VOLUME I

Methow Valley Irrigation District

Water Supply Facility Plan

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Prepared for

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METHOW VALLEY IRRIGATION DISTRICT
WATER SUPPLY FACILITY PLAN

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EXECUTIVE SUMMARY

This *Water Supply Facility Plan* was prepared by Montgomery Water Group under the direction of the Methow Valley Irrigation District and the Washington State Department of Ecology. The goals for this Plan and for subsequent upgrades to the MVID system were to develop an improved, reliable system serving members who desire water service, promote water conservation, increase in-stream flows for fisheries, avoid increased assessments, prevent disruptions to irrigation practices, preserve the landscape and aesthetics of the valley and avert the possibility of a lawsuit brought by the Yakama Indian Nation who will try to force reduced irrigation diversions.

The process of evaluating and selecting an alternative water supply system to replace the current MVID canal system required groundwater analyses, wetlands studies, socioeconomic studies, preliminary engineering and cost estimating studies and a public involvement process. That process resulted in the selection of a preferred alternative by the MVID Board of Directors in their August 1, 1995 meeting. Subsequent to that meeting, the MVID issued a Determination of Non-Significance for adoption of this Plan and construction of the preferred alternative. Public and agency comments were received and considered in the SEPA process.

The preferred alternative consists of replacing the existing canal system with pressure pipe systems fed by groundwater wells. The groundwater wells would be located along the Twisp River in Twisp, the Methow River in Twisp and the Methow River near Alder Creek. The East Canal service area would extend from Twisp to approximately one mile downstream of Loup Spill. The West Canal service area would extend from Twisp to one-half mile downstream of Roach Spill and from Alder Creek to the End Spill. The remainder of the current MVID service area would no longer be in the District. The MVID service area would be reduced in size from 2,276 acres to approximately 930 acres.

The total peak demand and diversion from the Methow and Twisp Rivers is estimated to be 17.6 cfs for the reduced MVID service area. The current diversions total approximately 67 cfs. In-stream flows will increase in both rivers, resulting in significant increases in fisheries habitat availability. In addition to crop irrigation requirements, 1.3 cfs of the 17.6 cfs peak demand will be allocated to irrigate and preserve stands of trees along the canal right-of-way where the new pipeline will be located.

The estimated construction costs of the preferred alternative is $2.5 million. Another $1.35 million is proposed as compensation to MVID members who would leave the District. The money is to compensate for the costs of drilling a private water supply well to serve their own property. Money for construction of the preferred alternative will come from Referendum 38 funds and from other agencies. The MVID is not proposing to provide construction funding.

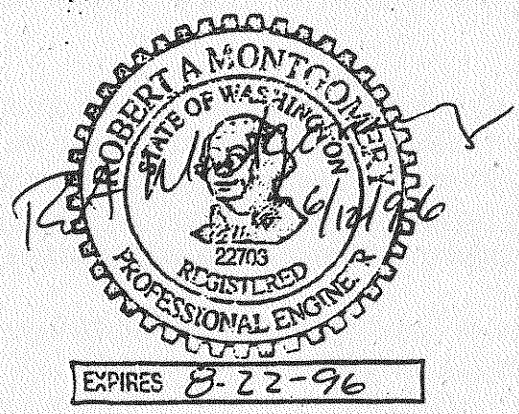
The estimated annual O & M costs of operating the new system is $74 per acre, assuming a two-acre minimum assessment of $200. The assessment will include contributions for accumulating a reserve fund, to be used to properly fund maintenance and preserve the integrity of the system.

ACKNOWLEDGEMENTS

This *Water Supply Facility Plan* was completed as a joint effort between the Methow Valley Irrigation District, Washington State Department of Ecology and Montgomery Water Group, Inc. The Directors of the MVID are Jim Adams, President, Jim Gerlach and Gary Logan. Paul Wagner was a Director when this plan was started.

The key staff at the Department of Ecology who assisted in the preparation of this plan were J. Mike Harris and Ray Newkirk, P.E.

Consultants who assisted in preparation of this plan were Hong West & Associates who prepared groundwater studies; Parametrix, Inc. who prepared environmental studies and SEPA documents; Berk & Associates who assisted in the public involvement program and prepared socio-economic analyses; and Pacific Engineering and Design, who assisted in inventories and inspections of District facilities.



This Water Supply Facility Plan was prepared under the supervision and direction of the above licensed Professional Engineer.

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1.0 INTRODUCTION

1.1 Background of Methow Valley Irrigation District

The Methow Valley Irrigation District (MVID) is located between the towns of Twisp and Carlton in the Methow River Valley in north-central Washington (see Drawings 1-5). The MVID irrigation system is comprised of two main canals located on both the east and west sides of the Methow River Valley. The West Canal diverts an average of about 26 cfs of water from the Twisp River at a rockfill diversion weir located a few miles west of Twisp. The East Canal diverts an average of about 40 cfs of water from the Methow River at a wood and rockfill weir located about five miles north of Twisp. Currently, the MVID delivers water to 239 parcels covering a total of approximately 873 acres. Another 316 parcels representing 1,403 acres, are also part of the MVID but currently do not receive water. The total service area of the MVID is 2,276 acres, consisting of 555 parcels (tax lots) owned by 344 MVID members.

The MVID system was constructed at the turn of the century and supplied orchards using flood irrigation techniques. A number of orchards were devastated during record cold temperatures in the winter of 1968 and were not replanted. The primary use of water today is for hay, alfalfa, lawn watering, and some apple orchards. Sprinkler systems are used throughout the District and water is pumped directly from the canal or from ditches and pipes supplied by turnout structures. Some sprinkler systems are supplied by gravity.

Due to high seepage losses and operational and maintenance problems in the system, the MVID canal system has a low efficiency in terms of the volume of irrigation water delivered to farm land compared to the water diverted from the Methow and Twisp Rivers. Water supply to the lower ends of the system is also unreliable, prompting the District in recent years to consider reorganizing its service area. Previous studies have recognized these problems and recommended strategies for improvement. Suggestions have included various structural improvements to reduce conveyance losses, abandonment of inefficient and unreliable lower canal segments, and complete abandonment of the surface canal system in favor of conversion to groundwater sources. All would result in efficiency improvements, meaning less water diverted from the Twisp and Methow Rivers. None of the strategies for improving the District have been implemented, because of their seemingly high costs or resistance to change by the District.

1.2 Purpose and Goals

The purpose of this Water Supply Facility Plan is to evaluate various strategies to improve the water use efficiency of the MVID. The goal of the planning process is to reach a consensus on a preferred strategy for upgrading MVID facilities which will substantially reduce the amount of surface water diverted from the Methow and Twisp Rivers. Alternative water supply systems that consider both surface and groundwater sources are considered. A comprehensive evaluation of potential impacts from system changes is also performed, with consideration for engineering, environmental, public benefit, aesthetic, economic, financial, and operation and maintenance cost factors in the selection of a preferred strategy. A comprehensive public involvement program was completed which determined the opinion of a majority of land owners in the District and facilitated a vote by the Board of Directors and the MVID membership on a preferred strategy.

The MVID directors expressed the following goals for the project:

- Design an improved, reliable, efficient, low maintenance system serving a district comprised of properties desiring the service
- Not place a financial burden on the MVID and its members
- Not disrupt irrigation practices of the community
- Promote water conservation
- Increase in-stream flows for fisheries
- Preserve landscape or aesthetic values of the valley
- Avert the possibility of a lawsuit with the Yakama Indian Nation

1.3 Scope of Work

The scope of work for this study included the following tasks:

1. **Mapping.**

   Map the legal boundaries of the MVID depicting existing surface water and groundwater supply facilities, lands receiving irrigation water, lands not receiving irrigation water, and lands for which assessments have been paid.

2. **Water Supply and Use.**

Tabulate historical streamflow records at the diversions on the Twisp and Methow Rivers, MVID irrigation diversions, and spill quantities, and tabulate groundwater withdrawals and estimate groundwater availability and potential safe yields in areas likely to be considered for water supply.

3. **Existing Water Supply Facilities and Operations.**

Describe the type and condition of existing irrigation systems, and describe how the system is operated.

4. **Water Demands/Needs - Efficiency.**

Determine monthly irrigation water requirements and other water demands for future land uses, evaluate the efficiency of the existing surface water systems and prepare water balances for each canal reach for early, peak, and late season demand periods.

5. **Alternative Water Supply System Analysis.**

Using information described above, develop and evaluate alternative water supply systems to service a reorganized MVID, based on the goal of serving the necessary District land with reasonable efficiency to reduce present surface water diversion and groundwater pumpage rates.

6. **Selection of Preferred Water Supply System Plan.**

Select a preferred plan, as facilitated by meetings with Ecology, the MVID Board of Directors, and their patrons.

7. **Operations Program.**

Identify and describe the management and operations level and criteria required to effectively manage the preferred Water Supply Facility Plan.

8. **Financial Program.**

Develop a financial program to effectively and efficiently operate the preferred plan on a long term basis.

1.4 Previous Studies

The MVID and the Methow Valley has been the subject of several studies that were used in the preparation of this Plan. They are briefly described below.

Inventory and Evaluation, Methow Valley Irrigation District (SCS, 1975).

This report was prepared by the Soil Conservation Service (SCS) in 1975. The report describes the MVID system as requiring extensive and costly rehabilitation of the canals and structures. The report recommends that, due to the cost of rehabilitating the existing system, the District should move towards abandoning the existing canals in favor of about 12 small pump stations with pressurized trunk lines to carry water to each land owner. This recommendation was not implemented.

Water Management Plan for Methow Valley Irrigation District (Klohn Leonoff, 1990).

An extensive evaluation of MVID facilities was carried out during the 1989 irrigation season and reported in that study. The study contained a complete inventory of the canals and structures, estimated conveyance and project efficiencies, and determined crop water requirements and total water demands. Canal flow measurements performed for that study indicated that conveyance efficiencies are 30 percent for the West Canal and 41 percent for the East Canal. A comparison of crop water demands to the amount of water actually supplied to farmers indicated field application efficiencies of 47 percent and 45 percent, for the West and East Canals, respectively. Besides seepage through the canals, spillage of water over canal spillways and leakage through turnouts were identified as major contributing factors to the low efficiencies. Because of the low efficiencies and the condition of the canals, it was concluded that the current system is not capable of supplying the entire MVID service area.

In the study, a reorganized service area and three system improvement levels were evaluated in terms of diversion requirements, area served, and impacts on assessments to MVID members. The report found that the current peak August demand of 60 cfs could be reduced to 31 cfs in a reorganized MVID with a reduced service area (by abandoning the lower reaches of the canals), but at a cost of increased annual assessments, from $24.60 an acre to $41-$43 an acre. The most cost effective system improvement scenario, consisting mostly

of improved management with improvements to canal turnouts, resulted in a further decrease in the required diversion, to 21 cfs, but at higher rates of $51-$53 an acre. Even higher system efficiencies could be achieved by major improvements such as canal lining and replacement of laterals with pipes, reducing the diversion to 16 cfs, but at a cost of up to $124 an acre. The recommended plan was not implemented.

Report to Economic and Engineering Services, Inc. on Water Budget for the Methow Basin (Golder, 1993).

A water budget analysis of the entire Methow River Basin was conducted in 1993 as part of the Methow Valley Pilot Planning Project. The objective of this study was to quantify streamflow patterns within each of the seven major subbasins of the Methow River. Two of the subbasins, Lower Methow and Middle Methow, are contiguous with the MVID. Estimates of the streamflow were made for high flow, median flow, and low flow conditions (i.e., 10 percent, 50 percent, and 90 percent exceedence, respectively). The water budget analysis relied primarily on historical data from U.S. Geological Survey (USGS) stream gauge records to derive these exceedence estimates.

The hydraulics and water balance data from the 1990 *Water Management Plan for the MVID* were incorporated into this study. Also, statistical analyses of Methow and Twisp River hydrology that were derived in the 1993 *Water Budget for the Methow Basin* report were used as well without revision.

2.0 EXISTING WATER SUPPLY FACILITIES AND OPERATION

2.1 MVID Service Area

The 1995 MVID assessment roll lists a total of 555 separate parcels under 344 owners. The total MVID acreage is 2,276 acres, with parcel sizes varying from a fraction of an acre up to 70 acres. To determine the extent of the current MVID service area, land parcels listed in the assessment roll were mapped onto Geographic Information System (GIS) maps provided by Okanogan County. Drawing 1 delineates the MVID service area.

The MVID currently separates parcels into three categories, Category I, II or III. Category I and II members do not receive irrigation water but pay reduced assessments to stay in the MVID. They have an option to receive water in the future. Category III members pay for a full allotment of

irrigation water. Table 2-1 lists the acreage of Category I, II and III members based on the 1995 assessment roll, along with the amount of irrigated acreage that was determined in 1989.

Table 2-1
MVID Area

Category	Acreage
Category I	695 ac
Category II	708 ac
Category III	873 ac
Total Area	2,276 ac
Irrigated Area	776 ac

Of all acreage within the MVID, only 38 percent are in Category III and pay for a full allotment of water. It is planned that all MVID members will be combined into a single category and pay one rate when the system is upgraded.

2.2 Existing Facilities

Appendix A contains a summary of an inventory of existing MVID water supply facilities, including canal reaches and laterals. Both the East and West Canals are divided into reaches, which primarily lie between spillways. Table 2-2 lists the reach numbers used in this report and their corresponding locations.

Table 2-2
Reach Numbers and Descriptions

Canal	Reach Number	Description
East Canal	1	Intake to Barkley Canal
	2	Barkley Canal to Mill Spill
	3	Mill Spill to Loup Spill
	4	Loup Spill to Beaver Spill
	5	Beaver Spill to Benson Spill
	6	Benson Spill to End Spill
West Canal	1	Intake to Alder Creek Road
	2	Alder Creek Road to Roach Spill
	3	Roach Spill to Hotchkiss Spill
	4	Hotchkiss Spill to End Spill
	5	(abandoned)

A field inventory and inspection of the MVID canals, laterals and structures was performed for this study in May, 1994, and in 1989 for the previous *1990 Water Management Plan.* A notebook with photographs and inspection reports was prepared and is available for review. In the most recent inspection, canals and associated structures (pipelines, flumes, etc.) were inventoried for their dimensions, physical condition and operational risk. The operational risk was classified as being either high, medium or low. The locations of high operational risk were mapped to determine areas where the MVID should take action to repair or replace their facilities.

2.2.1 East Canal System

The East Canal diverts water from the Methow River approximately four miles upstream from Twisp. The diversion dam is a timber and rockfill dam with wooden flashboards to control the water level at the intake structure. The river intake is a reinforced concrete structure with fish screens and measuring weirs. The *1990 Water Management Plan* reported that the total length of the East Canal is approximately 82,100 feet (15.5 miles). Of that length, 72,300 feet (13.8 miles) is unlined, 9,000 feet (1.7 miles) cement-lined and the remainder culvert or wood flume. Five laterals exist on the canal, with a total length of 16,280 feet (3.2 miles). Of the total lateral length, 11,650 feet is pipe, 2,800 feet is unlined ditch and 500 feet is lined ditch. Fifty-seven turnouts exist on the main canal and 21 on the laterals. Some of the turnouts are abandoned.

It was found in the 1994 field inspection that 3.3 miles of canal have a high operational risk. In general, the condition of the canal and related structures is fair to poor with most areas of the canal system requiring replacement to allow the MVID to operate a safe and efficient system. The areas requiring the most attention include the diversion dam, Reach 2 and other areas that are perched above adjacent properties or roads.

