ATTACHMENT 5

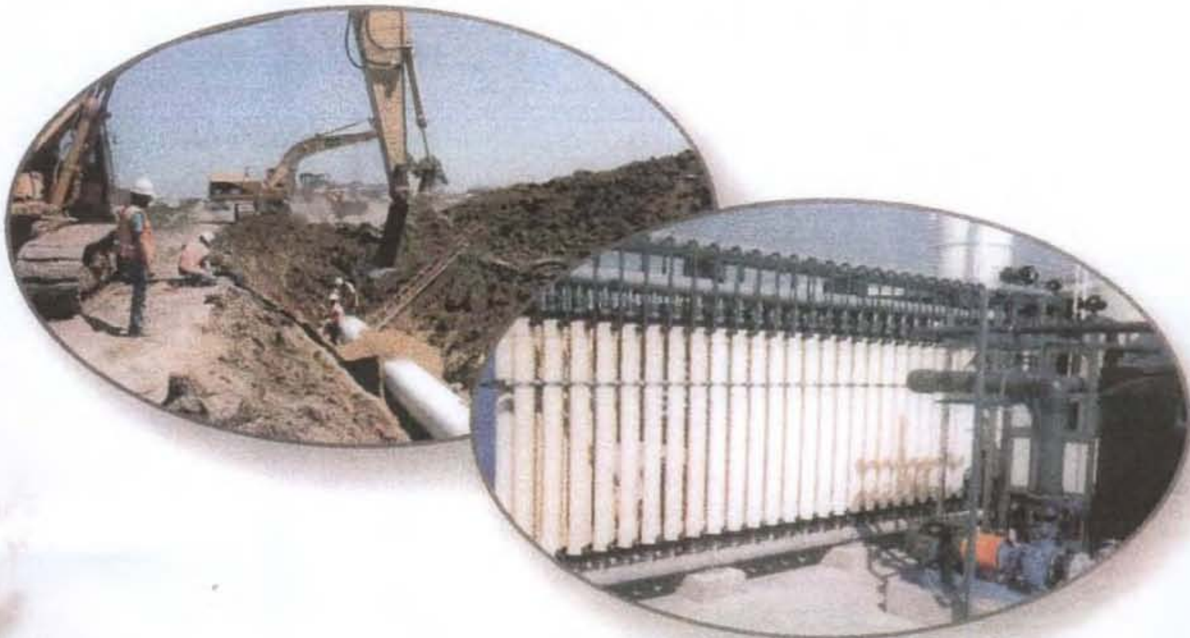
(Supplemental Documentation to the: Mogollon Rim Water Resource Management Study Report of Findings)

Town of Payson: Blue Ridge Reservoir Water Supply Pipeline and Treatment Plant, 2007

Payson

Town of Payson

Blue Ridge Reservoir Water Supply Pipeline and Treatment Plant



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Black & Veatch Corporation

Town of Payson, Arizona
Blue Ridge Reservoir Water Supply
Pipeline and Treatment Plant

B&V Project 141789
February 10,2006

Mr. Buzz Walker
Town of Payson
303 N. Beeline Highway
Payson, AZ 85541-4306

Dear Mr. Walker:

Enclosed you will find five (5) copies of the final report entitled "Blue Ridge Reservoir Water Supply Pipeline and Treatment Plant." Please review and contact me if you have any questions or comments concerning the report. We are available to discuss the details of the report in person at your convenience.

Very truly yours,

BLACK & VEATCH

Brad Hemken

Brad E. Hemken
Project Manager

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1.0 INTRODUCTION

The Town of Payson has secured a 3,000 ac. ft annual allocation of water from the Blue Ridge Reservoir. The Town plans to divert it's allocation from the Blue Ridge Power Plant, operated by the Salt River Project (SRP), on the downstream side of the power generation turbine. A pipeline approximately 14.5 miles in length would deliver raw water to Payson. The alignment would generally follow the Houston Mesa Road. A water treatment plant (WTP) would be constructed in Payson to treat the raw water to drinking water standards prior to delivery to the Town's potable water distribution system. For the purpose of this analysis a membrane filtration plant will be assumed. The Town will take it's Blue Ridge Reservoir allocation continuously over the nine months that SRP operates the turbine. During periods of low water demand the excess water will be used to recharge the local aquifer. This analysis will also take into consideration a potential 250 ac. ft allocation for the Tonto Indian Community to be delivered through the pipeline to the WTP in Payson.

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The community of Pine may secure a potential 500 ac. ft annual allocation of water from the Blue Ridge Reservoir. Pine plans to divert it's allocation from the Blue Ridge Power Plant in a common pipeline with Payson. Where the alignment to Pine diverges from that for Payson, the Pine Extension will start and convey Pine's allocation to the community along Forest Road (FR) 64 and State Route 87. For the purpose of this analysis it is assumed that Pine will only take it's Blue Ridge Reservoir allocation concurrent with Payson. It is also assumed for this analysis that a membrane filtration plant will be provided to treat the raw water to drinking water standards prior to delivery to Pine's potable water distribution system.

The purpose of the feasibility study is to develop sizing criteria and preliminary cost estimates for the pipelines and treatment facilities.

1.1 Hydraulic Capacity

Table 1-1 presents the design flows for a nine month delivery period of the Town's 3,000 ac. ft annual allocation, the Tonto Indian Community's 250 ac. ft annual allocation and Pine's potential 500 ac. ft annual allocation.

Table 1-1
Raw Water Main / WTP Design Capacity

Entity	Annual Allocation (ac-ft/yr)	Capacity (gpm)	Capacity (mgd)
Town of Payson	3,000	2,515	3.6
Tonto Indian Community	250	210	0.3
Pine	500	420	0.6
Total	**3,750**	**3,145**	**4.5**

The raw water main will be sized to deliver the combined design flow of 4.5 mgd for the initial length with the Pine Extension taking 0.6 mgd and the remaining length sized to deliver a flow of 3.9 mgd. The Payson WTP will be designed to initially treat the Town's water allocation with a design capacity of 3.6 mgd. However, the WTP will be designed to allow expansion to an ultimate capacity of 3.9 mgd for treatment of the Tonto Indian Community's potential water allocation. The Pine WTP will be designed to treat the community's water allocation with a design capacity of 0.6 mgd.

2.0 PAYSON RAW WATER MAIN

2.1 Location and Alignment

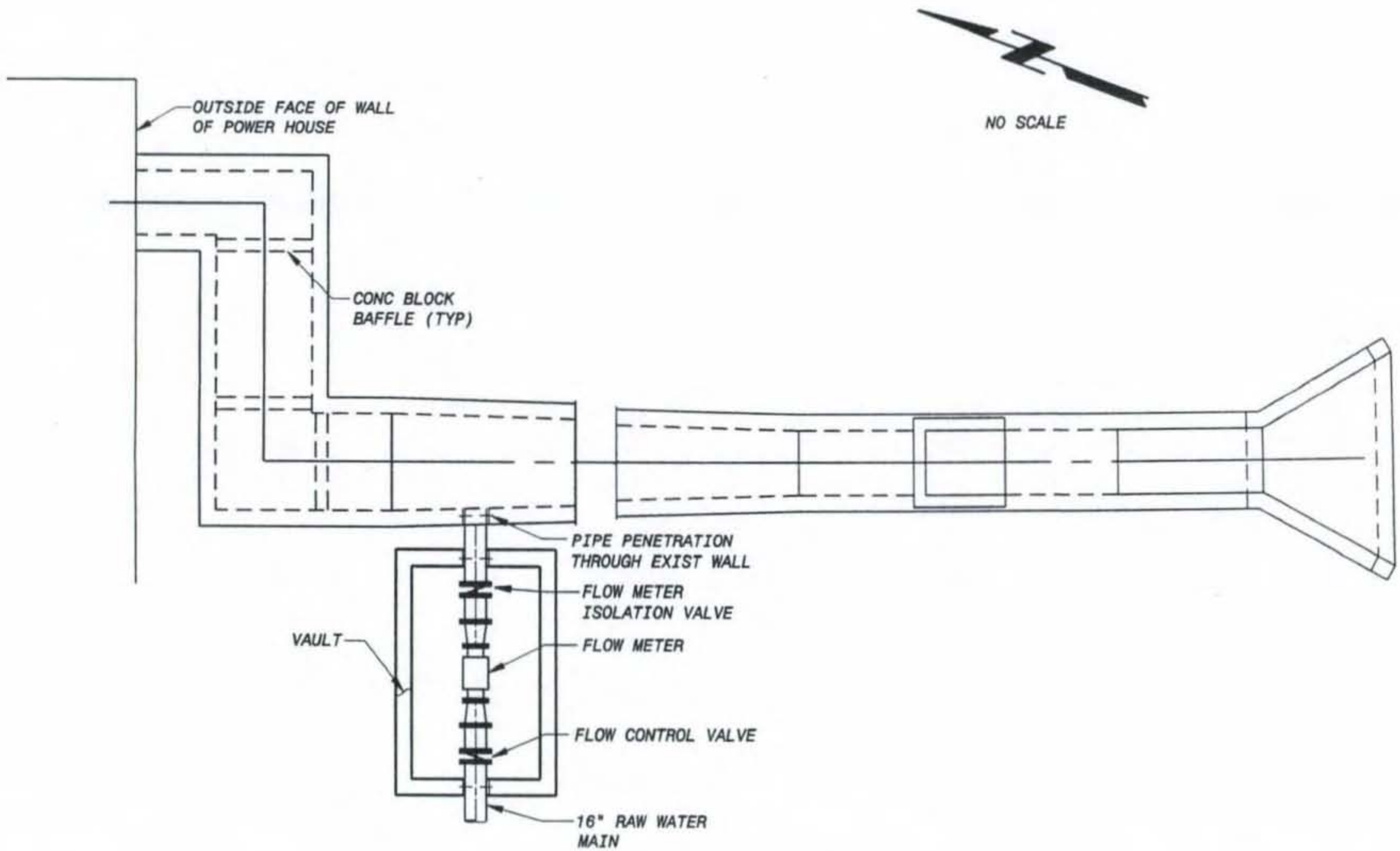
The raw water main will begin at the Blue Ridge Power Plant and follow the alignment of the Houston Mesa Road to the WTP location within the Town of Payson. Two potential alignments were initially evaluated: 1) Houston Mesa Road and 2) powerline utility easement. The powerline easement provided a shorter pipeline length, however, permitting concerns and construction issues associated with the rugged topography negated any advantage of a shorter alignment. The alignment along the Houston Mesa Road was selected to minimize permitting issues, such as environmental impact statements and 404 permits, and facilitate ease of construction. One disadvantage of the Houston Mesa Road alignment would be traffic control during construction. However, the pipeline can be constructed within the existing roadway easement along the edge of the road to minimize the impact.

