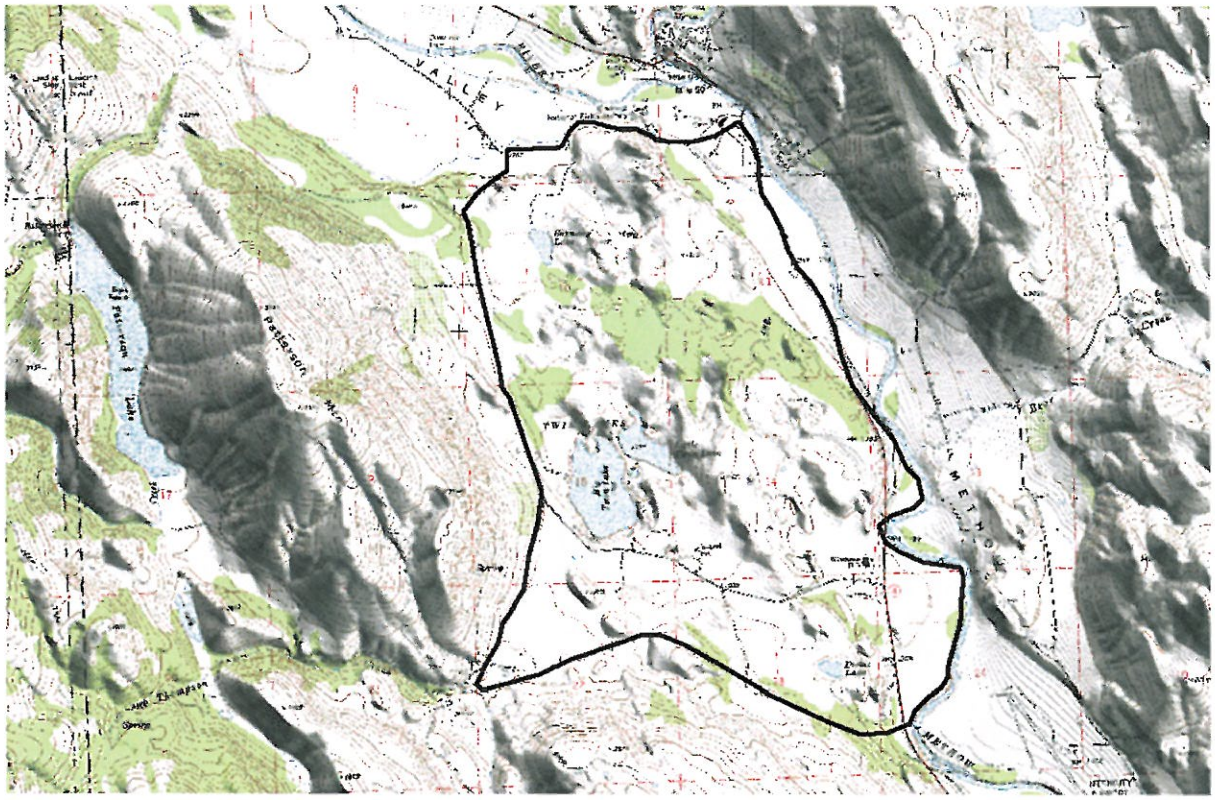
Twin Lakes Aquifer Recharge Project

Final Conceptual Design Report



June 30, 2003

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Presented to:

Twin Lakes Aquifer Coalition
North Central Washington RC&D
Washington Dept. of Ecology
Washington Dept. of Fish and Wildlife
Washington Legislature

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Executive Summary

Groundwater levels in the Twin Lakes Aquifer (Aquifer) have dropped by as much as 11 feet since 1999. The decline has impacted Twin Lakes fisheries as well as it's recreational value. Also there are more than 500 home sites that rely on this aquifer for their source of water. Two domestic wells have already been adversely affected. A municipal water system for this area would have relatively high construction and annual operating costs. Also, WAC 173-548 currently subjects all future water appropriation in the Methow Basin to base flows. Consequently, there is no uninterruptible water available for such a Class A water system.

This precipitous decrease in water levels has been caused by two factors:

- A decrease in aquifer recharge due to mandated changes to the Wolf Creek Reclamation District and
- Less than average precipitation.

To combat this situation the Twin Lakes Aquifer Coalition secured funding from the Washington Department of Ecology to seek engineering answers for the declining water levels.

Fortunately, there are answers. There are potential sources of water that can remedy this situation. And equally important, there is a wide, diverse coalition of support for several of the available options.

In our January 2003 interim report, seventeen potential measures were evaluated. They generally consisted of adding more water to the Aquifer through gravity or by pumping. The sources of water included additional water from Wolf Creek, efficiency savings in the Wolf Creek Reclamation District, Thompson Creek drainage, and from the Methow River.

Three of the options were found to be clearly superior to the others, based on a matrix consisting of amount of cost, available water, community acceptance, and other criteria. They were, in order of preference:

- Thompson Creek Diversion,
- Wolf Creek Diversion, and
- Methow River Well.

The review of the interim report by the effected parties (Appendix A) revealed that our understanding of the water rights that would be required to implement the options was incomplete. Specifically, the Washington Department of Ecology stated that the Wolf Creek and Thompson Creek options may not be achievable (at least in the short term), because these basins are closed to further appropriations.

However, our particular water right from these closed basins may be approved at some time because our right will not be a consumptive use of water. In addition, the Washington Department of Fish and Wildlife also considered the Methow River Well option to be their preferred solution because the well would provide filtered, pathogen-free water to the Aquifer.

As a result of these review comments, we consider the Methow River Well Option to be the preferred alternative to add water to the Twin Lakes Aquifer. The Thompson Creek and the Wolf Creek options would be implemented in the next five years if the water rights can be secured and if the well option is unable to provide all of the needed water.

The Methow River Well Option, however, cannot be fully designed at this time because the exact location, depth, size, and number of wells cannot yet be determined (a detailed site investigation will be completed during the next phase to resolve these issues). In addition, the routing of the pipeline to deliver the water from the well to the Aquifer cannot be finalized, pending discussions with Sun Mountain Ranch. As a result, this report is considered as a conceptual design.

To fully implement the project, the next phase will be a design/construction project that will develop the information discussed above and design and construct the preferred alternative(s) based on the studies described above and discussed in this report.

This report is **not** comprehensive by nature. We incorporate aspects from prior reports, including the Final Interim Report (IRZ, 2003a), by reference only. However, we do discuss project history from the Interim Report and how we arrived at the decisions and conclusions in this report.

The estimated annual volume of water provided, five year development cost, and annual operating cost for each of the three options is summarized in the following table.

Option	Annual Volume (acre-feet)	Five Year Cost ($)	Annual Cost ($/yr)
Methow River Well	1,000	$633,000 to $782,000	$20,000
Thompson Creek Diversion	500	$45,000	$2,000
Wolf Creek Diversion	700	$212,000 to $292,000	$4,000

NOTE: Since the costs of materials fluctuate over time and the Engineer/ Consultant has no control over the costs of services and equipment furnished by others, all cost estimates herein are based on the Engineer/Consultant's experience and represent their best judgment as professionals. The Engineer/Consultant can not guarantee that the final costs will not vary from the probable cost estimates prepared by the Engineer/Consultant for this project.

1.0 PROJECT ACTIVITIES SINCE THE INTERIM REPORT

The purpose of this section is to describe project activities since the completion of the Final Interim Report in January 2003 and how these activities led to the development of this conceptual design report. These include the review of the Interim Report by the affected organizations, additional field work, and conceptual design activities. Many of the geographic areas or engineering features discussed in this report are shown on Figure 1.

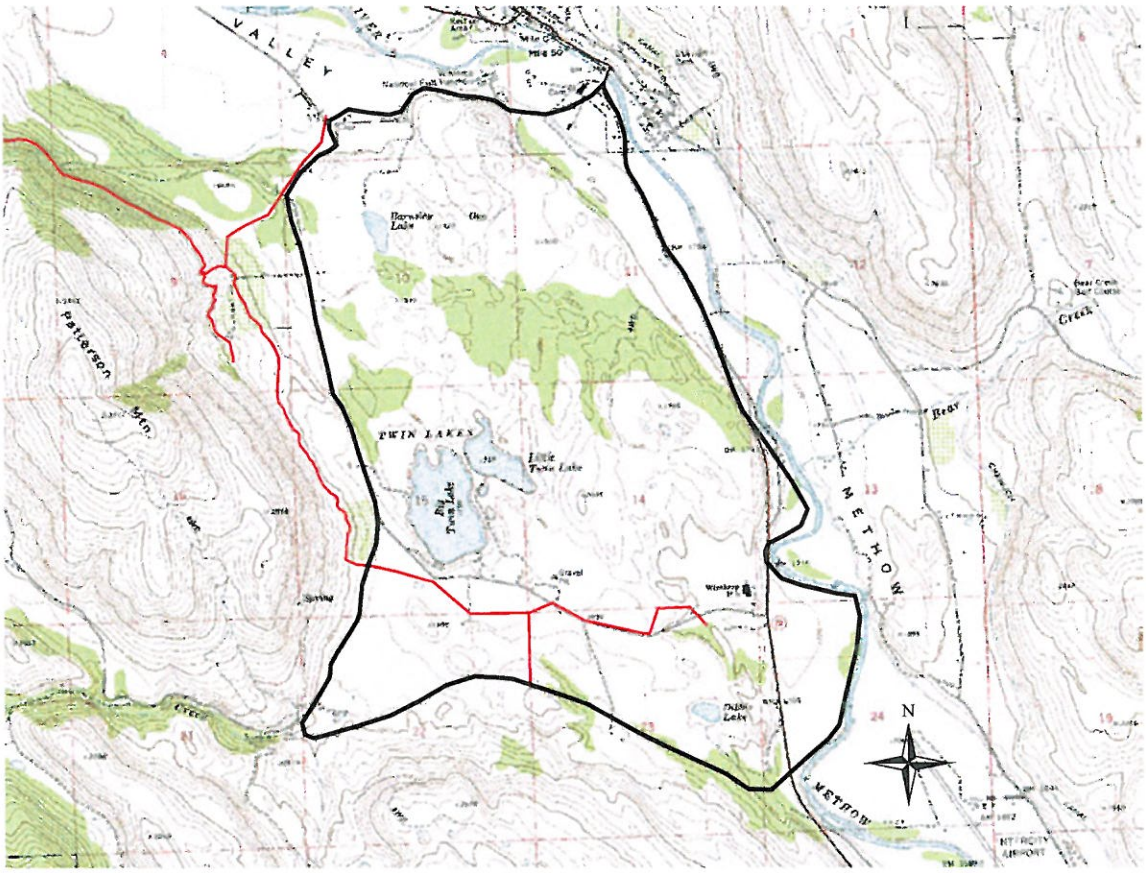


Figure 1. Location Map of Twin Lakes Aquifer (approximate boundary shown by heavy black line) and the Wolf Creek Reclamation District's Delivery System (red line).

1.1 Review of the Interim Report by Affected Organizations

The Final Interim Report (IRZ, 2003) was a feasibility study that reviewed seventeen options to add water to the Twin Lakes Aquifer (Aquifer). The seventeen options were generally lumped as approaches that added more water to the Aquifer by pumping or gravity. These options were evaluated through a spreadsheet matrix that considered costs, quantity of water that could be added, and acceptance of the option by the affected parties. Based on a meeting in December 2002, IRZ revised the matrix to provide additional weight to the regulatory community acceptance.

Three of the seventeen options that were ranked received a significantly greater score than the others. They were:

- Methow River Water Right (Methow River Well Option),
- Thompson Creek Diversion, and
- Wolf Creek Diversion.

These three options were subject to a further economic evaluation. Although all three were acceptable measures to add a considerable amount of water to the Aquifer, the Thompson Creek option was considered to be the best option because of its' lower construction and operation cost. The Methow River option was considered to be the least acceptable (of the best options) because of its' higher operation cost (the water must be pumped to the Aquifer).

The review of the Final Interim Report was completed by the affected parties in January and February of 2003. The review comments in their entirety are included in Appendix A of this report. The review comments raised some concerns. A summation of the review comments and our general response follows:

1.1.1 WDOE Review Comments

The Washington Department of Ecology (WDOE) had several pages of review comments for which the reviewer of this report is directed to Appendix A. We believe that the comments can be grouped in three main areas:

- **WDOE states that there was an inadequate discussion of the geology of the aquifer and surrounding area.** We generally concur with the comments and we still believe that a more thorough review of well logs and geological reports is justified. However, we believe that given the time and financial constraints of the project that our discussions were reasonable and further work would not generally change the thrust of the project.
- **WDOE states that there was too much activity related to the developments and analysis of alternatives and too little attention was placed on the analysis of the Methow Well Option.** We believe that the purpose of the Interim Report was to develop and evaluate alternatives (consistent with a Feasibility Study) and that to pre-judge the outcome is inconsistent with generally accepted practices for a Feasibility Study.
- **WDOE strongly stated that the Wolf Creek and Thompson Creek basins are closed to further appropriation and as a result, that these options are not viable.** We generally concur with these comments and readily agree that our knowledge of WDOE regulations is not as complete as WDOE. As a result, we have changed our priority of solutions to reflect that the Methow Well Option is a better solution because it can be more promptly implemented. However, we also believe that a permanent gravity-based option should be part of the solution.

These closed basins do have water supplies (at times) that exceeds all water rights (including in-stream rights). The closing of these basins may have been premature. A portion of our proposed solution is to explore the legal and regulatory aspects of the decision to close these basins to ascertain if our non-consumptive use recharge project may be allowed in the future.