2.2.2 West Canal System

The West Canal diverts water from the Twisp River approximately 3.5 miles upstream from Twisp. The diversion is a boulder weir and excavated side channel. The intake is a reinforced concrete structure with fish screens and measuring weirs. The *1990 Water Management Plan* reported that the total length of the West Canal that is currently being used is approximately 66,050 feet (12.5 miles). Of that total length, 11,100 feet (2.1 miles) is lined, 3,150 feet (0.6 miles) is pipe, and 51,600 feet (9.8 miles) is unlined. Sixty-seven turnouts exist on the canal.

It was found in the 1994 field inspection that approximately 3.5 miles of canal have a high operational risk. The greatest risks are in Reach 1, upstream of Alder Creek Road. Our recommendation is to replace or abandon that section as soon as possible. Other areas on the canal have experienced rock slides and washouts, and have structural problems or low freeboard. Little maintenance to remove tree growth intruding into the canal section has been performed. It appears that most of the canal should be replaced to allow the MVID to operate a safe and efficient system.

2.2.3 Canal Turnouts

Turnouts varied from structures with concrete headwalls and operating sluice gates to pipes with wood slats and no means to adequately shut off water. In general, most of the turnouts examined would need replacing in order to adequately measure or shut off water. All turnouts should be replaced when the system is upgraded.

2.3 Irrigated Area

Drawings 2-5 delineate the most recent aerial photographic survey of irrigated acreage in the Methow Valley, taken in 1990. The data collected in the *1990 Water Management Plan* was used for this report as it was already delineated by crop type and total acreage by reach within the MVID, and the 1990 maps were not. Total irrigated acreage within the MVID is summarized by canal and reach in Table 2-3.

Table 2-3
Summary Of Irrigated Areas

Reach	Area (acres)				
	Total MVID	Irrigated in 1989			
		Pasture	Alfalfa	Orchard	Total
EAST CANAL					
1	0	0	0	0	0
2	0	0	0	0	0
3	466	85.3	50.2	26.5	162.0
4	310	116.2	23.6	5.0	144.8
5	120	20.5	0	0	20.5
6	683	104.6	10.1	3.4	118.1
Subtotal	1579	326.6	83.9	34.9	445.4
WEST CANAL					
1	0	0	0	0	0
2	102	67.1	5.5	3.3	75.9
3	436	153.1	5.0	23.3	181.4
4	159	51.4	8.0	13.9	73.3
5	0	0	0	0	0
Subtotal	697	271.6	18.5	40.5	330.6
TOTAL	**2276**	**598.2**	**102.4**	**75.4**	**776.0**

2.4 Operation and Maintenance

The canal system is operated by three employees of the MVID; the ditch supervisor and his assistants. They are responsible for gate and spill settings to ensure both an adequate supply of water to users of the system, and a safe level of operations in the canal system. The ditch supervisor and his assistants also monitor the condition of the canal system by walking the system and looking for potential problems such as leaks, washouts, slides and structural failures of the canal system. The frequency of the inspections varies from every day for critical or known problem areas to several days or weeks in other areas. The operating costs of the District were $78,370 in 1994 and $84,802 in 1993. The 1995 budget is $72,000.

System maintenance is performed by the ditch supervisor and his assistants along with temporary employees in the months preceeding the start-up of the system in the spring. The maintenance tasks performed by that crew generally consist of cleaning, brushing and patching cracks and leaks in lined areas. Maintenance requiring heavy equipment is contracted outside the District, as are emergency repairs. It appears that higher cost maintenance items, such as repair to lined sections or repairing sections that are in danger of washing out, are deferred until such time the situation becomes an emergency.

The amount of preventative maintenance and construction of upgrades to the system appears minimal, given the age and condition of the system. Breaks and washouts in the canal system have occurred in recent years without much warning to the District. It appears that since 1989, more effort has been made to cleaning some of the reaches of the canal and replacing canal sections with pipelines. However, the overall need for improvements is much greater than the financial capability of the District to perform those improvements. The canal system will likely remain in poor condition until such time that a complete upgrade of the system is performed.

3.0 HISTORICAL WATER SUPPLY AND USE

This section summarizes the Methow and Twisp Rivers' historical streamflow records, the available record of MVID irrigation diversions and spills, and available records of groundwater use in the MVID service area. These data are used to determine the rate and volume of irrigation diversions, and are used to compare MVID diversions to streamflows within the rivers at and below the point of diversion. In addition, well records are presented which show the approximate number of wells currently used in the Methow River Valley in the MVID service area.

3.1 Surface Water Source

Surface water diversions on the Methow and Twisp Rivers supply all irrigation water for the MVID canals. The Methow and Twisp Rivers have a combined drainage area of 1,300 square miles at Twisp, draining mostly National Forest and wilderness lands on the eastern slopes of the North Cascade mountains. The Methow River discharges into the Columbia River near Pateros.

The East Canal diversion from the Methow River is located at River Mile 44.8, midway between Twisp and Winthrop, and the canal spills back to the Methow River at River Mile 26.6, near

Carlton. The West Canal diversion from the Twisp River is located at River Mile 3.9, and the canal spills into the Methow River at River Mile 28.9, upstream of Carlton.

3.1.1 Historical Streamflows

Three USGS streamflow gauges are located on the lower Methow River and one gauge is located on the Twisp River. Pertinent data from these stations are provided in Table 3-1. The location of streamflow gauges within the MVID service area is shown on Drawing 1. The East Canal diversion is located on the Methow River between the Winthrop and Twisp gauges, at about River Mile 44.8. The West Canal diversion is located on the Twisp River above the Twisp gauge, at about River Mile 3.9.

Table 3-1
USGS Streamflow Gauges on Lower Methow and Twisp Rivers

Name	Station ID	River Mile	Drainage Area (sq mi)	Average Annual Flow		Period of Record
				(cfs)	(ac-ft)	
Methow River near Pateros	12449950	6.7	1,772	1,540	1,111,000	1959-present
Methow River at Twisp	12449500	40.0	1,301	1,346	973,000	1919-1929, 1934-1962, 1991-present
Methow River at Winthrop	12448500	49.8	1,007	1,178	852,000	1912-1913, 1971-1972 1990-present
Twisp River near Twisp	12448998	1.6	245	250	181,000	1975-1979, 1990-present

3.1.2 Streamflow Statistical Summary

A statistical analysis of streamflows within the Methow River Basin was performed as part of a *Report to EES on Water Budget for the Methow Basin* (Golder, 1993). The water budget used streamflow data for the period of record through water year 1992. The data was incorporated into this study without revision.

Estimates of streamflow in each of the seven Methow River subbasins were made for high-flow, median-flow, and low-flow conditions. These correspond statistically to the 10 percent, 50 percent, and 90 percent exceedence flows, respectively. The 10 percent exceedence flow is the streamflow that is equaled or exceeded only 10 percent of the time, and has been chosen by Ecology to represent high flow conditions (Ecology, 1992). Normal flow conditions are defined as the 50 percent exceedence (or median) flow, and low flow is defined as the 90 percent exceedence flow. Exceedence flows provide an estimate of the amount of time within any given month that certain flow rates will occur, and therefore are valuable for instream flow analyses.

Estimates of monthly exceedence streamflows for four locations on the Methow and Twisp Rivers are tabulated in Table 3-2. Exceedence flows at the two stream gauges closest to the MVID - Methow River at Twisp and Twisp River near Twisp - are graphically illustrated in Figures 3-1 and 3-2. These estimates are based on historical data, and therefore are affected by historical MVID irrigation diversions and other diversions upstream on the Methow and Twisp Rivers.

Mean monthly flows are also included in Table 3-2. In general, mean flows are slightly higher than the median because high flows of short duration disproportionately affect the calculated mean flow.

Table 3-2
Monthly Exceedance Streamflows - Recorded (cfs)

Exceedence Flow [1]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
Methow River near Pateros													
10% [2]	658	621	981	2,552	8,043	10,442	3,936	1,186	708	700	813	735	2,614
50% [2]	390	393	501	1,403	4,459	5,455	1,891	608	401	431	450	397	1,396
90% [2]	274	285	314	660	2,248	2,762	846	338	275	334	328	293	745
Mean [3]	431	424	602	1,491	4,844	5,936	2,121	701	444	488	528	471	1,540
Methow River at Twisp													
10%	459	471	648	2,484	7,831	9,280	3,133	817	497	708	757	639	2,307
50%	292	274	327	1,272	4,192	4,878	1,474	419	262	357	401	347	1,205
90%	208	211	231	446	2,061	2,208	633	225	171	226	257	223	590
Mean	313	318	420	1,538	4,944	4,835	1,694	486	309	427	466	397	1,346
Methow River at Winthrop													
10%	396	424	600	1,964	6,354	7,839	2,379	811	469	451	532	478	1,888
50%	235	253	313	1,073	3,355	4,100	1,318	404	260	278	296	258	1,010
90%	165	194	218	393	1,691	2,078	589	215	168	216	215	190	527
Mean	241	240	463	1,234	4,192	4,424	1,477	577	292	261	426	307	1,178
Twisp River at Twisp													
10%	151	139	195	608	1,268	1,856	1,139	273	108	104	229	250	527
50%	65	62	90	276	735	872	400	92	56	63	84	97	241
90%	32	32	44	106	290	316	80	27	24	33	44	46	89
Mean	70	68	107	283	756	862	414	109	54	62	112	105	250

1) All historical records, except Methow River at Winthrop, are affected by MVID diversions.
2) From Methow Basin water budget (Golder 1993)
3) From historical USGS streamflow records.

3.2 Irrigation Diversions and Spills

The MVID began measuring their irrigation diversions on the Methow and Twisp Rivers on a regular basis in 1989. For this study, daily flow data collected through 1993 by the MVID staff were compiled to determine average monthly diversion rates and annual diversion quantities. Estimates of spill rates were determined from more limited data collected in 1989 and 1993.

3.2.1 Diversions

Daily flows at the two canal diversion structures were calculated from the depth of flow over the weir using rating curves. The weir rating curves were developed from flow measurements taken during the 1990 MVID study (Klohn Leonoff, 1990). The equations, based on the standard weir equation $Q=C(L-0.2H)H^{3/2}$, are given in Table 3-3.

Table 3-3
Diversion Weir Rating Curves

Location	Discharge Equation
WEST CANAL (TWISP RIVER)	
- Left weir	$Q = 3.37[10.33-(0.2)(h+0.03)](h+0.03)^{3/2}$
- Right weir	$Q = 3.37[10.28-(0.2)(h+0.08)](h+0.08)^{3/2}$
EAST CANAL (METHOW RIVER)	
- Left weir	$Q = 3.37[9.36-(0.2)(h+0.03)](h+0.03)^{3/2}$
- Right weir	$Q = 3.37[9.36-(0.2)(h+0.04)](h+0.04)^{3/2}$
where: Q = Discharge in cubic feet per second h = Gauge reading in feet, adjusted in equation to obtain depth of flow over weir	

Historical diversion data are summarized in Table 3-4. Diversions begin the first week of May and last to between the end of September and mid-October. The average annual diversion quantity for both canals is 20,600 acre feet per year. Average monthly diversion rates are 41 cfs for the East Canal and 26 cfs from the West Canal, for a total of 67 cfs.

Table 3-4
Monthly Recorded MVID Diversions

	May		June		July		August		September		October		Annual	
Year	cfs	ac-ft	cfs	ac-ft	cfs	ac-ft	cfs	ac-ft	cfs	ac-ft	cfs	ac-ft	cfs	ac-ft
Methow River - MVID East Canal														
1989	41.2	2,527	49.5	2,943	52.0	3,195	38.6	2,371	46.7	2,773	65.4[a]	1,813	47.2	15,620
1990	51.6	3,165	42.5	2,522	36.0	2,210	37.9	2,327	25.0	1,485	—	—	38.7	11,709
1991	34.4	1,838	34.1	2,025	39.1	2,400	36.2	2,224	36.2	2,149	—	—	36.1	10,636
1992	42.1	2,584	40.7	2,415	34.0	2,088	34.8	2,137	47.7	2,833	47.4	844	40.2	12,901
1993	41.2	1,878	38.9	2,308	46.8	2,872	39.2	2,407	42.2	2,422	—	—	41.7	11,887
Avg	39.1	2,398	41.1	2,524	41.6	2,553	37.4	2,293	39.3	2,410	56.4	1,328	40.8	13,507
Twisp River - MVID West Canal														
1989	26.5	1,628	27.3	1,621	31.2	1,912	30.7	1,883	27.0	1,602	23.7	656	28.1	9,302
1990	28.3	1,734	23.3	1,382	26.3	1,617	26.8	1,273	28.1	1,223	—	—	26.5	7,229
1991	26.6	1,421	22.1	1,312	23.8	1,459	27.4	1,684	28.0	1,665	—	—	25.6	7,542
1992	25.8	1,585	25.6	1,319	25.0	1,532	26.4	1,620	23.3	1,387	24.2	431	25.2	7,874
1993	23.3	1,059	24.4	1,448	25.0	1,534	26.7	1,638	25.0	1,435	—	—	25.0	7,114
Avg	24.2	1,485	23.8	1,464	26.2	1,611	26.4	1,620	24.6	1,511	23.9	544	26.1	8,235
Total Diversion From Twisp And Methow Rivers														
1989	67.7	4,155	76.8	4,563	83.2	5,107	69.3	4,254	73.6	4,375	89.0	2,468	75.4	24,923
1990	79.8	4,899	65.7	3,904	62.4	3,827	64.7	3,600	53.1	2,709	—	—	65.1	18,939
1991	61.0	3,259	56.2	3,337	62.9	3,859	63.7	3,908	64.2	3,814	—	—	61.6	18,178
1992	67.9	4,169	66.3	3,734	59.0	3,620	61.2	3,757	71.0	4,220	71.6	1,275	65.4	20,775
1993	64.5	2,937	63.2	3,756	71.8	4,406	65.9	4,045	67.2	3,858	—	—	66.6	19,001
Avg	63.3	3,884	65.0	3,988	67.8	4,164	63.7	3,913	63.9	3,921	80.3	1,871	66.8	21,741

Note: Average diversion flow in cfs is calculated based on total number of days of diversion:

Year	Days of Irrigation	Period of Irrigation
1989	167	May 1 - October 14
1990	153	May 1 - September 30 (West Canal shutdown Aug 25 - Sept. 8 for canal repairs)
1991	149	May 5 - September 30
1992	162	May 1 - October 9 (West Canal shutdown June 12 - 15)
1993	144	May 9 - September 29

[a] The diversion rate that was recorded on the East Canal from September 15 to October 14, 1989, does not appear to reflect normal operations. An incorrect reading may have been recorded.

The data from 1989 - 1993 indicates that diversion rates are fairly constant from month to month, except for October, varying by only a few cubic feet per second. However, as illustrated in Figures 3-3 and 3-4, the diversion rates within any given year may vary widely from day to day and month to month. This is particularly true for the East Canal, where diversions typically fluctuate by 10-20 cfs over short periods and during 1989 and 1990 varied substantially throughout the irrigation season. The combined diversion from the Methow and Twisp Rivers may fluctuate by as much as 40 cfs over a few days, as shown in Figure 3-5. In general, the East Canal diversion varied between 32 cfs and 48 cfs, with extremes of 25 cfs and 65 cfs. Diversions to the West Canal varied between 22 cfs and 27 cfs, with extremes of 19 cfs and 37 cfs.