The raw water main will penetrate the tailrace conduit downstream of the Blue Ridge Power Plant turbine, as shown in **Figure 2-1**, prior to discharge to the East Verde River. A flowmeter and flow control valve will be installed in the pipe to control and meter the flow in the raw water main.

The raw water main alignment along the Houston Mesa Road will run in a southwesterly direction from the Blue Ridge Power Plant to the Town. **Figure 2-2** presents the proposed alignment of the raw water main. An alternate alignment is also shown, which follows a powerline alignment through a small community adjacent to the Blue Ridge Power Plant. The proposed alignment along the Houston Mesa Road has a slight elevation gain at the beginning, which would require an increased pipe trench depth to maintain gravity flow. The alternate alignment has a negative slope from the start and would require less excavation. However, a detailed survey and easement search would be required to evaluate this option. It is recommended that the alternate alignment be evaluated further in the design stage of this project. The Pine extension turnout will be located at the intersection of Houston Mesa Road and FR 64 at Station 183+00.

2.2 Design Criteria

The raw water main was sized to satisfy two conditions: 1) gravity flow along the length of the pipeline alignment and 2) sufficient pressure at the end of pipe to drive the membrane filtration process without the use of booster pumps. Several different pipe sizes were evaluated. **Table 2-1** presents the resulting pressure along the length of the alignment for five different pipe diameters ranging from 14 to 24-inches. The resulting pressure along the length of the alignment between Station 0+00 and Station 183+00 was based on a design flow of 4.5 mgd. The resulting pressure along the remaining alignment was based on a design flow of 3.9 mgd.



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PROJECT NO. 141789

TOWN OF PAYSON

BLUE RIDGE RESERVOIR WATER SUPPLY PIPELINE AND TREATMENT PLANT

TAILRACE CONDUIT MODIFICATIONS

FIGURE NO. 2-1

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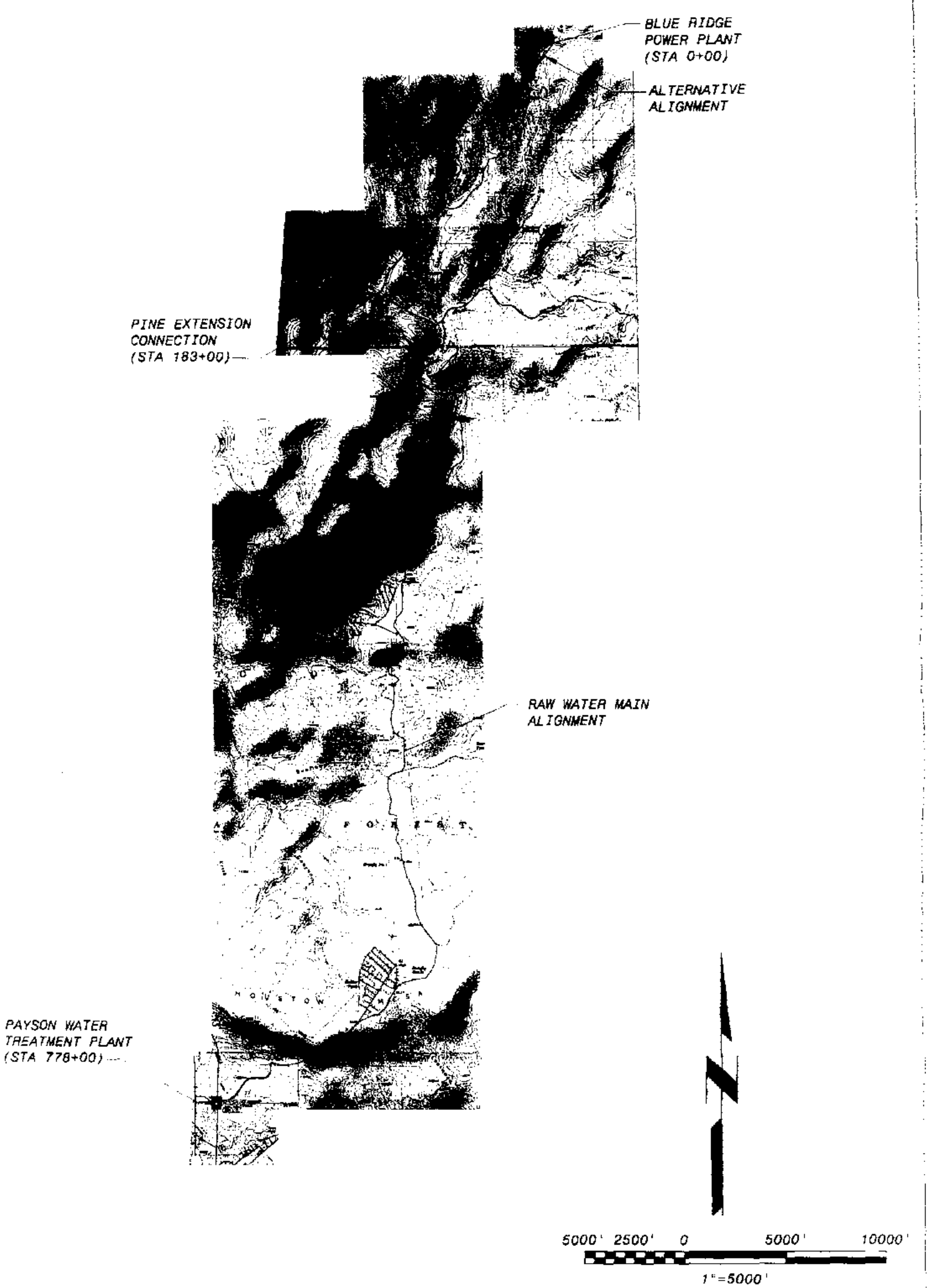
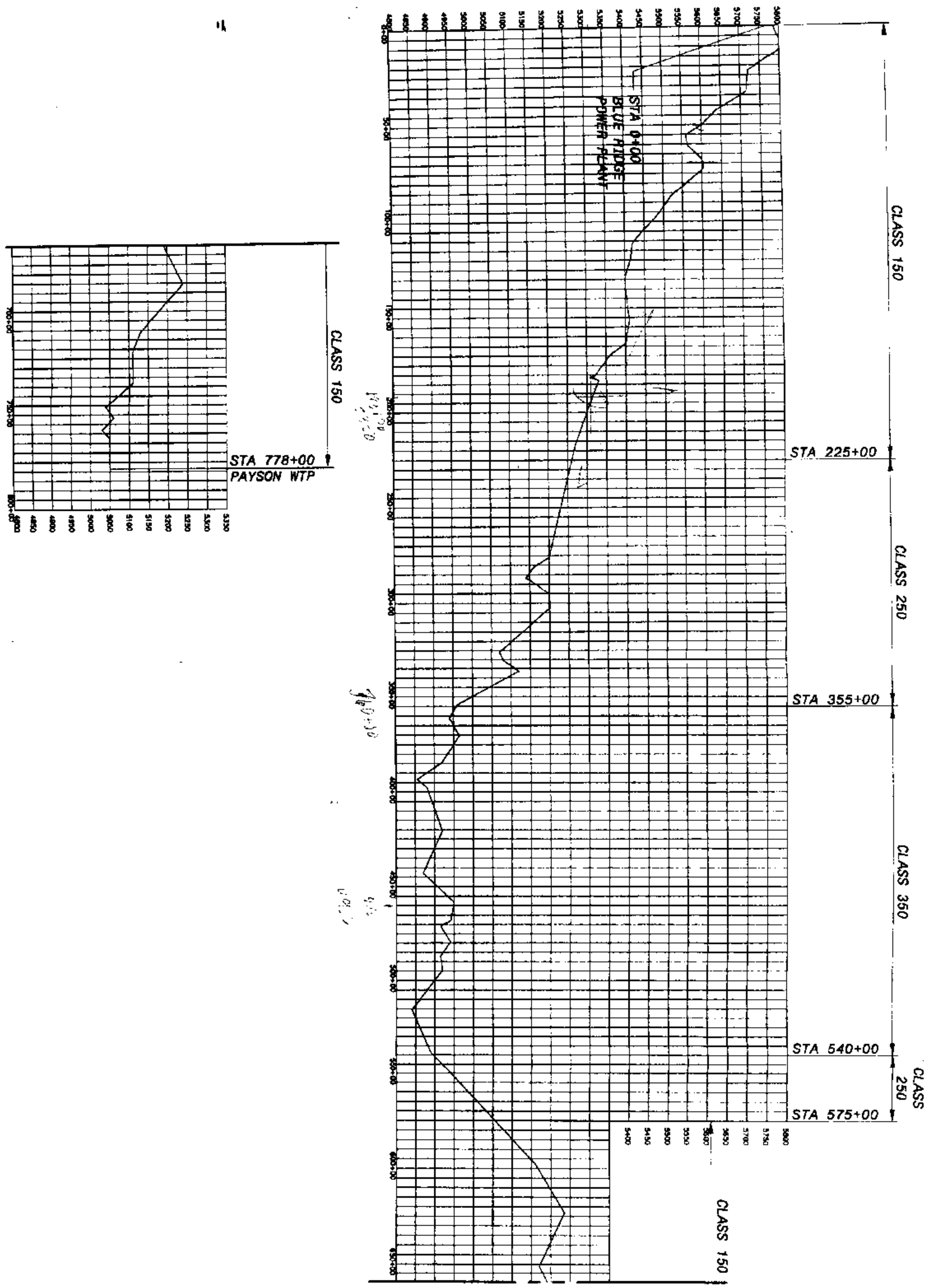


BLACK & VEATCH Corporation PROJECT NO. 141789	TOWN OF PAYSON BLUE RIDGE RESERVOIR WATER SUPPLY PIPELINE AND TREATMENT PLANT RAW WATER MAIN ALIGNMENT	FIGURE NO. 2-2



BLACK & VEATCH Corporation PROJECT NO. 141789	TOWN OF PAYSON BLUE RIDGE RESERVOIR WATER SUPPLY PIPELINE AND TREATMENT PLANT RAW WATER MAIN PIPE CLASS	FIGURE NO. 2-3

Table 2-1
Pipe Diameter versus Pressure

Station	Pipeline Pressure (psi)				
	14-inch	16-inch	18-inch	20-inch	24-inch
0+00	0	0	0	0	0
33+00	5	16	21	24	27
55+00	59	77	86	91	95
71+00	29	52	63	69	74
130+00	76	119	140	151	160
164+00	52	107	133	147	158
183+00	69	130	160	175	188
225+00	77	149	183	201	216
275+00	76	161	201	222	241
287+00	95	183	225	247	266
295+00	64	154	197	219	238
326+00	105	203	249	273	295
336+00	78	178	226	251	273
370+00	128	238	250	317	341
393+00	161	277	331	360	385
420+00	119	241	299	329	356
458+00	85	218	280	312	342
495+00	78	220	287	322	353
515+00	102	249	318	354	387
575+00	-24	139	215	255	292
623+00	-128	47	129	172	211
652+00	-115	68	153	198	239
680+00	-161	30	118	165	207
634+00	-79	99	182	226	265
758+00	-112	99	196	248	295
778+00	-131	84	184	238	286

The pressure within the pipeline along the alignment was calculated based on elevation head minus friction loss. In order to minimize the cost of the pipeline the smallest pipe diameter meeting the design criteria will be used. As shown in **Table 2-1**, a 14 inch diameter pipe would result in a negative pressure in the pipeline and would require an intermediate pump station. The smallest pipe diameter meeting the design criteria is a 16-inch pipe diameter. This will ensure gravity flow along the pipe alignment and provide a residual pressure of 84 psi at the WTP. A larger diameter pipe could be used, however this would increase the working pressure due to decreased friction loss and increase the cost.

