

Table 2-3
Manastash Creek Water Rights List

				Irrigation Water										Stock Water			
Point of Diversion	Court Claim #	Priority Date	Name	Area (acres)	Mar (cfs)	Apr (cfs)	May (cfs)	Jun (cfs)	Jul (cfs)	Aug (cfs)	Sep (cfs)	Oct (cfs)	Volume (ac-ft)	Stock Water	Contin-uous	Flow (cfs)	Volume (ac-ft)
Anderson	2253	1872-06-30	Anderville Farms,	10	-	0.23	0.23	0.23	0.12	0.12	0.12	0.12	72				
Anderson	1950	1872-06-30	Anderville Farms,	101	-	2.35	2.35	2.35	1.18	1.18	1.18	1.18	720				
Anderson	2260	1872-06-30	Gardinier, Robert	17	-	0.40	0.40	0.40	0.20	0.20	0.20	0.20	122				
Anderson	1846	1874-06-30	Cooke, Brian	4.5	-	0.11	0.11	0.11	0.05	0.05	0.05	0.05	32	x		0.01	1.0
Anderson	1153	1874-06-30	Rock, Bob	2	-	0.05	0.05	0.05	0.02	0.02	0.02	0.02	14	x		0.01	1.0
Anderson	2270	1877-06-30	Dean, Robert	36	-	0.84	0.84	0.84	0.42	0.42	0.42	0.42	256				
Barnes Rd	826	1872-06-30	Kembel, Walter	1.5	-	0.06	0.06	0.06	0.06	0.06	0.06	0.06	12				
Barnes Rd	826	1872-06-30	Mellergaard, Brian	60	-	2.27	2.27	2.27	2.27	2.27	2.27	2.27	692				
Barnes Rd	1946	1892-02-29	Anderson, Lawrence	105	-	2.45	2.45	2.45	1.23	1.23	1.23	1.23	747				
Evans	1478	1877-06-30	Evans, Peter	86.2	-	2.00	2.00	2.00	1.00	1.00	1.00	1.00	612	x	x	0.01	1.0
Hatfield	328	1882-06-30	Richards, Carrol	60	-	1.40	1.40	1.40	0.70	0.70	0.70	0.70	428				
Hatfield	328	1883-06-30	Richards, Carrol	60	-	1.40	1.40	1.40	0.70	0.70	0.70	0.70	428				
Jensen	1553	1871-06-30	Craddock, James	4	-	0.09	0.09	0.09	0.05	0.05	0.05	0.05	28	x			
Jensen	2283	1871-06-30	Matthews, John	15	-	0.35	0.35	0.35	0.18	0.18	0.18	0.18	117	x		0.01	1.0
Jensen	4816	1871-06-30	Renfrow, Brent	5.5	-	0.13	0.13	0.13	0.06	0.06	0.06	0.06	39	x		0.01	1.0
Jensen	1553	1871-06-30	Williams, Mitch	35.5	-	0.83	0.83	0.83	0.41	0.41	0.41	0.41	258				
Jensen	1553	1871-06-30	Wrigley, Donald	8	-	0.19	0.19	0.19	0.09	0.09	0.09	0.09	56	x			
Jensen	1723	1874-06-30	Bland, Larry	37	-	1.17	1.17	1.17	0.06	0.06	0.06	0.06	353				
Jensen	1949	1874-06-30	Hellison, George	-	-	-	-	-	-	-	-	-	-	x	x	0.01	1.0
Jensen	770	1874-06-30	Moore, Woodly	-	-	-	-	-	-	-	-	-	-	x	x	0.01	1.0
Jensen	1896	1874-06-30	Skibeness, Bruce	31	-	0.90	0.90	0.90	0.45	0.45	0.45	0.45	276	x		0.01	1.0
Jensen	1968	1874-06-30	Steward, Charles	150	-	4.76	4.76	4.76	2.38	2.38	2.38	2.38	1452	x	x	0.10	5.0
Jensen	1896	1880-06-30	Skibeness, Bruce	20	-	0.58	0.58	0.58	0.29	0.29	0.29	0.29	178	x		0.01	1.0
Jensen	1896	1886-06-30	Bland, Bart	31.0*	-	0.26	0.26	0.26	0.13	0.13	0.13	0.13	78				
Jensen	1723	1886-06-30	Bland, Larry	37.0*	-	0.70	0.70	0.70	0.35	0.35	0.35	0.35	217				
Jensen	3204	1886-06-30	Sullivan, Ed	3	-	0.07	0.07	0.07	0.04	0.04	0.04	0.04	21	x		0.04	0.7
Jensen	578	1886-06-30	Wells, Wayne	27	-	0.63	0.63	0.63	0.32	0.32	0.32	0.32	183	x	x	0.32	5.0
Jensen	1896	1890-0630	Bland, Bart	31.0*	-	0.64	0.64	0.64	0.32	0.32	0.32	0.32	194				
Jensen	1723	1890-06-30	Bland, Larry	37.0*	-	1.63	1.63	1.63	0.82	0.82	0.82	0.82	506				
Keach	982	1874-06-30	Mellergaard, Laurin	40	-	0.93	0.93	0.93	0.47	0.47	0.47	0.47	284				
Keach	982	1876-06-30	Mellergaard, Laurin	40	-	1.17	1.17	1.17	0.59	0.59	0.59	0.59	356				
Keach	982	1877-06-30	Mellergaard, Laurin	40	-	1.17	1.17	1.17	0.59	0.59	0.59	0.59	356				
Keach	982	1878-06-30	Mellergaard, Laurin	40	-	1.17	1.17	1.17	0.59	0.59	0.59	0.59	356				
Keach	1967	1878-06-30	Stringfellow, Ewing	32	-	0.75	0.75	0.75	0.37	0.37	0.37	0.37	228	x		0.01	1.0
Keach	1953	1880-06-30	Orr, Harold	50	-	1.17	1.17	1.17	0.58	0.58	0.58	0.58	355				

Table 2-3 (Continued)
Manastash Creek Water Rights List

Point of Diversion	Court Claim #	Priority Date	Name	Irrigation Water										Stock Water			
				Area (acres)	Mar (cfs)	Apr (cfs)	May (cfs)	Jun (cfs)	Jul (cfs)	Aug (cfs)	Sep (cfs)	Oct (cfs)	Volume (ac-ft)	Stock Water	Contin-uous	Flow (cfs)	Volume (ac-ft)
Keach	982	1883-06-30	Mellergaard, Laurin	40	-	1.17	1.17	1.17	0.59	0.59	0.59	0.59	356				
Keach	1723	1886-06-30	Bland, Larry	43.6	-	0.67	0.67	0.67	0.33	0.33	0.33	0.33	207				
Keach	1723	1888-06-30	Bland, Larry	10	-	0.23	0.23	0.23	0.12	0.12	0.12	0.12	72				
Keach	1723	1890-06-30	Bland, Larry	86.4	-	1.66	1.66	1.66	0.83	0.83	0.83	0.83	516				
Keach	1969	1891-04-19	Cole, Richard	7	-	0.16	0.16	0.16	0.08	0.08	0.08	0.08	50	x		0.01	1.0
Manastash	950	1872-06-30	M.W.D.A.,	2191	-	27.96	27.96	27.96	13.98	13.98	13.98	13.98	8443	x	x	1.18	118.2
Neilson	1449	1886-08-05	Nielson, Ramon	6.8	-	0.16	0.16	0.16	0.08	0.08	0.08	0.08	48				
Nickles	1671	1871-06-30	Nickles, Ron	3	-	0.07	0.07	0.07	0.04	0.04	0.04	0.04	21				
Reed	987	1871-06-30	Christian, Edmund	25	-	0.58	0.58	0.58	0.29	0.29	0.29	0.29	178				
Reed	657	1871-06-30	Harrell, Clarence	120	1.40	2.80	2.80	2.80	1.40	1.40	1.40	1.40	942				
Reed	477	1871-06-30	Harrell, Clarence	140	1.63	3.26	3.26	3.26	1.63	1.63	1.63	1.63	1099				
Reed	477	1871-06-30	Harrell, Clarence	25	0.29	0.58	0.58	0.58	0.29	0.29	0.29	0.29	196				
Reed	258	1871-06-30	Smith, Wayne	30	-	0.70	0.70	0.70	0.35	0.35	0.35	0.35	213	x	x	0.01	1.0
Reed	477	1872-06-30	Harrell, Clarence	165	1.92	3.84	3.84	3.84	1.92	1.92	1.92	1.92	1294				
Reed	477	1872-06-30	Harrell, Clarence	13.5	0.16	0.32	0.32	0.32	0.16	0.16	0.16	0.16	106				
Reed	987	1874-06-30	Christian, Edmund	20	-	0.47	0.47	0.47	0.23	0.23	0.23	0.23	142				
Reed	657	1874-06-30	Harrell, Clarence	25	0.29	0.58	0.58	0.58	0.29	0.29	0.29	0.29	196				
Reed	1478	1877-06-30	Chapman , William	4.66	-	0.11	0.11	0.11	0.06	0.06	0.06	0.06	28				
Reed	477	1877-06-30	Harrell, Clarence	4.8	0.06	0.11	0.11	0.11	0.06	0.06	0.06	0.06	38				
Reed	477	1877-06-30	Harrell, Clarence	125	1.45	2.91	2.91	2.91	1.45	1.45	1.45	1.45	96				
Reed	1478	1877-06-30	Page, Howard	4.5	-	0.11	0.11	0.11	0.05	0.05	0.05	0.05	32				
Reed	1478	1877-06-30	Smith, James	9.34	-	0.22	0.22	0.22	0.11	0.11	0.11	0.11	67				
Reed	258	1877-06-30	Smith, Wayne	22.5	-	0.52	0.52	0.52	0.26	0.26	0.26	0.26	159				
Reed	1478	1877-06-30	Sparks, Roger	45	-	1.46	1.46	1.46	0.73	0.73	0.73	0.73	447				
Reed	373	1877-06-30	Weeber, H.H.	33.4	-	0.78	0.78	0.78	0.39	0.39	0.39	0.39	238	x		0.02	2.0
Reed	477	1878-06-30	Harrell, Clarence	80	0.92	1.84	1.84	1.84	0.92	0.92	0.92	0.92	627				
Reed	1772	1878-06-30	Lindstrom, Harold	1.25	-	0.03	0.03	0.03	0.02	0.02	0.02	0.02	9				
Reed	923	1878-06-30	Ross, Dean	2.5	-	0.06	0.06	0.06	0.03	0.03	0.03	0.03	18				
Reed	4536	1878-06-30	Samson, Scott	2.5	-	0.06	0.06	0.06	0.03	0.03	0.03	0.03	18	x		0.02	1.0
Reed	987	1889-06-30	Christian, Edmund	20	-	0.47	0.47	0.47	0.23	0.23	0.23	0.23	142				
Schwab	1771	1872-06-30	Schwab, Joseph	2.5	-	0.06	0.06	0.06	0.03	0.03	0.03	0.03	18	x		0.01	1.0
Upper Canyon 1	516	1889-02-22	Mathews, Garry	0.5	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	3				
Upper Canyon 2	4584	1892-06-30	Roe, Lee	15	-	0.28	0.28	0.28	0.28	0.28	0.28	0.28	60	x	x	0.01	1.0
Upper Canyon 3	1593	1896-01-16	Baumann, Harold	6	-	0.14	0.14	0.14	0.14	0.14	0.14	0.14	43				
Upper Canyon 4	907	1896-01-16	Williams, Burton	6	-	0.14	0.14	0.14	0.14	0.14	0.14	0.14	43				
Upper Canyon 5	659	1884-05-24	Lazy F Camp,	7	-	0.30	0.30	0.30	0.30	0.30	0.30	0.30	81	x			
Total				**4,465**	**8.1**	**87.6**	**87.6**	**87.6**	**44.9**	**44.9**	**44.9**	**44.9**	**26,273**			**1.8**	**146**

**Indicates duplicated area.*

Water is diverted for irrigation use from Manastash Creek at 15 separate locations. Four of the diversions are in the upper canyon, which serve land above the KRD South Branch Canal. These account for less than 1% of the total volume of water diverted from Manastash Creek. Below the KRD South Branch Canal there are six major diversions that serve multiple properties. They feed the following ditches: Manastash Ditch Association, Keach Ditch, Jensen Ditch, Reed Ditch, Anderson Ditch and Barnes Road Ditch. The other diversions below the KRD South Branch Canal are smaller and serve single landowners. Table 2-4 summarizes the allowable diversions for each point of diversion.

Table 2-4
Manastash Creek Water Rights Summary

	Irrigation Water										Stock Water		Summary	
Point of Diversion	Area (acres)	Mar (cfs)	Apr (cfs)	May (cfs)	Jun (cfs)	Jul (cfs)	Aug (cfs)	Sep (cfs)	Oct (cfs)	Volume (ac-ft)	Flow (cfs)	Volume (ac-ft)	Unit Volume (feet)	Max. Flow (gpm/acre)
Anderson	171	-	4.0	4.0	4.0	2.0	2.0	2.0	2.0	1,216	0.02	2.0	7.1	10.5
Barnes Rd	167	-	4.8	4.8	4.8	3.6	3.6	3.6	3.6	1,452	-	-	8.7	12.9
Evans	86	-	2.0	2.0	2.0	1.0	1.0	1.0	1.0	612	0.01	1.0	7.1	10.4
Hatfield	120	-	2.8	2.8	2.8	1.4	1.4	1.4	1.4	857	-	-	7.1	10.5
Jensen	336	-	12.9	12.9	12.9	5.9	5.9	5.9	5.9	3,957	0.51	16.7	11.8	17.2
Keach	429	-	10.2	10.2	10.2	5.1	5.1	5.1	5.1	3,138	0.02	2.0	7.3	10.7
Manastash	2,191	-	28.0	28.0	28.0	14.0	14.0	14.0	14.0	8,443	1.18	118.2	3.9	5.7
Neilson	7	-	0.16	0.16	0.16	0.08	0.08	0.08	0.08	48	-	-	7.1	10.4
Nickles	3	-	0.07	0.07	0.07	0.04	0.04	0.04	0.04	21	-	-	7.1	10.5
Reed	919	8.1	21.8	21.8	21.8	10.9	10.9	10.9	10.9	6,283	0.05	4.0	6.8	10.6
Schwab	3	-	0.06	0.06	0.06	0.03	0.03	0.03	0.03	18	0.01	1.0	7.1	10.4
Upper Canyon	35	-	0.87	0.87	0.87	0.87	0.87	0.87	0.87	229	0.01	1.0	6.6	11.3
Total	**4,465**	**8.1**	**87.6**	**87.6**	**87.6**	**44.9**	**44.9**	**44.9**	**44.9**	**26,273**	**1.8**	**145.9**	**5.9**	**8.8**

During spring months when streamflow exceeds allowable diversions, water is likely diverted to all of the major ditches. However, by July most farms are heavily supplemented with KRD water. In most years after July, Manastash Creek supplies water only to a few senior water rights holders. Nearly all of the landowners that have water rights on Manastash Creek rely on supplemental water provided by either the KRD South Branch Canal or the Westside Canal.

2.4 Hydrology of Manastash Creek

The area of the Manastash Creek basin (above the irrigation diversions) is approximately 75 square miles. The upper basin contains mountainous terrain that ranges in elevation from 2,000 feet to over 5,500 feet. The volume and rate of streamflow is highly dependent upon the amount of snowfall and the timing of snowmelt. Discharge is highest (100 to 200 cfs) in the spring runoff period of March through early June. The streamflow then tapers off during June and July to the lowest flows, which typically occur in August. By August flows are probably in the range of 5 to 10 cfs. They continue to be low until fall rains occur, generally in November.

At the point where Manastash Creek crosses the KRD South Branch Canal, Manastash Creek leaves the upper canyon and flows onto an alluvial fan. The creek most likely starts to lose water through seepage into the streambed and ground water system. In addition to losing water via seepage, much of the flow is diverted at the upper part of the alluvial fan through irrigation ditches including Manastash Ditch Association Ditch, Keach Ditch, Jensen Ditch and Reed Ditch. During the majority of years in the summer-fall months, Manastash Creek will dry up in

the vicinity of Cove Road. It then usually reappears where the Westside Canal spills excess water into the dry creek bed above Barnes Road.

Continuous streamflow data on Manastash Creek is available from a gauging station operated by the USGS (Station No. 12483500). The gauging station was located upstream of the Manastash Ditch Association diversion and was in operation from 1909 to 1914. The daily average flow data for these years were averaged and are plotted in Figure 2-3. The average annual runoff in that time period was 42,000 ac-ft/year (58 cfs average annual flow). The runoff for those years was then compared to other streamflow stations to determine if the period of 1909-1914 is representative of long-term average conditions (see Table 2-5). The USGS streamflow stations at the Kachess River near Easton and the Cle Elum River near Roslyn have period of records over 70 years that began prior to 1909. The average annual streamflow from these stations during the period of 1909 to 1914 was compared to averages calculated for their entire period of records (POR). Table 2-5 presents that comparison. It was found the average annual streamflow from the 1909-1914 period was within –2% to +5% of average annual streamflow for the period of record. This indicates that the data collected by USGS on Manastash Creek is fairly representative of average runoff years.

Table 2-5
Comparison of Annual Streamflow From 1909-1914

Period	Kachess River Near Easton, USGS 12476000, POR 1904-1978 (cfs)	Cle Elum River Near Roslyn, USGS 12479000, POR 1903-1978 (cfs)
1909	220	999
1910	367	1,071
1911	292	724
1912	347	810
1913	280	1,031
1914	342	869
1909-1914	308	917
Period of Record	292	933
% Difference	**105%**	**98%**

The Kittitas County Conservation District (KCCD) collected weekly spot streamflow measurements during 2001 at five locations on Manastash Creek from Brown Road at the downstream end to upstream of the Manastash Ditch diversion. The upstream KCCD streamflow measurements (located upstream of Manastash Ditch) are compared to the 1909-1914 flows collected by the USGS on Figure 2-3. The KCCD flows are less than the average streamflow measured at the USGS station in 1909-1914. The difference could be attributed to 2001 being a drought year or potentially changes in the basin or other factors. A comment made by a water user in the public meeting was logging in the Manastash Creek basin after 1914 may have changed the basin response, causing spring runoff to occur much quicker and leaving a dryer summer and early fall.

Both sets of streamflow data are compared with the adjudicated water rights on Manastash Creek in Figure 2-3. It appears that during average years Manastash Creek flow in the months from April through June exceeds the adjudicated water rights (88 cfs), but from July through October Manastash Creek does not supply enough water for all of the adjudicated water rights (45 cfs). The total volume of water that can be supplied by Manastash Creek to the irrigators during an average year is estimated to be 20,000 acre-feet. This available volume is depicted as the hatched area on Figure 2-3, and is about 6,000 acre-feet less than the total water rights.

3.0 ALTERNATIVES TO CONSERVE MANASTASH CREEK WATER

In this study we analyze five major alternatives for conserving Manastash Creek water. These alternatives include piping the existing Manastash Creek ditches, piping the KRD laterals, piping the KRD laterals with eliminating all diversions from Manastash Creek, using groundwater as a water source, and providing supplemental storage upstream on Manastash Creek. Each of these alternatives includes additional measures that provide further water conservation benefits. These measures consist of on-farm water conservation, pumping water from the Westside Canal, KRD water conservation projects, and supplemental groundwater for a limited number of users.

The new pipe system in Alternatives 1 through 3 will be pressurized using available elevation differences from Manastash Creek or the KRD South Branch Canal. The pipe system will facilitate on-farm water conservation improvements by providing pressurized water.

3.1 Alternative 1 – Pipe Manastash Creek Ditches and Selected KRD Laterals

Alternative 1 has two potential components; the baseline alternative of piping the existing ditches, which convey Manastash Creek water, piping selected KRD laterals and one supplemental measure of performing on-farm water conservation measures.

3.1.1 Baseline Alternative Description

The baseline alternative includes replacing the existing ditches and selected KRD laterals with pressurized pipes, and includes consolidating 11 existing diversions from Manastash Creek to 4 new diversions. Figure 3-1 presents the proposed elements of this alternative. We are assuming the new pipe would be constructed in the existing ditch right-of-way in most cases.

The amount of seepage currently lost from the ditches is not known. For this preliminary study we estimated the seepage at 30% of the flow diverted. That same rate of seepage loss was applied to the KRD laterals located in the Manastash Creek area described in the *KRD Water Conservation Plan* (CH2M Hill, 1999, 2001). A 70% conveyance efficiency is within the range of expected efficiencies for unlined irrigation ditches, based upon our experience.

The capacity of the new pipelines was assumed to be 70% of the peak water rights listed in Table 2-4, or equal to the current amount diverted minus seepage losses. Additional studies are required to more precisely determine the amount of seepage occurring on the existing ditches and to confirm or adjust the 70% conveyance efficiency estimate. The new pipe sizes were estimated using a guideline of the maximum velocity equal to five feet per second. Table 3-1 summarizes the pipe sizing calculations.

Table 3-1
Pipe Sizes For Existing Manastash Creek Ditches

Pipe Segment	Irrigated Area (acres)	Adjudicated Peak Flow		Estimated Conveyance Efficiency	Estimated Peak Flow		Pipe Size (inches)	Pipe Length (feet)
		(cfs)	(gpm/ac)		(cfs)	(gpm/ac)		
MD1-1	3,998	76	8.5	0.70	53	5.9	42	900
MD1-2	3,233	53	7.3	0.70	37	5.1	36	1,800
MD1-3	2,191	28	5.7	0.70	20	4.0	24	10,000
MD1-4	1,096	14	5.7	0.70	10	4.0	18	10,400
R1	922	22	10.6	0.70	15	7.4	24	6,600
R2	459	11	10.6	0.70	8	7.4	18	6,400
H1	120	3	10.5	0.70	2	7.3	6	6,400
A1	171	4	10.5	0.70	3	7.3	12	3,000
A2	85	2	10.5	0.70	1	7.3	6	2,700
B1	167	5	12.9	0.70	3	9.0	12	3,500

For this alternative, the existing Manastash Ditch diversion will be replaced with a new, larger diversion so it can divert water to the Manastash Ditch, Hatfield Ditch, Reed Ditch, Nickles property, Jensen Ditch and Keach Ditch. The new Manastash Ditch pipe system is divided into four sections; MD1-1 through MD1-4. Section MD1-1 of Manastash pipe begins at the point of diversion on Manastash Creek and ends at the KRD South Branch Canal. A portion of the water diverted from Manastash Creek will be discharged to the KRD South Branch Canal, and will then be conveyed to properties that are served by the Keach and Jensen ditches. Since most of these properties already receive Manastash Creek water through the KRD South Branch Canal and laterals, we propose to abandon the existing Jensen and Keach diversions and ditches. The conveyance system for these properties will be the same as discussed in the *KRD Water Conservation Plan*, which includes replacing SB14.3 and SB16.7/SB17.6 laterals with pipe, and extending the laterals in several places. We also propose to replace the KRD South Branch Canal with pipe from Manastash Creek to SB 16.7. See Table 3-5 in Section 3.2.1 for the criteria used in sizing KRD lateral improvements.

Section MD1-2 of the Manastash Ditch pipe starts at the KRD South Branch Canal and ends at the crossing of the KRD SB13.8 lateral. A portion of the flow in the pipe will be diverted to the KRD SB13.8 lateral, which will serve Hatfield Ditch, the Reed Ditch and the Nickles property. The KRD SB13.8 lateral will be replaced with pipe as described in the *KRD Water Conservation Plan*. The Hatfield and Reed ditches will also be replaced with pipes with sizes as shown in Table 3-1. Section MD1-3 and MD1-4 extend along the Manastash Ditch and serve Manastash Ditch Association properties.

The Anderson diversion will be replaced and will have increased capacity to divert additional water to the Evans property. The Anderson Ditch will be replaced with pipe with sizes as shown in Table 3-1 represented by pipe segments A1 and A2. The Barnes Road and Neilson diversions will also be replaced. The Barnes Road Ditch will replaced with the pipe segment labeled B1 in Table 3-1.

The upgrades to the KRD system for this alternative include replacing 5,000 feet of SB13.8, SB14.3, and SB17.6 with pipes. New pipes M1, M2, M3, M4 and M5 will be added to the KRD

system so the KRD system can serve the Manastash Creek water users. The sizes for the replacement and extensions to the KRD system were obtained directly from the *KRD Water Conservation Plan Addendum #1* (CH2M Hill, 2001).

This baseline alternative conserves water from both Manastash Creek and the KRD system. For Manastash Creek water users, the water savings is equal to the water that currently seeps out of the ditches. Our estimate at this time is the ditches are about 70% efficient. The water saved is equal to the water diverted multiplied by 0.30. Approximately 20,000 ac-ft of water is diverted from Manastash Creek during an average streamflow year. We estimate that replacing the ditches with pipe can save up to 6,000 ac-ft (20,000 x 0.3) of water. The remaining 14,000 ac-ft per year is currently delivered to water users from Manastash Creek during an average year.

The water savings for piping KRD laterals was estimated by multiplying the area land irrigated by the KRD laterals SB14.3, 16.7 and 17.6 by a seepage loss factor. Since no data exists on exactly how much land is served by individual laterals within the KRD, it was estimated in the *KRD Water Conservation Plan* that 70 percent of the original design flow of the laterals divided by a water delivery of 0.02 cfs/acre is representative of the amount of land served by individual laterals. These laterals have a combined original design flowrate of 64 cfs, and are calculated to serve approximately 2,240 acres. It is estimated that the KRD laterals are about 70% efficient. The total amount of water that is diverted by the KRD during an average year is 310,453 ac-ft to 55,576 acres, which is approximately 5.59 ac-ft/acre. Of the diverted water, 1.68 ac-ft/acre (conservatively 30%) is lost due to seepage. Piping the KRD laterals described in this alternative saves approximately 3,760 ac-ft (2,240 acres x 1.68 ac-ft/acre) of water lost due to seepage. The combined annual water savings for this baseline alternative is then approximately 9,760 ac-ft.

For the piping of the existing ditches, it was assumed that reinforced concrete pipe would be used for diameters greater than 18 inches and PVC pipe would be used for all diameters less than 18 inches. The cost of the pipe per lineal foot was taken from the cost estimates provided by CH2M Hill in the *KRD Water Conservation Plan*, updated to November 2002 construction costs per the Engineering News Record (ENR) Construction Cost Indices (as found at www.enr.com).

The earthwork calculations were made assuming that the entire trench would be excavated and the pipe would be laid on 3 inches of gravel bedding, backfilled with 1/3 select fill and 2/3 native fill, with a total of 1.5 foot of cover over the crown of the pipe. A smaller depth of cover was selected as the pipelines will not be operated during the winter months, therefore additional ground cover for freeze protection is not necessary. It was also assumed that additional cover is not necessary to avoid other utility crossings (sewer, storm, etc.). It was assumed that the trench would have 1 to 1 side slopes. The quantity and costs for the piping appurtenances, turnouts, road crossings, lateral inlets and reestablishment of drainage patterns should be verified during the next phase.

The estimated construction costs for laterals M1 through M5 were taken from Table 2 of *Addendum #1* of the *KRD Water Conservation Plan* (CH2M Hill, 2001). Contingency, state sales tax and/or engineering, legal, and administrative costs were added to the estimated construction costs.

The costs for the Manastash Diversion was based on current quotes from equipment suppliers and a recent project of similar proportion bid recently in Eastern Washington. The diversion

structure would consist of a dam spanning the creek with a fish ladder, bar screen/trashrack, automated head gates (to control elevation of water) and a fish screen. A rubber dam was selected at this stage of planning due to concerns that permits for a concrete diversion would be expensive and more difficult to obtain. A concrete dam would be similar in overall price.

The diversion costs for the Anderson and Barnes Diversions were generated assuming the diversion structure would consist of a concrete dam spanning the Creek with a fish ladder, bar screen/trash rack, head gate (to control elevation of water) and a fish screen. The fish screen costs were taken from a table generated by the Washington State Department of Fish and Wildlife (WDFW), which compiles costs per cfs for screens installed within Washington State.

The Neilson Diversion consists of a small, vertical turbine pump set in a concrete vault with a NEMA enclosure. Small diameter PVC pipe would be used for both suction and discharge piping. Costs were based on quotes from local vendors.

The cost for demolition of the existing diversion structures along Manastash Creek was estimated to be $497,200. Demolition consists of removal of the existing structure, hauling and disposal of materials and some minor site restoration.

3.1.2 Supplemental Measure 1A - On Farm Water Conservation

On-farm water conservation measures can include structural and non-structural measures. Structural measures consist of changes to the methods of applying water on-farm, such as replacing surface irrigation methods with a pressurized sprinkler system. Non-structural methods can include use of irrigation scheduling programs, soil moisture sensors, tailwater re-use and other techniques of reducing the amount of water applied to a farm or reusing water that would normally run off a farm.

The amount of water potentially saved through on-farm water conservation measures was estimated using data collected for this study. The data collected includes: acreage currently receiving water diverted from Manastash Creek; estimates of current water use from the creek; estimates of the amount of water delivered to portions of those lands from the KRD; estimates of Crop Irrigation Requirements; data on cropping patterns; data on current irrigation practices; and estimates of the potential efficiency after implementation of on-farm water conservation methods. A summary of the data collected follows.

Summary Of Acreage And Water Supplied

The area currently irrigated by water diverted from Manastash Creek is 4,465 acres. The total estimated volume of Manastash Creek water delivered to farms during an average year is 14,000 acre-feet (Section 3.1.1). Of the 4,465 acres, 2,910 acres are also supplied water from KRD. The water delivered during an average year by the KRD is approximately 3.5 ac-ft/acre (CH2M Hill, 1999), which equates to about 10,185 ac-ft/year. Note that in Section 3.1.1 KRD water deliveries are estimated using the design flow for particular laterals, which include all water users supplied by each lateral. For this calculation we are estimating the KRD water deliveries to only Manastash Creek water users on all KRD laterals that supply the Manastash Creek water users. The total water delivered to Manastash Creek supplied lands is estimated to be 24,185 ac-ft/year.

Cropping Patterns

In the previous section Table 2-1 presents a breakdown of the crop type and acreage by point of diversion. Hay and alfalfa are grown over the majority of land in the study area. Overall, at least 68% of the land served by Manastash Creek water contains hay or alfalfa crops. Sixteen percent of the area was not mapped or had other crop types. It is likely some of that area is also planted in hay or alfalfa. Since a majority of the land area is in hay and alfalfa, we are assuming the crop water demands for hay and alfalfa are representative for the study area.

