

APPENDIX F
DIVERSION DAM DESIGN ALTERNATIVES AND DITCH
ENLARGEMENT FOR PERMIT 15000 FEASIBILITY STUDY

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EXECUTIVE SUMMARY

The following technical appendix provides the engineering technical analysis for the evaluation and possible replacement of the existing diversion ditch and diversion structure located on the Santa Margarita River near the Naval Hospital on Camp Pendleton, California. The purpose of this ditch and diversion structure is to help perfect Camp Pendleton's permit to divert and store up to 165,000 acre-feet per year of water from the Santa Margarita River and develop local supplies of water for water demands due to the following:

- 1) national or drought emergencies
- 2) water transfers to Fallbrook Public Utilities District to settle *U.S. vs. Fallbrook*
- 3) closure of other training facilities (BRAC)
- 4) maintenance of the riparian habitat in the Chappo and Upper Ysidora Basins
- 5) Use of water by Camp Pendleton to support military training, irrigation, and expanding military and family housing.

The preferred project plan is to replace the existing sheet pile diversion dam on the Santa Margarita River with an Obermeyer Spillway (inflatable rubber bladder) diversion dam and to enlarge the existing ditch capacity from approximately 60 cfs to 200 cfs. This will increase the calculated average annual diversion from approximately 4,400 acre-feet to 18,400 acre-feet based on a simulated period of record of 1980 to 1999 (20 years).¹ The capital cost for the new diversion dam is \$1,206,000. The capital cost for enlarging the ditch and related structures is \$237,000, for a total cost of \$1,443,000. A portion of this capital cost may be allocated to repairs of the existing ditch and facilities. The repair portion is \$251,000.

¹ *Simulated diversion without Settlement Augmentation assuming existing Ditch is operating at full capacity when water is available.*

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1.0 INTRODUCTION

The following technical memorandum provides the engineering technical analysis for the evaluation and possible replacement of the existing diversion ditch and diversion structure located on the Santa Margarita River near the Naval Hospital on Camp Pendleton, California. The purpose of this Ditch and diversion structure is to help perfect Camp Pendleton's permit to divert and store up to 165,000 acre-feet per year of water from the Santa Margarita River for water demands due to the following:

- 1) national or drought emergencies
- 2) water transfers to Fallbrook Public Utilities District to settle *U.S. vs. Fallbrook*
- 3) closure of other training facilities (BRAC)
- 4) maintenance of the riparian habitat in the Chappo and Upper Ysidora Basins
- 5) Use of water by Camp Pendleton to support military training, irrigation, and expanding military and family housing.

Camp Pendleton is allowed to divert water from the Santa Margarita River from October 1st through June 30th (nine months) using Permit 15000 Applications 2147A and 2147B. No diversions are allowed in July, August and September with this permit. Additional water rights exist for diverting water to Lake O'Neill. The existing diversion structure was constructed of sheet pilings across the Santa Margarita River in 1982 after the diversion structure was washed out during a flood. The top of the sheetpiling diversion dam is at an elevation of 115.5 feet above mean sea level according to the plans prepared by Lockman and Associates in 1982 and 3.4 feet above the invert of the diversion ditch feeder pipeline. Historically, the area upstream of the sheet piling would fill up with sediment during high flow events, causing reduced diversion capability. In addition to the reduced diversion capability, the sediment would also be transported into the ditch, causing reduced capacity and increased maintenance costs.

The alternatives considered for solving the sediment problem at the diversion dam and increasing diversions are as follows:

- 1) Replace existing sheet piling diversion dam with a new inflatable rubber diversion dam.
- 2) Replace existing sheet piling diversion dam with a new Obermeyer spillway gate system (inflatable rubber bladder).

- 3) Annually remove the sediment from behind (upstream) of the existing diversion dam.
- 4) Add a sluice gate to the existing diversion dam.
- 5) Replace a portion of the existing sheet piling diversion dam with a removable flashboard diversion dam.
- 6) Install a sheet pile box well.

1.1 Scope of Work

The scope of work is to evaluate the water diversion problem caused by the sediment and provide an appropriate solution and enlarge the diversion capacity. Numerous alternatives were considered, including:

- 1) Replace existing sheet piling diversion dam with a new inflatable rubber diversion dam.
- 2) Replace existing sheet piling diversion dam with a new Obermeyer spillway gate system (inflatable rubber bladder).
- 3) Annually remove the sediment from behind (upstream) of the existing diversion dam.
- 4) Add a sluice gate to the existing diversion dam.
- 5) Replace a portion of the existing sheet piling diversion dam with a removable flashboard diversion dam.
- 6) Install a sheet pile box well.

Alternatives 1 and 2 consider the cost associated with a 200 cfs diversion capacity diversion dam and repairing the existing ditch headgates to its design capacity of approximately 60 cfs. Alternative 4 considers the cost associated with repairing the existing ditch headgate to its design capacity of approximately 60 cfs. Alternatives 3, 5 and 6 do not consider costs for repairing ditch

headgate. Cost to enlarge the entire ditch and related structures from 60 cfs to 200 cfs capacity is considered in Section 3.0. This scope of work does not include environmental review for retro-fit or new facilities/structures in the Santa Margarita River or adjacent areas. This scope of work also does not include review of permits or requirements by the Army Corps of Engineers, or critical habitat assessment, endangered species identification, Biological Opinion (BO) for the project or design of a fish screen at the diversion.

1.2 Purpose and Need for Project Development

The purpose for enlarging the existing ditch capacity and improving the diversion dam is to help perfect Camp Pendleton's permit to divert and store up to 165,000 acre-feet per year of water from the Santa Margarita River and develop local supplies of water.

1.3 Project Location

The existing diversion dam and ditch are located on Camp Pendleton near the Naval Hospital approximately 1.2 miles downstream of the confluence of DeLuz Creek with the Santa Margarita River, approximately two miles upstream of Basilone Road's Santa Margarita River bridge and one mile north of Lake O'Neill, as shown on Figure F-1. The existing diversion dam is located on the Monro Hill 7.5-minute USGS quadrangle in Sections 5 and 6 of Township 10 South Range 4 West.