2.3 Pipe Materials

Pipe materials were evaluated based on a 16-inch diameter pipe with a maximum working pressure of 277 psi. Investigation into the pipe materials resulted in two potential pipe materials, ductile iron pipe (DIP) and steel. Both pipe materials are suitable for the required working pressure and cost effective for a 16-inch diameter pipe. Other pipe material were evaluated including prestressed concrete cylinder pipe (PCCP) and PVC. However, PVC pipe is not suited for the high pressures that will occur in the pipeline and PCCP is cost prohibitive in pipe diameters below 30-inches.

Ductile iron pipe is available in three pressure classes, Class 150, 250 and 350. The pressure class is based on working pressure and has a test pressure of twice the working pressure plus 100 psi for surge, for example Class 350 DIP would have a test pressure of 800 psig. DIP has a benefit for installations in areas where a significant amount of rock is present because it requires a lower class of bedding material than for steel pipe, which reduces installation cost.

Steel pipe is designed based on working pressure by varying the pipe wall thickness to accommodate the design pressure. Steel pipe requires a full pipe embedment with a higher class bedding material required in installations with a significant amount of rock to decrease the point loads that occur from surrounding rock. Additionally, the standard coating system comprising of a tape wrap is delicate and not suited for rocky installations. A more durable coating system of either concrete mortar or fusion bonded epoxy would be required for this project.

It is recommended that DIP be used for this project. DIP provides a cost effective material that would be suitable for installation under the existing geotechnical conditions. **Figure 2-3** presents the required DIP pressure class along the length of the pipeline. Steel pipe can be bid against DIP to ensure a competitive environment to obtain the lowest price for the pipeline.

3.0 PINE EXTENSION

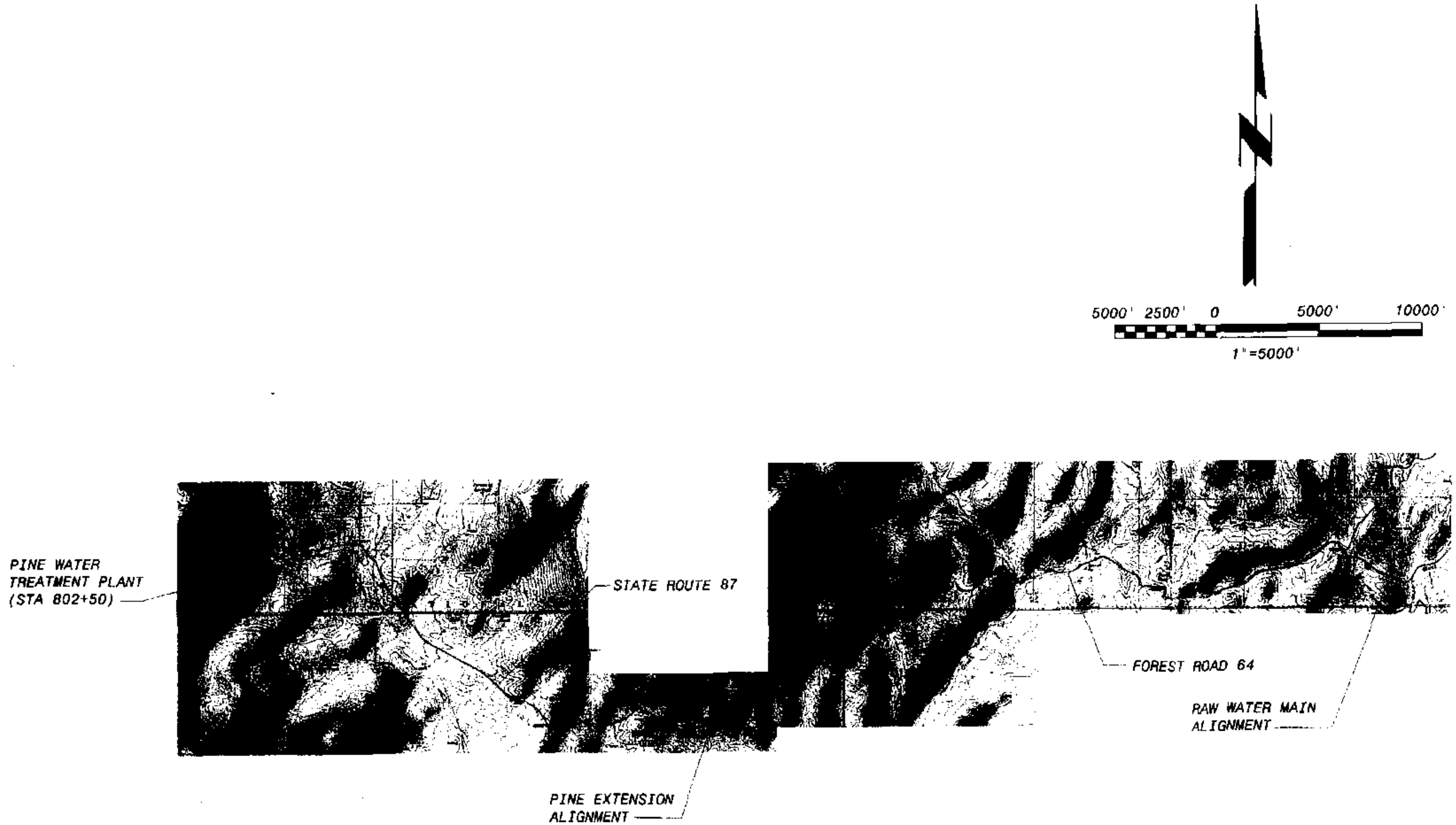
3.1 Location and Alignment

The Pine extension will begin at Station 183+00 of the raw water main alignment at the intersection of Houston Mesa Road and FR 64. **Figure 3-1** presents the proposed alignment of the Pine extension. The Pine extension will run east along FR 64 to the intersection of State Route 87 and then northwesterly along State Route 87 to the Pine WTP. A flowmeter and flow control valve will be installed at the beginning of the Pine extension to control and meter the flow in the pipeline.

The proposed alignment crosses several hills and climbs up to the community of Pine at the base of the Mogollon Rim. Therefore, intermediate pump stations will be required, which will be discussed further in the following section. The pipeline will be constructed within the roadway alignment along FR 64 and within the roadway easement along State Route 87. The alignment along FR 64 and State Route 87 was selected to minimize permitting issues, such as environmental impact statements and 404 permits, and facilitate ease of construction. One disadvantage of the State Route 87 alignment would be traffic control during construction. However, the pipeline can be constructed within the existing roadway easement along the edge of the road to minimize the impact.

3.2 Design Criteria

The Pine extension will consist of the pipeline and intermediate booster pump stations to convey the design flow to the Pine WTP. The system was designed to provide sufficient pressure at the end of the pipe to drive the membrane filtration process without the use of on-site booster pumps.



TOWN OF PAYSON

BLUE RIDGE RESERVOIR WATER SUPPLY PIPELINE AND TREATMENT PLANT

PINE EXTENSION
ALIGNMENT

FIGURE NO. 3-1

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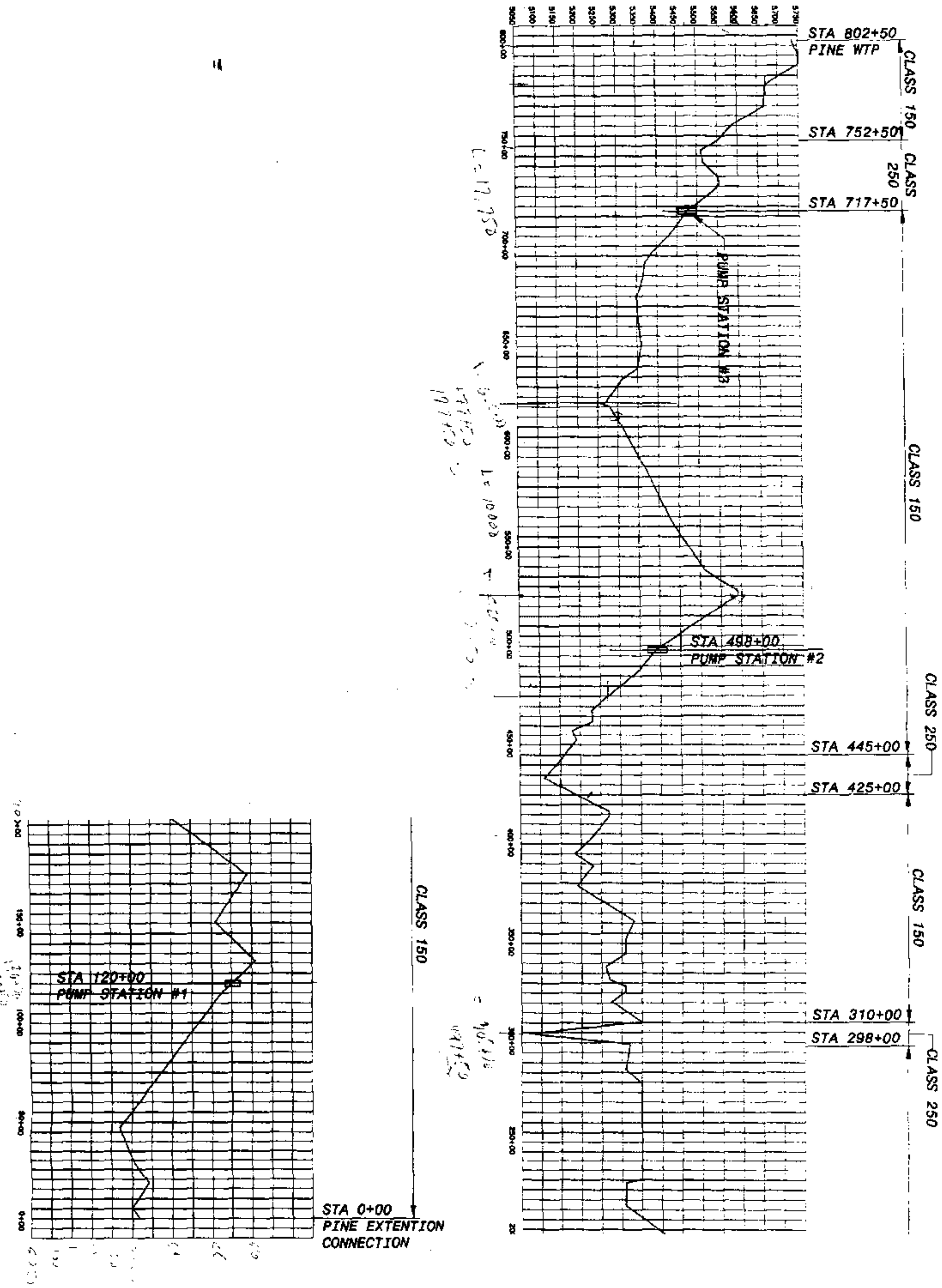