Crop Irrigation Requirements

Crop irrigation requirements were estimated using crop evapotranspiration (ET) data that was obtained from the *Washington State University Public Agricultural Weather System* (PAWS) and from the *Washington State Irrigation Guide* (USDA, 1985). The PAWS network contains a station in Ellensburg. The Reference Crop ET data for Alfalfa for the period of 1990-2001 is listed in Table 3-2. The average annual Reference Crop ET for that period is 41.1 inches. However, that Reference Crop ET is for an actively growing alfalfa crop with at least 8-12 inches of top growth. It overestimates annual crop water requirements because of lower water needs during early growth stages and during cuttings. An estimate of annual crop needs accounting for cuttings is 85% of the Reference Crop ET (USBR, 2002). Using that percentage, the annual crop needs for alfalfa are approximately 34.9 inches (41.1 x 0.85).

Table 3-2
Reference Crop ET in Ellensburg (Alfalfa) April-October

Water Year	Annual ET (inches)
1990	39.0
1991	42.4
1992	39.3
1993	40.8
1994	46.5
1995	41.6
1996	41.8
1997	39.3
1998	42.6
1999	41.1
2000	39.8
2001	39.5
Average	*41.1*

The *Washington State Irrigation Guide Appendix B* lists the seasonal net irrigation requirement for alfalfa in Ellensburg to be 29.76 inches. For the study area, we selected a crop irrigation requirement of 32 inches (about halfway between the PAWS data and the *Washington State Irrigation Guide* values) to represent average crop needs.

Current Irrigation Practices

In the previous section Table 2-2 provides a breakdown of irrigation methods practiced in the study area. The prevalent irrigation practices are different forms of surface irrigation including

earthen or cement ditch and gated pipe. Although the irrigation method was not determined for almost one-half of the study area, the acreage using pressurized sprinklers is still small. The total acreage using wheel lines or lateral move sprinklers is 227 acres, or 5% of the total acreage in the study area.

Efficiencies

The efficiencies for current irrigation practices are likely low, as surface application is not usually a precise method of applying water. The *Washington State Irrigation Guide* contains estimates of expected irrigation efficiencies for different irrigation practices. Those efficiencies are listed in Table 3-3.

Table 3-3
Estimated Irrigation Efficiencies

Method	Efficiency
Level Border	75
Graded Border	70
Flood Irrigation	50
Contour Ditch	50
Level Furrow	65
Graded Straight Furrow	60
Graded Contour Furrow	60
Corrugations	60
Subirrigation – Water Table Control	65
Subirrigation – Trickle	70
Trickle – Point Source Emitter	90
Trickle – Spray Emitter	85
Trickle – Continuous Tape	90
Handline/Wheel line	65
Big Gun (Fixed Place)	60
Traveling Gun	65
Solid Set (Above Canopy)	65
Solid Set (Below Canopy)	70
Center Pivot	70
Linear Move	70

The efficiencies for surface irrigation techniques, the most prevalent in the study area, are estimated to be 50-60%. In contrast, the efficiencies for pressurized irrigation systems can be 70-80%.

The efficiency of current on-farm irrigation practices was estimated using the estimates of water supplied to the 4,465 acres in the study area (24,185 acre-feet/year or 5.4 acre-feet/acre) and the crop irrigation requirement (2.67 acre-feet/acre). It appears the current on-farm efficiency is about 50%, assuming all 4,465 acres are currently irrigating and has a crop irrigation requirement of 2.67 feet per year.

The total efficiency, which includes seepage loss in ditches and on-farm losses, is estimated to be 32% (2.67 / (5.4 + 1.68 + (6,000 / 4,465))). The total efficiency is similar to efficiencies found in other irrigated areas in the Kittitas Valley and is likely representative of actual conditions.

Potential Improvements In Efficiencies

It is difficult to assess the potential improvements in efficiencies and their costs without performing a farm-by-farm water audit to review current irrigation practices and determine what types of improvements would work on a particular farm. For this study we are making simplified assumptions and using unit costs of improvements based upon other on-farm conservation projects performed in the Kittitas Valley.

To estimate water savings, we are assuming that one-half of the acreage currently irrigated with Manastash Creek water will voluntarily implement on-farm water conservation measures if provided funding assistance. That acreage is 2,232 acres. If the efficiency of those farms is increased by 25% (from 50% to 75%), the resulting water savings would be 3,970 ac-ft per year.

2,232ac x 2.67ft / 50% - 2,232ac x 2.67 ft / 75% = 3,970 ac-ft water savings

The type of on-farm improvement suggested at this level of study is pressurized sprinkler systems. Several types of pressurized sprinkler systems are available, including a center pivot system, linear move system, and smaller systems such as wheel lines. The center pivot and linear move systems have developed low-pressure drop tubes that closely control the rate of water delivered to the crop. Linear move sprinklers are the type that would likely work best in the study area given the configuration of the farms and crop type. Based upon discussions with equipment representatives and the Kittitas Conservation District, a unit cost of $1000 per acre can be used at this preliminary level of study.

The total estimated cost of on-farm improvements is $2,230,000. That estimate is a budget-level number, which will depend on farmer acceptance of the new sprinkler systems and site-specific conditions at each farm.

3.1.3 Summary of Potential Costs and Water Savings

The construction costs for all components of Alternative 1 are summarized in Table 3-4. A more detailed breakdown of these planning level cost estimates has been included in Appendix A. The costs include sales tax; an allowance for engineering; legal and administrative fees of 25% of construction costs; and a contingency ranging from 25 to 30%. Both the estimate of the contingency and engineering, legal and administrative fees are conservative, but reflect the conceptual level of analysis performed for this study. An additional +50% to –30% range in costs is included in the Appendix A, and should be considered with the estimated construction costs in this study as an added measure of uncertainty.

Summarized in Table 3-4, the baseline alternative estimated project cost is approximately $12,004,000, which saves an estimated 9,760 ac-ft/year of water diverted from Manastash Creek. The supplemental measure for this alternative costs approximately $2,230,000, and saves an estimated 3,970 ac-ft/year of water. The total cost for this alternative is approximately $14,234,000, and has potential water savings estimated to be 13,730 ac-ft/year. Those water savings are the estimated reduction in diversions from Manastash Creek.

Table 3-4
Alternative 1 Cost vs. Water Savings

Description	Estimated Project Cost	Estimated Water Savings (ac-ft)	Estimated Construction Cost per Annual Water Savings ($/ac-ft)
Baseline Alternative 1			
Pipe Manastash Ditches (Manastash, Reed, Hatfield, Anderson and Barnes Rd)	$3,833,000		
Four New Diversions and Removal of the Old Diversions	$2,587,000		
KRD Improvements (portion of SB13.8, 14.3, 16.7, 17.6, and portion of South Branch Canal)	$5,391,000		
KRD Extensions (M1-M5)	$193,000		
Subtotal	$12,004,000	9,760	$1,230/ac ft
Supplemental Measure 1A			
On-Farm Water Conservation	$2,230,000	3,970	$562/ac ft
Total	$14,234,000	13,730	$1,037/ac ft

Estimated project costs may vary from +50% to –30%.. See Appendix A for cost variations.

3.1.4 Potential Implementation Issues

The potential implementation issues related to Manastash Creek water users for Alternative 1 include the following:

- Willingness of all the water users in replacing their existing open ditches;
- The willingness of water users to combine diversions and portions of their ditches and to manage combined water diversions in the future;
- The willingness of the KRD to agree to upgrades in their lateral system and to use portions of their system to deliver water to Manastash Creek water users;
- The capacity of the KRD South Branch Canal to provide enough flow after improvements to serve Manastash Creek water users; and
- The willingness of farmers to construct on-farm irrigation improvements.

The permits required for implementation of Alternative 1 include:

- SEPA or NEPA process depending on source of funding of project;
- Water Right Change Applications and State Trust Water Rights will need to be applied for through the Washington State Department of Ecology;
- Hydraulic Project Approval from WDFW for instream work (removal and construction of diversion dams) is required;
- U.S. Army Corps of Engineers Section 10 Permits are required for instream work;
- Water Quality Certification from Department of Ecology is required for instream work;

- Shorelines Permit from Kittitas County is required for instream work; and
- Other Kittitas County permits relating to use of road rights-of-ways and building permits are required for pipelines and structures.

Additional data that we recommend be collected and studies we recommend be performed before implementation of Alternative 1 include:

- Perform measurements on Manastash Creek to obtain data on streamflow and seepage loss in the creek from the mouth of the canyon;
- Measure existing diversions from Manastash Creek and seepage loss in ditches;
- Measure seepage losses in KRD laterals proposed for improvement;
- Perform study of KRD South Branch Canal to ensure enough capacity is available to serve Manastash Creek water users;
- Prepare water balance for project area along with groundwater study to estimate effects on groundwater users from reduced seepage; and
- Perform more detailed engineering studies to estimate costs and water savings with a greater degree of certainty.

3.2 Alternative 2 – Pipe and Use KRD Laterals, Consolidate Diversions

Alternative 2 has four potential components. The baseline alternative includes piping the existing KRD laterals, which will convey both Manastash Creek water and KRD water. Supplemental measures include constructing on-farm water conservation measures; offsite KRD system improvements; and wells to supply with groundwater to isolated properties and for stock water.

3.2.1 Baseline Alternative Description

The baseline alternative for Alternative 2 includes replacing the existing KRD laterals that serve the Manastash Creek basin with pressurized pipes, consolidating the 11 existing diversions from Manastash Creek to one new diversion located at the Manastash Ditch diversion, and replacing the Manastash Ditch with a pressurized pipe so that it interconnects with each of the KRD laterals. Figure 3-2 presents the proposed elements of this alternative.

This alternative allows for the parcels within the KRD service area to be irrigated with either KRD or Manastash Creek water with a single conveyance system, the KRD laterals. The land within the Westside Canal service area currently served with Manastash Creek water would be served by groundwater as described later in Supplemental Measure 2C.

The KRD system that serves the Manastash Creek area will be replaced with pipes, and this includes SB9.9, SB11.7, SB12.8, SB13.8, SB14.3, SB16.7, SB17.6 and the lower portion of the KRD South Branch Canal. Most of these pipe sizes were obtained directly from the *KRD Water Conservation Plan Addendum #1* (CH2M Hill, 2001*)*. However, SB11.7, SB12.8 and the lower portion of the KRD South Branch Canal are not in the *KRD Water Conservation Plan Addendum #1* because they were not considered high loss laterals as reported in the *KRD Water Conservation Plan*. These laterals and canal serve the Manastash Creek area, and for this alternative will be replaced with pipes so they can deliver pressurized water. Table 3-5 summarizes the pipe sizing calculations not included in the *KRD Water Conservation Plan*, but

use the same method for calculating the size. The laterals were arbitrarily divided into three segments for cost savings.

Table 3-5
KRD Lateral Pipe Sizing

Pipe Segment	Original Design Flowrate From USBR Records (cfs)	Estimated Conveyance Efficiency	Estimated Flowrate Based on Conveyance Efficiency (cfs)	Required Pipe Size (inches)	Pipe Length (feet)
SB11.7a	34.1	0.70	24	30	2,980
SB11.7b	25.6	0.70	18	24	4,000
SB11.7c	17.1	0.70	12	18	7,700
SB12.8a	32.1	0.70	22	30	2,850
SB12.8b	24.1	0.70	17	24	7,180
SB12.8c	16.1	0.70	11	18	4,710
Lower KRD South Branch Canal	32.4	0.70	23	30	12,500

As described in the *KRD Water Conservation Plan Addendum #1*, the KRD laterals will be extended to serve the Manastash Creek water users. The extensions are labeled M1 through M14 as shown on Figure 3-2. Sizes and lengths were obtained directly from the *KRD Water Conservation Plan Addendum #1*.

In addition to the KRD lateral improvements, the existing diversions on Manastash Creek will be consolidated to one new diversion located at the Manastash Ditch diversion. This new diversion will be connected to the KRD laterals through a new pipe that will replace most of the Manastash Ditch. The new diversion may be necessary to meet peak demands by the Manastash Creek water users, as the capacity of the KRD canal is limited. Section MD2-1 of the Manastash Ditch pipe (see Figure 3-2) will connect the new diversion on Manastash Creek to the KRD South Branch Canal. A portion of the Manastash Creek water will enter then KRD South Branch Canal to serve SB14.3, SB16.7, and SB17.6. Sections MD2-2, MD2-3 and MD2-4 of Manastash Ditch pipe continue to the north and connect to KRD laterals SB13.8, SB12.8 and SB11.7. Table 3-6 presents Alternative 2 estimated pipe sizes and lengths for the Manastash Ditch.

Table 3-6
Manastash Ditch Pipe Sizing

Pipe Segment	Irrigated Area (acres)	Adjudicated Peak Flow		Estimated Conveyance Efficiency	Estimated Peak Flow		Pipe Size (inches)	Pipe Length (feet)
		(cfs)	(gpm/ac)		(cfs)	(gpm/ac)		
MD2-1	4,257	82	8.6	0.70	57	6.0	48	900
MD2-2	3,492	59	7.5	0.70	41	5.3	36	1,800
MD2-3	2,191	28	5.7	0.70	20	4.0	24	5,800
MD2-4	1,096	14	5.7	0.70	10	4.0	18	4,500

As described in Alternative 1, the amount of seepage currently lost from the laterals and ditches is not known, and for this preliminary study we estimated the seepage to be 30% of the flow. The capacity of the new pipelines was assumed to be 70% of the peak water rights listed in Table

2-4 or equal to the current amount diverted minus seepage losses. The new pipe sizes were estimated using a guideline of a maximum velocity equal to five feet per second.

Improving the KRD laterals conserves water from both Manastash Creek and the KRD system. For Manastash Creek the savings are the same as in Alternative 1, which is equal to the water that currently seeps out of the ditches. Our estimate of the seepage at this time is 6,000 ac-ft (see Section 3.1.1).

The KRD water savings for this alternative includes the land irrigated by the KRD laterals SB9.9, 11.7, 12.8, 13.8, 14.3, 16.7 and 17.6. These laterals serve approximately 5,400 acres, which was determined using GIS mapping of KRD assessed acreage. It is estimated that the KRD laterals are about 70% efficient. The total amount of water that is diverted by the KRD during an average year is 310,453 ac-ft to 55,576 acres, which is approximately 5.59 ac-ft/acre. Of the diverted water, 1.68 ac-ft/acre (conservatively 30%) is lost due to seepage. Piping the KRD laterals described in this alternative saves approximately 9,070 ac-ft (5,400 acres x 1.68 ac-ft/acre) of water lost due to seepage. The combined annual water savings for this baseline alternative is then approximately 15,070 ac-ft.

The costs developed for converting the existing KRD laterals to a pressure pipe system were taken from the *KRD Water Conservation Plan* and *Addendum #1*, developed by CH2M Hill (1999 and 2001). The costs were updated to reflect November 2002 construction costs per the Engineering News Record (ENR) Construction Cost Indices (as found at www.enr.com). Concrete pipe was specified for all pipes greater than 18 inches in diameter, while PVC pipe was used for pipes 18 inches and smaller.

Earthwork calculations for all KRD laterals (with the exception of SB11.7 and SB12.8) were taken from the *KRD Water Conservation Report* and *Addendum #1* (CH2M Hill, 1999 and 2001). For all other pipelines, the earthwork calculations were made assuming that the entire trench would be excavated and the pipe would be laid on 3 inches of gravel bedding, backfilled with 1/3 select fill and 2/3 native fill, with a total of 1.5 foot of cover over the crown of the pipe. A smaller depth of cover was selected as the pipelines will not be operated during the winter months, therefore additional ground cover for freeze protection is not necessary. It was also assumed that additional cover is not necessary to avoid other utility crossings (sewer, storm, etc.). It was assumed that the trench would have 1 to 1 side slopes. The quantity and costs for the piping appurtenances, turnouts, road crossings, lateral inlets and reestablishment of drainage patterns should be verified during the next phase.

The estimated construction costs for laterals M1 through M14 were taken from Table 2 of *Addendum #1* of the *KRD Water Conservation Plan* (CH2M Hill, 2001). Contingency, state sales tax and/or engineering, legal, and administrative costs were added to the estimated construction costs.

As part of Alternative 2, a single diversion structure is planned to replace the 11 existing diversion structures placed along the Creek. The costs for the Manastash Diversion was based on current quotes from equipment suppliers and a recent project of similar proportion bid recently in Eastern Washington. The diversion structure would consist of a dam spanning the creek with a fish ladder, bar screen/trashrack, automated head gates (to control elevation of water) and a fish screen. A rubber dam was selected at this stage of planning due to concerns

that permits for a concrete diversion would be expensive and more difficult to obtain. A concrete dam would be similar in overall price.

The cost for demolition of the existing diversion structures along Manastash Creek was estimated to be $497,000. Demolition consists of removal of the existing structure, hauling and disposal of materials and some minor site restoration.

3.2.2 Supplemental Measure 2A - On Farm Water Conservation

Expected water savings for on-farm water conservation is approximately 3,970 ac-ft per year and cost is approximately $2,230,000. A description of this measure is contained in Section 3.1.2.

3.2.3 Supplemental Measure 2B – Offsite KRD System Improvements

The *KRD Water Conservation Plan* evaluated alternatives for improving the KRD's water distribution facilities and the associated water saving. The *KRD Water Conservation Plan Addendum #1* investigated how the saved water could be used for fish benefits in four tributary streams including Manastash Creek. The preferred alternative included piping high loss laterals, construction of two re-regulation reservoirs (Page Canyon and Johnson), and the automation of the Wippel Pumping Plant. These improvements save 48,500 ac-ft of water annually, where two-thirds of the saved water (32,000 ac-ft) can be reallocated for use in serving creek water rights holders. This saved water would then be conveyed to users on Big, Little and Manastash Creeks consistent with stated allocations of saved water for improvements financed under the Yakima River Basin Water Enhancement Project (YRBWEP). The allocation of water is required under legislation authorizing YRBWEP, but if the projects are funded outside of YRBWEP the allocation may not be required. It is our opinion the saved water can all go to replacing creek water rights as long as it can be shown there is no impact to downstream the water user and in-stream flow.

Most of the improvements listed in the *KRD Water Conservation Plan* are on the KRD North Branch Canal. These include piping most of the high loss laterals, construction of the Johnson Re-regulation Reservoir and automation of the Wippel Pumping Plant. Currently the South Branch Tunnel, located at the beginning of the KRD South Branch Canal runs at maximum capacity during peak irrigation season. Water savings from these North Branch improvements would not benefit the Manastash Creek water users because the South Branch Tunnel is a constriction, which wouldn't allow additional water be conveyed to the Manastash Creek water users. Only improvements on the KRD South Branch Canal would benefit the Manastash Creek water users because the water saved would be supplied in the same canal, not increasing the water conveyed through the South Branch Tunnel. These improvements include piping a limited number of high loss laterals and constructing the Page Canyon Reservoir. Piping the laterals is described in Section 3.2.1 above. The construction of Page Canyon Re-regulation Reservoir will save approximately 1,500 ac-ft of water (CH2M Hill, 2001). It is our opinion that all of the water saved with this measure can be applied to Manastash Creek water users, as long as there are no downstream impacts to water supply and in-stream flow.

3.2.4 Supplemental Measure 2C - Groundwater for Some Water Users

This supplemental measure entails supplying groundwater to a limited number of users including year-round stock water users and parcels located outside of the KRD service area (includes

parcels in the upper canyon and within the Westside Canal service area). Groundwater will be provided through either 8-inch or 12-inch wells. The 8-inch wells will serve properties less than 10 acres in size and individual stock water users. The 12-inch wells will serve larger parcels in 40-acre increments. Groundwater supply and well design is described in Section 3.4 of this report.

Table 3-7 presents the breakdown of groundwater requirements for this alternative including the number of 8-inch and 12-inch wells, the acreage served by the wells, and the approximate Manastash Creek water saved. The number of wells for irrigation was estimated using a GIS parcel boundary map. The effective water savings for this supplemental measure is somewhat less than the adjudicated water right. Ditch leakage and on-farm water conservation have already been accounted for in this alternative. The water savings, in terms of reduced surface water use from Manastash Creek, is equal to the crop irrigation requirement of 2.67 ac-ft/acre per season (Section 3.1.2) divided by an average on-farm efficiency of 75% (assuming parcels served by pressure system would upgrade to more efficient irrigation system). The total water savings for this measure is approximately 1,830 ac-ft.

Table 3-7
Groundwater Supply Summary

Description	No. of 8-inch Wells	No of 12-inch Wells	Land Area (acres)	Approximate Water Saved (ac-ft)
Land Served by Barnes Road Ditch (within Westside service area)	6	5	167	595
Land Served Manastash (within Westside service area)	1	3	72	256
Neilson Parcel (within Westside service area)	1	-	7	25
Land Served by Reed Ditch (within Westside service area)	-	5	193	687
Upper Canyon Parcels	5	-	35	125
Year-round Stockwater	11	-	-	146
Total	24	13	474	1,830*

**Rounded to the nearest 10 ac-ft.*

The estimated costs for individual 8-inch and 12-inch wells are $90,000 and $135,000. Cost breakdowns are provided in Appendix A. The total estimated costs for constructing irrigation wells are $3,925,000. Total annual power costs are estimated at $51,300 per year, the estimate of which is also provided in Appendix A.

3.2.5 Summary of Potential Costs and Water Savings

A cost summary of the components that comprise Alternative 2 is presented in Table 3-8. A more detailed breakdown of these planning level cost estimates has been included in Appendix A. The costs include sales tax; an allowance for engineering; legal and administrative fees of 25% of construction costs; and a contingency ranging from 25 to 30%. Both the estimate of the contingency and engineering, legal and administrative fees are conservative, but reflect the conceptual level of analysis performed for this study.

The baseline alternative estimated project cost is approximately $14,020,000, which saves an estimated 15,070 ac-ft/year of water diverted from Manastash Creek. The supplemental measures for this alternative costs approximately $7,844,000, and saves an estimated 7,300 ac-ft/year of water. The total cost for this alternative is approximately $21,864,000, and has potential water savings estimated to be 22,370 ac-ft/year. Those water savings are the estimated reduction in diversions from Manastash Creek.

Table 3-8
Alternative 2 Cost vs. Water Savings

Description	Estimated Project Cost	Estimated Water Savings (ac-ft)	Estimated Construction Cost per Annual Water Savings ($/ac-ft)
Baseline Alternative 2			
KRD Lateral and Canal Improvements	$9,251,000		
KRD Laterals Extensions (M1-M14)	$1,516,000		
Pipe Manastash Ditch	$1,295,000		
New Manastash Diversion and Removal of Old Diversions	$1,958,000		
Subtotal	$14,020,000	15,070	$930/ac ft
Supplemental Measure 2A			
On-Farm Water Conservation	$2,230,000	3,970	$562/ac ft
Supplemental Measure 2B			
Page Canyon Re-regulating Reservoir	$1,688,000	1,500	$1,125/ac ft
Supplemental Measure 2C			
Groundwater for Some Water Users	$3,925,000	1,830	$2,145/ac ft
Total	$21,864,000	22,370	$977/ac ft

Estimated project costs may vary from +50% to –30%.. See Appendix A for cost variations.

3.2.6 Potential Implementation Issues

The potential implementation issues related to Manastash Creek water users for Alternative 2 include the following:

- Willingness of all the water users in replacing their existing open ditches;
- The willingness of water users to combine diversions and portions of their ditches and to manage combined water diversions in the future;
- The willingness of the KRD to agree to upgrades in their canal and lateral system and to use their system to deliver water to Manastash Creek water users;
- The capacity of the KRD South Branch Canal to provide enough flow after improvements to serve Manastash Creek water users;

- The availability of groundwater to serve some users; and
- The willingness of farmers to construct on-farm irrigation improvements.

The permits required for implementation of Alternative 2 include:

- SEPA or NEPA process depending on source of funding of project;
- Water Right Change Applications and State Trust Water Rights will need to be applied for through the Washington State Department of Ecology;
- Hydraulic Project Approval from WDFW for instream work (removal and construction of diversion dams) is required;
- U.S. Army Corps of Engineers Section 10 Permits are required for instream work;
- Water Quality Certification from Department of Ecology is required for instream work;
- Shorelines Permit from Kittitas County is required for instream work;
- Well Construction Permits from Department of Ecology;
- Washington State Dam Safety Permit is required for a re-regulating reservoir; and
- Other Kittitas County permits relating to use of road rights-of-ways and building permits are required for pipelines and structures.

Additional data that we recommend be collected and studies we recommend be performed before implementation of Alternative 2 include:

- Perform measurements on Manastash Creek to obtain data on streamflow and seepage loss in the creek from the mouth of the canyon;
- Measure existing diversions from Manastash Creek and seepage loss in ditches;
- Measure seepage losses in KRD laterals proposed for improvement;
- Perform study of KRD South Branch Canal to ensure enough capacity is available to serve Manastash Creek water users;
- Prepare water balance for project area along with groundwater study to estimate water availability and effects on groundwater users from reduced seepage; and
- Perform more detailed engineering studies to estimate costs and water savings with a greater degree of certainty.

3.3 Alternative 3 – Pipe KRD Laterals and Eliminate Diversions from Manastash Creek

Alternative 3 incorporates further water savings measures than Alternative 2 and eliminates all diversions from Manastash Creek. It has five potential components. The baseline alternative includes piping the existing KRD laterals. Supplemental measures include performing on-farm water conservation measures; offsite KRD system improvements; supplement with groundwater for isolated properties and/or for stock water; and pumping from the Westside Canal to serve farms located near the canal. The difference between Alternatives 2 and 3 is Alternative 3 does not incorporate a new diversion on Manastash Creek and proposes to use Westside Canal water to meet peak demands as needed for Manastash Creek water users.

3.3.1 Baseline Alternative Description

The baseline alternative for Alternative 3 includes replacing the existing KRD laterals that serve the Manastash Creek basin with pressurized pipes and removing the 11 existing diversions from Manastash Creek. Figure 3-3 presents the proposed elements of this alternative. The land within

the Westside Canal service area would be served by either solely groundwater or a combination of groundwater and Westside Canal water described later in Supplemental Measures 3C and 3D.

As in Alternative 2, the KRD system that serves the Manastash Creek area will be replaced with pipes, and this include SB9.9, SB11.7, SB12.8, SB13.8, SB14.3, SB16.7, SB17.6 and the lower portion of the KRD South Branch Canal. Most of these pipe sizes were obtained directly from the *KRD Water Conservation Plan Addendum #1* (CH2M Hill, 2001*)*. However, SB11.7, SB12.8 and the lower portion of the KRD South Branch Canal are not in the *KRD Water Conservation Plan Addendum #1* because they were not considered high loss laterals as reported in the *KRD Water Conservation Plan*. These laterals and canal serve the Manastash Creek area, and for this alternative will be replaced with pipes so they can deliver pressurized water. Table 3-5 in Section 3.2.1 summarizes the pipe sizing calculations using the same methods used in the *KRD Water Conservation Plan*. The laterals were arbitrarily divided into three segments for cost savings.

The KRD laterals will also be extended to serve the Manastash Creek water users. The extensions are labeled M1 through M14 as shown on Figure 3-3. Sizes and lengths were obtained directly from the *KRD Water Conservation Plan Addendum #1*.

In addition to the KRD lateral improvements, the existing diversions on Manastash Creek will be removed and the Creek will be reestablished.

This alternative conserves water from both Manastash Creek and the KRD systems. For the case of the Manastash Creek ditches, we effectively save the amount of water that currently seeps out of the ditches. Our estimate of the seepage at this time is 6,000 ac-ft (see Section 3.1.1). For this alternative, there will be no water diverted from Manastash Creek to seep out of the Manastash Creek ditches.

The KRD water savings for this alternative includes the land irrigated by the KRD laterals SB9.9, 11.7, 12.8, 13.8, 14.3, 16.7 and 17.6. These laterals serve approximately 5,400 acres, which was determined using GIS mapping of KRD assessed acreage. It is estimated that the KRD laterals are about 70% efficient. The total amount of water that is diverted by the KRD during an average year is 310,453 ac-ft to 55,576 acres, which is approximately 5.59 ac-ft/acre. Of the diverted water, 1.68 ac-ft/acre (conservatively 30%) is lost due to seepage. Piping the KRD laterals described in this alternative saves approximately 9,070 ac-ft (5,400 acres x 1.68 ac-ft/acre) of water lost due to seepage. The combined annual water savings for this baseline alternative is then approximately 15,070 ac-ft.

The costs developed for converting the existing KRD laterals to a pressure pipe system are the same as in Alternative 2. The cost for demolition of the existing diversion structures along Manastash Creek was estimated to be $497,000. Demolition consists of removal of the existing structure, hauling and disposal of materials and some minor site restoration.

3.3.2 Supplemental Measure 3A - On Farm Water Conservation

Expected water savings for on-farm water conservation is approximately 3,720 ac-ft per year and cost is approximately $2,230,000. A description of this measure is contained in Section 3.1.2.

3.3.3 Supplemental Measure 3B – Offsite KRD System Improvements

The construction of Page Canyon Re-regulation Reservoir will save approximately 1,500 ac-ft of water. See Section 3.2.3 for a full description of this supplemental measure.

3.3.4 Supplemental Measure 3C - Groundwater for Some Water Users

For Alternative 3, groundwater will be supplied for limited users including year-round stock water users and parcels located outside of the KRD service area (includes parcels in the upper canyon and within the Westside service area). Groundwater will be provided through either 8-inch or 12-inch wells. The 8-inch wells will serve properties less than 10 acres in size and individual stock water users. The 12-inch wells will serve larger parcels in 40-acre increments. Groundwater supply and well design is described in Section 3.4 of this report.

As described in Section 3.2.4, the total water savings for this measure is approximately 1,810 ac-ft. The estimated costs for individual 8-inch and 12-inch wells are $90,000 and $135,000. Cost breakdowns are provided in Appendix A. The total estimated costs for constructing irrigation wells are $3,925,000. Total annual power costs are estimated at $51,300 per year, the estimate of which is also provided in Appendix A.

3.3.5 Supplemental Measure 3D - Pump from Westside Canal

The Westside Canal crosses under Manastash Creek upstream of Barnes Road, and serves a small portion of the Manastash Creek water users. This supplemental measure considers pumping Westside Canal water to Manastash Creek water users within 100 vertical feet of the Westside Canal. This proposed measure includes four pump systems labeled P1 through P4 (see Figure 3-2). Each pump system consists of a pump located alongside the Westside Canal housed in a concrete vault or building and piping to convey the water up to their respective KRD lateral. Using the GIS maps we estimated the acreage each pump system would serve. Table 3-9 presents a summary of irrigated area, peak flow, pipe size, and pipe length for each of the pump systems.

