December 2012

Ochoco Irrigation District System Optimization Review

Ochoco Irrigation District
1001 N. Deer Street

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I. Executive Summary and Action Plan

This System Optimization Review ("SOR") of the Ochoco Irrigation District was commissioned by the United States Bureau of Reclamatioin under its 2010 WaterSMART funding opportunity number (R10SF80256). The intended impacts of the study are to benefit the water resources of the lower Crooked River, Ochoco Reservoir, Ochoco Creek, and McKay Creek and other tributaries. The goals of the SOR are to optimize water and energy conservation and efficiency in the District, while benefiting the anadromous reintroduction effort and ESA-listed fish, and reducing potential future conflict over community water supply.

The study covers a description of the District's facilities to irrigate is current 20,062 acres including:

- Arthur R. Bowman Dam on the Crooked River
- Ochoco Dam on Ochoco Creek
- Diversion Screen, Headworks and Diversion Canal on the Crooked River
- Lytle Creek Diversion Dam and Wasteway
- Two Major Pumping Plants
- Nine Small Pumping Plants
- Ochoco Main and Distribution Canals

Significant efforts were employed by the project team to develop an SOR that pragmatically evaluated the various major District facilities and other potential energy, wetland treatment, measurement/telemetry, and habitat/fishery improvement projects. Level of evaluation and costing detail was intended to provide the District with enough information to make decisions regarding pursuit of future projects that may optimize the District's operation and efficiencies. In some instances, projects and their associated simple benefit versus cost ratios were low, therefore indicating projects that the District may either pursue no further or hold-on until need or funding opportunities improved for those projects. In other cases, projects with a higher benefit/cost ratio or projects with obvious data benefits such as telemetry projects were identified and presented. It is anticipated that these projects will be further evaluated by the District and moved when funding mechanisms may be compiled.

In summary, 8 pumping plants, 13 canal and lateral piping projects, 1 new pump-back project (to mitigate tailwater), the relocation of the District's Crooked River Diversion intake and evaluation of the associated pumping and piping necessary to accomplish that, 10 measurement/telemetry sites, a hydroelectric power plant on the Ochoco Reservoir discharge pipe, and a treatment wetlands to polish tailwater at Lytle Creek were evaluated in detail for efficiency improvements, conservation potential, and operational benefits.

The following table "OCHOCO IRRIGATION DISTRICT PROJECT PRIORITIES" and the associated "PROJECT PRIORITIZATION MAP" are the summary of a majority of the work developed in this SOR. The associated evaluations and detailed work are contained in the referenced report Deliverables Tabs 1-12.

The recommended Action Plan associated with this SOR is as follows:

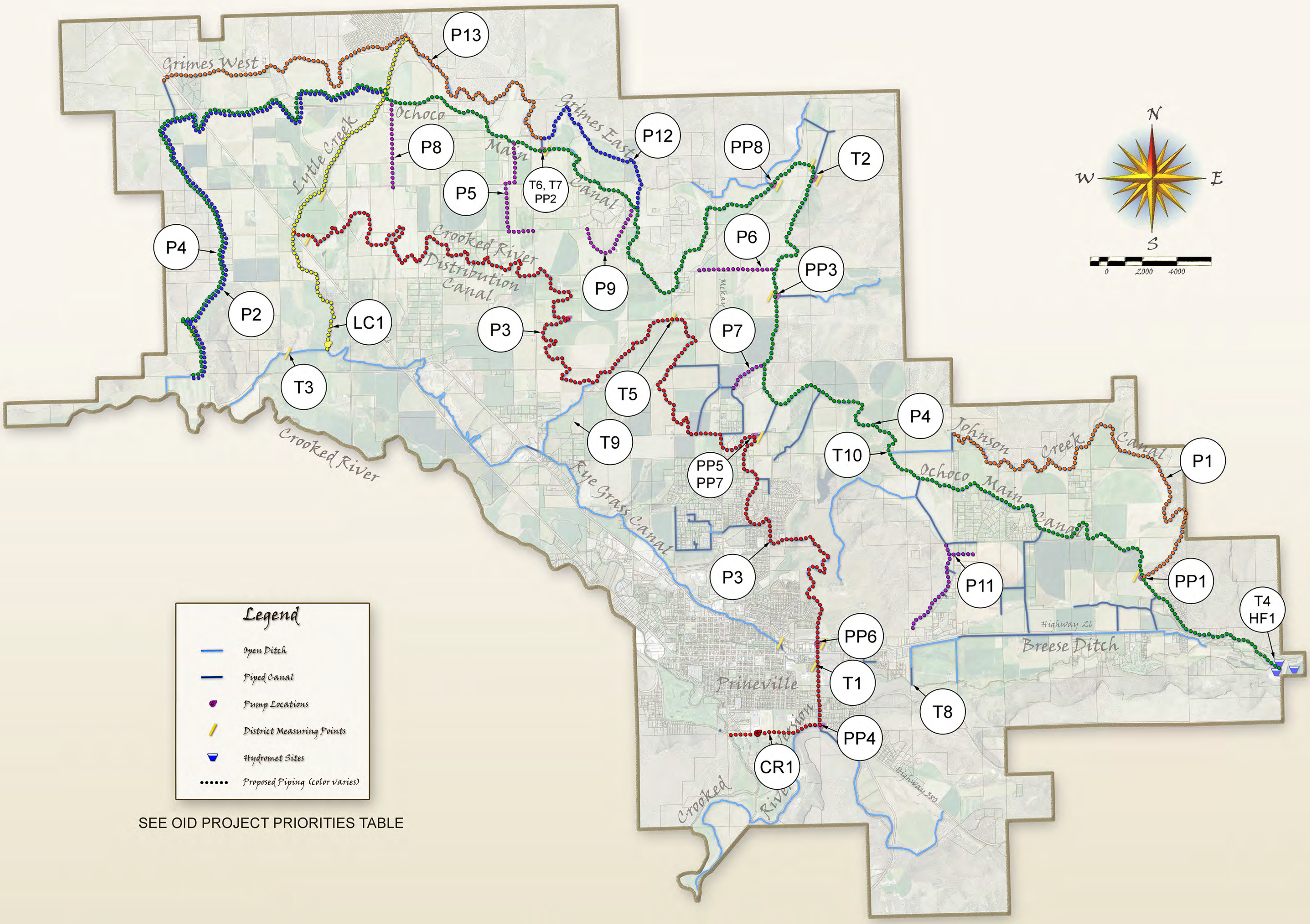
1) Ochoco Irrigation District, may review and assess this SOR and determine which projects it intends to initially pursue.
2) In its annual budget cycle, the District may choose to incorporate projects identified in this SOR and as partner funding becomes available.
3) Measurement and Telemetry projects may be pursued earlier to provide the necessary data to better assess tail-water mitigation projects and to provide the District with a more robust general database.
4) For projects with lower benefit to cost ratios, the District may continue to monitor these over time to assess if need or funding assumptions have changed (for example, the value of partner funding for 1 AF of conserved water in the Crooked River).
5) OID and the DRC may continue to pursue water conservation and instream leasing programs and opportunities.
6) Hydroelectric Power Plant on Ochoco reservoir should continue to be monitored based upon rapidly changing funding opportunities and utility Schedule 37 rates.
7) The District may consider development of a capital plan and/or rate study to better assess the financial impacts of SOR project development on long-term District budget and assessment planning.
8) At the time of this SOR development, the District's Water Conservation and Management Plan were in process with the Oregon Water Resources Department. The District should finalize the approval process of this Plan on its current schedule (January, 2013).

OCHOCO IRRIGATION DISTRICT PROJECT PRIORITIES

Ochoco Irrigation District System Optimization Review

12/12 Black Rock Consulting

Project Label	Project Description	System Opt. Rev. Report Location	Total Cost	B/C Ratio	Other Benefits	PRIORITY
		PUMPING PLANT PROJECTS				
PP1	Johnson Creek	Deliverables Tab 5	$291,000	1.01		#1
PP2	Grimes Flat	Deliverables Tab 5	$343,000	0.63		#2
PP3	Tunnel	Deliverables Tab 5	$107,000	0.35		#3
PP4	Combs Flat	Deliverables Tab 5	$115,000	0.33		#4
PP5	Ochoco Relift 24-Inch	Deliverables Tab 5	$285,000	0.26	Aging Infras.	#5
PP6	Barnes Butte Retrofit	Deliverables Tab 5	$2,988,000	0.20	Aging Infras.	#6
PP7	Ochoco Relift 42-Inch	Deliverables Tab 5	$1,932,000	0.17	Aging Infras.	#7
PP8	McKay	Deliverables Tab 5	$27,900	0.07		#8
	MOVE CROOKED RIVER DIVERSION 6 MILES DOWNSTREAM					
CR1	Intake, Pump Sta, Piping	Deliverables Tab 4	$25,529,708	N/A	Habitat and Fishery	#1
	LYTLE CREEK/RYEGRASS CANAL PUMPBACK PUMPING PLANT					
LC1	Intake, Pump Sta, Piping	Deliverables Tab 2	$5,249,000	0.60	Habitat and Fishery	#1
		CANAL PIPING PROJECTS				
P1	Johnson Creek Lateral	Deliverables Tab 1	$8,478,944	0.14	Habitat and Fishery	#1
P2	Ochoco Canal Lytle to Tail	Deliverables Tab 1	$12,908,718	0.10	Habitat and Fishery	#2
P3	Crooked River Distribution Canal	Deliverables Tab 1	$44,324,560	0.07	Habitat and Fishery	#3
P4	Ochoco Main Canal	Deliverables Tab 1	$158,666,460	0.04	Habitat and Fishery	#4
P5	389 Lateral	Deliverables Tab 1	$116,243	N/A	Pressure/Tailwater	#5
P6	321 Lateral	Deliverables Tab 1	$178,835	N/A	Pressure/Tailwater	#6
P7	311 Lateral	Deliverables Tab 1	$118,271	N/A	Pressure/Tailwater	#7
P8	407 Lateral	Deliverables Tab 1	$203,387	N/A	Pressure/Tailwater	#8
P9	375 Lateral	Deliverables Tab 1	$214,189	N/A	Pressure/Tailwater	#9
P10	381 Lateral	Deliverables Tab 1	$408,167	N/A	Pressure/Tailwater	#10
P11	J Lateral	Deliverables Tab 1	$548,263	N/A	Pressure/Tailwater	#11
P12	Lytle Creek (Grimes) East	Deliverables Tab 1	$931,376	N/A	Pressure/Tailwater	#12
P13	Lytle Creek (Grimes) West	Deliverables Tab 1	$6,222,200	N/A	Pressure/Tailwater	#13
		MEASUREMENT/TELEMETRY				
T1	CR Div. Canal at Ochoco Creek	Deliverables Tab 3		N/A		#1
T2	Jones Dam	Deliverables Tab 3		N/A		#2
T3	Lytle Creek-Campbell Ranch Rd	Deliverables Tab 3		N/A		#3
T4	Head of Ochoco Main Canal	Deliverables Tab 3		N/A		#4
T5	Reynolds Dam	Deliverables Tab 3		N/A		#5
T6	Grimes Flat West	Deliverables Tab 3		N/A		#6
T7	Grimes Flat East	Deliverables Tab 3		N/A		#7
T8	D-2 Drain	Deliverables Tab 3		N/A		#8
T9	D-8 Drain to McKay	Deliverables Tab 3		N/A		#9
T10	Johnson Creek	Deliverables Tab 3		N/A		#10
	HYDROELECTRIC FACILITY ON OCHOCO DAM OUTLET					
HF1	Hydro Plant and Interconnect	Deliverables Tab 6	$2,008,600	0.87		#1
	WETLANDS AT LYTLE CREEK TAILWATER					
	Lytle Creek Tail Wetlands	Deliverables Tab 8	$585,000	N/A		NOT REC.



SEE OID PROJECT PRIORITIES TABLE

Project Priorities Map

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OID

II. OID System Optimization Review Background and Purpose

This System Optimization Review ("SOR") of the Ochoco Irrigation District was commissioned by the United States Bureau of Reclamatioin under its 2010 WaterSMART funding opportunity number (R10SF80256). The intended impacts of the study are to benefit the water resources of the lower Crooked River, Ochoco Reservoir, Ochoco Creek, and McKay Creek and other tributaries. The goals of the SOR are to optimize water and energy conservation and efficiency in the District, while benefiting the anadromous reintroduction effort and ESA-listed fish, and reducing potential future conflict over community water supply.

The District developed a list of specific objectives and through direct work of its staff and/or the work of the review team, evaluated or addressed each specific objective. The staff and review team consisted of:

OID Staff: Mike Kasberger, Manager and Russel Rhoden, Assistant Manager
Main Consulting: Bob Main, Retired Regional Watermaster
Black Rock Consulting: Kevin L. Crew, P.E., David C. Prull, P.E., Rick Nichols
Deschutes River Conservancy: Kate Fitzpatrick and Staff
Bonneville Power Administration (BPA): Energy Audits and Pump Testing of the Two Largest District Pumping Plants – BPA Technical Staff
United States Bureau of Reclamation Bend Field Office Staff

The list of specific objectives were:

1. Updated Water Budget and Prioritized Piping Projects
2. Cost/Benefit Analysis of Rye Grass Canal Pump-Back
3. Ranked List of Measurement/Telemetry Needs
4. Cost/Benefit Analysis of Moving Crooked River Diversion 6 Miles Downstream
5. Cost/Benefit Analysis of Modernizing Barnes Butte Pump Plant, Ochoco Relift Pump Plant, and Other Smaller District Plants
6. Cost/Benefit of Hydro Facility on Ochoco Dam
7. OID Water Conservation and Management Plan
8. Cost/Benefit Analysis of Wetlands Installation at Lytle Creek/Rye-Grass Tail Area
9. Updated GIS Mapping
10. Conceptual Framework for Managing Conservation Savings to Improve Instream Flows in Ochoco Creek
11. MOU with the DRC Identifying Parameters for Managing Non-District Water Conserved Upstream of Ochoco Reservoir Through the Reservoir
12. Prioritized Recommendations to Optimize Water Marketing

Upon completion of these objectives, the District developed an “Action Plan” with the purpose of maximizing efficiency and conservation benefits and leveraging significant support and resources necessary for implementation.

The Ochoco Irrigation District and its partners are heavily invested in improving water conservation and management in the basin to support the recent effort to reintroduce anadromous fish and to work collaboratively to ensure reliable water supplies for irrigation, municipalities and fish and wildlife in the future.

III. OID System Summary Description (Existing Conditions)

CROOKED RIVER PROJECT AUTHORIZATION

The reconstruction of Ochoco Dam was authorized on June 28, 1948, in the Interior Department Appropriation, 1949. The Crooked River Project was authorized by Congress on August 6, 1956 (70 Stat. 1058-9, Public Law 84-992) which incorporated Ochoco Dam. This Act was amended by the Congress on September 14, 1959 (73 Stat. 554, Public Law 86-271) to authorize the Secretary of the Interior to include extra capacity in the canal and pumping plants for future irrigation. The cost of this extra capacity was a deferred obligation until such time as additional lands were incorporated into the project.