Based on the review comments from WDOE and a March 27, 2003 meeting with the affected parties, we had a conference call on April 29, 2003 to attempt to rectify the WDOE comments and IRZ responses. All the affected parties agreed that the best response to the comments would be for IRZ to concentrate all efforts on the Conceptual Design Report (this document) rather than to attempt to address the WDOE's comments. We agreed in this conference call that the full regulatory comments would be a portion of this report (Appendix A) and that IRZ would attempt to summarize the comments and our responses.

1.1.2 WDFW Review Comments

The Washington Department of Fish and Wildlife (WDFW) also prepared written comments to the Final Interim Report (Appendix A). A summation of the review comments and our general response follows.

WDFW selected the Methow River Well Option as their preferred alternative. One stated reason, which we had not considered, was that this option would supply filtered water to Twin Lakes. The filtered groundwater would be more desirable because of the decreased risk of introduced pathogens to the lakes. We fully concur that this is a desirable attribute that we had not considered. Thompson Creek water, however, would be filtered prior to introduction to the Aquifer and any water added to Barnsely Lake would be filtered through the lake sediments prior to reaching groundwater. In addition, Wolf Creek water (we believe) is extremely pure and may be acceptable for direct introduction to Twin Lakes.

WDFW also stated that the matrix scores did not reflect the opinions of the affected parties. We agree that the scores from the Interim Report reflected our opinions only. We did ask for, but did not receive, any matrix scores from the affected parties prior to the development of the Interim Report. One purpose of this report is an attempt to rectify any comments that we received from the review of our Interim Report.

1.2 Field Activities Completed Since the Interim Report

The Interim Report was completed with some haste to comply with the Washington Legislature's session. The main purpose of the document was to provide a rough estimate of the project costs so that a funding mechanism could be developed. As a result, there was very little investigation work that was completed prior to the development of the interim report and there were several major questions that had to be answered prior to selection and costing of the preferred alternative(s).

There were two major lines of investigation that needed to be completed prior to the completion of this conceptual design report. They were:

- Data gaps regarding physical aspects of the Twin Lakes Aquifer that may tend to aid the selection of the preferred solution(s).
- Data gaps about the preferred solutions that may tend to aid the selection of the preferred solution(s).

These investigations are discussed below.

1.2.1 Data gaps regarding physical aspects of the Twin Lakes Aquifer that may tend to aid the selection of the preferred solution(s)

In the Final Interim Report, we discussed several data gaps regarding the physical aspects of the Aquifer that made the selection of the preferred solution more difficult. For example, since we had not performed a pump test in the Aquifer, we did not know it's specific yield. This meant that we did not know, more precisely than a factor of three, how much water it would take to restore the water level in the Aquifer. In addition, we did not know if the Methow River Well Option would be capable to add the required amount of water to the Aquifer.

As a result, our field activities concentrated on these data gaps. We did not find a series of wells with the right spacing to perform a pump test. However, we did enough field investigation and took enough materials samples to indicate that our initial assumption (that the specific yield is 0.1) is acceptable. We also found through our field investigations in the proposed well site (and the nearby well logs) that we **should** be able to generate a large percentage of the required amount of water from our well system (approximately 1,000-3,000 gpm for 90 days).

The information that was gathered during our field work has given us increased confidence that the Methow Well Option could provide a major portion of the needed water. However, given the limitations of extrapolating geology in a glacial terrain, we cannot specifically design a well system (exact number, size, depth, and location of the wells). This limitation is further discussed in Section 2.1 of this report.

1.2.2 Data gaps about the preferred solutions that may tend to aid the selection of the preferred solution(s).

There were several data gaps regarding the preferred solution(s). Limitations to the knowledge regarding the Methow Well Option were discussed in Section 1.2.1.

The principal data gaps regarding the Thompson Creek Diversions are discussed below.

- **The possibility of achieving a water right.** Without a viable water right, this option is not a solution. It is not yet clear that a water right is achievable.

However, we have been provided some encouragement by the WDOE that it may be possible to obtain a water right because our use is non-consumptive, the water will remain in the Thompson Creek watershed, and our water requirements need not be used during the irrigation season.

- **How much water may be available.** We were un-certain how much water could be made available from Thompson Creek. Discharge measurements that have been made to date, all of which has exceeded 1 cfs, indicates that our assumption of 1 cfs for 9 months (or approximately 500 acre-feet) is achievable.

- **How to route streamflows from Thompson Creek to Twin Lakes.** We were uncertain how much head was available and the path of conveyance from Thompson Creek. We found, during our surveying work, that it would be possible to route water along a pr-existing canal and that the head was sufficient to transfer the water to Twin Lakes (this work is further discussed in Section 2.2.)

The principal data gaps regarding the Wolf Creek Diversions are discussed below.

- **The possibility of achieving a water right.** Without a viable water right, this option is not a solution. It is not yet clear that a water right is achievable and it is not as likely as Thompson Creek. However, it appears from our analysis that there is water in the creek at times that exceeds existing consumptive and in stream water rights. In addition, it appears that others, such as the Bureau of Reclamation and Wolf Creek Reclamation District may have some interest in increasing diversions from Wolf Creek. This renewed interest indicates to us that a water right may be achievable at some time in the future.

- **How much water may be available.** We were un-certain how much water could be made available from Wolf Creek. Discharge measurements that have been made to date by the USGS, indicates that our assumption of 4 cfs for 3 months (or approximately 700 acre-feet) is achievable.

- **How to route streamflows from Wolf Creek to Barnsley and Twin Lakes.** We were uncertain how much flow could be conveyed from the diversion at Wolf Creek to Patterson Lake. We found, during our surveying work, that it would be possible to route additional water along through the existing canal and pipeline system by performing certain upgrades to the system (this work is further discussed in Section 2.3.)

2.0 CONCEPTUAL DESIGN ACTIVITIES

As previously stated, there is a level of uncertainty regarding the capability to produce the required amount of water from the Methow River Well Option (the option that appears to have the greatest amount of support from the affected community). In addition, it is not exactly clear how much water will be required to replenish the Aquifer or how much water will needed to be added per year to maintain the water levels (even if we assume that the maintenance amount of water will equal the historic canal leakage, we still don't know how much water will be required because the canal leakage was never measured).

Still our design goal is to replenish the Aquifer within a fairly short period of time (5 years). And we know that we need to add about 4000 to 13,000 acre-feet of water (depending on the specific yield) during those five years to replenish the Aquifer (800 to 2,600 acre-feet per year).

At the upper range of the expected yield of the well system we may be able to generate the minimum amount of water that will be required to replenish the aquifer. It is theoretically possible that a high yielding well system could produce most of the upper amount of water that would be required. It is also possible; that the well system may not produce a sufficient amount of water to provide even a small percentage of the required flow (there are no guaranties in glacial terrains).

In addition, even if the water is available, we still do not know what type of wells will be the best. A large diameter interception well system may work the best in shallow, highly productive groundwater (similar to the well system in the nearby State Fish Hatchery). However, if a large amount of drawdown results from the pumping, a shallow well will not work and a deep well will be the best. It is because of these un-certainties that a flexible design of one or more of the preferred alternatives may be required and that is why this report is a conceptual design report.

All three of the preferred alternatives are discussed to some extent. Conceptual drawings and refined cost estimates are developed for all of the alternatives. Planning for the actual design/construction phase is developed and a decision strategy is discussed to aid in the process.

2.1 Methow River Well Option

Although this option has the greatest regulatory and affected parties acceptance and maybe capable of providing all of the water that is required to replenish the Aquifer, it also has the greatest risk because the water supply is unproven. As a result, one of the first, critical tasks that would be required with this option is to conduct an investigation that will determine the location, number, depth, and type of wells. The investigation may proceed as follows.

The selected engineering/construction team would mobilize to the proposed well site near the Methow River (Figure 2). An excavator capable of digging a 15-18 foot deep hole will be employed to see if the site has the potential for the shallow, interceptor well. A conceptual drawing of this type of well is seen in Figure 3. Such an interceptor well is used in areas of shallow depths to groundwater. They are capable of producing a large quantity of water (greatly exceeding 1000 gpm) with very little drawdown (less than 10 feet), but only if the formation surrounding the well is capable of delivering that quantity of water.

The excavator will dig a large exploration pit (nominally greater than 10 ft. in diameter) as deep as the excavator can dig (a bench may be constructed to allow the excavator to dig even deeper). After the pit fills with water, a sump pump(s) capable of pumping several hundred gpm will be used to try and drain the water from the pit. The pump will run for approximately 1 hour or until a stable pumping water level is achieved. The drawdown and the pumping rate will be measured. The contractor will be seeking a test pit area(s) that can produce approximately 50 gpm/ft of drawdown. The test pit depth may also be extended after the pump test is completed by continuing dewatering of the test pit.

If a suitable test pit site is found, the contractor will then complete the excavation of the interceptor laterals, which may have a nominal length of 100-200 ft. for two laterals. Figure 3 provides conceptual drawings of the interceptor well. The interceptor well then will be constructed according to common practices for interceptor wells.

If the test pit is not suitable, the construction contractor may need to try as many as two other sites (three sites in total). If none of the three sites proves to be acceptable, then the interceptor well concept may be abandoned in favor of a conventional well system.

The State Fish Hatchery, which is located immediately to the west of our proposed well site location, has three conventional wells that supply approximately 1500 gpm for each well. We believe that our site may be capable of providing as much water, but it may not have as favorable of geology. Therefore, a drilling sub-contractor will be mobilized to the site to drill a series of test wells. The driller will drill a 6 inch casing to a nominal depth of approximately 150 feet. The cuttings from the drilling may be logged by a geologist or an engineer to determine the sub-surface stratigraphy and hydrogeological properties. Informal pump tests may be completed during the drilling operation to further ascertain the hydrogeology properties.

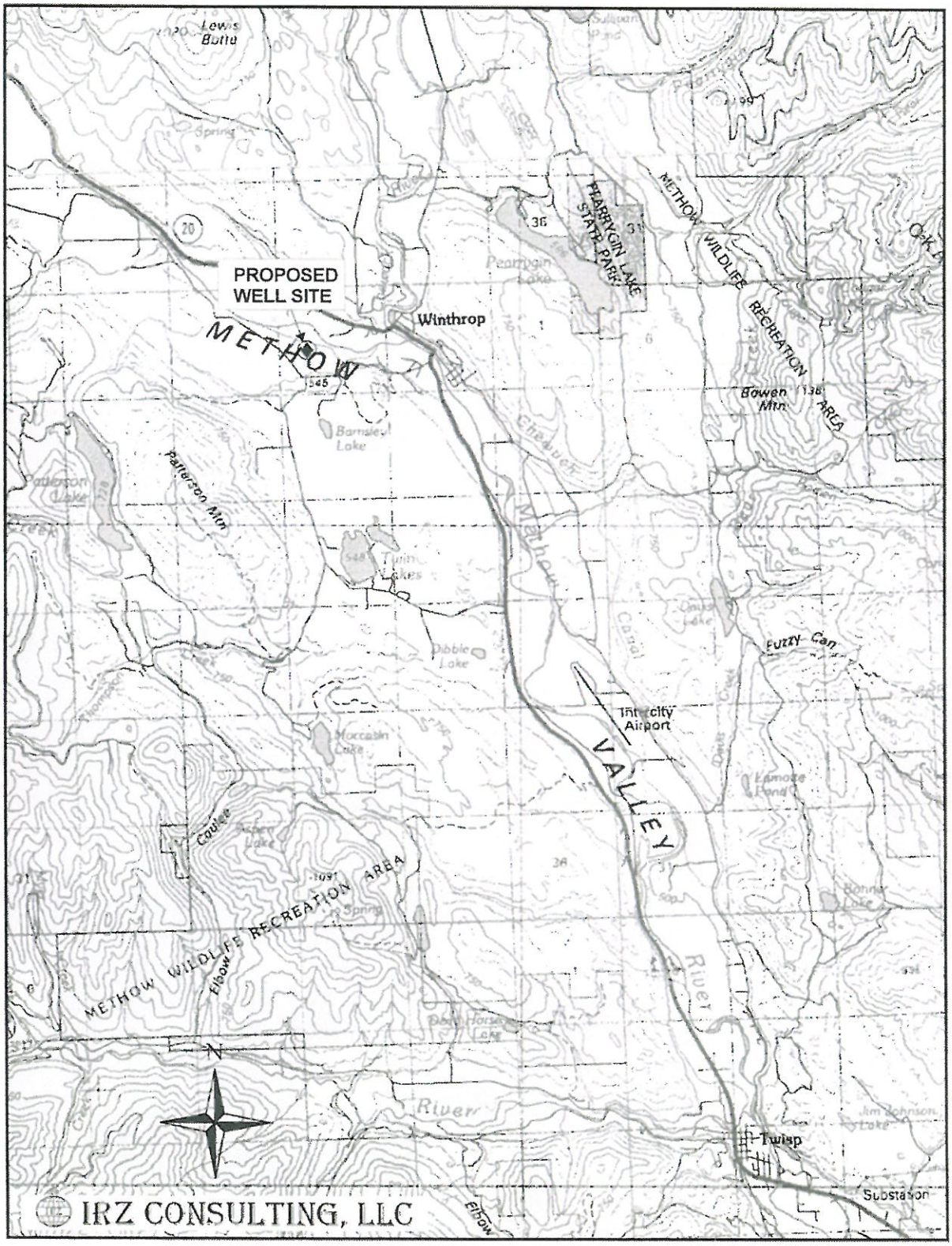
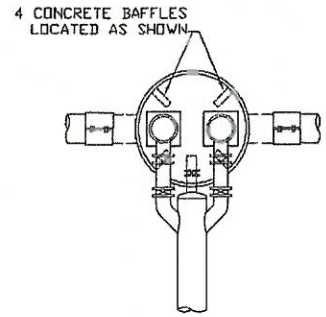
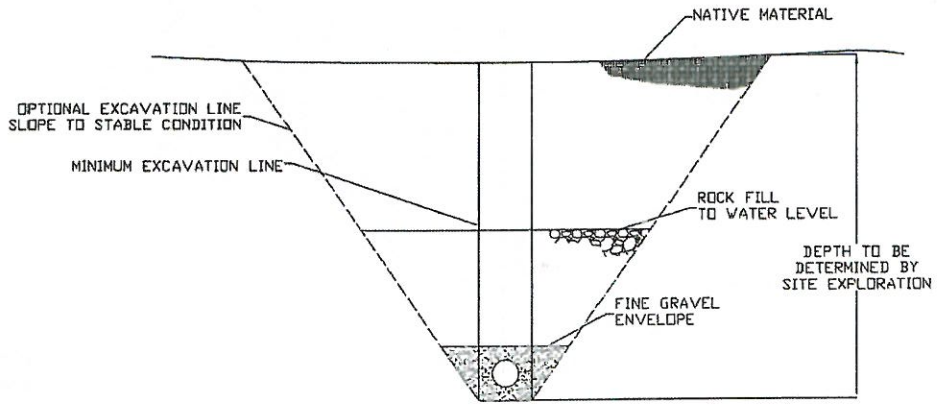