Table 3-9
Pump and Pipe Sizing from Westside Canal

Pump System	Irrigated Area (acres)	Adjudicated Peak Flow (cfs)	Estimated Conveyance Efficiency	Estimated Peak Flow		Pipe Size (inches)	Pipe Length (feet)
				(cfs)	(gpm)		
P1	960	12	0.70	9	4,000	18	1,700
P2	570	14	0.70	9	4,000	18	400
P3	128	3	0.70	2	900	6	1,400
P4	610	19	0.70	13	5,800	24	800
Total	2,268	48		33			

Approximately 2,270 acres of the Manastash Creek water users could be served by pumping water from the Westside Canal, which is about one-half of the current acreage served by Manastash Creek water. For this alternative, we already save the water by supplying it from KRD. This supplemental measure should be framed as a potential measure if KRD water savings aren't enough. Water savings are equal to approximately 8,080 ac-ft/year (2,270 x 2.67 / 0.75), but only needed if KRD cannot supply that water.

The costs for the systems pumping water from the Westside Canal to Manastash Creek water users was based on current quotes from equipment suppliers and a recent project of similar proportion completed in Eastern Oregon. Costs for pump stations P1 through P4 and the associated piping is 2,789,000, shown in Appendix A. The total annual power costs are estimated at $103,700 per year, the estimate of which is also provided in Appendix A.

The Westside Canal runs at maximum capacity (approximately 100-120 cfs) during the peak irrigation season, and may need major improvements before conveying additional water for Manastash Creek water users. The additional capacity needed is approximately 33 cfs, assuming water savings of 8,080 ac-ft/year. No information was found regarding potential improvements to the Westside Canal and no costs were estimated for canal improvements at this time.

3.3.6 Summary of Potential Costs and Water Savings

A cost summary of the components that comprise Alternative 3 is presented in Table 3-10. A more detailed breakdown of these planning level cost estimates has been included in Appendix A. The costs include sales tax; an allowance for engineering; legal and administrative fees of 25% of construction costs; and a contingency ranging from 25 to 30%. Both the estimate of the contingency and engineering, legal and administrative fees are conservative, but reflect the conceptual level of analysis performed for this study.

Table 3-10 summarizes the estimated project cost for the baseline alternative, which is approximately $11,264,000, and saves an estimated 15,070 ac-ft/year of water diverted from Manastash Creek. The supplemental measures for this alternative excluding pumping from Westside Canal costs approximately $7,844,000, and saves an estimated 7,300 ac-ft/year of water. The total cost for this alternative excluding pumping from Westside Canal is approximately $19,108,000, and has potential water savings estimated to be 22,370 ac-ft/year. Those water savings are the estimated reduction in diversions from Manastash Creek. The cost for Supplemental Measure 3D is $2,789,000, but does not include potential costs for upgrading the Westside Canal.

Table 3-10
Alternative 3 Cost vs. Water Savings

Description	Estimated Project Cost	Estimated Water Savings (ac-ft)	Estimated Construction Cost per Annual Water Savings ($/ac-ft)
Baseline Alternative 3			
KRD Lateral and Canal Improvements	$9,251,000		
KRD Laterals Extensions (M1-M14)	$1,516,000		
Removal of Old Diversions	$497,000		
Subtotal	$11,264,000	15,070	$747/ac ft
Supplemental Measure 3A			
On-Farm Water Conservation	$2,230,000	3,970	$562/ac ft
Supplemental Measure 3B			
Page Canyon Re-regulating Reservoir	$1,688,000	1,500	$1,125/ac ft
Supplemental Measure 3C			
Groundwater for Some Water Users	$3,925,000	1,830	$2,145/ac ft
Subtotal	$19,108,000	22,370	$854/ac ft
Supplemental Measure 3D			
Pump from Westside Canal	$2,789,000	8,080	$345/ac-ft
Total	$21,897,000	30,430	$719/ac-ft

Estimated project costs may vary from +50% to –30%.. See Appendix A for cost variations.

3.3.7 Potential Implementation Issues

The potential implementation issues related to Manastash Creek water users for Alternative 3 include the following:

- Willingness of all the water users in replacing their existing open ditches and receive water through the KRD lateral system;
- The willingness of the KRD to agree to upgrades in their canal and lateral system and to use their system to deliver water to Manastash Creek water users;
- The capacity of the KRD South Branch Canal to provide enough flow after improvements to serve Manastash Creek water users;
- The availability of groundwater to serve some users;
- The capacity and use of Westside Canal to serve additional water users; and
- The willingness of farmers to construct on-farm irrigation improvements.

The permits required for implementation of Alternative 3 include:

- SEPA or NEPA process depending on source of funding of project;
- Water Right Change Applications and State Trust Water Rights will need to be applied for through the Washington State Department of Ecology;
- Hydraulic Project Approval from WDFW for instream work (removal and construction of diversion dams) is required;
- U.S. Army Corps of Engineers Section 10 Permits are required for instream work;
- Water Quality Certification from Department of Ecology is required for instream work;
- Shorelines Permit from Kittitas County is required for instream work;
- Well Construction Permits from Department of Ecology;
- Washington State Dam Safety Permit is required for a re-regulating reservoir; and
- Other Kittitas County permits relating to use of road rights-of-ways and building permits are required for pipelines and structures.

Additional data that we recommend be collected and studies we recommend be performed before implementation of Alternative 3 include:

- Perform measurements on Manastash Creek to obtain data on streamflow and seepage loss in the creek from the mouth of the canyon;
- Measure existing diversions from Manastash Creek and seepage loss in ditches;
- Measure seepage losses in KRD laterals proposed for improvement;
- Perform study of KRD South Branch Canal to ensure enough capacity is available to serve Manastash Creek water users;
- Prepare water balance for project area along with groundwater study to estimate water availability and effects on groundwater users from reduced seepage;
- Perform study of Westside Canal to determine if additional capacity is available and the potential for obtaining additional capacity (if supplemental measure 3D is needed); and
- Perform more detailed engineering studies to estimate costs and water savings with a greater degree of certainty.

3.4 Alternative 4 – Supply With Groundwater

An alternative to supplying surface water (diverted from Manastash Creek) to irrigators is to convert their source to groundwater. This section presents a discussion of the potential availability of groundwater and provides an estimate of potential costs assuming groundwater is available. This discussion is provided on a conceptual basis as very little information is known about the availability of groundwater in the project area, the potential yield of wells, the long term effects on aquifers from pumping and the potential interference with existing groundwater users.

3.4.1 Available Data

Data available on geology and groundwater resources in the study area include well logs obtained from the Department of Ecology and several studies on geology and groundwater. Those studies include *Effects of Hydraulic and Geologic Factors on Streamflow of the Yakima River Basin, Washington* (Kinnison & Sceva, 1963), *Geology of the Yakima Area* (Campbell, 1998), Geologic Map from DNR (Walsh et al, 1987) and others.

3.4.2 Description of Geology

The three main geologic units present in the study area are the Grande Ronde Basalt unit, the Ellensburg Formation sediments and stream deposits. The Grande Ronde Basalt is a member of the Columbia River Basalt Group (CRBG). The CRBG are a series of lava flows that originated from feeder dikes located southeast of the present-day location of the confluence of the Columbia and Snake Rivers. The Grande Ronde Basalt is the oldest and most widespread of the various basalt flows that occurred in the period of 10-16 million years ago. The thickness of the Grande Ronde Basalt is not known; an oil and gas exploration well drilled on Whisky Dick Mountain east of Ellensburg drilled through 3600 feet of basalt flow. The Grande Ronde Basalt is the deepest geologic unit present in the study area. Water bearing zones in the Grande Ronde Basalt are normally found in interflow and interbed zones; those zones are located between basalt flow layers. The interflow zones are those located between basalt flows that contain a porous, fractured top. An interbed zone contains sediments deposited between basalt flows. Aquifers contained in the Grande Ronde Basalt are usually confined because the basalt flows located between the water bearing zones usually act as aquitards and don't transmit water between zones. The source of water found in the Grande Ronde Basalt is from percolation through fractures or faults from overlying formations such as the Ellensburg; recharge from rivers or streams that have cut into interflow zones; and intake areas in the mountains where snow and rain water can enter into the aquifers.

The Ellensburg Formation is post-basalt sediment comprised of mudflow (lahar) deposits interfingered with tuff, pumice and stream-reworked material. The majority of the formation is believed to be derived from volcanic sources located west of Yakima. The Ellensburg Formation overlies the Grande Ronde Basalt. Aquifers contained in the Ellensburg Formation are usually unconfined. The source of recharge for aquifers in the Ellensburg Formation is from precipitation and percolation of water through sediments from streams, irrigation canals and irrigation.

Stream deposits are more recent sand and gravel deposits laid down by Manastash Creek or the Yakima River. They overlie and are partially mixed with the Ellensburg Formation deposits. If aquifers are present in this formation they are usually shallow, perched and associated with surface water. The source of water is the same as for the Ellensburg Formation.

A northwest trending fault is located about one mile east of the mouth of the Manastash Creek canyon. The Grande Ronde Basalt is closer to the ground surface west of the fault than east of the fault. The fault may block recharge to the basalt located east of the fault (Kirk, pers. comm.) and reduce its yield.

3.4.3 Well Log Data

Well logs were obtained from the Department of Ecology for the study area. A total of 218 well logs were obtained. The distribution of those well logs is listed in Table 3-11.

Table 3-11
Distribution of Well Logs in Study Area

Location (Township/Range/Section)	Number of Wells
T17-R17-S1	9
T17-R17-S11	6
T17-R17-S12	48
T17-R17-S13	16
T17-R17-S14	10
T17-R18-S4	21
T17-R18-S5	5
T17-R18-S6	8
T17-R18-S7	16
T17-R18-S8	18
T17-R18-S9	10
T17-R18-S16	9
T17-R18-S17	4
T17-R18-S18	3
T18-R17-S35	9
T18-R17-S36	5
T18-R18-S31	11
T18-R18-S32	10

A number of well logs were selected to represent hydrogeologic conditions in the study area and are summarized in Table 3-12.

Table 3-12
Representative Well Logs

Location (Township/Range/ Section)	Owner Name	Casing Size (in)	Completed Depth (ft)	Depth to Ground-water (ft)	Well Yield (gpm)	Depth to Basalt (ft)
T17-R18-S4	Anderson	6	245	12	50	-
T17-R18-S5	Burghart	6	405	95	40	-
T17-R18-S5	Harrell	6	240	65	-	-
T17-R18-S6	Auckland	6	240	45	25	-
T17-R18-S6	Olson	6	138	45	10-12	-
T17-R18-S6	Andrews	6	200	35	10-15	-
T17-R18-S7	Louise	6	282	114	12	-
T17-R18-S7	Martin	6	200	185	15	-
T17-R18-S8	Cooke	6	152	68	-	-
T17-R18-S8	Chapman	6	260	87	12	-
T17-R18-S8	Skibeness	6	145	56	20	-
T18-R17-S36	High Valley	6	274	66	60	239
T18-R17-S36	Mundy	6	255	100	40-50	240

These wells shown in Table 3-12 are small domestic wells and were mostly completed into the Ellensburg Formation sediments. Two wells were completed into the underlying basalt

formation, but not very far. The well capacities shown in Table 3-12 vary from 10 gpm to 60 gpm.

A larger and deeper well drilled into the Grande Ronde Basalt is located about 10 miles southeast of the project area. That well is located in Section 2, T16N, R19E. The well is 762 feet deep, and is 12-inch diameter to 425 feet and 10-inch diameter to 762 feet. The well has several water bearing zones and is perforated from 430 feet to 760 feet below ground level. The well log indicates a large quantity of water at the interface between the Ellensburg Formation and the Grande Ronde Basalt at about 554 feet below ground level. The well likely intercepts water from both the Ellensburg Formation and from the Grande Ronde Formation. The static water level in the well is reported to be 54 feet below ground level. The pumping capacity of the well was not reported, however the volume of water pumped in 2002 was 260 acre-feet (Hoselton, pers. comm.). It is likely the well has a capacity of at least 300 gpm in order to supply that quantity of water over an irrigation season.

3.4.4 Design of Groundwater Wells for Manastash Creek Area

Assumptions were made on the depth and capacity of wells that could be constructed to provide irrigation water to Manastash Creek water users. We assumed that wells would be constructed through the Ellensburg Formation and penetrate the Grande Ronde Formation. No analyses of the potential yield of the Ellensburg Formation or the Grande Ronde Formation were made for this study. The depth to the Grande Ronde Formation is not known except in a few locations where wells have reached basalt. In Section 36, T18N, R17E (in the Manastash Ditch Association service area) basalt was encountered at 240 feet below ground level. In Section 5, T17N, R18E near the intersection of the Westside Canal and Manastash Creek, basalt was encountered at a depth of 400 feet below ground level. For the purposes of estimating costs, we assumed the average well depth would be 400 feet.

We also assumed two sizes of wells would be constructed. A 12-inch well is sized for each 40-acre parcel, as the demand from a 40-acre irrigated parcel would range from about 280 gpm (assumes efficient pressurized sprinkler system) to slightly more than 400 gpm (using gravity irrigation techniques). For parcels greater than 40 acres, the number of 12-inch wells is directly proportional to the size of the parcel. An 8-inch well is sized for parcels less than 10-acres (70-100 gpm). The study area contains 4,465 acres of irrigated land from Manastash Creek. The total number of wells required is estimated by summing number of parcels greater than 40 acres, the number of parcels between 10 and 40 acres, and the number of parcels less than 10 acres. These parcels were counted using a GIS parcel boundary map provided by the County. Approximately 140 12-inch wells and 51 8-inch wells are required.

3.4.5 Summary of Potential Costs and Water Savings

The estimated costs for individual 8-inch and 12-inch wells are $90,000 and $135,000. The total estimated costs for constructing irrigation wells to replace surface water diverted from Manastash Creek are $23,559,000. Total annual power costs are estimated at $281,400 per year. The cost estimates are contained in Appendix A.

A cost summary of the components that comprise Alternative 4 is presented in Table 3-13. A more detailed breakdown of these planning level cost estimates has been included in Appendix A. The costs include sales tax; an allowance for engineering; legal and administrative fees of

25% of construction costs; and a contingency of 30%. Both the estimate of the contingency and engineering, legal and administrative fees are conservative, but reflect the conceptual level of analysis performed for this study.
The total cost for this alternative is approximately $26,286,000, and has potential water savings estimated to be 20,000 ac-ft/year. Those water savings are the estimated reduction in diversions from Manastash Creek.

Table 3-13
Alternative 4 Cost vs. Water Savings

Description	Estimated Project Cost	Estimated Water Savings (ac-ft)	Estimated Construction Cost per Annual Water Savings ($/ac-ft)
Alternative 4			
Groundwater for all Manastash Creek Water Users	$23,559,000	10,030	$2,349/ac ft
Removal of Old Diversions	$497,000		
Water Saved from Eliminating Ditch Seepage		6,000	
On-Farm Water Conservation	$2,230,000	3,970	$562/ac ft
Total	$26,286,000	20,000	$1,314/ac ft

Estimated project costs may vary from +50% to –30%.. See Appendix A for cost variations.

3.4.6 Potential Implementation Issues

The potential implementation issues related to Manastash Creek water users for Alternative 4 include the following:

- Willingness of all the water users in replacing their existing open ditches and converting to groundwater wells;
- The availability of groundwater to serve water users; and
- The willingness of farmers to construct on-farm irrigation improvements.

The permits required for implementation of Alternative 4 include:

- SEPA or NEPA process depending on source of funding of project;
- Water Right Change Applications and State Trust Water Rights will need to be applied for through the Washington State Department of Ecology;
- Hydraulic Project Approval from WDFW for instream work (removal of diversion dams) is required;
- U.S. Army Corps of Engineers Section 10 Permits are required for instream work;
- Water Quality Certification from Department of Ecology is required for instream work;
- Shorelines Permit from Kittitas County is required for instream work;
- Well Construction Permits from Department of Ecology; and

- Other Kittitas County permits such as building permits may be required for structures.

Additional data that we recommend be collected and studies we recommend be performed before implementation of Alternative 4 include:

- Prepare water balance for project area that will include measuring stream and ditch seepage (groundwater recharge);
- Perform groundwater study to estimate water availability and effects on groundwater users from reduced seepage and increased use of groundwater; and
- Perform more detailed engineering studies to estimate costs and water savings with a greater degree of certainty.

3.5 Alternative 5 – Supplemental Storage on Upper Manastash Creek

3.5.1 Alternative Description, Potential Costs and Water Savings

Constructing supplemental storage upstream on Manastash Creek was mentioned at the December 3, 2001 workshop as a potential alternative. The storage volume required to supply both Manastash Creek and the irrigators is based on in-stream flow needs, the adjudicated water rights and the discharge in Manastash Creek. An analysis of the storage needs during an average runoff year was performed for this study. A comparison of average runoff to adjudicated water rights is shown in Figure 2-3. Our estimate of the volume of water supplied by Manastash Creek to irrigators during an average runoff year is 20,000 ac-ft.

In-stream flow recommendations have been prepared for Manastash Creek by the U.S. Fish & Wildlife Service (USFWS). During the irrigation season, those flow recommendations are 135 cfs for April, 240 cfs for May, 215 cfs for June, 55 cfs for July, 25 cfs for August and 20 cfs for September-October. A comparison of those recommendations to the natural flow hydrograph shown in Figure 2-3 shows the recommended flows generally exceed the average flow in the creek and could not be met, except maybe during wet years.

For this preliminary analysis of storage requirements we used a smaller instream flow target than the USFWS flow recommendations. Those flow targets are 50 cfs during the April through June time period, 25 cfs during July and August and 20 cfs for September and October. The flow targets were arbitrarily modified from USFWS recommendations to ensure a reasonable reservoir size was analyzed. The total volume of storage needed was calculated by determining the volume of water required to meet those instream flow targets and adjudicated water rights, provided sufficient natural flow is available to satisfy the water rights. During periods when streamflow is less than the instream flow target only the naturally occurring flowrate would be supplied from storage, which would then be left instream. When the creek has enough flow to meet adjudicated water right needs and instream flow targets, no release from storage is needed.

The storage volume needed to meet instream flow targets and adjudicated water rights (up to the available water in the creek) for an average runoff year is estimated to be 6,000 ac-ft. Design, permitting and construction costs for large storage facilities are in the range of $2,500 per ac-ft. Based on these values, a storage facility may cost approximately $15 million. Those costs assume no other projects are constructed to improve fish passage or improve the efficiency of the water users. Those other improvements would also be desirable and may be needed to improve

the reliability of the water supply during drought years, as the reservoir size and cost listed here covers water supply needs during average water supply years. The additional costs to improve the existing diversions and irrigation facilities would be $12.0 million (the cost of the Baseline Alternative 1 project). The additional water savings for the Baseline Alternative 1 project are 9,760 acre-feet. The total cost of Alternative 5 is estimated to be $27.0 million, with water savings (additional water supplied plus reduction in irrigation ditch seepage) of 15,760 acre-feet.

3.5.2 Potential Implementation Issues

The potential implementation issues related to Manastash Creek water users for Alternative 5 include the following:

- The willingness of water users to combine diversions and portions of their ditches and to manage combined water diversions in the future;
- The availability of water to fill a reservoir; and
- The ability to receive permits for a new reservoir.

The permits required for implementation of Alternative 5 include:

- SEPA or NEPA process depending on source of funding of project;
- Water Right Change Applications and State Trust Water Rights will need to be applied for through the Washington State Department of Ecology;
- Hydraulic Project Approval from WDFW for instream work (removal and construction of diversion dams) is required;
- U.S. Army Corps of Engineers Section 10 Permits are required for instream work;
- Water Quality Certification from Department of Ecology is required for instream work;
- Shorelines Permit from Kittitas County is required for instream work;
- Washington State Dam Safety Permit is required for a new storage reservoir; and
- Other Kittitas County permits relating to use of road rights-of-ways and building permits are required for pipelines and structures.

Additional data that we recommend be collected and studies we recommend be performed before implementation of Alternative 5 include:

- Perform reconnaissance studies of potential reservoir sites;
- Perform measurements on Manastash Creek to obtain data on streamflow and perform hydrologic studies to determine potential yield at reservoir sites;
- Perform instream flow studies on Manastash Creek to determine a desired instream flow regime, size of storage reservoir and schedule of storage releases; and
- Perform more detailed engineering studies to estimate costs and water savings with a greater degree of certainty.

3.6 Alternative 6 – Water Supply from Yakima River with Minimal Conservation

Alternative 6 essentially retains the existing irrigation conveyance system and supplies additional water by pumping directly from the Yakima River (Concept A), or taking water indirectly from the river by pumping from the Packwood Canal, also referred to as the Ellensburg Power Canal (Concept B). The Yakima River from Cle Elum to Roza Dam generally has high flows during the summer irrigation season because of irrigation releases from upstream reservoirs requiring delivery to water users near Yakima. Pumped water would be used to replace irrigation water withdrawal from Manastash Creek during periods of low stream flow (i.e. during July-October).

The value of irrigation efficiencies in the Kittitas Valley has been debated by many because summer instream flow in the Yakima River is high and most "wasted" water either returns to the Yakima River and is reused or is captured and used by downslope irrigation systems and water users. While maximum water use efficiency is essential to maintain in-stream flows on tributaries, particularly during summer low flow, such efficiency is arguably not necessary - or may even be counterproductive - for diversions off the main-stem Yakima River in the reach from Cle Elum to Roza Dam.

During spring runoff, prior to July 1st, KRD could supply additional water to the Manastash Creek water users. The amount of additional water KRD can supply is based on the average flow in the South Branch canal between April 20th and July 1st and is approximately 50% of full capacity (KRD, 2002). KRD could supply an additional 7,200 ac-ft if the South Branch Canal was run at full capacity during this period.

The Manastash Creek water users would supplement their water supply from KRD by a new consolidated Manastash Creek diversion. The volume diverted from the new diversion prior to July 1st is estimated by subtracting the amount of additional water KRD can supply from the early season water rights from Manastash Creek (15,500 ac-ft). The estimated diversion requirement from Manastash Creek prior to July 1st is 8,300 ac-ft.

The size of the new Manastash Creek diversion is estimated by subtracting the minimum available flowrate from the KRD canal during this period from the early season water right flowrate. The KRD South Branch Canal usually runs no more than 64% capacity at the South Branch Tunnel prior to July 1st (KRD, 2002). Further downstream, between the most upstream laterals that serve the Manastash Creek water users, the South Branch Canal has a capacity of 105 cfs. Since we have no flow data at this location, we assume that the remaining capacity of the South Branch Canal is approximately 38 cfs (105 cfs x (1 – 0.64)). Since the flood water right is approximately 88 cfs, the Manastash Diversion could then divert as much as 50 cfs (88 cfs – 38 cfs).

As spring flows recede, pumping would begin. Typically, after July 1st, the KRD South Branch Canal runs at maximum capacity. The Manastash Creek water users would then receive water pumped from the Yakima River supplemented by water diverted from Manastash Creek. The maximum pumping rate is 25 cfs, based on an approximate minimum instream flow of 25 cfs. The pumping system would only deliver the same volume of water that is flowing in Manastash Creek during times when Manastash Creek is flowing less than 25 cfs. In average years, the pump station would deliver 4,000 ac-ft, which is calculated from an average flow of 16.5 cfs for

4 months. The remainder of the water, 500 ac-ft, would be diverted from Manastash Creek. Scenarios of pumping rates and diversion rate are shown in Table 3-14.

Table 3-14
Alternative 6 Late Season Pumping Scenarios

Manastash Creek Discharge (cfs)	Diversion from Manastash Creek (cfs)	Pumping Rate from Yakima River (cfs)	Water for Irrigators* (cfs)	Water Left in Manastash Creek (cfs)
0	0	0	0	0
25	0	25	25	25
45	20	25	45	25
70	45	0	45	25

**Late Season Water Rights = 44.9 cfs*

For this alternative, pumped water would not only be supplied to the Manastash water users, but also to some KRD water users. In return, KRD could supply water to the Manastash water users located above the pump supply line equal to the amount pumped to the KRD water users. This would save pumping costs because water would not have to be pumped to the highest Manastash Creek water users. For both Concepts A and B, we conservatively estimated this location so that the pumped water will be distributed to approximately two-thirds of the Manastash Creek water users.

From October 15 to April 15 it would be more efficient to deliver water for livestock needs through shallow wells rather than pumping it from the Yakima River. There are 8 continuous stock water rights holders throughout the study area, totaling 146 ac-ft (73 ac-ft for October 15 to April 15). We estimate that 11 6-inch wells would be sufficient to supply the stock water needs during the time period when KRD, Westside and Packwood canals are not in operation. While shallow wells may not produce enough water for irrigation, they could potentially provide water for a series of stock tanks.

3.6.1 Concept A – Direct Pumping from Yakima River

Direct pumping from the Yakima River includes the following:

- Locate a pump station near the Yakima River at Riverbottom Road, and install pipe to supply Manastash Creek water users (see Figure 3-4).
- Install shallow stockwater wells where winter stockwater is needed and cannot be supplied by existing wells.
- Install new fish screen and consolidated diversion at current Manstash Ditch headworks.
- Install new turnouts from KRD as needed.
- Transfer any conserved water to state water trust for instream flow.

3.6.2 Concept B –Pump from Packwood Canal

Pumping from Packwood Canal includes the following:

- Locate a pumping station on Packwood Canal, and install pipe to supply Manastash Creek water users (see Figure 3-5). The Packwood Canal is the old Ellensburg power canal, which is substantially oversized for current need. Potentially, a hydro-power plant could be added at the Packwood Canal spill (site of old Ellensburg City Light

hydropower turbine) to power the pumping plant. The new fish screen for Packwood canal would need to accommodate the demand of Manastash Creek water users supplementation.

- Install shallow stockwater wells where winter stockwater is needed and cannot be supplied by existing wells.
- Install new fish screen and consolidated diversion at current Manstash Ditch headworks.
- Install new turnouts from KRD as needed.
- Transfer any conserved water to state water trust for instream flow.

3.6.3 Summary of Potential Costs and Water Savings

A cost summary of the components that comprise Alternative 6 is presented in Table 3-15. A more detailed breakdown of these planning level cost estimates is included in Appendix A. The costs include sales tax; an allowance for engineering; legal and administrative fees of 25% of construction costs; and a contingency ranging from 25 to 30%. Both the estimate of the contingency and engineering, legal and administrative fees are conservative, but reflect the conceptual level of analysis performed for this study.

The estimated project cost for Concept A is $5,931,000 with an annual operating cost of $111,000/year. The estimated water savings are 11,273 ac-ft/year. The estimated project cost for Concept B is $5,584,000 with an annual operating cost of $81,000/year. The estimated water savings are 11,273 ac-ft/year. Those water savings are the estimated reduction in diversions from Manastash Creek.

Table 3-15
Alternative 6 Cost vs. Water Savings

Description	Estimated Project Cost	Estimated Water Savings (ac-ft)	Estimated Construction Cost per Annual Water Savings ($/ac-ft)
Concept A			
Additional water from KRD	0	7,200	
Pump Station, Piping and Fish Screen on Yakima	$4,079,000	4,000	$1,020/ac ft
Manastash Creek Diversion	$1,461,000	0	
Groundwater Wells for Stock water	$391,000	73	$5,356/ac ft
Total	**$5,931,000**	**11,273**	**$526/ac ft**
Concept B			
Additional water from KRD	0	7,200	
Pump Station, Piping and Fish Screen on Yakima	$3,732,000	4,000	$933/ac ft
Manastash Creek Diversion	$1,461,000	0	
Groundwater Wells for Stock water	$391,000	73	$5,356/ac ft
Total	**$5,584,000**	**11,273**	**$495/ac ft**

Estimated project costs may vary from +50% to –30%.. See Appendix A for cost variations.

3.6.4 Potential Implementation Issues

The potential implementation issues related to Manastash Creek water users for Alternative 6 include the following:

- The willingness of the KRD to agree to increase the flow during early season to supply the Manastash Creek water users;
- The ability to locate a pump station near Packwood Canal or Riverbottom Road and use of the Packwood Canal for irrigation water;
- The availability of groundwater to serve stock water needs; and
- The willingness of farmers to receive water from a consolidated diversion, and additional water from KRD.
- The willingness of farmers or others to pay electrical power costs.

The permits required for implementation of Alternative 6 include:

- SEPA or NEPA process depending on source of funding of project;
- Water Right Change Applications and State Trust Water Rights will need to be applied for through the Washington State Department of Ecology;
- Hydraulic Project Approval from WDFW for instream work (removal and construction of diversion dams) is required;
- U.S. Army Corps of Engineers Section 10 Permits are required for instream work;
- Water Quality Certification from Department of Ecology is required for instream work;
- Shorelines Permit from Kittitas County is required for instream work;
- Well Construction Permits from Department of Ecology; and
- Other Kittitas County permits relating to use of road rights-of-ways and building permits are required for pipelines and structures.

Additional data that we recommend be collected and studies we recommend be performed before implementation of Alternative 6 include:

- Perform measurements on Manastash Creek to obtain data on streamflow and seepage loss in the creek from the mouth of the canyon;
- Perform study of KRD South Branch Canal to ensure enough capacity is available to serve Manastash Creek water users;
- Determine optimal instream flowrate (and pumping rate) to balance fisheries enhancement and pumping costs; and
- Perform more detailed engineering studies to estimate costs and water savings with a greater degree of certainty.

4.0 SUMMARY

Table 4-1 presents a summary of the estimated costs and estimated water savings for the six alternatives reviewed for this study. The costs of the alternatives range from $5.6 million to $26.5 million. The estimated water savings also vary substantially, from 13,730 acre-feet for Alternative 1 to 22,370 acre-feet for Alternatives 2 and 3.

Table 4-1
Summary of Alternatives

Alternative	Estimated Project Cost	Estimated Water Savings (ac-ft)	Estimated Construction Cost per Annual Water Savings ($/ac-ft)	Estimated Annual Power Costs
Alternative 1	$14,234,000	13,730	$1,037/ac ft	-
Alternative 2	$21,864,000	22,370	$977/ac ft	$51,300/yr
Alternative 3*	$19,108,000	22,370	$854/ac ft	$51,300/yr
Alternative 4	$26,286,000	20,000	$1,314/ac ft	$281,000/yr
Alternative 5	$27,000,000	15,760	$1,713/ac ft	-
Alternative 6A	$5,931,000	11,273	$526/ac ft	$111,000/yr
Alternative 6B	$5,584,000	11,273	$495/ac ft	$81,000/yr

Pump from Westside Canal Supplemental Measure not included because of unknown construction costs to upgrade canal. Estimated project costs may vary from +50% to –30%. See Appendix A for cost variations.