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PROJECT NO. 141789

TOWN OF PAYSON

BLUE RIDGE RESERVOIR WATER SUPPLY PIPELINE AND TREATMENT PLANT

PINE EXTENSION

PIPE CLASS AND PUMP STATION LOCATIONS

FIGURE NO. 3-2

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Several different pipe sizes were evaluated, including 6-inch, 8-inch and 10-inch diameter. A cost optimization was performed for each of the three pipe diameters based on pipeline and booster pump station cost. Based on pipeline cost and number of booster pump stations required, an 8-inch pipeline is the most cost-effective.

Table 3-1 presents the resulting pressure along the length of the alignment and proposed booster pump station locations for an 8-inch diameter pipeline. The resulting pressure along the length of the alignment was based on a design flow of 0.6 mgd.

Table 3-1
Pipe Pressure and Pump Station Locations

Station	Pipeline Pressure (psi)	Station	Pipeline Pressure (psi)
0+00	130.4	457+00	114.1
6+00	141.9	462+00	91.2
17+50	121.6	468+00	89.6
47+50	142.1	487+50	32.7
113+00	23.6	**498+00**	**105.0**
120+00	**40.0**	520+00	30.1
125+00	25.7	525+00	11.5
130+00	11.5	527+50	10.9
150+00	49.7	537+50	43.0
170+00	9.9	560+50	71.7
217+50	119.0	620+00	121.5
227+50	116.4	622+00	129.6
230+00	98.5	623+00	125.0
280+00	85.7	632+50	107.4
286+00	101.5	638+00	86.6
298+00	94.1	651+00	78.9
303+00	201.1	667+50	79.0
310+00	78.1	672+50	77.7
320+00	108.0	682+50	68.7
325+00	91.5	691+00	64.4
327+50	90.9	**717+50**	**175.0**
332+00	107.1	730+00	139.3
337+50	110.0	735+00	140.2
345+00	86.4	742+00	153.6
352+50	84.5	747+50	154.4
362+00	75.6	752+50	135.8
377+00	128.0	762+00	113.9
388+00	110.1	768+00	82.0
395+00	125.6	780+00	76.8
413+00	86.4	790+00	39.6
417+00	85.4	797+00	37.8
433+00	150.5	802+50	42.9
452+00	111.0		

Notes:
(1) Pump Station locations are shown in bold.

The pressure within the pipeline along the alignment was calculated based on elevation head minus friction loss. Booster pump stations were located along the alignment to boost the pressure within the pipeline to convey the raw water to the Pine WTP. Three booster pump stations are provided as follows:

Pump Station #1	
Location	Station 120+00
No. Pumps	1 (plus 1 standby)
Type	Centrifugal
Capacity, gpm	420
TDH, ft	92
Motor, hp	20

Pump Station #2	
Location	Station 498+00
No. Pumps	1 (plus 1 standby)
Type	Centrifugal
Capacity, gpm	420
TDH, ft	245
Motor, hp	50

Pump Station #3	
Location	717+50
No. Pumps	1 (plus 1 standby)
Type	Centrifugal
Capacity, gpm	420
TDH, ft	405
Motor, hp	75

3.3 Pipe Materials

Pipe materials were evaluated based on an 8-inch diameter pipe with a maximum working pressure of 201 psi. Investigation into the pipe materials resulted in two potential pipe materials, ductile iron pipe (DIP) and steel. Both pipe materials are suitable for the required working pressure and cost effective for a 8-inch diameter pipe. Other materials were evaluated including prestressed concrete cylinder pipe (PCCP) and PVC. However, PVC pipe is not suited for the high pressure that will occur in the pipeline and PCCP is cost prohibitive in pipe diameters below 30-inches.

Ductile iron pipe is available in three pressure classes, Class 150, 250 and 350. The pressure class is based on working pressure and has a test pressure of twice the working pressure plus 100 psi for surge, for example Class 350 DIP would have a test pressure of 800 psig. DIP has a benefit for installations in areas where a significant amount of rock is present because it requires a lower class of bedding material than for steel pipe, which reduces installation cost.

Steel pipe is designed based on working pressure by varying the pipe wall thickness to accommodate the design pressure. Steel pipe requires a full pipe embedment with a higher class bedding material required in installations with a significant amount of rock to decrease the point loads that occur from surrounding rock. Additionally, the standard coating system comprising of a tape wrap is delicate and not suited for rocky installations. A more durable coating system of either concrete mortar or fusion bonded epoxy would be required for this project.

It is recommended that DIP be used for this project. DIP provides a cost effective material that would be suitable for installation under the existing geotechnical conditions. **Figure 3-2** presents the required DIP pressure class along the length of the pipeline. Steel pipe can be bid against DIP to ensure a competitive environment to obtain the lowest price for the pipeline.

4.0 WATER TREATMENT PLANTS

The water treatment plants (WTP) for this project will be located within the limits of the Town of Payson and the community of Pine. The WTPs will consist of microfiltration treatment followed by disinfection. An on-site finished water reservoir and pump station will be constructed for storage and distribution of treated water. The following sections will present an overview of the microfiltration process, design criteria for the treatment processes and cost estimate. A preliminary site layout for the Payson WTP is presented in **Figure 4-1**. The Pine WTP site layout will be similar to that of the Payson WTP, only at a smaller scale.

4.1 The Microfiltration Process

Microfiltration (MF) membranes provide an effective barrier to particles, bacteria, cryptosporidium and giardia in the influent stream in a small footprint technology. In a cartridge configuration the membranes are housed in a pressure vessel and feed water is delivered to the membranes at approximately 35psi. Raw water is fed to the membranes in an outside-in mode. Permeate is withdrawn leaving solids to accumulate in the vessel. Solids are removed via periodic backwashing, air scrubbing and chemical cleaning.

4.2 Payson WTP

The following presents the design criteria for the WTP processes. Raw water will be delivered to the WTP on a continuous basis during a nine month period. Finished water will be delivered into the potable water distribution system or used to recharge the local aquifer during periods of low demand. The Town will use wells for peaking and for the drinking water supply in the remaining three months of the year.

It was assumed that the residual pressure in the raw water main will be sufficient to drive the MF process. Excess pressure can be relieved through pressure regulating valves (PRV) prior to the process. An alternative to PRVs would be an in-line power generation turbine. This option would alleviate some of the power cost of the WTP and further examination of this option is suggested during the design phase.

4.2.1 _MF Process_. Prefilter strainers will be provided as a barrier to larger particles to protect the membranes. Flow will then pass through the MF membranes and into the reservoir.

The design criteria for the MF process are as follows:

Prefilter Strainers	
Number of units	1 (plus 1 standby)
Mesh opening, micron	500
MF Membranes	
Manufacturer	Pall Corporation
Number at assembly trains	2
Type	Microza hollow fiber
Number of modules	130
Flux rate, gfd	55
Module area, m^2	50/27 (O.D/I.D.)
Membrane rating	0.1 micron

4.2.2 _Reservoir and Pump Station_. An at-grade steel reservoir will be constructed to provide on-site storage and system control flexibility. The reservoir will store finished water for delivery to the potable water distribution system and off-site storage tanks. During periods of low water demand the water level within the reservoir will rise and initiate recharge to the local aquifer. The pump station will be constructed adjacent to the reservoir to deliver finished water to the distribution system.

The design criteria for the reservoir and pump station are as follows:

Reservoir	
Type	At-grade, steel
Volume, MG	1.0
SWD, ft	24
Diameter, ft	85
Pump Station	
Number of units	2 (plus 1 standby)
Type	Vertical turbine, canned
Capacity, gpm	1,260

4.2.3 _Disinfection_. Disinfection will occur via on-site sodium hypochlorite generation. On-site generation passes a salt and water solution through an electrical field to produce sodium hypochlorite and hydrogen. The process is comprised of a water softener to prevent scaling in the process, a brine tank to generate a salt water solution, an electrolytic cell to generate sodium hypochlorite and stand pipe to vent hydrogen to atmosphere. Two storage tanks will be required to meet Arizona regulations pertaining to critical chemicals for potable water systems. A hydrogen dilution blower will be located at the storage tanks to prevent hydrogen buildup within the tanks and prevent explosions. Sodium hypochlorite will be fed to the permeate stream prior to the reservoir.

The design criteria for the disinfection system are as follows:

<u>Storage Tank</u>	
Number	2
Type	FRP
Volume, gal	2,500
Storage capacity, days	3

<u>Chemical Feed Pumps</u>	
Number of units	1 (plus 1 standby)
Type	Diaphragm

4.3 Pine WTP

The following presents the design criteria for the WTP processes. Raw water will be delivered to the WTP on a continuous basis during a nine month period. Finished water will be delivered into the potable water distribution system. It was assumed that the residual pressure in the raw water main will be sufficient to drive the MF process. Excess pressure can be relieved through pressure regulating valves (PRV) prior to the process.