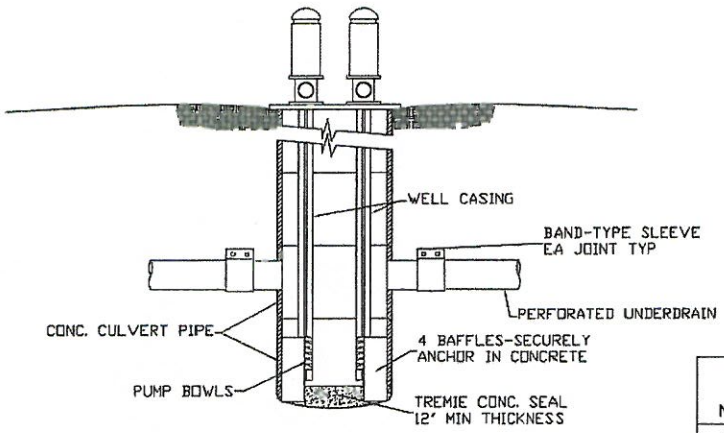
Figure 2. Site Map for Proposed Well Location.



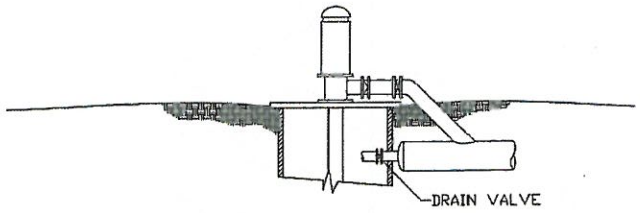
PLAN VIEW



TYPICAL SECTION
PERFORATED DRAIN



ELEVATION VIEW 1



ELEVATION VIEW 2

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TWIN LAKES AQUIFER
RECHARGE PROJECT
INTERCEPTOR WELL

DESIGNED PLW, P.E.	SCALE NOTED	FILE INF.:	DRAWING NO.	SHT 1
DRAWN AWJ	DATE 6/26/03		FIGURE 3	OF 1
CHECKED	DATE			

Upon completion of the test boring, a monitoring well will be emplaced (subject to all relevant state of Washington standards) as the test well casing is removed. If the test well proves to be an adequate location, a full production well will be drilled within about 10 feet from the test well.

The production well will be approximately 100-150 deep and about 16-18 inches in diameter. A conceptual drawing of a two well system is shown in Figure 4. The well will have well screens that are sized to the formation properties to maximize the yield and minimize the pumping and other operational costs.

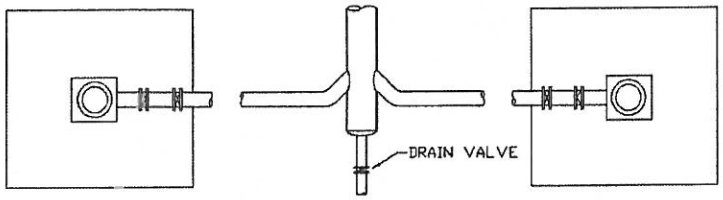
Ideally, one production well could provide as much as 3,000-4,000 gpm. More realistically, however, is that each well may produce from 1,000-1,500 gpm. Our estimated costs for the wells and pumping system are estimated for two wells that will produce 1,250 gpm each.

After the pumping well is installed and developed, a 24 hour pump test should be performed so that the hydraulic properties of the formation (specifically the hydraulic conductivity and specific yield may be determined). Groundwater measurements will be made at about 1 minute intervals in both the production well and the nearby observation well. If more than 1 production or observation well is drilled, water levels will be made in all of these wells on a similar time basis. The time interval for water level measurements for each well should be based on conventional pump test standards.

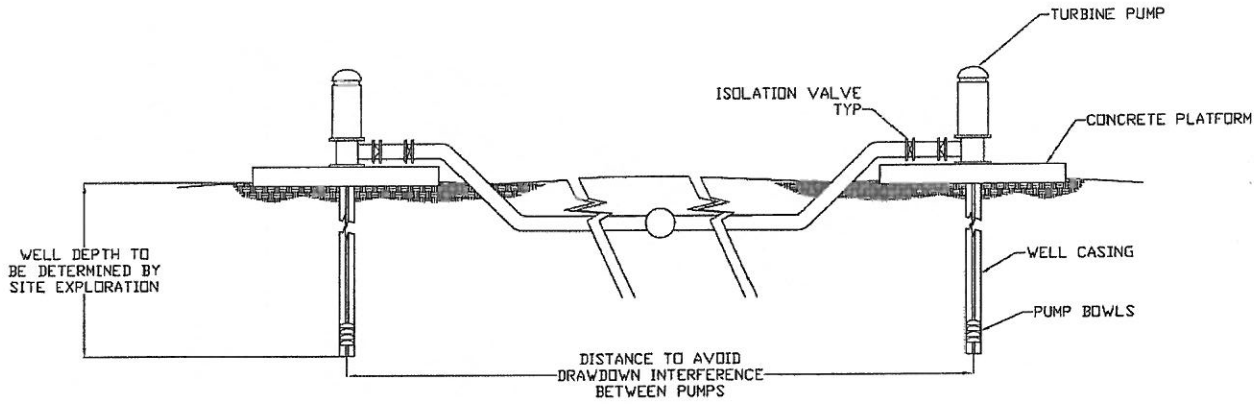
Initial cost estimates were made for both an interceptor well and two drilled wells. These costs include construction of the wells and the required pumping stations. These cost estimates are presented in Table 1.

Table 1. Methow River Water Source: Estimated Costs for Interceptor and Drilled Wells.

	Interceptor	Drilled
Construction	$ 93,000	$ 66,000
Pumps and Motors (2)	$ 24,000	$ 24,000
Valves, Fittings, Pipe, & Fabrication	$ 6,000	$ 6,000
Utility Power	$ 10,000	$ 12,000
Electrical Control Equipment	$ 18,000	$ 18,000
Electrician	$ 6,000	$ 6,000
Pump House	$ 10,000	$ 12,000
Sub-Total:	**$167,000**	**$144,000**
Engineering, Legal, Con. Mgmt.	$ 23,000	$ 7,000
Contingency and Sales Tax	$ 35,000	$ 12,000
TOTAL:	**$225,000**	**$163,000**



PLAN VIEW
PUMPS AND TEE ASSEMBLY



ELEVATION VIEW

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TWIN LAKES AQUIFER
RECHARGE PROJECT
DRILLED WELLS

DESIGNED PLW, P.E.	SCALE NOTED	FILE INF.:	DRAWING NO.	SHT 1
DRAWN AWJ	DATE 6/26/03		FIGURE 4	OF 1
CHECKED	DATE			

Based on the total pumping head and the efficiencies of the pumps and motors, power usage should be 300 kWh per acre-foot of water pumped. To pump a total volume of 1,000 acre-feet annually would require 300,000 kWh. At an average power cost of $0.0365 per kWh, the annual cost of power, including monthly charges, would be around $12,000. The sum of the estimated annual operation, maintenance, and replacement costs is $8,000. Therefore, the total estimated annual cost to operate and maintain the pumping station would be **$20,000** for either well type.

Following the completion of the well system, a piping system will need to be engineered and built to convey the water from the wells to Barnsley and Twin Lakes. The exact design of this conveyance system (particularly pipe size) will depend on the discharge capability of the well system.

Figures 5 and 6 show plan and profile views, respectively for four potential pipeline routes. The profiles were based on 7.5-Minute Digital Elevation Models from the United States Geological Survey.

- **Route 1**, beginning at the proposed Well Site 1, runs southwest along an existing fence line to Wolf Creek Road; along Wolf Creek Road to Twin Lakes Road (node 1); along Twin Lakes Road (past node 2) to a gravel access road (node 5); along the gravel access road (past node 6) to the discharge point into Twin Lakes (node 7). There is also a branch from Twin Lakes Road (node 2 past node 3) to the discharge point into Barnsley Lake (node 4).

- **Route 2**, beginning at the proposed Well Site 2, runs south along an existing fence line to Twin Lakes Road (node 1); under Twin Lakes Road and across private property (past node 3) to the gravel access road (node 6); along the gravel access road to the discharge point into Twin Lakes (node 7). There is also a branch to the discharge point into Barnsley Lake (from node 3 to node 4).

- **Route 3**, beginning at the proposed Well Site 1, runs southwest along an existing fence line to Wolf Creek Road; along Wolf Creek Road to Twin Lakes Road (node 1); along Twin Lakes Road to a gravel access road (node 2); along the gravel access road (past node 3) across private property along an existing fence line to the gravel access road (node 6); along the gravel access road to the discharge point into Twin Lakes (node 7). There is also a branch to the discharge point into Barnsley Lake (from node 3 to node 4).

- **Route 4**, beginning at the proposed Well Site 2, runs south along an existing fence line to Twin Lakes Road (node 1); from this point it is the same as Route 3.

Route 1 follows along existing paved roads for a significant distance. As a result, there would be more easement and utility issues (and costs) associated with Route 1. Route 2 runs across private property, a portion of which (from node 1 to node 3) the landowner objects to. Route 3 has the support of the property owners. However, Route 4 may be the best compromise. Table 2 provides cost estimates for all four routes, as well as all other costs associated with this alternative.