The intent of these cost estimates is to build off the work done in the *Kittitas Reclamation District Water Conservation Plan Irrigation Water Conservation Plan of System Improvements* of February 1999 and *Addendum #1* of July 2001. The estimates generated in that plan were reviewed for reasonableness, updated to November 2002 construction costs and checked for consistency between alternatives. At the pre-feasibility study level of effort estimates have accuracy sufficient to make choices between alternatives, but significant additional effort is needed once an alternative is selected to refine the design and the cost estimates[1].

Construction contingencies of 25 to 30%, Engineering, Legal and Administrative fees of 25% and in some estimates a 10% Permitting cost was added to the estimate. These are reasonable estimates for the overall project costs of the Alternatives. However great care must be taken if "sub-projects" are taken out of an Alternative for construction without all of the other elements of that Alternative. Besides the economy of scale effect there is a particular concern when dealing with in-stream or near-stream construction because of the special legal, coordination and permitting requirement. Recent experience is that engineering, legal, administrative expenses for small screening and diversion projects can be as high as 45-50% of construction costs if they are not part of a larger effort.

[1] For instance, one area of cost savings could be in selecting low-pressure piping in some areas of the project area instead of the high-pressure pipe used for estimating purposes in this report. Low pressure pipe could be used in the higher elevations of the project area and where on-farm practices do not require high pressure. A quick estimate for one alternative indicated that 7% to 15% savings could be expected using this refinement. This level of design detail is beyond the scope of this study however and is left for later study and design efforts.

The alternatives will provide for increased instream flow in Manastash Creek and improved fish passage, but some alternatives more fully meet those goals. Table 4-2 presents a qualitative analysis of the ability of each alternative to meet the goals of the project.

Table 4-2
Ability of Alternatives to Meet Project Goals

Alternative	Ability of Alternative to Improve Instream Flow	Ability of Alternative to Improve Fish Passage
Alternative 1 - Pipe Manastash Creek Ditches and Selected KRD Laterals	A water savings of 13,730 ac-ft is predicted, however diversions of about 6,000 ac-ft from Manastash Creek will still be required to meet irrigation needs	Although the existing diversions will be removed and fish passage conditions will be improved, four diversions on Manastash Creek will still be required
Alternative 2 – Pipe and Use KRD Laterals, Consolidate Diversions	A water savings of 22,370 ac-ft is predicted. The capacity of the KRD system to serve irrigators is not known and some diversions may be required from Manastash Creek to meet peak demands.	The existing diversions will be removed and fish passage conditions will be improved, however one diversion dam on Manastash Creek will still be required
Alternative 3 – Pipe KRD Laterals and Eliminate Diversions from Manastash Creek	A water savings of 22,370 ac-ft is predicted and all diversion from Manastash Creek may be eliminated, however the use of the Westside Canal to supplement irrigation supply for Manastash Creek water users may not be feasible	The existing diversions will be removed and fish passage will be restored
Alternative 4 – Supply with Groundwater	If sufficient groundwater supply is available, no diversions from Manastash Creek would be required	The existing diversions will be removed and fish passage will be restored
Alternative 5 – Supplemental Storage on Upper Manastash Creek	This alternative would provide sufficient flow to meet instream flow targets in Manastash Creek even though diversions would still occur from the creek	Although the existing diversions will be removed and fish passage conditions will be improved, four diversions on Manastash Creek will still be required
Alternative 6 – Water Supply from Yakima River with Minimal Conservation	This alternative would provide sufficient flow to meet instream flow targets in Manastash Creek even though diversions would still occur from the creek	The existing diversions will be removed and fish passage conditions will be improved, however one diversion dam on Manastash Creek will still be required

Further study and design will be necessary to more fully develop the alternatives, evaluate their environmental benefits and impacts and determine the effect on Manastash Creek water users. Those studies will be needed to determine which alternative has the best combination of benefits and costs and is most desirable to all stakeholders.

5.0 REFERENCES

Campbell. 1998. *Geology of the Yakima Area*

CH2M Hill. 2/1999. *Kittitas Reclamation District Water Conservation Plan Irrigation Water Conservation Plan System Improvements*

CH2M Hill. 7/2001. *Addendum #1 Kittitas Reclamation District, Water Conservation Plan, Irrigation Water Conservation Plan of System Improvements.*

Hoselton, Anna. 2/2002. Personal communication.

Kinnison & Sceva. 1963. *Effects of Hydraulic and Geologic Factors on Streamflow of the Yakima River Basin, Washington*

Kirk, John Todd. 2/2002. Personal communication.

Kittitas Reclamation District (KRD). 1/2002. Provisional discharge data of the South Branch Canal near the South Branch Tunnel.

Yakima County Superior Court. 9/1998. *Yakima River Basin Water Rights Adjudication, Second Supplemental Report of Referee – Volume 17B, Re: Subbasin No. 11 – Manastash.*

Yakima County Superior Court. 6/2001. *Conditional Final Order, Subbasin No. 11 - Manastash.* No. 77-2-01484-5.

Yakama Nation, Yakama Kittitas Fisheries Program (YKRP). 2000. *Reestablish Safe Access into Tributaries of the Yakima Subbasin Management Plan.*

Walsh et al. 1987. USGS. *Geologic Map of Washington – Southwest Quadrant*

Washington State Conservation Commission. 10/2001. *Habitat Limiting Factors, Yakima River Watershed, Water Resource Inventory Areas 37-39.*

United State Department of Agriculture. 10/1985. *Washington State Irrigation Guide.*

FIGURES

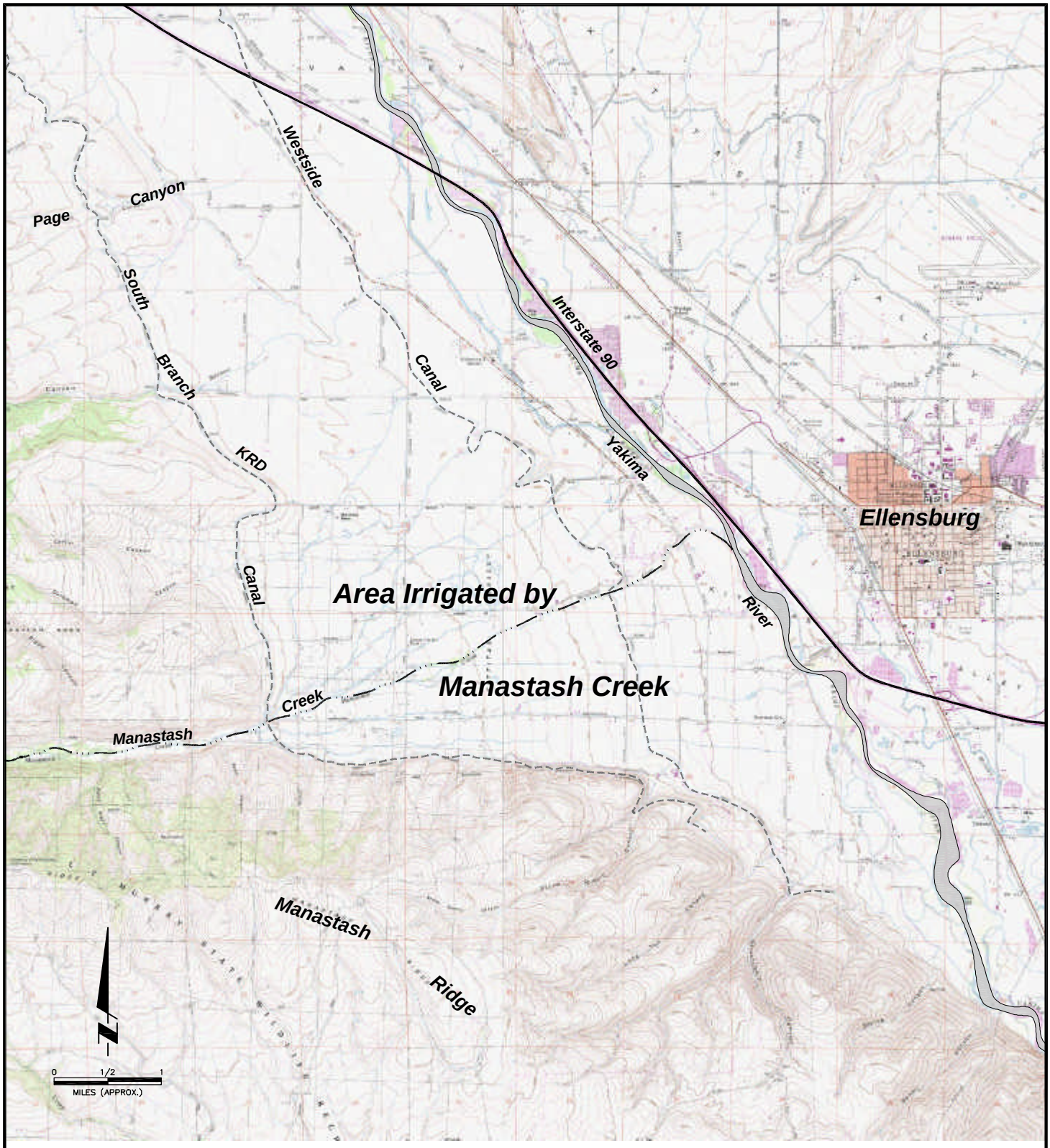

Figure 1-1
Manastash Creek
Location Map

Water Conservation Study for Manastash Creek

MONTGOMERY WATER GROUP, INC.
Water Resources Engineering

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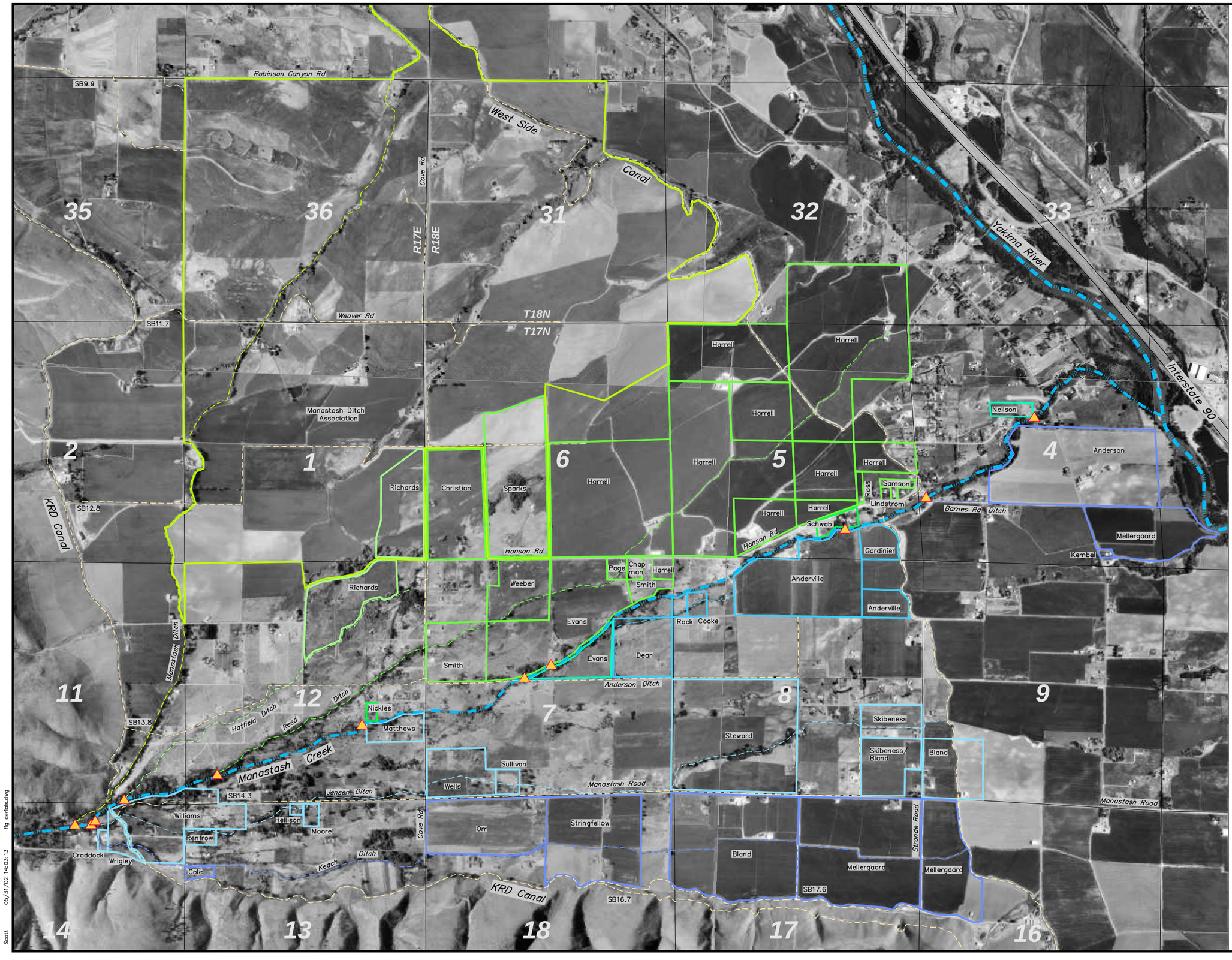

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NOTES

1. DATUM: STATE PLANE SOUTH, NAD 27.

2. MAP BASED ON USGS AERIAL PHOTOGRAPHS DATED 6/2000, THE YAKIMA RIVER BASIN WATER RIGHTS ADJUDICATION SECOND SUPPLEMENTAL REPORT OF REFEREE (SUBBASIN NO. 11, MANASTASH), AND THE KITTITAS RECLAMATION DISTRICT (KRD) GIS.

LEGEND

- DIVERSION POINT FROM MANASTASH CREEK
- LAND IRRIGATED BY MANASTASH CREEK. (COLOR CODED BY DIVERSION)
- IRRIGATION DITCH FROM MANASTASH CR. (COLOR CODED BY DIVERSION)
- WESTSIDE IRRIGATION CANAL
- KRD IRRIGATION CANAL AND LATERALS
- STREAM

Figure 2-1
Aerial Photo of Manastash Creek Water Users

Water Conservation Study
For Manastash Creek

MWH
MONTGOMERY WATSON HARZA

MONTGOMERY WATER GROUP, INC.

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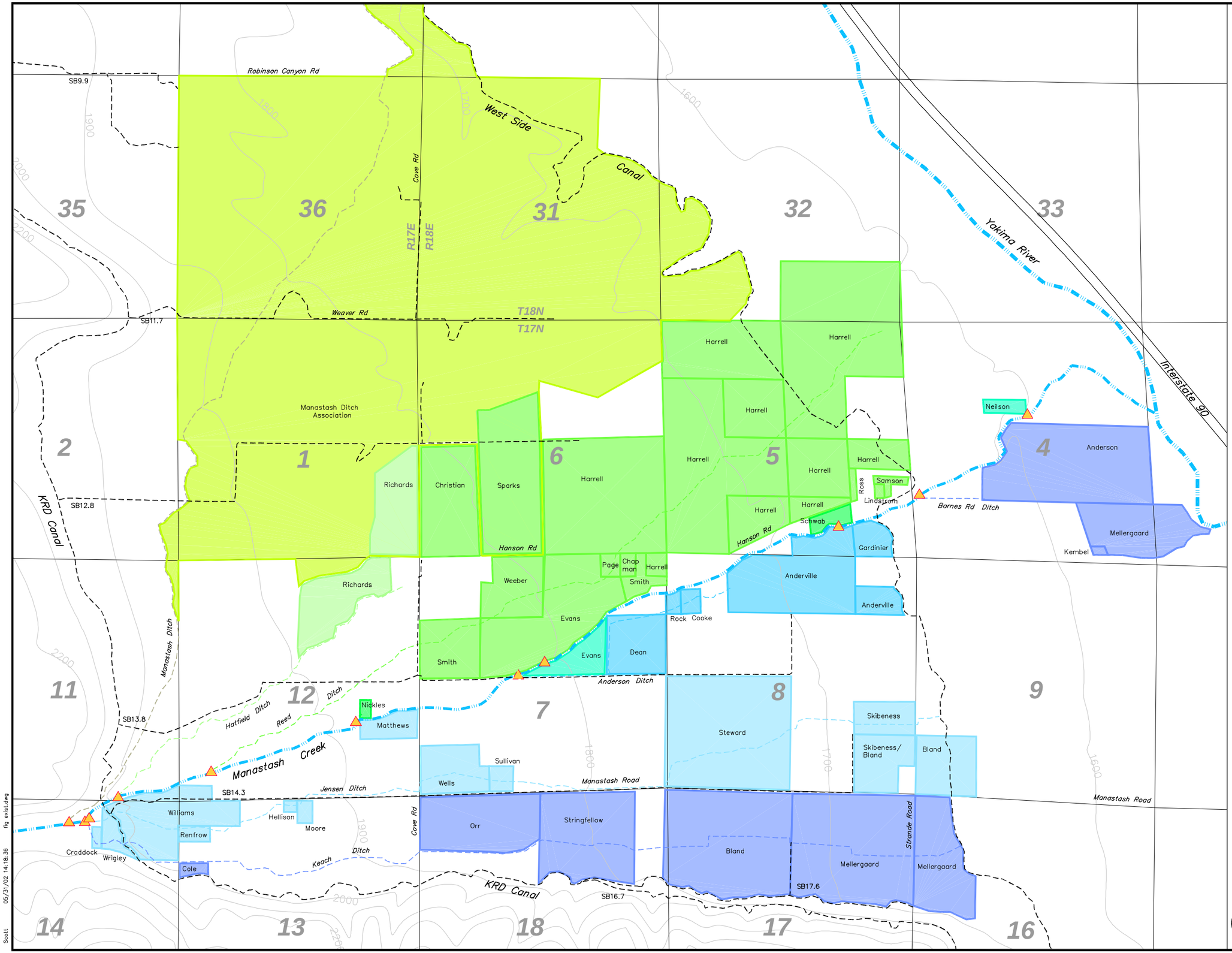

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NOTES

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LEGEND

LAND IRRIGATED BY MANASTASH CREEK WATER. COLOR CODED BY DIVERSION AS FOLLOWS:

- MANASTASH WATER DITCH ASSOC.
- HATFIELD
- REED
- NICKLES AND SCHWAB
- EVANS AND NEILSON
- ANDERSON
- JENSEN
- KEACH AND BARNES
- POINT OF DIVERSION FROM MANASTASH CREEK
- IRRIGATION DITCH FROM MANASTASH CR. COLOR CODED BY DIVERSION.
- WESTSIDE IRRIGATION CANAL
- KRD IRRIGATION CANAL AND LATERALS
- STREAM

Figure 2-2
Manastash Creek Water Users

Water Conservation Study For Manastash Creek

MWH
MONTGOMERY WATSON HARZA

MONTGOMERY WATER GROUP, INC.

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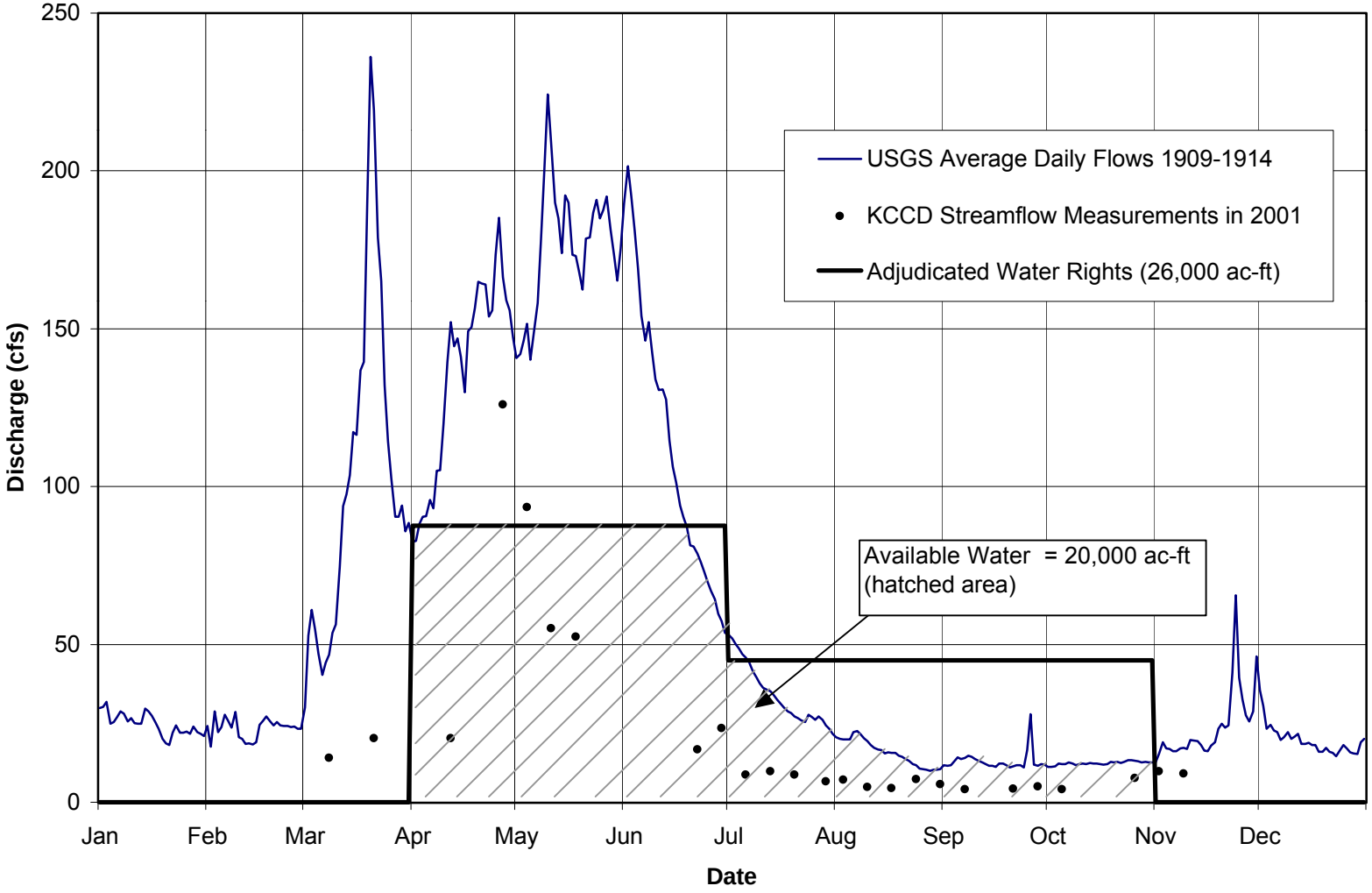
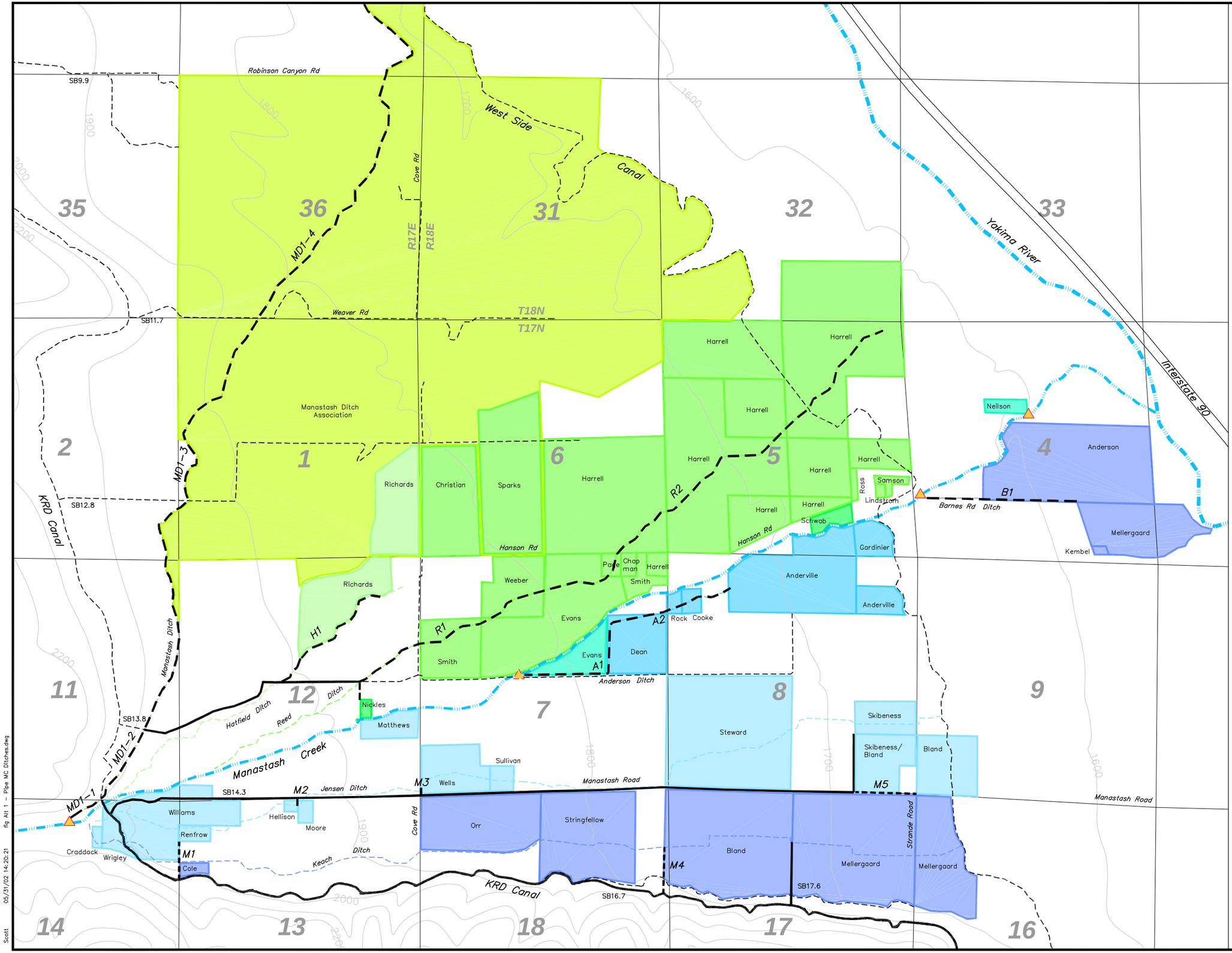
Scott

Figure 2-3
Average Manastash Creek Hydrograph





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NOTES

1. DATUM: STATE PLANE SOUTH, NAD 27.

2. MAP BASED ON USGS AERIAL PHOTOGRAPHS DATED 6/2000, THE YAKIMA RIVER BASIN WATER RIGHTS ADJUDICATION SECOND SUPPLEMENTAL REPORT OF REFEREE (SUBBASIN NO. 11, MANASTASH), AND THE KITTITAS RECLAMATION DISTRICT (KRD) GIS.

LEGEND

- DIVERSION POINT FROM MANASTASH CREEK
- LAND IRRIGATED BY MANASTASH CREEK. (COLOR CODED BY DIVERSION)
- IRRIGATION DITCH FROM MANASTASH CR. (COLOR CODED BY DIVERSION)
- WESTSIDE IRRIGATION CANAL
- KRD IRRIGATION CANAL AND LATERALS
- STREAM
- REPLACE MANASTASH CREEK DITCHES WITH NEW PIPE
- REPLACE KRD LATERALS WITH NEW PIPE (AS SHOWN IN THE KRD WATER CONSERVATION PLAN)
- CONSTRUCT NEW PIPE (AS SHOWN IN THE KRD WATER CONSERVATION PLAN)

Figure 3-1
Alternative 1: Pipe Manastash Creek Ditches

Water Conservation Study
For Manastash Creek

MWH
MONTGOMERY WATSON HARZA

MONTGOMERY WATER GROUP, INC.

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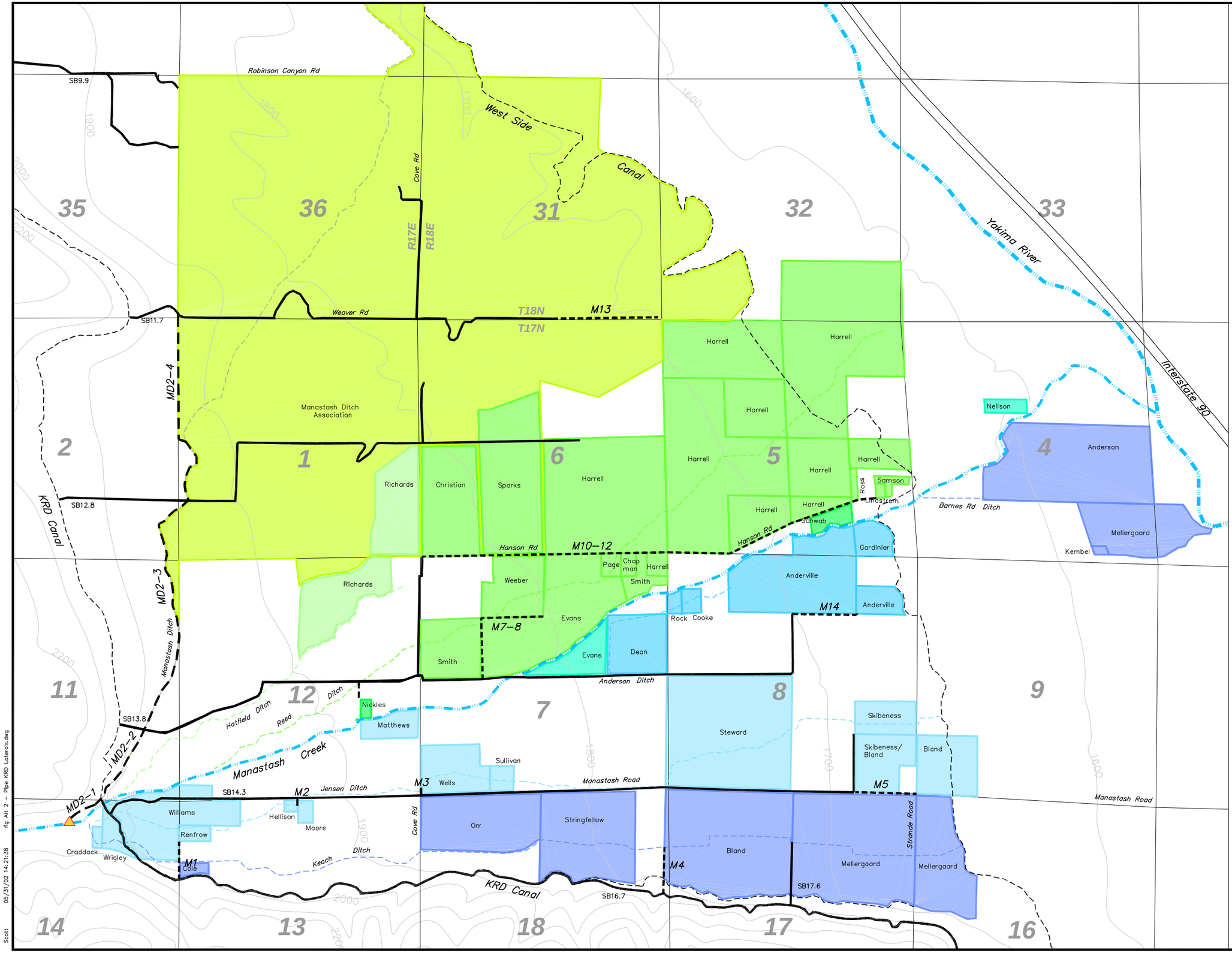

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NOTES

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LEGEND

- DIVERSION POINT FROM MANASTASH CREEK
- LAND IRRIGATED BY MANASTASH CREEK. (COLOR CODED BY DIVERSION)
- IRRIGATION DITCH FROM MANASTASH CR. (COLOR CODED BY DIVERSION)
- WESTSIDE IRRIGATION CANAL
- KRD IRRIGATION CANAL AND LATERALS
- STREAM
- CONSTRUCT NEW PIPE (FROM WESTSIDE CANAL OR REPLACE MANASTASH DITCHES)
- REPLACE KRD LATERALS WITH NEW PIPE (AS SHOWN IN THE KRD WATER CONSERVATION PLAN)
- CONSTRUCT NEW PIPE (AS SHOWN IN THE KRD WATER CONSERVATION PLAN)

Figure 3-2
Alternative 2: Pipe KRD Laterals

Water Conservation Study
For Manastash Creek

MWH
MONTGOMERY WATSON HARZA

MONTGOMERY WATER GROUP, INC.