The Crooked River Project Extension was authorized by the Act of September 18, 1964 (78 Stat. 954, Public Law 88-598). Rehabilitation and betterment of the lateral and drainage system was accomplished in 1982 under the provisions of the Rehabilitation and Betterment Act of October 7, 1949, as amended (63 Stat. 724 and 64 Stat. 11, Public Laws 81-335 and 81-451).

The 1956 Act authorized the Crooked River Project for irrigation and other beneficial purposes. Flood control is one of the project purposes. The preservation and propagation of fish and wildlife is provided for through the installation of a ladder and screen at the diversion headworks and a minimum release of 10 cubic feet per second for fish life cycle during months when there is no other discharge from Prineville Reservoir. Minimum basic recreation facilities were also authorized.

SUMMARY (SEE FIGURE 1, SOR BASE MAP, PAGE 9 AND FIGURE 2, SYSTEM SCHEMATIC PAGE 10 FOR REFERENCE)

The Ochoco Irrigation District (established in 1917) operates the Ochoco Dam in conjunction with what was originally known as the Crooked River Project, authorized by the Congress on August 6, 1956 (70 Stat. 1058-9, Public Law 84-992). Generally, the Crooked River Project lies north and west of Prineville, Oregon, and utilizes Ochoco Creek and Crooked River to furnish irrigation water for approximately 20,062 acres.

In its 2000 Water Conservation and Management Plan, the District estimated it average total season diversion at 83,742 AF based upon 1992-1997 records. A more detailed and current water budget for the District was developed and is included herein under the District's updated Water Conservation and Management Plan (Deliverable Tab 7).

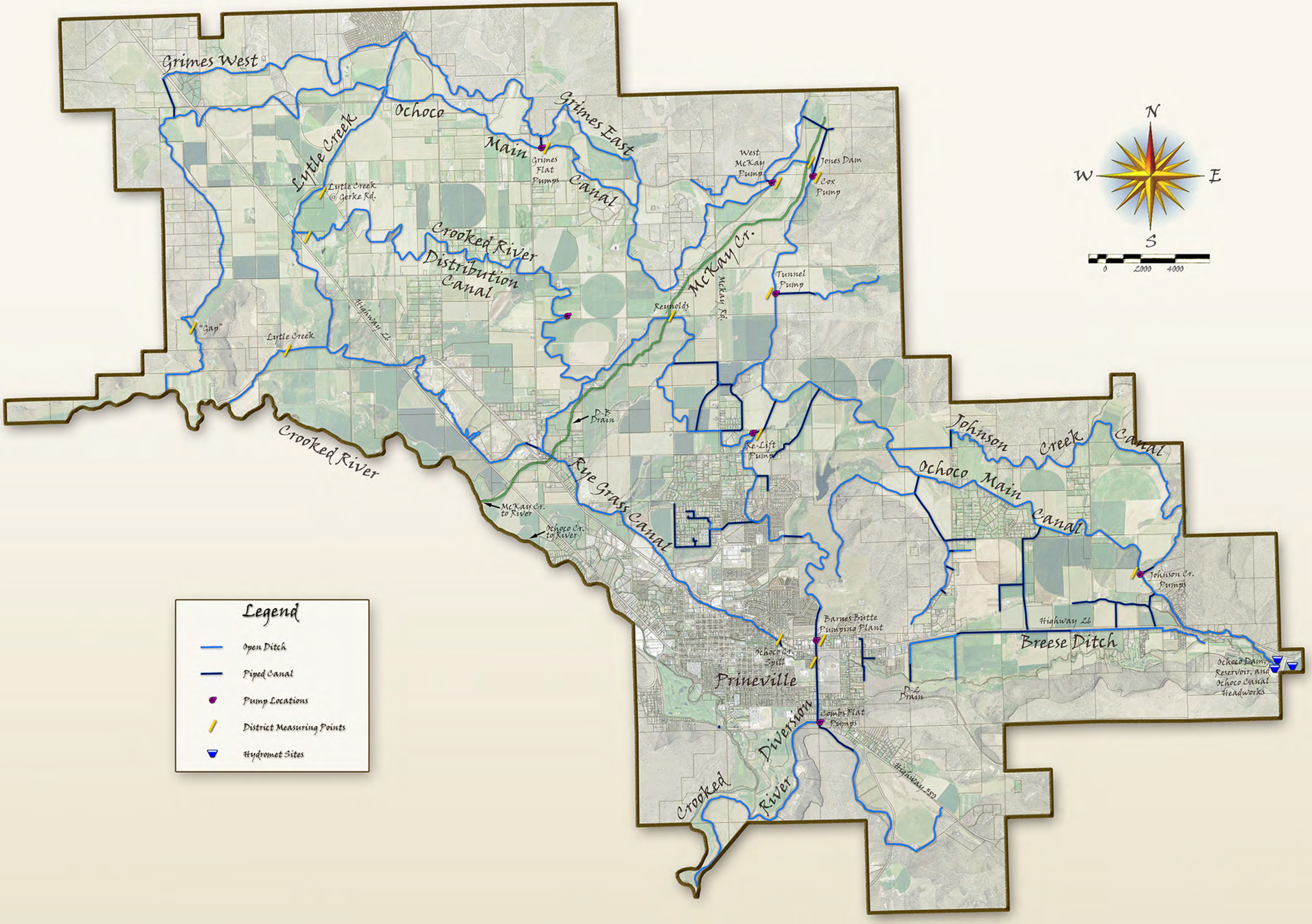
As may be seen by examining Figures 1 and 2, OID manages and operates a complex system of reservoirs, screened diversions, canals, pumping plants, canals, laterals, valves and gates, measurement devices, and turnouts. Through careful management of these systems, OID has historically met water demands in the district although upgrades and efficiency improvements investigated herein are welcomed by the District to further improve its ability to operate and deliver the necessary irrigation demands while improving its water conservation and energy efficiencies.

Key features of the OID system include:

- Arthur R. Bowman Dam on the Crooked River
- Ochoco Dam on Ochoco Creek
- Diversion Screen, Headworks and Diversion Canal on the Crooked River
- Lytle Creek Diversion Dam and Wasteway
- Two Major Pumping Plants
- Nine Small Pumping Plants
- Ochoco Main and Distribution Canals

By congressional approval in 1964, the 3,450-acre Crooked River Extension was added to the Project. This additional acreage was made possible by using the extra capacity included in the canal and pumping plants when the Crooked River Project was constructed, by the addition of six small pumping plants, and by utilizing a portion of the unassigned space in Prineville Reservoir.

A 5-year rehabilitation and betterment program was completed in 1982 during which concrete pipe was installed in laterals and drains to replace existing open and unlined channels. Some 18 miles of open laterals were enclosed with concrete pipe ranging from 10 to 24 inches in diameter. In addition, about 3 miles of open drain were enclosed with concrete pipe ranging from 6 to 18 inches in diameter. The program increased the efficiency of system operation and resulted in substantial water savings.



System Optimization Review Base Map

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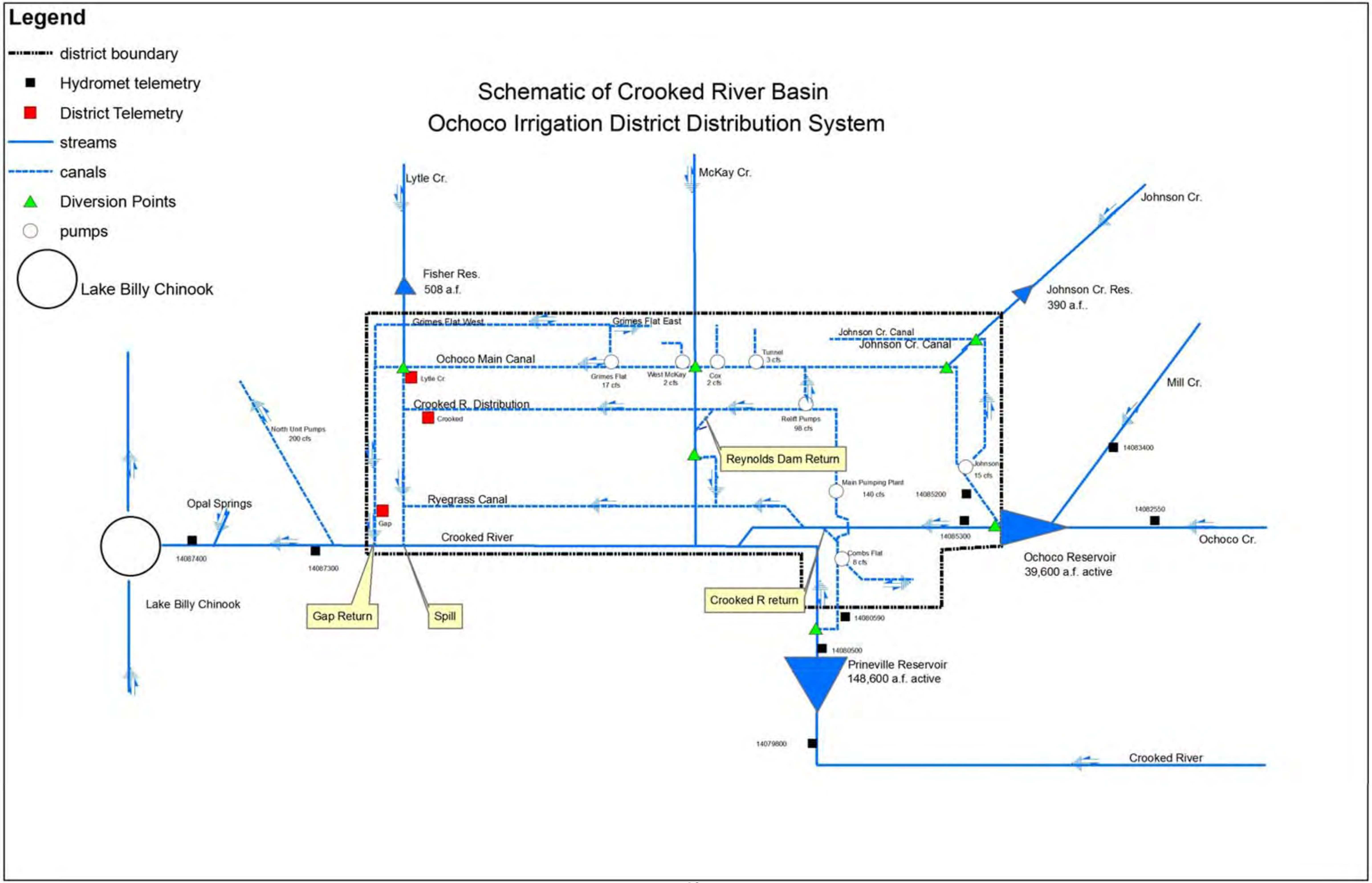

Legend
district boundary
Hydromet telemetry
District Telemetry
streams
canals
Diversion Points
pumps
Lake Billy Chinook
Schematic of Crooked River Basin
Ochoco Irrigation District Distribution System
Lytle Cr.
McKay Cr.
Johnson Cr.
Fisher Res.
508 a.f.
Johnson Cr. Res.
390 a.f..
Grimes Flat West
Grimes Flat East
Johnson Cr. Canal
Johnson Cr. Canal
Tunnel
3 cfs
Ochoco Main Canal
Lytle Cr
Grimes Flat
17 cfs
West McKay
2 cfs
Cox
2 cfs
Mill Cr.
Crooked R. Distribution
Crooked
Relift Pumps
98 cfs
North Unit Pumps
200 cfs
Reynolds Dam Return
14083400
Johnson
15 cfs
Main Pumping Plant
140 cfs
14085200
Opal Springs
Ryegrass Canal
14082550
Gap
Crooked River
14085300
Ochoco Cr.
14087400
14087300
Combs Flat
8 cfs
Ochoco Reservoir
39,600 a.f. active
Lake Billy Chinook
Gap Return
Spill
Crooked R return
14080590
14080500
Prineville Reservoir
148,600 a.f. active
14079800
Crooked River

The Crooked River Project provides water via a complex delivery system. The rehabilitated Ochoco Dam, supplemented by assigned space in Prineville Reservoir, (currently 68,273 acre-feet) furnishes water supply to District and non-District lands. Releases from Ochoco Reservoir flow into the Ochoco Main Canal serving the higher elevation project lands east and north of Prineville. Storage from Prineville Reservoir is released into the Crooked River and diverted from the Crooked River at a screened diversion structure and canal headworks approximately six (6) miles above Prineville. From the headworks, the Crooked River Diversion Canal runs north approximately eight (8) miles across Ochoco Creek to the Barnes Butte Pumping Plant. The Crooked River Diversion Canal serves irrigable lands along its course.

The Barnes Butte Pumping Plant lifts the influent water from the Crooked River Diversion Canal to the Crooked River Distribution Canal that runs through the center of the district lands. The Ochoco Relift Pumping Plant lifts a portion of the water from the Crooked River Distribution Canal to replenish flows in the Ochoco Main Canal, thus serving lands located west of McKay Creek. Lytle Creek Diversion Dam and Wasteway capture return flows from project lands in the Lytle Creek area and divert them into the Rye Grass Ditch.

KEY FACILITY DESCRIPTIONS

Arthur R. Bowman Dam and Prineville Reservoir

As indicated above, the Arthur R. Bowman Dam impounds stored water for multiple uses including the delivery of water to OID.

Arthur R. Bowman Dam (formerly Prineville Dam) is an earthfill structure on the Crooked River about 20 miles upstream from Prineville. The dam has a height of 245 feet, a crest length of 800 feet, and a volume of 1,424,000 cubic yards of material.

The spillway consists of an uncontrolled-crest inlet structure, chute, and stilling basin. Capacity of the spillway is 8,120 cubic feet per second at maximum water surface elevation of 3,257.9 ft. The outlet works has an intake structure with an 11-foot-diameter circular tunnel upstream from the gate chamber, an 11-foot modified horseshoe tunnel downstream from the gate chamber, and a stilling basin which is shared with the spillway. The capacity of the outlet works is 3,300 cubic feet per second at normal water surface elevation of 3,234.8 ft.

The total capacity of Prineville Reservoir at closure was 154,690 acre-feet (active 152,800 acre-feet). A reservoir sedimentation survey completed in 1998 estimates the total capacity at 150,200 acre-feet (active 148,633 acre-feet).

Ochoco Dam and Reservoir

As indicated above, the Ochoco Dam and reservoir serve water to the upper extremities of the Districts topographic area.