4.3.1 *<u>MF Process</u>*. A skid mounted MF membrane will be provided to treat the raw water. The skid mounted unit will consist of the prefilter strainers, MF membranes, clean-in-place (CIP) system and required instrumentation and controls. Flow will pass through the prefilter strainers and MF membranes and into the Finished Water Reservoir.

The design criteria for the MF process are as follows:

<u>MF Membranes</u>	
Manufacturer	Pall Corporation
Model	Aria AP-6
Number of units	1
Type	Microza hollow fiber
Number of modules	30
Flux rate, gfd	55
Module area, m^2	50/27 (O.D/I.D.)
Membrane rating	0.1 micron

4.3.2 *<u>Reservoir and Pump Station</u>*. An at-grade steel reservoir will be constructed to provide on-site storage and system control flexibility. The pump station will be constructed adjacent to the reservoir to deliver finished water to the distribution system.

The design criteria for the reservoir and pump station are as follows:

<u>Finished Water Reservoir</u>	
Type	At-grade, steel
Volume, MG	0.2
SWD, ft	24
Diameter, ft	40

<u>Pump Station</u>	
Number of units	1 (plus 1 standby)
Type	Horizontal, split case
Capacity, gpm	420

4.3.3 *Disinfection*. A tablet chlorination system will be provided for disinfection. Tablet chlorination systems comprise of a package system that is easily delivered and installed and requires minimal operator attention and maintenance for proper operation. Solid chlorine tablets are dissolved into a chlorine solution that will be delivered to the storage tanks. Two storage tanks will be required to meet Arizona regulations pertaining to critical chemicals for potable water systems. From the storage tanks, the chlorine solution will be fed to the permeate from the MF membranes via chemical feed pumps prior to the Finished Water Reservoir.

The design criteria for the disinfection system are as follows:

<u>Storage Tank</u>	
Number	2
Type	FRP
Volume, gal	500
Storage capacity, days	3
<u>Chemical Feed Pumps</u>	
Number of units	1 (plus 1 standby)
Type	Diaphragm

5.0 COST

The following presents the cost for the pipelines and water treatment plants. All cost data is presented in 2006 dollars.

5.1 Raw Water Main

The estimated construction cost for the pipeline will include the modifications to the existing tailrace conduit and pipe installation. Several assumptions were made in order to establish a cost for the pipeline, including:

- Seventy-five percent of the pipeline alignment will be in the road and require pavement replacement. Pavement replacement will occur only within the limits of the pipe trench.
- Half of the pipe trench depth along seventy-five percent of the pipeline alignment will be through hard rock and require blasting.
- Traffic control will comprise of two flagmen during construction activities along with the required traffic control signage.
- Construction schedule of 10 months based on installation of 400 linear feet of pipe per day.
- Cost does not include land acquisition, surveying or engineering services.

Table 5-1 presents the estimated construction cost for the raw water main.

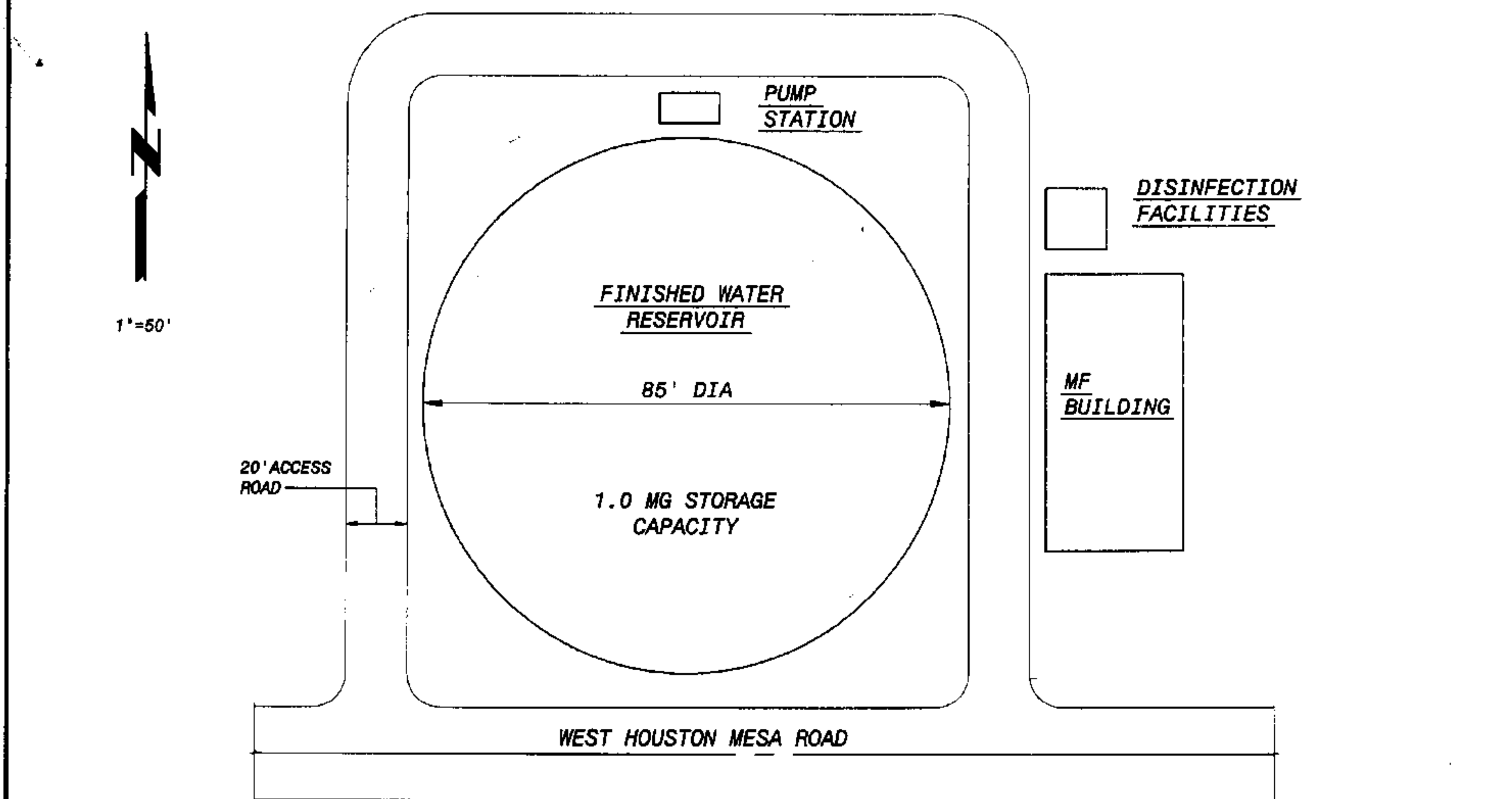
Table 5-1
Raw Water Main Construction Cost Estimate

Item	Units	Unit Cost	Subtotal
Tailrace Modifications	1	Lump Sum	$55,000
Raw Water Main			
Pipeline	14.5 miles	$7.50/in-dia/lf	$9,187,200
Pavement Replacement	57,420 lf	$40/lf	$2,296,800
Rock Excavation	29,774 cy	$45/cy	$1,339,830
Water/ Wash Crossings	16	$45,000	$720,000
Traffic Control		Lump Sum	$170,000
Subtotal			$13,768,830
Contingency (25%)			$3,442,207
Total			**$17,211,037**

5.2 Pine Extention

The estimated construction cost for the pipeline will include the three booster pump stations and pipe installation. Several assumptions were made in order to establish a cost for the project, including:

- Seventy-five percent of the pipeline alignment will be in the road and require pavement replacement. Pavement replacement will occur only within the limits of the pipe trench.
- Half of the trench depth along seventy-five percent of the pipeline alignment will be through hard rock and require blasting.
- Traffic control will comprise of two flagman during construction along with the required traffic control signage.
- Construction schedule of 10 months based on installation of 400 linear feet of pipe per day.
- Each pump station will consist of a building to house pumps and other equipment. Surge control will consist of an air chamber on the pumps discharge header and small reservoir on the pump suction.
- Cost does not include land acquisition, surveying or engineering services.



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PROJECT NO. 141789

TOWN OF PAYSON

BLUE RIDGE RESERVOIR WATER SUPPLY PIPELINE AND TREATMENT PLANT

WTP SITE PLAN

FIGURE NO. 4-1

141789/FIGURE 3-1   07/05/2005 14:02:32

Table 5-2 presents the estimated cost for the pipeline and booster pump stations.

Table 5-2
Pine Extension Construction Cost Estimate

Item	Units	Unit Cost	Subtotal
Pipeline	15.2 miles	$7.50/in-dia/lf	$4,815,000
Pavement Replacement	60,200 lf	$40/lf	$2,408,000
Rock Excavation	30,000 cy	$45/cy	$1,350,000
Water / Wash Crossings	20	$45,000	$900,000
Traffic Control		Lump Sum	$200,000
Booster Pump Stations	3	$825,000	$2,475,000
Subtotal			$12,148,000
Contingency (25%)			$3,037,000
Total			**$15,185,000**

5.3 Water Treatment Plants

The estimated cost for the WTP's is presented in **Table 5-3**.

Table 5-3
WTP Construction Cost Estimate

Item	Payson WTP	Pine WTP	
General Requirements (9%)	$288,000	$72,000	
Sitework (20%)	$640,000	$160,000	232
MF Building (1,600 sq ft)	$176,000	$88,000	320
MF Equipment	$1,780,000	$415,000	735
Disinfection	$275,000	$50,000	785
Finished Water Reservoir (@ $0.75/gal)	$750,000	$150,000	[illegible]
Pump Station	$215,000	$100,000	[illegible]
Electrical / I&C (20%)	$703,000	$177,000	1212
HVAC / Plumbing (5%)	$176,000	$44,000	1256
Subtotal	$5,003,000	$1,336,000	1,256,000
Contingency (25%)	$1,250,750	$334,000	
Total Capital	**$6,253,750**	**$1,670,000**	
Cost per 1,000 Gallons Treatment Capacity ($/kgal)	**$6.40** w/e	**$10.25**	

5.4 Payson Cost Summary

The following presents the total cost of the project, including both capital and operating expenses. The total capital cost of the project is $23,464,784. The annual cost of the project amortized over a period of 20 years at a 7% interest rate is $2,214,910. The estimated yearly operation and maintenance cost including power, chemicals, membrane replacement, waste disposal and full-time operator is $168,433. Therefore, the total annual cost of the project (annual capital plus yearly operation and maintenance) is $2,383,343, or $2.44 for every thousand gallons treated over a 20 year period. **Table 5-4** summarizes the cost information.