3.2.2 Spills

Data on canal spills are not as extensive as on river diversion records. The 1990 *Water Management Plan* contains daily operational data for a week in August, 1989. In 1991, canal staff gauges were read on a daily basis by MVID personnel. Those records were reduced to discharges using rating curves derived for the 1990 report. Spill rates were obtained by subtracting flows downstream of the spill from flows upstream of the spill. The spill data was available at four of eight spillways (East End, West End, Roach, and Hotchkiss). In addition, visual observations of spills were obtained in May, 1994. From these data, estimates of average spill rates were derived, which are summarized in Tables 3-5 and 3-6. The spill data was typically collected early in the morning.

Table 3-5
Estimated MVID Spills
East Canal

Location	Estimated Spills	
	1991	May 1994
Mill Spill	Not Measured	Not Measured
Loup Spill	Not Measured[a]	No Spill
Beaver Spill	Not Measured	0.7 cfs
Benson Spill	Not Measured	0.2 cfs
End Spill	2.4 cfs	1.0 cfs (estimated)
Totals	N/A	1.9 cfs
Percent of East Canal Flow	N/A	8% (estimated)

N/A = Not Available
[a] measurements made at Loup Spill were unusable due to inaccurate discharge rating curves.

Table 3-6
Estimated MVID Spills
West Canal

Location	Estimated Spills	
	1991	May 1994
Roach Spill	3.9 cfs	No Spill
Hotchkiss Spill	4.7 cfs	No Spill
End Spill	< 0.4 cfs	< 0.4 cfs
Totals	9.0 cfs	< 0.4 cfs
Percent of West Canal Flow	34%	2% (estimated)

Of the spills, the Roach and Hotchkiss Spills on the West Canal are by far the largest, accounting for 70-80 percent of total MVID spill in 1991. The spills also equaled 34 percent of the total diversion into the West Canal from the Twisp River. Spill rates were fairly consistent from month to month in 1991. The spills may be over-estimated, as the spill rates decline later in the day as demand for water increases. The average spill rate may be less than that measured in the morning.

The spills in 1994 were substantially reduced from those observed in 1991. One reason may be that 1991 was a cooler, wetter year and spills were high because demand was lower. In addition, the canals were not operating at full head at the time of the observed spill in May, 1994 and spills may have increased later in the irrigation season.

3.3 Groundwater Use

Although the only source of water to the MVID canals is surface water, an additional quantity of water supply is provided within the boundary of the MVID by groundwater wells that tap the Twisp River and Methow River alluvial aquifers. The quantity of water that these wells supply to lands within the MVID is unknown. The wells are not owned or operated by the MVID, but rather have been installed over the years by property owners and public water supply systems for the purposes of domestic, irrigation, and municipal water supply.

The number and capacities of these wells are not known because this information is not well documented in the Department of Ecology water well reports, which are the only official records of groundwater wells in the State of Washington. An accurate determination of existing groundwater use can only be determined through an extensive field inventory and well owner survey, which was beyond the scope of this study.

To determine the approximate number of existing domestic, irrigation and municipal wells in the MVID area, a review of available water well reports was conducted. This review provides a limited amount of information, because it is not known whether all wells are documented in the water well reports. Many wells that are documented do not report important information such as well size and capacity, and well owners are not required to report the amount of water that they pump. Also, based on the information provided in the reports, it is very difficult to determine whether the irrigation well is located within the MVID boundary.

The total number of documented domestic, irrigation and municipal wells are summarized in Table 3-7 and shown on Drawing 10. The inventory was conducted on a section-by-section (e.g., square mile) basis. Therefore, wells located outside of the MVID boundary are likely included in the tally. The reaches reported in Table 3-7 were divided based on similar geologic and hydrogeologic characteristics. The data indicates that most irrigation wells are concentrated in the Carlton and Beaver reaches, near the lower ends of the East and West Canals.

Table 3-7
Existing Wells in MVID Area

Reach[a]	Number of Wells		
	Domestic	Irrigation	Municipal
Barkley	21	1	1
Twisp	63	1	1
Beaver	41	6	0
Carlton	60	15	1
Total	184	23	3

[a] Reaches: Barkley: East Canal intake to Twisp
Twisp: Twisp to Loup Spill
Beaver: Loup Spill to Benson Spill
Carlton: Benson Spill to Carlton

3.4 Canal System Efficiency

Conveyance and field application efficiencies of the existing system were calculated in the 1990 MVID study using a water balance approach. The results of the 1990 water balance analyses are summarized in Tables 3-8 and 3-9.

Table 3-8
Water Balance Model - East Canal

Reach #	Inflow (cfs)	Conveyance Efficiency	Canal Seepage (cfs)	Irrigated Areas, Acres			Total	Irrigation Demand (cfs)	Water Supplied (cfs)	Outflow (cfs)	Application Efficiency
				Pasture	Alfalfa	Orchard					
1	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-
3	30.0	0.76	7.2	85.3	50.2	26.5	161.9	2.03	2.8	20.0	0.73
4	20.0	0.83	3.4	116.2	23.6	5.0	144.8	1.78	3.6	13.0	0.49
5	13.0	0.67	4.3	20.5	-	-	20.5	0.25	0.7	8.0	0.36
6	8.0	0.64	2.9	104.6	10.1	3.4	118.1	1.46	5.1	-	0.29
Totals			17.8	326.5	83.9	34.8	445.3	5.52	12.2		

Source (Klohn Leonoff, 1990)

Table 3-9
Water Balance Model - West Canal

Reach #	Inflow (cfs)	Conveyance Efficiency	Canal Seepage (cfs)	Irrigated Areas, Acres			Total	Irrigation Demand (cfs)	Water Supplied (cfs)	Outflow (cfs)	Application Efficiency
				Pasture	Alfalfa	Orchard					
1	30.0	0.80	6.0	-	-	-	-	-	-	24.0	-
2	24.0	0.82	4.3	67.1	5.5	3.3	75.9	0.94	2.7	17.0	0.35
3	17.0	0.50	8.5	153.1	5.0	23.3	181.4	2.31	5.0	3.5	0.46
4	3.5	0.33	2.4	51.4	8.0	13.9	73.3	0.94	1.2	-	0.81
5*	-	-	-	-	-	-	-	-	-	-	-
Totals			21.2	271.6	18.5	40.5	330.6	4.19	8.8		

Source (Klohn Leonoff, 1990)
* - Reach five is abandoned

3.5 Comparison of Irrigation Diversions to Streamflows

To compare MVID irrigation diversions to streamflows, streamflow diversion percentages were calculated by dividing the average historical irrigation diversion rates by the high, median, and low flow streamflow rates (i.e., 10 percent, 50 percent, and 90 percent exceedence flows). Table 3-10 summarizes the streamflow diversion percentages for each month of irrigation over the three separate reaches of river affected by diversions: Methow River above the Twisp River confluence, the Methow River below the Twisp River confluence, and the Twisp River. The irrigation season normally ends by October 1st, but occasionally runs several days into October. In Table 3-10, natural streamflow is defined as the streamflow that would have existed in the absence of MVID diversions. It was calculated by adding the MVID diversion rates to the recorded streamflows.

Table 3-10
Percentage of Streamflow Diverted by MVID Canals

Location	Month				
	May	June	July	Aug	Sept
METHOW RIVER ABOVE TWISP RIVER					
East Canal Diversion (cfs)[a]	39.1	41.4	41.6	37.4	39.3
Natural streamflow above diversion (cfs)[b]:					
- 10% Exceedence Flow (cfs)	6,497	7,673	2,228	715	468
- Percent Diverted	**1%**	**1%**	**2%**	**5%**	**8%**
- 50% Exceedence Flow (cfs)	3,445	4,094	1,238	403	272
- Percent Diverted	**1%**	**1%**	**3%**	**9%**	**14%**
- 90% Exceedence Flow (cfs)	1,771	2,026	613	244	196
- Percent Diverted	**2%**	**2%**	**7%**	**15%**	**20%**
METHOW RIVER BELOW TWISP RIVER					
East and West Canal Diversion (cfs)[a]	63.3	65	67.8	63.7	63.9
Natural streamflow at confluence (cfs)[b]:					
- 10% Exceedence Flow (cfs)	7,894	9,345	3,201	880	561
- Percent Diverted	**1%**	**1%**	**2%**	**7%**	**11%**
- 50% Exceedence Flow (cfs)	4,255	4,943	1,542	483	326
- Percent Diverted	**1%**	**1%**	**4%**	**13%**	**20%**
- 90% Exceedence Flow (cfs)	2,125	2,272	700	289	235
- Percent Diverted	**3%**	**3%**	**10%**	**22%**	**27%**
TWISP RIVER					
West Canal Diversion (cfs)[a]	24.2	23.8	26.2	26.4	24.6
Natural streamflow above diversion (cfs)[b]:					
- 10% Exceedence Flow (cfs)	1,292	1,879	1,166	299	133
- Percent Diverted	**2%**	**1%**	**2%**	**9%**	**18%**
- 50% Exceedence Flow (cfs)	759	896	427	118	80
- Percent Diverted	**3%**	**3%**	**6%**	**22%**	**31%**
- 90% Exceedence Flow (cfs)	314	339	106	53	49
- Percent Diverted	**8%**	**7%**	**25%**	**50%**	**50%**

a) Based on recorded 1989-1993 diversions (Table 3-4)
b) Natural streamflows are derived from Table 3-2 exceedence flows (from Golder, 1993) as adjusted to compensate for historical canal diversions.

The ratio of MVID diversions to natural streamflows is highest during the late summer, when natural streamflow rates decline. Diversion amounts are relatively small during early summer months due to high streamflow rates during the spring snowmelt period. A higher percentage of Twisp River flows is diverted than the Methow River flows. Under median flow conditions, an estimated 31 percent of the streamflow in the Twisp River is diverted in September. Under low flow conditions, an estimated 50 percent of the streamflow in the Twisp River is diverted. In the Methow River under median flow conditions, an estimated 17 percent of the streamflow above the Twisp River confluence is diverted and an estimated 24 percent is diverted below the confluence. Under low flow conditions in September, an estimated 20 percent of the streamflow in the Methow River above the Twisp River confluence is diverted and 27 percent of the streamflow in the Methow River below the Twisp River confluence is diverted.

A graphical comparison of recorded MVID diversions to recorded streamflows in the Methow and Twisp Rivers is shown in Figures 3-6 and 3-7 for 1990-1993. Figures 3-6 and 3-7 show the percentage of MVID diversions to streamflows throughout the irrigation season. The MVID diversions are relatively constant from year to year (see Figures 3-3 to 3-5), even while streamflows varied widely. The result is a varying percentage of diversions to streamflows. For example, on the Twisp River the percent of streamflow diverted ranged from 31 percent to 48 percent in the month of September. On the Methow River, the percent diverted ranged from 13 percent to 24 percent.

4.0 IRRIGATION WATER DEMAND

The total water demand of an irrigation system, as measured at the diversion on a river, is a function of the area and water needs of the crops, the efficiency of the water delivery system, and the efficiency of the field delivery systems. Values of those parameters that were used in the analysis of alternatives are discussed below.

4.1 Crop Irrigation Requirement

The crop irrigation requirement (CIR) is the volume of irrigation water needed for evapotranspiration by the crop to avoid undesirable water stress in the plants throughout the growing cycle. It defines the essential minimum water needs of the crops, and is used to satisfy crop water requirements that are not provided by water stored in the soil as a result of natural precipitation.

Average monthly CIR's in the MVID for the crops alfalfa, pasture, and apples (with and without cover) were estimated in the *1990 Water Management Plan.* The CIR's were estimated based on the methodology outlined in *Irrigation Requirements for Washington - Estimates and Methodology* (James et.al., 1982). The CIR is given by the equation:

$$CIR=CU - EP_g - EP_d$$

Where,
CIR=Crop irrigation requirement
CU=Consumptive use
EP_g=Growing season effective precipitation
EP_d=Dormant season effective precipitation

EP_d is dependent on several factors, one of which is soil texture which determines the water holding capacity of the soil. In the 1990 report, a loamy textured soil with an average water holding capacity of 0.15 inches of water per inch of soil was assumed. Meteorological data required for the calculation of CIR was obtained from the *State of Washington Irrigation Guide* (USDA, 1990).

The resulting average monthly CIR's are summarized in Table 4-1. The CIR for the MVID is assumed to be the average of CIR's for Winthrop and Methow that were calculated using the above methodology. Detailed CIR calculations are contained in the *1990 Water Management Plan.*

Table 4-1
Crop Irrigation Requirements

Crop and Location	Month (inches)						Total Annual	
	May	Jun.	Jul.	Aug.	Sep.	Oct.	Inches	Feet
Alfalfa								
- Methow	0.0	4.3	8.7	6.7	4.3	0.4	24.4	2.0
- Winthrop	0.0	0.0	7.5	6.5	4.0	0.3	18.2	1.5
- Average (MVID)	0.0	2.2	8.1	6.6	4.1	0.3	21.3	1.8
Pasture								
- Methow	1.4	6.4	9.1	7.1	4.5	0.4	28.9	2.4
- Winthrop	0.0	3.4	8.5	6.8	4.2	0.3	23.2	1.9
- Average (MVID)	0.7	4.9	8.8	7.0	4.4	0.4	26.0	2.2
Apples with cover								
- Methow	0.0	5.3	11.5	9.1	5.5	0.4	31.8	2.7
- Winthrop	0.0	1.2	10.8	8.7	5.2	0.3	26.1	2.2
- Average (MVID)	0.0	3.2	11.1	8.9	5.3	0.3	28.9	2.4

In addition to CIR's calculated in the 1990 *Water Management Plan*, standards for crops in the Methow Valley were established in the *Draft Methow Basin Plan* (Methow Valley Water Pilot Planning Project, 1994). Those standards are:

- "The standard for alfalfa irrigation in the Methow Valley should be established at 0.02 cubic feet per second (cfs) instantaneous diversion, not to exceed 2.7 acre feet per acre; plus ditch transportation loss at 15 percent per mile, not to exceed 4.0 acre feet per acre total diversion annually."

- "The standard for orchard irrigation in the Methow Valley should be established at 0.02 cfs instantaneous diversion, not to exceed 4.2 acre feet; plus ditch transportation loss at 15 percent per mile, not to exceed 5.0 acre feet per acre total diversion annually."

4.2 System Demand

In the analysis of MVID alternatives in the following sections, the total irrigation system demand is calculated by applying the crop irrigation requirements, system efficiency, and crop distribution to the irrigated acreage that is associated with each alternative. The CIR's are summarized in Table 4-1. A total system efficiency of 70 percent was used in the analysis of alternatives, which assumes no conveyance loss in the MVID distribution system and a 70 percent field application efficiency. A 70 percent field application efficiency is a reasonable efficiency for a permanent set sprinkler

system (USDA, 1990). No conveyance loss was assumed as it is this report's recommendation that the system be entirely piped or lined. The crop distribution assumes that future irrigation patterns will be similar to that which was inventoried in 1989 (summarized in Table 2-3).

The resulting total irrigation requirement is given by canal reach in Table 4-2. Water demand is listed as instantaneous peak season demand and total annual volume. The average peak demand for the entire system is 7.8 gallons per minute per acre, the average volume of water required is 36.6 inches. In the analysis of alternatives in Section 5, total system demand is calculated by multiplying the total irrigation requirement by the number of irrigated acres associated with each alternative.

The current system demand, using the estimate of 776 acres of irrigated area, is 13.5 cfs. The overall efficiency of the current conveyance system, including seepage and spills, is calculated by dividing the current demand by the total diversion rate. The overall conveyance efficiency is estimated to be 20 percent (13.5/67).