Ochoco Dam is a hydraulic-fill structure located on Ochoco Creek six (6) miles east of Prineville, and was constructed immediately after World War I as a part of the Veterans Farm Settlement Program administered by the State of Oregon. The left abutment is an alluvial fan, and the right abutment is a slide mass consisting of fine earth and rock. The original dam was about 126 feet high and 1,000 feet long, with an average crest width of 15 feet. The dam leaked badly through the main section, with heavy leakage at or through the right abutment. Since the dam was a constant hazard to life and property in the valley and the city of Prineville, some rehabilitation was required. The dam was rehabilitated by the Bureau of Reclamation in 1949 and the reservoir capacity was increased at that time. The dam serves the beneficial roles of flood control and irrigation storage in addition to recreation. Upon completion of repairs and improvements by the Bureau of Reclamation, the dam is currently125 feet high with a crest length of 1,350 feet. The spillway is an open concrete chute at the south end of the dam.

Work under the Safety of Dams Program was initiated in 1994 and completed in 1998. This included, among other things, installation of an upstream interceptor trench and drainage system, replacement of riprap on the upstream face of the dam, a new outlet works, spillway modifications, and raising of the outlet tower discharge ports. These improvements, as ground-truthed through a1990 sedimentation survey, resulted in an estimated active reservoir capacity of 39,600 acre-feet at spillway crest elevation 3,130.7 feet.

The Ochoco Irrigation District holds title to the Dam.

Barnes Butte Pumping Plant

Barnes Butte Pumping Plant lifts a current maximum of approximately 140 cubic feet per second from the end of the diversion canal to the head of the distribution canal. The pump site is at the foot of Barnes Butte, about 0.75 mile east of the city limits of Prineville. The plant consists of five pumping units that total 1,800 horsepower. This plant is evaluated in significant detail under Deliverables Tab 5.

Distribution Canal

The Crooked River Distribution Canal serves all Ochoco District lands west of Barnes Butte below an elevation of 2,950 feet and above Rye Grass Ditch. In addition, the canal carries water lifted by Ochoco Relift Pumping Plant to Ochoco Main Canal near McKay Creek to serve lands below this main canal. The distribution canal carries water approximately15.8 miles in a northerly direction. This canal is evaluated in more detail under Deliverables Tab 1.

Ochoco Relift Pumping Plant

The Ochoco Relift Pumping Plant pumps a maximum of 98 cubic feet per second from the distribution canal to the Ochoco Main Canal to irrigate lands west of McKay Creek. The plant contains four units, operates against a total dynamic head of 99 feet, and produces a total of 1,550 horsepower. This plant is evaluated in significant detail under Deliverables Tab 5.

Extension Pumping Plants

The features completed to serve the additional acreage in the Crooked River Project Extension include six small pumping plants and associated canals, laterals, and drains.

These features serve lands of six separate areas located generally east and north of the original project area. Combs Flat Pumping Plant pumps water from the Crooked River Diversion Canal, and the Cox Pumping Plant pumps water from the Ochoco Main Canal. The remaining four pumping plants, Johnson Creek, Tunnel, McKay Creek, and Grimes Flat, pump from the Ochoco Main Canal. Three much smaller pumping plants, Houston, and Stahancyk Nos. 1 and 2, were later installed in the extension area by the Ochoco Irrigation District. Evaluation of pumping plants is under Deliverables Tab 5.

Because of the increased water requirement for the additional acres in the extension area, additional pumping unit at both the Barnes Butte and Ochoco Relift Pumping Plants have been added and exist today.

KEY PROJECT BENEFITS

Irrigation

Irrigation in the project area has been successful over a period of over ninety (90) years. The principal crops raised in the District are currently grain, hay, pasture, garlic and carrot seed, and mint. The operating units vary widely in size, ranging from small suburban residential tracts to large livestock ranches that own or lease considerable grazing land outside the project area.

Recreation, Fish & Wildlife

State parks located on both reservoirs are among the most heavily used in Oregon. Ochoco Reservoir has 8 miles of shoreline, but there are only 20 acres of publicly owned lands in the reservoir area. Camping, swimming, picnicking, and boat launching and mooring facilities are available. Ochoco Reservoir is stocked annually with rainbow trout.

The Prineville Reservoir area encompasses over 8,700 acres with a reservoir surface of 3,030 acres providing 43 miles of shoreline. Camping, picnicking, swimming, lodging, dining, and boat launching and mooring facilities are provided by the State Park, by Crook County through its park system, and by a concessionaire. The reservoir offers excellent fishing for both warm- and cold- water species. A trout fishery has developed in Crooked River below the dam since the reservoir was created. The upper end of the reservoir has been designated a wildlife management area, and 3,800 acres of land and water provide habitat for a variety of wildlife including mule deer and numerous species of waterfowl.

A minimum release of 10 cubic feet per second is maintained from Prineville Reservoir to sustain fish life when there is no other discharge, but this release may be reduced for brief periods if it is determined that the release of the full 10 cubic feet per second is harmful to the primary purpose of the project.

Flood Control

Flood Control

In addition to the major purpose of furnishing an increased stable supply of irrigation water, the Project provides long-needed flood protection for the City of Prineville and adjacent farm land areas. Flood control volumetric space is held in Ochoco Reservoir on a forecast basis to control Ochoco Creek, below the dam, to no more than 1,100 cubic feet per second that, per the SOP, is the safe channel capacity. Similarly, space is held in Prineville Reservoir to control the Crooked River below Arthur R. Bowman Dam to no more than 3,000 cubic feet per second.

POWER SOURCES AND CONTRACTS

Ochoco Irrigation District receives subsidized power through the Bureau of Reclamation's power contracts with BPA on the Crooked River project. The power is delivered by Pacific Power and Light (PP&L).

Ochoco Irrigation District relies on 27 pumps to move water around the District, with the largest being the Barnes Butte and Ochoco Relift pump plant.

These pumping plants are evaluated in significant detail under Deliverables Tab 5.

ENDANGERED SPECIES ACT CONSIDERATIONS

Federally listed threatened Mid-Columbia summer steelhead (*Onchorrychus mykiss)* were recently reintroduced to the lower Crooked River subbasin as part of a FERC relicensing obligation to provide fish passage for anadromous fish at the Pelton Round Butte Dam Complex at the mouth of the Crooked River. Smolts were first released in 2008 and planned releases are on-going. The reintroduction is a $200 million effort to provide fish passage and sufficient fish habitat to successfully re-establish historic populations of anadromous fish in the lower Crooked River, Whychus Creek and the Metolius River. Ochoco Irrigation District is invested in working collaboratively and proactively to reduce conflict around ESA issues and to support the reintroduction effort. It is currently engaged in developing a Habitat Conservation Plan with the Deschutes Basin Board of Control and the City of Prineville in an effort to minimize and mitigate its impacts on listed fish. The goals of this SOR, including water conservation and efficiency and water marketing, are designed to benefit the reintroduction effort.

OCHOCO IRRIGATION DISTRICT/UNITED STATES BUREAU OF RECLAMATION PARTNERSHIP

Ochoco Irrigation District has a long-standing relationship with the BOR. The partnership began in the 1940s. This relationship continued through the Crooked River Project development. During these many years of partnership the District has participated in many USBR programs and grants, a few of which are listed below:

Bureau of Reclamation Projects Within Ochoco Irrigation District

2000 Johnson Creek Lift-Power & water savings by installation of a variable speed pump at the Johnson Creek Lift Station.

2001 Installation of automated gate at the Reynolds Dam.

2001 Thun gravity pressure pipeline.

2002 Installation of bituminous canal liners (two installations).

2002 Rubber Canal liner installation.

2002 Geosynthetic Clay liner installation.

2002 6 ponds in Ochoco Main Canal for purpose of verifying canal seepage.

2003-2010 Several grants covering GIS Mapping/Geo Spatial upgrades/Mapping of easements & facilities.

2004 Installation of 3 small pipelines to replace the Lanius ditch to conserve water by reducing seepage losses & increase water efficiency.

2006 Digital Water Records Management Enhancement-Financial assistance to enhance water management thru purchase and operation of a web based water right & facilities record keeping system.

2006 Ochoco Johnson Creek Pipeline Project and Delivery Relocation Project-This project curtailed erosion by replacing the last 1000 feet of concrete pipe with 15" smooth wall pipe.

2007 Conserve water by upgrading 600 feet of the Ochoco Main Canal with shotcrete to reduce seepage.

2007 2025 Action Plan & Telemetry Grant-Five irrigations working though the Water 2025 Challenge Cost Program working on water conservation efforts within Deschutes Basin by installing flow measurement telemetry stations at 18 locations.

2009 Relocated approximately 300 acres of demand from the Johnson Creek lateral to the Main Canal to reduce demands on the Johnson Creek Canal and Pumping System.

2010 Lytle Creek West (AKA Grimes Flat West) Canal Relocation-Relocate delivery to 198 acres from Lytle Creek West to the Ochoco Main Canal. Piping 1500 feet of delivery line, moved an irrigation pump and provided power to a center pivot while conserving water and demand on Lytle Creek West Canal.

DELIVERABLES - TAB 1

UPDATED WATER BUDGET AND EVALUATED PIPING PROJECTS

DELIVERABLES – TAB 1
Updated Water Budget and Prioritized Piping Projects

GENERAL

When referring to the SOR Base Map and Distribution System Schematic provided in Section III above, the complexity of the storage, transmission, pumping, distribution and return flows within the Ochoco Irrigation District is quite evident. Although historical measurements have been performed at key District locations such as the District's primary diversions (Ochoco Main Canal at the Ochoco Reservoir and Crooked River Diversion Canal at the Crooked River) and other key tail-water returns and inner-District locations, a comprehensive network of measurement devices located throughout the District is not in place. The OID believes that it could benefit from additional measurement; however it currently is able to control and manage its diversion, transmission and distribution system without the addition of additional measurement. Due to the flat canal profiles (i.e. little water surface drop), measurement devices requiring head differential such as weirs and other standard devices would not work well, therefore comprehensive measurement throughout all segments of the District has not been installed. The list of key sites for additional telemetry-based monitoring has expanded recently as indicated under Deliverables Tab 3, and over time these installations will provide a more complete record of water balance and return/tail-water flows.

The OID Water Budget contained herein was also coordinated with the updated District Water Conservation Plan work. The budget is based upon the record of information available during the time of preparation of this SOR.

Piping projects to be evaluated under this SOR were discussed and coordinated with the OID staff based upon local knowledge of District operations and management staff and the highest likelihood of conservation, power reduction, and/or tail-water reduction.

UPDATED WATER BUDGET

The best (longest) period of record for District water budget/water balance measurements is found at gauges 14085200 (Ochoco Main Canal) and 14080590 (Crooked River Diversion Canal). These gauges provide key continuous irrigation diversion flow rate measurements and have for many years. As may be seen when reviewing the OID Distribution System Schematic (Section III above), the diverted water is conveyed to the irrigated areas of the District via open channel and piped canal sections, and in some cases is lifted by pumping plants to higher areas of the District. The District also utilizes its water rights and conveyance of irrigation water in McKay Creek, Lytle Creek and Ochoco Creek. District return-flows exiting the OID distribution system are delivered to these creeks as well as directly to the Crooked River through a variety of return-flow systems. In most instances, return-flows are direct measurements of diverted irrigation water being returned out of the irrigation system. In other instances, such as Lytle Creek, the flows measured are a combination of returned irrigation flows and naturally occurring flows. For this reason, determining an accurate water budget/balance is difficult and until more measurement points are added, the accuracy of water balance and budget estimates will be reduced.

In 2012, as part of this Systems Optimization Review effort, the OID added and has measured flows at several additional return flow points throughout the District including Jones Dam (return flow to McKay Creek), Pine Products (return flow to McKay Creek), D-2 Drain (return flow to Ochoco Creek), D-8 Drain (return flow to McKay Creek), and Dry Creek (return flow to McKay Creek). The District has also upgraded some of its measurement devices including the device at the Crooked River Diversion Canal to Ochoco Creek at Combs Flat Road. The following OID Gross System Water Balance Table incorporates all of the newly recorded data and also reports data gathered from 2007-2012 at other available measurement sites in service during that period of time. With all major return sites measured in 2012, the total diversion to the District's system was 84,983 AF, whereas the measured return flows were 26,590 AF for a net consumption of 58,393 AF without adjustment for natural returning flows. Given 19,701 Acres of irrigation and 360 Acres of Manufacturing and Industrial (reported under Deliverables Tab 7, Water Management and Conservation Plan), the District averaged per-acre consumption would be approximately 2.91-Feet.