Table 5-4
Payson Cost Summary

Item	Cost
Raw Water Main	$17,211,037
Water Treatment Plant	$6,253,750
Total Capital Cost	$23,464,787
Amortized (20 years)	$2,214,910
Operation & Maintenance ($/year)	$168,433
Total Annual Cost	**$2,383,343**
Cost per 1,000 Gallons ($/kgal)	**$2.44**

0.071
n 7.17%,
w 8%

5.5 Pine Cost Summary

The following presents the total cost of the project, including both capital and operating expenses. The total capital cost of the project is $16,855,000. The annual cost of the project amortized over a period of 20 years at a 7% interest rate is $1,590,993. The estimated yearly operation and maintenance cost including power, chemicals, membrane replacement, waste disposal and full-time operator is $162,262. Therefore, the total annual cost of the project (annual capital plus yearly operation and maintenance) is $1,753,255, or $10.76 for every thousand gallons treated over a 20 year period. **Table 5-5** summarizes the cost information.

Table 5-5
Pine Cost Summary

Item	Cost
Raw Water Main	$15,185,000
Water Treatment Plant	$1,670,000
Total Capital Cost	$16,855,000
Amortized (20 years)	$1,590,993
Operation & Maintenance ($/year)	$162,262
Total Annual Cost	**$1,753,255**
Cost per 1,000 Gallons ($/kgal)	**$10.76**

0.1020

APPENDIX A

Pall Microfiltration System

Preliminary
Design Information

for

Payson Arizona

And

Black & Veatch

June 6, 2005

Submitted by:
Pall Corporation
2200 Northern Boulevard
East Hills, New York 11548

Proprietary Information Notice

Microfiltration System Equipment
Preliminary Design Information

Table of Contents

Section

1.0 OVERVIEW OF PALL CORPORATION

1.1 Qualifications

Pall Corporation is the world's largest supplier of membrane filters, filter systems and fluid purification equipment. We focus our strengths on advancing the state-of-the-art in separation technology in thousands of diverse applications. We owe our success to developing products that offer our customers optimal value and economy of use.

Pall Corporation offers our Microza hollow fiber filters that are available in ultrafiltration and microfiltration ratings. The enclosed information is built upon our 0.1 micron PVDF hollow fiber filter.

The first membrane filtration plant was installed in Japan in April 1993. The first municipal water treatment plant using Pall's membrane was installed in Japan in October 1993. Since then, over a hundred membrane plants have been installed. All of these projects have shown excellent performance, reliability, and cost-effectiveness.

As shown in these tables, Pall microfilters have been successfully tested and installed in a wide range of applications, including:

- Surface waters (reservoirs, lakes, and rivers)
- Coagulated and clarified surface water
- Ground water with iron, manganese and arsenic
- Waste filter washwater from conventional granular filters
- Drinking water from an open, finished storage reservoir
- Secondary Wastewater Effluent (pretreatment to RO)

In addition to the over one hundred hollow fiber membrane systems, we also supplied a 44 MGD coarse membrane system to protect nanofilters for the City of Paris for drinking water, and over 1,600 specialty Reverse Osmosis membrane systems that produce drinking water from seawater for ships and resorts.

For the treatment of surface waters for potable use, Pall Corporation offers our Microza hollow fiber filters that are available in ultrafiltration and microfiltration ratings. Our proposal is built upon our 0.1 micron PVDF hollow fiber filter.

Microza filters are currently installed and operating at over one hundred drinking water sites around the world. See Section 6, for additional qualifications.

Membrane Filtration systems are operating or on order for the following microfiltration water applications:

- Pittsburgh, Pennsylvania
- Holladay, Utah
- Meeteetse, Wyoming
- Travis County WC&ID 17 & 18, TX
- Point Hope, Alaska
- Wainwright, Alaska
- Alamitos Barrier, California
- City of Chandler, Arizona
- San Patricio Municipal Water District, TX
- Beverly Beach, Oregon
- Bullard's Beach, Oregon
- Abilene, TX
- San Diego, California
- Atqasuk, Alaska
- Point Lay, Alaska
- Young's River, Oregon
- Solano Irrigation District, CA
- Fountain Hill Sanitation District, AZ
- Upper Eagle Regional Water Authority – Edwards, CO

And over 100 additional UF installations worldwide!

1.2 Corporate Philosophy

Pall is a billion-dollar corporation with manufacturing, sales, marketing, engineering and technical support throughout the world. We have over 50 years of experience in thousands of successful installations using state-of-the-art filters to remove contaminants from liquid and gas streams. The cornerstone of Pall's philosophy is service to customers. This extends beyond product quality and prompt delivery to problem solving, system recommendations and the sharing of scientific information.

Our charter is clearly stated in our latest Annual Report. "Pall Corporation is committed to being the preeminent supplier of filtration products within each geographic area and industry it serves. We enter only those markets where we can provide superior products that are recognized by our customers as delivering clear and compelling benefits. Pall products and support services provide users with the most economical and reliable solution to their filtration and separation requirements. We call this standard ***"Absolute Performance."***

We serve customers who must remove contaminants from gases and liquids used to produce their products. Across a wide array of industries we adopt a "systems" approach to filtration that takes into account ever tightening environmental regulations, with economy of use and the push for finer particle removal. By design, our filters minimize waste and reduce operator exposure to hazardous materials.

New orders in our fiscal year 1999 totaled over a billion dollars, which makes us the largest manufacturer of filters, on a global basis. Since filters and filter systems are our only business, we provide our customers with the highest value and economy of use.

We design and manufacture our own media, elements, vessels and fully integrated separation systems. We provide expert engineering, applications and system design assistance and technical support. Since we supply the broadest array of polymeric, glass, metallic and ceramic filters to industry, we select the optimum filter medium that meets specific customer requirements. Our internal research and development organizations are continually developing and testing advanced filtration membranes for new and challenging applications.

While our strategies for meeting customer requirements may vary in different parts of the world, our guiding philosophy is consistent. Our global network of employees, sales distributors and manufacturing facilities is made up of highly trained professionals with a focus on ***Absolute Performance.*** Each Pall manufacturing facility adheres to uniform manufacturing procedures. Our manufacturing facilities, research and development and scientific laboratories in

Europe and the USA have been granted International Standard Organization (ISO) certification to the ISO 9001 Quality Management System. No matter where in the world you order Pall filters, you can be assured they will perform exactly as specified.

Pall maintains a global network of support and service with top management headquarters in East Hills, New York; Portsmouth, England and Tokyo, Japan. In many different markets, Pall Corporation has formed alliances with leading companies to provide advanced solutions to customers' purification challenges. We design and build products that offer our customers superior performance and economical operation. Through strategic alliances, we can provide customers unique value that makes our alliance partners more competitive. For ultrafiltration and microfiltration hollow fiber systems, Pall has an alliance with Asahi Chemical to supply systems that are more economical than other available technology. The strengths of both companies ensure a successful system design with good operational performance.

Many alliance partners select Pall as an alliance partner because we are the leading filter manufacturer in the world. Not only are we the leading manufacturer of high technology filter products, but Pall also has the resources and the commitment to continually developing new leading edge products.

1.3 Pall Microfiltration Modules

Our Microza microfiltration modules employ homogeneous (polyvinylidenefluoride) PVDF hollow fiber membranes. Our PVDF product is unequaled in strength and chemical compatibility. The fiber porosity is double that of most competing membranes resulting in higher sustainable unit flow rates.

1.4 Pall Microfiltration System

All Pall filtration systems for water applications are manufactured in our factory in Cortland, New York. Cortland is located 30 miles South of Syracuse, New York. Our engineers have designed a wide range of membrane filtration systems for use in diverse water applications. Reference Section 2.0 for a description and the operation of the Pall microfiltration system.

2.0 PROCESS DESCRIPTION

2.1 Description of the Pall Filtration Systems

The Pall MF system will treat surface water, with an estimated recovery of 92-97%. The system is comprised of Pall Microza Microfiltration modules, along with all required pumps, tanks, piping, valves, instrumentation, and controls required for a complete and functional system. Installation of the system is usually by others with construction technical advice provided by Pall. The system includes the components as identified in our P&ID and Scope of Supply.

Pall Microza Microfiltration modules are specially designed for water processing applications. These modules use proprietary PVDF (Polyvinylidenefluoride) hollow fiber membrane technology with high and stable flux rates and advanced bonding techniques for an exceptionally strong module design.

The Microza Modules operate in an outside-in mode with a small amount of recirculation. In conventional or single pass filtration, the membrane filter is perpendicular to feed flow direction. Solids are dead end filtered by the media and are generally removed when the filters are backwashed. For Microza modules, the membranes are places parallel to the feed direction and only clean liquid passes through the membrane. Two exit streams are produced during filtration: filtrate or permeate and the recirculation. The filtrate is the processed water and the recirculation is a small portion of the flow that is returned to the feed stream. This flow stream is taken from the top of the module and ensures complete utilization of the available filter area by increasing the velocities in the upper end of the module. Solids retained on the filter are removed via periodic backwashing, air scrubbing and chemical cleaning.

Microza Hollow Fiber membrane provide:

- A very high filter area per module
- A small footprint,
- Low energy requirements,
- Low system hold-up and efficient regeneration.

2.2 Pall Microfiltration System Operation

Typical Operating Processes:

Water is pumped through backwashable strainers into the microfiltration system, then through the supply manifold to the module racks holding the Microza Modules. Each module is fed an equivalent flow rate.

- *Forward Flow –*

The pressure-reducing valve reduces the incoming feed to maintain a constant pressure. As water flows through each module, the module will gradually foul, and the valve will automatically adjust the feed pressure as required to maintain the set-point. A control valve on each control block will automatically adjust to maintain a constant level in the filtered water tank. A set of excess recirculation pumps, controlled by a VFD and flowmeter will maintain a constant recirculation percentage.

- *Reverse Filtration -*

Approximately every 30 - 60 minutes, the module racks will go through a reverse filtration (RF) cycle that cleans the modules. First isolation valves are closed. The RF backwash valves open. The RF control valve, which takes filtrate from between the module racks and the filtrate control valve, modulates to maintain the RF flow set-point, at which time about 150% the normal forward flow is forced through the module filaments in the reverse direction. This flow is maintained for about 15 -30 seconds and is diverted to the drain. At the end of this time period, the RF control valve closes and the other valves revert to their normal operating positions.

As required to prevent biological fouling, a chemical injection system pumps a small amount of chlorine into the reverse filtration water as it is being fed into the modules. The amount of chlorine required varies based on feed-water conditions.