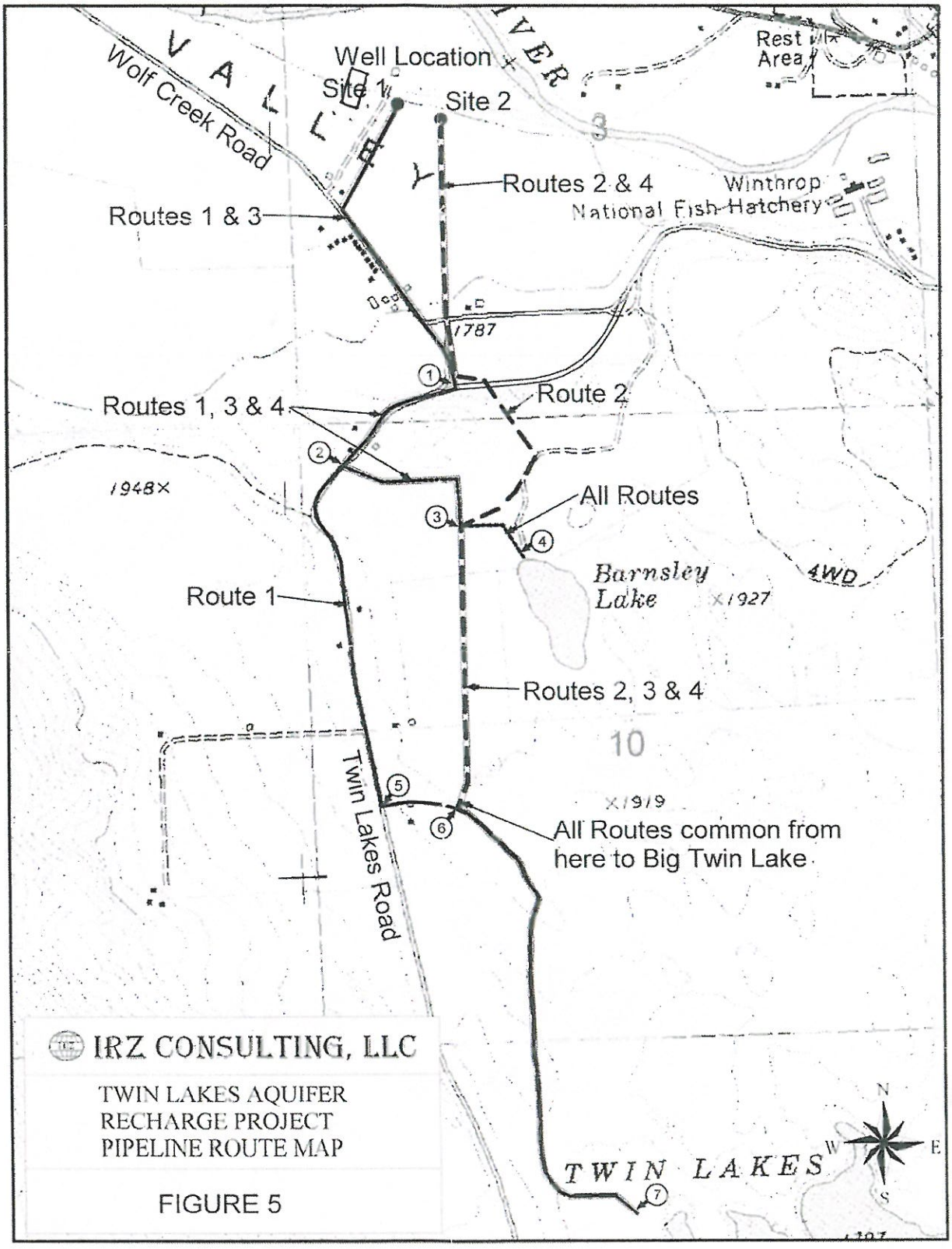
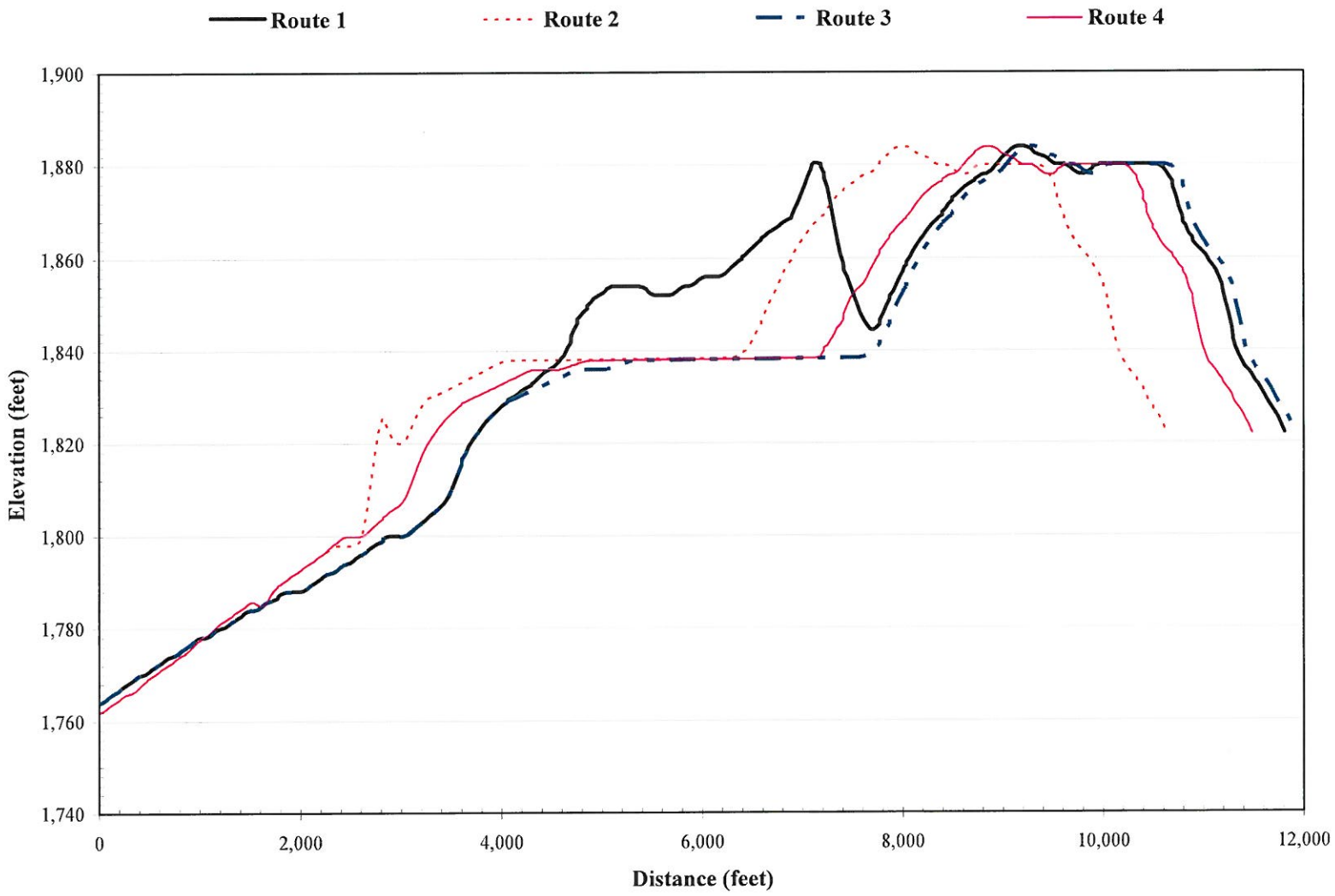

Well Location
Site 1
Site 2
Wolf Creek Road
Rest Area
Routes 2 & 4
Winthrop National Fish Hatchery
Routes 1 & 3
1787
Route 2
Routes 1, 3 & 4
1948X
All Routes
Barnsley Lake
X1927
4WD
Route 1
Routes 2, 3 & 4
10
X1919
Twin Lakes Road
All Routes common from here to Big Twin Lake
TWIN LAKES
IRZ CONSULTING, LLC
TWIN LAKES AQUIFER
RECHARGE PROJECT
PIPELINE ROUTE MAP
FIGURE 5

Figure 6. Profiles of Proposed Pipeline Routes.



Pipelines are ended short of Barnsley and Twin Lakes so that the discharge can flow through a man-made open channel to the lakes. The main purpose of these channels is to re-oxygenate the pumped water prior to introduction into the lakes. The channels will be lined with an impermeable liner to prevent leakage. The liner will be covered with a soil and rock matrix for energy dissipation and to promote a natural look to the stream.

Table 2. Methow River Water Source: Estimated Costs for Pipeline Routes.

	Route 1.	Route 2.	Route 3.	Route 4.
Pipe - Materials	$186,100	$153,100	$171,400	$164,400
Pipe - Installation	$126,200	$ 96,400	$111,700	$105,300
Other	$ 44,700	$ 35,500	$ 32,900	$ 32,300
Sub-Total:	**$357,000**	**$285,000**	**$316,000**	**$302,000**
Engineering, Legal, Con. Mgmt.	$ 30,000	$ 25,000	$ 25,000	$ 25,000
Contingency and Sales Tax	$ 70,000	$ 60,000	$ 65,000	$ 60,000
TOTAL:	**$457,000**	**$370,000**	**$406,000**	**$387,000**

As can be seen in Tables 1 and 2, there is a considerable range of costs associated with this option because of the range in type and number of well(s), pipeline routes, and discharge of the system. Combining the costs from Tables 1 and 2 with the sum of the five year annual costs, the estimated five year cost of the Methow Well Option could range from $633,000 to $ 782,000. It is difficult to estimate the cost of this option per acre-foot because we don't know how much water the well system will produce. If however, we assume that the well field will produce 2,500 gpm for 90 days (approximately 1,000 acre-feet/year), the estimated cost per acre-foot (for the five year period is about $127 to $156/acre-foot.).

A potential addition to this option would be infiltration galleries along the course of the pipeline. These infiltration galleries would consist of a perforated drain pipe with a gravel and rock envelope buried in a trench below the frost line. These galleries would extend away from the main pipeline. Each gallery would be connected to the main pipeline with a valve to regulate the discharge rate into it. The logical locations for these galleries would be at low points along the main pipeline route. These locations would allow for both the introduction of water for seepage to the groundwater when desired and draining the mainline if needed. The rate at which water could be discharged would depend upon the subsoil in the immediate area around each gallery site. The estimated cost of one 100 foot long infiltration gallery (including all materials and labor) would be $5,000 to $7,000.

2.2 Thompson Creek Diversion Option

The Thompson Creek Diversion Option diverts water from Thompson Creek and supplies it to Big Twin Lake through a sinkhole. The location of this natural sinkhole is shown on Figure 7.

Three potential ways of diverting and conveying water to the sinkhole were considered. One way was to divert water from Thompson Creek into a gravity pipeline. This option would require extensive clearing of trees and brush along a portion of Thompson Creek to facilitate construction of a diversion structure and installation of the first few hundred feet of pipeline. This clearing was objected to by the property owner. A second way was to construct a pumping station in Thompson Creek and install a pressure pipeline. This option is not desirable due to the annual operation and maintenance costs of the pumping station. The third option was to reconstruct an abandoned irrigation ditch diverting water from a swamp fed by Thompson Creek. This preferred option would not drain the swamp, just lower its level by a few inches. The routes of all three options are shown in Figure 7.

A key element of this option, is that water will be delivered to Big Twin Lake through a geological, underground pathway located at the sinkhole. The advantage of this pathway is that the Thompson Creek water would be filtered by the glacial sediments that compose the Aquifer before introduction to the lake (thereby eliminating most potential pathogens).

The reliability of the sink hole to introduce water to the lake can best be seen through history. As water was diverted to the sinkhole in the past to try to create a pond near the Rodeo Grounds, Big Twin Lake levels responded directly to the increased input. In addition, the sinkhole appears to receive and discharge a considerable amount of irrigation return flow. On a November, 2002 field trip, IRZ calculated that in excess of 1 cfs was discharging through the sinkhole with no signs of ponding, as seen in Figure 8.

Although no formal hydrological study has been performed to estimate how much water could be delivered from Thompson Creek, several discharge measurements made throughout 2003, indicates that our assumption of one cfs for nine months (approximately 500 acre-feet) is achievable. The diversion and canal will be designed to divert as much as 2 cfs.

The Thompson Creek diversion is clearly a low technology, low cost option. Table 3 shows the estimated project cost for this option.

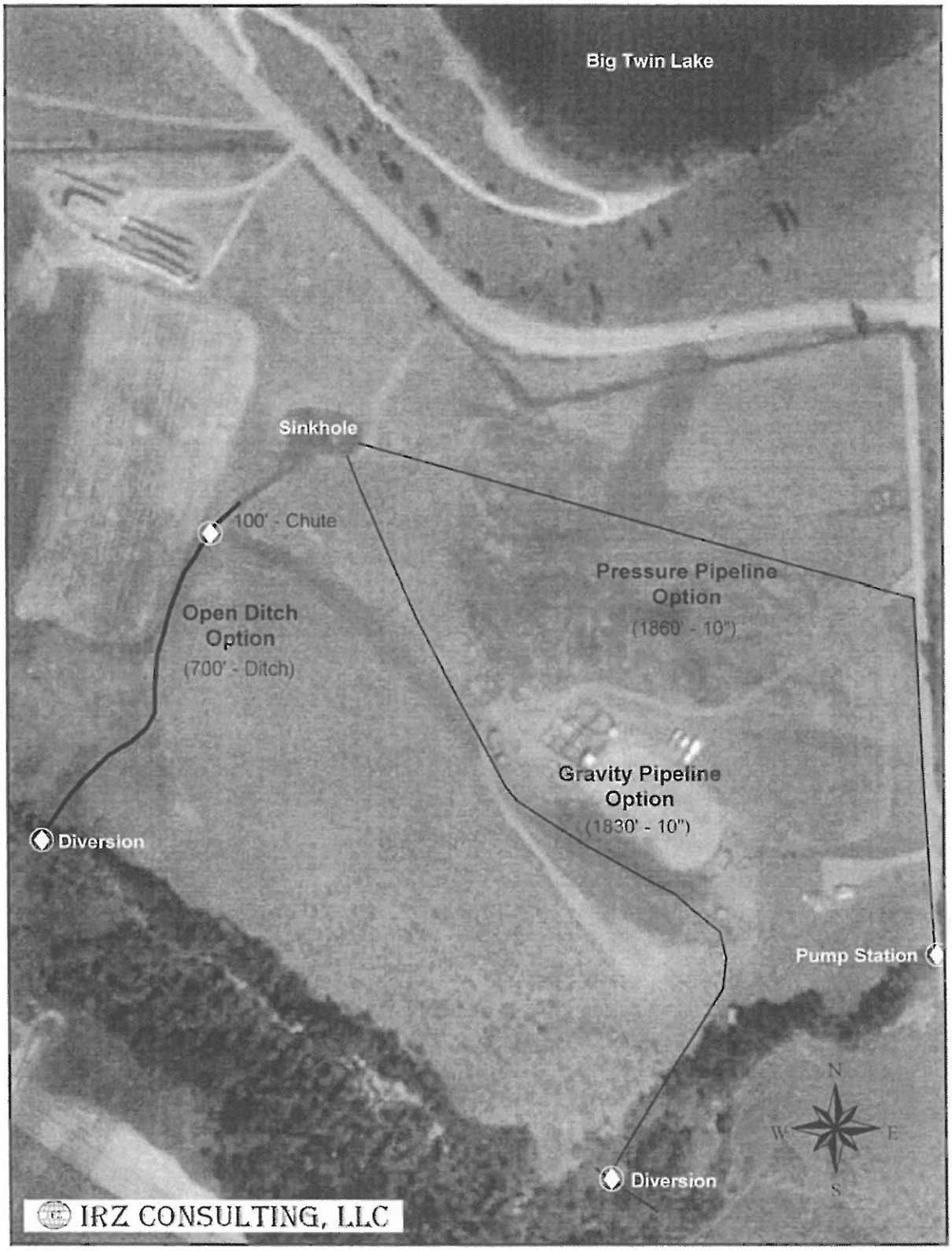


Figure 7. Site Map of Thompson Creek Options.

Figure 8. Picture of the Sinkhole taken on November 2, 2002.

Table 3. Estimated Costs for Thompson Creek Diversion.

Diversion Structure	$ 15,000
Construction of Lined Earthen Ditch	$ 15,000
Concrete Transition Box	$ 2,000
Concrete Chute	$ 3,000
Sub-Total:	**$ 35,000**
Engineering, Legal, Con. Mgmt.	$ 5,000
Contingency and Sales Tax	$ 5,000
TOTAL:	**$ 45,000**

The estimate annual operation and maintenance costs of this option would be $2,000.

As can be seen in comparing the costs of Tables 1 and 2 and Table 3, the Thompson Creek Diversion Option has a much lower cost per acre-foot of water than the Methow Well Option. For the Thompson Creek Diversion Option the estimated cost per acre-foot for the five year period is about $22/acre-foot. Annual costs for the Thompson

Creek Option are also much lower than the Methow Well Option because it is a gravity-based option so there will be no pumping costs. As previously stated, the main detriment of this option is that the water right may not be available for Thompson Creek, or may not be made available for some time. As a result, we are proposing that the water rights application for this option should be completed as soon as possible.