Ochoco Irrigation District Gross System Water Balance

Period: 2007-2012

	Crooked River Diversion Canal		Ochoco Main Canal		Lytle Creek Return	Gap Return	Ochoco Creek Return	Reynolds Return	Jones Return	Pine Products Return	D-2 Drain Return	D-8 Drain Return	Dry Creek Return
	Ave CFS	Acre-Feet	Ave CFS	Acre-Feet	Acre-Feet	Acre-Feet	Acre-Feet	Acre-Feet	Acre-Feet	Acre-Feet	Acre-Feet	Acre-Feet	Acre-Feet
2007													
April	102	6,081	68	4,023	588	174	994	1,346	No Data	No Data	No Data	No Data	No Data
May	153	9,418	109	6,706	1,164	365	909	556	No Data	No Data	No Data	No Data	No Data
June	163	9,725	72	4,290	1,286	178	1,637	173	No Data	No Data	No Data	No Data	No Data
July	166	10,202	99	6,107	815	341	1,206	114	No Data	No Data	No Data	No Data	No Data
August	158	9,722	72	4,437	1,004	366	1,069	15	No Data	No Data	No Data	No Data	No Data
September	134	7,996	33	1,977	1,309	390	1,002	516	No Data	No Data	No Data	No Data	No Data
October	67	2,007	18	534	743	172	350	230	No Data	No Data	No Data	No Data	No Data
	TOTALS	**55,151**		**28,075**	**6,909**	**1,986**	**7,168**	**2,951**					
2008													
April	80	4,757	57	3,394	844	174	562	565	No Data	No Data	No Data	No Data	No Data
May	147	9,036	76	4,679	1,225	444	1,344	469	No Data	No Data	No Data	No Data	No Data
June	128	7,610	81	4,798	1,226	259	1,461	382	No Data	No Data	No Data	No Data	No Data
July	162	9,957	116	7,126	933	234	1,049	197	No Data	No Data	No Data	No Data	No Data
August	166	10,202	75	4,601	1,391	226	1,376	167	No Data	No Data	No Data	No Data	No Data
September	149	8,888	46	2,735	1,548	342	1,455	267	No Data	No Data	No Data	No Data	No Data
October	80	2,066	36	922	1,363	161	761	282	No Data	No Data	No Data	No Data	No Data
	TOTALS	**52,515**		**28,255**	**8,530**	**1,840**	**8,010**	**2,329**					
2009													
April	96	6,075	28	1,726	1,079	164	594	174	No Data	No Data	No Data	No Data	No Data
May	146	8,989	61	3,758	1,449	307	792	447	No Data	No Data	No Data	No Data	No Data
June	130	7,750	42	2,514	1,449	348	673	316	No Data	No Data	No Data	No Data	No Data
July	155	9,521	120	7,396	577	212	614	145	No Data	No Data	No Data	No Data	No Data
August	154	9,459	74	4,533	1,355	259	624	225	No Data	No Data	No Data	No Data	No Data
September	153	9,108	40	2,392	1,355	266	731	389	No Data	No Data	No Data	No Data	No Data
October	93	2,393	20	506	1,118	56	469	298	No Data	No Data	No Data	No Data	No Data
	TOTALS	**53,295**		**22,825**	**8,382**	**1,612**	**4,497**	**1,992**					
2010													
April	120	7,121	5	269	1,326	161	396	374	No Data	No Data	No Data	No Data	No Data
May	142	8,737	65	3,994	1,525	275	992	773	No Data	No Data	No Data	No Data	No Data
June	126	7,519	70	4,145	1,204	238	1,950	688	No Data	No Data	No Data	No Data	No Data
July	159	9,796	128	7,853	787	241	634	407	No Data	No Data	No Data	No Data	No Data
August	155	9,535	77	4,753	1,367	298	673	368	No Data	No Data	No Data	No Data	No Data
September	115	6,862	49	2,909	1,699	313	1,061	529	No Data	No Data	No Data	No Data	No Data
October	81	2,244	19	526	1,073	51	572	89	No Data	No Data	No Data	No Data	No Data
	TOTALS	**51,813**		**24,449**	**8,981**	**1,577**	**6,279**	**3,228**					
2011													
April	50	2,991	89	4,033	852		0	0	No Data	No Data	No Data	No Data	No Data
May	107	6,600	119	7,287	1,669	325	1,109	1,066	No Data	No Data	No Data	No Data	No Data
June	134	7,972	107	6,351	1,352	303	1,010	692	No Data	No Data	No Data	No Data	No Data
July	162	9,979	89	5,501	939	268	1,049	519	No Data	No Data	No Data	No Data	No Data
August	164	10,095	77	4,724	1,332	299	1,247	335	No Data	No Data	No Data	No Data	No Data
September	149	8,865	53	3,163	1,418	259	1,232	419	No Data	No Data	No Data	No Data	No Data
October	102	2,431	32	755	984	68	564	75	No Data	No Data	No Data	No Data	No Data
	TOTALS	**48,934**		**31,814**	**8,546**	**1,522**	**6,211**	**3,106**					
2012													
April	118	7,031	19	1,128	827	128	594	283	594	89	74	134	30
May	143	8,789	89	5,447	972	277	1,202	657	1,228	184	153	277	61
June	154	9,136	77	4,571	1,051	312	1,406	445	1,101	185	149	267	59
July	156	9,586	107	6,554	1,109	238	851	188	537	323	195	222	80
August	160	9,809	105	6,446	1,237	328	838	312	360	254	236	198	96
September	155	9,233	45	2,648	1,279	337	1,049	310	233	211	206	260	28
October	100	3,173	45	1,430	765	202	644	225	101	129	135	127	8
	TOTALS	**56,759**		**28,224**	**7,240**	**1,822**	**6,584**	**2,420**	**4,153**	**1,376**	**1,148**	**1,485**	**363**

2012 Water Balance	**Diversion Total=**	**84,983 AF**
	Return Flows=	**26,590 AF**
	Net Consumption=	**58,393 AF**

PRIORITIZED PIPING PROJECTS

The District has determined over a period of time through various measurements and management of its system that the Districts conveyance system is considerably "tight" when it comes to general water seepage losses. Additionally, it has found that the three major parallel canals: the Ochoco Main Canal, Crooked River Distribution Canal, and Ryegrass Canal, likely intercept irrigation runoff and/or what limited seepage may escape from each of the higher canals. This premise is supported by the OID Gross System Water Balance provided above since the water depth applied as an average across the District (2.91-Feet) is reasonable when considering the cropping patterns in the District (i.e. alfalfa hay, other hay and grass pasture). It is also supported given the lengthy open-channel canal runs with little noted water loss. Additional measurement and telemetry installed within the District will help to better quantify District losses over time and on a per-project basis. For the purposes of this System Optimization Review, following this District premise, an emphasis was placed on obvious project benefits such as pumping energy reduction and reduction or complete termination of return-water (tail-water) losses as primary project considerations versus a focus on canal seepage losses. Return flows (tail-water) of 26,590 AF (2012) indicate that a significant reduction in District diversions is possible.

The piping projects identified for consideration under this SOR were as follows:

1) Complete piping of the Ochoco Main Canal from the Ochoco Reservoir to the tail end at the "Gap".
2) Complete piping of the Crooked River Distribution Canal from the discharge of the Barnes Butte pump plant to the tail of the Crooked River Distribution Canal at its connection to Lytle Creek.
3) Piping of the Ochoco Main Canal from Lytle Creek to the tail end at the "Gap". This is a reduced portion of the project identified under item 1) above given the cost magnitude of piping the entire Ochoco Main Canal.
4) Relocation of the Crooked River Diversion Canal intake and complete piping of the diversion system from the new intake through a new pump station to the interconnection with the Crooked River Distribution Canal. This item is evaluated under Deliverables Tab 4.
5) Pump-back of the Ryegrass/Lytle Creek return flows to be reused for irrigation and resulting in tail-water reduction. This item is evaluated under Deliverables Tab 2.
6) Complete piping of the Johnson Creek Lateral.

The following analyses were developed and provided for this SOR by the Ochoco Irrigation District:

7) Complete piping of Grimes Flat East (Lytle Creek East) Canal.
8) Complete piping of Grimes Flat West (Lytle Creek West) Canal.
9) Complete piping of the following smaller laterals:

- 389 Lateral
- 407 Lateral
- 381 Lateral
- 375 Lateral
- 311 Lateral
- J Lateral
- 321 Lateral

Prioritization of the projects was based upon the estimated value of the water conserved (i.e. return or tail-water reduction) and any power or O&M benefits, versus the cost of the project in a simple benefit versus cost format. For each piping project evaluated a table was developed to define the major project elements and the associated benefit versus cost of the project.

OCHOCO MAIN CANAL PIPING PROJECT (SEE EXHIBIT)

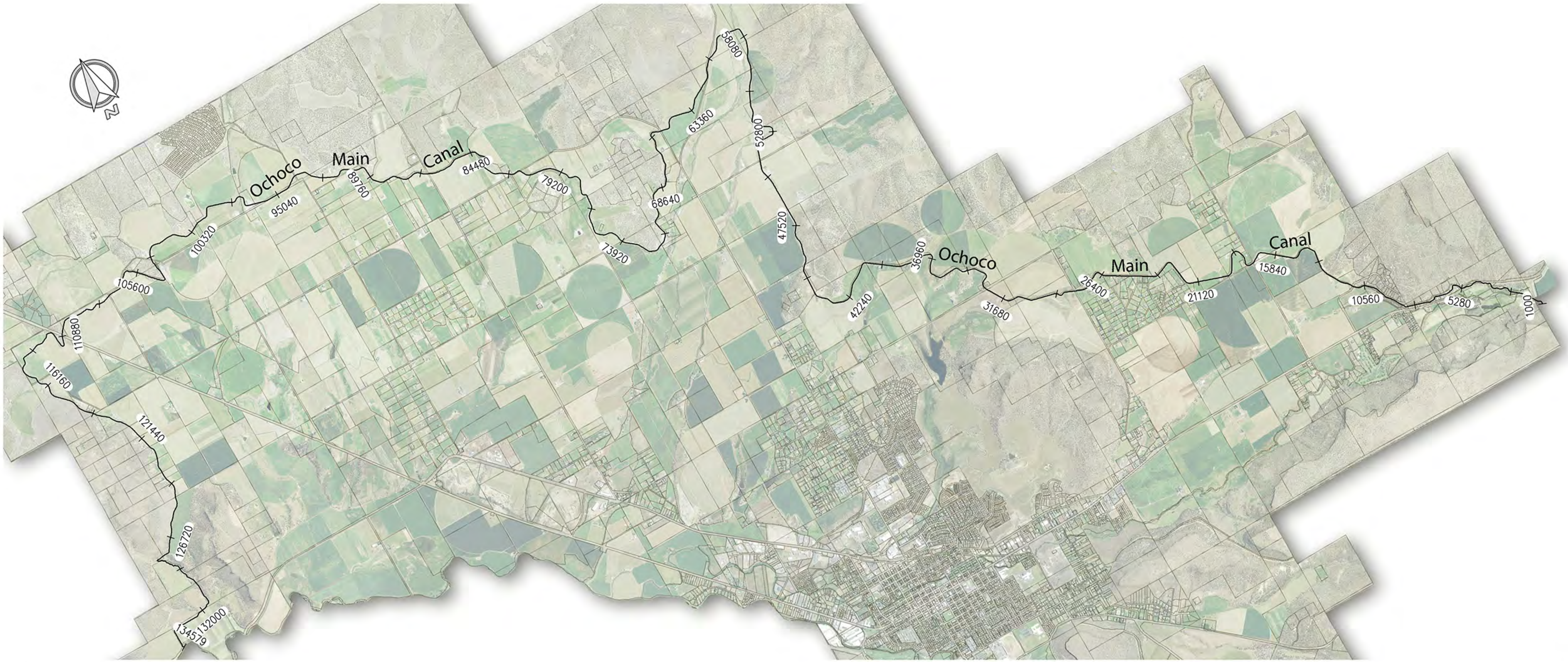
The Ochoco Main Canal Piping Project was evaluated to completely pipe the canal from the Ochoco Reservoir to the tail end at the “Gap”. The pipe sizing was based upon an estimated 160 CFS of peak delivery flow from the reservoir to the McKay Creek junction with the Ochoco Main Canal. This capacity was deemed necessary by the District to allow for emergency conveyance to the Jones Dam return and also to adjust for the currently planned conveyance of replacement irrigation flows to properties along McKay Creek. From the McKay Creek crossing to the tail, flow rates were estimated and prorated in the pipeline based upon the stationing and associated acreage of user turnouts along the alignment as well as withdrawal by the Grimes Flat pump station for the Grimes Flat East and West delivery areas. A value of 9 gallons per minute per acre was used to estimate the peak irrigation flow volume for pipe sizing purposes. Although this is slightly conservative, District records indicate nearly 8 gallons per minute per acre has actually been delivered historically for short periods of time. Other Districts are also using 9 gallons per minute per acre for pipe sizing and planning purposes in an effort also to adjust for pivot application systems that can use a higher demand over a shorter daily irrigation cycle. Elevations necessary to calculate pipe sizing were developed by the OID through a survey-grade GPS (global positioning system) field survey conducted in 2012. These canal grade elevations are indicated in the project exhibit profile.

The results of the Ochoco Main Canal Piping evaluation indicated that approximately 129,320 LF (approximately 24.5 miles) of open canal would be piped. The pipe materials chosen for the purposes of this analysis were profile wall HDPE (high-density polyethylene) pipe between 63-inches in diameter and 96-inches in diameter and solid wall HDPE for any pipe below 63-inches in diameter. Profile wall HDPE is expected to address pressurization up to 15 PSI and solid wall pipe wall thicknesses (DR rating) was sized to anticipated working pressures throughout the project. Approximately 22 miles of the project would have pressures less than 20 PSI if initial connection were downstream of the Ochoco Reservoir versus a direct connection to the reservoir pool. The final 3 miles range in static pressure from 18 PSI to approximately 98 PSI. The final range of pipe sizes necessary to convey irrigation flows along the Ochoco Main Canal ranged from 96-inches in inside diameter to 19.78-inches in inside diameter.

The reconnaissance-level cost estimate for the project was developed using current (2012) material pipe material pricing obtained from vendors experienced with shipments to Central Oregon and includes shipping and welding costs. The pipe estimates also include a cost factor for installation, excavation, backfill and compaction of 1.5 times the total pipe material, delivery and shipping cost. The total project cost estimate also includes an estimate for turnouts at an average of approximately $4,000/turnout (tee, valve, meter, air/vacuum relief, minor piping), an allocation for road crossings, and estimates for contractor overhead and profit (10%), contractor bonds and insurance (2%), engineering/administration (15%) and project contingencies (30%). The resulting total cost estimate for the project was $158,666,460. Contingencies can normally be reduced as project specificity is increased through design and estimates for materials may be made as close as possible to project bidding.