- *Air Scrub -*

The reverse filtration cycle will restore the modules to near clean condition but once every thirty 40 - 120 minutes a second cleaning will be required. This cleaning cycle is called air scrubbing, and involves injecting instrument grade compressed air into the feed side of the module rack while maintaining feed water flow through the modules. The air scrub mode is maintained for one hundred and twenty (120) seconds, 30 seconds with air and 90 seconds with air and water.

- *Clean-In-Place -*

Periodically, the system will require a more thorough cleaning than RF or air scrubbing can provide. Cleaning chemicals will be added to the system and recirculated as required to regenerate the modules. The clean in place (CIP) operation happens infrequently, it is designed to be an automatic operation, which the operator manually initiates when indicated by the control system. Included in this section is a more detailed description of the cleaning procedure.

- *Integrity Test Method -*

Integrity testing of hollow fiber microfiltration modules specified in the proposed water filtration system is conducted in accordance with standardized procedures developed at Pall Corporation. These methods have been optimized for modular installations and have proven successful in detecting an integrity breach in system modules consisting of over a half of a million hollow fibers.

In operation, the filtrate quality is constantly monitored to immediately detect a performance change at the system level while an off line pressure hold test provides the ability to isolate and identify a questionable module. These easily implemented procedures ensure system reliability without adding an extensive cost (capital or operating) and maintenance burden on users.

2.3 Design Philosophy and Equipment Selection

Pall proposes to offer the following microfiltration systems with an average continuous treated water output of approximately **3.6 MGD.**

The equipment proposed is designed for simplicity of operation. All plant operations are automatically controlled via a PLC and a distributed control system. There are no routine operations that require manual operation of valves etc. The system design philosophy is to reduce as far as possible the potential for system problems caused by operator error.

Pall Microfiltration System Components

The following outlines the general scope of supply for the proposed microfiltration system: (See section 3 for detailed description)

- Microza Microfiltration Modules
- Module Rack System
- Valve Rack System
- Reverse Filtration System
- Clean-In-Place System
- Air Compressor System
- System Valves & Piping
- Instrumentation & Controls

The Membrane Filtration Equipment

Complete Membrane System.

The Microfiltration MF System includes Module Rack Assemblies consisting of Microza Microfiltration modules. The system also includes all tanks, piping, valvès, instrumentation, and controls required for a complete and functional microfiltration system.

Membrane Design

The design flux is based on previously pilot and plant experience.

Hollow-Fiber Membrane Design Flux & Hydraulic Capacity

Membrane Flux Rate	*55 gfd*
Membrane Module Area*	$50\ m^2$ / $27\ m^2$ (O.D. / I.D)
Membrane Rating	0.1 micron

All aspects of performance and materials are identical to the piloted module and are operating in Pall's existing microfiltration plants.

<u>*Membrane Clean-In-Place Equipment*</u>

CIP System.

A Clean-In-Place (CIP) System is included with the proposal. The CIP system is designed to clean one module rack at a time. Therefore, the CIP system proposed for the demonstration unit will be incorporated into the full-scale system.

<u>*Reverse Filtration System*</u>

Reverse Filtration System.

The system periodically undergoes an automated procedure for cleaning the membranes. Filtrate is directed backward through the filtrate valve into the membranes in the reverse direction to dislodge any particles that may be fouling the membranes, and then to drain. The flow reversal is of short duration - usually about 15-30 seconds every 15 – 30 minutes. The fluid used for the Reverse Flow is treated filtrate diverted from the pressurized filtrate line. Chlorine is typically introduced to the reverse flow to assist the cleaning process.

<u>*Air Supply System*</u>

Air Compressor and Related Equipment.

The air supply system will have two air compressor units and will be supplied complete with an air receiver tank, air drier unit and discharge air pressure filter regulators and filters to ensure clean, oil-free process air.

<u>*Chemical Feed System*</u>

Chemical feed systems are included in the above systems and consist of small storage/mixing/feed tanks and metering pumps with appropriate redundancy.

<u>*Integrity Testing System*</u>

Integrity testing of hollow fiber microfiltration is conducted in accordance with standardized procedures developed at Pall Corporation. The Pressure Decay Test has been optimized for modular installations and has proven successful in detecting an integrity breach in system modules. An automatic procedure, programmed into the HMI, will be initiated automatically at a pre-set time or initiated by an operator at any time.

2.4 Features & Benefits of the Pall Microfiltration System

- ***High Quality Treated Water***

  Pall's Microfiltration System is a cost-effective method for the removal of micro-solids and is particularly recommended for a wide range of water filtration applications.

- ***Pall System Certification (DHS, NSF and TNRCC)***

  CA- Department of Health
  In January 1999, Pall completed the test program for certification by California Department of Health Services of its 0.1 micron microfiltration system. As of October 1999, the CA-DHS has accepted the Pall Microza Microfiltration System as an alternative SWTR filtration technology granting **4-log** removal for Giardia and Cryptosporidium.

  NSF-61 Certification
  The Pall family of microfilter assemblies for water treatment is certified to ANSI/NSF 61. National Sanitation Foundation International issued the NSF 61 certification to Pall on July 14, 1999. For more information please contact NSF or Pall Corporation.

  TNRCC
  Pall Corporation has furnished a 7.8 MGD Membrane Filtration System to San Patricio Municipal Water District in Ingelside, Texas. Performance data has been collected and submitted through Malcolm Pirnie, Inc. and SPMWD to the TNRCC for the operation in Texas.

- ***Advantages of Microza Hollow Fiber (MF) "Outside-In" Membrane***

1. The rating of the medium assures the finest protection for the downstream systems, reduced downtime and maintenance costs. The membrane provides narrow pore size distribution for excellent effluent quality.

2. The hollow fiber membranes have extremely high permeability which facilitates automated, clean-in-place regeneration via reverse flushing, and permits operation at high flux thereby reducing equipment cost.

3. The membranes permit operation at high chlorine residuals to minimize biofouling rates and extend process time between chemical cleanings.

4. The outside-in flow configuration tends to minimize any contamination to the filtrate water resulting from an integrity breach.

- ***Chemical Resistance – Oxidant Resistant (Chlorine Dioxide)***

The MF membrane is resistant to chlorine in concentrations as high as 5000 mg/L during cleaning. Pre-chlorination of the raw water is acceptable. This precludes the need for adding chemical such as bisulfite in a subsequent de-chlorination step. Chlorine resistance also allows for easy disinfection of the membrane and the system should this be required.

The 0.1 micron PVDF membrane has been tested and is compatible with the following, chemical additives:

- Ozone, ***Chlorine Dioxide***, Alum, Ferric Chloride, PACL, and PAC.

Pall Microfiltration / Membrane Compatibility

Chemical	Condition		Compatibility
	Concentration	Temperature	
Sodium hypochlorite	1 %	25	Excellent
Hydrogen peroxide	2 %	25	Excellent
Formaldehyde	3 %	25	Excellent
Ethanol	100 %	25	Good[1]
Caustic soda	1 N	25	Excellent[2]
Caustic soda and sodium hypochlorite	NaOH (1N) NaClO (0.5%)	25	Excellent
Nitric acid	1 N	25	Excellent
Hydrochloric acid	1 N	25	Excellent
Sulfuric acid	1 N	25	Excellent
Glycerin	100 %	25	Excellent
Chlorinated solvents		25	Not compatible
Aromatic base solvent		25	Not compatible
Ester base solvents		25	Not compatible
Ether base solvents		25	Not compatible
Ketone base solvents		25	Not compatible

NOTE: 1 Compatible up to 30 days exposure

2 Use of caustic soda alone will result in the slight discoloration of the membrane and extraction of F^- ion, however, there is no deterioration in the physical properties of membrane. Therefore, the cleaning of module by caustic soda alone should be limited and use of caustic soda with sodium hypochlorite is recommended.

- ***Robust Membrane: Sturdy Module***

The microfiltration modules use a proprietary PVDF hollow fiber membrane technology and advanced bonding techniques. This creates an exceptionally robust membrane and sturdy module.

- ***Operational Flexibility***

The Pall system is designed to produce a consistent quality of water irrespective of seasonal and weather related variations in the source raw water quality.

- ***Operational Simplicity***

The microfiltration process is an easy and inexpensive system to operate both in terms of maintenance costs and manpower requirement. The operators are required to ensure they maintain proper membrane permeating conditions.

- ***Flexible Modular Design***

The Pall Microfiltration System is modular in design. Plant expansion, if required, can be done by progressively adding Module Racks and control blocks with treated water pumping capacity. As demand incrementally increases, the plant is incrementally expanded.

- ***Compact System Footprint***

The Pall Microfiltration System is physically compact. This allows the purchaser to realize savings in physical plant size and hence construction costs.

3.0 TECHNICAL SPECIFICATIONS

3.1 Process Design

The equipment proposed is designed for simplicity of operation. All plant operations are automatically controlled via networked PLC's and a PC-based Human Machine Interface software system. There are no routine operations that require manual operation of valves, etc. The system design philosophy is to reduce as far as possible the potential for system problems caused by operator error.

The filtration system is designed with several skid mounted packaged units to minimize field assembly. The valve rack is completely assembled and the module rack is easily field assembled. The system PLC control panel will mounted adjacent to the plant and the operator control station will be located in a separate control room.

Pall Microfiltration System Components

The following outlines the general scope of supply for the proposed microfiltration system:

- Microza Hollow Fiber Membrane Modules
- Module and Valve Rack Assemblies
- Prefilter Strainer
- Clean-In-Place (CIP) System
- Reverse Filtration System
- Compressed Air System
- System Valve and Piping
- Process Instruments & Controls

Pumping Equipment

The Excess Feed recirculation pumps are ANSI centrifugal type with variable frequency drives. The chemical injection pumps are electric diaphragm pumps with adjustable output. The CIP circulation pumps are horizontal end suction ANSI pumps. The CIP drainage pump and chemical transfer pumps air operated diaphragm type.

Piping and Valves

Process valves equal to or less than 1" are ball valves and greater than 1" are butterfly valves.

Instrumentation and Control Processes

Instrumentation can include:

- Level Transmitters and Switch
- Pressure Transmitters and Switch
- Temperature Transmitters
- Flow Sensor and meters
- Conductivity Analyzer and Transmitter
- pH Analyzer and Transmitter

Remote Monitoring

The Pall Microfiltration System is outfitted with our remote monitoring equipment. This equipment monitors critical process variables 24 hours a day and tabulates this data over time to allow for trending of variables that are critical to the performance of the filter system. The performance data are available via advanced communication technology to the client or Pall personnel who are assigned to monitor the Pall filter system. Using this system, Pall personnel have the ability to view the data real-time, or to view the data as recorded over time. The same data is also available to process operators at the site.