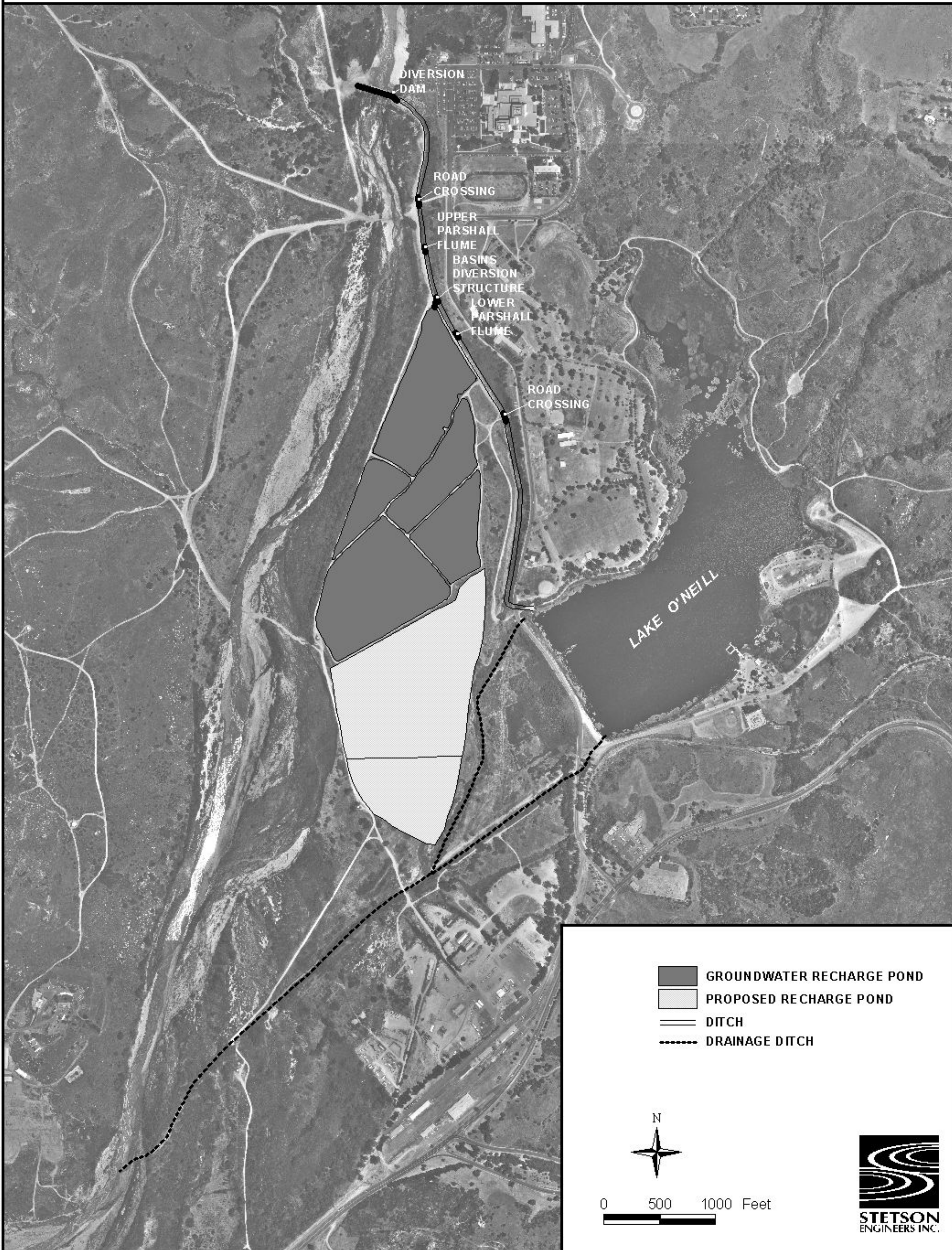
1.4 History

The diversion dam and ditch were initially constructed in 1882 (Malloy, 8/29/00). For many years, a sand diversion weir was reconstructed each year following winter flood events. In 1970, the diversion works were constructed as a rock weir. This reconstructed diversion dam was replaced in 1982 with a sheet pile diversion dam structure that currently exists. Notches were installed in some of the sheet piles in the mid-1990s to help remove the accumulated sediment located behind the dam.

2.0 PROJECT PLAN

A description and cost estimation for the six project plan alternatives follows:

PROPOSED RECHARGE PONDS ALTERNATIVE 3



2.1 Alternative 1 B Inflatable Rubber Dam

Replace the existing sheet pile diversion dam with an air inflatable rubber dam consisting of a single span five feet high and 280 feet long installed on a concrete foundation. A 280-foot long rubber dam was considered as the most appropriate length of the dam because it will match the width of the existing river channel. A dam less than 280 foot long, with an overflow channel, was initially considered but was rejected because of the high environmental cost associated with flooding a wider section of the river channel in the vicinity of the diversion dam. The rubber dam bladder consists of a three-ply, nylon reinforced fabric with a special five-mm thick EPDM (ethylene propylene diene monomer) outer cover to protect the dam against UV and ozone. Total fabric thickness is 0.50 inches and the expected life is more than 40 years. The bladder is inflated with air to a design pressure of two psi in about 30 minutes using a 20-HP Fuji blower. The control system automatically maintains internal pressure or deflates that bladder in the event of high water. Under conditions of power outage, a mechanical, fail-safe, auto-deflation system will lower the dam during high water. The control system can be operated remotely from an office PC with the addition of a modem and a phone line. The high water level auto-deflation system is typically set at one foot above the top of the dam because greater water depth causes the rubber bladder to oscillate and reduces its life expectancy.

The rubber dam will be deflated during flood flows and will allow sediment and debris to pass down the river channel. After the flood flow has passed, the rubber dam will be inflated to allow for increased diversions into the ditch and to the ground-water recharge basins and Lake O'Neill. A photograph of Orange County Water District's inflatable rubber dam on the Santa Ana River is shown in Figure F-2.

The concrete foundation consists of a 12-inch thick reinforced concrete slab extending 280 feet across the river with side walls of 2:1 slope. The concrete footings for the slab consist of two cutoff walls 12 inches thick and 12 feet deep located on the upstream edge and four feet deep located on the downstream edge of the slab. The rubber dam is attached to the concrete slab with an upper and lower clamping plate and anchor bolts at six inches on center. Two 60-inch wide by 60-inch high sluice gates (with electric motor gate openers) located on the east abutment will provide for by-pass flows of three cfs and sediment transport away from the ditch headgates during periods of high flows. A small concrete fish ladder will be installed near the east abutment for steelhead migration. The existing headgate for the ditch will be enlarged and relocated near the sluiceway and fitted with electric motor gate openers.



Inflatable Rubber Diversion Dam on Santa Ana River
Orange County Water District
June 26, 2000

2.1.1 Cost Estimation

The estimated cost for the inflatable rubber diversion dam is \$1,026,000. This cost is based on a cost of \$250,000 for the rubber bladder that is supplied and installed by Bridgestone Engineered Products Co., inc. of Huntington Beach, California. The removal of the existing sheet pile diversion dam was estimated at \$30,000. The construction of the diversion dam foundation cost of \$160,000 was based on 510 cubic yards of reinforced concrete at \$300 per cubic yard plus excavating and grading cost of \$11,000. The sluice gates and relocation of the existing headgate will cost \$151,000. The concrete block control building for the inflatable rubber dam controls will cost \$45,000. The construction of the fish ladder will cost \$10,000. Additional costs for contingencies and unlisted items (\$164,000), planning, engineering and design (\$123,000), and project management and administration (\$82,000) were included. A summary of the cost is shown on Table 1.

TABLE 1
RUBBER DAM B ALTERNATIVE 1
COST SUMMARY

ITEM	Cost
Rubber Bladder	\$250,000
Removal of Existing Dam	30,000
Diversion Dam Foundation	160,000
Diversion Dam Excavation and Grading	11,000
Control Building	45,000
Sluice Gates & Headgate Relocation	151,000
10,000	Fish Ladder
Contingencies and Unlisted Items @ 25%	164,000
<hr/>	
Subtotal	\$ 821,000
Planning, Engineering and Design @ 15%	123,000
Project Management and Administration @ 10%	82,000
<hr/>	
Total Estimated Capital Cost	\$ 1,026,000
Amortized Capital Cost ¹	91,100
Annual Operation and Maintenance Cost ²	5,800
<hr/>	
Total Estimated Annual Cost	\$ 96,900
Unit Cost ³	\$11 / acre-foot

1. Capital costs amortized over 30 years at eight percent interest.
2. Does not include man-hours for the day-to-day operation.
3. Unit cost based on 8,500 acre-feet per year increase in diversion.