To estimate the benefit versus the cost of the project, benefits were calculated (see table below) based upon the following factors:

1) **Reduction in operations and maintenance.** These costs were estimated by the District based upon recent herbicide application costs, District canal maintenance costs, and miscellaneous costs associated with open canal versus piped canal considerations. The District estimated that its proportion of O&M costs that may be eliminated by the project on an annual basis would be approximately $30,000. Given a 50-year project life cycle, and assumed inflation equals the inflation of such O&M costs, the simple current value of O&M mitigation would be 50x$30,000=$1,500,000.
2) **Reduction in power costs.** For this project, the reduction in power costs were found to be associated with approximately 116 acres. The estimated simple current benefit was based upon $50/acre per season for a period of 10-years as an estimated starting benefit calculation (about ½ the actual cost of pumping). For 116 acres, the estimated benefit would be 116 x $50 x 10 = $58,000.
3) **Reduction in return-flows/tail-water.** The reduction in tail-water for a fully piped Ochoco Main Canal was estimated based upon the assumption that all Jones Dam, "Gap" and Lytle Creek return flows measured at the Lytle Creek ramp flume/telemetry station (located between the Ochoco Main Canal return to Lytle Creek and the Rye Grass Canal return to Lytle Creek) would be eliminated and therefore would not require diversion into the OID system. The value of the elimination of diversion flows was provided by the Deschutes River Conservancy based upon recent water transactions made in the Crooked River basin. The estimated value (i.e. one-time capital contribution) was estimated at $500/AF based upon recent conserved water transactions.
4) **Benefits and costs in 2012 capital dollars.** The benefit versus cost ratio was estimated based upon the 2012 total project cost estimate and the estimated total current dollar project benefit. The resulting benefit/cost ratio was found to be 0.04 whereas a benefit/cost ratio exceeding 1.0 is necessary to consider moving a project forward if all merits may be quantified by cost and benefit.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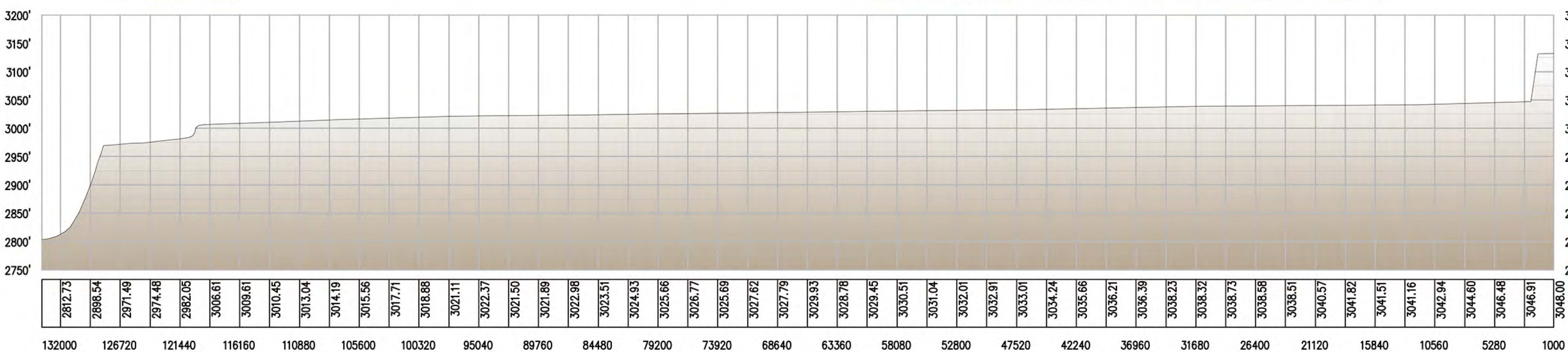
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OCHOCO CANAL PIPING TABLE

Ochoco Irrigation District System Optimization Review

OCTOBER, 2012 | Black Rock Consulting | 9 GPM/Acre | 130 HWC

Segment Description	Station Start (FT)	Elevation Start (FT)	Station End (FT)	Elevation End (FT)	Segment Length (FT)	Total Length (FT)	Elevation Differential (FT)	Current HGL Slope	Turnout Acres	Segment Withdrawal (CFS)	Segment Flow Rate (CFS)	Hydraulic Segment Length	Pipe Material	Hazen Williams Coefficient	Inside Diameter (IN)
Start at Reservoir to Sta 200+00	1000	3048	20000	3040	19000	19000	8	0.0004211			160	19000	HDPE	130	90
Sta 200+00 to Sta 400+00	20000	3040	40000	3035	20000	39000	5	0.00025			160	20000	HDPE	130	96
Sta 400+00 to McKay Creek Junction	40000	3035	57695	3030	17695	56695	5	0.0002826			160	17695	HDPE	130	96
Headgate: 341	57695	3030	58092	3030	397	57092									96
West McKay	58092	3030	60340	3028.9	2248		1.1	0.0004159		3	121.4	2645		130	96
342	60340	3028.9	60340	3028.9	0	57092			73						96
345	60340	3028.9	61601	3029	1261	58353			88.1						96
347	61601	3029	63131	3028.7	1530	59883			84.1						96
351	63131	3028.7	65525	3027.9	2394	62277			10						96
353	65525	3027.9	66428	3027.7	903	63180			18.6						96
355	66428	3027.7	68012	3028	1584	64764	0.9	0.0001173	32.4	6.1	118.4	7672		130	96
356	68012	3028	68175	3027.6	163	64927			6.2						90
359	68175	3027.6	69517	3026.9	1342	66269			4.7						90
361	69517	3026.9	70350	3027.5	833	67102			44						90
363	70350	3027.5	70585	3027.8	235	67337									90
365	70585	3027.8	71959	3027.4	1374	68711			114.4						90
367	71959	3027.4	73000	3026	1041	69752			45.3						90
369	73000	3026	74356	3026.1	1356	71108			462.5						90
371	74356	3026.1	75154	3026.9	798	71906			7.2						90
373	75154	3026.9	76160	3026	1006	72912			14						90
374	76160	3026	77270	3026.3	1110	74022			89.5						90
375	77270	3026.3	77966	3025.3	696	74718	2.7	0.0002712	231	20.4	112.2	9954		130	90
377	77966	3025.3	79800	3025.1	1834	76552			5.3						78
381	79800	3025.1	80173	3025.4	373	76925			125.5						78
382	80173	3025.4	80191	3025.4	18	76943			11.4						78
384	80191	3025.4	81182	3025.4	991	77934			188.8						78
385	81182	3025.4	83232	3023.4	2050	79984	1.9	0.0003608	103.8	8.7	91.8	5266		130	78
Grimes Flat Pump Station	83232	3023.4	85054	3022.7	1822	81806	0.7	0.0003842		18	83.1	1822		130	78
389	85054	3022.7	86797	3022.8	1743	83549			136.9						78
391	86797	3022.8	87899	3022.4	1102	84651									78
392	87899	3022.4	88680	3021.8	781	85432									78
393	88680	3021.8	89300	3022.2	620	86052			168.6						78
397	89300	3022.2	90787	3021.4	1487	87539			40.8						78
401	90787	3021.4	92737	3022	1950	89489			475.9						78
Pump	92737	3022	93126	3022	389	89878									78
403	93126	3022	93989	3022.4	863	90741			118.4						78
406	93989	3022.4	94095	3022.3	106	90847			106.1						78
407	94095	3022.3	95296	3021.5	1201	92048	1.2	0.0001172	144.9	23.9	65.1	10242		130	78
409	95296	3021.5	95454	3021.2	158	92206			201.5						50.47
413	95454	3021.2	96121	3020.9	667	92873			68.6						50.47
419	96121	3020.9	99087	3018.9	2966	95839			2.9						50.47
421	99087	3018.9	100267	3017.5	1180	97019			38.5						50.47
423	100267	3017.5	102701	3017.6	2434	99453			0.3						50.47
426	102701	3017.6	102880	3017.5	179	99632			4.7						50.47
425	102880	3017.5	103370	3016.2	490	100122			209.7						50.47
428	103370	3016.2	104884	3015.4	1514	101636			0.4						50.47
429	104884	3015.4	104986	3015.1	102	101738	6.4	0.0006605	255.2	15.7	41.2	9690		130	50.47
434	104986	3015.1	107648	3014.2	2662	104400									44.87
435	107648	3014.2	107961	3014.5	313	104713			169.2						44.87
436	107961	3014.5	108666	3013.3	705	105418			140.1						44.87
444	108666	3013.3	112000	3010.8	3334	108752	4.3	0.0006131	17.2	6.5	25.5	7014		130	44.87
Grimes Flat Return	112000	3010.8	112931	3010.3	931	109683			723.9						39.26
442	112931	3010.3	113566	3009.6	635	110318			75.1						39.26
445	113566	3009.6	114696	3009.2	1130	111448			54.5						39.26
447	114696	3009.2	114840	3009.7	144	111592			86.3						39.26
448	114840	3009.7	117212	3007.3	2372	113964			63.2						39.26
449	117212	3007.3	118000	3007.2	788	114752	3.6	0.0006	64.7	6.9	19.0	6000		130	39.26
450	118000	3007.2	118518	3005.6	518	115270			50.3						20.56
451X	118518	3005.6	119522	2984.2	1004	116274			40.6						20.56
451Y	119522	2984.2	119593	2983.9	71	116345			48.8						20.56
452	119593	2983.9	120000	2983.3	407	116752			12.1						20.56
454	120000	2983.3	121000	2979.6	1000	117752			9.9						20.56
455	121000	2979.6	121379	2978.9	379	118131	28.3	0.0083753	9.2	3.4	12.1	3379		130	20.56
456	121379	2978.9	121765	2978.9	386	118517			10.8						19.78
457	121765	2978.9	122595	2974.9	830	119347			10.5						19.78
458	122595	2974.9	123475	2974.2	880	120227			8.9						19.78
459	123475	2974.2	124657	2973.5	1182	121409			286.2						19.78
461	124657	2973.5	127153	2968	2496	123905			85.1						19.78
463	127153	2968	130320	2820.7	3167	127072	158.2	0.0176938	30.6	8.7	8.7	8941		130	19.78
Tail at Crooked River	130320	2820.7	133579		3259	130331									
									TOTAL	121.4	CFS	72625			

OCHOCO CANAL PIPING RECONNAISSANCE COST ESTIMATE

Ochoco Irrigation District System Optimization Review

OCTOBER, 2012

Construction Item	Station Start	Station End	Total Length	Diameter (O.D. Inches)	Material	Estimated Cost/LF	Estimated Total Cost
1. Pipe	1000	20000	19000	90	HDPE Profile	$925	$17,575,000
2. Pipe	20000	68012	48012	96	HDPE Profile	$1,000	$48,012,000
3. Pipe	68012	77966	9954	90	HDPE Profile	$925	$9,207,450
4. Pipe	77966	95296	17330	78	HDPE Profile	$790	$13,690,700
5. Pipe	95296	104986	9690	54	HDPE DR32.5	$300	$2,907,000
6. Pipe	104986	112000	7014	48	HDPE DR32.5	$270	$1,893,780
7. Pipe	112000	118000	6000	42	HDPE DR32.5	$230	$1,380,000
8. Pipe	118000	121379	3379	22	HDPE DR32.5	$120	$405,480
9. Pipe	121379	130320	8941	22	HDPE DR21	$150	$1,341,150
10. Turnouts							$500,000
11. Crossings and Major Connections							$250,000
						SUBTOTAL	**$97,162,560**
Contractor OH/Profit			10%				$9,716,256
Contractor Bonds and Insurance			2%				$1,943,251
Construction Contingency			30%				$29,148,768
						SUBTOTAL	**$137,970,835**
Engineering, Administration			15%				$20,695,625
						GRAND TOTAL	**$158,666,460**

OCHOCO CANAL PIPING BENEFIT VERSUS COST

					Value/Acre	Value/AF	Benefit
Potential Power Benefit	Acres=	115.7			$500		$57,850
O&M Mitigation							$1,500,000
Acre-Feet Saved (Spill Points)	Gap=	1,727	AF			$500	$863,500
	Lytle Cr.=	2,401	AF			$500	$1,200,500
	Jones Dam	4,153	AF			$500	$2,076,500
						TOTAL BENEFIT	**$5,698,350**
						B/C RATIO	**0.04**

CROOKED RIVER DISTRIBUTION CANAL PIPING PROJECT (SEE EXHIBIT)

The Crooked River Distribution Canal Piping Project was evaluated to completely pipe the canal from the Diversion Canal terminus (at the Barnes Butte Pump Station discharge point) to the tail end at the return to Lytle Creek. The pipe sizing was based upon an estimated 155 CFS of peak delivery flow from the head end to the Re-lift Pumping Station 70 CFS assumed from the Re-lift plant to the McKay Creek return (Reynolds). This assumption was based upon the premise that under emergency conditions such as power outage wherein the Re-lift plant were not operating and pumping to the Ochoco Main Canal that the excess flows could be shunted back to the Ochoco Creek at Combs Flat Road. From the Reynolds return to the tail connection at Lytle Creek, flow rates were estimated and prorated in the pipeline based upon the stationing and associated acreage of user turnouts along the alignment. A value of 9 gallons per minute per acre was used to estimate the peak irrigation flow volume for pipe sizing purposes. Although this is slightly conservative, District records indicate nearly 8 gallons per minute per acre has actually been delivered historically for short periods of time. Other Districts are also using 9 gallons per minute per acre for pipe sizing and planning purposes in an effort also to adjust for pivot application systems that can use a higher demand over a shorter daily irrigation cycle. Elevations necessary to calculate pipe sizing were developed by the OID through a survey-grade GPS (global positioning system) field survey conducted in 2012. These canal grade elevations are indicated in the project exhibit profile.

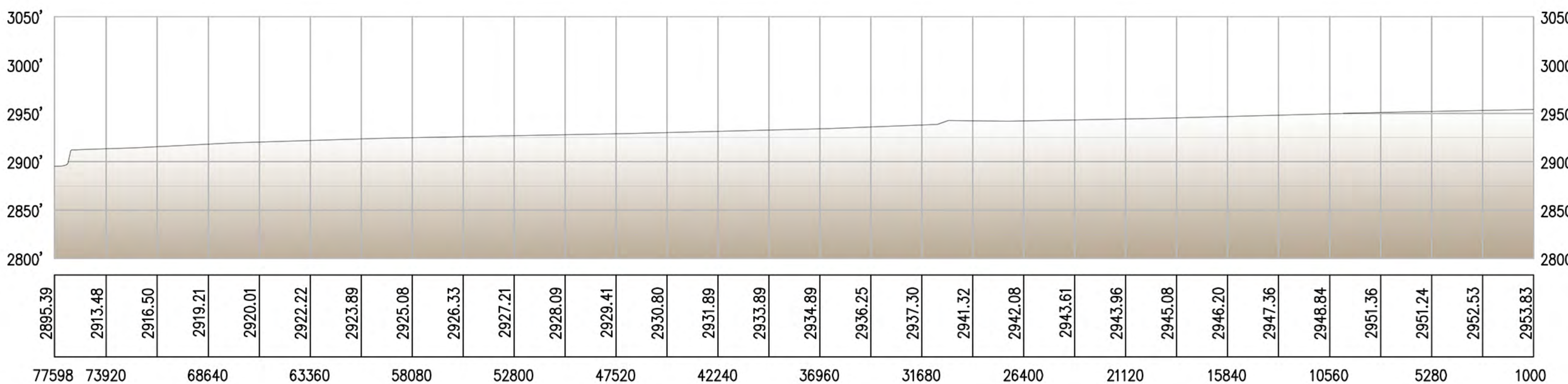
The results of the Crooked River Distribution Canal Piping evaluation indicated that approximately 66,010 LF (approximately 12.5 miles) of open canal would be piped. The pipe materials chosen for the purposes of this analysis were profile wall HDPE (high-density polyethylene) pipe between 63-inches in diameter and 90-inches in diameter and solid wall HDPE for any pipe below 63-inches in diameter. Profile wall HDPE is expected to address pressurization up to 15 PSI and solid wall pipe wall thicknesses (DR rating) was sized to anticipated working pressures throughout the project. With only 38-Feet of fall across the entire project, only minimal pipe pressure ratings were required. The final range of pipe sizes necessary to convey irrigation flows along the Crooked River Distribution Canal ranged from 90-inches in inside diameter to 12-inches in inside diameter.

The reconnaissance-level cost estimate for the project was developed using current (2012) material pipe material pricing obtained from vendors experienced with shipments to Central Oregon and includes shipping and welding costs. The pipe estimates also include a cost factor for installation, excavation, backfill and compaction of 1.5 times the total pipe material, delivery and shipping cost. The total project cost estimate also includes an estimate for turnouts at an average of approximately $4,000/turnout (tee, valve, meter, air/vacuum relief, minor piping), an allocation for road crossings, and estimates for contractor overhead and profit (10%), contractor bonds and insurance (2%), engineering/administration (15%) and project contingencies (30%). The resulting total cost estimate for the project was $44,324,560. Contingencies can normally be reduced as project specificity is increased through design and estimates for materials may be made as close as possible to project bidding.