Scott 05/31/02 14:21:38 fig Alt 2 – Pipe KRD Laterals.dwg

Robinson Canyon Rd
SB9.9
1900
2000
2200
35
36
31
32
33
West Side Canal
Cove Rd
R17E
R18E
T18N
T17N
M13
P1
Weaver Rd
SB11.7
Yakima River
Interstate 90
Harrell
Neilson
Anderson
Manastash Ditch Association
2
1
6
5
4
Richards
Christian
Sparks
Ross
Samson
Lindsley
Schwab
Barnes Rd Ditch
P2
Kembel
Mellergaard
SB12.8
KRD Canal
Hanson Rd
M10–12
Page
Chap man
Smith
Gardinier
Weeber
Anderville
M14
P3
Rock
Cooke
Evans
M7–8
Dean
Manastash Ditch
2200
11
12
7
8
9
Anderson Ditch
SB13.8
Hatfield Ditch
Reed Ditch
Nickles
Matthews
Steward
Skibeness
Skibeness/ Bland
Bland
Manastash Creek
Sullivan
M3
Wells
M2
Jensen Ditch
SB14.3
M5
P4
Manastash Road
1800
1700
1600
Williams
Renfrow
Hellison
Moore
Cove Rd
Orr
Stringfellow
Craddock
Wrigley
M1
Cole
Keach Ditch
1900
Stronde Road
M4
SB17.6
SB16.7
2000
14
13
18
17
16

0 1000 2000
FEET

NOTES

1. DATUM: STATE PLANE SOUTH, NAD 27.

2. MAP BASED ON USGS AERIAL PHOTOGRAPHS DATED 6/2000, THE YAKIMA RIVER BASIN WATER RIGHTS ADJUDICATION SECOND SUPPLEMENTAL REPORT OF REFEREE (SUBBASIN NO. 11, MANASTASH), AND THE KITTITAS RECLAMATION DISTRICT (KRD) GIS.

LEGEND

- DIVERSION POINT FROM MANASTASH CREEK
- LAND IRRIGATED BY MANASTASH CREEK. (COLOR CODED BY DIVERSION)
- IRRIGATION DITCH FROM MANASTASH CR. (COLOR CODED BY DIVERSION)
- WESTSIDE IRRIGATION CANAL
- KRD IRRIGATION CANAL AND LATERALS
- STREAM
- CONSTRUCT NEW PIPE (FROM WESTSIDE CANAL OR REPLACE MANASTASH DITCHES)
- REPLACE KRD LATERALS WITH NEW PIPE (AS SHOWN IN THE KRD WATER CONSERVATION PLAN)
- CONSTRUCT NEW PIPE (AS SHOWN IN THE KRD WATER CONSERVATION PLAN)
- LAND IRRIGATED FROM WESTSIDE CANAL BY GRAVITY.
- LAND IRRIGATED FROM WESTSIDE CANAL BY USING PUMPS.

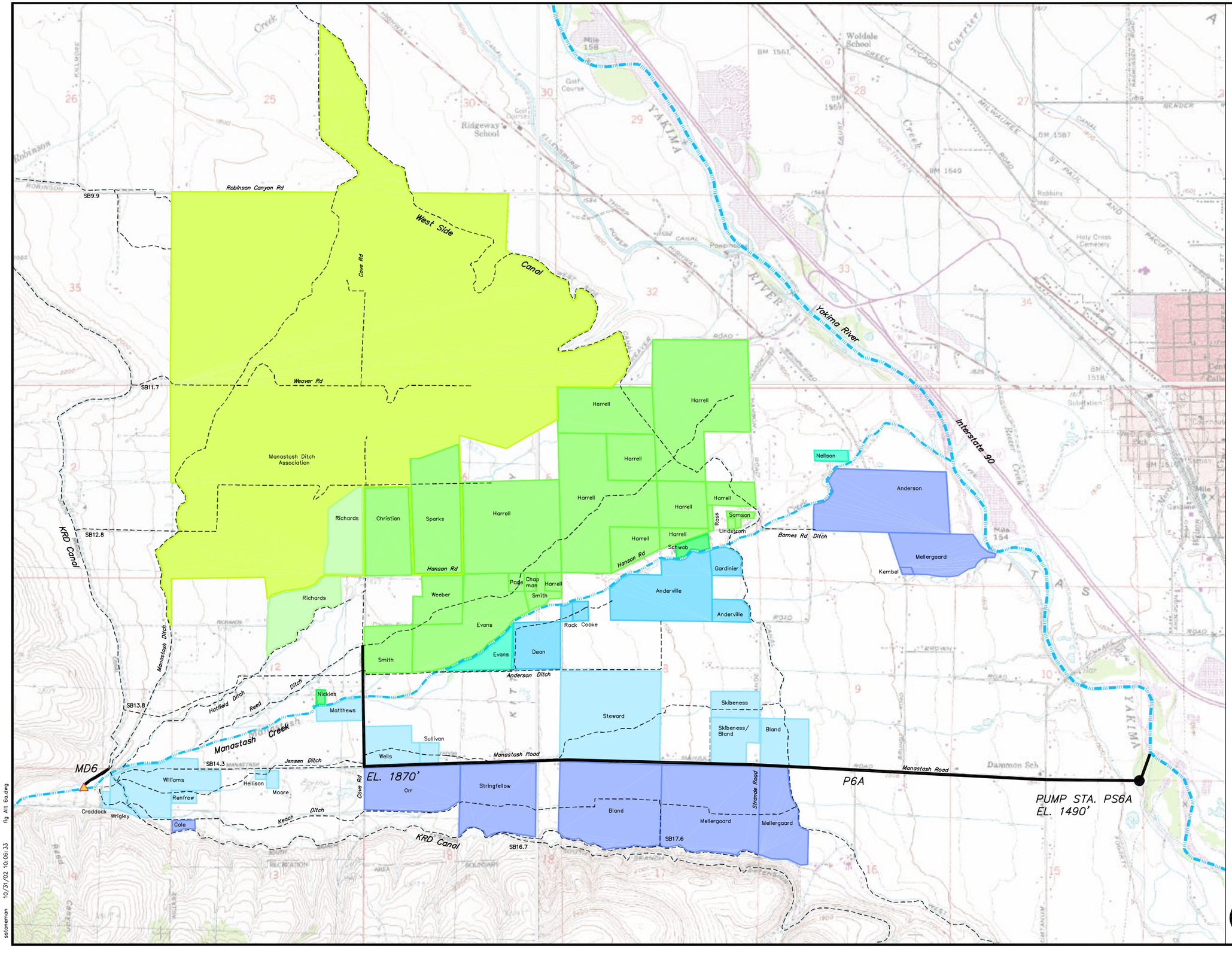
Figure 3-3
Alternative 3: Pipe KRD Laterals, Eliminate Manastash Diversions

Water Conservation Study
For Manastash Creek

MWH
MONTGOMERY WATSON HARZA

MONTGOMERY WATER GROUP, INC.

Scott 05/31/02 14:22:47 fig Alt 3 – Pipe KRD with no MC Div.dwg



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FEET

NOTES

1. DATUM: STATE PLANE SOUTH, NAD 27.

2. MAP BASED ON USGS AERIAL PHOTOGRAPHS DATED 6/2000, THE YAKIMA RIVER BASIN WATER RIGHTS ADJUDICATION SECOND SUPPLEMENTAL REPORT OF REFEREE (SUBBASIN NO. 11, MANASTASH), AND THE KITTITAS RECLAMATION DISTRICT (KRD) GIS.

LEGEND

- DIVERSION POINT FROM MANASTASH CREEK
- LAND IRRIGATED BY MANASTASH CREEK. (COLOR CODED BY DIVERSION)
- IRRIGATION DITCH FROM MANASTASH CR.
- WESTSIDE IRRIGATION CANAL
- KRD IRRIGATION CANAL AND LATERALS
- STREAM
- CONSTRUCT NEW PIPE TO CONVEY WATER FROM FOGARTY DITCH TO KRD SYSTEM

Figure 3-4
Alternative 6A: Pump From Yakima River

Water Conservation Study
For Manastash Creek

MWH
MONTGOMERY WATSON HARZA

MONTGOMERY WATER GROUP, INC.

sstoneman 10/31/02 10:06:33 fig Alt 6a.dwg

PUMP STA. PS6B
EL. 1580'

EL. 1860'

Robinson Canyon Rd

West Side Canal

Cove Rd

Weaver Rd

P6-2

P6B

SB9.9

SB11.7

SB12.8

SB13.8

SB14.3

SB16.7

SB17.6

Yakima River

Interstate 90

Manastash Creek

Manastash Road

Anderson Ditch

Barnes Rd Ditch

Hanson Rd

Jensen Ditch

Reed Ditch

Hatfield Ditch

Keach Ditch

Manastash Ditch

KRD Canal

Strande Road

MD6

Manastash Ditch Association

Richards

Christian

Sparks

Harrell

Ross

Samson

Lindstrom

Schwab

Gardinier

Kembel

Mellergaard

Anderville

Neilson

Anderson

Page

Chap man

Smith

Weeber

Evans

Dean

Rock

Cooke

Nickles

Matthews

Steward

Skibeness

Skibeness/ Bland

Bland

Sullivan

Wells

Orr

Stringfellow

Williams

Renfrow

Hellison

Moore

Craddock

Wrigley

Cole

0 1250 2500
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NOTES

1. DATUM: STATE PLANE SOUTH, NAD 27.

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LEGEND

- DIVERSION POINT FROM MANASTASH CREEK
- LAND IRRIGATED BY MANASTASH CREEK. (COLOR CODED BY DIVERSION)
- IRRIGATION DITCH FROM MANASTASH CR.
- WESTSIDE IRRIGATION CANAL
- KRD IRRIGATION CANAL AND LATERALS
- STREAM
- CONSTRUCT NEW PIPE TO CONVEY WATER FROM POWER CANAL TO KRD SYSTEM

Figure 3-5
Alternative 6B: Pump From Packwood Canal

Water Conservation Study
For Manastash Creek

MWH
MONTGOMERY WATSON HARZA
MONTGOMERY WATER GROUP, INC.

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APPENDIX A
COST WORKSHEETS

Alternative 1
Pipe Existing KRD Facilities
Summary of Costs

Description [1]	Total Estimated Project Cost	Total Estimated Project Cost Plus 50%	Total Estimated Project Cost Minus 30%
Baseline Alternative 1			
Pipe Manastash Ditch - MD1-1	$159,352	$239,027	$111,546
Pipe Manastash Ditch - MD1-2	$259,653	$389,480	$181,757
Pipe Manastash Ditch - MD1-3	$784,785	$1,177,178	$549,350
Pipe Manastash Ditch - MD1-4	$731,160	$1,096,739	$511,812
Pipe Reed Ditch - R1 and R2	$1,118,443	$1,677,664	$782,910
Pipe Hatfield Ditch - H1	$260,213	$390,319	$182,149
Pipe Anderson Ditch - A1 and A2	$287,141	$430,712	$200,999
Pipe Barnes Rd Ditch - B1	$232,346	$348,518	$162,642
Subtotal	*$3,833,092*		
Demolition of Existing Diversion Structures	$497,167	$745,750	$348,017
Manastash Ditch Diversion	$1,570,729	$2,356,094	$1,099,510
Anderson Ditch Diversion	$243,661	$365,491	$170,562
Barnes Rd. Ditch Diversion	$243,661	$365,491	$170,562
Neilson Diversion	$31,922	$47,882	$22,345
Subtotal	*$2,587,139*		
Pipe Portion of KRD Lateral 13.8	$529,014	$793,521	$370,310
Pipe KRD Lateral 14.3	$1,359,172	$2,038,757	$951,420
Pipe KRD Lateral 16.7 and 17.6	$2,217,085	$3,325,627	$1,551,959
Pipe Lower Portion of KRD Canal	$1,286,089	$1,929,133	$900,262
Subtotal	*$5,391,359*		
New KRD Lateral Extension M1 through M5	$192,858	$289,287	$135,001
Subtotal	***$12,004,448***	***$18,006,672***	***$8,403,114***
Supplemental Measure 1A			
On-Farm Water Conservation	***$2,230,000***	***$3,345,000***	***$1,561,000***
TOTAL ESTIMATED COST FOR ALT 1	**$14,234,448**	**$21,351,672**	**$9,964,114**

1 Please see figures in Water Conservation Study for Manastash Creek for location of each item.

Alternative 2
Pipe Existing KRD Facilities
Summary of Costs

Description [1]	Total Estimated Project Cost	Total Estimated Project Cost Plus 50%	Total Estimated Project Cost Minus 30%
Baseline Alternative 2			
Pipe Manastash Ditch - MD2-1	$171,644	$257,466	$120,151
Pipe Manastash Ditch - MD2-2	$259,653	$389,480	$181,757
Pipe Manastash Ditch - MD2-3	$504,187	$756,280	$352,931
Pipe Manastash Ditch - MD2-4	$359,906	$539,860	$251,935
Subtotal	*$1,295,390*		
Demolition of Existing Diversion Structures	$497,167	$745,750	$348,017
Manastash Ditch Diversion	$1,460,779	$2,191,169	$1,022,546
Subtotal	*$1,957,946*		
Pipe KRD Lateral 9.9	$531,403	$797,104	$371,982
Pipe KRD Lateral 11.7	$1,211,584	$1,817,377	$848,109
Pipe KRD Lateral 12.8	$1,148,108	$1,722,162	$803,676
Pipe KRD Lateral 13.8	$1,497,278	$2,245,917	$1,048,095
Pipe KRD Lateral 14.3	$1,359,172	$2,038,757	$951,420
Pipe KRD Lateral 16.7 and 17.6	$2,217,085	$3,325,627	$1,551,959
Pipe Lower Portion of KRD Canal	$1,286,089	$1,929,133	$900,262
Subtotal	*$9,250,718*		
New KRD Lateral Extension M1 through M14	*$1,516,478*	$2,274,717	$1,061,535
Subtotal	***$14,020,533***	***$21,030,800***	***$9,814,373***
Supplemental Measure 2A			
On-Farm Water Conservation	***$2,230,000***	***$3,345,000***	***$1,561,000***
Supplemental Measure 2B			
Page Canyon Reregulating Reservoir	***$1,688,407***	***$2,532,611***	***$1,181,885***
Supplemental Measure 2C			
(24) 8" Wells	$2,164,902	$3,247,353	$1,515,431
(13) 12" Wells	$1,760,490	$2,640,735	$1,232,343
Subtotal	**$3,925,392**	**$5,888,087**	**$2,747,774**
TOTAL ESTIMATED COST FOR ALT 2	**$21,864,332**	**$32,796,498**	**$15,305,033**

1 Please see figures in Water Conservation Study for Manastash Creek for location of each item.

Alternative 3
Pipe Existing KRD Facilities
Summary of Costs

Description [1]	Total Estimated Project Cost	Total Estimated Project Cost Plus 50%	Total Estimated Project Cost Minus 30%
Baseline Alternative 3			
Pipe KRD Lateral 9.9	$531,403	$797,104	$371,982
Pipe KRD Lateral 11.7	$1,211,584	$1,817,377	$848,109
Pipe KRD Lateral 12.8	$1,148,108	$1,722,162	$803,676
Pipe KRD Lateral 13.8	$1,497,278	$2,245,917	$1,048,095
Pipe KRD Lateral 14.3	$1,359,172	$2,038,757	$951,420
Pipe KRD Lateral 16.7 and 17.6	$2,217,085	$3,325,627	$1,551,959
Pipe Lower Portion of KRD Canal	$1,286,089	$1,929,133	$900,262
Subtotal	*$9,250,718*		
New KRD Lateral Extension M1 through M14	$1,516,478	$2,274,717	$1,061,535
Demolition of Existing Diversion Structures	$497,167	$745,750	$348,017
Subtotal	***$11,264,363***	***$16,896,545***	***$7,885,054***
Supplemental Measure 3A			
On-Farm Water Conservation	***$2,230,000***	***$3,345,000***	***$1,561,000***
Supplemental Measure 3B			
Page Canyon Reregulating Reservoir	***$1,688,407***	***$2,532,611***	***$1,181,885***
Supplemental Measure 3C			
(24) 8" Wells	$2,164,902	$3,247,353	$1,515,431
(13) 12" Wells	$1,760,490	$2,640,735	$1,232,343
Subtotal	**$3,925,392**	**$5,888,087**	**$2,747,774**
SUBTOTAL ESTIMATED COST FOR ALT 3	**$19,108,162**	**$28,662,244**	**$13,375,714**
Supplemental Measure 3D			
Pump Station P1	$774,838	$1,162,257	$542,387
Pump Station P2	$585,732	$878,598	$410,013
Pump Station P3	$382,906	$574,359	$268,034
Pump Station P4	$585,732	$878,598	$410,013
Pipe P1	$173,643	$260,465	$121,550
Pipe P2	$76,156	$114,234	$53,309
Pipe P3	$87,225	$130,837	$61,057
Pipe P4	$122,754	$184,131	$85,928
Subtotal	**$2,788,986**	**$4,183,479**	**$1,952,290**
TOTAL ESTIMATED COST FOR ALT 3	**$21,897,149**	**$32,845,723**	**$15,328,004**

1 Please see figures in Water Conservation Study for Manastash Creek for location of each item.

2 Supplemental Measure 3D does not include the cost of upgrading the Westside Canal.

Alternative 6A
Direct Pumping from Yakima River
Summary of Costs

Description [1]	Total Estimated Project Cost	Total Estimated Project Cost Plus 50%	Total Estimated Project Cost Minus 30%
Baseline Alternative 6A			
Pipeline 6a	$2,121,966	$3,182,949	$1,485,376
Pipeline MD6	$159,352	$239,027	$111,546
Demolition of Existing Diversion Structures	$497,167	$745,750	$348,017
Manastash Ditch Diversion	$1,460,779	$2,191,169	$1,022,546
Pump Station P6A	$1,300,378	$1,950,567	$910,264
Install 11 stockwater wells	$391,287	$586,930	$273,901
Subtotal	*$5,930,928*	*$8,896,392*	*$4,151,650*
TOTAL ESTIMATED COST FOR ALT 6A	**$5,930,928**	**$8,896,392**	**$4,151,650**

1 Please see figures in Water Conservation Study for Manastash Creek for location of each item.

2 Supplemental Measure 3D does not include the cost of upgrading the Fogarty Ditch.

Alternative 6B
Pump from Packwood Canal
Summary of Costs

Description [1]	Total Estimated Project Cost	Total Estimated Project Cost Plus 50%	Total Estimated Project Cost Minus 30%
Baseline Alternative 6B			
Pipeline 6B	$1,775,520	$2,663,280	$1,242,864
Pipeline MD6	$159,352	$239,027	$111,546
Demolition of Existing Diversion Structures	$497,167	$745,750	$348,017
Manastash Ditch Diversion	$1,460,779	$2,191,169	$1,022,546
Pump Station P6B	$1,300,378	$1,950,567	$910,264
Install 11 stockwater wells	$391,287	$586,930	$273,901
Subtotal	*$5,584,483*	*$8,376,724*	*$3,909,138*
TOTAL ESTIMATED COST FOR ALT 6B	**$5,584,483**	**$8,376,724**	**$3,909,138**

1 Please see figures in Water Conservation Study for Manastash Creek for location of each item.

2 Supplemental Measure 3D does not include the cost of upgrading the Ellensburg Power Canal.

Manastash Ditch MD1-1

Prices in November 2002 dollars updated from CH2M Hill Engineer's Opinion of Probable Cost

Item	Description	Quantity	Unit	Unit Cost	Cost
1	Mobilization	1	LS	9,880.20	$9,880
2	Trench Safety System	900	LF	1.10	$990
3	Excavation	1,873	CY	2.40	$4,495
4	Imported Pipe Bedding	47	CY	24.00	$1,121
5	Select Backfill	609	CY	9.60	$5,843
6	Native Backfill	1,217	CY	3.60	$4,382
7	Grade Spoil Material for Pipe	367	CY	1.20	$441
8	48" CPP, ASTM C361	-	LF	60.40	$0
9	42" CPP, ASTM C361	900	LF	56.00	$50,400
10	39" CPP, ASTM C361	-	LF	52.70	$0
11	36" CPP, ASTM C361	-	LF	47.20	$0
12	33" CPP, ASTM C361	-	LF	41.70	$0
13	30" CPP, ASTM C361	-	LF	36.20	$0
14	27" CPP, ASTM C361	-	LF	30.70	$0
15	24" CPP, ASTM C361	-	LF	25.20	$0
16	21" CPP, ASTM C361	-	LF	19.80	$0
17	18" PVC, 125 psi	-	LF	23.10	$0
18	15" PVC, 125 psi	-	LF	15.40	$0
19	12" PVC, 125 psi	-	LF	11.00	$0
20	10" PVC, 125 psi	-	LF	7.70	$0
20	8" PVC, 125 psi	-	LF	5.50	$0
21	6" PVC, 125 psi	-	LF	4.40	$0
22	Piping Appurtenances	1	LS	4,391.20	$4,391
23	Turnout & Flowmeter	1	EA	2,744.50	$2,745
24	Road Crossing	0	EA	5,489.00	$0
25	Lateral Inlet Structure	1	LS	3,293.40	$3,293
26	Reestablish Drainage Pattern	1	LS	4,391.20	$4,391
	SUBTOTAL CONSTRUCTION COSTS				$92,372
	CONSTRUCTION CONTINGENCY		30.0%		$27,712
	TOTAL ESTIMATED CONSTRUCTION COSTS				$120,084
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$9,246
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$30,021
	TOTAL ESTIMATED PROJECT COST				$159,352

Preliminary costs were based on information taken from KRD WCP Irrigation Water Conservation Plan of System Improvements by CH2M Hill, dated February 1999. Earthwork volumes were calculated by MWH and costs were updated to November 2002.

Manastash Ditch MD1-2

Prices in November 2002 dollars updated from CH2M Hill Engineer's Opinion of Probable Cost

Item	Description	Quantity	Unit	Unit Cost	Cost
1	Mobilization	1	LS	9,880.20	$9,880
2	Trench Safety System	1,800	LF	1.10	$1,980
3	Excavation	3,071	CY	2.40	$7,370
4	Imported Pipe Bedding	85	CY	24.00	$2,042
5	Select Backfill	995	CY	9.60	$9,554
6	Native Backfill	1,990	CY	3.60	$7,165
7	Grade Spoil Material for Pipe	556	CY	1.20	$668
8	48" CPP, ASTM C361	-	LF	60.40	$0
9	42" CPP, ASTM C361	-	LF	56.00	$0
10	39" CPP, ASTM C361	-	LF	52.70	$0
11	36" CPP, ASTM C361	1,800	LF	47.20	$84,960
12	33" CPP, ASTM C361	-	LF	41.70	$0
13	30" CPP, ASTM C361	-	LF	36.20	$0
14	27" CPP, ASTM C361	-	LF	30.70	$0
15	24" CPP, ASTM C361	-	LF	25.20	$0
16	21" CPP, ASTM C361	-	LF	19.80	$0
17	18" PVC, 125 psi	-	LF	23.10	$0
18	15" PVC, 125 psi	-	LF	15.40	$0
19	12" PVC, 125 psi	-	LF	11.00	$0
20	10" PVC, 125 psi	-	LF	7.70	$0
20	8" PVC, 125 psi	-	LF	5.50	$0
21	6" PVC, 125 psi	-	LF	4.40	$0
22	Piping Appurtenances	1	LS	7,684.60	$7,685
23	Turnout & Flowmeter	1	EA	2,744.50	$2,745
24	Road Crossing	1	EA	5,489.00	$5,489
25	Lateral Inlet Structure	1	LS	3,293.40	$3,293
26	Reestablish Drainage Pattern	1	LS	7,684.60	$7,685
	SUBTOTAL CONSTRUCTION COSTS				$150,515
	CONSTRUCTION CONTINGENCY		30.0%		$45,154
	TOTAL ESTIMATED CONSTRUCTION COSTS				$195,669
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$15,067
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$48,917
	TOTAL ESTIMATED PROJECT COST				$259,653

Preliminary costs were based on information taken from KRD WCP Irrigation Water Conservation Plan of System Improvements by CH2M Hill, dated February 1999. Earthwork volumes were calculated by MWH and costs were updated to November 2002.

Manastash Ditch MD1-3

Prices in November 2002 dollars updated from CH2M Hill Engineer's Opinion of Probable Cost

Item	Description	Quantity	Unit	Unit Cost	Cost
1	Mobilization	1	LS	9,880.20	$9,880
2	Trench Safety System	10,000	LF	1.10	$11,000
3	Excavation	10,671	CY	2.40	$25,611
4	Imported Pipe Bedding	380	CY	24.00	$9,124
5	Select Backfill	3,430	CY	9.60	$32,931
6	Native Backfill	6,861	CY	3.60	$24,698
7	Grade Spoil Material for Pipe	1,544	CY	1.20	$1,852
8	48" CPP, ASTM C361	-	LF	60.40	$0
9	42" CPP, ASTM C361	-	LF	56.00	$0
10	39" CPP, ASTM C361	-	LF	52.70	$0
11	36" CPP, ASTM C361	-	LF	47.20	$0
12	33" CPP, ASTM C361	-	LF	41.70	$0
13	30" CPP, ASTM C361	-	LF	36.20	$0
14	27" CPP, ASTM C361	-	LF	30.70	$0
15	24" CPP, ASTM C361	10,000	LF	25.20	$252,000
16	21" CPP, ASTM C361	-	LF	19.80	$0
17	18" PVC, 125 psi	-	LF	23.10	$0
18	15" PVC, 125 psi	-	LF	15.40	$0
19	12" PVC, 125 psi	-	LF	11.00	$0
20	10" PVC, 125 psi	-	LF	7.70	$0
20	8" PVC, 125 psi	-	LF	5.50	$0
21	6" PVC, 125 psi	-	LF	4.40	$0
22	Piping Appurtenances	1	LS	21,955.90	$21,956
23	Turnout & Flowmeter	10	EA	2,744.50	$27,445
24	Road Crossing	3	EA	5,489.00	$16,467
25	Lateral Inlet Structure	0	LS	3,293.40	$0
26	Reestablish Drainage Pattern	1	LS	21,955.90	$21,956
	SUBTOTAL CONSTRUCTION COSTS				$454,922
	CONSTRUCTION CONTINGENCY		30.0%		$136,476
	TOTAL ESTIMATED CONSTRUCTION COSTS				$591,398
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$45,538
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$147,850
	TOTAL ESTIMATED PROJECT COST				$784,785

Preliminary costs were based on information taken from KRD WCP Irrigation Water Conservation Plan of System Improvements by CH2M Hill, dated February 1999. Earthwork volumes were calculated by MWH and costs were updated to November 2002.

Manastash Ditch MD1-4

Prices in November 2002 dollars updated from CH2M Hill Engineer's Opinion of Probable Cost

Item	Description	Quantity	Unit	Unit Cost	Cost
1	Mobilization	1	LS	9,880.20	$9,880
2	Trench Safety System	10,400	LF	1.10	$11,440
3	Excavation	8,354	CY	2.40	$20,049
4	Imported Pipe Bedding	347	CY	24.00	$8,334
5	Select Backfill	2,669	CY	9.60	$25,620
6	Native Backfill	5,338	CY	3.60	$19,215
7	Grade Spoil Material for Pipe	1,028	CY	1.20	$1,234
8	48" CPP, ASTM C361	-	LF	60.40	$0
9	42" CPP, ASTM C361	-	LF	56.00	$0
10	39" CPP, ASTM C361	-	LF	52.70	$0
11	36" CPP, ASTM C361	-	LF	47.20	$0
12	33" CPP, ASTM C361	-	LF	41.70	$0
13	30" CPP, ASTM C361	-	LF	36.20	$0
14	27" CPP, ASTM C361	-	LF	30.70	$0
15	24" CPP, ASTM C361	-	LF	25.20	$0
16	21" CPP, ASTM C361	-	LF	19.80	$0
17	18" PVC, 125 psi	10,400	LF	23.10	$240,240
18	15" PVC, 125 psi	-	LF	15.40	$0
19	12" PVC, 125 psi	-	LF	11.00	$0
20	10" PVC, 125 psi	-	LF	7.70	$0
20	8" PVC, 125 psi	-	LF	5.50	$0
21	6" PVC, 125 psi	-	LF	4.40	$0
22	Piping Appurtenances	1	LS	21,955.90	$21,956
23	Turnout & Flowmeter	10	EA	2,744.50	$27,445
24	Road Crossing	3	EA	5,489.00	$16,467
25	Lateral Inlet Structure	0	LS	3,293.40	$0
26	Reestablish Drainage Pattern	1	LS	21,955.90	$21,956
	SUBTOTAL CONSTRUCTION COSTS				$423,836
	CONSTRUCTION CONTINGENCY		30.0%		$127,151
	TOTAL ESTIMATED CONSTRUCTION COSTS				$550,987
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$42,426
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$137,747
	TOTAL ESTIMATED PROJECT COST				$731,160

Preliminary costs were based on information taken from KRD WCP Irrigation Water Conservation Plan of System Improvements by CH2M Hill, dated February 1999. Earthwork volumes were calculated by MWH and costs were updated to November 2002.