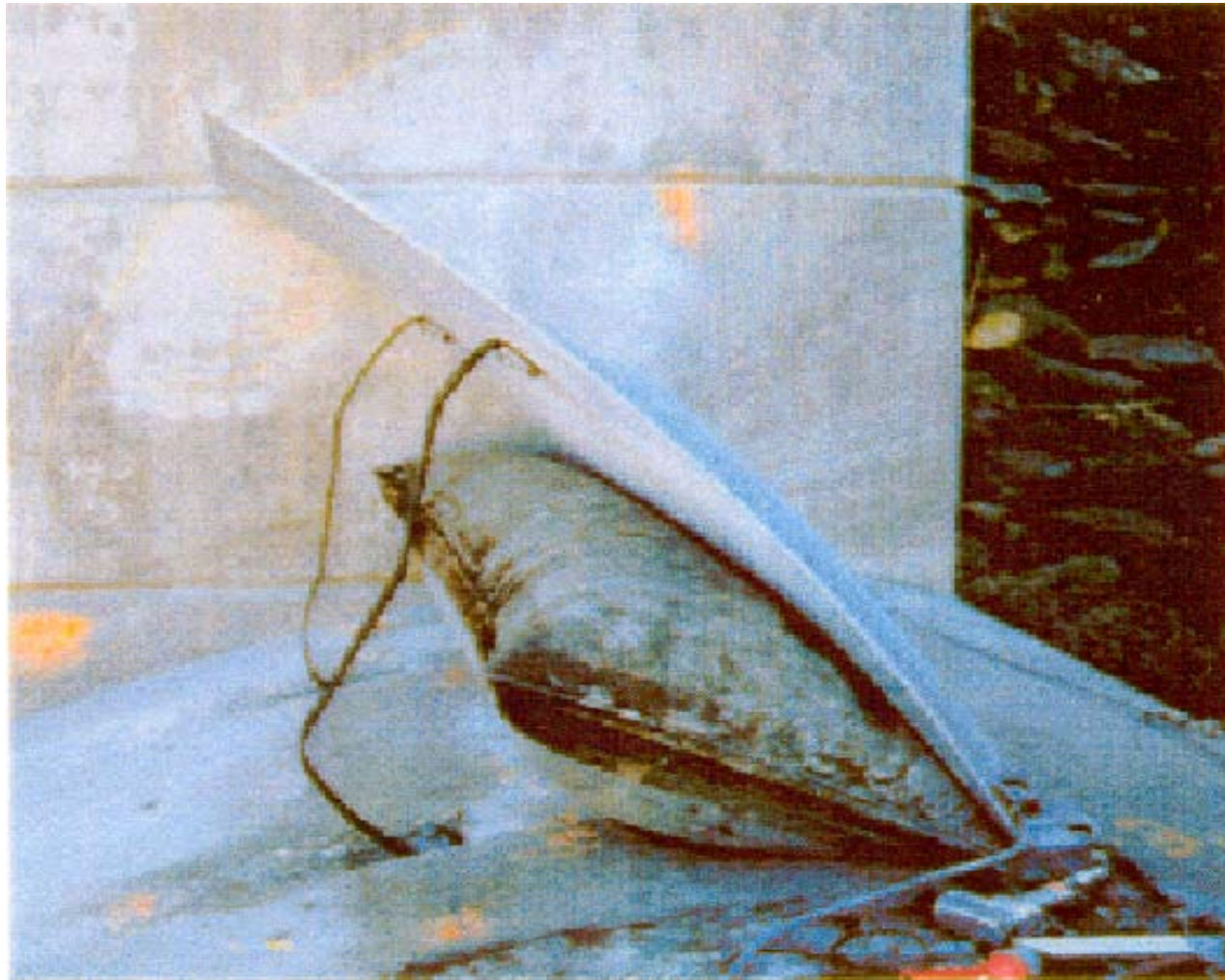
For comparison purposes, the capital cost is converted to an annual cost using a 30-year project facility life and an eight percent interest rate. An annual operation and maintenance cost for the rubber dam is estimated at \$1,000 above what is currently being spent on operation and maintenance. Ditch cleaning will continue to be performed on an annual basis at an estimated cost of \$4,800. Operation and maintenance cost does not include the annual man-hours cost for the day-to-day operation of the system. The total annual cost is \$96,900. The estimated increase in water diverted is 8,500 (12,900-4,400) acre-feet per year (Harrison, 11/10/00), for a cost of 11 dollars per acre-foot.

2.2 Alternative 2 B Obermeyer Spillway Gate System

Replace the existing sheet pile diversion dam with an Obermeyer spillway gate system consisting of a single span five feet high and 280 feet long installed on a concrete foundation. The Obermeyer spillway gate system consists of a row of steel gate panels supported on their downstream side by inflatable air bladders. The air bladders consist of a three-ply, nylon reinforced fabric with a special five-mm thick EPDM (ethylene propylene diene monomer) outer cover to protect the dam against UV and ozone. Total fabric thickness is 0.50 inches and the expected life is more than 30 years. The bladder is inflated with air to a design pressure of 16 to 20 psi in about 30 minutes using an air compressor. The control system automatically maintains internal pressure and can be operated remotely from an office PC with the addition of a modem and a phone line.

The Obermeyer spillway gate system will be lowered/deflated during flood flows and will allow sediment and debris to pass down the river channel. After the flood flow has passed, the Obermeyer spillway gate system will be raised/inflated to allow for increased diversions into the ditch and to the ground-water recharge basins and Lake O'Neill. A photograph of an inflatable Obermeyer spillway gate is shown in Figure F-3.

The concrete foundation consists of a 12-inch thick reinforced concrete slab extending 280 feet across the river with vertical side walls and stainless steel abutment plates. The concrete footings for the slab consist of two cutoff walls 12 inches thick and four feet deep located on the downstream edge of the slab and 12 feet deep located on the upstream edge of the slab. The Obermeyer spillway gate system is attached to the concrete slab with stainless steel anchor bolts at six inches on center. The bladders are clamped over the anchor bolts and connected to the air supply pipes. The bladder hinge flaps are fastened to the gate panels. The individual steel gate panels are fabricated in widths of 10 feet. The gaps between adjacent panels are spanned by reinforced EPDM rubber webs clamped to adjacent gate panel edges. At each abutment, an EPDM rubber wiper-type



Inflatable Obermeyer Spillway Gate

FIGURE F-3

seal is affixed to the gate panel edge. This seal rides up and down the stainless steel abutment plate, keeping abutment plate seepage to a minimum. The wedge-shaped profile of the Obermeyer gate system causes stable flow separation from the downstream edge of the gate without the vibration-inducing vortex shedding associated with simple rubber dams during overtopping. This results in vibration-free operation and excellent controllability throughout a wide range of water elevations and gate positions. Two 60-inch by 60-inch sluice gates (with electric motor gate openers) located on the east abutment will provide for by-pass flows of three cfs and sediment transport away from the ditch headgates during periods of high flows. A small concrete fish ladder will be installed near the east abutment for steelhead migration. The existing headgate for the ditch will be enlarged and relocated near the sluiceway and fitted with electric motor gate openers.