2.3 Wolf Creek Reclamation District Option

The Wolf Creek Reclamation District (WCRD) Option consists of diverting additional water from Wolf Creek, using the WCRD delivery system to points near Barnsley and Twin Lakes. Water would be added to Barnsley Lake through a lateral from the main WCRD pipeline. Water discharging through the lateral would outlet to a man made channel that would be similar to that of the Methow Well Option. Water would be delivered to Twin Lakes through the sinkhole, similarly to the Thompson Creek option. Water would be delivered to the sinkhole via a lateral from the main WCRD pipeline.

WCRD's fish screens and delivery system would need to be upgraded to divert the increased discharge. The existing fish screens are shown in Figure 9. The two, eight feet long, 32 inch diameter fish screens are capable of passing 14.5 cfs. We are planning to increase the discharge through the screens by replacing the existing screen in the modified foundation or adding an additional screen.

Figure 9. Wolf Creek Reclamation District's Fish Screens.

The existing conveyance to the siphon presents several potential areas of hydraulic control (portion(s) of the conveyance that may prohibit increased discharge without modification). IRZ surveyed the existing conveyance from Wolf Creek to the siphon and found that the existing combinations of pipe type and size and the existing slope of the conveyance are inadequate to add additional water.

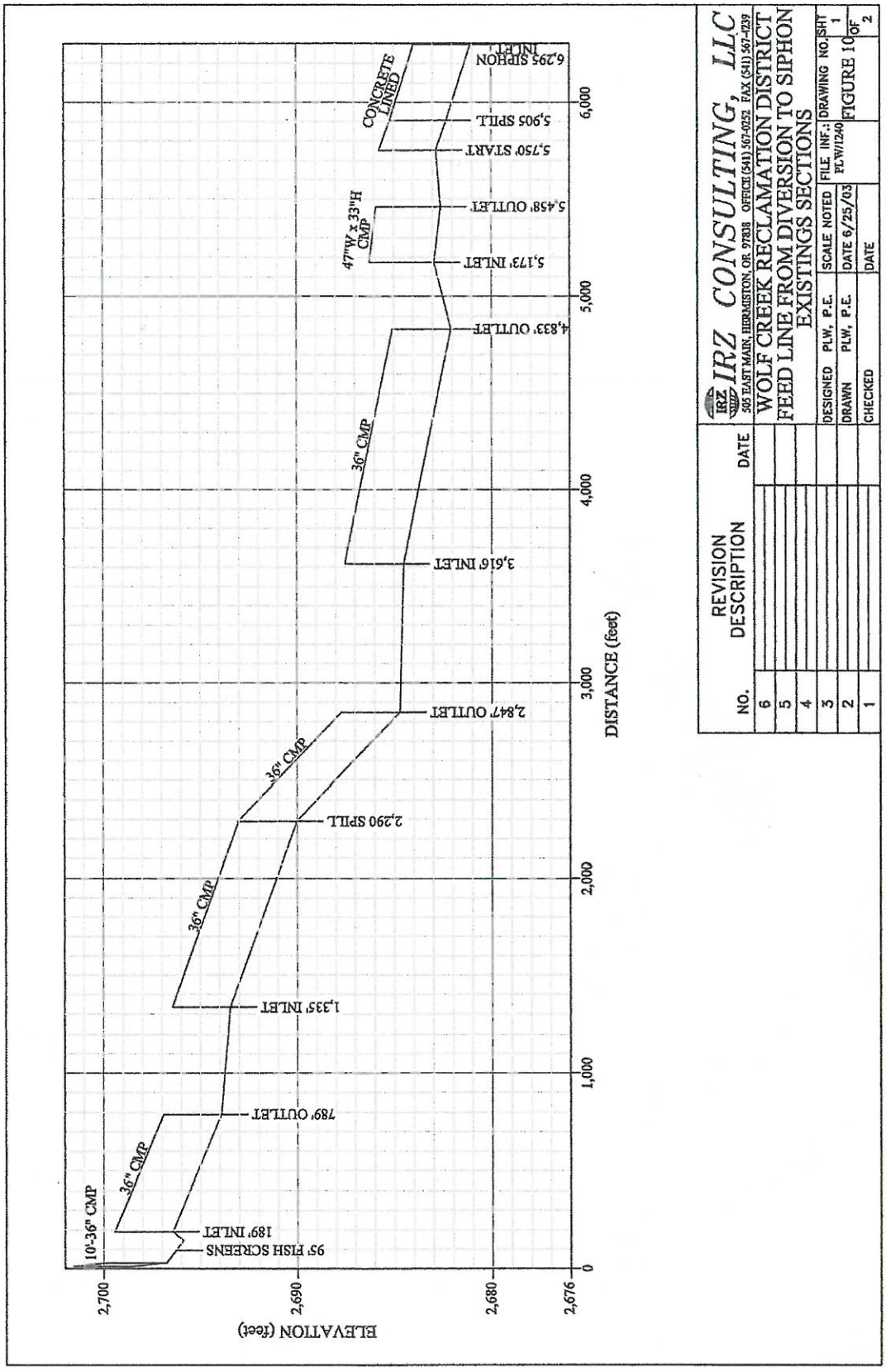
Figure 10 shows the existing conveyance invert profile with corrugated metal pipe (CMP) and concrete lined sections identified. Figure 11 shows the re-engineered conveyance to increase the discharge of the diversion from 14 to 18 cfs. As can be seen in Figure 11, the re-engineered conveyance would consist of installing approximately 2,100 linear feet of 36 inch HDPE pipe.

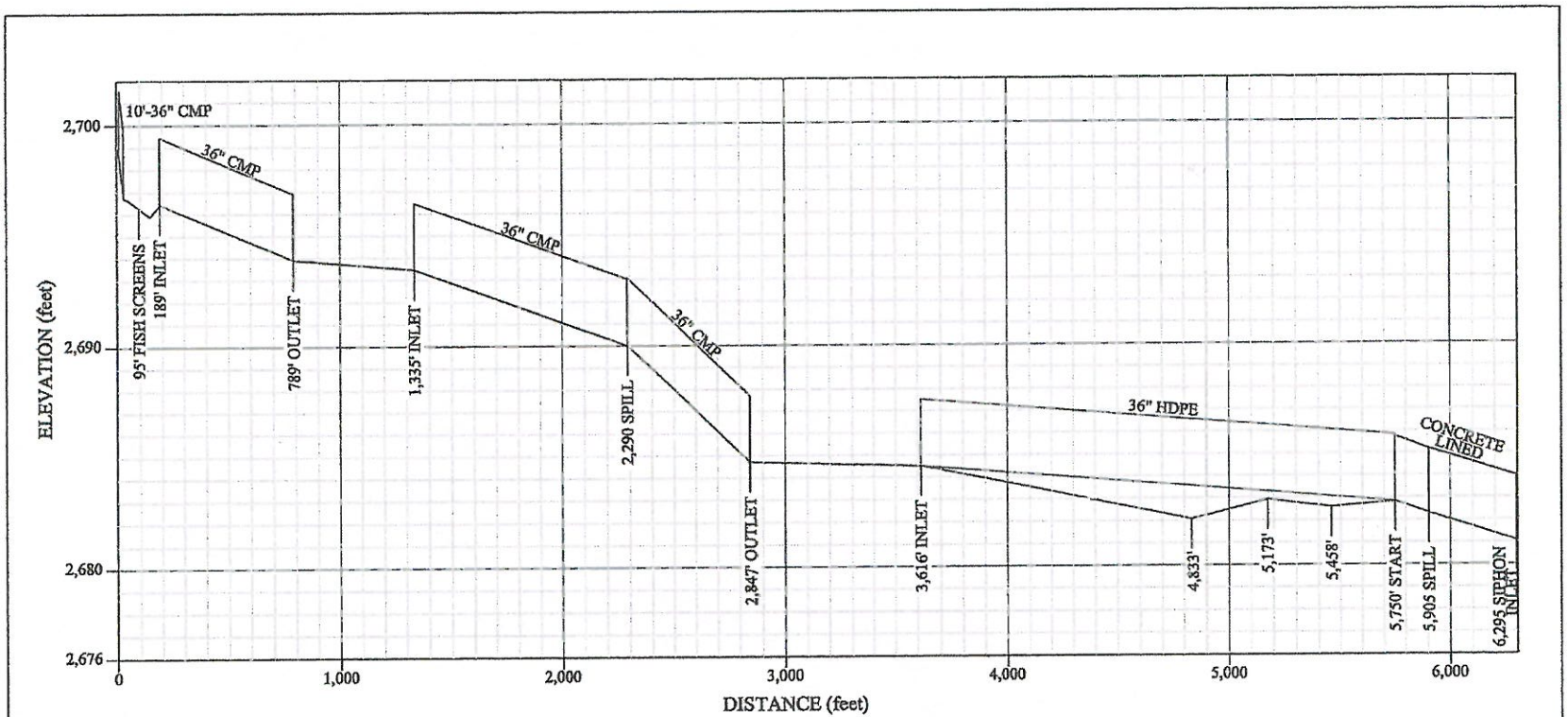
We are assuming, based on Wolf Creek flows and WCRD diversion records that we can increase the diversions by 4 cfs for a period of 90 days (or nearly 700 acre-feet). We will "piggy back" or add to the "shoulders" of the WCRD present diversions. Water will be added to both Barnsley and Twin Lakes via this option. Estimated costs for this option are shown in Table 4.

Table 4. Estimated Costs for Increasing the Wolf Creek Reclamation District Diversions.

Fish Screens	
Replace 32" Dia. with 40" Dia. Screens	$ 10,000
Replacing Entire Structure	$ 90,000
Conveyance System	
Reshape 1,484 feet of earthen channel	$ 16,500
Clean and Seal 545 feet of concrete channel	$ 1,500
Install 2,134 feet of 36 inch HDPE Pipe	$102,000
Inlet and Outlet Structures	$ 10,000
Modifications Below Paterson Lake	
Install 340 feet of 8" PVC to Sinkhole	$ 3,500
Provide 1,000 feet of 10" Gated Pipe	$ 2,500
Valves and Flow Meters	$ 6,000
Sub-Total:	**$152,000 to $232,000**
Engineering, Legal, Con. Mgmt.	$ 15,000
Contingency and Sales Tax	$ 45,000
TOTAL:	**$212,000 to $292,000**

The estimate annual operation and maintenance costs of this option would be $4,000. The estimated five year cost of this option is $232,000 to $312,000. The estimated cost per acre-foot (for the five year period is about $75 to $111/acre-foot.).


IRZ CONSULTING, LLC
505 EAST MAIN, HERMISTON, OR 97838 OFFICE (541) 567-0252 FAX (541) 567-4239
WOLF CREEK RECLAMATION DISTRICT
FEED LINE FROM DIVERSION TO SIPHON
EXISTINGS SECTIONS
REVISION DESCRIPTION
NO.
DATE
DESIGNED PLW, P.E.
DRAWN PLW, P.E.
CHECKED
SCALE NOTED
DATE 6/25/03
DATE
FILE INF.: TLW/1240
DRAWING NO. SHT 1 OF 2
FIGURE 10
ELEVATION (feet)
DISTANCE (feet)
2,700
2,690
2,680
2,676
0
1,000
2,000
3,000
4,000
5,000
6,000
10'-36" CMP
95' FISH SCREENS
189' INLET
36" CMP
789' OUTLET
1,335' INLET
36" CMP
2,290 SPILL
36" CMP
2,847' OUTLET
3,616' INLET
36" CMP
4,833' OUTLET
47"W x 33"H CMP
5,173' INLET
5,458' OUTLET
CONCRETE LINED
5,750' START
5,905 SPILL
6,295 SIPHON INLET



NO.	REVISION DESCRIPTION	DATE
6		
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IRZ CONSULTING, LLC
505 EAST MAIN, HERMISTON, OR 97838 OFFICE (541) 567-0252 FAX (541) 567-4239

WOLF CREEK RECLAMATION DISTRICT
FEED LINE FROM DIVERSION TO SIPHON
MODIFIED SECTIONS

DESIGNED PLW, P.E.	SCALE NOTED	FILE INF.: PLW/1240	DRAWING NO. FIGURE 11	SHT 2 OF 2
DRAWN PLW, P.E.	DATE 6/25/03			
CHECKED	DATE			

2.4 Comparison of Options

In the proceeding sections, the three main options to introduce water to the Aquifer (Methow River Well, Thompson Creek Diversion, and the Wolf Creek Diversion), have been described. In addition, the amounts and the costs of delivering the water through each system have been discussed and all major design assumptions have been listed. There is some uncertainty with the discussed options, but a great deal of flexibility has been achieved by considering all of the best options through this phase and into the design and construction phases.

All of the options will require an extensive amount of water rights activities. Because of this, we are estimating that the effort required for the acquisition of water rights for this project will cost approximately $100,000 over the five year period. This amount could be lower if the Methow River Well produces all of the water that is required to restore water levels in the Aquifer. However, this amount could be low if the well option needs to be supplemented by another option. Following is a re-iteration of the strengths and weaknesses of each of the options and a summation of the most likely scenario(s). We are also assuming that $50,000 will be needed for the five year period to measure wells in the Aquifer, water quality analysis, and reporting.

2.4.1 Strengths and Weaknesses

The main strength of the **Methow River Well Option** is the reasonable certainty of attaining a water right in the near future. This is why this option is preferred and, as a result, it appears to have the greatest amount of support by the affected parties. This option provides a filtered source of water and it can be delivered to Barnsley and Twin Lakes for introduction to the Aquifer. The greatest weakness of this option is that the well source is unproven and it has the highest construction and annual costs.