Manastash Ditch MD2-1

Prices in November 2002 dollars updated from CH2M Hill Engineer's Opinion of Probable Cost

Item	Description	Quantity	Unit	Unit Cost	Cost
1	Mobilization	1	LS	9,880.20	$9,880
2	Trench Safety System	900	LF	1.10	$990
3	Excavation	2,244	CY	2.40	$5,385
4	Imported Pipe Bedding	51	CY	24.00	$1,221
5	Select Backfill	731	CY	9.60	$7,016
6	Native Backfill	1,462	CY	3.60	$5,262
7	Grade Spoil Material for Pipe	470	CY	1.20	$564
8	48" CPP, ASTM C361	900	LF	60.40	$54,360
9	42" CPP, ASTM C361	-	LF	56.00	$0
10	39" CPP, ASTM C361	-	LF	52.70	$0
11	36" CPP, ASTM C361	-	LF	47.20	$0
12	33" CPP, ASTM C361	-	LF	41.70	$0
13	30" CPP, ASTM C361	-	LF	36.20	$0
14	27" CPP, ASTM C361	-	LF	30.70	$0
15	24" CPP, ASTM C361	-	LF	25.20	$0
16	21" CPP, ASTM C361	-	LF	19.80	$0
17	18" PVC, 125 psi	-	LF	23.10	$0
18	15" PVC, 125 psi	-	LF	15.40	$0
19	12" PVC, 125 psi	-	LF	11.00	$0
20	10" PVC, 125 psi	-	LF	7.70	$0
20	8" PVC, 125 psi	-	LF	5.50	$0
21	6" PVC, 125 psi	-	LF	4.40	$0
22	Piping Appurtenances	1	LS	4,391.20	$4,391
23	Turnout & Flowmeter	1	EA	2,744.50	$2,745
24	Road Crossing	0	EA	5,489.00	$0
25	Lateral Inlet Structure	1	LS	3,293.40	$3,293
26	Reestablish Drainage Pattern	1	LS	4,391.20	$4,391
	SUBTOTAL CONSTRUCTION COSTS				$99,498
	CONSTRUCTION CONTINGENCY		30.0%		$29,849
	TOTAL ESTIMATED CONSTRUCTION COSTS				$129,347
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$9,960
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$32,337
	TOTAL ESTIMATED PROJECT COST				$171,644

Preliminary costs were based on information taken from KRD WCP Irrigation Water Conservation Plan of System Improvements by CH2M Hill, dated February 1999. Earthwork volumes were calculated by MWH and costs were updated to November 2002.

Manastash Ditch MD2-2

Prices in November 2002 dollars updated from CH2M Hill Engineer's Opinion of Probable Cost

Item	Description	Quantity	Unit	Unit Cost	Cost
1	Mobilization	1	LS	9,880.20	$9,880
2	Trench Safety System	1,800	LF	1.10	$1,980
3	Excavation	3,071	CY	2.40	$7,370
4	Imported Pipe Bedding	85	CY	24.00	$2,042
5	Select Backfill	995	CY	9.60	$9,554
6	Native Backfill	1,990	CY	3.60	$7,165
7	Grade Spoil Material for Pipe	556	CY	1.20	$668
8	48" CPP, ASTM C361	-	LF	60.40	$0
9	42" CPP, ASTM C361	-	LF	56.00	$0
10	39" CPP, ASTM C361	-	LF	52.70	$0
11	36" CPP, ASTM C361	1,800	LF	47.20	$84,960
12	33" CPP, ASTM C361	-	LF	41.70	$0
13	30" CPP, ASTM C361	-	LF	36.20	$0
14	27" CPP, ASTM C361	-	LF	30.70	$0
15	24" CPP, ASTM C361	-	LF	25.20	$0
16	21" CPP, ASTM C361	-	LF	19.80	$0
17	18" PVC, 125 psi	-	LF	23.10	$0
18	15" PVC, 125 psi	-	LF	15.40	$0
19	12" PVC, 125 psi	-	LF	11.00	$0
20	10" PVC, 125 psi	-	LF	7.70	$0
20	8" PVC, 125 psi	-	LF	5.50	$0
21	6" PVC, 125 psi	-	LF	4.40	$0
22	Piping Appurtenances	1	LS	7,684.60	$7,685
23	Turnout & Flowmeter	1	EA	2,744.50	$2,745
24	Road Crossing	1	EA	5,489.00	$5,489
25	Lateral Inlet Structure	1	LS	3,293.40	$3,293
26	Reestablish Drainage Pattern	1	LS	7,684.60	$7,685
	SUBTOTAL CONSTRUCTION COSTS				$150,515
	CONSTRUCTION CONTINGENCY		30.0%		$45,154
	TOTAL ESTIMATED CONSTRUCTION COSTS				$195,669
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$15,067
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$48,917
	TOTAL ESTIMATED PROJECT COST				$259,653

Preliminary costs were based on information taken from KRD WCP Irrigation Water Conservation Plan of System Improvements by CH2M Hill, dated February 1999. Earthwork volumes were calculated by MWH and costs were updated to November 2002.

Manastash Ditch MD2-3

Prices in November 2002 dollars updated from CH2M Hill Engineer's Opinion of Probable Cost

Item	Description	Quantity	Unit	Unit Cost	Cost
1	Mobilization	1	LS	9,880.20	$9,880
2	Trench Safety System	5,800	LF	1.10	$6,380
3	Excavation	6,189	CY	2.40	$14,854
4	Imported Pipe Bedding	221	CY	24.00	$5,292
5	Select Backfill	1,990	CY	9.60	$19,100
6	Native Backfill	3,979	CY	3.60	$14,325
7	Grade Spoil Material for Pipe	895	CY	1.20	$1,074
8	48" CPP, ASTM C361	-	LF	60.40	$0
9	42" CPP, ASTM C361	-	LF	56.00	$0
10	39" CPP, ASTM C361	-	LF	52.70	$0
11	36" CPP, ASTM C361	-	LF	47.20	$0
12	33" CPP, ASTM C361	-	LF	41.70	$0
13	30" CPP, ASTM C361	-	LF	36.20	$0
14	27" CPP, ASTM C361	-	LF	30.70	$0
15	24" CPP, ASTM C361	5,800	LF	25.20	$146,160
16	21" CPP, ASTM C361	-	LF	19.80	$0
17	18" PVC, 125 psi	-	LF	23.10	$0
18	15" PVC, 125 psi	-	LF	15.40	$0
19	12" PVC, 125 psi	-	LF	11.00	$0
20	10" PVC, 125 psi	-	LF	7.70	$0
20	8" PVC, 125 psi	-	LF	5.50	$0
21	6" PVC, 125 psi	-	LF	4.40	$0
22	Piping Appurtenances	1	LS	19,760.30	$19,760
23	Turnout & Flowmeter	7	EA	2,744.50	$19,212
24	Road Crossing	3	EA	5,489.00	$16,467
25	Lateral Inlet Structure	0	LS	3,293.40	$0
26	Reestablish Drainage Pattern	1	LS	19,760.30	$19,760
	SUBTOTAL CONSTRUCTION COSTS				$292,265
	CONSTRUCTION CONTINGENCY		30.0%		$87,680
	TOTAL ESTIMATED CONSTRUCTION COSTS				$379,945
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$29,256
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$94,986
	TOTAL ESTIMATED PROJECT COST				$504,187

Preliminary costs were based on information taken from KRD WCP Irrigation Water Conservation Plan of System Improvements by CH2M Hill, dated February 1999. Earthwork volumes were calculated by MWH and costs were updated to November 2002.

Manastash Ditch MD2-4

Prices in November 2002 dollars updated from CH2M Hill Engineer's Opinion of Probable Cost

Item	Description	Quantity	Unit	Unit Cost	Cost
1	Mobilization	1	LS	9,880.20	$9,880
2	Trench Safety System	4,500	LF	1.10	$4,950
3	Excavation	3,615	CY	2.40	$8,675
4	Imported Pipe Bedding	150	CY	24.00	$3,606
5	Select Backfill	1,155	CY	9.60	$11,086
6	Native Backfill	2,310	CY	3.60	$8,314
7	Grade Spoil Material for Pipe	445	CY	1.20	$534
8	48" CPP, ASTM C361	-	LF	60.40	$0
9	42" CPP, ASTM C361	-	LF	56.00	$0
10	39" CPP, ASTM C361	-	LF	52.70	$0
11	36" CPP, ASTM C361	-	LF	47.20	$0
12	33" CPP, ASTM C361	-	LF	41.70	$0
13	30" CPP, ASTM C361	-	LF	36.20	$0
14	27" CPP, ASTM C361	-	LF	30.70	$0
15	24" CPP, ASTM C361	-	LF	25.20	$0
16	21" CPP, ASTM C361	-	LF	19.80	$0
17	18" PVC, 125 psi	4,500	LF	23.10	$103,950
18	15" PVC, 125 psi	-	LF	15.40	$0
19	12" PVC, 125 psi	-	LF	11.00	$0
20	10" PVC, 125 psi	-	LF	7.70	$0
20	8" PVC, 125 psi	-	LF	5.50	$0
21	6" PVC, 125 psi	-	LF	4.40	$0
22	Piping Appurtenances	1	LS	16,467.00	$16,467
23	Turnout & Flowmeter	7	EA	2,744.50	$19,212
24	Road Crossing	1	EA	5,489.00	$5,489
25	Lateral Inlet Structure	0	LS	3,293.40	$0
26	Reestablish Drainage Pattern	1	LS	16,467.00	$16,467
	SUBTOTAL CONSTRUCTION COSTS				$208,629
	CONSTRUCTION CONTINGENCY		30.0%		$62,589
	TOTAL ESTIMATED CONSTRUCTION COSTS				$271,218
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$20,884
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$67,805
	TOTAL ESTIMATED PROJECT COST				$359,906

Preliminary costs were based on information taken from KRD WCP Irrigation Water Conservation Plan of System Improvements by CH2M Hill, dated February 1999. Earthwork volumes were calculated by MWH and costs were updated to November 2002.

Manastash Ditch MD6

Prices in November 2002 dollars updated from CH2M Hill Engineer's Opinion of Probable Cost

Item	Description	Quantity	Unit	Unit Cost	Cost
1	Mobilization	1	LS	9,880.20	$9,880
2	Trench Safety System	900	LF	1.10	$990
3	Excavation	1,873	CY	2.40	$4,495
4	Imported Pipe Bedding	47	CY	24.00	$1,121
5	Select Backfill	609	CY	9.60	$5,843
6	Native Backfill	1,217	CY	3.60	$4,382
7	Grade Spoil Material for Pipe	367	CY	1.20	$441
8	48" CPP, ASTM C361	-	LF	60.40	$0
9	42" CPP, ASTM C361	900	LF	56.00	$50,400
10	39" CPP, ASTM C361	-	LF	52.70	$0
11	36" CPP, ASTM C361	-	LF	47.20	$0
12	33" CPP, ASTM C361	-	LF	41.70	$0
13	30" CPP, ASTM C361	-	LF	36.20	$0
14	27" CPP, ASTM C361	-	LF	30.70	$0
15	24" CPP, ASTM C361	-	LF	25.20	$0
16	21" CPP, ASTM C361	-	LF	19.80	$0
17	18" PVC, 125 psi	-	LF	23.10	$0
18	15" PVC, 125 psi	-	LF	15.40	$0
19	12" PVC, 125 psi	-	LF	11.00	$0
20	10" PVC, 125 psi	-	LF	7.70	$0
20	8" PVC, 125 psi	-	LF	5.50	$0
21	6" PVC, 125 psi	-	LF	4.40	$0
22	Piping Appurtenances	1	LS	4,391.20	$4,391
23	Turnout & Flowmeter	1	EA	2,744.50	$2,745
24	Road Crossing	0	EA	5,489.00	$0
25	Lateral Inlet Structure	1	LS	3,293.40	$3,293
26	Reestablish Drainage Pattern	1	LS	4,391.20	$4,391
	SUBTOTAL CONSTRUCTION COSTS				$92,372
	CONSTRUCTION CONTINGENCY		30.0%		$27,712
	TOTAL ESTIMATED CONSTRUCTION COSTS				$120,084
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$9,246
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$30,021
	TOTAL ESTIMATED PROJECT COST				$159,352

Preliminary costs were based on information taken from KRD WCP Irrigation Water Conservation Plan of System Improvements by CH2M Hill, dated February 1999. Earthwork volumes were calculated by MWH and costs were updated to November 2002.

Reed Ditch - R1 and R2

Prices in November 2002 dollars updated from CH2M Hill Engineer's Opinion of Probable Cost

Item	Description	Quantity	Unit	Unit Cost	Cost
1	Mobilization	1	LS	9,880.20	$9,880
2	Trench Safety System	13,000	LF	1.10	$14,300
3	Excavation	12,184	CY	2.40	$29,241
4	Imported Pipe Bedding	465	CY	24.00	$11,151
5	Select Backfill	3,906	CY	9.60	$37,501
6	Native Backfill	7,813	CY	3.60	$28,126
7	Grade Spoil Material for Pipe	1,651	CY	1.20	$1,982
8	48" CPP, ASTM C361	-	LF	60.40	$0
9	42" CPP, ASTM C361	-	LF	56.00	$0
10	39" CPP, ASTM C361	-	LF	52.70	$0
11	36" CPP, ASTM C361	-	LF	47.20	$0
12	33" CPP, ASTM C361	-	LF	41.70	$0
13	30" CPP, ASTM C361	-	LF	36.20	$0
14	27" CPP, ASTM C361	-	LF	30.70	$0
15	24" CPP, ASTM C361	6,600	LF	25.20	$166,320
16	21" CPP, ASTM C361	-	LF	19.80	$0
17	18" PVC, 125 psi	6,400	LF	23.10	$147,840
18	15" PVC, 125 psi	-	LF	15.40	$0
19	12" PVC, 125 psi	-	LF	11.00	$0
20	10" PVC, 125 psi	-	LF	7.70	$0
20	8" PVC, 125 psi	-	LF	5.50	$0
21	6" PVC, 125 psi	-	LF	4.40	$0
22	Piping Appurtenances	1	LS	54,889.90	$54,890
23	Turnout & Flowmeter	20	EA	2,744.50	$54,890
24	Road Crossing	3	EA	5,489.00	$16,467
25	Lateral Inlet Structure	3	LS	3,293.40	$9,880
26	Reestablish Drainage Pattern	1	LS	65,867.80	$65,868
	SUBTOTAL CONSTRUCTION COSTS				$648,335
	CONSTRUCTION CONTINGENCY		30.0%		$194,501
	TOTAL ESTIMATED CONSTRUCTION COSTS				$842,836
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$64,898
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$210,709
	TOTAL ESTIMATED PROJECT COST				$1,118,443

Preliminary costs were based on information taken from KRD WCP Irrigation Water Conservation Plan of System Improvements by CH2M Hill, dated February 1999. Earthwork volumes were calculated by MWH and costs were updated to November 2002.

Hatfield Ditch - H1

Prices in November 2002 dollars updated from CH2M Hill Engineer's Opinion of Probable Cost

Item	Description	Quantity	Unit	Unit Cost	Cost
1	Mobilization	1	LS	9,880.20	$9,880
2	Trench Safety System	6,400	LF	1.10	$7,040
3	Excavation	2,474	CY	2.40	$5,938
4	Imported Pipe Bedding	154	CY	24.00	$3,706
5	Select Backfill	773	CY	9.60	$7,423
6	Native Backfill	1,546	CY	3.60	$5,567
7	Grade Spoil Material for Pipe	201	CY	1.20	$241
8	48" CPP, ASTM C361	-	LF	60.40	$0
9	42" CPP, ASTM C361	-	LF	56.00	$0
10	39" CPP, ASTM C361	-	LF	52.70	$0
11	36" CPP, ASTM C361	-	LF	47.20	$0
12	33" CPP, ASTM C361	-	LF	41.70	$0
13	30" CPP, ASTM C361	-	LF	36.20	$0
14	27" CPP, ASTM C361	-	LF	30.70	$0
15	24" CPP, ASTM C361		LF	25.20	$0
16	21" CPP, ASTM C361	-	LF	19.80	$0
17	18" PVC, 125 psi	-	LF	23.10	$0
18	15" PVC, 125 psi	-	LF	15.40	$0
19	12" PVC, 125 psi	-	LF	11.00	$0
20	10" PVC, 125 psi	-	LF	7.70	$0
20	8" PVC, 125 psi	-	LF	5.50	$0
21	6" PVC, 125 psi	6,400	LF	4.40	$28,160
22	Piping Appurtenances	1	LS	27,444.90	$27,445
23	Turnout & Flowmeter	3	EA	2,744.50	$8,234
24	Road Crossing	4	EA	5,489.00	$21,956
25	Lateral Inlet Structure	1	LS	3,293.40	$3,293
26	Reestablish Drainage Pattern	1	LS	21,955.90	$21,956
	SUBTOTAL CONSTRUCTION COSTS				$150,839
	CONSTRUCTION CONTINGENCY		30.0%		$45,252
	TOTAL ESTIMATED CONSTRUCTION COSTS				$196,091
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$15,099
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$49,023
	TOTAL ESTIMATED PROJECT COST				$260,213

Preliminary costs were based on information taken from KRD WCP Irrigation Water Conservation Plan of System Improvements by CH2M Hill, dated February 1999. Earthwork volumes were calculated by MWH and costs were updated to November 2002.

Anderson Ditch - A1 and A2

Prices in November 2002 dollars updated from CH2M Hill Engineer's Opinion of Probable Cost

Item	Description	Quantity	Unit	Unit Cost	Cost
1	Mobilization	1	LS	9,880.20	$9,880
2	Trench Safety System	5,700	LF	1.10	$6,270
3	Excavation	2,773	CY	2.40	$6,655
4	Imported Pipe Bedding	151	CY	24.00	$3,634
5	Select Backfill	874	CY	9.60	$8,389
6	Native Backfill	1,748	CY	3.60	$6,291
7	Grade Spoil Material for Pipe	258	CY	1.20	$310
8	48" CPP, ASTM C361	-	LF	60.40	$0
9	42" CPP, ASTM C361	-	LF	56.00	$0
10	39" CPP, ASTM C361	-	LF	52.70	$0
11	36" CPP, ASTM C361	-	LF	47.20	$0
12	33" CPP, ASTM C361	-	LF	41.70	$0
13	30" CPP, ASTM C361	-	LF	36.20	$0
14	27" CPP, ASTM C361	-	LF	30.70	$0
15	24" CPP, ASTM C361		LF	25.20	$0
16	21" CPP, ASTM C361	-	LF	19.80	$0
17	18" PVC, 125 psi	-	LF	23.10	$0
18	15" PVC, 125 psi	-	LF	15.40	$0
19	12" PVC, 125 psi	3,000	LF	11.00	$33,000
20	10" PVC, 125 psi	-	LF	7.70	$0
20	8" PVC, 125 psi	-	LF	5.50	$0
21	6" PVC, 125 psi	2,700	LF	4.40	$11,880
22	Piping Appurtenances	1	LS	16,467.00	$16,467
23	Turnout & Flowmeter	8	EA	2,744.50	$21,956
24	Road Crossing	4	EA	5,489.00	$21,956
25	Lateral Inlet Structure	1	LS	3,293.40	$3,293
26	Reestablish Drainage Pattern	1	LS	16,467.00	$16,467
	SUBTOTAL CONSTRUCTION COSTS				$166,449
	CONSTRUCTION CONTINGENCY		30.0%		$49,935
	TOTAL ESTIMATED CONSTRUCTION COSTS				$216,384
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$16,662
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$54,096
	TOTAL ESTIMATED PROJECT COST				$287,141

Preliminary costs were based on information taken from KRD WCP Irrigation Water Conservation Plan of System Improvements by CH2M Hill, dated February 1999. Earthwork volumes were calculated by MWH and costs were updated to November 2002.

Barnes Rd. Ditch - B1

Prices in November 2002 dollars updated from CH2M Hill Engineer's Opinion of Probable Cost

Item	Description	Quantity	Unit	Unit Cost	Cost
1	Mobilization	1	LS	9,880.20	$9,880
2	Trench Safety System	3,500	LF	1.10	$3,850
3	Excavation	2,017	CY	2.40	$4,842
4	Imported Pipe Bedding	101	CY	24.00	$2,416
5	Select Backfill	639	CY	9.60	$6,133
6	Native Backfill	1,278	CY	3.60	$4,600
7	Grade Spoil Material for Pipe	202	CY	1.20	$243
8	48" CPP, ASTM C361	-	LF	60.40	$0
9	42" CPP, ASTM C361	-	LF	56.00	$0
10	39" CPP, ASTM C361	-	LF	52.70	$0
11	36" CPP, ASTM C361	-	LF	47.20	$0
12	33" CPP, ASTM C361	-	LF	41.70	$0
13	30" CPP, ASTM C361	-	LF	36.20	$0
14	27" CPP, ASTM C361	-	LF	30.70	$0
15	24" CPP, ASTM C361		LF	25.20	$0
16	21" CPP, ASTM C361	-	LF	19.80	$0
17	18" PVC, 125 psi	-	LF	23.10	$0
18	15" PVC, 125 psi	-	LF	15.40	$0
19	12" PVC, 125 psi	3,500	LF	11.00	$38,500
20	10" PVC, 125 psi	-	LF	7.70	$0
20	8" PVC, 125 psi	-	LF	5.50	$0
21	6" PVC, 125 psi	-	LF	4.40	$0
22	Piping Appurtenances	1	LS	16,467.00	$16,467
23	Turnout & Flowmeter	3	EA	2,744.50	$8,234
24	Road Crossing	3	EA	5,489.00	$16,467
25	Lateral Inlet Structure	2	LS	3,293.40	$6,587
26	Reestablish Drainage Pattern	1	LS	16,467.00	$16,467
	SUBTOTAL CONSTRUCTION COSTS				$134,685
	CONSTRUCTION CONTINGENCY		30.0%		$40,406
	TOTAL ESTIMATED CONSTRUCTION COSTS				$175,091
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$13,482
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$43,773
	TOTAL ESTIMATED PROJECT COST				$232,346

Preliminary costs were based on information taken from KRD WCP Irrigation Water Conservation Plan of System Improvements by CH2M Hill, dated February 1999. Earthwork volumes were calculated by MWH and costs were updated to November 2002.

Demolish Existing Diversions and Reestablish Streambed

Prices in November 2002 dollars

Item	Description	Quantity	Unit	Unit Cost	Total Cost
1	Manastash Ditch Diversion (Concrete Dam spanning Creek)	1	LS	60,000.00	$60,000
2	Keach/Jenson Ditch Diversion (Concrete Dam spanning Creek)	1	LS	60,000.00	$60,000
3	Reed Ditch Diversion (Concrete Dam spanning Creek)	1	LS	75,000.00	$75,000
4	Anderson Ditch Diversion	1	LS	3,000.00	$3,000
5	Barnes Road Diversion	1	LS	25,000.00	$25,000
6	Hatfield Diversion	1	LS	5,000.00	$5,000
7	Evans Diversion	1	LS	5,000.00	$5,000
8	Schwab Diversion	1	LS	5,000.00	$5,000
9	Neilson Diversion	1	LS	5,000.00	$5,000
10	Nickles Diversion	1	LS	5,000.00	$5,000
11	Upper Canyon	4	LS	5,000.00	$20,000
	SUBTOTAL CONSTRUCTION COSTS				$268,000
	CONSTRUCTION CONTINGENCY		30.0%		$80,400
	TOTAL ESTIMATED CONSTRUCTION COSTS				$348,400
	PERMITTING		10.0%		$34,840
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$26,827
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$87,100
	TOTAL ESTIMATED PROJECT COST				$497,167

New Manastash Ditch Diversion Structure (sized for 57 cfs) - MD1

Prices in November 2002 dollars

Item	Description	Quantity	Unit	Unit Cost	Total Cost
1	Mobilization	1	LS	$80,000.00	$80,000
2	Surveying	1	LS	$5,000.00	$5,000
3	Diversion of Water	1	LS	$25,000.00	$25,000
4	Erosion/Sedimentation Control	1	LS	$3,000.00	$3,000
5	River Bank Stabilization	1	LS	$10,000.00	$10,000
6	Structure Excavation	150	CY	$10.00	$1,500
7	Site Grading/Foundation Preparation	1	LS	$10,000.00	$10,000
8	Native Fill	400	CY	$5.00	$2,000
9	Crushed Surfacing	40	CY	$25.00	$1,000
10	Concrete Work for Diversion Structure/Fish Screen	100	CY	$500.00	$50,000
11	Concrete Work for Fish Ladder	80	CY	$500.00	$40,000
12	Diversion Structure (Rubber Dam)	1	LS	$200,000.00	$200,000
13	Trash Rack/Grating	1	LS	$10,000.00	$10,000
14	Intake Bar Screen	200	SF	$172.73	$34,545
15	Automated Screen Cleaner	1	LS	$100,000.00	$100,000
16	Automated Head Gate	2	LS	$15,000.00	$30,000
17	Ramp Gate/Hoist	1	LS	$20,000.00	$20,000
18	Jib Crane	1	LS	$25,000.00	$25,000
19	Miscellaneous Metal	1	LS	$40,000.00	$40,000
20	Miscellaneous Grating	1	LS	$20,000.00	$20,000
21	Mechanical	1	LS	$50,000.00	$50,000
22	Electrical	1	LS	$50,000.00	$50,000
23	Site Restoration	1	LS	$5,000.00	$5,000
24	Fencing	400	LF	$15.00	$6,000
	SUBTOTAL CONSTRUCTION COSTS				$818,045
	CONSTRUCTION CONTINGENCY		30.0%		$245,414
	TOTAL ESTIMATED CONSTRUCTION COSTS				$1,063,459
	PERMITTING		10.0%		$106,346
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$81,886
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		30.0%		$319,038
	TOTAL ESTIMATED PROJECT COST				$1,570,729

New Manastash Ditch Diversion Structure (sized for 53 cfs) - MD2

Prices in November 2002 dollars

Item	Description	Quantity	Unit	Unit Cost	Total Cost
1	Mobilization	1	LS	$74,400.00	$74,400
2	Surveying	1	LS	$4,650.00	$4,650
3	Diversion of Water	1	LS	$23,250.00	$23,250
4	Erosion/Sedimentation Control	1	LS	$2,790.00	$2,790
5	River Bank Stabilization	1	LS	$9,300.00	$9,300
6	Structure Excavation	150	CY	$9.30	$1,395
7	Site Grading/Foundation Preparation	1	LS	$9,300.00	$9,300
8	Native Fill	400	CY	$4.65	$1,860
9	Crushed Surfacing	40	CY	$23.25	$930
10	Concrete Work for Diversion Structure/Fish Screen	100	CY	$465.00	$46,500
11	Concrete Work for Fish Ladder	80	CY	$465.00	$37,200
12	Diversion Structure (Rubber Dam)	1	LS	$186,000.00	$186,000
13	Trash Rack/Grating	1	LS	$9,300.00	$9,300
14	Intake Bar Screen	200	SF	$160.64	$32,128
15	Automated Screen Cleaner	1	LS	$93,000.00	$93,000
16	Automated Head Gate	2	LS	$13,950.00	$27,900
17	Ramp Gate/Hoist	1	LS	$18,600.00	$18,600
18	Jib Crane	1	LS	$23,250.00	$23,250
19	Miscellaneous Metal	1	LS	$37,200.00	$37,200
20	Miscellaneous Grating	1	LS	$18,600.00	$18,600
21	Mechanical	1	LS	$46,500.00	$46,500
22	Electrical	1	LS	$46,500.00	$46,500
23	Site Restoration	1	LS	$4,650.00	$4,650
24	Fencing	400	LF	$13.95	$5,580
	SUBTOTAL CONSTRUCTION COSTS				$760,783
	CONSTRUCTION CONTINGENCY		30.0%		$228,235
	TOTAL ESTIMATED CONSTRUCTION COSTS				$989,018
	PERMITTING		10.0%		$98,902
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$76,154
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		30.0%		$296,705
	TOTAL ESTIMATED PROJECT COST				$1,460,779

New Anderson Diversion Structure (sized for 3 cfs) - Div A

Prices in November 2002 dollars

Item	Description	Quantity	Unit	Total Cost
1	Mobilization	1	LS	$15,000
3	Surveying	1	LS	$3,000
4	Diversion of Water	1	LS	$20,000
5	Erosion/Sedimentation Control	1	LS	$5,000
6	River Bank Stabilization	1	LS	$5,000
7	Structure Excavation	100	CY	$1,000
8	Site Grading/Foundation Preparation	1	LS	$5,000
9	Native Fill	30	CY	$150
10	Crushed Surfacing	10	CY	$250
11	Concrete Work for Dam/Fish Ladder	45	CY	$22,500
12	Fish Screen (from Yakima Screen Shop Estimates)	3	$/cfs	$15,000
13	Mechanical	1	LS	$15,000
14	Electrical	1	LS	$15,000
15	Site Restoration	1	LS	$2,000
16	Fencing	200	LF	$3,000
	SUBTOTAL CONSTRUCTION COSTS			$126,900
	CONSTRUCTION CONTINGENCY		30.0%	$38,070
	TOTAL ESTIMATED CONSTRUCTION COSTS			$164,970
	PERMITTING		10.0%	$16,497
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%	$12,703
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		30.0%	$49,491
	TOTAL ESTIMATED PROJECT COST			$243,661

New Barnes Diversion Structure (sized for 3 cfs) - Div B

Prices in November 2002 dollars

Item	Description	Quantity	Unit	Total Cost
1	Mobilization	1	LS	$15,000
3	Surveying	1	LS	$3,000
4	Diversion of Water	1	LS	$20,000
5	Erosion/Sedimentation Control	1	LS	$5,000
6	River Bank Stabilization	1	LS	$5,000
7	Structure Excavation	100	CY	$1,000
8	Site Grading/Foundation Preparation	1	LS	$5,000
9	Native Fill	30	CY	$150
10	Crushed Surfacing	10	CY	$250
11	Concrete Work for Dam/Fish Ladder	45	CY	$22,500
12	Fish Screen (from Yakima Screen Shop Estimates)	3	$/cfs	$15,000
13	Mechanical	1	LS	$15,000
14	Electrical	1	LS	$15,000
15	Site Restoration	1	LS	$2,000
16	Fencing	200	LF	$3,000
	SUBTOTAL CONSTRUCTION COSTS			$126,900
	CONSTRUCTION CONTINGENCY		30.0%	$38,070
	TOTAL ESTIMATED CONSTRUCTION COSTS			$164,970
	PERMITTING		10.0%	$16,497
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%	$12,703
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		30.0%	$49,491
	TOTAL ESTIMATED PROJECT COST			$243,661

New Neilson Diversion Structure (sized for 0.16 cfs) - Div N

Prices in November 2002 dollars

Item	Description	Quantity	Unit	Unit Cost	Total Cost
1	Mobilization	1	LS	1,000.00	$1,000
2	Suction Piping	25	LF	5.00	$125
3	Pump (Assume 100 gpm, 25 ft head) including Installation	1	LS	7,500.00	$7,500
4	Piping Appurtenances	1	LS	1,000.00	$1,000
5	Discharge Piping to Equipment	100	LF	5.00	$500
6	Screen for Intake Piping	1	LS	2,500.00	$2,500
7	Pad, Housing for Pump and Electrical Service	1	LS	4,000.00	$4,000
	SUBTOTAL CONSTRUCTION COSTS				$16,625
	CONSTRUCTION CONTINGENCY		30.0%		$4,988
	TOTAL ESTIMATED CONSTRUCTION COSTS				$21,613
	PERMITTING		10.0%		$2,161
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$1,664
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		30.0%		$6,484
	TOTAL ESTIMATED PROJECT COST				$31,922

KRD Lateral SB 9.9

Prices in November 2002 dollars updated from CH2M Hill Engineer's Opinion of Probable Cost

Item	Description	Quantity	Unit	Unit Cost	Cost
1	Mobilization	1	LS	9,880.20	$9,880
2	Trench Safety System	6,724	LF	1.10	$7,396
3	Excavation	5,074	CY	2.40	$12,178
4	Imported Pipe Bedding	358	CY	24.00	$8,592
5	Select Backfill	1,280	CY	9.60	$12,288
6	Native Backfill	2,679	CY	3.60	$9,644
7	Grade Spoil Material for Pipe	2,395	CY	1.20	$2,874
8	48" CPP, ASTM C361	-	LF	60.40	$0
9	42" CPP, ASTM C361	-	LF	56.00	$0
10	39" CPP, ASTM C361	-	LF	52.70	$0
11	36" CPP, ASTM C361	-	LF	47.20	$0
12	33" CPP, ASTM C361	-	LF	41.70	$0
13	30" CPP, ASTM C361	-	LF	36.20	$0
14	27" CPP, ASTM C361	2,724	LF	30.70	$83,627
15	24" CPP, ASTM C361	-	LF	25.20	$0
16	21" CPP, ASTM C361	4,000	LF	19.80	$79,200
17	18" PVC, 125 psi	-	LF	23.10	$0
18	15" PVC, 125 psi	-	LF	15.40	$0
19	12" PVC, 125 psi	-	LF	11.00	$0
20	10" PVC, 125 psi	-	LF	7.70	$0
20	8" PVC, 125 psi	-	LF	5.50	$0
21	6" PVC, 125 psi	-	LF	4.40	$0
22	Piping Appurtenances	1	LS	16,277.00	$16,277
23	Turnout & Flowmeter	7	EA	2,744.50	$19,212
24	Road Crossing	3	EA	5,489.00	$16,467
25	Lateral Inlet Structure	1	LS	3,293.40	$3,293
26	Reestablish Drainage Pattern	1	LS	27,113.40	$27,113
	SUBTOTAL CONSTRUCTION COSTS				$308,042
	CONSTRUCTION CONTINGENCY		30.0%		$92,413
	TOTAL ESTIMATED CONSTRUCTION COSTS				$400,454
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$30,835
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$100,114
	TOTAL ESTIMATED PROJECT COST				$531,403

Preliminary Cost Information taken from KRD WCP Irrigation Water Conservation Plan of System Improvements by CH2M Hill, dated February 1999. Costs were updated to November 2002.