2.2.1 Cost Estimation

The estimated cost for the Obermeyer spillway gate system is \$1,206,000. This cost is based on a cost of \$365,000 for the Obermeyer spillway gate system supplied by Obermeyer Hydro, Inc., of Fort Collins, Colorado. It will be installed by a local contractor. The removal of the existing sheet pile diversion dam was estimated at \$30,000. The construction of the diversion dam foundation cost of \$160,000 was based on 510 cubic yards of reinforced concrete at \$300 per cubic yard plus excavating and grading cost of \$11,000. The sluice gates and relocation of the existing headgate will cost \$151,000. The concrete block control building for the inflatable rubber dam controls will cost \$45,000. The construction of the fish ladder will cost \$10,000. Additional costs for contingencies and unlisted items (\$193,000), planning, engineering and design (\$145,000), and project management and administration (\$96,000) were included. A summary of the cost is shown on Table 2.

For comparison purposes, the capital cost is converted to an annual cost of \$107,100 using a 30-year project facility life and an eight percent interest rate. An annual operation and maintenance cost for the Obermeyer dam is estimated at \$1,000 above what is currently being spent on operation and maintenance. Ditch cleaning will continue to be performed on an annual basis at an estimated cost of \$4,800. Operation and maintenance cost does not include the annual man-hours cost for the day-to-day operation of the system. The total annual cost is \$112,900. The estimated increase in water diverted is 14,000 (18,400-4,400) acre-feet per year (Harrison, 11/10/00) for a cost of eight dollars per acre-foot.

TABLE 2
OBERMEYER SPILLWAY GATE SYSTEM B ALTERNATIVE 2
COST SUMMARY

ITEM	COST
Obermeyer Spillway Gate System	\$ 365,000
Removal of Existing Dam	30,000
Diversion Dam Foundation	160,000
Diversion Dam Excavation and Grading	11,000
Sluice Gates & Headgate Relocation	151,000
Control Building	45,000
Fish Ladder	10,000
Contingencies and Unlisted Items @ 25%	193,000
Subtotal	\$ 965,000
Planning, Engineering and Design @ 15%	145,000
Project Management and Administration @ 10%	96,000
Total Estimated Capital Cost	\$ 1,206,000
Amortized Capital Cost ¹	107,100
Annual Operation and Maintenance Cost ²	5,800
Total Estimated Annual Cost	\$ 112,900
Unit Cost ³	\$8 / acre-foot

1. Capital costs amortized over 30 years at eight percent interest.
2. Does not include man-hours for the day-to-day operation.
3. Unit cost based on 14,000 acre-feet per year increase in diversion.

2.3 Alternative 3 B Annual Sediment Removal

Annually remove the accumulated sediment from behind (upstream) of the existing sheet piling diversion dam. Mr. Burl Stolworthy of Stolworthy Sand was contacted on July 6, 2000 to discuss the cost associated with removing the sediment. Mr. Stolworthy's cost estimation is five dollars per cubic yard to remove the material and sort off-site. This is based on an annual removal of a minimum of approximately 30,000 cubic yards of material. This cost may be reduced if he is allowed to sort the material on-site.

In 1994, approximately 33,000 cubic yards of material was removed from behind the diversion dam. This was based on an estimate from Mr. Manual Alvarez, who is an engineer at the public works office, of 1,200 feet by 150 feet wide by 5 feet deep. Based on the river hydrology,

a flood event that deposits 33,000 cubic yards of material may occur only once every three years; therefore, it is estimated that approximately 11,000 cubic yards of material will be removed every year. A concern with guaranteeing Mr. Stolworthy a minimum of 30,000 cubic yards of material removal per year is that he may be removing more material than is annually accumulating.

2.3.1 Cost Estimation

The estimated annual cost for the removal of sediment behind the existing sheet piling diversion dam is \$55,000. This cost is based on a cost of five dollars per cubic yard of material removed by Stolworthy Sand and the removal of 11,000 cubic yards of material per year.

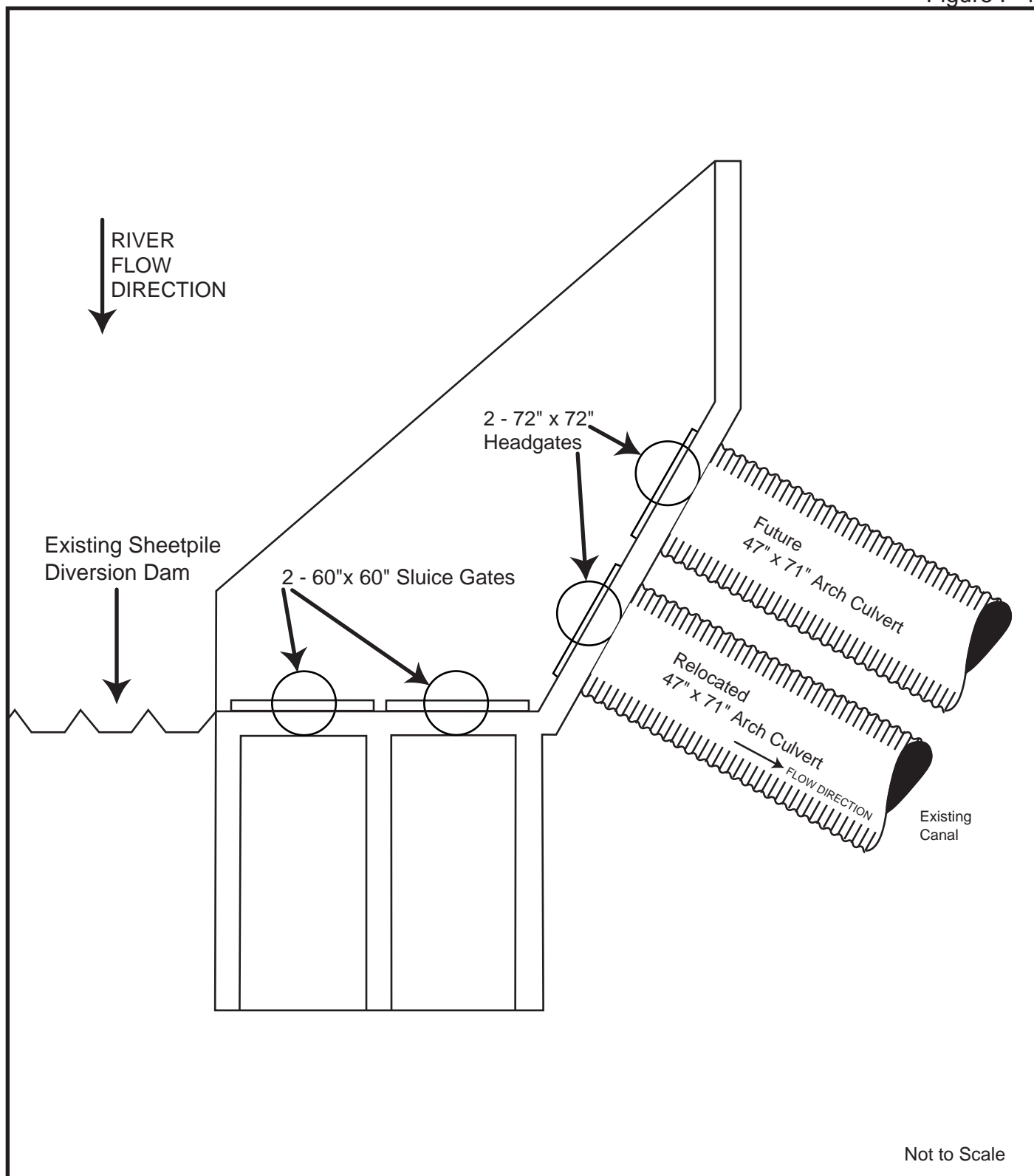
2.4 Alternative 4 B Sluice Gates

Install sluice gates at the side of the existing sheet piling diversion dam near the east abutment and relocate the existing headgate, as shown on Figure F-4. Sluice gates located adjacent to the headgate will help prevent the sediments from accumulating in front of the headgate and restricting the diversions. The two 60-inch by 60-inch gates and concrete gate mounting structure will be constructed near the east abutment. The existing headgate will be relocated adjacent to the proposed sluice gates.