To estimate the benefit versus the cost of the project, benefits were calculated (see table) based upon the following factors:

1) **Reduction in operations and maintenance.** These costs were estimated by the District based upon recent herbicide application costs, District canal maintenance costs, and miscellaneous costs associated with open canal versus piped canal considerations. The District estimated that its proportion of O&M costs that may be eliminated by the project on an annual basis would be approximately $15,000. Given a 50-year project life cycle, and assumed inflation equals the inflation of such O&M costs, the simple current value of O&M mitigation would be 50x$15,000=$750,000.
2) **Reduction in power costs.** For this project, the reduction in power costs were found to be negligible due to the minimal elevational difference from head end to tail of project.
3) **Reduction in return-flows/tail-water.** The reduction in tail-water for a fully piped Crooked River Distribution Canal was estimated from readings taken at the Reynolds Dam spill and a newly installed ramp flume and telemetry site located at the Crooked River Distribution Canal connection to Lytle Creek. The value of the elimination of diversion flows was provided by the Deschutes River Conservancy based upon recent water transactions made in the Crooked River basin. The estimated value (i.e. one-time capital contribution) was estimated at $500/AF based upon recent conserved water transactions.
4) **Benefits and costs in 2012 capital dollars. T**he benefit versus cost ratio was estimated based upon the 2012 total project cost estimate and the estimated total current dollar project benefit. The resulting benefit/cost ratio was found to be 0.07 whereas a benefit/cost ratio exceeding 1.0 is necessary to consider moving a project forward if all merits may be quantified by cost and benefit.


Crooked River Distribution Canal
77598
73920
68640
63360
58080
52800
47520
42240
36960
31680
26400
21120
15840
10560
5280
1000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2900'
2850'
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2913.48
2916.50
2919.21
2920.01
2922.22
2923.89
2925.08
2926.33
2927.21
2928.09
2929.41
2930.80
2931.89
2933.89
2934.89
2936.25
2937.30
2941.32
2942.08
2943.61
2943.96
2945.08
2946.20
2947.36
2948.84
2951.36
2951.24
2952.53
2953.83
77598
73920
68640
63360
58080
52800
47520
42240
36960
31680
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21120
15840
10560
5280
1000

CROOKED RIVER DISTIBUTION CANAL PIPING TABLE

Ochoco Irrigation District System Optimization Review

OCTOBER, 2012	Black Rock Consulting				9 GPM/Acre		130 HWC								
Segment Description	**Station Start (FT)**	**Elevation Start (FT)**	**Station End (FT)**	**Elevation End (FT)**	**Segment Length (FT)**	**Total Length (FT)**	**Elevation Differential (FT)**	**Current HGL Slope**	**Turnout Acres**	**Segment Withdrawal (CFS)**	**Segment Flow Rate (CFS)**	**Hydraulic Segment Length**	**Pipe Material**	**Hazen Williams Coefficient**	**Inside Diameter (IN)**
Siphon Exit to Relifts	9000	2950	17500	2947	8500	8500	3	0.0003529	47		155	8500		130	90
Relifts to 773 (McKay Crossing)	17500	2947	31443	2937.8	13943	22443	9.2	0.0004099			70	13943		130	60
774	31443	2937.8	33580	2937	2137	24580	0.8		25.7						50.47
775	33580	2937	34993	2936.2	1413	25993	0.8		7.4						50.47
777	34993	2936.2	37212	2935.1	2219	28212			73.7						50.47
779	37212	2935.1	39077	2932.6	1865	30077			35						50.47
781	39077	2932.6	39876	2932.6	799	30876			114.9						50.47
785	39876	2932.6	41816	2932.6	1940	32816			340.4						50.47
789	41816	2932.6	42118	2932	302	33118	5.8		72	13.4	42.6	10675		130	50.47
Headgate No Number	42118	2932	44383	2931	2265	35383									44.87
789? Possibly 790/791?	44383	2931	47283	2928.9	2900	38283									44.87
792	47283	2928.9	48662	2929.4	1379	39662			70.2						44.87
Pump	48662	2929.4	50051	2928.3	1389	41051									44.87
795	50051	2928.3	50907	2927.6	856	41907									44.87
798	50907	2927.6	50921	2927.9	14	41921			142.9						44.87
797	50921	2927.9	52736	2927.1	1815	43736	4.9		222.6	8.7	29.2	10618		130	44.87
799	52736	2927.1	54916	2927.1	2180	45916			77.8						39.26
800	54916	2927.1	54941	2926.8	25	45941			73.4						39.26
801	54941	2926.8	55673	2925.6	732	46673			100.5						39.26
806	55673	2925.6	58025	2925.3	2352	49025			3.8						39.26
807	58025	2925.3	58604	2925	579	49604			40						39.26
811	58604	2925	60332	2923.6	1728	51332			29.9						39.26
813	60332	2923.6	62255	2922.5	1923	53255	4.6	0.0003384	33.5	7.2	20.5	9519		130	39.26
815	62255	2922.5	62726	2922.7	471	53726			95.6						33.65
817	62726	2922.7	63839	2921.4	1113	54839			153.8						33.65
819	63839	2921.4	64647	2921.5	808	55647	1		65.5	6.3	13.3	2392		130	33.65
821	64647	2921.5	66515	2920.3	1868	57515			133.7						26.174
823	66515	2920.3	68199	2919.5	1684	59199		0	36.6						26.174
825	68199	2919.5	69592	2918	1393	60592	3.5	0.0025126	136.9	6.2	7.0	4945		130	26.174
827	69592	2918	70489	2918	897	61489			31						12
828	70489	2918	72344	2914.6	1855	63344	3.4		8.7	0.8	0.8	2752		130	12
829	72344	2914.6	75010	2912.4	2666	66010									
					0	66010			TOTAL	42.6	CFS	63344			

CROOKED RIVER DISTRIBUTION CANAL PIPING RECONNAISSANCE COST ESTIMATE

Ochoco Irrigation District System Optimization Review

OCTOBER, 2012

Construction Item	Station Start	Station End	Total Length	Diameter (O.D. Inches)	Material	Estimated Cost/LF	Estimated Total Cost
1. Pipe	9000	17500	8500	90	HDPE Profile	925	$7,862,500
2. Pipe	17500	31443	13943	60	HDPE Profile	675	$9,411,525
3. Pipe	31443	42118	10675	54	HDPE DR32.5	300	$3,202,500
4. Pipe	42118	52736	10618	48	HDPE DR32.5	270	$2,866,860
5. Pipe	52736	62255	9519	42	HDPE DR32.5	230	$2,189,370
6. Pipe	62255	64647	2392	36	HDPE DR32.5	200	$478,400
7. Pipe	64647	69592	4945	28	HDPE DR32.5	150	$741,750
8. Pipe	69592	72344	2752	12	HDPE DR32.5	60	$165,120
9. Turnouts							$150,000
10. Crossings and Major Connections							$75,000
						SUBTOTAL	**$27,143,025**
Contractor OH/Profit			10%				$2,714,303
Contractor Bonds and Insurance			2%				$542,861
Construction Contingency			30%				$8,142,908
						SUBTOTAL	**$38,543,096**
Engineering, Administration			15%				$5,781,464
						GRAND TOTAL	**$44,324,560**

CROOKED RIVER DISTRIBUTION CANAL PIPING BENEFIT VERSUS COST

					Value/Acre	Value/AF	Benefit
Potential Power Benefit	Acres=	0			$300		$0
O&M Mitigation							$750,000
Acre-Feet Saved (Spill Points)	Reynolds=	2,671	AF			$500	$1,335,500
	Lytle Cr.=	1,858	AF			$500	$929,000
						TOTAL BENEFIT	**$3,014,500**
						B/C RATIO	**0.07**

OCHOCO MAIN CANAL TAIL-END PIPING PROJECT (SEE EXHIBIT)

After having reviewed the cost versus benefit of piping the Ochoco Main Canal in its entirety, the District worked to optimize the solution to develop a less costly alternative to mitigation of return flows and the associated diversion necessary to generate those flows. The Ochoco Main Canal Tail-End Piping Project was evaluated to pipe the canal from the Ochoco Main Canal/Lytle Creek return to the tail-end at the "Gap". This reduced scope project was sized based upon flow rates that were estimated and prorated in the pipeline based upon the stationing and associated acreage of user turnouts along the alignment. A value of 9 gallons per minute per acre was used to estimate the peak irrigation flow volume for pipe sizing purposes. Although this is slightly conservative, District records indicate nearly 8 gallons per minute per acre has actually been delivered historically for short periods of time. Other Districts are also using 9 gallons per minute per acre for pipe sizing and planning purposes in an effort also to adjust for pivot application systems that can use a higher demand over a shorter daily irrigation cycle. Elevations necessary to calculate pipe sizing were developed by the OID through a survey-grade GPS (global positioning system) field survey conducted in 2012. These canal grade elevations are indicated in the project exhibit profile.

The results of the Ochoco Main Canal Tail-End Piping Project evaluation indicated that approximately 34,199 LF (approximately 6.5 miles) of open canal would be piped. The pipe material chosen for the purposes of this analysis was solid wall HDPE. Solid wall pipe wall thicknesses (DR rating) was sized to anticipated static/working pressures throughout the project ranging from 0 PSI to 87 PSI. The final range of pipe sizes necessary to convey irrigation flows along the Crooked River Distribution Canal ranged from 50.47-inches in inside diameter to 19.78-inches in inside diameter.

The reconnaissance-level cost estimate for the project was developed using current (2012) material pipe material pricing obtained from vendors experienced with shipments to Central Oregon and includes shipping and welding costs. The pipe estimates also include a cost factor for installation, excavation, backfill and compaction of 1.5 times the total pipe material, delivery and shipping cost. The total project cost estimate also includes an estimate for turnouts at an average of approximately $4,000/turnout (tee, valve, meter, air/vacuum relief, minor piping), an allocation for road crossings, and estimates for contractor overhead and profit (10%), contractor bonds and insurance (2%), engineering/administration (15%) and project contingencies (30%). The resulting total cost estimate for the project was $12,908,708. Contingencies can normally be reduced as project specificity is increased through design and estimates for materials may be made as close as possible to project bidding.

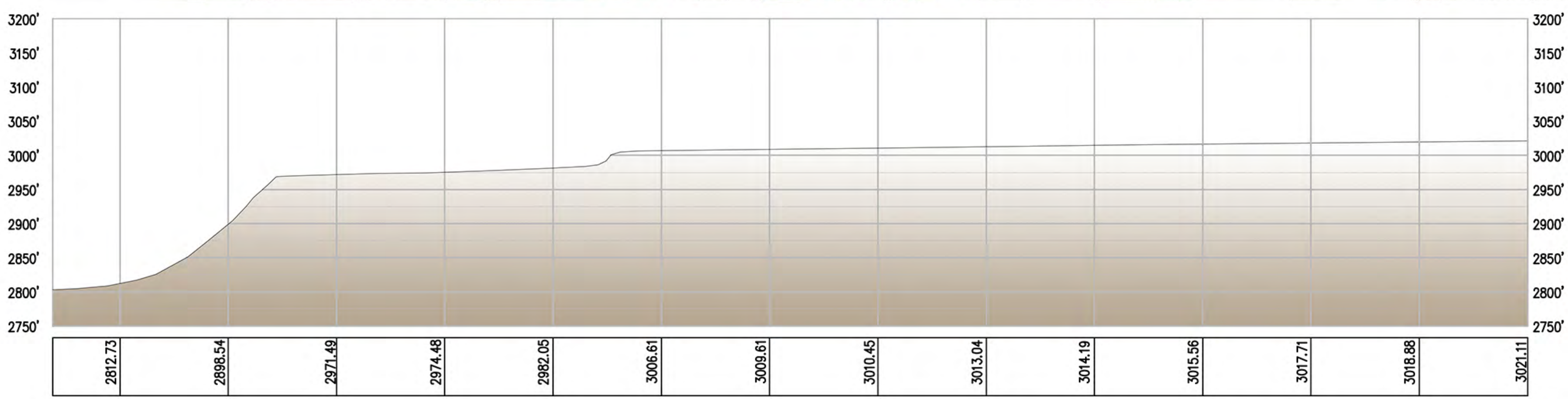
To estimate the benefit versus the cost of the project, benefits were calculated (see table below) based upon the following factors:

1) **Reduction in operations and maintenance.** These costs were estimated by the District based upon recent herbicide application costs, District canal maintenance

costs, and miscellaneous costs associated with open canal versus piped canal considerations. The District estimated that its proportion of O&M costs that may be eliminated by the project on an annual basis would be approximately $8,000. Given a 50-year project life cycle, and assumed inflation equals the inflation of such O&M costs, the simple current value of O&M mitigation would be 50x$8,000=$400,000.

2) **Reduction in power costs.** For this project, the reduction in power costs were found to be attributable to only 31 acres. The estimated simple current benefit was based upon $50/acre per season for a period of 10-years as an estimated starting benefit calculation (about ½ the actual cost of pumping). For 31 acres, the estimated benefit would be 31 x $50 x 10 = $15,500.
3) **Reduction in return-flows/tail-water.** The reduction in tail-water for this project was estimated to be the returning flows measured at the "Gap".
4) **Benefits and costs in 2012 capital dollars. Th**e benefit versus cost ratio was estimated based upon the 2012 total project cost estimate and the estimated total current dollar project benefit. The resulting benefit/cost ratio was found to be 0.10 whereas a benefit/cost ratio exceeding 1.0 is necessary to consider moving a project forward if all merits may be quantified by cost and benefit.