Table 4-2
Total Irrigation Requirement

Canal and Reach	Crop Distribution (percent)				Crop Irrigation Requirement[a] (inches)			Total Irrigation Requirement[b]	
	Pasture	Alfalfa	Orchard	Total	Early Season	Peak Season	Late Season	Peak Demand (gpm/acre)	Volume (inches)
East Canal									
E-3	53	31	16	100	3.8	9.0	4.5	7.8	35.7
E-4	80	16	4	100	4.4	8.8	4.4	7.7	36.1
E-5	100	0	0	100	4.9	8.8	4.4	7.7	37.1
E-6	89	9	2	100	4.6	8.8	4.4	7.7	36.7
Subtotal	73%	19%	8%	100%	4.4	8.9	4.4	7.7	36.2
West Canal									
W-2	88	7	5	100	4.6	8.9	4.4	7.8	36.9
W-3	84	3	13	100	4.6	9.1	4.5	7.9	37.4
W-4	70	11	19	100	4.3	9.2	4.5	8.0	37.1
Subtotal	82%	6%	12%	100%	4.5	9.1	4.5	7.9	37.2
Total	**73%**	**13%**	**10%**	**100%**	**4.5**	**8.9**	**4.4**	**7.8**	**36.6**

[a] Based on the following crop irrigation requirements (peak month): 8.8 inches for pasture, 8.1 inches for alfalfa, and 11.1 inches for orchard. Early season is June, peak season is July, late season is September.

[b] Assumes 70 percent field application efficiency.

5.0 ALTERNATIVES ANALYSIS AND SELECTION

5.1 MVID Objectives

The goal of this study was to evaluate various strategies to improve the reliability of the District's water supply and increase the water use efficiency of the District. In meeting the goal of improving reliability and efficiency of water use, the MVID Board of Directors established a number of objectives for the project. They were:

- Develop an improved, reliable, and low-maintenance system, serving a district comprised of members desiring this service;
- To the extent possible, avoid increased assessment charges to the MVID and its members;
- Prevent disruptions to the irrigation practices of the community;
- Promote water conservation;
- Increase in-stream flows for fisheries;
- Preserve the landscape or aesthetic values of the valley; and
- Avert the possibility of a lawsuit with the Yakama Indian Nation.

These goals and objectives formulated the basis for developing the water supply system alternatives.

5.2 Process of Evaluating and Selecting Alternatives

The process of evaluating and selecting the alternative water supply system to replace the East and West Canals required groundwater analyses, wetlands studies, socioeconomic studies, preliminary engineering and cost estimating studies and a public involvement process. During the study, several meetings were held with the MVID Board of Directors, Ecology, and the Project Team. The purpose of those meetings was to review and discuss a wide range of alternatives, select those that merited further consideration and provide direction to the Project Team as to which alternatives should be presented to MVID members in a general meeting.

A general meeting of MVID members was held on November 17, 1994 to present and discuss three alternatives that the Board of Directors believed were most viable at that time. These alternatives are identified below as Alternatives 1, 2, and 3. Following this meeting it was decided that a fourth alternative be developed to closer match the concerns that were communicated during that meeting,

and also to reflect the members opinions that were expressed in a MVID member survey (see Section 5.6). This resulted in Alternative 4, which became the Board's preferred alternative. Alternative 4 was selected by the Board of Directors in a meeting on August 1, 1995. A vote of the MVID membership was then held to ratify the selection of Alternative 4. The MVID membership ratified that alternative with an 86 percent "yes" vote. A discussion of the vote is contained in Section 8.

The four alternatives evaluated in this Plan are as follows:

- **Alternative 1**: The existing canals would be replaced with gravity pipe systems, one along the East Canal and one along the West Canal, beginning at the existing river diversions. The lower reaches of the East Canal would be abandoned and property owners in that reach would no longer be in the District.

- **Alternative 2**: The existing canals would be replaced with pressure pipe systems, one along the East Canal and one along the West Canal, starting at river pump stations in Twisp. The lower reaches of the East Canal would be abandoned and property owners in that reach would no longer be in the District.

- **Alternative 3**: The existing canals would be replaced with pressure pipe systems starting in Twisp, supplied by groundwater wells along the pipeline route. The lower reaches of the East Canal would be abandoned and property owners in that reach would no longer be in the District.

- **Alternative 4**: The existing canals would be replaced with pressure pipe systems, one along the East Canal and two along the West Canal, starting in Twisp and supplied by groundwater well fields at the head of pipelines and extending to canal ends. The lower reaches of the East Canal and a middle reach of the West Canal would be abandoned and property owners in those reaches would no longer be in the District. Also, any member wanting out of the District in areas served by the new pipe system would be allowed to leave the District.

In addition to the new water supply system constructed for areas remaining in the District, the areas leaving the District would be compensated for the cost of replacing their water supply and would receive a groundwater right for their parcel. For Alternatives 2, 3 and 4, the reach of the East Canal that serves Barkley Ditch Company users would be abandoned and converted back to Barkley Ditch Company ownership.

A detailed description of the alternatives and the work performed to analyze the alternatives is provided in the following sections.

5.3 Detailed Descriptions of Alternatives

5.3.1 Alternative 1

Table 5-1 summarizes the size of the MVID area which would be served by Alternative 1 and the peak irrigation demand for the East and West Canals. The peak irrigation demand is the sum of the crop irrigation requirements for the estimate of maximum irrigated acreage, and the flow required for maintenance of existing vegetation along the pipeline reach. The estimate of maximum irrigated acreage is less than the total acreage in the reorganized District. The estimate was made by determining the acreage of all Category II and III lands, and assuming that all that acreage could be irrigated. The percentage of irrigated acreage to total acreage used in our calculations is 83 percent. Category I lands within the reorganized District could be irrigated, but it is our opinion that a substantial amount of land in the District would lie fallow each year because of the number of small parcels which do not raise crops.

Table 5-1
Water Demand for Alternative 1

Canal	MVID Area (acres)	Maximum Irrigated Area (acres)	Crop Irrigation Requirement		Vegetation Maintenance[a] (cfs)	Total Peak Demand (cfs)
			Per Acre (gpm/acre)	Total (cfs)		
East Canal	836	685	7.7	11.8	1.0	12.8
West Canal	697	592	7.9	10.4	1.0	11.4
Total	**1,533**	**1,277**	--	**22.2**	**2.0**	**24.2**

[a] Assumes 1 cfs for each canal reach.

Drawing 18 depicts the facilities required for Alternative 1. These facilities and changes to the MVID are described in the following paragraphs.

East Canal

A high density polyethylene (HDPE) pipeline would replace the entire existing canal, starting at the existing Methow River diversion and following the current canal right-of-way to approximately one mile below Beaver Spill. The river intake would be replaced by a smaller, less intrusive structure that would require much less instream maintenance. The smaller structure would be made possible by eliminating canal seepage and therefore reducing diversion rates.

The pipe system would serve the MVID area located above Benson Creek Road. Areas on the lower East Canal below Benson Creek Road would be removed from the MVID. The total area served by the pipeline would be approximately 836 acres. The current service area along the East Canal is 1,579 acres. The peak water demand and total capacity of the pipeline would be 12.8 cfs. Of that 12.8 cfs, one cfs of water would be used to irrigate the existing cottonwood trees along the canal right-of-way, thereby preserving their aesthetic value. The pipeline would be 30 inches in diameter at the intake, increasing to 33 inches along the reach where Barkley Canal water is currently transported by the MVID canal, and then gradually decreasing to 12 inches in diameter at the end. The pipeline would be a gravity flow system. HDPE pipe was selected because of its durability, ease of installation, long service life, and competitive price.

West Canal

An HDPE pipeline would replace the entire existing canal, starting at the existing Twisp River diversion and following the current canal right-of-way to End Spill. The river intake would be replaced by a smaller, less intrusive structure that would require much less instream maintenance. The smaller structure would be made possible by eliminating canal seepage and therefore reducing diversion rates.

The pipe system would serve the entire MVID service area along the West Canal, which totals approximately 697 acres. The pipeline capacity would be 11.4 cfs. One cfs of water would be used to irrigate the existing cottonwood trees along the canal right-of-way, thereby preserving their aesthetic value. The HDPE pipeline would be 27 inches in diameter at the intake, gradually decreasing to 12 inches in diameter at the end. The West Canal pipeline would also be a gravity flow system.

Other Facilities

In addition to the pipelines described above, other facilities would have to be constructed to compensate land owners for the loss of the canals. To replace the lower East Canal, it was assumed that a pressurized groundwater system would be constructed. It would consist of several groundwater wells supplying a network of distribution pipes. These wells would be located adjacent to the Methow River to tap the surface water, thereby limiting the potential for these wells to impact existing wells in the area.

5.3.2 Alternative 2

Table 5-2 summarizes the size of the MVID area which would be served by Alternative 2 and the peak irrigation demand for the East and West Canals. The new service area and irrigation demand would be the same as described in Alternative 1.

Table 5-2
Water Demand for Alternative 2

Canal	MVID Area (acres)	Maximum Irrigated Area (acres)	Crop Irrigation Requirement		Vegetation Maintenance[a] (cfs)	Total Peak Demand (cfs)
			Per Acre (gpm/acre)	Total (cfs)		
East Canal	836	685	7.7	11.8	1.0	12.8
West Canal	697	592	7.9	10.4	1.0	11.4
Total	**1,533**	**1,277**	--	**22.2**	**2.0**	**24.2**

[a] Assumes 1 cfs for each canal reach.

Drawing 19 depicts the facilities required for Alternative 2. These facilities and changes to the MVID are described in the following paragraphs.

East Canal

An HDPE pipeline that follows the existing canal right-of-way would replace the existing canal, beginning near Mill Spill and extending to approximately one mile below Beaver Spill. A pump station located on the Methow River near Mill Spill would supply water to the pipeline. The pump station would eliminate the need (and substantial cost) for a 4-mile pipeline between the intake and Alder Creek Road. However, additional operating costs would be incurred for power purchases for the pump station. The existing facilities in Reaches 1 and 2 (including the diversion dam on the Methow River) would be abandoned.

The pipe system would serve 836 acres above Benson Creek Road, and would also irrigate the existing cottonwood stands along the canal right-of-way, as described in Alternative 1. The pipe diameter would range between 21 inches at Mill Spill to 12 inches at End Spill. Since the pipe system would be pressurized, it will have smaller diameter pipes compared to a gravity flow system.

West Canal

A pipeline that follows the existing canal right-of-way would replace the existing canal, beginning near Alder Creek Road and extending to End Spill. A pump station located on the Twisp River near Alder Creek Road would supply water to the pipeline. The pump station would eliminate the need (and substantial cost) for a 3-mile pipeline between the intake and Alder Creek Road. However, additional operating costs would be incurred for power purchases for the pump station.

The pipe system would serve the entire MVID area (697 acres) along the West Canal and also irrigate the existing cottonwood stands along the canal right-of-way, as described above. The pipe diameter would range between 18 inches at Alder Creek Road to 12 inches at End Spill. Since the pipe system would be pressurized, it will have smaller diameter pipes compared to a gravity flow system.

Other Facilities

As in Alternative 1, other facilities would have to be constructed to compensate land owners for the loss of the canals. For this alternative, it was assumed that a pressurized groundwater system would be constructed to replace the lower East Canal.

5.3.3 Alternative 3

Table 5-3 summarizes the size of the MVID area which would be served by Alternative 3 and the peak irrigation demand for the East and West Canals. The new service area and irrigation demand would be the same as described in Alternatives 1 and 2.

Table 5-3
Water Demand for Alternative 3

Canal	MVID Area (acres)	Maximum Irrigated Area (acres)	Crop Irrigation Requirement		Vegetation Maintenance[a] (cfs)	Total Peak Demand (cfs)
			Per Acre (gpm/acre)	Total (cfs)		
East Canal	836	685	7.7	11.8	1.0	12.8
West Canal	697	592	7.9	10.4	1.0	11.4
Total	**1,533**	**1,277**	--	**22.2**	**2.0**	**24.2**

[a] Assumes 1 cfs for each canal reach.

Drawing 20 depicts the facilities required for Alternative 3. These facilities and changes to the MVID are described in the following paragraphs.

East Canal

A pipeline that follows the existing canal right-of-way would replace the existing canal, beginning near Mill Spill and extending to approximately one mile below Beaver Spill. The pipeline would be supplied along the pipeline route by groundwater wells that tap the Methow River alluvial aquifer. To avoid potential adverse impacts of the additional wells on existing water levels, the new wells would be located as close to the river as possible to withdraw water in direct continuity with the river. As with the river pumping station alternative, annual power purchases for pumping would be incurred. The existing facilities in Reaches 1 and 2 (including the diversion dam) would be abandoned.

The pipe system would serve 836 acres above Benson Creek Road, and would also irrigate the existing cottonwood stands along the canal right-of-way, as described in Alternatives 1 and 2. Because water would be supplied to the pipeline at several locations, and would be pressurized by the well pumps, the diameter of the pipe can be reduced to 12 inches throughout the system.

West Canal

A pipeline that follows the existing canal right-of-way would replace the existing canal, beginning near Alder Creek Road and extending to the End Spill. The pipeline would be supplied along the pipeline route by regional groundwater wells that tap the Twisp River and Methow River alluvial

aquifers. To avoid potential adverse impacts of the additional wells on existing water levels, the new wells would be located as close to the river as possible to withdraw water in direct continuity with the river. As with the river pumping station alternative, annual power purchases for pumping would be incurred.

The pipe system would serve the entire MVID area (697 acres) along the West Canal and also irrigate the existing cottonwood stands along the canal right-of-way as described above. Because water would be supplied to the pipeline at several locations, and would be pressurized by the well pumps, the diameter of the pipe can be reduced to 12 inches throughout the system.

Other Facilities

As in Alternatives 1 and 2, other facilities would have to be constructed to compensate land owners for the loss of the canals. For this alternative, it was assumed that a pressurized groundwater system would be constructed to replace the lower East Canal.

5.3.4 Alternative 4

Alternative 4 would consist of three low pressure pipeline systems that generally follow existing canal rights-of-way. Several existing canal reaches would be abandoned and areas served by them would be removed from the District. Also, members in reaches remaining in the MVID would also be given the opportunity to leave the District.

Table 5-4 summarizes the size of the MVID area which would be served by Alternative 4 and the peak irrigation demand for the East and West Canals. The peak irrigation is the sum of the crop irrigation requirements for the new service area plus flow required for irrigation of existing trees along the canal right-of-way. For this alternative, we have assumed that all of the parcels remaining in the District could irrigate each year. The Board of Directors has expressed their desire to allow people who do not wish to remain in the District, to leave the District. It was assumed that the remaining parcels desire the service and could utilize it each year.

Table 5-4
Water Demand for Alternative 4

Canal	MVID Area[a] (acres)	Maximum Irrigated Area[a] (acres)	Total Irrigation Requirement		Vegetation Maintenance[b] (cfs)	Total Peak Demand (cfs)
			Per Acre (gpm/acre)	Total (cfs)		
East Canal	439	439	7.8	7.6	0.4	8.0
West Canal						
- Pipeline 1	155	155	7.9	2.7	0.4	3.1
- Pipeline 2	336	336	8.0	6.0	0.5	6.5
Total	**930**	**930**	--	**16.3**	**1.3**	**17.6**

[a] Estimate of MVID area in pipeline reach with members wanting out of District removed.
[b] Based on assumption of 1 cfs for entire canal reach, pro-rated to pipeline length.

Drawing 21 depicts the facilities required for Alternative 4. These facilities and changes to the MVID are described in the following paragraphs.