2.4.1 Cost Estimation

The estimated cost for the sluice gate alternative is \$267,000. This cost is based on a cost of \$151,000 for the sluice gates that will be supplied by Waterman and installed by a local contractor, foundation, headwall and relocation of the existing headgate. The construction of the foundation and headwall cost was based on 120 cubic yards of reinforced concrete at \$500 per cubic yard. The removal of a section of existing sheet pile diversion dam was estimated at \$10,000. A small concrete fish ladder will be installed near the east abutment for steelhead migration for a cost of \$10,000. Additional costs for contingencies and unlisted items (\$43,000) planning, engineering and design (\$32,000) and project management and administration (\$21,000) were included. A summary of the cost is shown on Table 3. Also shown on Table 3 is the cost to repair the existing headgate structure, which includes the sluice gates but does not include the fish ladder.

Figure F-4



Sluice Gate and Headgate Structure

1828-324SluiceGate

TABLE 3
SLUICE GATES B ALTERNATIVE 4
COST SUMMARY

ITEM	COST	COST WITHOUT FISH LADDER ¹
Sluice Gates and Headgate Relocation	\$ 151,000	\$ 151,000
Remove Portion of Existing Dam	10,000	10,000
Fish Ladder	10,000	0
Contingencies and Unlisted Items @ 25%	43,000	40,000
Subtotal	\$ 214,000	\$ 201,000
Planning, Engineering and Design @ 15%	32,000	30,000
Project Management & Administration @ 10%	21,000	20,000
Total Estimated Capital Cost	\$ 267,000	\$ 251,000
Amortized Capital Cost ²	23,700	
Annual Operation and Maintenance Cost	9,800	
Total Estimated Annual Cost	\$ 33,500	
Unit Cost ⁴	N/A	

1. Cost used for repair of existing headgates.
2. Capital costs amortized over 30 years at eight percent interest.
3. Does not include man-hours for day-to-day operation.
4. Unit cost not calculated because no increase in diversion is anticipated.

For comparison purposes, the capital cost is converted to an annual cost using a 30-year project facility life and an eight percent interest rate. An annual operation and maintenance cost is estimated at \$5,000 above what is currently being spent on operation and maintenance. Ditch cleaning will continue to be performed on an annual basis at an estimated cost of \$4,800. Operation and maintenance cost does not include the annual man-hours cost for the day-to-day operation of the system. The total annual cost is \$33,500.

2.5 Alternative 5 B Removable Flashboard Diversion Dam

Replace a portion of the existing sheet piling diversion dam with a removable flashboard diversion dam. Replace the eastern 20 feet of the existing diversion dam and abutment adjacent to the existing headgate to provide a flow of water in front of the headgate for removal of sediment. Five (5) four-foot sections with two- by six-foot flashboards can be added to increase the water level behind the diversion dam. The flashboards will be removed during flood flows and will allow some

of the sediment and debris to pass down the river channel. After the flood has passed, the flashboards will be installed to allow for increased diversions into the ditch.

2.5.1 Cost Estimation

The estimated cost for the removable flashboard diversion dam is \$52,000. This cost is based on a cost of \$5,000 for the flashboards and steel structure. The removal of a portion of the existing sheet pile diversion dam was estimated at \$10,000. The construction of the foundation cost of \$13,000 was based on 26 cubic yards of reinforced concrete at \$500 per cubic yard plus excavating and grading cost of \$5,000. Additional costs for contingencies and unlisted items (\$9,000), planning, engineering and design (\$6,000) and project management and administration (\$4,000) were included. A summary of the cost is shown on Table 4.

TABLE 4
REMOVABLE FLASHBOARD DIVERSION DAM B ALTERNATIVE 5
COST SUMMARY

ITEM	COST
Flashboards and Structure	\$ 5,000
Remove Portion of Existing Dam	10,000
Foundation	13,000
Excavation and Grading	5,000
Contingencies and Unlisted Items @ 25%	9,000
 Subtotal	 \$ 42,000
Planning, Engineering and Design @ 15%	6,000
Project Management and Administration @ 10%	4,000
 Total Estimated Capital Cost	 \$ 52,000
Amortized Capital Cost ¹	4,600
Annual Operation and Maintenance Cost ²	9,800
 Total Estimated Annual Cost	 \$ 14,400
Unit Cost ³	N/A

1. Capital costs amortized over 30 years at eight percent interest.
2. Does not include cost for day-to-day operation.
3. Unit cost not calculated because no increase in diversion is anticipated.

For comparison purposes, the capital cost is converted to an annual cost using a 30-year project facility life and an eight percent interest rate. An annual operation and maintenance cost is estimated at \$5,000 above what is currently being spent on operation and maintenance. Ditch cleaning will continue to be performed on an annual basis at an estimated cost of \$4,800. Operation and maintenance cost does not include the annual man-hours cost for the day-to-day operation of the system. The total annual cost is \$14,400.

2.6 Alternative 6 B Sheet Pile Box Well

Install a sheet pile box well adjacent to the existing sheet pile diversion dam. The sheet pile box well was sized for a 200 cfs diversion. The box well will have to be 280 feet long by 64 feet wide in order to divert 200 cfs. This was based on the permeability of gravel in the box well of five gpm per square foot. The size of the sheet pile box well and the pumps that would be required to divert the water made this alternative impractical; therefore, a no-cost estimation was performed for comparison purposes. For example, a minimum of six parallel 36-inch-diameter pipes would need to be installed in the sheet pile box well for conveyance of the water into the ditch. The pipe collection system will require a pump to get the water into the ditch because of the head loss in the pipe collection system and the depth the pipes will need to be buried.

2.7 Cost Summary

The total capital and annual cost summary for comparison purposes is shown on Table 5. The annual costs include the total capital cost amortized at eight percent interest for 30 years plus annual operation and maintenance costs ranging from \$14,400 to \$112,900. As shown on Table 5, the total capital costs range from \$0 to \$1,206,000. The cost per acre-foot increase in annual diversion ranges from \$8 to \$11.

TABLE 5
COST SUMMARY

ALTERNATIVE	TOTAL CAPITAL COST	ANNUAL COST ¹	COST PER ACRE-FOOT ²
Alternative 1	\$ 1,026,000	\$ 96,900	\$ 11
Alternative 2	1,206,000	112,900	8
Alternative 3	0	55,000	N/A
Alternative 4	267,000	33,500	N/A
Alternative 5	52,000	14,400	N/A
Alternative 6 ³	N/A	N/A	N/A

1. Annual Cost includes operation and maintenance plus amortized capital cost using eight percent interest for 30 years, not including man-hours cost for day-to-day operation.
2. Costs per acre-foot are based on an enlarged diversion capacity to 200 cfs, with annual acre-foot diversion increases ranging from 8,500 to 14,000 acre-feet.
3. Cost was not calculated for this alternative because of diversion rate limitations and pumping requirements.