Ochoco Main Canal Lytle Cr. to Tail
38428
36960
31680
26400
21120
15840
10560
5280
1000


3200'
3150'
3100'
3050'
3000'
2950'
2900'
2850'
2800'
2750'
2812.73
2898.54
2971.49
2974.48
2982.05
3006.61
3009.61
3010.45
3013.04
3014.19
3015.56
3017.71
3018.88
3021.11

OCHOCO CANAL - LYTLE TO TAIL PIPING RECONNAISSANCE COST ESTIMATE

Ochoco Irrigation District System Optimization Review

OCTOBER, 2012

Construction Item	Station Start	Station End	Total Length	Diameter (O.D. Inches)	Material	Estimated Cost/LF	Estimated Total Cost
1. Pipe	96121	104986	8865	54	HDPE DR32.5	300	$2,659,500
2. Pipe	104986	112000	7014	48	HDPE DR32.5	270	$1,893,780
3. Pipe	112000	118000	6000	42	HDPE DR32.5	230	$1,380,000
4. Pipe	118000	121379	3379	22	HDPE DR32.5	120	$405,480
5. Pipe	121379	130320	8941	22	HDPE DR21	150	$1,341,150
6. Turnouts							$125,000
7. Crossings and Major Connections							$100,000
						SUBTOTAL	**$7,904,910**
Contractor OH/Profit			10%				$790,491
Contractor Bonds and Insurance			2%				$158,098
Construction Contingency			30%				$2,371,473
						SUBTOTAL	**$11,224,972**
Engineering, Administration			15%				$1,683,746
						GRAND TOTAL	**$12,908,718**

OCHOCO CANAL-LYTLE TO TAIL PIPING BENEFIT VERSUS COST

					Value/Acre	Value/AF	Benefit
Potential Power Benefit	Acres=	31			$500		$15,500
O&M Mitigation							$400,000
Acre-Feet Saved (Spill Point)	Gap=	1,727	AF			$500	$863,500
						TOTAL BENEFIT	**$1,279,000**
						B/C RATIO	**0.10**

JOHNSON CREEK LATERAL PIPING PROJECT (SEE EXHIBIT)

The Johnson Creek Lateral Piping Project was evaluated to pipe the Johnson Creek Lateral from the terminus of the Johnson Creek Pump discharge pipe to the tail end of the Johnson Creek Lateral at its connection to the Ochoco Main Canal. The District determined that approximately 605 Acres of irrigated properties are served by this lateral. The project piping was sized based upon flow rates that were estimated and prorated in the pipeline. A value of 9 gallons per minute per acre was used to estimate the peak irrigation flow volume for pipe sizing purposes. Although this is slightly conservative, District records indicate nearly 8 gallons per minute per acre has actually been delivered historically for short periods of time. Other Districts are also using 9 gallons per minute per acre for pipe sizing and planning purposes in an effort also to adjust for pivot application systems that can use a higher demand over a shorter daily irrigation cycle. Elevations necessary to calculate pipe sizing were obtained through free-ware imagery for reconnaissance-level estimating purposes only.

The results of the Johnson Creek Lateral Piping Project evaluation indicated that approximately 30,500 LF (approximately 5.8 miles) of open canal would be piped. The pipe material chosen for the purposes of this analysis was solid wall HDPE. Solid wall pipe wall thicknesses (DR rating) was sized to anticipated static/working pressures throughout the project ranging from 0 PSI to 55 PSI. The final range of pipe sizes necessary to convey irrigation flows along the Crooked River Distribution Canal ranged from 33.65-inches in inside diameter to 16.53-inches in inside diameter.

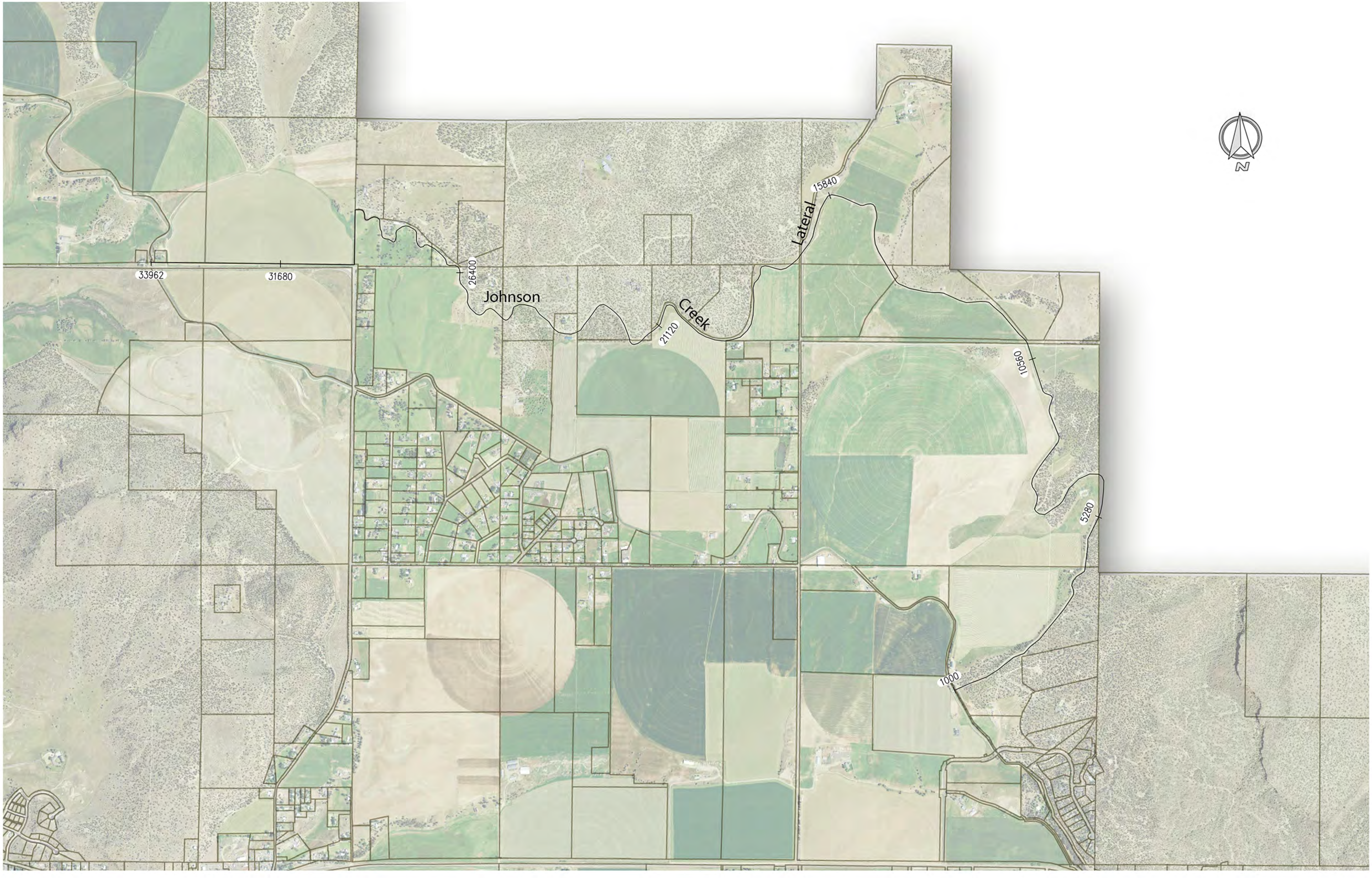
The reconnaissance-level cost estimate for the project was developed using current (2012) material pipe material pricing obtained from vendors experienced with shipments to Central Oregon and includes shipping and welding costs. The pipe estimates also include a cost factor for installation, excavation, backfill and compaction of 1.5 times the total pipe material, delivery and shipping cost. The total project cost estimate also includes an estimate for turnouts at an average of approximately $4,000/turnout (tee, valve, meter, air/vacuum relief, minor piping), an allocation for road crossings, and estimates for contractor overhead and profit (10%), contractor bonds and insurance (2%), engineering/administration (15%) and project contingencies (30%). The resulting total cost estimate for the project was $8,478,944. Contingencies can normally be reduced as project specificity is increased through design and estimates for materials may be made as close as possible to project bidding.

To estimate the benefit versus the cost of the project, benefits were calculated (see table) based upon the following factors:

1) **Reduction in operations and maintenance.** These costs were estimated by the District based upon recent herbicide application costs, District canal maintenance costs, and miscellaneous costs associated with open canal versus piped canal considerations. The District estimated that its proportion of O&M costs that may be eliminated by the project on an annual basis would be approximately $8,000. Given a 50-year project life cycle, and assumed inflation equals the inflation of

such O&M costs, the simple current value of O&M mitigation would be 50x$8,000=$400,000.

2) **Reduction in power costs.** For this project, the reduction in power costs were found to be attributable to only 46.2 acres. The estimated simple current benefit was based upon $50/acre per season for a period of 10-years as an estimated starting benefit calculation (about ½ the actual cost of pumping). For 46.2 acres, the estimated benefit would be 46.2 x $50 x 10 = $23,100.
3) **Reduction in return-flows/tail-water.** The reduction in tail-water for this project were return flows to the Ochoco Main Canal and were estimated based upon current total acre-feet pumped to irrigate the area minus the estimated necessary irrigation volume necessary to irrigate the area (at an assumed 9 GPM/Acre).
4) **Benefits and costs in 2012 capital dollars. Th**e benefit versus cost ratio was estimated based upon the 2012 total project cost estimate and the estimated total current dollar project benefit. The resulting benefit/cost ratio was found to be 0.14 whereas a benefit/cost ratio exceeding 1.0 is necessary to consider moving a project forward if all merits may be quantified by cost and benefit.



N
15840
Lateral
33962
31680
26400
Johnson
Creek
21120
10560
5280
1000

JOHNSON CREEK LATERAL RECONNAISSANCE COST ESTIMATE

Ochoco Irrigation District System Optimization Review

OCTOBER, 2012

Construction Item	Station Start	Station End	Total Length	Diameter (O.D. Inches)	Material	Estimated Cost/LF	Estimated Total Cost
1. Pipe	1000	8625	7625	36	HDPE DR32.5	200	1,525,000
2. Pipe	8625	16250	7625	32	HDPE DR32.5	180	1,372,500
3. Pipe	16250	23875	7625	30	HDPE DR32.5	170	1,296,250
4. Pipe	23875	28000	4125	24	HDPE DR32.5	140	577,500
5. Pipe	28800	32300	3500	18	HDPE DR21	100	350,000
6. Turnouts							56,000
7. Crossings and Major Connections							15,000
						SUBTOTAL	**5,192,250**
Contractor OH/Profit			10%				519,225
Contractor Bonds and Insurance			2%				103,845
Construction Contingency			30%				1,557,675
						SUBTOTAL	**7,372,995**
Engineering, Administration			15%				1,105,949
						GRAND TOTAL	**8,478,944**

JOHNSON CREEK PIPING BENEFIT VERSUS COST

					Value/Acre	Value/AF	Benefit
Potential Power Benefit	Acres=	0			$300		$0
O&M Mitigation							$400,000
Acre-Feet Saved (Spill Point)	Main Canal	1,500	AF			$500	$750,000
						TOTAL BENEFIT	**$1,150,000**
						B/C RATIO	**0.14**

DELIVERABLES TAB 1 - 389 Lateral

Ochoco Irrigation District
System Optimization Review
Laterals Design

	Length of Pipe	Size of Pipe	Labor	Equipment	Materials	Contingency	Project Total	Project Cost/LF
389-Lateral	2,380.00	14"	$16,700.00	$23,925.00	$65,050.50	$10,567.55	$116,243.05	$48.84
407-Lateral	4,922.00	12"	$29,200.00	$43,300.00	$112,397.30	$18,489.73	$203,387.03	$41.32
Lytle Creek East	9,576.00	24"	$54,200.00	$86,600.00	$705,905.31	$84,670.53	$931,375.84	$97.26
Lytle Creek West	32,734.00	36"	$175,100.00	$303,700.00	$5,177,745.51	$565,654.55	$6,222,200.06	$190.08
381-Lateral	7,122.00	14"	$41,700.00	$68,750.00	$260,610.95	$37,106.10	$408,167.05	$57.31
375-Lateral	3,642.00	18"	$19,200.00	$26,700.00	$148,816.85	$19,471.69	$214,188.54	$58.81
311-Lateral	2,284.00	16"	$13,600.00	$18,400.00	$75,518.86	$10,751.89	$118,270.75	$51.78
J-Lateral	5,745.00	24"	$29,200.00	$43,300.00	$425,921.04	$49,842.10	$548,263.14	$95.43
321-Lateral	4,201.00	12"	$26,700.00	$41,920.00	$93,957.58	$16,257.76	$178,835.34	$42.57

Ochoco Irrigation District
389-Lateral

Labor

Description	Unit Price	Unit	Extended
Headworks	$ 25.00	$ 96.00	$ 2,400.00
Lay Pipe	$ 25.00	$ 500.00	$ 12,500.00
Outlet	$ 25.00	$ 72.00	$ 1,800.00
	$ 25.00		$ -
	$ 25.00		$ -
	$ 25.00		$ -
	$ 25.00		$ -
			$ 16,700.00

Equipment

Description			
230 Excavator	100.00	100.00	10,000.00
120 Excavator	75.00	24.00	1,800.00
Backhoe	40.00	100.00	4,000.00
Dozer	55.00	75.00	4,125.00
Pickup	10.00	100.00	1,000.00
Dump Truck	30.00	100.00	3,000.00
			0.00
			23,925.00

Materials

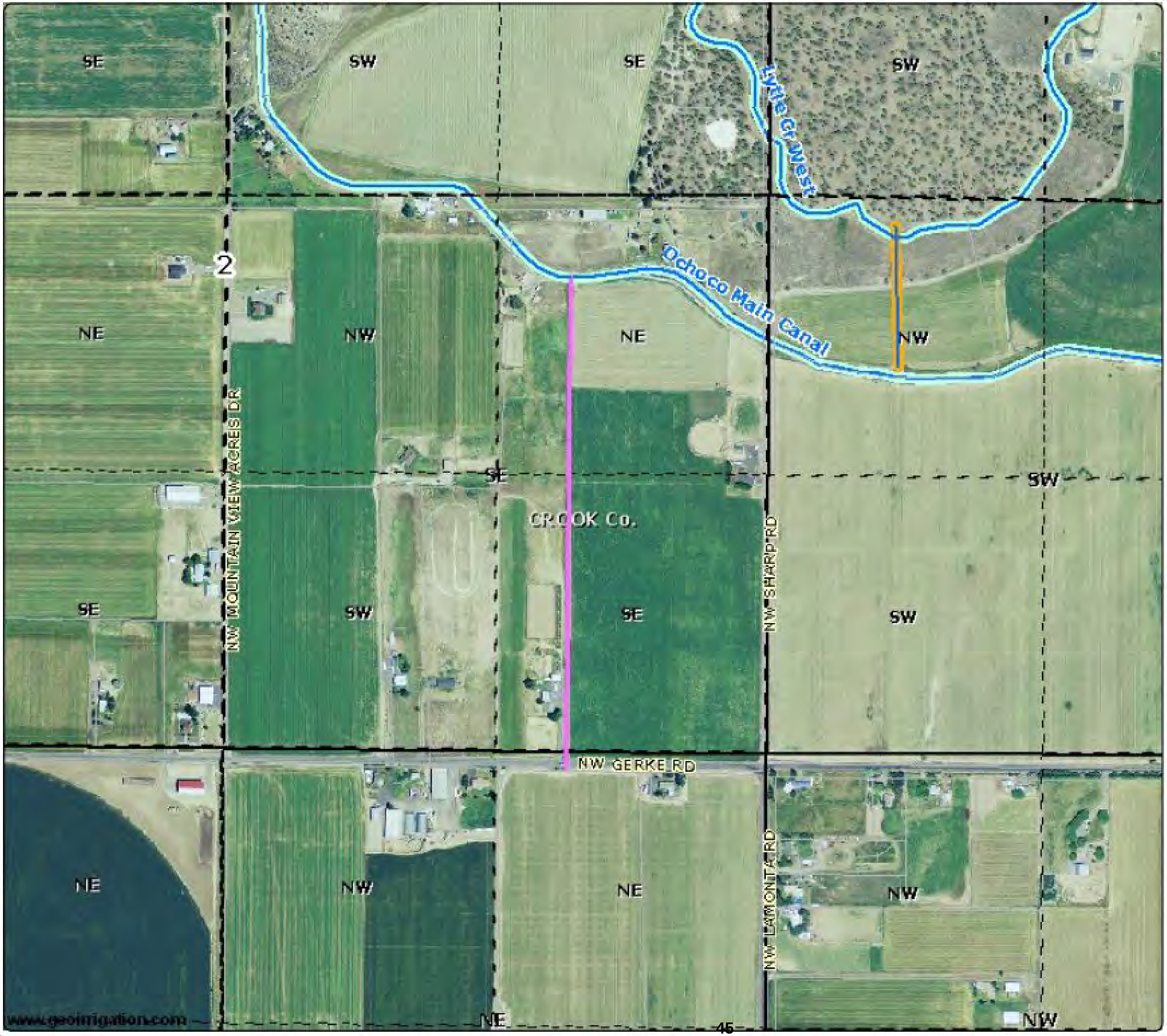
Description			
Headworks - Concrete, HG, Measuring Device	1.00	$ 5,800.00	$ 5,800.00
14" Pipe	2,380.00	$ 19.58	$ 46,600.40
Fittings	1.00	$ 11,650.10	$ 11,650.10
Outlet Concrete	1.00	$ 1,000.00	$ 1,000.00
			$ -
			$ -
			$ -
			$ -
			$ 65,050.50