East Canal

A pipeline would be constructed along Reach 3 and Upper Reach 4 of the East Canal. It would begin at a groundwater well field located adjacent to the Methow River near the Highway 20 bridge in Twisp, join the canal right-of-way about 3,000 feet east of the bridge, and then extend to approximately 1 mile below Loup Spill. The pipeline would range from 12 to 15 inches in diameter, and the total pipeline length would be about 15,950 feet. Another 7,100 feet of laterals would also be required. The peak water demand and capacity of the pipeline was based on the total number of acres remaining in the MVID after the lower portion of the East Canal is abandoned and the members in the remaining reaches who are allowed to leave the District. Based on data collected during a member survey (described in Section 5.6) this area was estimated to be 439 acres. The existing facilities in Reaches 1 and 2 (including the diversion dam) would be abandoned.

West Canal

One pipeline would be constructed along Reach 2 and Upper Reach 3 of the West Canal. It would begin at a groundwater well field located on the Twisp River below Alder Creek Road and extend

to just below Roach Spill, for a total length of about 18,400 feet. The pipeline would vary in size from 8 to 12 inches in diameter. The peak water demand and capacity of the pipeline is based on the MVID area remaining along this reach after members wanting out of the District are allowed to leave, or approximately 155 acres.

A second pipeline would be constructed along lower Reach 3 and Reach 4 of the West Canal. It would begin at a groundwater well field located adjacent to the Methow River at Alder Creek and extend to the End Spill, for a total length of about 19,550 feet. The area served by this pipeline is approximately 336 acres. The pipeline would vary in size from 12 to 15 inches in diameter. The pipeline is proposed to extend to the current End Spill because parcels in that reach that are not located adjacent to the Methow River (such as those located west of the Twisp-Carlton Road) could have difficulty obtaining an adequate supply of groundwater.

The wells supplying the East and West Canals would tap the Twisp River and Methow River alluvial aquifers. To avoid potential adverse impacts of the additional wells on existing wells, the new wells would be located as close to the rivers as possible to withdraw water which is in direct continuity with the river. Additional well fields may be located at other points along the pipeline, where the canal right-of-way is near the river channel, if a single well field at the head of the pipeline cannot provide a sufficient supply of water. Water would be supplied to parcels at metered turnouts along the pipeline route.

Other Compensation

It has been proposed by the MVID that parcels excluded from a reorganized district be compensated for the costs of constructing wells, which would be the replacement source of water. The amount of compensation would be based on the parcel size, with a minimum payment of $2,000. A discussion of those costs is contained in Section 6.3.

5.4 Cost Estimates

5.4.1 Construction Costs

The estimated construction costs of Alternatives 1-4 are summarized in Table 5-5. Detailed cost spreadsheets are contained in Appendix B. The construction costs contained in Table 5-5 include direct construction costs, sales tax, engineering costs (15 percent of construction costs) and an

allowance for contingencies of 20 percent. Costs were based on data provided by the manufacturers of pumps, HDPE pipe, and other major equipment, and from experience with similar projects. These estimates should be considered preliminary due to the limited level of engineering analysis that was performed on the alternative pipeline arrangements. More detailed analysis and cost estimating would be performed during the design phase.

Table 5-5
Construction Cost Estimate Summary for Alternatives 1- 4

Item	Alternative			
	1	2	3	4
Construction Cost				
- East Canal	$3,434,800	$1,513,400	$1,780,400	$991,600
- West Canal	$2,874,800	$1,943,600	$2,059,000	$1,482,600
- Subtotal	$6,309,600	$3,457,000	$3,839,400	$2,474,200
Other Capital Costs				
- Lower East Canal	$1,516,300	$1,516,300	$1,516,300	$0
- Compensation for Members Leaving MVID	$0	$0	$0	$1,345,000
- Subtotal	$1,516,300	$1,516,300	$1,516,300	$1,345,000
Total Construction	**$7,825,900**	**$4,973,300**	**$5,355,700**	**$3,819,200**

[a] Range between amount of current and maximum irrigated acreage, due to difference in pumping energy needed.

5.4.2 Annual Operations and Maintenance Costs

Operations and Maintenance (O & M) Costs include the costs of maintenance and repair (M & R) and the costs of operating the system. Maintenance and repair costs include costs of maintaining, repairing or replacing system components while operations costs include energy costs and the costs to employ ditch walkers and other staff to ensure that a proper level of service can be provided to water users in the District. Maintenance and repair costs will generally be higher for systems with a number of mechanical components such as pumps. Mechanical equipment wears out quicker and has a shorter, useful life than a buried pipe. For this estimate, we have assumed that all pumps and mechanical equipment will be replaced every twenty years. The cost of repair or replacing that equipment was also assumed to be spread out over twenty years to provide a reserve fund for repairs or replacement when needed. An annual maintenance and repair cost of five percent of the estimated pump and mechanical equipment cost was applied.

Maintenance and repair costs for pipe systems will be much lower, and buried pipe systems have a useful life of over 50 years. For this system, maintenance and repair costs will most likely be associated with repair of turnouts and pipe joints, and repair of pipe sections damaged by rock slides, earth movements and heavy machinery. For this estimate we applied an annual maintenance and repair cost of one percent of the estimated construction cost of the pipe system. Since the system will be new, it is expected that the replacement fund would not be extensively used in the first five to ten years. This will allow the MVID to compile an operating reserve necessary to meet unforeseen conditions.

It was also assumed that the costs of operations for alternatives with primarily gravity system components will not change significantly from current levels of operations. For alternatives with primarily pumping or well components we would expect costs of operations to increase to allow for hiring maintenance people with additional skills in pump and electrical system maintenance.

Estimates of annual costs of operations were based on the number of personnel needed to operate the pipeline systems. Half-time employees were assumed because the systems would operate for only six months of the year. For Alternative 1, it was assumed that personnel and administrative costs would be approximately the same as current costs. For Alternatives 2 and 3, it was assumed that two employees with skills in electrical and mechanical maintenance would be employed along with one employee with lesser skills. Labor costs were based on $12/hour for skilled laborers and $6/hour for unskilled, and an overhead burden of 35 percent to cover payroll taxes and benefits. Salary and benefit costs were estimated to be approximately $49,000/year. For Alternative 4, it was assumed that only two employees would be required, a Manager and a maintenance person. The estimated costs of salaries and benefits is $36,000/year. District administrative costs were assumed to be $20,000/year and mileage, supplies and other miscellaneous maintenance items were assumed to be $4,000/year for Alternatives 1-3, and $3,000/year for Alternative 4. Maintenance costs should be lower for Alternative 4 because a smaller District will exist under that alternative.

Energy costs were based on total pumping heads and flow volumes for the irrigated acreage. Power rates were obtained from P.U.D. No. 1 of Okanogan County. Service Schedule No. 6 details the rate schedule for irrigation power usage. For energy, the cost is 1.462 cents per kilowatt-hour. For demand, the seasonal charge ranges between $8.15 and $12 per kilowatt, depending on the

connected load. These rates will probably be fairly constant for the next several years, as the PUD's 1995 rate increase (for energy only) was the first change since 1987. The estimated O & M costs for Alternatives 1-4 are summarized in Table 5-6.

Table 5-6
Operations and Maintenance
Cost Estimates for Alternatives 1-4

Item	Alternative			
	1	2	3	4
Operations Costs				
- Operation, Personnel, Equipment and Administrative Costs	$64,000	$74,000	$74,000	$59,000
- Maintenance and Repair Costs	$41,200	$26,600	$38,600	$26,500
- Energy Purchase[a]	$0	$11,800 - $24,300	$6,900 - $10,800	$7,700 - $12,500
Total Annual[a]	**$105,200**	**$112,400- $124,900**	**$119,500 - $123,400**	**$93,200 - $98,000**

[a] Range between amount of current and maximum irrigated acreage, due to difference in pumping energy needed.

The annual O & M costs will be paid through the MVID annual assessments. The cost range shown in Table 5-6 reflects the current and maximum amount of irrigated acreage which affects the amount of water that needs to be pumped. A discussion of the MVID budget and future assessment rates is contained in Section 7.5.

5.5 Instream Flow Benefits

5.5.1 Changes in Diversion Rates

The water supply requirements for the current canal system and the four alternatives are summarized in Table 5-7. Whereas, current irrigation diversions are relatively constant throughout the May through early October diversion season, diversions under each of the alternatives would fluctuate during the season depending on the total irrigation demand. The demands shown in Table 5-7 for Alternatives 1-4 are peak demands. Diversions during the early and late season months should be lower than those shown in Table 5-7. For early season (May), the total irrigation demand is about

50 percent of the July peak, and for late season (September) the total irrigation demand is also about 50 percent of the July peak. However, the irrigation demand will vary depending on the weather and other factors.

Table 5-7
Irrigated Areas and Diversion Rates

Alternative	Peak Water Demand (cfs)		
	East Canal	West Canal	Total
Existing	41.6	26.4	68.0
Alternative 1	12.8	11.4	24.2
Alternative 2	12.8	11.4	24.2
Alternative 3	12.8	11.4	24.2
Alternative 4	8.0	9.6	17.6

5.5.2 Changes to River Flows

Estimated changes in river flows are summarized in Table 5-8. The amount of additional flow in the rivers at the diversion that would result from the alternatives is equal to the difference between the existing and proposed diversions. Due to the complexity of surface and groundwater interactions along the Methow River, two basic assumptions were made on how Methow River flow increases were calculated. First, groundwater pumping in Alternatives 3 and 4 would tap groundwater that is in direct continuity with the surface water. Thus, the pumping would result in an immediate reduction in river flow at or near the pumping site. Second, groundwater seepage and spills from the existing canals do not significantly affect the flow in the Methow River during the time of peak irrigation usage.

For the Twisp River, a flow increase of 15.0 cfs would occur for Alternative 1 and a flow increase of 26.4 cfs would occur for Alternatives 2-4 between the existing diversion and the Town of Twisp. A river pumping station or groundwater pumping station would be located in the Town of Twisp and would divert a maximum of 11.4 cfs for Alternatives 1 and 2, a maximum of 2 cfs for Alternative 3 and a maximum of 3.1 cfs for Alternative 4. The increase in Twisp River flows below the Town of Twisp to its confluence with the Methow River would be 15.0 cfs for Alternatives 1 and 2, 24.4 cfs for Alternative 3, and 23.1 cfs for Alternative 4.

Table 5-8
Flow Increases in Rivers

Alternative	Flow Increase During Peak Irrigation Period (cfs)			
	Methow River above Twisp	Methow River below Twisp	Twisp River above Twisp	Twisp River below Twisp
Alternative 1	28.8	43.8	15	15
Alternative 2	41.6	43.8	26.4	15
Alternative 3	41.6	43.8	26.4	24.4[a]
Alternative 4	41.6	50.4	26.4	23.1[b]

[a] Groundwater wells will divert 2.0 cfs in Twisp.
[b] Groundwater wells will divert 3.1 cfs in Twisp.

5.6 Public Involvement Process

A survey of MVID members was conducted during May and June, 1995 by Berk and Associates of Seattle. The purpose of the survey was to gain a clear understanding of which members want to remain in the District, and to identify which canal reaches could remain in the District and which could be abandoned. Table 5-9 is a summary of the survey. A written summary of the methodology and results of the survey is contained in their July 20, 1995 report, contained in Appendix C.

The survey was conducted to obtain a representative sampling of opinions along each canal reach. Over 50 percent of the members (based on assessed acres) were surveyed on each canal reach. Overall, a total of 173 members representing 65 percent of the assessed acreage in the MVID responded to the survey.

Table 5-9
MVID Member Survey Results

Reach	Estimated MVID Area[a] (acres)	Percent of Acreage Responding to Survey	Survey Results (Percent of Acres in Reach)			Survey Consensus: In or Out of MVID
			Stay In	Want Out	Undecided	
EAST CANAL						
East-3	466	58%	35%	21%	2%	In
East-4	310	53%	13%	39%	1%	Out
East-5	120	74%	8%	66%	0%	Out
East-6	683	73%	4%	66%	3%	Out
WEST CANAL						
West-2	102	57%	39%	2%	16%	In
West-3 (upper)	174	57%	8%	43%	6%	Out
West-3 (Lower)	262	58%	42%	14%	2%	In
West-4	159	67%	24%	34%	9%	Divided

[a] Based on total assessed acreage of 2,276 acres.

On the East Canal, members in Reach 3 expressed an opinion to remain in the District. This reach is located between Mill Spill in Twisp and Loup Spill. Members along Reaches 4, 5, and 6, which lie between Loup Spill and the canal end, expressed an opinion to be removed from the District.

On the West Canal, members in Reach 2 and the lower end of Reach 3 expressed an opinion to remain in the District. Reach 2 lies between Alder Creek Road in Twisp and Roach Spill, and lower Reach 3 lies between Alder Creek (below Roach Spill) and Hotchkiss Spill. Members in upper Reach 3, located between Roach Spill and Alder Creek, clearly expressed an opinion to leave the District. Members in Reach 4 were divided, with slightly more expressing a desire to leave the District. Reach 4 runs from Hotchkiss Spill to the canal end.

It should be noted that the member survey was conducted to obtain a general consensus of opinion from the MVID members for the purposes of defining the alternatives. Once the alternatives were defined, the Board of Directors selected a preferred alternative and a formal vote on the preferred alternative was held (see Section 8).

5.7 Groundwater Availability Study

A concern in the reaches where a canal will be abandoned is whether land owners can obtain an adequate supply of groundwater to replace the canal water that they may currently use for irrigation. It is likely that many new irrigation wells would need to be constructed to serve parcels that would no longer be in the District. If the aquifer supply is limited, pumping from new wells might cause draw-downs in existing wells, resulting in reduced yields or dry wells.

A hydrogeologic evaluation was conducted to determine the potential availability of groundwater within the MVID area. This analysis was conducted to determine whether an adequate supply of groundwater exists to replace the irrigation water supply that currently comes from the East and West Canals. The groundwater evaluation was performed by Hong West & Associates. Their report is contained in Appendix D. The following is a summary.

The project area was divided into five reaches based upon similar geologic and hydrogeologic characteristics:

- Barkley Reach, extending from the East Canal intake to Twisp
- Twisp Reach, extending from Twisp to Roach and Loup Spills
- Beaver Reach, extending from Roach and Loup Spills to Benson Creek
- Upper Beaver Reach, including the upper plateau area east of the river at Beaver Creek
- Carlton Reach, extending from Benson Creek to Carlton

The hydrogeology for all of the reaches generally consists of a sand and gravel alluvial valley fill aquifer overlying a bedrock aquifer. Fractures and joints in the bedrock may contain appreciable amounts of water in some places, however, since this water is generally difficult to find and in most cases is very limited, bedrock aquifers are not considered in this discussion of potential groundwater development. Drawing 11 shows the estimated extent of the bedrock/valley fill interface, and locations of geologic cross-sections prepared using well log data. Drawings 12-17 illustrate geologic cross-sections in the Methow River Valley.

The potential groundwater supply was calculated as the amount of groundwater that is flowing through each of the reaches, based on cross-sectional area, groundwater gradient (assumed roughly

equal to valley gradient), and an estimated hydraulic conductivity for sand and gravel aquifers. The estimated values for groundwater flow ranged from approximately 40 to 200 cfs depending on the reach. These numbers agree fairly well with those estimated in Golder's 1993 report and in the Ecology (Walters et al., 1974) report. The potential yield is computed by multiplying specific yield (estimated to be 15% to 25%) by aquifer area, and by change in head. The change in aquifer head is based on aquifer geometry, existing well penetration, and formation characteristics, and was assumed to be between 5 and 15 feet, depending on the reach. The change in head is assumed to be even over the entire area, but in reality would be greater near the pumping wells and less further away. In Table 5-10, the current MVID irrigation demand is listed. That demand was obtained from Section 4.1, and is based on existing irrigated acreage. The maximum possible irrigation demand is also listed in Table 5-10, which assumes the entire MVID service area is under irrigation. That scenario is very unlikely, as few commercial farms currently exist in the MVID.