2.8 Preferred Project Plan Diversion Dam Alternative

Each of the six diversion dam alternatives has their advantages and disadvantages. An alternative evaluation summary is shown on Figure F-5.

2.8.1 Alternative 1 **B** Inflatable Rubber Dam

Advantages: The major advantage of the inflatable rubber dam is its simple operation and maintenance and its ability to permit sediment and debris to pass over the dam unencumbered when the dam is deflated. Because of the simple design and high-quality materials, routine maintenance is reduced to periodic inspections. When the dam is deflated, the rubber body of the dam lies completely flat on its concrete base and is almost never damaged by floods or bed-load movement. The dam has a minimum life of 40 years and requires virtually no maintenance. There are no environmental impacts to the river channel after the dam is constructed.

Disadvantages: The major disadvantage of the inflatable rubber dam is the high initial investment cost when compared to four of the five other alternatives. Also, the dam will automatically deflate when the depth of water flowing over the dam is greater than

Figure F-5

Lake O'Neill Diversion System Alternative Evaluation Summary

PROJECT	WATER SUPPLY			SYSTEM RELIABILITY	TIME	Investment COST	Annual COST	OTHER BENEFITS OR PROBLEMS	OVERALL RATING	RECOMMENDATION
	Diversion Improvement	Maintenance and Repair Improvement	Additional Construction Requirements	System Operation Improvement	Time Required to Implement Project	Cost Required to Implement Project	Operation Maintenance and Repair	Comment		Comment
Alternative 1 Inflatable Rubber Dam	●	●	●	●	●	●	○	● Can't capture peak flows at maximum diversion rate	○	Recommended for additional analysis
Alternative 2 Obermeyer Spillway	●	●	●	●	●	●	○	● High investment cost	○	Recommended for additional analyses.
Alternative 3 Annual Sediment Removal	○	●	●	●	●	●	●	● Environmental Issues	○	Dismiss alternative from further consideration.
Alternative 4 Sluice Gate	○	○	○	○	○	○	○	○ May still require some sediment removal	○	Recommended for additional analysis
Alternative 5 Removable Flashboards	○	○	○	○	○	○	○	○ Must Physically Remove boards prior to Flood Flow	○	Recommended for additional analysis
Alternative 6 Sheet Pile Box Well	●	●	○	○	○	○	○	● Diversion rate limitation	○	Dismiss alternative from further consideration.

Relative Rating Scale				
●	○	○	○	●
Very Good	Good	Moderate or No Improvement	Bad	Very Bad

on foot (1,100 cfs). This means that during high flow events when the dam is deflated, the diversion flow will be limited by the depth of the river during the flood event. For example, if the river is flowing 1,100 cfs, the depth of the water will be approximately one foot deep and the flow into the diversion ditch will also be only one foot deep.

2.8.2 *Alternative 2 B Obermeyer Spillway Gate System*

Advantages: The major advantage of the Obermeyer Spillway gate is the same as the inflatable rubber dam (Alternative 1), except that it doesn't need to be deflated when the flow over the dam is greater than one foot. Therefore, the average annual divertable flow is 5,500 AFY more than Alternative 1, which represents 68 percent more water.

Disadvantages: The major disadvantage of the Obermeyer Spillway gate is the high initial investment cost when compared to the other alternatives.

2.8.3 *Alternative 3 B Annual Sediment Removal*

Advantages: The only advantage to this alternative is the low initial cost.

Disadvantages: The major disadvantages of this alternative are the high annual cost of manually removing the sediment which accumulates in front of the headgate and the reduced diversion rate caused by this accumulation of sediment.

2.8.4 *Alternative 4 B Sluice Gates*

Advantages: The major advantage of the installation of sluice gates is the removal of sediment from the front of the headgate.

Disadvantages: The major disadvantage of this alternative is that sediment may still need to be periodically removed from behind the existing sheet pile diversion dam.

2.8.5 *Alternative 5 B Removable Flashboard Diversion Dam*

Advantages: The major advantage of the installation of the removable flashboards is the removal of sediment from the front of the headgate.

Disadvantages: The major disadvantage of this alternative is that sediment may still need to be periodically removed from behind the existing sheet pile diversion dam. Another disadvantage is that the flashboards must be installed after each flood event and removed prior to the next flood event.

2.8.6 Alternative 6 B Sheet Pile Box Well

Advantages: The major advantage of the sheet pile box well is the delivery of clean water into the diversion ditch.

Disadvantages: The major disadvantage of this alternative is the limitation on the peak diversion rate. This limitation is caused by the size of the sheet pile box well needed to collect 200 cfs.

3.0 PROJECT PLAN FOR DITCH ENLARGEMENT

The existing ditch that supplies water to the ground water recharge ponds and Lake O'Neill consists of the following:

- \$ Headgate at Santa Margarita River
- \$ 40-inch by 65-inch headgate arch culvert, 44 feet long
- \$ 1,000 feet of unlined ditch with a bottom width of 14 feet
- \$ Two 36-inch diameter culverts (road crossing) with control gates
- \$ 400 feet of unlined ditch with a bottom width of 14 feet
- \$ Parshall flume (5 feet wide by 4.5 feet high)
- \$ 470 feet of unlined ditch with a bottom width of 14 feet
- \$ 48-inch ground water recharge ponds turnout control gate and 48-inch control gate in the ditch
- \$ 350 feet of unlined ditch with a bottom width of 14 feet
- \$ Parshall flume (3 feet wide by 4.5 feet high)
- \$ 800 feet of unlined ditch
- \$ 42-inch diameter culvert (second road crossing)

- \$ 1,500 feet of unlined ditch
- \$ Lake O'Neill turnout structure (24-inch RCP)

The capacity of the existing ditch from the headgate to the ground water recharge ponds turnout was estimated at approximately 60 cfs based on 3.4 feet of water depth at the headgate. This is the maximum depth of water obtainable without water spilling over the sheet pile diversion dam. A spreadsheet table showing the existing ditch capacity is shown in Table 6. The structures limiting the ditch capacity are the road crossing (60 cfs maximum) and the headgate culvert (75 cfs maximum), as shown on Table 6, Column 12.

The determination of the proposed ditch capacity that is appropriate for diverting the appropriate amount of Santa Margarita River water during critical dry periods is 200 cfs. This is based on the hydrology of the river for a 75-year period of record (1925 to 1999) and available off-stream storage in the enlarged ground water recharge ponds and Lake O'Neill.

For Alternatives 1 and 2 (new diversion dam), a water depth in the existing and enlarged ditch of 4.15 feet is required for a 200-cfs flow, as shown on Table 7. The ditch facilities that need to be replaced or enlarged are as follows:

- \$ Relocate and repair existing headgate with two new 72-inch by 72-inch headgates with electric motor hoists and one new 47-inch by 71-inch arch pipe culvert to match the relocated culvert. The cost for relocating and repairing one of the headgates and culverts is included with the sluiceway costs (Alternative 4). The cost for adding the new 47-inch by 71-inch arch pipe culvert and headgate is \$28,000.
- \$ Enlarge the 1,000-foot section of the 14-foot wide ditch downstream of the headgate to a 15-foot wide ditch at a cost of \$5,000.
- \$ Replace the two 36-inch road crossing culverts (first crossing) with two 47-inch by 71-inch arch pipe culverts at a cost of \$32,000
- \$ Replace the two 36-inch control gates at the first road crossing with two 72-inch steel slide gates at a cost of \$18,000.
- \$ Enlarge the 400-foot section of the 14-foot wide ditch downstream of the road crossing to a 15-foot wide ditch at a cost of \$2,000.