Clearly, the **Thompson Creek Diversion Option** is the lowest cost means of adding the water to the Aquifer. The greatest weaknesses of this option is that there is not a high expectation of producing a water right, the amount of water that may be produced is relatively small, and water may not be introduced to the Aquifer at Barnsley Lake.

The **Wolf Creek Diversion Option** is the middle priced option. It may produce the most water, essentially enough to add all of the needed water to the Aquifer. However, the water rights associated with this option are the most uncertain.

2.4.2 Most Likely Scenario(s)

Although there are numerous possibilities that could result during the next phase of investigation, design and construction, the following is, what we believe, is the most likely scenario(s) that could occur during the next five years.

We believe that it is fairly likely (greater than 50% probability) that we will be able to achieve a Methow River Well System that will produce a significant portion of the amount of water that is required. Because we are close to an operating system (State

Fish Hatchery), we believe that achieving 2500 gpm for 3 months is quite possible (or about 1000 acre-feet). It is quite likely, under this scenario, that the water rights for Thompson Creek would also have to be completed and the Thompson Creek Diversion Option would need to be built. The Thompson Creek Diversion could also be used to maintain the water levels after water levels are restored. It is conceivable under this scenario, that the Wolf Creek Option may also have to be developed if the amount of water required to boost the water levels in the Aquifer is greater than our estimates. The five year cost for this scenario is $ 828,000 to $977,000 which includes:

- $633,000 to $782,000 for the well and pumping system for 5 years,
- $45,000 for the Thompson Creek Option for years,
- $100,000 in water rights work, and
- $50,000 for Aquifer measurements and reporting.
- Wolf Creek Diversions, if needed could cost an additional $232,000 to $312,000 plus an additional amount for water rights applications.

It is less likely, but certainly possible that the Methow River Well Option could produce all of the water that is required. This could mean that more wells, or larger pump(s) and a greater capacity conveyance system would be designed and built. The added costs would make this scenario similar in price to that discussed above.

It is less likely (than the above two scenarios), that the Methow River Well Option could produce very little water. In that case, the option would be abandoned after explorations proved futile, and the Thompson Creek and Wolf Creek Diversions would be built if the necessary water rights can be obtained. The five year cost for this scenario is $ 427,000 to $507,000 which includes:

- $ 232,000 to $312,000 for the improvements to the Wolf Creek Diversion,
- $ 45,000 for the Thompson Creek Option for years,
- $100,000 in water rights work, and
- $50,000 for Aquifer measurements and reporting.
- This option could cost more for water rights.

APPENDIX A.

Department of Ecology Comments
RE: Twin Lakes Aquifer Recharge Project Final Interim Report
January 23, 2003

General Comments

The report uses very limited data to reach broad specific conclusions well beyond what the data supports. Leakage from the formerly unlined Wolf Creek Reclamation District (WCRD) certainly contributed water to the aquifer in the Twin Lakes area. The report claims to contain data demonstrating this effect and assigns a percentage of total recharge water contributed by WCRD. However, the report actually includes a very limited amount of data, shows little clear correlation between recent WCRD operational changes and aquifer/lake levels, and assigns parameter values well beyond any technically valid level of confidence.

Overall, the report effectively communicates concerns about declining aquifer levels experienced by members of the Twin Lakes Aquifer Coalition (TLAC) and perhaps others in the area. It, however, falls short of the stated intent to be "...roughly equivalent of a Feasibility Study."

The report does not adequately address the geologic and hydrogeologic character of kettle lakes, the glacial kame-moraine that forms the structure for the aquifer of concern or the bedrock base of the aquifer(s). Adequate characterization is necessary to assure that the intended results of the proposed action can be accomplished. A characterization, in this case, should estimate aquifer parameters, etc., and include consideration of the occurrences of springs at the north, east and south sides of the remnant kame-moraine to identify discharge points, as well as estimate the volume which may be lost from the aquifer during recharge and whether any negative effects might result. In addition, evaluation of basic ground water gradients (ground water flow directions), the aquifer's saturated thickness and depth to bedrock particularly along the topographically expressed ridge south and southeast of Barnsley Lake should be examined to assess whether subsurface conditions might preclude ground water recharge at Barnsley Lake from reaching the Twin Lakes area or other project target regions. Adequate characterization of the entire aquifer is needed to evaluate similar issues for any proposed recharge point to determine whether recharge at a particular location will effectively recharge all of the identified stressed regions.

Perhaps more importantly, the report is silent with regard to examples or precedents from other areas of the state where similar irrigation improvements have occurred, and where well owners have been informed there is no right to the artificially high ground water. Individual well owners in other such areas have not been provided state funds to deepen their wells. The report should serve to inform and educate the affected parties in this case.

The introduction refers to a December 16, 2002, meeting between IRZ, stakeholders, WDOE and the Twin Lakes Aquifer Coalition. Unfortunately, the opinions expressed by various stakeholders at the meeting were not reflected in developing this report and its recommendations. The opinions expressed by participants at the meeting included the difficulty of obtaining new water rights from Wolf and Thompson Creeks, the strongly expressed desire of WCRD to avoid any actions that may trigger a tentative determination of their rights, and the need to establish a local improvement district to serve the water needs of future development. The meeting was represented as an opportunity to join a collaborative process to address the issues and that is not reflected in this draft report. In our detailed comments, we point to the prioritization process as one way to correct this deficiency.

Specific Comments

Executive Summary

The report incorrectly states that the decrease in water level is a result of, "A decrease in aquifer recharge due to state-enforced changes on the Wolf Creek Reclamation District's operations". The quantity of Wolf Creek Reclamation District's (WCRD) water right is defined by an Adjudication and has not changed in recent years. It is likely that WCRD improved their efficiencies in order to maximize the water available for irrigation by reducing waste. "State-enforced changes" were not a factor since the state has not required the district to make any changes. The report should be corrected.

The report states that ground water decline "...has adversely affected more than 500 home sites that rely on this aquifer". The report should distinguish between existing homes presently affected and vacant undeveloped parcels. If there are a substantial number of undeveloped parcels, then future stresses on the shallow ground water supply may occur in spite of the proposed solutions. Example: 500 homes x ½ acre irrigated lawn (allowed under the domestic exemption) = 250 acres = 0.4 sq miles = 9% of the aquifer recharge area = approximately 430 acre-feet of potential consumptive irrigation (90% efficiency). What portion of this amount has already been developed and how much of it is presently undeveloped?

Section 1 - Introduction

The report states, "This restrictions, together with low flows from Wolf Creek limited WCRD's diversions from 1998 to 2002" WCRD has indicated that in 2002, they diverted their full permitted annual quantity from Wolf Creek. The report should be corrected.

The report states, "The Twin Lakes Aquifer is approximately 4.6 square miles in size...its vertical extent...consists of as much as 230 feet of glacial deposits..." This comment appears to be referring to the total thickness of sedimentary deposits and not to the thickness of the aquifer. The thickness of the aquifer would be its saturated thickness. The report does not appear to identify or estimate the aquifer's saturated thickness.
The report indicates, "This decline [~11 ft] has been nearly catastrophic..." A drop of 11 feet must be looked at relative to the aquifer's total saturated thickness before concluding that a catastrophic aquifer event has occurred. What percent of the total saturated thickness does the 11 foot drop actually represent? Does it exceed a reasonable and feasible pumping lift?

Domestic well owners are commonly advised that they must fully penetrate and fully utilize the available aquifer before regulatory assistance can be given. Deepening of shallow wells in an aquifer with a reasonably large saturated thickness is perhaps a short term economic hardship on the individual well owner, however it is far from catastrophic when compared to actual aquifer mining or having no other options. In addition, domestic wells in this area may still be deepened into underlying bedrock where fracture flow often provides water sources adequate for domestic requirements.

The report states, "some wells have experienced a ...degradation of water quality". This should be explained further, documented and possible causes evaluated to determine whether or not water quality issues are actually related to declines in aquifer water levels. It would be unusual for the reduction of water levels in an otherwise healthy aquifer to produce water quality problems (it is more likely this reflects only shallow wells very near the lake(s) and the associated decline in surface water quality as lake levels decline).

The report states, "...other wells have/or will... be rendered useless because there is no additional water that can be developed even if they are deepened." This should be explained further. Domestic well owners have the option of drilling into deeper bedrock aquifers.

The report states, "several ...potential alternatives result in water being added to the aquifer through the Barnsley Lake bottom." Lake bottoms, due to their still water depositional environments, often have clogging layers of clay to silt sized sediment. It is more likely that water will perch and pond over the lake bottom and leak from the kettle's sides into the aquifer. Further, it should be noted that ground water flow paths around Barnsley Lake do not appear to have been considered although the lake/depression is located at the northern extreme of the aquifer where "the extent of the aquifer...is less well known." No consideration has been given to loss of water by evaporation while ponded in the lake bed before it is able to migrate to ground water. No consideration of discharge points in this area has been discussed. Are there discharge points below and to the north of Barnsley Lake where water may discharge to instead of recharging the aquifer and the lakes to the south? Is this option assuming injection wells for recharging the aquifer or simple percolation though the sediments?

Section 2 - Geology of the Twin Lakes Aquifer

The report states that "...a geologic cross section developed by Glen Benzona (a local geologist and well driller and ... part of the IRZ team) is [given] in Figure 2." First, it appears this name has been misspelled in the text since the name on the cross-section is spelled B e z o n a. Secondly, an inquiry of the Department of Licensing suggests that Mr. Bezona does not hold a valid, current, license to practice geology, hydrogeology, or well drilling in the State of Washington. This would imply that the consulting PE is responsible under his/her license and professional stamp for all geologic, hydrogeologic, and well drilling interpretations presented in this report rather than Mr. Bezona.

Figure 2 depicts a cross section apparently based on data from two wells spaced 200 feet apart. There are many wells in the Twin Lakes area. Does data from additional wells support the conclusions? Citing this supporting data would strengthen the report's geologic credibility. If additional data from wells were not used, the geologic conclusions drawn by the report are of very limited value and should not be used to characterize the entire "4.6 square mile aquifer" since, as the report appropriately notes, "...hummocky glacial sediments are chaotic in nature."

Local water well reports from wells drilled in the area of the topographic high points between Barnsley Lake and the Twin Lakes suggest the possibility of a bedrock protrusion below overlying sediments. A local well inventory, a well location and elevation survey and the construction of adequate cross-sections should be done to confirm or rule out the possibility of a sub-surface obstruction that could impede or prevent water discharged to Barnsley Lake from reaching the Twin Lakes area. A ground penetrating radar survey may also be appropriate.

Section 3 - Hydrogeology of the Twin Lakes Aquifer

There is very little aquifer specific useful information in this section. The section simply illustrates that more work needs to be done to characterize the aquifer and more work needs to be done to determine how much water will be needed for the proposed project.

Section 3.1 - Precipitation Recharge

Figure 3 provides a graphic representation of the Winthrop precipitation totals and departure from the mean for a period from approximately 1960 to 2002. Figure 4 provides a graphic representation of eight lake level measurements taken between 1922 and 2002. Without precipitation data, it is ill-advised to draw relationship conclusions based solely on lake level measurements prior to 1960. Four lake level measurements are shown between 1960 and 2002. These measurements seem to align roughly with the accumulated departure from mean precipitation for the period, though drawing specific conclusions from this very limited data would be unscientific.

It is interesting to note that in 1990, when presumably WCRD was in full operation, the measured lake level was within one foot of the 2002 lake level. The recently observed dropping lake level may be more heavily linked to recent rainfall trends. Since lake level data is quite limited, a more definitive relationship between water level and other factors may become more apparent as additional data is collected.

The report states, "The USGS has been monitoring some of the wells in the aquifer since 1980. Well monitoring has increased in intensity since 2000, due to concern expressed by residents of the area of their declining well-water levels." Personal communications with staff at the USGS Tacoma office indicate this statement is incorrect and that:

> "As part of our ground water investigation in the Methow, we inventoried [Twin Lake area] wells and put the static levels (when the well was drilled) from the well reports in our data base. When we pulled water levels for all of the wells around the Twin Lakes, it included those initial static levels. USGS did measure water levels in wells from November 2000 to August 2001. In any event, we don't have good long term records on ground water levels in the Twin Lakes area, but the levels from Water Year 2001 do provide a good basis for assessing recent changes."

The USGS started monitoring the Twin Lakes area wells as part of a larger basin wide study. Monitoring has not increased in intensity due to concerns over dropping water levels in Twin Lakes. Monitoring by the USGS has been performed at the Twin Lakes on the schedule established for the basin wide study.

Figure 5 of the report purports to show "the trend in those wells that have been monitored over a long period of time." Since the wells have not been monitored over a long term period, no "trend" can be drawn between the original static water levels and the USGS Methow Basin Study monitoring records.

The report states, "...it [the total water lost] could be nearly three times greater if the specific yield of the aquifer is 0.3 rather than the 0.1 assumed above." It is unlikely that poorly sorted, stagnant-ice, glacial sediments deposited as a kame-moraine complex will display a specific yield of 0.3. It is more reasonable to assume the lower range value.

The report states, "Clearly other factors, besides natural precipitation are responsible for the ...drop in ...Big Twin Lakes and the associated ground water levels..." It is not clear from the information in the report to what degree man-caused activities are affecting lake and ground water levels.

Section 3.2 - Wolf Creek Reclamation

The first paragraph includes the statement, "However, it is also increasingly clear that the irrigation return flow from a district may supply a substantial amount of water back to a river, supplementing stream flows at times and

locations that may prove advantageous for fisheries and other purposes." Unlined irrigation ditches almost certainly contribute to ground water recharge which may result in measurable increases in ground water discharge to streams but Ecology is unaware of any scientific studies that conclusively show this relationship to be more advantageous to fisheries than reducing waste and leaving water in its original stream. Please cite your sources for this statement.