KRD Lateral SB 11.7

Prices in November 2002 dollars updated from CH2M Hill Engineer's Opinion of Probable Cost

Item	Description	Quantity	Unit	Unit Cost	Cost
1	Mobilization	1	LS	9,880.20	$9,880
2	Trench Safety System	14,680	LF	1.10	$16,148
3	Excavation	14,530	CY	2.40	$34,873
4	Imported Pipe Bedding	536	CY	24.00	$12,870
5	Select Backfill	4,665	CY	9.60	$44,780
6	Native Backfill	9,329	CY	3.60	$33,585
7	Grade Spoil Material for Pipe	2,047	CY	1.20	$2,457
8	48" CPP, ASTM C361	-	LF	60.40	$0
9	42" CPP, ASTM C361	-	LF	56.00	$0
10	39" CPP, ASTM C361	-	LF	52.70	$0
11	36" CPP, ASTM C361	-	LF	47.20	$0
12	33" CPP, ASTM C361	-	LF	41.70	$0
13	30" CPP, ASTM C361	2,980	LF	36.20	$107,876
14	27" CPP, ASTM C361		LF	30.70	$0
15	24" CPP, ASTM C361	4,000	LF	25.20	$100,800
16	21" CPP, ASTM C361		LF	19.80	$0
17	18" PVC, 125 psi	7,700	LF	23.10	$177,870
18	15" PVC, 125 psi	-	LF	15.40	$0
19	12" PVC, 125 psi	-	LF	11.00	$0
20	10" PVC, 125 psi	-	LF	7.70	$0
20	8" PVC, 125 psi	-	LF	5.50	$0
21	6" PVC, 125 psi	-	LF	4.40	$0
22	Piping Appurtenances	1	LS	45,956.00	$45,956
23	Turnout & Flowmeter	7	EA	2,744.50	$19,212
24	Road Crossing	4	EA	5,489.00	$21,956
25	Lateral Inlet Structure	1	LS	3,293.40	$3,293
26	Reestablish Drainage Pattern	1	LS	70,771.70	$70,772
	SUBTOTAL CONSTRUCTION COSTS				$702,327
	CONSTRUCTION CONTINGENCY		30.0%		$210,698
	TOTAL ESTIMATED CONSTRUCTION COSTS				$913,025
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$70,303
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$228,256
	TOTAL ESTIMATED PROJECT COST				$1,211,584

Preliminary costs were based on information taken from KRD WCP Irrigation Water Conservation Plan of System Improvements by CH2M Hill, dated February 1999. Earthwork volumes were calculated by MWH and costs were updated to November 2002.

KRD Lateral SB 12.8

Prices in November 2002 dollars updated from CH2M Hill Engineer's Opinion of Probable Cost

Item	Description	Quantity	Unit	Unit Cost	Cost
1	Mobilization	1	LS	9,880.20	$9,880
2	Trench Safety System	16,791	LF	1.10	$18,470
3	Excavation	12,112	CY	2.40	$29,068
4	Imported Pipe Bedding	486	CY	24.00	$11,659
5	Select Backfill	3,875	CY	9.60	$37,202
6	Native Backfill	7,750	CY	3.60	$27,901
7	Grade Spoil Material for Pipe	1,630	CY	1.20	$1,955
8	48" CPP, ASTM C361	-	LF	60.40	$0
9	42" CPP, ASTM C361	-	LF	56.00	$0
10	39" CPP, ASTM C361	-	LF	52.70	$0
11	36" CPP, ASTM C361	-	LF	47.20	$0
12	33" CPP, ASTM C361	-	LF	41.70	$0
13	30" CPP, ASTM C361	2,850	LF	36.20	$103,170
14	27" CPP, ASTM C361		LF	30.70	$0
15	24" CPP, ASTM C361	7,180	LF	25.20	$180,936
16	21" CPP, ASTM C361		LF	19.80	$0
17	18" PVC, 125 psi	4,710	LF	23.10	$108,801
18	15" PVC, 125 psi	-	LF	15.40	$0
19	12" PVC, 125 psi	-	LF	11.00	$0
20	10" PVC, 125 psi	-	LF	7.70	$0
20	8" PVC, 125 psi	-	LF	5.50	$0
21	6" PVC, 125 psi	-	LF	4.40	$0
22	Piping Appurtenances	1	LS	45,956.00	$45,956
23	Turnout & Flowmeter	4	EA	2,744.50	$10,978
24	Road Crossing	1	EA	5,489.00	$5,489
25	Lateral Inlet Structure	1	LS	3,293.40	$3,293
26	Reestablish Drainage Pattern	1	LS	70,771.70	$70,772
	SUBTOTAL CONSTRUCTION COSTS				$665,531
	CONSTRUCTION CONTINGENCY		30.0%		$199,659
	TOTAL ESTIMATED CONSTRUCTION COSTS				$865,191
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$66,620
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$216,298
	TOTAL ESTIMATED PROJECT COST				$1,148,108

Preliminary costs were based on information taken from KRD WCP Irrigation Water Conservation Plan of System Improvements by CH2M Hill, dated February 1999. Earthwork volumes were calculated by MWH and costs were updated to November 2002.

KRD Lateral SB 13.8

Prices in November 2002 dollars updated from CH2M Hill Engineer's Opinion of Probable Cost

Item	Description	Quantity	Unit	Unit Cost	Cost
1	Mobilization	1	LS	9,880.20	$9,880
2	Trench Safety System	16,840	LF	1.10	$18,524
3	Excavation	14,620	CY	2.40	$35,088
4	Imported Pipe Bedding	1,059	CY	24.00	$25,416
5	Select Backfill	3,759	CY	9.60	$36,086
6	Native Backfill	7,306	CY	3.60	$26,302
7	Grade Spoil Material for Pipe	7,314	CY	1.20	$8,777
8	48" CPP, ASTM C361	-	LF	60.40	$0
9	42" CPP, ASTM C361	-	LF	56.00	$0
10	39" CPP, ASTM C361	-	LF	52.70	$0
11	36" CPP, ASTM C361	-	LF	47.20	$0
12	33" CPP, ASTM C361	-	LF	41.70	$0
13	30" CPP, ASTM C361	8,200	LF	36.20	$296,840
14	27" CPP, ASTM C361	-	LF	30.70	$0
15	24" CPP, ASTM C361	8,640	LF	25.20	$217,728
16	21" CPP, ASTM C361	-	LF	19.80	$0
17	18" PVC, 125 psi	-	LF	23.10	$0
18	15" PVC, 125 psi	-	LF	15.40	$0
19	12" PVC, 125 psi	-	LF	11.00	$0
20	10" PVC, 125 psi	-	LF	7.70	$0
20	8" PVC, 125 psi	-	LF	5.50	$0
21	6" PVC, 125 psi	-	LF	4.40	$0
22	Piping Appurtenances	1	LS	51,521.80	$51,522
23	Turnout & Flowmeter	14	EA	2,744.50	$38,423
24	Road Crossing	4	EA	5,489.00	$21,956
25	Lateral Inlet Structure	1	LS	3,293.40	$3,293
26	Reestablish Drainage Pattern	1	LS	78,101.70	$78,102
	SUBTOTAL CONSTRUCTION COSTS				$867,937
	CONSTRUCTION CONTINGENCY		30.0%		$260,381
	TOTAL ESTIMATED CONSTRUCTION COSTS				$1,128,318
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$86,880
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$282,079
	TOTAL ESTIMATED PROJECT COST				$1,497,278

Preliminary Cost Information taken from KRD WCP Irrigation Water Conservation Plan of System Improvements by CH2M Hill, dated February 1999. Costs were updated to November 2002.

Portion of KRD Lateral SB 13.8

Prices in November 2002 dollars updated from CH2M Hill Engineer's Opinion of Probable Cost

Item	Description	Quantity	Unit	Unit Cost	Cost
1	Mobilization	1	LS	9,880.20	$9,880
2	Trench Safety System	5,613	LF	1.10	$6,175
3	Excavation	4,873	CY	2.40	$11,696
4	Imported Pipe Bedding	353	CY	24.00	$8,472
5	Select Backfill	1,253	CY	9.60	$12,029
6	Native Backfill	2,435	CY	3.60	$8,767
7	Grade Spoil Material for Pipe	2,438	CY	1.20	$2,926
8	48" CPP, ASTM C361	-	LF	60.40	$0
9	42" CPP, ASTM C361	-	LF	56.00	$0
10	39" CPP, ASTM C361	-	LF	52.70	$0
11	36" CPP, ASTM C361	-	LF	47.20	$0
12	33" CPP, ASTM C361	-	LF	41.70	$0
13	30" CPP, ASTM C361	5,000	LF	36.20	$181,000
14	27" CPP, ASTM C361	-	LF	30.70	$0
15	24" CPP, ASTM C361	-	LF	25.20	$0
16	21" CPP, ASTM C361	-	LF	19.80	$0
17	18" PVC, 125 psi	-	LF	23.10	$0
18	15" PVC, 125 psi	-	LF	15.40	$0
19	12" PVC, 125 psi	-	LF	11.00	$0
20	10" PVC, 125 psi	-	LF	7.70	$0
20	8" PVC, 125 psi	-	LF	5.50	$0
21	6" PVC, 125 psi	-	LF	4.40	$0
22	Piping Appurtenances	1	LS	17,173.90	$17,174
23	Turnout & Flowmeter	5	EA	2,744.50	$13,723
24	Road Crossing	1	EA	5,489.00	$5,489
25	Lateral Inlet Structure	1	LS	3,293.40	$3,293
26	Reestablish Drainage Pattern	1	LS	26,033.90	$26,034
	SUBTOTAL CONSTRUCTION COSTS				$306,657
	CONSTRUCTION CONTINGENCY		30.0%		$91,997
	TOTAL ESTIMATED CONSTRUCTION COSTS				$398,654
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$30,696
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$99,664
	TOTAL ESTIMATED PROJECT COST				$529,014

Preliminary Cost Information taken from KRD WCP Irrigation Water Conservation Plan of System Improvements by CH2M Hill, dated February 1999. Costs were updated to November 2002.

KRD Lateral SB 14.3

Prices in November 2002 dollars updated from CH2M Hill Engineer's Opinion of Probable Cost

Item	Description	Quantity	Unit	Unit Cost	Cost
1	Mobilization	1	LS	9,880.20	$9,880
2	Trench Safety System	16,791	LF	1.10	$18,470
3	Excavation	16,262	CY	2.40	$39,029
4	Imported Pipe Bedding	736	CY	24.00	$17,664
5	Select Backfill	2,496	CY	9.60	$23,962
6	Native Backfill	4,688	CY	3.60	$16,877
7	Grade Spoil Material for Pipe	11,574	CY	1.20	$13,889
8	48" CPP, ASTM C361	-	LF	60.40	$0
9	42" CPP, ASTM C361	-	LF	56.00	$0
10	39" CPP, ASTM C361	-	LF	52.70	$0
11	36" CPP, ASTM C361	-	LF	47.20	$0
12	33" CPP, ASTM C361	-	LF	41.70	$0
13	30" CPP, ASTM C361	3,200	LF	36.20	$115,840
14	27" CPP, ASTM C361	6,838	LF	30.70	$209,927
15	24" CPP, ASTM C361	-	LF	25.20	$0
16	21" CPP, ASTM C361	6,753	LF	19.80	$133,709
17	18" PVC, 125 psi	-	LF	23.10	$0
18	15" PVC, 125 psi	-	LF	15.40	$0
19	12" PVC, 125 psi	-	LF	11.00	$0
20	10" PVC, 125 psi	-	LF	7.70	$0
20	8" PVC, 125 psi	-	LF	5.50	$0
21	6" PVC, 125 psi	-	LF	4.40	$0
22	Piping Appurtenances	1	LS	45,956.00	$45,956
23	Turnout & Flowmeter	17	EA	2,744.50	$46,657
24	Road Crossing	4	EA	5,489.00	$21,956
25	Lateral Inlet Structure	1	LS	3,293.40	$3,293
26	Reestablish Drainage Pattern	1	LS	70,771.70	$70,772
	SUBTOTAL CONSTRUCTION COSTS				$787,880
	CONSTRUCTION CONTINGENCY		30.0%		$236,364
	TOTAL ESTIMATED CONSTRUCTION COSTS				$1,024,244
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$78,867
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$256,061
	TOTAL ESTIMATED PROJECT COST				$1,359,172

Preliminary Cost Information taken from KRD WCP Irrigation Water Conservation Plan of System Improvements by CH2M Hill, dated February 1999. Costs were updated to November 2002.

KRD Lateral SB 16.7 & 17.6

Prices in November 2002 dollars updated from CH2M Hill Engineer's Opinion of Probable Cost

Item	Description	Quantity	Unit	Unit Cost	Cost
1	Mobilization	1	LS	9,880.20	$9,880
2	Trench Safety System	25,917	LF	1.10	$28,509
3	Excavation	21,266	CY	2.40	$51,038
4	Imported Pipe Bedding	1,573	CY	24.00	$37,752
5	Select Backfill	5,464	CY	9.60	$52,454
6	Native Backfill	10,937	CY	3.60	$39,373
7	Grade Spoil Material for Pipe	10,329	CY	1.20	$12,395
8	48" CPP, ASTM C361	-	LF	60.40	$0
9	42" CPP, ASTM C361	-	LF	56.00	$0
10	39" CPP, ASTM C361	-	LF	52.70	$0
11	36" CPP, ASTM C361	-	LF	47.20	$0
12	33" CPP, ASTM C361	-	LF	41.70	$0
13	30" CPP, ASTM C361	4,500	LF	36.20	$162,900
14	27" CPP, ASTM C361	13,100	LF	30.70	$402,170
15	24" CPP, ASTM C361	-	LF	25.20	$0
16	21" CPP, ASTM C361	-	LF	19.80	$0
17	18" PVC, 125 psi	8,317	LF	23.10	$192,123
18	15" PVC, 125 psi	-	LF	15.40	$0
19	12" PVC, 125 psi	-	LF	11.00	$0
20	10" PVC, 125 psi	-	LF	7.70	$0
20	8" PVC, 125 psi	-	LF	5.50	$0
21	6" PVC, 125 psi	-	LF	4.40	$0
22	Piping Appurtenances	1	LS	75,743.60	$75,744
23	Turnout & Flowmeter	27	EA	2,744.50	$74,102
24	Road Crossing	5	EA	5,489.00	$27,445
25	Lateral Inlet Structure	1	LS	3,293.40	$3,293
26	Reestablish Drainage Pattern	1	LS	116,014.10	$116,014
	SUBTOTAL CONSTRUCTION COSTS				$1,285,192
	CONSTRUCTION CONTINGENCY		30.0%		$385,558
	TOTAL ESTIMATED CONSTRUCTION COSTS				$1,670,750
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$128,648
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$417,687
	TOTAL ESTIMATED PROJECT COST				$2,217,085

Preliminary Cost Information taken from KRD WCP Irrigation Water Conservation Plan of System Improvements by CH2M Hill, dated February 1999. Costs were updated to November 2002.

Lower Portion of KRD SB Canal

Prices in November 2002 dollars updated from CH2M Hill Engineer's Opinion of Probable Cost

Item	Description	Quantity	Unit	Unit Cost	Cost
1	Mobilization	1	LS	9,880.20	$9,880
2	Trench Safety System	12,500	LF	1.10	$13,750
3	Excavation	25,434	CY	2.40	$61,042
4	Imported Pipe Bedding	533	CY	24.00	$12,792
5	Select Backfill	8,300	CY	9.60	$79,680
6	Native Backfill	16,600	CY	3.60	$59,760
7	Grade Spoil Material for Pipe	2,806	CY	1.20	$3,367
8	48" CPP, ASTM C361	-	LF	60.40	$0
9	42" CPP, ASTM C361	-	LF	56.00	$0
10	39" CPP, ASTM C361	-	LF	52.70	$0
11	36" CPP, ASTM C361	-	LF	47.20	$0
12	33" CPP, ASTM C361	-	LF	41.70	$0
13	30" CPP, ASTM C361	12,500	LF	36.20	$452,500
14	27" CPP, ASTM C361		LF	30.70	$0
15	24" CPP, ASTM C361	-	LF	25.20	$0
16	21" CPP, ASTM C361	-	LF	19.80	$0
17	18" PVC, 125 psi		LF	23.10	$0
18	15" PVC, 125 psi	-	LF	15.40	$0
19	12" PVC, 125 psi	-	LF	11.00	$0
20	10" PVC, 125 psi	-	LF	7.70	$0
20	8" PVC, 125 psi	-	LF	5.50	$0
21	6" PVC, 125 psi	-	LF	4.40	$0
22	Piping Appurtenances	1	LS	50,000.00	$50,000
23	Turnout & Flowmeter	1	EA	2,744.50	$2,745
24	Road Crossing	-	EA	5,489.00	$0
25	Lateral Inlet Structure	-	LS	3,293.40	$0
26	Reestablish Drainage Pattern	1	LS	50,000.00	$0
	SUBTOTAL CONSTRUCTION COSTS				$745,516
	CONSTRUCTION CONTINGENCY		30.0%		$223,655
	TOTAL ESTIMATED CONSTRUCTION COSTS				$969,170
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$74,626
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$242,293
	TOTAL ESTIMATED PROJECT COST				$1,286,089

Preliminary costs were based on information taken from KRD WCP Irrigation Water Conservation Plan of System Improvements by CH2M Hill, dated February 1999. Earthwork volumes were calculated by MWH and costs were updated to November 2002.

Page Canyon Reregulating Reservoir

Prices in November 2002 dollars updated from CH2M Hill Engineer's Opinion of Probable Cost

Item	Description	Quantity	Unit	Unit Cost	Cost
1	Mobilization	1	LS	88,921.60	$88,922
2	Trench Safety System	2,500	LF	1.10	$2,750
3	Excavation for Pipe	1,560	CY	2.40	$3,744
4	Imported Pipe Bedding	99	CY	24.00	$2,376
5	Select Backfill for Pipe	377	CY	9.60	$3,619
6	Native Backfill for Pipe	882	CY	3.60	$3,175
7	Grade Spoil Material for Pipe	678	CY	1.20	$814
8	Excavation for Earthen Dam	56,538	CY	11.00	$621,918
9	12" PVC, 125 PSI (Reservoir Drain Pipe)	350	LF	11.00	$3,850
10	21" CPP, ASTM C361 (Pump Suction Pipe)	350	LF	19.80	$6,930
11	21" CPP, ASTM C361 (Canal Inlet/Outlet Pipe)	1,800	LF	19.80	$35,640
12	Piping Appurtenances	1	LS	4,632.70	$4,633
13	Canal Inlet/Outlet Structure w/ Sluice Gate	1	LS	22,653.00	$22,653
14	Dam Spillway (36" Corrugated Steel Pipe)	200	LF	38.40	$7,680
15	Trashrack/Wingwall	1	LS	6,630.70	$6,631
16	24" Sluice Gate	1	LS	3,161.70	$3,162
17	Sluice Gate Manway	1	LS	11,603.70	$11,604
18	Pump Station Pumps & Motors	1	EA	25,633.60	$25,634
19	Pump Station Electrical Gear	1	LS	39,224.30	$39,224
20	Pump Station Site Work	1	LS	12,976.00	$12,976
21	Pump Station Control Valve	1	LS	4,929.10	$4,929
22	South Branch Automation with Telemetry	1	LS	65,867.80	$65,868
	SUBTOTAL CONSTRUCTION COSTS				$978,730
	CONSTRUCTION CONTINGENCY		30.0%		$293,619
	TOTAL ESTIMATED CONSTRUCTION COSTS				$1,272,349
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$97,971
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$318,087
	TOTAL ESTIMATED PROJECT COST				$1,688,407

Preliminary Cost Information taken from KRD WCP Irrigation Water Conservation Plan of System Improvements by CH2M Hill, dated February 1999. Costs were updated to November 2002.

New KRD Lateral extensions - M1 through M5

Prices in November 2002 dollars

1 LATERAL NAME	ACRES	2 FLOW (cfs)	LENGTH (LF)	3 CALCULATED DIAMETER (in)	4 PIPE COST Nov-02	HEADWORK COST Nov-02	SUBTOTAL CONSTRUCTION COSTS Nov-02
M1	5.5	0.12	650	6.0	$11,016	$5,136	$18,207
M2	-	0.01	225	6.0	$3,814	$5,136	$11,004
M3	27.0	0.84	200	6.0	$3,390	$5,136	$10,580
M4	100.0	1.94	850	8.0	$19,208	$5,136	$26,398
M5	74.0	1.44	1,700	8.0	$38,416	$5,136	$45,606
				SUBTOTAL CONSTRUCTION COSTS			**$111,795**
				CONSTRUCTION CONTINGENCY			$33,539
				TOTAL ESTIMATED CONSTRUCTION COSTS			**$145,334**
				ESTIMATED WASHINGTON STATE SALES TAX			$11,191
				ENGINEERING, LEGAL, & ADMINISTRATIVE FEES			$36,333
				TOTAL ESTIMATED PROJECT COST			**$192,858**

1 Preliminary cost information taken from Addendum #1 KRD WCP Irrigation Water Conservation Plan of System Improvements by CH2M Hill, dated July 2001. Costs were updated to November 2002.

2 Flow required is based on a crop requirement of 0.01943 cfs per acre.

3 Pipe diameter is calculated for a maximum velocity of 5 fps.

4 Cost of pipe is based on $2.75 per diameter inch per foot.

New KRD Lateral Extensions - M1 through M14

Prices in November 2002 dollars

1 LATERAL NAME	ACRES	2 FLOW (cfs)	LENGTH (LF)	3 CALCULATED DIAMETER (in)	4 PIPE COST Nov-02	HEADWORK COST Nov-02	TURNOUT COST Nov-02	SUBTOTAL CONSTRUCTION COSTS Nov-02
M1	5.5	0.12	650	6.0	$11,016	$5,136	$2,054	$18,207
M2	-	0.01	225	6.0	$3,814	$5,136	$2,054	$11,004
M3	27.0	0.84	200	6.0	$3,390	$5,136	$2,054	$10,580
M4	100.0	1.94	850	8.0	$19,208	$5,136	$2,054	$26,398
M5	74.0	1.44	1,700	8.0	$38,416	$5,136	$2,054	$45,606
M6	2191.0	57.58	50	48.0	$6,779	$5,136	$5,136	$17,051
M7	119.6	2.35	1,275	10.0	$36,016	$5,136	$2,054	$43,206
M8	86.2	1.69	1,475	6.0	$24,999	$5,136	$2,054	$32,189
M9	36.0	0.70	225	8.0	$5,084	$5,136	$2,054	$12,275
M10	145.0	2.82	2,950	12.0	$99,995	$5,136	$2,054	$107,185
M11	609.8	11.94	7,200	21.0	$427,098	$5,136	$4,109	$436,342
M12	17.0	0.33	650	6.0	$11,016	$5,136	$2,054	$18,207
M13	-	0.00	2,550	8.0	$57,624	$5,136	$2,054	$64,814
M14	10.0	0.19	1,700	6.0	$28,812	$5,136	$2,054	$36,002
				SUBTOTAL CONSTRUCTION COSTS				**$879,067**
				CONSTRUCTION CONTINGENCY			30%	$263,720.07
				TOTAL ESTIMATED CONSTRUCTION COSTS				**$1,142,787**
				ESTIMATED WASHINGTON STATE SALES TAX			7.7%	$87,995
				ENGINEERING, LEGAL, & ADMINISTRATIVE FEES			25%	$285,696.75
				TOTAL ESTIMATED PROJECT COST				**$1,516,478**

1 Preliminary cost information taken from Addendum #1 KRD WCP Irrigation Water Conservation Plan of System Improvements by CH2M Hill, dated July 2001. Costs were updated to November 2002.