**Table 6
Lake O'Neill and Ground Water Recharge Ponds Existing Feeder Ditch and Facilities Capacity**

[1] Ditch Reach	[2] Facility	[3] Structure Size	[4] Area sf	[5] Length (feet)	[6] Length (miles)	Ditch Channel Information															Ditch Structures Information																
						[7] [8] [9] Water Surface Elevation			[10] Inlet Elev.	[11] Outlet Elev.	[12] Design Capacity (cfs)	[15] Bottom Slope (ft/ft)	[16] Side Slope	[17] Manning "n"	[18] Bottom Width (feet)	[19] Water Depth (feet)	[20] [21] Velocity		[22] Hydraulic Radius	[23] Wetted Perimeter	[24] Water Area (sq.feet)	[25] Water Fb (feet)	[30] Number of Pipes	[31] Flow per Pipe cfs	[32] Pipe Diameter (inches)	[33] Pipe Velocity ft/sec	[34] Friction	[35] Entrance	[36] Exit	[37] Velocity	[38] Factor	[39] Total					
						Inlet	Outlet	Drop	Invert	Invert	Capacity	Slope	Slope	"n"	Width	Depth	Q/A	Calc.	Radius	Perimeter	Area	Fb	Friction	Entrance	Exit	Velocity	Factor	Total									
	Diversion Dam	283'	--	283	0.05	115.50	Crest Elevation of Sheet Piling Diversion Dam per 1982 drawings															3.40	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1	Headgate	48" x 60"	20.00	0	0.00	115.50	115.50	0.00	112.10	112.10	75	--	--	--	--	3.40	3.75	3.75	--	--	--	--	--	--	--	--	--	--	--	--	--						
2	Headgate Pipe	40" x 65"	14.70	44	0.01	115.50	114.75	0.75	112.10	112.10	75	--	--	--	2.65	4.72	4.72	--	--	--	--	--	--	1	75	54	4.72	0.06	0.17	0.35	0.35	-0.17	0.75				
3	Ditch	14'	39.44	1,000	0.19	114.75	114.00	0.75	112.10	111.35	105	0.000750	0.333	0.025	14	2.65	2.66	2.62	2.01	19.59	39.44	2.0	--	--	--	--	--	--	--	--	--	--					
							114.59	Minimum water slope			60	0.000160	0.333	0.025	14	3.05	1.31	1.30	2.24	20.43	45.80	2.0	--	--	--	--	1.3	--	--	--	--	--	--				
4	Road Crossing	36" & 36"	14.13	78	0.01	114.75	114.10	0.65	111.70	111.26	60	--	--	--	2.84	4.25	4.25	--	--	--	--	--	2	30	36	4.25	0.13	0.14	0.28	0.13	-0.04	0.65					
5	Ditch	14'	42.45	400	0.08	114.10	113.98	0.12	111.26	111.14	73	0.000300	0.333	0.025	14	2.84	1.72	1.72	2.12	19.99	42.45	2.0	--	--	--	--	--	--	--	--	--	--					
6	Parshall Flume	5' x 4.5'	22.50	14	0.00	113.98	113.55	0.43	111.14	110.71	105	--	--	--	2.84	7.39	7.39	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--					
7	Ditch	14'	42.45	470	0.09	113.55	112.75	0.80	110.71	109.91	174	0.001700	0.333	0.025	14	2.84	4.10	4.09	2.12	19.99	42.45	2.0	--	--	--	--	--	--	--	--	--	--	--				
8	Control Gates	48"	16.00	37	0.01	112.75	112.75	0.00	109.91	109.91	82	--	--	--	2.84	5.77	5.77	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--					
9	Ditch	8'	25.41	350	0.07	112.75	112.16	0.59	109.91	109.32	93	0.001700	0.333	0.025	8	2.84	3.66	3.68	1.82	13.99	25.41	2.0	--	--	--	--	--	--	--	--	--	--	--				
10	Parshall Flume	3' x 4.5'	13.50	26	0.00	112.16	111.59	0.57	109.32	108.75	62	--	--	--	2.84	4.37	4.37	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--				
11	Ditch	8'	25.41	800	0.15	111.59	110.31	1.28	108.75	107.47	91	0.001600	0.333	0.025	8	2.84	3.58	3.57	1.82	13.99	25.41	2.0	--	--	--	3.57	--	--	--	--	--	--	--				
12	Road Crossing	42"	9.62	54	0.01	110.31	109.85	0.46	107.47	107.01	39	--	--	--	2.84	4.06	4.06	--	--	--	--	--	1	39	42	4.06	0.07	0.13	0.26	0.00	0	0.46					
13	Ditch	8'	25.41	1,550	0.29	109.85	107.99	1.86	107.01	105.15	78	0.001200	0.333	0.025	8	2.84	3.07	3.09	1.82	13.99	25.41	2.0	--	--	--	3.09	--	--	--	--	--	--	--				
14	Lake Div. Str.	24"	3.14	280	0.05	107.99	105.24	2.75	105.99	103.24	20	--	--	--	2.00	6.37	6.37	--	--	--	--	--	1	20	24	6.37	1.64	0.31	0.63	0.17	0	2.75					
				5,386	1.01																																

Notes:
1. Road crossing, reach 4, column 7, water surface elevation (inlet) was based on the depth of water in the ditch if reach 3 was not restricting the flow (level water surface past headgate pipe discharge).

Table 7
Lake O'Neill and Ground Water Recharge Ponds Proposed Feeder Ditch and Facilities Capacity Enlargement for Alternatives 1 and 2