Table 5-10 summarizes the results of the preliminary groundwater analyses. The resulting calculations indicate that groundwater could adequately supply the current water demands for all reaches. For the scenario of all area in the MVID irrigating, there would be the potential for water supply problems in the Twisp and Carlton Reaches.

Table 5-10
Potential Groundwater Yields

Reach	Current MVID Irrigation Demand	Maximum Possible Irrigation Demand	Estimated Groundwater Through-Flow	Estimated Reasonable Potential Yield
Barkley	0[a]	13.5 cfs[a]	48 to 110 cfs	14 to 23.5 cfs
Twisp	4.2	9.9 cfs	48 cfs	5 to 8 cfs
Beaver	5.3	9.9 cfs	110 to 220 cfs	21 to 35
Upper Beaver	---[b]	---[b]	---[b]	5.5 to 9.5 cfs
Carlton	4.2	19.2 cfs	46 to 110 cfs	3.6 to 6 cfs

[a] Includes Barkley Acreage.
[b] Included with Beaver Reach.

The groundwater geologists also reviewed the use of wells developed in alluvial aquifers in close continuity with the Methow or Twisp Rivers. These wells would be drilled adjacent to the river and obtain water from the river through porous gravel formations in the river channel. The capacity of

these types of wells have the potential to be much higher than wells drilled further away from the river. The alluvial aquifer wells can be used as a water supply for the MVID or to supplement groundwater supplies in areas where the groundwater supply is not sufficient to meet demands. That may be the case in the Carlton Reach if much more irrigation takes place than what currently does.

The groundwater availability analysis was based on limited data and a broad range of assumptions. Determining total wellfield production potential for a given area requires considerably more data then is available for the MVID project area. For a complete evaluation, better subsurface characterization, aquifer testing and analysis for each of the designated MVID study reaches would be required. Due to the high cost of performing such an analysis, it was not included as part of the study.

5.8 Wetlands and Wildlife Study

The MVID canal system consists of over 136,000 lineal feet of man-made canals. Artificial wetlands have formed adjacent to many portions of these canals, mainly in response to seepage from the mostly unlined canals. This seepage has established the necessary hydrology to support the hydrophytic vegetation such as trees and brush adjacent to the canals. A concern expressed by MVID members was the potential impacts to vegetation and wildlife along the canals from the project. A wetlands and wildlife study was performed by Parametrix, Inc. for this project and is included in Appendix E.

5.8.1 Wetland Regulations

The irrigation canals were constructed and are maintained as part of ongoing agricultural activities. The wetlands along canals are considered artificial because the hydrophytic vegetation along the canals is irrigation-induced, and the areas were non-wetland in their natural state. However, federal and state regulations apply to developments in or near wetlands or "waters of the U.S.". These laws include the State Environmental Policy Act (SEPA), Section 404 of the Clean Water Act, and the Governors Executive Order 90-04. Waters in the irrigation canals are considered "waters of the U.S." by the Corps of Engineers. Therefore, Ecology has requested the MVID to evaluate riparian areas associated with the canals and wetlands potentially impacted by the alternatives.

5.8.2 Wetland Identification

The first phase of the wetland evaluation consisted of a review of existing information. These sources included the Soil Survey of Okanogan County (Lenfesty, 1980), the Soil Conservation Service listing of hydric soils (SCS 1991), and the National Wetland Inventory (NWI) maps. A series of wetland maps were prepared by incorporating the NWI map information onto the MVID project base maps. Drawings 6 through 9 present the NWI map information. A second phase consisted of a field reconnaissance during site visits.

Wetlands were identified according to the "three-parameter" approach. This methodology relies on the presence of hydrophytic vegetation, hydric soils, and inundation or saturation of surface or shallow groundwater. All three parameters are necessary if a wetland is to be considered a jurisdictional wetland. A detailed description of existing wetlands along the East and West Canals is contained in Appendix E.

5.8.3 Vegetation Types

Vegetation along the canals and spillways is dominated by riparian species of trees, shrubs, and herbaceous plants. Dominant trees include black cottonwood, red alder, and trembling aspen. Dominant shrub species include red-osier dogwood, bearberry honeysuckle, serviceberry, peachleaf willow, and pacific willow. Herbaceous species include cattail, hardstem bulrush, reed canary grass, poison oak, and stinging nettles. Upland vegetation above the canals consisted of native drought-tolerant plant communities. These species are described in Appendix E.

5.8.4 Potential Wetland Impacts

An estimate of the amount of riparian vegetation that could be potentially impacted by replacement of the open canals is summarized in Tables 5-11 and 5-12 for the East and West Canals, respectively. These estimates assume a 5-foot zone of hydrologic influence on each side of the canals. Areas of adjacent wetlands and riparian corridors along the canals were estimated from the NWI wetland maps.

Table 5-11
Potentially Affected Riparian Vegetation along East Canal

Vegetation Type	Total Potentially Affected Riparian Vegetation						
	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Total
Trees	6,000 ft (1.4 ac)	3,000 ft (0.69 ac)	2,000 ft (0.46 ac)	4,600 ft (1.0 ac)	7,200 ft (1.65 ac)	8,000 ft (1.8 ac)	30,800 ft (7.07 ac)
Shrubs	3,000 ft (0.69 ac)	10,000 ft (2.3 ac)	9,750 ft (2.2 ac)	4,000 ft (0.92 ac)	6,000 ft (1.4 ac)	3,000 ft (0.7 ac)	35,750 ft (8.2 ac)
Herbaceous	0	0	1,600 ft (0.37 ac)	1,750 ft (0.4 ac)	3,300 ft (0.75 ac)	8,800 ft (2.02 ac)	15,450 ft (3.55 ac)
Total	9,000 ft (2.1 ac)	13,000 ft (3.0 ac)	13,350 ft (3.0 ac)	10,350 ft (2.3 ac)	16,500 ft (3.8 ac)	19,300 ft (4.5 ac)	82,000 ft (18.8 ac)

Table 5-12
Potentially Affected Riparian Vegetation along West Canal

Vegetation Type	Total Potentially Affected Riparian Vegetation				
	Reach 1	Reach 2	Reach 3	Reach 4	Total
Trees	15,700 ft (3.6 ac)	12,400 ft (3.1 ac)	18,200 ft (4.2 ac)	1,050 ft (0.42 ac)	473,500 ft (10.9 ac)
Shrubs	800 ft (0.18 ac)	800 ft (0.18 ac)	6,600 ft (1.5 ac)	4,000 ft (0.92 ac)	12,200 ft (2.8 ac)
Herbaceous	0	0	0	0	0
Total	16,500 ft (3.8 ac)	13,200 ft (3.0 ac)	24,800 ft (5.7 ac)	5,050 ft (1.2 ac)	59,550 ft (13.7 ac)

In general, riparian species require large amounts of water to maintain their health and vigor. If water is not supplied, the riparian vegetation adjacent to or within the canal would be impacted. Other areas lying below the canal and along the canal spillways would also be affected.

The potential impacts of canal abandonment without the supply of water to the riparian vegetation can be observed along Reach 5 on the West Canal, south of the End Spill. This canal reach has been abandoned for many years and riparian vegetation that once grew there has died, replaced by drought-tolerant species. Riparian vegetation that could be identified included black cottonwood and trembling aspen snags. Many upland species have survived but show signs of stress.

5.8.5 Wildlife

The riparian vegetation associated with the East and West Canals currently provides wildlife values including a water resource, protective cover, and nesting and foraging habitat. Wildlife species that may utilize these areas include mule deer, coyote, striped skunk, and other small mammals, upland birds, songbirds, reptiles, and amphibians.

The proposed alternatives will eliminate the water resource currently provided by the open canals. However, due to the proximity of the canals to the Methow and Twisp Rivers, this should not adversely impact wildlife. The riparian vegetation along the canals would be replaced by native or introduced drought-tolerant species. This would cause a shift in the vegetative structure and composition. These drought-tolerant species would not provide the quantity or density of protective cover and nesting habitat provided by the current riparian community. Foraging habitat would be reduced by the decrease in the quantity of vegetation currently growing along the canals and a shift in wildlife species utilizing these areas.

5.9 Fisheries Studies

An analysis and comparison of instream habitat benefits for the MVID alternatives was conducted for this study by Parametrix, Inc. This analysis was based on the results of an Instream Flow Incremental Methodology (IFIM) study on the Methow and Twisp Rivers that was conducted by Ecology and other agencies and Tribes during 1991. The results of those efforts are reported in the *Methow River Basin Fish Habitat Analysis Using the Instream Flow Incremental Methodology* (Ecology, 1992). The Parametrix report is contained in Appendix F.

IFIM is a standard methodology used to determine flow recommendations for water diversion and storage projects. It is based on a combination of hydraulic modeling to determine flow depth and velocity relationships at specific locations along the rivers, and application of fish preference curves that define which depths and velocities the fish have been observed to prefer. The habitat quantity that results from this analysis is termed the Weighted Usable Area (WUA). WUA's are calculated for several different locations along a river reach, representing different habitat types, and is summed over the length of a river to determine the total WUA for a river segment.

It should be noted that no quantitative relationships exist between the predicted changes in habitat and production of a particular species. However, it is reasonable to conclude that large magnitude changes in habitat would result in increased production if fish are available to fill the habitats. In the Methow River system, sufficient fish will be available to utilize all of the habitat in some years, while in other years insufficient numbers will be available. No attempt was made to determine what level of production might result from the predicted increase in habitat.

5.9.1 Determination of Benefit

The determination of instream habitat benefit is derived by comparing total habitat (as expressed by WUA) under current streamflow rates with the total habitat under proposed streamflow rates, as defined by each alternative. The percentage change in WUA was calculated for the Methow River above Twisp, the Methow River below Twisp, and the Twisp River under both normal and dry years streamflow rates (corresponding to the 50 percent and 90 percent exceedences, respectively).

Fish species evaluated include chinook salmon (spawning and juvenile rearing), steelhead (spawning and juvenile rearing), and bull trout (juvenile rearing). Habitat relationships for most species and life history stages were calculated based on September flow and diversion rates. September was chosen because natural flow rates are low while irrigation use is still high, yielding a calculation of maximum flow benefit. Also, adult chinook salmon would be holding and possibly spawning during September. For steelhead, the month of May was used for spawning.

Tables 5-13 and 5-14 summarize the percentage change in habitat availability as described by the habitat relationships from the 1992 Ecology report. The following general conclusions were found from this analysis:

<u>Methow River above Twisp:</u>

- Significant increases in habitat availability would occur with implementation of any of the alternatives.
- Alternatives 2-4 yield the greatest increase in instream habitat.

<u>Methow River below Twisp:</u>

- Significant increases in habitat availability would occur with implementation of any of the alternatives.

- Alternative 4 yields the greatest increase in instream habitat.

Twisp River:

- Significant increases in habitat availability would occur with implementation of any of the alternatives.

- Alternatives 2-4 yield the greatest increase in instream habitat. Alternatives 3 and 4 will also divert less flow at Twisp, increasing flows between Twisp and the confluence with the Methow River.

Implementation of any of the alternatives would lead to increases in habitat within the affected reaches of the rivers for most of the live history stages examined. The exception is spawning habitat for steelhead, which was found to decrease with increased flow. This decrease in habitat results because steelhead spawn during the spring when high flows render many portions of the stream channel as unsuitable habitat due to high water velocities. However, the area of spawning habitat for steelhead is typically not considered a limiting factor in steelhead production.

Table 5-13
Increase in Habitat Availability - Average Year Flow Conditions

Location and Species	Percent Change for Each Alternative			
	1	2	3	4
Methow River above Twisp				
Chinook				
Adult Holding	+ 9	+ 11	+ 11	+ 11
Spawning	+ 11	+ 13	+ 13	+ 13
Juvenile Rearing	0	0	0	0
Steelhead				
Spawning	- [a]	- [a]	- [a]	- [a]
Juvenile Rearing	+ 15	+ 17	+ 17	+ 17
Bull Trout				
Juvenile Rearing	+ 8	+ 10	+ 10	+ 10
Wetted Area	+ 2	+ 3	+ 3	+ 3
Methow River below Twisp				
Chinook				
Adult Holding	+ 8	+8	+ 8	+8
Spawning	+ 22	+ 22	+ 22	+ 23
Juvenile Rearing	+ 5	+ 5	+ 5	+ 5
Steelhead				
Spawning	- [a]	- [a]	- [a]	- [a]
Juvenile Rearing	+ 11	+ 11	+ 11	+ 11
Bull Trout				
Juvenile Rearing	+ 15	+ 15	+ 16	+ 16
Wetted Area	+ 3	+ 3	+ 3	+ 3
Twisp River				
Chinook				
Spawning	+ 34	+ 44	+ 44	+ 44
Juvenile Rearing	+ 8	+ 10	+ 10	+ 10
Steelhead				
Spawning	- 7	- 7	- 7	- 7
Juvenile Rearing	+ 35	+ 46	+ 46	+ 46
Bull Trout				
Juvenile Rearing	+ 43	+ 56	+ 56	+ 56
Wetted Area	+ 3	+ 5	+ 5	+ 5

[a] Flow levels are above extrapolation range.

Table 5-14
Increase in Habitat Availability - Dry Year Flow Conditions

Location and Species	Percent Change for Each Alternative			
	1	2	3	4
Methow River above Twisp				
Chinook				
Adult Holding	+ 14	+ 17	+ 17	+ 17
Spawning	+ 21	+ 25	+ 25	+ 25
Juvenile Rearing	+ 2	+ 2	+ 2	+ 2
Steelhead				
Spawning	- 4	- 5	- 5	- 5
Juvenile Rearing	+ 19	+ 23	+ 23	+ 23
Bull Trout				
Juvenile Rearing	+ 14	+ 17	+ 17	+ 17
Wetted Area	+ 3	+ 3	+ 3	+ 3
Methow River below Twisp				
Chinook				
Adult Holding	+ 11	+ 11	+ 11	+ 12
Spawning	+ 45	+ 45	+ 46	+ 48
Juvenile Rearing	+ 8	+ 9	+ 9	+ 9
Steelhead				
Spawning	- 5	- 5	- 5	- 6
Juvenile Rearing	+ 17	+ 17	+ 17	+ 18
Bull Trout				
Juvenile Rearing	+ 29	+ 29	+ 30	+ 31
Wetted Area	+ 10	+ 10	+ 10	+ 10
Twisp River				
Chinook				
Spawning	+ 159	+ 214	+ 214	+ 214
Juvenile Rearing	+ 44	+ 55	+ 55	+ 55
Steelhead				
Spawning	- 3	- 3	- 3	- 3
Juvenile Rearing	+ 108	+ 142	+ 142	+ 142
Bull Trout				
Juvenile Rearing	+ 145	+ 189	+ 189	+ 189
Wetted Area	+ 8	+ 10	+ 10	+ 10

5.10 Socioeconomic Costs and Benefits

An analysis of socioeconomic benefits and costs was performed by Berk and Associates (see Appendix C for the full report). This analysis was based primarily on interviews and written comments of MVID members and other knowledgeable MVID residents and professionals, information obtained from resource scientists and water experts, and other similar socioeconomic analyses.