2 Flow required is based on a crop requirement of 0.01943 cfs per acre.

3 Pipe diameter is calculated for a maximum velocity of 5 fps.

4 Cost of pipe is based on $2.75 per diameter inch per foot.

6-Inch Groundwater Supply Well

Prices in November 2002 dollars

Item	Description	Quantity	Unit	Unit Cost	Cost
1	Mobilization	1	LS	1,000	$1,000
2	12" Surface Seal	1	EA	800	$800
3	6" Drilling with casing and well screen	350	LF	25	$8,750
4	8" Drive Shoe	1	EA	125	$125
8	8" Surface Grout	1	EA	500	$500
9	Pump, Submersible (10 gpm @ 350 ft) including Installation	1	LS	3,000	$3,000
11	Electrical Service	1	LS	5,000	$5,000
	SUBTOTAL CONSTRUCTION COSTS				$19,175
	CONSTRUCTION CONTINGENCY		30.0%		$5,753
	TOTAL ESTIMATED CONSTRUCTION COSTS				$24,928
	PERMITTING		10.0%		$2,493
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$1,919
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$6,232
	TOTAL ESTIMATED PROJECT COST				$35,572

8-Inch Groundwater Supply Well

Prices in November 2002 dollars

Item	Description	Quantity	Unit	Unit Cost	Cost
1	Mobilization	1	LS	2,100	$2,100
2	12" Surface Seal	1	EA	800	$800
3	8" Drilling	400	LF	32	$12,800
4	8" Drive Shoe	1	EA	125	$125
5	8" Casing	400	LF	12	$4,800
6	8" Well Screen	50	LF	130	$6,500
8	8" Surface Grout	1	EA	500	$500
9	Pump, Vertical Turbine (100 gpm @ 400 ft) including Installation	1	LS	15,000	$15,000
10	Pump Testing	1	LS	2,000	$2,000
11	Electrical Service	1	LS	4,000	$4,000
	SUBTOTAL CONSTRUCTION COSTS				$48,625
	CONSTRUCTION CONTINGENCY		30.0%		$14,588
	TOTAL ESTIMATED CONSTRUCTION COSTS				$63,213
	PERMITTING		10.0%		$6,321
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$4,867
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$15,803
	TOTAL ESTIMATED PROJECT COST				$90,204

12-Inch Groundwater Supply Well

Prices in November 2002 dollars

Item	Description	Quantity	Unit	Unit Cost	Cost
1	Mobilization	1	LS	2,100	$2,100
2	16" Surface Seal	1	EA	1,000	$1,000
3	12" Drilling	400	LF	50	$20,000
4	12" Drive Shoe	1	EA	300	$300
5	12" Casing	400	LF	20	$8,000
6	12" Well Screen	50	LF	200	$10,000
8	12" Surface Grout	1	EA	600	$600
9	Pump, Vertical Turbine (400 gpm @ 400 ft) including Installation	1	LS	25,000	$25,000
10	Pump Testing	1	LS	2,000	$2,000
11	Electrical Service	1	LS	4,000	$4,000
	SUBTOTAL CONSTRUCTION COSTS				$73,000
	CONSTRUCTION CONTINGENCY		30.0%		$21,900
	TOTAL ESTIMATED CONSTRUCTION COSTS				$94,900
	PERMITTING		10.0%		$9,490
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$7,307
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$23,725
	TOTAL ESTIMATED PROJECT COST				$135,422

Pump From West Side Canal - Pump Station P1

Prices in November 2002 dollars

Item	Description	Quantity	Unit	Unit Cost	Total Cost
1	Mobilization	1	LS	11,500.00	$11,500
2	Construction Surveying	1	LS	2,875.00	$2,875
3	Permits	1	LS	2,300.00	$2,300
4	Start Up/Testing	1	LS	12,650.00	$12,650
5	Civil Site Work	1	LS	10,350.00	$10,350
6	Concrete Slab and Pump Vaults	1	LS	9,200.00	$9,200
7	Intake Structure/Bar Screen/Trashrack	1	LS	9,671.50	$9,672
8	Install Var Speed, Vertical Turbine, 100 hp pumps	3	EA	43,700.00	$131,100
9	Suction/Discharge/Utility Piping and Appurtenances	1	LS	55,614.00	$55,614
10	Install Flow Meter (Propeller)	3	LS	2,300.00	$6,900
11	Electrical Work	1	LS	67,045.00	$67,045
12	Instrumentation/Sensors	1	LS	129,950.00	$129,950
	SUBTOTAL CONSTRUCTION COSTS				$449,156
	CONSTRUCTION CONTINGENCY		30.0%		$134,747
	TOTAL ESTIMATED CONSTRUCTION COSTS				$583,902
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$44,960
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$145,976
	TOTAL ESTIMATED PROJECT COST				$774,838

1. From the Yakima River Basin Water Rights Adjudication Second Supplemental Report of Referee.

2. Reduction in water consumed through reduced leakage.

3. Pipe size based on the estimated flow at a velocity of 5 fps.

Pump From West Side Canal - Pump Station P2

Prices in November 2002 dollars

Item	Description	Quantity	Unit	Unit Cost	Total Cost
1	Mobilization	1	LS	11,500.00	$11,500
2	Construction Surveying	1	LS	2,875.00	$2,875
3	Permits	1	LS	2,300.00	$2,300
4	Start Up/Testing	1	LS	9,200.00	$9,200
5	Civil Site Work	1	LS	8,855.00	$8,855
6	Concrete Slab and Pump Vaults	1	LS	7,012.70	$7,013
7	Intake Structure/Bar Screen/Trashrack	1	LS	9,671.50	$9,672
8	Install Var Speed, Vertical Turbine, 100 hp pumps	2	EA	43,700.00	$87,400
9	Suction/Discharge/Utility Piping and Appurtenances	1	LS	37,076.00	$37,076
10	Install Flow Meter (Propeller)	2	LS	2,300.00	$4,600
11	Electrical Work	1	LS	67,045.00	$67,045
12	Instrumentation/Sensors	1	LS	92,000.00	$92,000
	SUBTOTAL CONSTRUCTION COSTS				$339,535
	CONSTRUCTION CONTINGENCY		30.0%		$101,861
	TOTAL ESTIMATED CONSTRUCTION COSTS				$441,396
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$33,987
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$110,349
	TOTAL ESTIMATED PROJECT COST				$585,732

1. From the Yakima River Basin Water Rights Adjudication Second Supplemental Report of Referee.

2. Reduction in water consumed through reduced leakage.

3. Pipe size based on the estimated flow at a velocity of 5 fps.

Pump From West Side Canal - Pump Station P3

Prices in November 2002 dollars

Item	Description	Quantity	Unit	Unit Cost	Total Cost
1	Mobilization	1	LS	11,500.00	$11,500
2	Construction Surveying	1	LS	2,875.00	$2,875
3	Permits	1	LS	2,300.00	$2,300
4	Start Up/Testing	1	LS	8,050.00	$8,050
5	Civil Site Work	1	LS	8,050.00	$8,050
6	Concrete Slab and Pump Vaults	1	LS	6,325.00	$6,325
7	Intake Structure/Bar Screen/Trashrack	1	LS	9,671.50	$9,672
8	Install Var Speed, Vertical Turbine, 25 hp pumps	1	EA	18,515.00	$18,515
9	Suction/Discharge/Utility Piping and Appurtenances	1	LS	18,630.00	$18,630
10	Install Flow Meter (Propeller)	1	LS	2,300.00	$2,300
11	Electrical Work	1	LS	67,045.00	$67,045
12	Instrumentation/Sensors	1	LS	66,700.00	$66,700
	SUBTOTAL CONSTRUCTION COSTS				$221,962
	CONSTRUCTION CONTINGENCY		30.0%		$66,588
	TOTAL ESTIMATED CONSTRUCTION COSTS				$288,550
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$22,218
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$72,137
	TOTAL ESTIMATED PROJECT COST				$382,906

1. From the Yakima River Basin Water Rights Adjudication Second Supplemental Report of Referee.

2. Reduction in water consumed through reduced leakage.

3. Pipe size based on the estimated flow at a velocity of 5 fps.

Pump From West Side Canal - Pump Station P4

Prices in November 2002 dollars

Item	Description	Quantity	Unit	Unit Cost	Total Cost
1	Mobilization	1	LS	11,500.00	$11,500
2	Construction Surveying	1	LS	2,875.00	$2,875
3	Permits	1	LS	2,300.00	$2,300
4	Start Up/Testing	1	LS	9,200.00	$9,200
5	Civil Site Work	1	LS	8,855.00	$8,855
6	Concrete Slab and Pump Vaults	1	LS	7,012.70	$7,013
7	Intake Structure/Bar Screen/Trashrack	1	LS	9,671.50	$9,672
8	Install Var Speed, Vertical Turbine, 100 hp pumps	2	EA	43,700.00	$87,400
9	Suction/Discharge/Utility Piping and Appurtenances	1	LS	37,076.00	$37,076
10	Install Flow Meter (Propeller)	2	LS	2,300.00	$4,600
11	Electrical Work	1	LS	67,045.00	$67,045
12	Instrumentation/Sensors	1	LS	92,000.00	$92,000
	SUBTOTAL CONSTRUCTION COSTS				$339,535
	CONSTRUCTION CONTINGENCY		30.0%		$101,861
	TOTAL ESTIMATED CONSTRUCTION COSTS				$441,396
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$33,987
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$110,349
	TOTAL ESTIMATED PROJECT COST				$585,732

1. From the Yakima River Basin Water Rights Adjudication Second Supplemental Report of Referee.

2. Reduction in water consumed through reduced leakage.

3. Pipe size based on the estimated flow at a velocity of 5 fps.

Pump From Yakima River - Pump Station 6A

Prices in November 2002 dollars

Item	Description	Quantity	Unit	Unit Cost	Total Cost
1	Mobilization	1	LS	11,500.00	$11,500
2	Construction Surveying	1	LS	2,875.00	$2,875
3	Permits	1	LS	2,300.00	$2,300
4	Start Up/Testing	1	LS	9,200.00	$9,200
5	Civil Site Work	1	LS	8,855.00	$8,855
6	Concrete Slab and Pump Vaults	1	LS	115,000.00	$115,000
7	Intake Structure/Bar Screen/Trashrack	1	LS	28,750.00	$28,750
8	Install 1 Var Speed, Vertical Turbine, 500 hp pumps	3	EA	49,450.00	$148,350
9	Suction/Discharge/Utility Piping and Appurtenances	1	LS	74,750.00	$74,750
10	Install Flow Meter (Propeller)	3	LS	6,900.00	$20,700
11	Electrical Work	1	LS	159,850.00	$159,850
12	Instrumentation/Sensors	1	LS	143,750.00	$143,750
	SUBTOTAL CONSTRUCTION COSTS				$725,880
	CONSTRUCTION CONTINGENCY		35.0%		$254,058
	TOTAL ESTIMATED CONSTRUCTION COSTS				$979,938
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$75,455
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$244,985
	TOTAL ESTIMATED PROJECT COST				$1,300,378

1. From the Yakima River Basin Water Rights Adjudication Second Supplemental Report of Referee.

2. Reduction in water consumed through reduced leakage.

3. Pipe size based on the estimated flow at a velocity of 5 fps.

Pump From Packwood Canal - Pump Station 6B

Prices in November 2002 dollars

Item	Description	Quantity	Unit	Unit Cost	Total Cost
1	Mobilization	1	LS	11,500.00	$11,500
2	Construction Surveying	1	LS	2,875.00	$2,875
3	Permits	1	LS	2,300.00	$2,300
4	Start Up/Testing	1	LS	9,200.00	$9,200
5	Civil Site Work	1	LS	8,855.00	$8,855
6	Concrete Slab and Pump Vaults	1	LS	115,000.00	$115,000
7	Intake Structure/Bar Screen/Trashrack	1	LS	28,750.00	$28,750
8	Install 1 Var Speed, Vertical Turbine, 500 hp pumps	3	EA	49,450.00	$148,350
9	Suction/Discharge/Utility Piping and Appurtenances	1	LS	74,750.00	$74,750
10	Install Flow Meter (Propeller)	3	LS	6,900.00	$20,700
11	Electrical Work	1	LS	159,850.00	$159,850
12	Instrumentation/Sensors	1	LS	143,750.00	$143,750
	SUBTOTAL CONSTRUCTION COSTS				$725,880
	CONSTRUCTION CONTINGENCY		30.0%		$217,764
	TOTAL ESTIMATED CONSTRUCTION COSTS				$943,644
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$72,661
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$235,911
	TOTAL ESTIMATED PROJECT COST				$1,252,216

1. From the Yakima River Basin Water Rights Adjudication Second Supplemental Report of Referee.

2. Reduction in water consumed through reduced leakage.

3. Pipe size based on the estimated flow at a velocity of 5 fps.

Pipe from Westside Canal- P1

Prices in November 2002 dollars updated from CH2M Hill Engineer's Opinion of Probable Cost

Item	Description	Quantity	Unit	Unit Cost	Cost
1	Mobilization	1	LS	9,880.20	$9,880
2	Trench Safety System	1,700	LF	1.10	$1,870
3	Excavation	1,366	CY	2.40	$3,277
4	Imported Pipe Bedding	57	CY	24.00	$1,362
5	Select Backfill	436	CY	9.60	$4,188
6	Native Backfill	872	CY	3.60	$3,141
7	Grade Spoil Material for Pipe	168	CY	1.20	$202
8	48" CPP, ASTM C361	-	LF	60.40	$0
9	42" CPP, ASTM C361	-	LF	56.00	$0
10	39" CPP, ASTM C361	-	LF	52.70	$0
11	36" CPP, ASTM C361	-	LF	47.20	$0
12	33" CPP, ASTM C361	-	LF	41.70	$0
13	30" CPP, ASTM C361	-	LF	36.20	$0
14	27" CPP, ASTM C361	-	LF	30.70	$0
15	24" CPP, ASTM C361	-	LF	25.20	$0
16	21" CPP, ASTM C361	-	LF	19.80	$0
17	18" PVC, 125 psi	1,700	LF	23.10	$39,270
18	15" PVC, 125 psi	-	LF	15.40	$0
19	12" PVC, 125 psi	-	LF	11.00	$0
20	10" PVC, 125 psi	-	LF	7.70	$0
20	8" PVC, 125 psi	-	LF	5.50	$0
21	6" PVC, 125 psi	-	LF	4.40	$0
22	Piping Appurtenances	1	LS	12,000.00	$12,000
23	Turnout & Flowmeter	2	EA	2,744.50	$5,489
24	Road Crossing	2	EA	5,489.00	$10,978
25	Reestablish Drainage Pattern	1	LS	9,000.00	$9,000
	SUBTOTAL CONSTRUCTION COSTS				$100,657
	CONSTRUCTION CONTINGENCY		30.0%		$30,197
	TOTAL ESTIMATED CONSTRUCTION COSTS				$130,854
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$10,076
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$32,714
	TOTAL ESTIMATED PROJECT COST				$173,643

Pipe from "Westside Canal - P2

Prices in November 2002 dollars updated from CH2M Hill Engineer's Opinion of Probable Cost

Item	Description	Quantity	Unit	Unit Cost	Cost
1	Mobilization	1	LS	9,880.20	$9,880
2	Trench Safety System	400	LF	1.10	$440
3	Excavation	321	CY	2.40	$771
4	Imported Pipe Bedding	13	CY	24.00	$321
5	Select Backfill	103	CY	9.60	$985
6	Native Backfill	205	CY	3.60	$739
7	Grade Spoil Material for Pipe	40	CY	1.20	$47
8	48" CPP, ASTM C361	-	LF	60.40	$0
9	42" CPP, ASTM C361	-	LF	56.00	$0
10	39" CPP, ASTM C361	-	LF	52.70	$0
11	36" CPP, ASTM C361	-	LF	47.20	$0
12	33" CPP, ASTM C361	-	LF	41.70	$0
13	30" CPP, ASTM C361	-	LF	36.20	$0
14	27" CPP, ASTM C361	-	LF	30.70	$0
15	24" CPP, ASTM C361	-	LF	25.20	$0
16	21" CPP, ASTM C361	-	LF	19.80	$0
17	18" PVC, 125 psi	400	LF	23.10	$9,240
18	15" PVC, 125 psi	-	LF	15.40	$0
19	12" PVC, 125 psi	-	LF	11.00	$0
20	10" PVC, 125 psi	-	LF	7.70	$0
20	8" PVC, 125 psi	-	LF	5.50	$0
21	6" PVC, 125 psi	-	LF	4.40	$0
22	Piping Appurtenances	1	LS	5,000.00	$5,000
23	Turnout & Flowmeter	3	EA	2,744.50	$8,234
24	Road Crossing	1	EA	5,489.00	$5,489
25	Reestablish Drainage Pattern	1	LS	3,000.00	$3,000
	SUBTOTAL CONSTRUCTION COSTS				$44,146
	CONSTRUCTION CONTINGENCY		30.0%		$13,244
	TOTAL ESTIMATED CONSTRUCTION COSTS				$57,390
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$4,419
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$14,347
	TOTAL ESTIMATED PROJECT COST				$76,156

Pipe from Westside Canal - P3

Prices in November 2002 dollars updated from CH2M Hill Engineer's Opinion of Probable Cost

Item	Description	Quantity	Unit	Unit Cost	Cost
1	Mobilization	1	LS	9,880.20	$9,880
2	Trench Safety System	1,400	LF	1.10	$1,540
3	Excavation	541	CY	2.40	$1,299
4	Imported Pipe Bedding	34	CY	24.00	$811
5	Select Backfill	169	CY	9.60	$1,624
6	Native Backfill	338	CY	3.60	$1,218
7	Grade Spoil Material for Pipe	44	CY	1.20	$53
8	48" CPP, ASTM C361	-	LF	60.40	$0
9	42" CPP, ASTM C361	-	LF	56.00	$0
10	39" CPP, ASTM C361	-	LF	52.70	$0
11	36" CPP, ASTM C361	-	LF	47.20	$0
12	33" CPP, ASTM C361	-	LF	41.70	$0
13	30" CPP, ASTM C361	-	LF	36.20	$0
14	27" CPP, ASTM C361	-	LF	30.70	$0
15	24" CPP, ASTM C361	-	LF	25.20	$0
16	21" CPP, ASTM C361	-	LF	19.80	$0
17	18" PVC, 125 psi	-	LF	23.10	$0
18	15" PVC, 125 psi	-	LF	15.40	$0
19	12" PVC, 125 psi	-	LF	11.00	$0
20	10" PVC, 125 psi	-	LF	7.70	$0
20	8" PVC, 125 psi	-	LF	5.50	$0
21	6" PVC, 125 psi	1,400	LF	4.40	$6,160
22	Piping Appurtenances	1	LS	10,000.00	$10,000
23	Turnout & Flowmeter	2	EA	2,744.50	$5,489
24	Road Crossing	1	EA	5,489.00	$5,489
25	Reestablish Drainage Pattern	1	LS	7,000.00	$7,000
	SUBTOTAL CONSTRUCTION COSTS				$50,562
	CONSTRUCTION CONTINGENCY		30.0%		$15,169
	TOTAL ESTIMATED CONSTRUCTION COSTS				$65,731
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$5,061
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$16,433
	TOTAL ESTIMATED PROJECT COST				$87,225

Pipe from Westside Canal - P4

Prices in November 2002 dollars updated from CH2M Hill Engineer's Opinion of Probable Cost

Item	Description	Quantity	Unit	Unit Cost	Cost
1	Mobilization	1	LS	9,880.20	$9,880
2	Trench Safety System	800	LF	1.10	$880
3	Excavation	854	CY	2.40	$2,049
4	Imported Pipe Bedding	30	CY	24.00	$730
5	Select Backfill	274	CY	9.60	$2,634
6	Native Backfill	549	CY	3.60	$1,976
7	Grade Spoil Material for Pipe	123	CY	1.20	$148
8	48" CPP, ASTM C361	-	LF	60.40	$0
9	42" CPP, ASTM C361	-	LF	56.00	$0
10	39" CPP, ASTM C361	-	LF	52.70	$0
11	36" CPP, ASTM C361	-	LF	47.20	$0
12	33" CPP, ASTM C361	-	LF	41.70	$0
13	30" CPP, ASTM C361	-	LF	36.20	$0
14	27" CPP, ASTM C361	-	LF	30.70	$0
15	24" CPP, ASTM C361	800	LF	25.20	$20,160
16	21" CPP, ASTM C361	-	LF	19.80	$0
17	18" PVC, 125 psi	-	LF	23.10	$0
18	15" PVC, 125 psi	-	LF	15.40	$0
19	12" PVC, 125 psi	-	LF	11.00	$0
20	10" PVC, 125 psi	-	LF	7.70	$0
20	8" PVC, 125 psi	-	LF	5.50	$0
21	6" PVC, 125 psi	-	LF	4.40	$0
22	Piping Appurtenances	1	LS	8,000.00	$8,000
23	Turnout & Flowmeter	3	EA	2,744.50	$8,234
24	Road Crossing	2	EA	5,489.00	$10,978
25	Reestablish Drainage Pattern	1	LS	5,489.00	$5,489
	SUBTOTAL CONSTRUCTION COSTS				$71,158
	CONSTRUCTION CONTINGENCY		30.0%		$21,347
	TOTAL ESTIMATED CONSTRUCTION COSTS				$92,505
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$7,123
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$23,126
	TOTAL ESTIMATED PROJECT COST				$122,754

Pipeline from Yakima River (near Fogarty Ditch) - Pipeline 6A

Prices in November 2002 dollars updated from CH2M Hill Engineer's Opinion of Probable Cost

Item	Description	Quantity	Unit	Unit Cost	Cost
1	Mobilization	1	LS	9,880.20	$9,880
2	Trench Safety System	25,500	LF	1.10	$28,050
3	Excavation	26,145	CY	2.40	$62,747
4	Imported Pipe Bedding	931	CY	24.00	$22,355
5	Select Backfill	8,404	CY	9.60	$80,682
6	Native Backfill	16,809	CY	3.60	$60,511
7	Grade Spoil Material for Pipe	3,782	CY	1.20	$4,539
8	48" CPP, ASTM C361	-	LF	60.40	$0
9	42" CPP, ASTM C361	-	LF	56.00	$0
10	39" CPP, ASTM C361	-	LF	52.70	$0
11	36" CPP, ASTM C361	-	LF	47.20	$0
12	33" CPP, ASTM C361	-	LF	41.70	$0
13	30" CPP, ASTM C361	25,500	LF	36.20	$923,100
14	27" CPP, ASTM C361	-	LF	30.70	$0
15	24" CPP, ASTM C361	-	LF	25.20	$0
16	21" CPP, ASTM C361	-	LF	19.80	$0
17	18" PVC, 125 psi	-	LF	23.10	$0
18	15" PVC, 125 psi	-	LF	15.40	$0
19	12" PVC, 125 psi	-	LF	11.00	$0
20	10" PVC, 125 psi	-	LF	7.70	$0
20	8" PVC, 125 psi	-	LF	5.50	$0
21	6" PVC, 125 psi	-	LF	4.40	$0
22	Piping Appurtenances	1	LS	8,000.00	$8,000
23	Turnout & Flowmeter	3	EA	2,744.50	$8,234
24	Road Crossing	3	EA	5,489.00	$16,467
25	Reestablish Drainage Pattern	1	LS	5,489.00	$5,489
	SUBTOTAL CONSTRUCTION COSTS				$1,230,054
	CONSTRUCTION CONTINGENCY		30.0%		$369,016
	TOTAL ESTIMATED CONSTRUCTION COSTS				$1,599,070
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$123,128
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$399,767
	TOTAL ESTIMATED PROJECT COST				$2,121,966

Pipeline from Ellensburg Power Canal (Packwood Ditch) - P6B

Prices in November 2002 dollars updated from CH2M Hill Engineer's Opinion of Probable Cost

Item	Description	Quantity	Unit	Unit Cost	Cost
1	Mobilization	1	LS	9,880.20	$9,880
2	Trench Safety System	21,000	LF	1.10	$23,100
3	Excavation	22,410	CY	2.40	$53,783
4	Imported Pipe Bedding	798	CY	24.00	$19,161
5	Select Backfill	7,204	CY	9.60	$69,156
6	Native Backfill	14,407	CY	3.60	$51,867
7	Grade Spoil Material for Pipe	3,242	CY	1.20	$3,890
8	48" CPP, ASTM C361	-	LF	60.40	$0
9	42" CPP, ASTM C361	-	LF	56.00	$0
10	39" CPP, ASTM C361	-	LF	52.70	$0
11	36" CPP, ASTM C361	-	LF	47.20	$0
12	33" CPP, ASTM C361	-	LF	41.70	$0
13	30" CPP, ASTM C361	21,000	LF	36.20	$760,200
14	27" CPP, ASTM C361	-	LF	30.70	$0
15	24" CPP, ASTM C361	-	LF	25.20	$0
16	21" CPP, ASTM C361	-	LF	19.80	$0
17	18" PVC, 125 psi	-	LF	23.10	$0
18	15" PVC, 125 psi	-	LF	15.40	$0
19	12" PVC, 125 psi	-	LF	11.00	$0
20	10" PVC, 125 psi	-	LF	7.70	$0
20	8" PVC, 125 psi	-	LF	5.50	$0
21	6" PVC, 125 psi	-	LF	4.40	$0
22	Piping Appurtenances	1	LS	8,000.00	$8,000
23	Turnout & Flowmeter	3	EA	2,744.50	$8,234
24	Road Crossing	3	EA	5,489.00	$16,467
25	Reestablish Drainage Pattern	1	LS	5,489.00	$5,489
	SUBTOTAL CONSTRUCTION COSTS				$1,029,227
	CONSTRUCTION CONTINGENCY		30.0%		$308,768
	TOTAL ESTIMATED CONSTRUCTION COSTS				$1,337,996
	ESTIMATED WASHINGTON STATE SALES TAX		7.7%		$103,026
	ENGINEERING, LEGAL, & ADMINISTRATIVE FEES		25.0%		$334,499
	TOTAL ESTIMATED PROJECT COST				$1,775,520

Power Costs for Pumping - Alternative 2 Groundwater

PSE Irrigation and Drainage Pumping Rates - Effective April 1, 2001

Description	Calculation	Cost
Monthly Rate (per month)		
Monthly Rate (per month)	$17.79	
No. of Connections	37	
Annual Cost		**$7,898.76**
Demand Charge (per kW ea. month)		
no charge for less than 50 kW	$0.00	
over 50 kW Oct-Mar	$6.92	
over 50 kW Apr-Sep	$2.47	
12" well pump @ Q=400 gpm, H=400 ft		
kW=62.4 x H(ft) x Q(cfs) / 550 / eff. x 0.746		
kW =	43	
No. of Wells	24	
Annual Cost		**$0.00**
8" well pump @ Q=100 gpm, H=400 ft		
kW=62.4 x H(ft) x Q(cfs) / 550 / eff. x 0.746		
kW =	11	
No. of Wells	13	
Annual Cost		**$0.00**
Energy Charge (per kWh)		
base rate Apr-Sep	$0.041	
kWh = 62.4 x H(ft) x V(ac-ft) / 3600 x 43,560 / 550 / eff. x 0.746		
Total Season Volume (ac-ft)	1,810	
Total Head (ft)	400	
kWh =	1,059,221	
Annual Cost		**$43,428.07**
Total Annual Cost (rounded)		**$51,300**

Power Costs for Pumping - Alternative 3 Groundwater

PSE Irrigation and Drainage Pumping Rates - Effective April 1, 2001

Description	Calculation	Cost
Monthly Rate (per month)		
Monthly Rate (per month)	$17.79	
No. of Connections	37	
Annual Cost		**$7,898.76**
Demand Charge (per kW ea. month)		
no charge for less than 50 kW	$0.00	
over 50 kW Oct-Mar	$6.92	
over 50 kW Apr-Sep	$2.47	
12" well pump @ Q=400 gpm, H=400 ft, 12 months		
kW=62.4 x H(ft) x Q(cfs) / 550 / eff. x 0.746		
kW =	43	
No. of Wells	24	
Annual Cost		**$0.00**
8" well pump @ Q=100 gpm, H=400 ft		
kW=62.4 x H(ft) x Q(cfs) / 550 / eff. x 0.746		
kW =	11	
No. of Wells	13	
Annual Cost		**$0.00**
Energy Charge (per kWh)		
base rate Apr-Sep	$0.041	
kWh = 62.4 x H(ft) x V(ac-ft) / 3600 x 43,560 / 550 / eff. x 0.746		
Total Season Volume (ac-ft)	1,810	
Total Head (ft)	400	
kWh =	1,059,221	
Annual Cost		**$43,428.07**
Total Annual Cost (rounded)		**$51,300**

Power Costs for Pumping - Alternative 3 Westside Canal

PSE Irrigation and Drainage Pumping Rates - Effective April 1, 2001

Description	Calculation	Cost
Monthly Rate (per month)		
Monthly Rate (per month)	$17.79	
No. of Connections	4	
Annual Cost		**$853.92**
Demand Charge (per kW ea. month)		
no charge for less than 50 kW	$0.00	
over 50 kW Oct-Mar	$6.92	
over 50 kW Apr-Sep	$2.47	
pumps P1-P4 @ Q=9 cfs, H=200 ft, 4 months		
kW = 62.4 x H(ft) x Q(cfs) / 550 / eff. x 0.746		
kW =	798	
Annual Cost		**$5,908.31**
Energy Charge (per kWh)		
base rate Apr-Sep	$0.041	
kWh = 62.4 x H(ft) x V(ac-ft) / 3600 x 43,560 / 550 / eff. x 0.746		
Total Season Volume (ac-ft)	8,080	
Total Head (ft)	200	
kWh =	2,364,228	
Annual Cost		**$96,933.36**
Total Annual Cost (rounded)		**$103,700**

Power Costs for Pumping - Alternative 4 Groundwater

PSE Irrigation and Drainage Pumping Rates - Effective April 1, 2001

Description	Calculation	Cost
Monthly Rate (per month)		
Monthly Rate (per month)	$17.79	
No. of Connections	191	
Annual Cost		**$40,774.68**
Demand Charge (per kW ea. month)		
no charge for less than 50 kW	$0.00	
over 50 kW Oct-Mar	$6.92	
over 50 kW Apr-Sep	$2.47	
12" well pump @ Q=400 gpm, H=400 ft, 12 months		
kW=62.4 x H(ft) x Q(cfs) / 550 / eff. x 0.746		
kW =	43	
No. of Wells	140	
Annual Cost		**$0.00**
8" well pump @ Q=100 gpm, H=400 ft		
kW=62.4 x H(ft) x Q(cfs) / 550 / eff. x 0.746		
kW =	11	
No. of Wells	51	
Annual Cost		**$0.00**
Energy Charge (per kWh)		
base rate Apr-Sep	$0.041	
kWh = 62.4 x H(ft) x V(ac-ft) / 3600 x 43,560 / 550 / eff. x 0.746		
Total Season Volume (ac-ft)	10,030	
Total Head (ft)	400	
kWh =	5,869,606	
Annual Cost		**$240,653.86**
Total Annual Cost (rounded)		**$281,400**

Power Costs for Pumping - Alternative 6A from Yakima River*

PSE Irrigation and Drainage Pumping Rates - Effective April 1, 2001

Description	Calculation	Cost
Monthly Rate (per month)		
Monthly Rate (per month)	$17.79	
No. of Connections	1	
Annual Cost		**$213.48**
Demand Charge (per kW ea. month)		
no charge for less than 50 kW	$0.00	
over 50 kW Oct-Mar	$6.92	
over 50 kW Apr-Sep	$2.47	
pump @ Q=25 cfs, H=380 ft, 3 months		
kW = 62.4 x H(ft) x Q(cfs) / 550 / eff. x 0.746		
kW =	1,149	
Annual Cost		**$7,029.47**
Energy Charge (per kWh)		
base rate Apr-Sep	$0.041	
kWh = 62.4 x H(ft) x V(ac-ft) / 3600 x 43,560 / 550 / eff. x 0.746		
Total Season Volume (ac-ft)	4,550	
Total Head (ft)	380	
kWh =	2,529,549	
Annual Cost		**$103,711.50**
Total Annual Cost (rounded)		**$111,000**

This Alternative can have water pumped from the Yakima River or Fogarty Ditch

Power Costs for Pumping - Alternative 6B from Packwood Canal*

PSE Irrigation and Drainage Pumping Rates - Effective April 1, 2001

Description	Calculation	Cost
Monthly Rate (per month)		
Monthly Rate (per month)	$17.79	
No. of Connections	1	
Annual Cost		**$213.48**
Demand Charge (per kW ea. month)		
no charge for less than 50 kW	$0.00	
over 50 kW Oct-Mar	$6.92	
over 50 kW Apr-Sep	$2.47	
pump @ Q=25 cfs, H=280 ft, 3 months		
kW = 62.4 x H(ft) x Q(cfs) / 550 / eff. x 0.746		
kW =	846	
Annual Cost		**$4,789.61**
Energy Charge (per kWh)		
base rate Apr-Sep	$0.041	
kWh = 62.4 x H(ft) x V(ac-ft) / 3600 x 43,560 / 550 / eff. x 0.746		
Total Season Volume (ac-ft)	4,550	
Total Head (ft)	280	
kWh =	1,863,878	
Annual Cost		**$76,419.00**
Total Annual Cost (rounded)		**$81,400**

* Ellensburg Power Canal is also called Packwood Ditch