The report cites the Columbia Basin Irrigation Project where irrigation practices have increased ground water levels in the Pasco Basin and compares this to the Wolf Creek Reclamation District. The Phase 2 – Level 1 Assessment, March 2002, for the Methow River Basin Watershed Planning effort cautions against comparing the Pasco example directly with the Methow Valley: "In the Methow, the relative magnitudes of "natural" ground water recharge and irrigation recharge are not as large as the Pasco example. This relative magnitude irrigation recharge is unlikely to cause significant changes in ground water level..."

It is uncertain exactly what Figure 7 illustrates. Although the text asserts that it suggests steady, constant recharge due to irrigation return flows over time and in spite precipitation variation, this conclusion is not readily apparent. Data from the aquifer is not included on this graph, so any conclusions about aquifer recharge based upon the graph are strongly speculative.

In the discussion on return flows from irrigated fields, the author's calculations appear to assume that the fields were not irrigated the entire season since the estimated return flows are based on full season irrigation. In reality, WCRD patrons could irrigate up until irrigation water deliveries were suspended. Furthermore the WCRD stores water in Patterson Lake and can continue to deliver water after the diversion of Wolf Creek water has ended. The deficit to the Twin Lakes Aquifer due to irrigation return flows may be much less than what is described.

The end of this section assigned percentages to the reduced aquifer recharge: 55% WCRD, 45% drought. These percentages are extremely speculative being based on little or no measured data. It is difficult to estimate a level of confidence for these percentages but the error is likely to be far larger than the difference between them. In other words, the relationships asserted based on these percentages are not likely to be valid.

Section 3.3 - Hydrology Conclusions

The report suggests the estimated specific yield could be "considerably higher". As stated earlier, it is unlikely that poorly sorted glacial sediments deposited as a kame-moraine complex will display a specific yield of 0.3. It is more reasonable to assume the lower range value.

The report suggests that "as water is added...discharge will increase". Since there is an incomplete understanding of the hydrogeology of this area, the flow paths, and local discharge points, the authors should take into consideration the possibility of creating new points of discharge where none had occurred previously. What monitoring would be needed to assure that as water moves into the aquifer that it flows to the intended regions and that new discharge points are not created? (see comment above on discharging water to the aquifer via Barnsley Lake bottom)

Section 4

Presented here are general comments and an overview of the legal constraints pertaining to new water right permitting in the area and changes to existing water rights.

Both Wolf Creek and Thompson Creek are closed year-round by WAC 173-458 to further appropriations since 1976. This includes both increases in instantaneous diversion rate and lengthening the period of time for a diversion. The first three alternatives would necessitate a determination that there is more water available in these watersheds and WAC 173-548 would have to be amended to reflect this. No basis for such a conclusion is reflected in this report and this is a subject area currently under the purview of the Methow Planning Unit. Modifications to WAC 173-548 to reflect local planning recommendations have twice failed in the past five years, so we think it is unrealistic to characterize these three alternatives as potential short term, or perhaps even intermediate term, solutions to the problem.

Any new application filed for a new water right from the Methow River would be at the end of a long line of new applications for water within the Methow Watershed. Ecology is not expecting to be processing new water right applications in the Methow Valley in the near future as most of the permitting resources have been prioritized to support decisions on applications to water right changes. New applications such as might be filed to pump water

from the Methow River to Twin Lakes may not be eligible for expedited processing under WAC 173-170, unless the proposed use is both non-consumptive and accomplishes a substantial environmental benefit. The report should reflect that any new water right authorized under WAC 173-548 would be subject to interruption based on the Methow River instream flows. This would affect the facility design, particularly as it relates to peak capacity, and this will affect its reliability as a source of water for Twin Lakes, particularly in drought years.

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4.1.2 Increase Diversion Time from Wolf Creek and
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After spending a lot of money to pipe their system, it is highly unlikely that this is really an option. The state is encouraging water users to become more efficient by lining canals and piping water delivery systems. Funding a project that would decrease efficiencies would be counter productive.

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4.1.6 - High School Well Active Pumping Alternative

The authorization that allows the High School to use the well is specific in that the amount of water withdrawn from the well must be allowed to stay in Wolf Creek from the WCRD diversion down to the confluence with the Methow River. The school still needs to use the well for irrigation (in addition to the WCRD delivery system), so what is proposed in both of these alternatives requires a new water right to use the school well for aquifer augmentation. The problem of a new water right application is described above. See comments above regarding Barnsley Lake as a recharge point.

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4.1.10 - Methow Aquifer Ground Water Right (new)

These alternatives suggest a ground water interceptor well (infiltration gallery?) near the National Fish Hatchery. Efforts by the National Hatchery to establish a new infiltration gallery in this area have been unsuccessful to date. Test excavations, etc. in the fall of 2002 have demonstrated a need to find more promising sites. The issues regarding new water right applications are described above.

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existing water rights along the Methow River above Winthrop. The water could then be pumped from a well or pump station near Winthrop or the high school to the Twin Lakes area. Such a water right change could be processed by the newly formed Okanogan County Water Conservancy Board, or if eligible for expedited processing, by Ecology.

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The section refers to the evaluation criteria including input from the December 16, 2002 meeting of stakeholders. It appears that at least some of the feedback provided was not factored in, such as the regulatory and effected community difficulties with new water diversions from Wolf and Thompson Creek. Properly factored in, this input would drop the top two options well below 40 points. A re-evaluation of measures is necessary that includes accurate stakeholder input and assessment of water availability.

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The "Quantity" of water available under the Wolf Creek diversions should not rate a "20" since under present law, no additional water is available from Wolf Creek. On the other hand, the quantity of water available under either temporary or permanent transfers should be a 20, since it is only a matter of how big a water right or how many water rights are leased or purchased (although this may change the capital cost figures).

The "increase Wolf Creek diversions", High School Offset, and several other alternatives are given a "10" for "Place". The "place" described is Barnsley Lake, yet the author concedes that it is unknown if Barnsley Lake is a good candidate for aquifer recharge. Without further information, Barnsley Lake should not receive a top score in the matrix.

Section 5.2 - Costs

Most of the alternatives include some piping system to deliver water to the Twin Lakes area, however, no mention is made to estimate the cost of acquiring property easements for the pipeline.

Sec 5.3 - Ranking of Options

The ranking of options appears to be highly flawed. If proper weight is given to the regulatory difficulties, potential for negative public comments or appeals, and the legal and physical availability of water, the first and second rated options of new water from Thompson and/or Wolf Creeks will score far lower. We suggest that the matrix be re-worked and all the options be re-ranked using a more realistic assessment of the legal, administrative, and physical factors scores that could drive success or failure of the proposal. Much of this guidance was reflected in the comments of the participants in the initial meeting on December 16, 2002.

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General Comments

The report uses very limited data to reach broad specific conclusions well beyond what the data supports. Leakage from the formerly unlined Wolf Creek Reclamation District (WCRD) certainly contributed water to the aquifer in the Twin Lakes area. The report claims to contain data demonstrating this effect and assigns a percentage of total recharge water contributed by WCRD. However, the report actually includes a very limited amount of data, shows little clear correlation between recent WCRD operational changes and aquifer/lake levels, and assigns parameter values well beyond any technically valid level of confidence.

Overall, the report effectively communicates concerns about declining aquifer levels experienced by members of the Twin Lakes Aquifer Coalition (TLAC) and perhaps others in the area. It, however, falls short of the stated intent to be "...roughly equivalent of a Feasibility Study."

The report does not adequately address the geologic and hydrogeologic character of kettle lakes, the glacial kame-moraine that forms the structure for the aquifer of concern or the bedrock base of the aquifer(s). Adequate characterization is necessary to assure that the intended results of the proposed action can be accomplished. A characterization, in this case, should estimate aquifer parameters, etc., and include consideration of the occurrences of springs at the north, east and south sides of the remnant kame-moraine to identify discharge points, as well as estimate the volume which may be lost from the aquifer during recharge and whether any negative effects might result. In addition, evaluation of basic ground water gradients (ground water flow directions), the aquifer's saturated thickness and depth to bedrock particularly along the topographically expressed ridge south and southeast of Barnsley Lake should be examined to assess whether subsurface conditions might preclude ground water recharge at Barnsley Lake from reaching the Twin Lakes area or other project target regions. Adequate characterization of the entire aquifer is needed to evaluate similar issues for any proposed recharge point to determine whether recharge at a particular location will effectively recharge all of the identified stressed regions.

Perhaps more importantly, the report is silent with regard to examples or precedents from other areas of the state where similar irrigation improvements have occurred, and where well owners have been informed there is no right to the artificially high ground water. Individual well owners in other such areas have not been provided state funds to deepen their wells. The report should serve to inform and educate the affected parties in this case.

The introduction refers to a December 16, 2002, meeting between IRZ, stakeholders, WDOE and the Twin Lakes Aquifer Coalition. Unfortunately, the opinions expressed by various stakeholders at the meeting were not reflected in developing this report and its recommendations. The opinions expressed by participants at the meeting included the difficulty of obtaining new water rights from Wolf and Thompson Creeks, the strongly expressed desire of WCRD to avoid any actions that may trigger a tentative determination of their rights, and the need to establish a local improvement district to serve the water needs of future development. The meeting was represented as an opportunity to join a collaborative process to address the issues and that is not reflected in this draft report. In our detailed comments, we point to the prioritization process as one way to correct this deficiency.

Specific Comments

Executive Summary

The report incorrectly states that the decrease in water level is a result of, "A decrease in aquifer recharge due to state-enforced changes on the Wolf Creek Reclamation District's operations". The quantity of Wolf Creek Reclamation District's (WCRD) water right is defined by an Adjudication and has not changed in recent years. It is likely that WCRD improved their efficiencies in order to maximize the water available for irrigation by reducing waste. "State-enforced changes" were not a factor since the state has not required the district to make any changes. The report should be corrected.

The report states that ground water decline "...has adversely affected more than 500 home sites that rely on this aquifer". The report should distinguish between existing homes presently affected and vacant undeveloped parcels. If there are a substantial number of undeveloped parcels, then future stresses on the shallow ground water supply may occur in spite of the proposed solutions. Example: 500 homes x ½ acre irrigated lawn (allowed under the domestic exemption) = 250 acres = 0.4 sq miles = 9% of the aquifer recharge area = approximately 430 acre-feet of potential consumptive irrigation (90% efficiency). What portion of this amount has already been developed and how much of it is presently undeveloped?

Section 1 - Introduction

The report states, "This restrictions, together with low flows from Wolf Creek limited WCRD's diversions from 1998 to 2002" WCRD has indicated that in 2002, they diverted their full permitted annual quantity from Wolf Creek. The report should be corrected.

The report states, "The Twin Lakes Aquifer is approximately 4.6 square miles in size...its vertical extent...consists of as much as 230 feet of glacial deposits..." This comment appears to be referring to the total thickness of sedimentary deposits and not to the thickness of the aquifer. The thickness of the aquifer would be its saturated thickness. The report does not appear to identify or estimate the aquifer's saturated thickness.
The report indicates, "This decline [~11 ft] has been nearly catastrophic..." A drop of 11 feet must be looked at relative to the aquifer's total saturated thickness before concluding that a catastrophic aquifer event has occurred. What percent of the total saturated thickness does the 11 foot drop actually represent? Does it exceed a reasonable and feasible pumping lift?

Domestic well owners are commonly advised that they must fully penetrate and fully utilize the available aquifer before regulatory assistance can be given. Deepening of shallow wells in an aquifer with a reasonably large saturated thickness is perhaps a short term economic hardship on the individual well owner, however it is far from catastrophic when compared to actual aquifer mining or having no other options. In addition, domestic wells in this area may still be deepened into underlying bedrock where fracture flow often provides water sources adequate for domestic requirements.

The report states, "some wells have experienced a ...degradation of water quality". This should be explained further, documented and possible causes evaluated to determine whether or not water quality issues are actually related to declines in aquifer water levels. It would be unusual for the reduction of water levels in an otherwise healthy aquifer to produce water quality problems (it is more likely this reflects only shallow wells very near the lake(s) and the associated decline in surface water quality as lake levels decline).

The report states, "...other wells have/or will... be rendered useless because there is no additional water that can be developed even if they are deepened." This should be explained further. Domestic well owners have the option of drilling into deeper bedrock aquifers.

The report states, "several ...potential alternatives result in water being added to the aquifer through the Barnsley Lake bottom." Lake bottoms, due to their still water depositional environments, often have clogging layers of clay to silt sized sediment. It is more likely that water will perch and pond over the lake bottom and leak from the kettle's sides into the aquifer. Further, it should be noted that ground water flow paths around Barnsley Lake do not appear to have been considered although the lake/depression is located at the northern extreme of the aquifer where "the extent of the aquifer...is less well known." No consideration has been given to loss of water by evaporation while ponded in the lake bed before it is able to migrate to ground water. No consideration of discharge points in this area has been discussed. Are there discharge points below and to the north of Barnsley Lake where water may discharge to instead of recharging the aquifer and the lakes to the south? Is this option assuming injection wells for recharging the aquifer or simple percolation though the sediments?

Section 2 - Geology of the Twin Lakes Aquifer

The report states that "...a geologic cross section developed by Glen Benzona (a local geologist and well driller and ... part of the IRZ team) is [given] in Figure 2." First, it appears this name has been misspelled in the text since the name on the cross-section is spelled B e z o n a. Secondly, an inquiry of the Department of Licensing suggests that Mr. Bezona does not hold a valid, current, license to practice geology, hydrogeology, or well drilling in the State of Washington. This would imply that the consulting PE is responsible under his/her license and professional stamp for all geologic, hydrogeologic, and well drilling interpretations presented in this report rather than Mr. Bezona.