The socioeconomic impacts of the proposed improvements to the water supply and delivery system involve two general kinds of benefits and costs: those affecting individual properties and those affecting the general public. The impacts are described in the following sections.

5.10.1 Public Benefits

The primary public benefits of the irrigation system upgrades pertain to enhanced fisheries habitat on the Methow and Twisp Rivers. This and other benefits are discussed below.

Enhanced fisheries. The Twisp and Methow Rivers have traditionally been home to coho and chinook salmon, steelhead and bull trout. The fishery in the entire Columbia watershed has declined significantly in recent years, and this is of great concern to the Yakama Indian Nation and to the state Department of Ecology and Fisheries. The proposed improvements to the MVID water supply system are projected to increase the flow in the Twisp River by over 15 cfs and in the Methow River by over 28.8 cfs, amounts that will contribute substantially to enhancing the number of fish and the quality of the fish habitat in the Twisp and Methow Rivers.

Species protection. If chinook and steelhead in the Methow River decline further, they could be subject to listing as endangered species, necessitating very costly efforts to preserve or restore their habitat and reintroduce the species to the river. Preventive improvements to the fishery and its habitat now could avoid these consequences. All four system upgrade alternatives will provide these benefits.

Water conservation. Additional benefits of more efficient use of water include the ability to accommodate new water applications as development occurs.

Preservation of the landscape aesthetics associated with the open canals. In canal reaches where pipelines will be installed, the alternatives contain a provision to irrigate the larger cottonwood and aspen stands that are highly valued by residents. A public benefit of the proposed upgrades is the retention of these values by providing irrigation to the most significant vegetation.

Economic "ripple" effects from the construction of the new system. Direct benefits of the expenditure of $4.0 - $8.0 million in new construction will occur through construction jobs and purchases of equipment, materials and supplies.

5.10.2 Public Costs

The primary public costs will be the capital cost of the system upgrade (ranging from $4.0 to $8.0 million) which will be borne by the state's taxpayers, as well as some loss of riparian vegetation along the canals. This and other costs are discussed below.

Capital construction costs. The general public and utility rate payers will bear the capital costs of the system upgrade. These figures represent the single largest quantifiable cost of the proposed system upgrades. The costs will be borne by the state's taxpayers through the Department of Ecology and other agencies. Ecology believes that these costs are a worthwhile investment for the public's benefit in enhanced fisheries and water conservation that will result.

Vegetation and wildlife impacts. While provision is being made to irrigate the larger stands of cottonwood and aspen trees that have taken root along the canals, there would be smaller plants that would probably not be preserved. Some small species of wildlife that could not migrate to the river for water would also likely be affected.

Other perceived public impacts. From the interviews, it became apparent that perceptions vary widely about the costs and benefits of the proposed upgrades versus retaining the open canal. Other expressed concerns include increased migration of deer and other larger animals across the road, creating new traffic hazards, migration of rattlesnakes to the river across residential property, elimination of seepage from the ditch to the aquifer, and less accessible water for fire protection.

5.10.3 Benefits to Private Property

The benefits and costs to individual properties will depend substantially on their location, their current classification under the MVID assessment schedule, and whether they are using MVID water for commercial or domestic irrigation purposes. The primary benefit to private land owners is improved reliability of irrigation water supply. This and other benefits are discussed below.

Improved irrigation water supply. The most direct benefit to the MVID members will be a vastly more reliable supply of irrigation water. With the old canal, the system is susceptible to washouts, major breaks, weed seed contamination, shortfalls, and springtime delays.

Potential increased farm productivity. The improvements to the system will have beneficial effects to all irrigators. Net income or yields from crop production may also go up. Any increased benefits in farm productivity would likely be quite small, up to $10,000 to $25,000 per year in economic value, for all acres currently in the District.

Reduced risk and improved cost certainty for MVID members. With the upgrades, MVID members will no longer face the risk and uncertainty of a system that is susceptible to expensive repairs at any time. The new system's operation and maintenance costs will be much more predictable in the next years, and assessment rates will be much more predictable and stable as a result.

Reduced costs for properties excluded from the MVID. Properties removed from the MVID will no longer pay assessments to the District. This is a large cost saving to a large number of property owners and one they have been seeking for a number of years. Most of these properties, dissatisfied with the reliability of the MVID water supply, have already installed groundwater wells and are thus paying twice for their water.

Stable or increasing land values. A reliable water supply, the potential for increased farm productivity and a strong degree of cost certainty will lead to stable or increasing property values overtime.

5.10.4 Costs to Private Property

The costs to private properties will be increased assessments and, in some cases, possible loss of water rights if the individual parcel does not actively exercise its irrigation right for five years. These are discussed below.

Increased assessments. Annual MVID assessments will go up somewhat under all alternatives due to the smaller number of acres in the reorganized District and due to an increase in operation and maintenance costs. Annual operating costs are estimated to range from $60 to $80 per acre, increases of $10 to $30 per acre from existing assessment rates, depending on classification.

Potential loss of property value. Properties that are excluded from the District and that are not irrigating potentially lose their rights to water that they are not using. Property values would decline in such a case. These property owners must have their water rights transferred to their individual property and exercising their water rights to avoid the loss of the right.

6.0 OTHER CONSIDERATIONS

6.1 Water Rights

Water Rights will be issued by the Department of Ecology to property owners who will no longer be a member of the MVID and will require groundwater to irrigate. Those water rights will have an allowable usage of nine gallons per minute and four acre-feet/acre per year. Those quantities will be more than adequate to irrigate crops. The CIR for the MVID service area is approximately 3 acre-feet/acre (Section 4.1). The water rights will also have a priority date issued that will be the same as the current MVID surface water rights. The new rights will pre-date instream flow regulations for the Methow River, and the new water rights will not be interruptible.

6.2 Barkley Canal Users

The upper portion of the East Canal is currently used to convey Barkley Ditch Company water to several farms. Water from the Barkley Canal enters the East Canal at the end of Reach 1 and the Barkley users withdraw the water along Reach 2. This arrangement was made to enable the MVID to utilize the Barkley Ditch Company right-of-way along Reach 2. The preferred alternative for the MVID includes abandonment of East Canal Reach 1 and Reach 2. This would result in the Barkley Ditch Company assuming the right-of-way along Reach 2 from the MVID. The Barkley Ditch can

still supply water to the existing MVID ditch and to its members along Reach 2, but it is believed that the Barkley Ditch could not supply enough water to meet its members needs.

The Department of Ecology will not pay for a replacement water supply for the Barkley users and no compensation is under consideration.

6.3 Compensation to MVID Members Leaving District

The preferred alternative would remove 1,346 acres of land from the MVID. It is the opinion of the Board of Directors that those members who want out of the District should be compensated for the costs of replacing their water supply. The rationale for compensation is based on the MVID's desire that all MVID members should benefit equally from the water supply improvements that may result from this Plan.

It has been proposed by the MVID that parcels which would be excluded from the reorganized District be compensated for the costs of constructing wells, which is the likely replacement for water supply in the areas removed from the District. The amount of compensation would be based on parcel size. The proposed compensation is listed in Table 6-1.

Table 6-1
Compensation Formula

Parcel Size (acres)	Formula (acres = size of parcel)	Payment Range
0-2	$2,000 (minimum payment)	$2,000
2-5	$2,000 + (acres - 2) x $1,000	$2,000 - $5,000
5-10	$5,000 + (acres - 5) x $900	$5,000 - $9,500
10-15	$9,500 + (acres - 10) x $800	$9,500 - $13,500
15-20	$13,500 + (acres - 15) x $700	$13,500 - $17,000
20-25	$17,000 + (acres - 20) x $600	$17,000 - $20,000
25-30	$20,000 + (acres - 25) x $500	$20,000 - $22,500
30-35	$22,500 + (acres - 30) x $400	$22,500 - $24,500
35-40	$24,500 + (acres - 35) x $300	$24,500 - $26,000
40-45	$26,000 + (acres - 40) x $200	$26,000 - $27,000
45+	$27,000 + (acres - 45) x $100	$27,000 - $29,514*

* Based on 70.14 maximum parcel size in district.

7.0 DISCUSSION OF RECOMMENDED ALTERNATIVE

Alternative 4 was selected in the August 1, 1995 meeting by the MVID Board of Directors as the alternative that best meets the goals and objective of the MVID and their members. A description of this alternative was presented in Section 5.3.4. A brief summary is provided below. Drawing 21 illustrates this alternative.

7.1 Description

The proposed project consists of the following:

- Replacement of the East Canal and associated laterals with a new pressure pipeline, starting in Twisp and extending to midway between Loup and Beaver Spills. The peak capacity of this pipeline would be 8.0 cfs, supplying 439 acres.

- Replacement of the West Canal with two new pressure pipelines. The first would begin in Twisp (at Alder Creek Road) and extend to below Roach Spill. The capacity of this pipeline would be 3.1 cfs, supplying 155 acres. The second pipeline would begin at Alder Creek (across from Benson Creek) and extend to the end of the

present canal system. The capacity of this pipeline would be 6.5 cfs, supplying 336 acres.

- Abandonment of the remaining canal reaches and removal of approximately 1,346 acres from the MVID. Abandoned canal reaches include Reach 1, Reach 2, Lower Reach 4, Reach 5 and Reach 6 of the East Canal, and Reach 1 and the middle portion of Reach 3 on the West Canal. The existing diversion dam on the Methow River will be abandoned and removed. In addition, members wanting out of the District would be removed from the remaining reaches. The MVID would decrease in size from 2,276 acres currently to approximately 930 acres.

Approximately 11.6 miles of 6- to 15- inch pipe would be required for the new system. The pipelines would be placed primarily along the existing canal right-of-way. The pipelines would operate as low pressure systems that are supplied by groundwater well fields located at the head of the pipelines. These wells would tap the Twisp River and Methow River alluvial aquifers. To avoid potential adverse impacts of the additional wells on existing wells, the new wells would be located as close to the rivers as possible to withdraw water in direct continuity with the river. Water would be supplied to MVID parcels using metered valves at or near existing turnout locations.

7.2 Revised MVID Boundary

Table 7-1 summarizes the size of the existing MVID service area and the service area assumed for Alternative 4. The MVID would reduce in size from 2,276 acres to 930 acres, a reduction of 1,346 acres. Estimates of areas removed are based on analyses of the MVID assessment roll. Considerable difficulty was encountered trying to locate all the MVID parcels on the County assessors maps, either because the maps did not show all current tax lots or because the assessment roll contains outdated or erroneous tax lot numbers. Therefore, the values in Table 7-1 are approximate.

Table 7-1
Reorganized MVID Service Area

Canal	Existing MVID (acres)	Area Removed (acres)	Reorganized MVID (acres)
East Canal	1,579	1,140	439
West Canal	697	206	491
Total	2,276	1,346	930

7.3 Costs

7.3.1 Construction Costs

The estimated construction costs of the preferred alternative are outlined in Table 7-2. The costs contained in Table 7-2 include construction costs, sales tax, engineering (15 percent of construction costs) and an allowance for contingencies of 20 percent. The estimated construction costs total $2.5 million. Detailed cost spreadsheets are contained in Appendix B.

Table 7-2
Estimated Construction Costs
Preferred Alternative

Canal System	Construction Cost
East Canal	$991,600
West Canal	$1,482,600
Totals	**$2,474,200**

7.3.2 Compensation Costs

For MVID areas being removed from the District, it was assumed that parcel owners would be paid compensation for the costs of constructing wells. The proposed compensation would be based on parcel size. The distribution of parcel size in the reaches that would be removed from the MVID was derived from the MVID assessment roll for those reaches that would be totally abandoned and from the member survey data for those owners in the remaining reaches who have indicated their desire to leave the District.

A formula was developed which would define the amount of money paid to property owners to compensate for the costs of drilling wells and changing their water supply. The proposed compensation formula is contained in Table 6-1.

Based on the parcel size information, the total cost of compensating those members of the MVID who will leave the District is estimated to be $1,345,000.

7.3.3 Annual Operations and Maintenance Costs

The estimated annual O & M cost, to be paid by the MVID members through annual assessments, is estimated at $93,200 or approximately $82 per acre (assuming a two acre minimum assessment). If a two acre minimum assessment of $200 is assessed, the annual assessment would be $74 per acre. The annual cost includes costs for operations, a maintenance and repair fund, and energy for well pumping. The annual cost of energy is $7,700 per year, and is based on current irrigated acreage in the District. If all 930 acres were irrigated, the energy cost would be $12,500, increasing the estimated annual cost to $98,000, or approximately $80 per acre. The annual cost, to be paid through MVID assessments, is higher than the existing rates of $50/acre but the water delivered will be cleaner and under pressure, reducing on-farm costs of screening and pumping.

These costs are believed to be conservative estimates, as the costs of operating the new system could be lower once experience has been gained in its operation. The new system will also require less oversight as the diversions, spillways and open canals will have been eliminated. Water demands will be met automatically through the use of well pumps and equalizing reservoirs at the head of the systems.

7.4 Operations Program

After construction of the new water supply facility, the MVID will need to operate and maintain the system to ensure its reliability and integrity. To operate and maintain the new system, the MVID will require employees skilled in electrical and mechanical maintenance and troubleshooting and skilled in operations of pressure pipeline systems. Our recommendations for operations are described in the following paragraphs.

7.4.1 Personnel

We recommend that three staff be employed with the following titles and responsibilities:

Manager/Chief of O & M. This employee will be responsible for managing the O & M activities and other MVID staff. The Manager/Chief of O & M will plan, organize and supervise the area of preventative maintenance (PM) and repair of the District water distribution system. This employee will:

- Develop annual budget for O & M.
- Formulate and direct the implementation of specific O & M activities such as a PM program.
- Determine whether it is more cost effective to hire outside contractors to perform certain maintenance and monitors their performance.
- Ensure adequate personnel are available to handle emergencies.
- Take water delivery orders and schedule deliveries if necessary.

Since the MVID will be a small District, it will be expected of the Manager will also perform maintenance activities.

Maintenance Worker. This employee will perform monitoring, construction, maintenance and repair work on the system under the supervision and assistance of the Manager. This employee will:

- Read meters and perform accounting of water usage.
- Perform scheduled PM on valves, meters, turnouts, pumps and other mechanical equipment.
- Perform clearing and maintenance on District rights-of-way.
- Repair or replace system components as required.

Secretary/Bookkeeper. The functions of this employee will remain the same as they currently are.

Since the District does not have heavy equipment, any excavation or other repairs that require equipment will need to be contracted out. Repairs to well pumps or repairs to the electrical system may also require outside contracting, as the District staff probably would not have those capabilities. We would recommend that the District have on-call contractors that can provide those services.

Consideration should be given to contracting O & M of the wells and mechanical equipment out to a single source on an annual basis for a negotiated fee. The new pressurized water supply system

will operate more like a municipal water system than the previous gravity flow canal system. There may be contractors, or even the City of Twisp, who would be qualified to operate a system of this kind. A trend in the water utility business is to utilize satellite water system operators. These operators may manage a number of water systems or a small water system (satellite system) that is located near their larger water system. That operations arrangement can take advantage of the resources and training the larger organization may have.

7.4.2 Operations

An outline of a suggested operations program is listed below. The specifics of an operations program should be prepared as the design and construction of the new system commences.

Water Delivery and Measurement

- Provide turnouts with locking valves and totalizing meters.
- Provide instantaneous rate and totalizing water meters at each pump station.
- Record water pumped and deliver on a bi-monthly basis. Compare pumping and delivery records to check for the possibility of leaks or malfunctioning meters. Check deliveries for over-usage.
- Prepare written procedures and policies regarding delivery of water and usage during both normal operations and during emergency situations. Distribute to all members.