[1] Ditch Reach	[2] Facility	[3] Structure Size	[4] Area sf	[5] Length (feet)	[6] Length (miles)	Ditch Channel Information										Ditch Structures Information																	
						[7] Water Surface Elevation					[10] Bottom Water Velocity					[31] Flow per Pipe					[34] Head Loss in feet												
						[8] Inlet Elev.	[9] Outlet Elev.	[10] Drop	[11] Crest Elev.	[12] Invert Elev.	[13] Capacity (cfs)	[14] Slope (ft/ft)	[15] Side Slope	[16] Manning "n"	[17] Width (feet)	[18] Depth (feet)	[19] Q/A (ft ³ /sec)	[20] Calc. (ft/sec)	[21] Hydraulic Radius	[22] Wetted Perimeter	[23] Area (sq. feet)	[24] Fb (feet)	[25] Number of Pipes	[26] Flow per Pipe (cfs)	[27] Pipe Diameter (inches)	[28] Pipe Velocity (ft/sec)	[29] Friction	[30] Entrance	[31] Exit	[32] Velocity	[33] Factor	[34] Total	
	Diversion Dam	280'	--	280	0.05	117.10	117.10	0.00	112.10	112.10	200	--	--	--	--	5.00	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1	Headgates	72" & 72"	72.00	0	0.00	117.10	117.10	0.00	112.10	112.10	200	--	--	--	5.00	2.78	2.78	--	--	--	--	--	--	--	0.00	--	--	--	--	--	--	--	
2	Headgate Pipes	2-47"X71"	39.25	44	0.01	117.10	116.25	0.85	112.10	112.10	200	--	--	--	4.15	5.10	5.10	--	--	--	--	2	100	60	5.10	5.10	0.06	0.20	0.40	0.40	-0.22	0.85	
3	Ditch	15'	67.99	1,000	0.19	116.25	115.50	0.75	112.10	111.35	225	0.000750	0.33	0.025	15	4.15	3.31	3.31	2.86	23.75	67.99	2.0	--	--	--	--	--	--	--	--	--	--	
						115.92 Minimum water slope					200	0.000330	0.33	0.025	15	5.00	2.40	2.40	3.26	25.54	83.33	2.0	--	--	--	3.31	--	--	--	--	--	--	
4	Road Crossing	2-47"X71"	39.25	78	0.01	115.92	115.07	0.85	111.35	111.15	200	--	--	--	3.92	5.10	5.10	--	--	--	--	2	100	60	5.10	0.10	0.20	0.40	0.05	0.09	0.85		
5	Ditch	15	63.92	400	0.08	115.07	114.79	0.28	111.15	110.87	200	0.000705	0.33	0.025	15	3.92	3.13	3.13	2.75	23.26	63.92	2.0	--	--	--	--	--	--	--	--	--	--	
6	Parshall Flume	6' x 5'	30.00	14	0.00	114.79	114.54	0.25	110.87	110.62	212	--	--	--	3.92	9.01	9.01	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
7	Ditch	14'	60.00	470	0.09	114.54	114.15	0.39	110.62	110.23	200	0.000820	0.33	0.025	14	3.92	3.33	3.33	2.70	22.26	60.00	2.0	--	--	--	--	--	--	--	--	--	--	
8	Control Gates	48"	16.00	37	0.01	114.15	114.15	0.00	111.31	111.31	82	--	--	--	2.84	2.89	2.89	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
9	Ditch	8'	25.41	350	0.07	114.15	113.56	0.59	111.31	110.72	93	0.001700	0.33	0.025	8	2.84	3.66	3.68	1.82	13.99	25.41	2.0	--	--	--	--	--	--	--	--	--	--	
10	Parshall Flume	3' x 4.5'	13.50	14	0.00	113.56	113.13	0.43	110.72	110.29	62	--	--	--	2.84	7.28	7.28	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
11	Ditch	8'	25.41	800	0.15	113.13	111.85	1.28	110.29	109.01	91	0.001600	0.33	0.025	8	2.84	3.58	3.57	1.82	13.99	25.41	2.0	--	--	--	3.57	--	--	--	--	--	--	
12	Road Crossing	42"	9.62	54	0.01	113.56	113.11	0.45	109.01	108.56	39	--	--	--	2.84	2.75	2.75	--	--	--	--	1	39	42	4.06	0.07	0.13	0.26	0.00	0	0.45		
13	Ditch	8'	25.41	1,562	0.30	113.11	111.24	1.87	108.56	106.69	78	0.001200	0.33	0.025	8	2.84	3.07	3.09	1.82	13.99	25.41	2.0	--	--	--	3.09	--	--	--	--	--	--	
14	Lake Div. Str.	24"	3.14	280	0.05	111.24	108.49	2.75	106.69	103.94	20	--	--	--	2.00	2.00	2.00	--	--	--	--	1	20	24	6.37	1.64	0.31	0.63	0.17	0	2.75		
				5,383	1.02																												

- \$ The existing Parshall flume (5 feet wide by 4.5 feet high) will need to be replaced with a new Parshall flume 6-feet wide by 5-feet high at a cost of \$23,000.
- \$ Install two new 72-inch turnouts to the existing ground water recharge ponds at a cost of \$44,000.
- \$ The existing 48-inch control gate in the ditch will remain.
- \$ The 3-foot by 4.5-foot Parshall flume downstream of the ground water recharge ponds turnout will remain.
- \$ The 42-inch road crossing culvert (second crossing) will remain.
- \$ The last 3,146 feet of ditch with 8-foot bottom width will remain.
- \$ The 24-inch diameter Lake O'Neill intake structure will remain.

A summary of the costs for ditch enlargement is shown on Table 8.

For Alternatives 3, 4, 5 and 6 (existing sheet pile diversion dam), a maximum water depth in the existing ditch is limited to 3.4 feet because of the height of the existing sheet pile diversion dam. This maximum water depth limits the capacity of the enlarged ditch and facilities to less than 200 cfs. The 200 cfs future design capacity is based on a water depth of 4.15 feet, which will be obtained with a new diversion dam.

4.0 WATER SUPPLY

The water supply for this project will be provided by surface water flows from the Santa Margarita River. Historical water records were used to reconstruct the flow at the diversion dam from 1925 to 1999 (75 years). An analysis was performed to determine the divertable portion of the Santa Margarita River flow and is presented in Appendix E.

TABLE 8
DITCH ENLARGEMENT COST SUMMARY

ITEM	COST
Headgate	\$ 28,000
Enlarge Portion of Ditch (Reach 3)	5,000
First Road Crossing Culverts	32,000
First Road Crossing Control Gates	18,000
Enlarge Portion of Ditch (Reach 5)	2,000
Replace Parshall Flume	23,000
Turnout to Existing Recharge Ponds	44,000
Contingencies and Unlisted Items @ 25%	38,000
<hr/>	
Subtotal	\$ 190,000
Planning, Engineering and Design @ 15%	28,000
Project Management and Administration @ 10%	19,000
<hr/>	
Total Estimated Capital Cost	\$ 237,000
Amortized Capital Cost ¹	21,000
Annual Operation and Maintenance Cost ²	4,800
<hr/>	
Total Estimated Annual Cost	\$ 25,800
Unit Cost ³	\$2 / acre-foot

1. Capital costs amortized over 30 years at eight percent interest.
2. Ditch cleaning will continue to be performed on an annual basis at an estimated cost of \$4,800. Operation and maintenance cost does not include the annual man-hours cost for the day-to-day operation of the system.
3. Unit cost based on 14,000 acre-feet per year increase in diversion.

4.1 Historical Diversion Records

Historical diversion records for the period October 1960 through September 1999 showed that an average of 2,112 acre-feet was diverted to the ground water spreading basins and O'Neill Lake (Harrison, 11/10/00). For our analysis, the last 20 years of records (1980 to 1999) were used. For a fair comparison, diversions were assumed to be what would occur if the system could operate at 100 percent efficiency. The mean diversion for this period was estimated at approximately 4,400 acre-feet per year (Harrison, 11/10/00).

4.2 Flood Flows

An estimated 100-year flood flow of 40,000 cfs will have an estimated water depth of 12 feet at the diversion dam. This was based on an estimated water velocity of 12 feet per second. This

flood flow depth was used as a basis fo preliminary design and cost estimation of the diversion dam and ditch enlargement facilities.

5.0 ABBREVIATIONS AND ACRONYMS

AFY.....	Acre-Feet per Year
BA.....	Biological Assessment
BO.....	Biological Opinion
cfs.....	cubic feet per second
BRAC.....	Base Realignment and Closure
PC.....	personal computer
EPDM.....	ethylene propylene diene monomer
HP.....	horse-power
RCP.....	Reinforced concrete pipe
SMR.....	Santa Margarita River
UV.....	ultra-violet
USGS.....	United States Geological Survey

6.0 REFERENCES

Harrison, Dawn, 11/10/00. Comparison 1980-1999.

Malloy, Mike, 8/29/00. Telephone communication.