Membrane Integrity

Integrity testing of hollow fiber microfiltration is conducted in accordance with standardized procedures developed at Pall Corporation. The Pressure Decay Test has been optimized for modular installations and has proven successful in detecting an integrity breach in system modules. If a broken fiber, or fibers, is present, the row of modules will be isolated for a brief period of time while an air leak test is performed on the modules. For the air leak test, air is introduced into the feed side while a test is conducted visually. When air on the filtrate side is detected in a module, the identified module is further tested with air to identify the individual broken fibers. The broken fibers are repaired by inserting a straight stainless steel pin or approved epoxy into the upstream end of the fiber to plug off filtrate flow. Once repairs are completed the row of modules is put back into service.

The Pressure Decay Test offers the advantage of high sensitivity, not being affected by changes in feed water quality.

3.2 Technical Specifications

3.2.1 Scope of Supply of MF System

The main equipment included with the Microfiltration System is listed briefly as follows. Detailed equipment specifications are included within this section.

- One Pall Microfiltration System with a continuous design treated water capacity output per below. All MF Systems include one train of redundancy:

System Design (MGD)	**3.6**
Total Number of Modules	130
Number of Assembly Trains / Racks	2

Scope of Supply by Pall:

- Microza Membrane Hollow Fiber Modules
- Module Rack Systems (per above)
- Assembly Block Systems
- Prefilter Strainer
- Integral Clean-In-Place (CIP) System
- Reverse Filtration System
- Compressor Air System
- System Valves
- Instrumentation & Controls
- Process Instrumentation
- Valve Rack Control Panel
- Anchor bolts, adhesive anchors, and expansion anchors materials for supporting the MF system equipment, piping, tanks, electrical.
- Equipment General Arrangement and Layout Drawings
- Operating & Maintenance Manuals
- Site visits and personnel training as required (TBD)
- Spare Parts List
- Start-Up Assistance

3.2.2 Scope of Supply - OTHERS

The following items are for supply by Others and includes but is not limited to:

- Final Plant Design
- Review of equipment drawings and specifications. (Pall & Client)
- Equipment foundations, civil work, equipment mounting pads, buildings etc.
- Unloading of delivered equipment at plant site (or other mutually agreed FOB point).
- Receiving and safe storage of equipment until ready for installation.
- Treated water discharge piping from MF system to the treated water storage.
- Backwash / drain water piping from the MF system to the disposal or storage point.
- Electrical wiring, conduit and other appurtenances required to provide power connections as needed from the electrical power source to the PALL control panels, VFDs and other equipment and from the terminal boxes on the skids to the main plant panels.
- Instrumentation wiring, conduit and other appurtenances required to provide connections as needed between the terminal boxes on the skids, and to other equipment the PALL control panel.
- Air piping, supports etc. from the air compressor systems to the main instrument air supply header located on the skids.
- Bulk chemical storage facilities
- Laboratory Services, Operating and Maintenance Personnel during equipment Checkout, Start-Up and Operation.
- Any on-site painting or touch-up painting of equipment supplied.
- Approval Permits
- Interconnecting piping between Pall supplied equipment

3.3 Equipment Selection

The following sections provide a description and specifications of major components incorporated into the Pall Microfiltration Systems.

3.3.1 Membrane Modules and Module Rack Assembly

The microfiltration includes Microza Hollow Fiber Modules.

Microfiltration Module:

Module	Microza Hollow Fiber Modules
Dimensions:	6" diameter x 80" long
Removal Rating:	0.1 µm
Membrane Material:	PVDF

Microfiltration Module and Valve Rack:

Model Number:	PMDM Series
Operation:	Single Block Operation
Dimensions:	Reference Layout Drawing
Material:	HDPE

3.3.2 Prefilter – Bachwashable Strainers

Automatic backwashable strainer rated at 400 micron.

3.3.3 Clean-In-Place (CIP) System

CIP System.
System includes a CIP tanks and accessories, CIP pumps, CIP tank heater control panel, heater and controls, citric acid dose system, sodium hypochlorite dose system, sodium hydroxide dose system, cleaning solution dose pumps, instrumentation, interconnecting piping and valves. Below briefly describes some of the system components.

- Acid Feed System
- Caustic Feed System
- CIP Circulating Pump

3.3.4 Reverse Filtration System

Reverse Filtration System.
The membrane periodically undergoes an automated procedure for cleaning the membranes. Flow is directed through the Reverse Filtration

control valve to the membranes in the reverse direction to dislodge any particles that may be fouling the membranes.

3.3.5 Compressed Air System

Compressed Air System
The Compressed Air System will supply air to the various pneumatically actuated valves included with the Microfiltration System, and supply Air Scrub air.

The compressed air system will consist of compressors with integral dryers and outlet filters; supply air filter assemblies; one air receiver with accessories; process air regulator assembly; control air regulator assembly; pneumatic control panel; instrumentation and controls.

3.3.6 Excess Feed Recirculation System

Excess Feed Recirculation System
The EF pumping system includes pumps supplied with suction and discharge piping manifolds, valves, pressure gauges and other associated ancillary equipment.

3.3.7 System Valves and Piping Specifications

Process Valves
The following is a general list of main valves used on Microfiltration system. The following specifications do not include miscellaneous small bore valves for isolating instruments, seal water line isolation etc. (Automatic butterfly, non-cyclic butterfly, check-valves, and ball valves)

3.3.8 Process Instruments and Controls

The following process instruments and controls are included with the MF systems.

- Electromagnetic Flowmeters
- Level Transmitters
- Pressure Transmitters
- Temperature Transmitters
- Turbidity meters

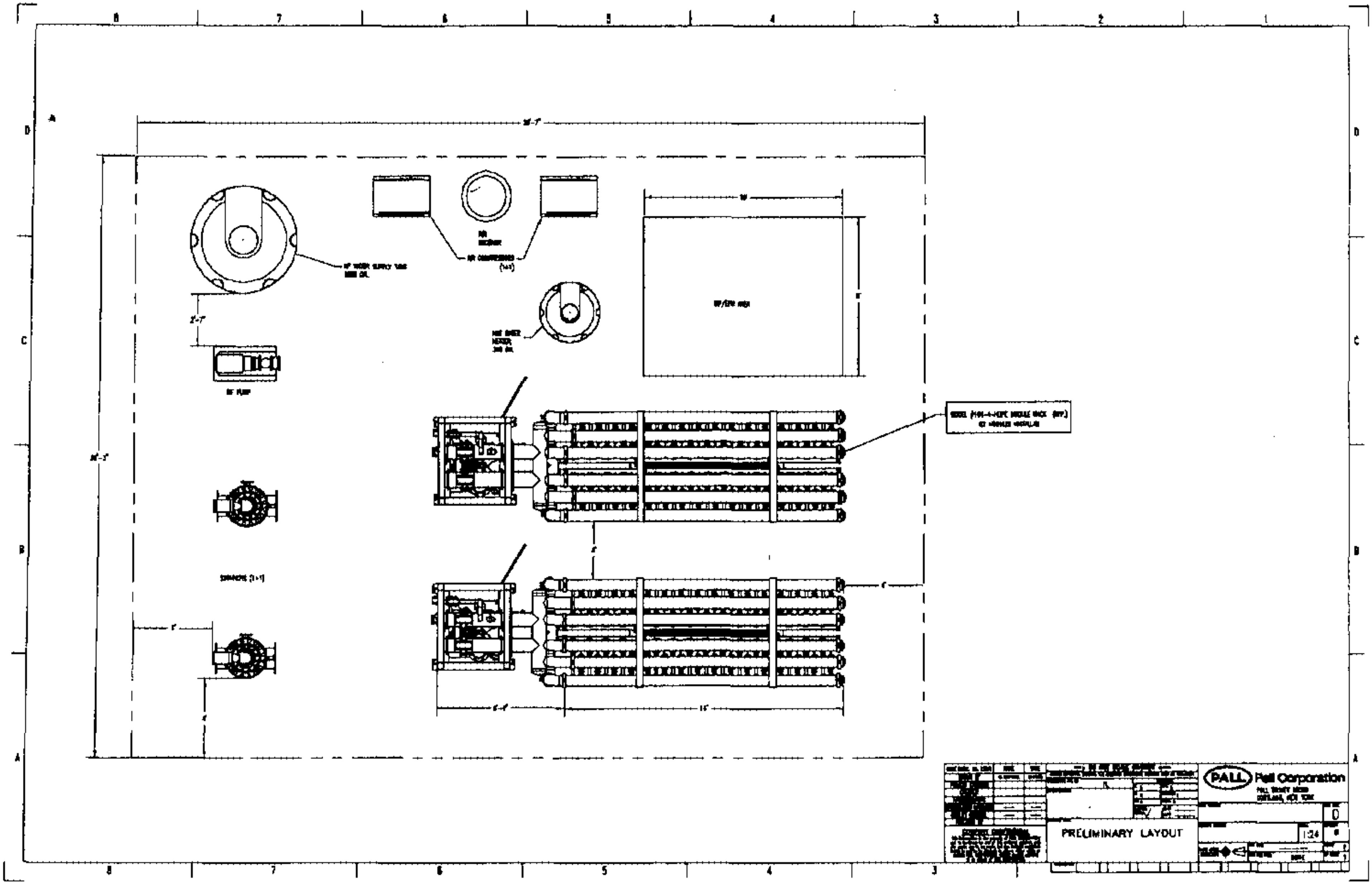
Control Panel

The microfiltration system is controlled by a PLC based control system, which monitors process variables and provide the control functionality.

The microfiltration system is supplied with an Allen Bradley SLC –5/04 PLC based distributed Field I/O control system. The control enclosures have terminal block connections for all PALL supplied instrumentation (flow, level and turbidity etc.) and outputs for control of the pumps, control valves etc.

All valves and control devices are interlocked through the PLC to allow smooth and continuous automatic operation. Valves will open/close and or modulate depending on signals from the PLC. These signals are predetermined through the PLC programming and allow the system to operate at optimal conditions.

All operating parameters are continuously monitored by the PLC and if an alarm or emergency condition occurs the PLC program will instruct the various components to change operation conditions and/or shut down the system and alert the operator. The system control logic will be designed with the ability to shut down the system in the event of an alarm condition that could be detrimental to the equipment.


PALL Pall Corporation
PRELIMINARY LAYOUT
1:24
D