Preventative Maintenance

- Prepare written Preventative Maintenance Program. Incorporate O & M Manual to be supplied by contractor and engineer at end of construction.
- Prepare system of tracking maintenance actions (called job history records).

7.5 Financial Program

The budgets for the MVID for the period of 1993-1995 are listed in Table 7-3.

Table 7-3
MVID Operations and Maintenance Costs
1993-1995

Category	1993	1994	1995 (budgeted)
Revenue	$94,637	$83,128	$74,281
Administrative Costs	$29,484	$17,941	$21,468
Operations Costs			
- Salaries and Benefits	$39,007	$35,715	$39,413
- Travel	$3,905	$4,522	$4,300
- Repair and Maintenance/ Outside Contractors	$20,111	$6,603	$8,200
- Supplies	$902	$649	$900
- Total	$63,925	$47,489	$52,813
Total Costs	$93,409	$65,430	$74,281

Table 7-3 splits expenses into two categories; administrative costs and operations costs. Administrative costs include secretarial wages and expenses, Directors expenses, insurance, accounting and legal expenses and miscellaneous expenses incurred in the administration of the District. Total administrative costs have varied from approximately $18,000 to $29,500 the last three years.

Operations costs are expenses incurred in the operation and maintenance of District facilities such as maintenance staff salaries and benefits, supplies, mileage costs and maintenance and repair costs. Operations costs have varied from approximately $47,500 to $63,900 in the last three years. The total costs of operating the District have varied from approximately $65,000 to $93,000 the last three years.

For the preferred alternative, a suggested budget has been prepared. That budget is listed in Table 7-4.

Table 7-4
Proposed Budget for MVID

Category	Proposed Expenditure
Administrative Costs	$20,000
Operations Costs	
- Salaries and Benefits	$36,000
- Travel and Supplies, Misc	$3,000
- Energy	$7,700
- Maintenance and Repair Fund	$26,500
Total Costs	$93,200

A description of how the costs were derived is contained in Section 5.4. The total costs of operating the new system will not appreciably decline from the existing system. The primary reason is the need to fund M & R activities and to develop a reserve account to ensure the long-term integrity of the system. The suggested M & R charge appears high at the outset, and may be reduced if the District accumulates a substantial surplus. We recommend that the District strive for an operating reserve of $100,000 to enable the District to fund emergency repairs

An option that the District may consider is to utilize the Referendum 38 Program to borrow funds for emergency projects, and repay those loans through annual assessments. However, the Referendum 38 Program may not exist for the life of the irrigation system and the District should accumulate an operating reserve.

Assessment rates for the reorganized District were calculated by first estimating the number of parcels and acreage which would remain in the District. If a two-acre minimum assessment is applied to all parcels less than two acres after the new system is contracted, the required assessment rate is estimated at $82/acre. If the District applies a minimum charge of $200 to parcels less than two acres, the required assessment rate is estimated at $74/acre.

The assessment rate is greater than the current rate of $50/acre; but clean, pressurized water will be supplied to users, reducing on-farm costs of screening and pumping. The water supply will also be much more reliable.

8.0 MEMBERSHIP VOTE

Following selection of the preferred alternative by the MVID Board of Directors, a ballot measure was prepared and sent to the MVID membership to ratify the selection of the alternative. A copy of the ballot measure is enclosed in Appendix G. Enclosed with the ballots was an information packet describing the preferred alternative. That packet is also enclosed in Appendix G. The ballots were sent to MVID members on November 15, 1995 with a deadline for returning on November 30, 1995.

The results of counting all the ballots received are summarized in Tables 8-1 and 8-2. The results were evaluated in a number of different formats: total yes/no votes by acre, yes/no votes by number of ballots, yes/no by acreage and reach and yes/no by zip code. The results of the ballot count by number of ballots and acreage are summarized below in Tables 8-1 and 8-2. The results shown include ballots received after November 30, 1995. Votes for approximately 150 acres were received after that date. Those votes were included because the ballot was an advisory ballot and the additional votes did not appreciably change the percentage of yes or no votes received.

Table 8-1
Ballot Results

	Yes	No	Undecided	Total
Number of Ballots	168	48	3	219
Acreage	1365.21	212.96	2.82	1580.99

Table 8-2
Percentages

	Yes Votes		No Votes		Undecided	
	% of Vote	% of District	% of Vote	% of District	% of Vote	% of District
# of Ballots	77%	48%[1]	22%	14%	1%	1%
Acreage	86%	60%[2]	14%	9%	0.2%	0.1%

[1] There are 352 members in the District.
[2] There are 2276 acres in the District.

The ballot count shows that 86% (by acreage) of the members who responded to the ballot measure voted yes for the proposed plan. That represents 60% of the 2276 acres in the District. Fourteen percent (by acreage) of the members who responded to the ballot voted against the proposed plan. That represents nine percent of the total acreage in the District. Sixty-two percent of the ballots were returned, which represents 69% of the total acreage in the MVID.

Table 8-3 summarizes the results of the ballot measure by reach. All reaches had a majority vote in favor of the ballot measure.

Table 8-3
Ballot Results by Reach (acres)

Reach	Yes	No	Undecided	Total
Reach E3	223.37	16.09	--	239.46
Reach E4A	100.58	11.04	--	111.62
Reach E4B	60.79	5.78	--	66.57
Reach E5	91.42	21.59	--	113.01
Reach E6	560.42	37.24	.26	597.92
Reach W2	39.11	37.11	.8	77.02
Reach W3A	27.79	2	--	29.79
Reach W3B	57.92	11.24	--	69.16
Reach W3C	81.29	40.58	--	121.87
Reach W4	91.87	--	--	91.87
Unknown Reach	30.65	30.29	1.76	62.7

Table 8-4 summarizes the results by zip code. This tabulation was made to compare the response by members living within and outside the District. Table 8-5 summarizes that calculation. It was found that of the members living within the District boundaries (in Zip Codes 98814 and 98856), 1060.11 acres voted yes and 109.01 acres voted no. Of members living outside the District, it was found that 305.1 acres voted yes and 103.95 acres voted no.

Table 8-4
Ballot Results by Zip Code (acres)

Zip Code	City	Yes	No	Undecided	Total
59840	Hamilton, MT	--	1	--	1
59901	Kalispell, MT	--	7.13	--	7.13
80249	Denver, CO	--	1.34	--	1.34
84150	SLC, UT	2	--	--	2
87501	Santa Fe, NM	--	2.91	--	2.91
89905	Boulder City, NV	--	1	--	1
97204	Portland, OR	0.5	--	--	0.5
98001	Auburn	30.41	--	--	30.41
98020	Edmonds	16.49	--	--	16.49
98021	Bothell	--	5.87	--	5.87
98022	Enumclaw	9.5	--	--	9.5
98037	Lynnwood	--	9.25	--	9.25
98045	North Bend	6.56	--	--	6.56
98046	Lynnwood	6.28	--	--	6.28
98059	Renton	--	14.17	--	14.17
98103	Seattle	14.83	--	--	14.83
98107	Seattle	7.67	5	--	12.67
98111	Seattle	--	1	--	1
98113	Seattle	--	9.83	--	9.83
98177	Seattle	1.36	--	--	1.36

Table 8-4 Continued

Zip Code	City	Yes	No	Undecided	Total
98203	Everett	5.33	--	--	5.33
98208	Everett	7.02	--	--	7.02
98223	Arlington	5.61	--	--	5.61
98226	Bellingham	16.45	--	--	16.45
98247	Everson	10.36	--	--	10.36
98249	Freeland	5.25	--	--	5.25
98257	La Conner	2.13	18.95	--	21.08
98258	Lake Stevens	--	1.41	--	1.41
98264	Lynden	1.4	--	--	1.4
98270	Marysville	7.91	--	--	7.91
98273	Mt. Vernon	20.14	--	--	20.14
98277	Oak Harbor	0.98	11.24	--	12.22
98284	Sedro Woolley	10.5	--	--	10.5
98290	Snohomish	4.7	--	--	4.7
98294	Sultan	5	--	--	5
98310	Bremerton	13.16	--	--	13.16
98366	Port Orchard	4.84	--	--	4.84
98504	Olympia	11.32	--	--	11.32
98801	Wenatchee	4.53	--	--	4.53
98814	Carlton	319.13	9.88	--	329.01
98817	Seattle	25.35	--	--	25.35
98828	Walaga, WA	3.41	--	--	3.41
98840	Okanogan	27.08	1.12	--	28.2
98846	Pateros	6.58	--	--	6.58
98856	Twisp	740.98	99.13	.8	840.91
98862	Winthrop	10.45	--	1.76	12.21
98901	Yakima	--	.23	--	.23

Table 8-4 Continued

Zip Code	City	Yes	No	Undecided	Total
99113	Grand Coulee	--	12.5	--	12.5
99336	Kennewick	--	--	.26	.26

Table 8-5
Results of those Inside and Outside the District

	Yes	No	Undecided	Total
Outside District	305.1	103.95	2.02	411.07
Inside District	1060.11	109.01	0.8	1169.92

9.0 SEPA PROCESS

A SEPA Checklist was prepared for adoption and implementation of this Plan. The MVID reviewed the checklist and, as lead agency, issued a Determination of Non-Significance (DNS) in accordance with WAC 197-11-340. The DNS was issued on February 23, 1996, with a comment period extending to March 15, 1996. A notice of Environmental Determination was published in the Methow Valley News on February 29, 1996. A copy of the SEPA checklist and DNS is enclosed in Appendix H.

The SEPA Checklist and DNS was also distributed to the following agencies and tribes:

- Department of Ecology (SEPA Clearing House)
- Department of Fish and Wildlife
- U.S. Army Corps of Engineers
- U.S. Fish and Wildlife Service
- U.S. Forest Service
- Natural Resources Conservation Service
- Colville Indian Nation
- Yakama Indian Nation
- Okanogan County Commissioners

- Okanogan County Council for Economic Development
- North Central Washington Resource Conservation and Development Council

Copies of the letters sent to those agencies are enclosed in Appendix H. A number of comment letters were received by the MVID in response to the DNS. Copies of those letters are enclosed in Appendix H. The comment letters were reviewed and the comments summarized. A response to those comments was prepared and is enclosed in Appendix H.

After the MVID reviewed the comments and prepared responses, the Board of Directors decided to retain the DNS for adoption and implementation of this Plan.

10.0 SUMMARY

The following conclusions and recommendations were made in this *Water Supply Facility Plan.*

- The existing MVID canal system contains many areas of high operational risk. It appears that most of the existing canal system should be replaced to allow the MVID to operate a safe and efficient irrigation water supply system.

- The MVID diverts an average of 41 cfs from the Methow River for the East Canal and 26 cfs from the Twisp River for the West Canal, for a total of 67 cfs. The existing irrigation demand, assuming a 70 percent field application efficiency, is approximately 13.5 cfs. The overall conveyance system efficiency, including seepage and spills, is estimated to be 20 percent.

- The MVID West Canal diversions represent an estimated 31 percent of average Twisp River streamflows in September, and 50 percent of dry year streamflows in September. The East Canal diversions represent an estimated 14 percent of average Methow River flows in September and 20 percent of dry year streamflows in September.

- The Department of Ecology and the MVID Board of Directors established goals for completion of this Plan. Those goals included developing an improved, reliable system serving members who desire water service, promote water conservation, increase in-stream flows for fisheries, avoid increased assessments, prevent disruptions to irrigation practices, preserve the landscape and aesthetics of the valley and avert the possibility of a lawsuit brought by the Yakama Indian Nation who will try to force reduced irrigation diversions.

- An opinion survey was mailed to all MVID members to gain an understanding of which members want to remain in the District and to determine which canal reaches could remain within the District and which could be abandoned. A total of 173 members representing 65 percent of the acreage in the MVID responded. The results of that survey led to the formulation of a water supply alternative which would supply water to areas that desire to remain in the District. This water supply alternative was selected by the MVID Board as the preferred plan in their August 1, 1995 meeting.

- The preferred plan consists of replacing the existing canal system with pressure pipe systems fed by groundwater wells. The groundwater wells would be located along the Twisp River in Twisp, the Methow River in Twisp and the Methow River near Alder Creek. The East Canal service area would extend from Twisp to approximately one mile downstream of Loup Spill. The West Canal service area would extend from Twisp to one-half mile downstream of Roach Spill and from Alder Creek to the End Spill. The remainder of the current MVID service area would no longer be in the District. The MVID service area would be reduced in size from 2,276 acres to approximately 930 acres.

- The groundwater supply for the MVID would be developed adjacent to the Methow and Twisp Rivers and would withdraw groundwater from the alluvial aquifers in close continuity with the rivers. The current diversions would be abandoned and removed. Additional wells would need to be constructed to supply water to parcels that would no longer be in the District.

- The total peak demand, and diversion from the Methow and Twisp Rivers, is estimated to be 17.6 cfs for the reduced MVID service area. Instream flows will increase in both rivers, resulting in significant increases in fisheries habitat availability. In addition to crop irrigation requirements, 1.3 cfs of the 17.6 cfs peak demand will be allocated to irrigate and preserve stands of trees along the canal right-of-way where the new pipeline will be located.

- The estimated construction costs of the preferred alternative is $2.5 million. Another $1.35 million is proposed as compensation to MVID members who would leave the District. The money is to compensate for the costs of drilling a private water supply well to serve their own property. Money for construction of the preferred alternative will come from Referendum 38 funds and from other agencies. The MVID is not proposing to provide construction funding.

- The estimated annual O & M costs of operating the new system is $74 per acre, assuming a two-acre minimum assessment of $200. The assessment will include contributions for accumulating a reserve fund, to be used to properly fund maintenance and preserve the integrity of the system.

- A vote of the MVID membership was solicited to ratify the preferred alternative. The preferred alternative was ratified with an 86% "yes" vote, representing 60% of the acreage within the District.

- A SEPA Checklist was prepared, and a Determination of Non-Significance issued for adoption of this plan and construction of the preferred alternative. Comments were received on the DNS and a response to those comments was prepared. It was decided by the District to retain the DNS and proceed with the implementation of this Plan.

Respectfully Submitted,

MONTGOMERY WATER GROUP, INC.

R. A. Montgomery

Robert A. Montgomery, P.E.
Principal Engineer

REFERENCES

Golder, 1993. Report to Economic and Engineering Services, Inc. on Water Budget for the Methow Basin.

James et.al., 1982. Irrigation Requirements for Washington - Estimates and Methodology. Agricultural and Research Center, Washington State University, Research Bulletin XB0923.

Klohn Leonoff, 1990. Water Management Plan for Methow Valley Irrigation District. Klohn Leonoff, Inc., Kirkland, WA. January 19, 1990.

Methow Valley Water Pilot Planning Project, 1994. Draft Methow Basin Plan.

SCS, 1975. Inventory and Evaluation, Methow Valley Irrigation District, Okanogan County, Washington. U.S. Department of Agriculture, Soil Conservation Service. ca. 1975.

USDA, 1990. State of Washington Irrigation Guide. U.S. Department of Agriculture, Soil Conservation Service in Cooperation with Washington State University Cooperative Extension Service, January, 1990.

Walters, K.L. and E.G. Nasser, 1974. Water in the Methow River Basin, Washington. State of Washington Department of Ecology Water-Supply Bulletin 38, 73 p.

Washington Department of Ecology, 1992. Methow River Basin Fish Habitat Analysis Using the Instream Flow Incremental Methodology.