Figure 2 depicts a cross section apparently based on data from two wells spaced 200 feet apart. There are many wells in the Twin Lakes area. Does data from additional wells support the conclusions? Citing this supporting data would strengthen the report's geologic credibility. If additional data from wells were not used, the geologic conclusions drawn by the report are of very limited value and should not be used to characterize the entire "4.6 square mile aquifer" since, as the report appropriately notes, "...hummocky glacial sediments are chaotic in nature."

Local water well reports from wells drilled in the area of the topographic high points between Barnsley Lake and the Twin Lakes suggest the possibility of a bedrock protrusion below overlying sediments. A local well inventory, a well location and elevation survey and the construction of adequate cross-sections should be done to confirm or rule out the possibility of a sub-surface obstruction that could impede or prevent water discharged to Barnsley Lake from reaching the Twin Lakes area. A ground penetrating radar survey may also be appropriate.

Section 3 - Hydrogeology of the Twin Lakes Aquifer

There is very little aquifer specific useful information in this section. The section simply illustrates that more work needs to be done to characterize the aquifer and more work needs to be done to determine how much water will be needed for the proposed project.

Section 3.1 - Precipitation Recharge

Figure 3 provides a graphic representation of the Winthrop precipitation totals and departure from the mean for a period from approximately 1960 to 2002. Figure 4 provides a graphic representation of eight lake level measurements taken between 1922 and 2002. Without precipitation data, it is ill-advised to draw relationship conclusions based solely on lake level measurements prior to 1960. Four lake level measurements are shown between 1960 and 2002. These measurements seem to align roughly with the accumulated departure from mean precipitation for the period, though drawing specific conclusions from this very limited data would be unscientific.

It is interesting to note that in 1990, when presumably WCRD was in full operation, the measured lake level was within one foot of the 2002 lake level. The recently observed dropping lake level may be more heavily linked to recent rainfall trends. Since lake level data is quite limited, a more definitive relationship between water level and other factors may become more apparent as additional data is collected.

The report states, "The USGS has been monitoring some of the wells in the aquifer since 1980. Well monitoring has increased in intensity since 2000, due to concern expressed by residents of the area of their declining well-water levels." Personal communications with staff at the USGS Tacoma office indicate this statement is incorrect and that:

> "As part of our ground water investigation in the Methow, we inventoried [Twin Lake area] wells and put the static levels (when the well was drilled) from the well reports in our data base. When we pulled water levels for all of the wells around the Twin Lakes, it included those initial static levels. USGS did measure water levels in wells from November 2000 to August 2001. In any event, we don't have good long term records on ground water levels in the Twin Lakes area, but the levels from Water Year 2001 do provide a good basis for assessing recent changes."

The USGS started monitoring the Twin Lakes area wells as part of a larger basin wide study. Monitoring has not increased in intensity due to concerns over dropping water levels in Twin Lakes. Monitoring by the USGS has been performed at the Twin Lakes on the schedule established for the basin wide study.

Figure 5 of the report purports to show "the trend in those wells that have been monitored over a long period of time." Since the wells have not been monitored over a long term period, no "trend" can be drawn between the original static water levels and the USGS Methow Basin Study monitoring records.

The report states, "...it [the total water lost] could be nearly three times greater if the specific yield of the aquifer is 0.3 rather than the 0.1 assumed above." It is unlikely that poorly sorted, stagnant-ice, glacial sediments deposited as a kame-moraine complex will display a specific yield of 0.3. It is more reasonable to assume the lower range value.

The report states, "Clearly other factors, besides natural precipitation are responsible for the ...drop in ...Big Twin Lakes and the associated ground water levels..." It is not clear from the information in the report to what degree man-caused activities are affecting lake and ground water levels.

Section 3.2 - Wolf Creek Reclamation

The first paragraph includes the statement, "However, it is also increasingly clear that the irrigation return flow from a district may supply a substantial amount of water back to a river, supplementing stream flows at times and

locations that may prove advantageous for fisheries and other purposes." Unlined irrigation ditches almost certainly contribute to ground water recharge which may result in measurable increases in ground water discharge to streams but Ecology is unaware of any scientific studies that conclusively show this relationship to be more advantageous to fisheries than reducing waste and leaving water in its original stream. Please cite your sources for this statement.

The report cites the Columbia Basin Irrigation Project where irrigation practices have increased ground water levels in the Pasco Basin and compares this to the Wolf Creek Reclamation District. The Phase 2 – Level 1 Assessment, March 2002, for the Methow River Basin Watershed Planning effort cautions against comparing the Pasco example directly with the Methow Valley: "In the Methow, the relative magnitudes of "natural" ground water recharge and irrigation recharge are not as large as the Pasco example. This relative magnitude irrigation recharge is unlikely to cause significant changes in ground water level..."

It is uncertain exactly what Figure 7 illustrates. Although the text asserts that it suggests steady, constant recharge due to irrigation return flows over time and in spite precipitation variation, this conclusion is not readily apparent. Data from the aquifer is not included on this graph, so any conclusions about aquifer recharge based upon the graph are strongly speculative.

In the discussion on return flows from irrigated fields, the author's calculations appear to assume that the fields were not irrigated the entire season since the estimated return flows are based on full season irrigation. In reality, WCRD patrons could irrigate up until irrigation water deliveries were suspended. Furthermore the WCRD stores water in Patterson Lake and can continue to deliver water after the diversion of Wolf Creek water has ended. The deficit to the Twin Lakes Aquifer due to irrigation return flows may be much less than what is described.

The end of this section assigned percentages to the reduced aquifer recharge: 55% WCRD, 45% drought. These percentages are extremely speculative being based on little or no measured data. It is difficult to estimate a level of confidence for these percentages but the error is likely to be far larger than the difference between them. In other words, the relationships asserted based on these percentages are not likely to be valid.

Section 3.3 - Hydrology Conclusions

The report suggests the estimated specific yield could be "considerably higher". As stated earlier, it is unlikely that poorly sorted glacial sediments deposited as a kame-moraine complex will display a specific yield of 0.3. It is more reasonable to assume the lower range value.

The report suggests that "as water is added...discharge will increase". Since there is an incomplete understanding of the hydrogeology of this area, the flow paths, and local discharge points, the authors should take into consideration the possibility of creating new points of discharge where none had occurred previously. What monitoring would be needed to assure that as water moves into the aquifer that it flows to the intended regions and that new discharge points are not created? (see comment above on discharging water to the aquifer via Barnsley Lake bottom)

Section 4

Presented here are general comments and an overview of the legal constraints pertaining to new water right permitting in the area and changes to existing water rights.

Both Wolf Creek and Thompson Creek are closed year-round by WAC 173-458 to further appropriations since 1976. This includes both increases in instantaneous diversion rate and lengthening the period of time for a diversion. The first three alternatives would necessitate a determination that there is more water available in these watersheds and WAC 173-548 would have to be amended to reflect this. No basis for such a conclusion is reflected in this report and this is a subject area currently under the purview of the Methow Planning Unit. Modifications to WAC 173-548 to reflect local planning recommendations have twice failed in the past five years, so we think it is unrealistic to characterize these three alternatives as potential short term, or perhaps even intermediate term, solutions to the problem.

Any new application filed for a new water right from the Methow River would be at the end of a long line of new applications for water within the Methow Watershed. Ecology is not expecting to be processing new water right applications in the Methow Valley in the near future as most of the permitting resources have been prioritized to support decisions on applications to water right changes. New applications such as might be filed to pump water

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The ranking of options appears to be highly flawed. If proper weight is given to the regulatory difficulties, potential for negative public comments or appeals, and the legal and physical availability of water, the first and second rated options of new water from Thompson and/or Wolf Creeks will score far lower. We suggest that the matrix be re-worked and all the options be re-ranked using a more realistic assessment of the legal, administrative, and physical factors scores that could drive success or failure of the proposal. Much of this guidance was reflected in the comments of the participants in the initial meeting on December 16, 2002.

030135/gh

RE: Comments on the Twin Lakes Aquifer Design Report, June 30, 2003 Draft

General Comments:

- Wolf Creek and Thompson Creek remain closed basins. An application for water from either one would have to be denied under current water law.
- The project has consumptive characteristics.
- Washington Dept of Fish and Wildlife comments to the Final Interim Report do not appear to be included in Appendix A.

Specific Comments:

Pg ii, Executive Summary: "Groundwater levels in the Twin Lakes Aquifer (Aquifer) have dropped by as much as 11 feet since 1999."

- Comment: This statement should be corrected to reflect updated information regarding recent rising water levels.

Pg ii, Executive Summary: "Also there are more than 500 home sites that rely on this aquifer for their source of water."

- Comment: This statement should clearly point out the number of existing homes or cabins vs undeveloped lots. Further, if the current planning only takes into account the effect the existing homes have on the local water balance, then additional planning is needed to factor in full build-out of the area and the water needs for full build-out conditions.

Pg ii, Executive Summary: "Two domestic wells have already been adversely affected."

- Comment: The two wells and "adverse effects" should be identified. Without additional information, correlation of cause and effect are not possible.

Pg ii, Executive Summary: "This precipitous decrease in water levels…"

- Comment: It has not been established that the decreases in the aquifer are "precipitous"… no evaluation of the aquifer's saturated thickness has been presented. No comparison of water levels to the total saturated thickness has been presented. Classification or characterization of the aquifer's water levels in this manner without supporting evidence is premature and inappropriate.

Pg ii, Executive Summary: "caused by two factors: • A decrease in aquifer recharge due to mandated changes to the Wolf Creek Reclamation District levels.

- Comment: There is no mandate to change or upgrade irrigation systems including the Wolf Creek Reclamation District.

Pg iii, Executive Summary: "However, our particular water right from these closed basins may be approved at some time because our right will not be a consumptive use of water."

- Comment: Within the context of the project there are consumptive properties to the right desired.

Pg iii, Executive Summary: "To fully implement the project, the next phase will be a design/construction project that will develop the information discussed above and design and construct the preferred alternative(s)…"

- Comment: Moving directly to design and construction as the next phase appears premature. Water rights need to be acquired. Easements and right of ways need to be secured. A more comprehensive understanding of the twin lakes area hydrogeology is needed. An evaluation of potential impairment to existing water right holders in the areas of proposed ground water withdrawal facilities would also be prudent.

Pg 1, Section 1.1: "The Final Interim Report (IRZ, 2003) was a feasibility study…"

- Comment: The "Final Interim Report (IRZ, 2003) was considered to have fallen short of a "feasibility study". Numerous deficiencies were noted in Ecology comments submitted earlier. As noted in the current document "…there was very little investigation work that was completed prior to the development of the interim report…"

Pg 4, Section 1.2.1: "We …found through our field investigations… that we **should** be able to generate a large percentage of the required amount of water from our well system (approximately 1,000-3,000 gpm for 90 days).

- Comment: Please present the data and analysis on which this conclusion is based.

Pg 6, Section 2.0: "A large diameter interception well system may work the best in shallow, highly productive groundwater…"

- Comment: Assuming an interception well system would be installed very close to the mainstem Methow River, it should be noted that this reach of river has been determined to have hyphorehic characteristics important for spawning and food sources for fish. It may not be in the Public interest to allow a ground water installation that may have potential to degrade or negatively affect this area of the river.

Pg 7, Section 2.1: "…it is not exactly clear how much water will be required to replenish the Aquifer or how much water will needed to be added per year to maintain the water levels…"

- Comment: if the project goes forward, project water requirements will depend on changes in precipitation and climate as well as changes in well density and land use.

Pg 7, Section 2.1: "The State Fish Hatchery…immediately to the west of our proposed well site location, has three conventional wells that supply approximately 1500 gpm for each well. We believe that our site may be capable of providing as much water, but it may not have as favorable of geology."

- Comment: The State Fish Hatchery has four production wells and one domestic well. Personal communications with hatchery staff indicate that the production wells have a chronic sanding problem requiring regular maintenance. This suggests the possibility of improperly sized screens, or, the possibility that the rate of pumping is too high for the formation. Geologic studies conducted at the site also show an irregular aquifer base, thinning toward the river and thickening away from the river.

Pg 7, Section 2.1: "The driller will drill a 6 inch casing to a nominal depth of approximately 150 feet…" Pg 10, Section 2.1: "The production well will be approximately 100-150 deep and about 16-18 inches in diameter…the wells and pumping system are estimated for two wells that will produce 1,250 gpm each."

- Comment: Prior to any drilling, consideration should be given to the potential effects of this project on existing right holders in the area during testing and during the life of the proposed project. Tests should be designed to not only resolve aquifer parameters, but also for demonstrating the nature of effects on neighboring well users. Further, a minimum 72 hour test may be more appropriate than the proposed 24 hr test and should include neighboring wells as observation wells if possible.

Pg 15, Section 2.1: "A potential addition to this option would be infiltration galleries along the course of the pipeline."

- Comment: There may be need for review of such plans by Ecology's Water Quality Program.

Pg 16, Section 2.2: "As water was diverted to the sinkhole in the past to try to create a pond near the Rodeo Grounds, Big Twin Lake levels responded directly to the increased input. In addition, the sinkhole appears to receive and discharge a considerable amount of irrigation return flow."

- Comment: How is this observation documented? Documentation should be included in investigations and reporting.

Pg 19, Section 2.2: "As a result, we are proposing that the water rights application for this option [Thompson Creek] should be completed as soon as possible."

- Comment: Under current water law, this application would be denied.

Pg 24, Section 2.3: "Because we are close to an operating system (State Fish Hatchery), we believe that achieving 2500 gpm for 3 months is quite possible (or about 1000 acre-feet)."

- Comment: Assuming this project is seeking a right to withdraw water during the time of the spring freshet, it is imperative to examine existing rights in the area. For instance, the State Fish Hatchery's period of greatest water use occurs between October 1st and April 15th with use peaking in march and april. Likewise, the Federal Fish Hatchery's period of greatest water use is similar and occurs at this same time. It is uncertain if the proposed additional withdrawal at this location could occur without creating impairment issues.