Project Totals

	Labor	$ 16,700.00
	Equipment	$ 23,925.00
	Materials	$ 65,050.50
Contingency at 10%		$ 10,567.55

Project Grand Total $ 116,243.05

Ochoco Irrigation District



389 Pipeline

District Boundary
County Boundary
Major Roads
Road Labels
Township Range
Sections
Section Labels
Quarters
Quarter Labels
Quarter Quarters
Quarter Quarter Labels
Taxlots
Canal All
Canal Open
Canal Piped
Waterbodies NHD

Scale 1" = 700'
Created: 12/7/2012

DELIVERABLES TAB 1 - 407 Lateral

Ochoco Irrigation District
407-V Lateral

Labor

Description	Unit Price	Unit	Extended
Headworks	$ 25.00	$ 96.00	$ 2,400.00
Lay Pipe	$ 25.00	$ 1,000.00	$ 25,000.00
Outlet	$ 25.00	$ 72.00	$ 1,800.00
	$ 25.00		$
	$ 25.00		$
	$ 25.00		$
	$ 25.00		$
			$ 29,200.00

Equipment

Description			
230 Excavator	100.00	200.00	20,000.00
120 Excavator	75.00	24.00	1,800.00
Backhoe	40.00	200.00	8,000.00
Dozer	55.00	100.00	5,500.00
Pickup	10.00	200.00	2,000.00
Dump Truck	30.00	200.00	6,000.00
			0.00
			43,300.00

Materials

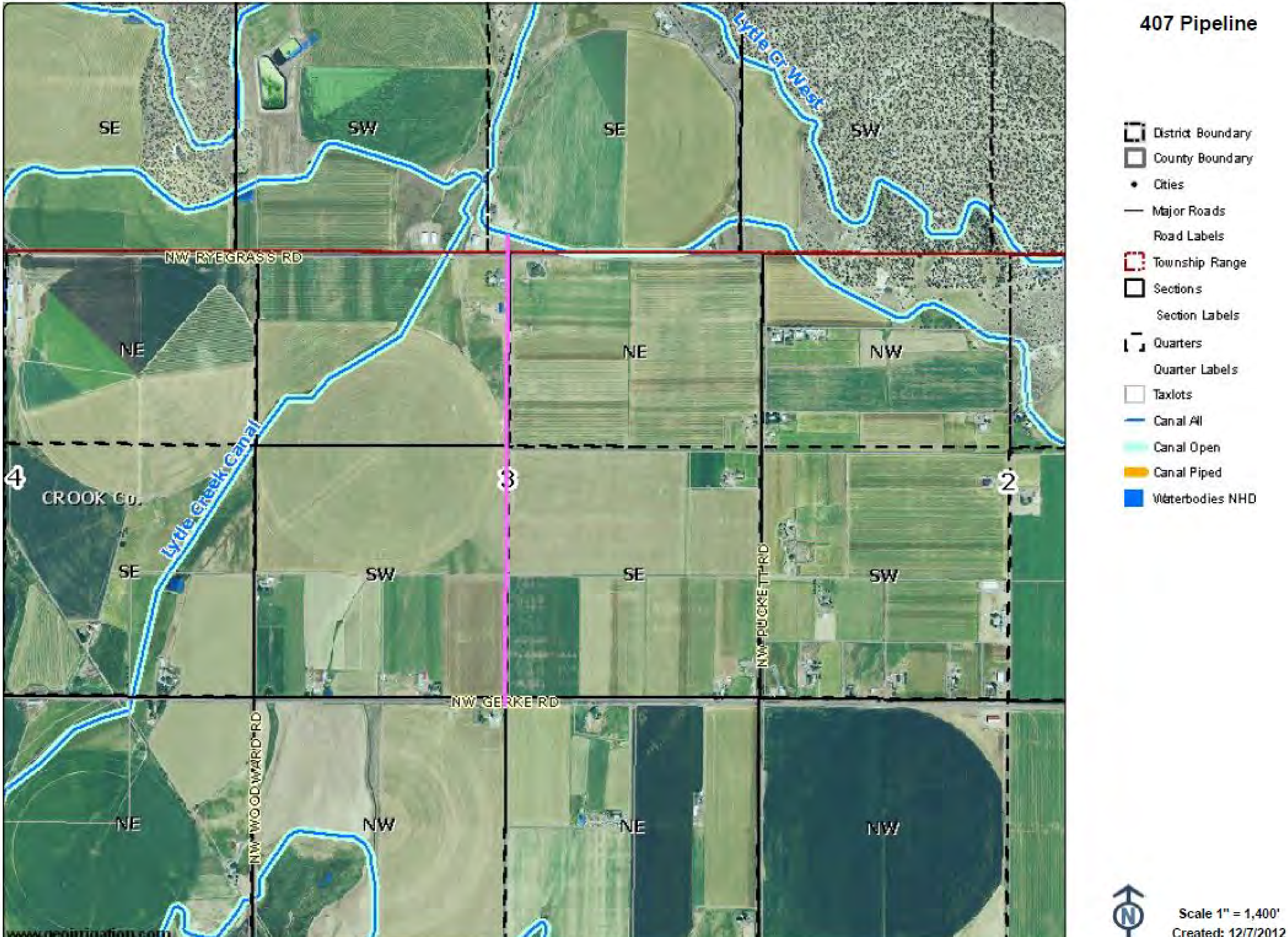
Description			
Headworks - Concrete, HG, Measuring Devise	1.00	$ 5,800.00	$ 5,800.00
12" Pipe	4,922.00	$ 14.58	$ 71,762.76
Fittings	1.00	$ 17,934.54	$ 17,934.54
Deliveries	3.00	$ 5,300.00	$ 15,900.00
Outlet Concrete	1.00	$ 1,000.00	$ 1,000.00
			$
			$
			$
			$
			$ 112,397.30

Project Totals

	Labor	$ 29,200.00
	Equipment	$ 43,300.00
	Materials	$ 112,397.30
Contingency at 10%		$ 18,489.73

Project Grand Total $ 203,387.03

Ochoco Irrigation District



DELIVERABLES TAB 1 – Lytle Creek East

Ochoco Irrigation District
Lytle Creek East

Labor

Description	Unit Price	Unit	Extended
Headworks	$ 25.00	$ 96.00	$ 2,400.00
Lay Pipe	$ 25.00	$ 2,000.00	$ 50,000.00
Outlet	$ 25.00	$ 72.00	$ 1,800.00
	$ 25.00		$ -
	$ 25.00		$ -
	$ 25.00		$ -
	$ 25.00		$ -
			$ 54,200.00

Equipment

Description			
230 Excavator	100.00	400.00	40,000.00
120 Excavator	75.00	48.00	3,600.00
Backhoe	40.00	400.00	16,000.00
Dozer	55.00	200.00	11,000.00
Pickup	10.00	400.00	4,000.00
Dump Truck	30.00	400.00	12,000.00
			0.00
			86,600.00

Materials

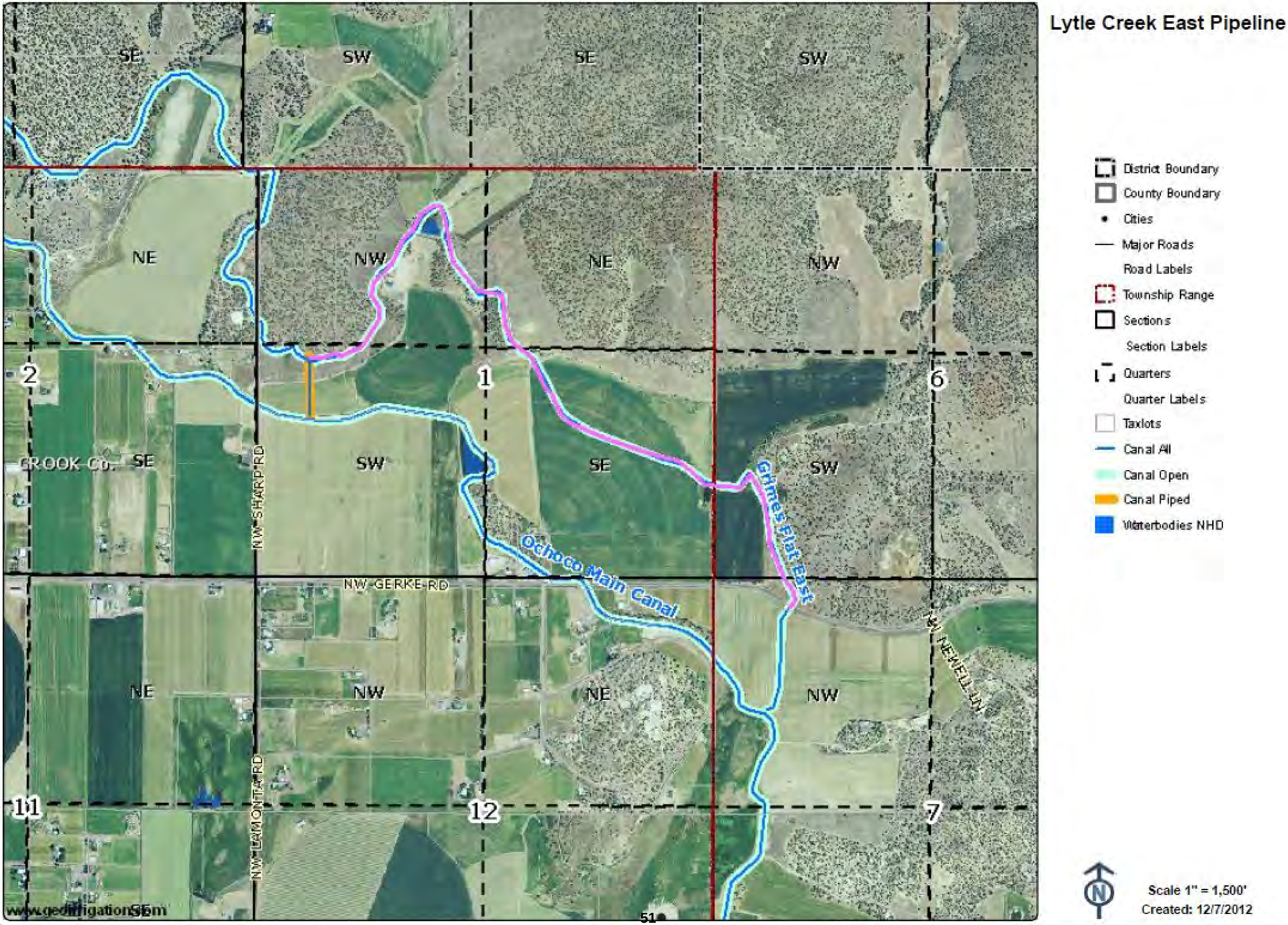
Description			
Headworks - Concrete, HG, Measuring Device	1.00	$ 5,800.00	$ 5,800.00
24" Pipe	9,576.00	$ 56.19	$ 538,075.44
Fittings	1.00	$ 134,529.87	$ 134,529.87
Outlet Concrete	1.00	$ 1,000.00	$ 1,000.00
Deleveries	5.00	$ 5,300.00	$ 26,500.00
			$ -
			$ -
			$ -
			$ 705,905.31

Project Totals

	Labor	$ 54,200.00
	Equipment	$ 86,600.00
	Materials	$ 705,905.31
Contingency at 10%		$ 84,670.53

Project Grand Total $ 931,375.84

Ochoco Irrigation District



DELIVERABLES TAB 1 – Lytle Creek West

Ochoco Irrigation District
Lytle Creek West

Labor

Description	Unit Price	Unit	Extended
Headworks	$ 25.00	$ 96.00	$ 2,400.00
Lay Pipe	$ 25.00	$ 6,836.00	$ 170,900.00
Outlet	$ 25.00	$ 72.00	$ 1,800.00
	$ 25.00		$ -
	$ 25.00		$ -
	$ 25.00		$ -
	$ 25.00		$ -
			$ 175,100.00

Equipment

Description			
230 Excavator	100.00	1,400.00	140,000.00
120 Excavator	75.00	176.00	13,200.00
Backhoe	40.00	1,400.00	56,000.00
Dozer	55.00	700.00	38,500.00
Pickup	10.00	1,400.00	14,000.00
Dump Truck	30.00	1,400.00	42,000.00
			0.00
			303,700.00

Materials

Description			
Headworks - Concrete, HG, Measuring Device	1.00	$ 5,800.00	$ 5,800.00
36" Pipe	32,734.00	$ 122.71	$ 4,016,789.14
Fittings	1.00	$ 1,004,156.37	$ 1,004,156.37
Outlet Concrete	1.00	$ 1,000.00	$ 1,000.00
Deleveries	15.00	$ 10,000.00	$ 150,000.00
			$ -
			$ -
			$ -
			$ 5,177,745.51

Project Totals

	Labor	$ 175,100.00
	Equipment	$ 303,700.00
	Materials	$ 5,177,745.51
Contingency at 10%		$ 565,654.55

Project Grand Total $ 6,222,200.06

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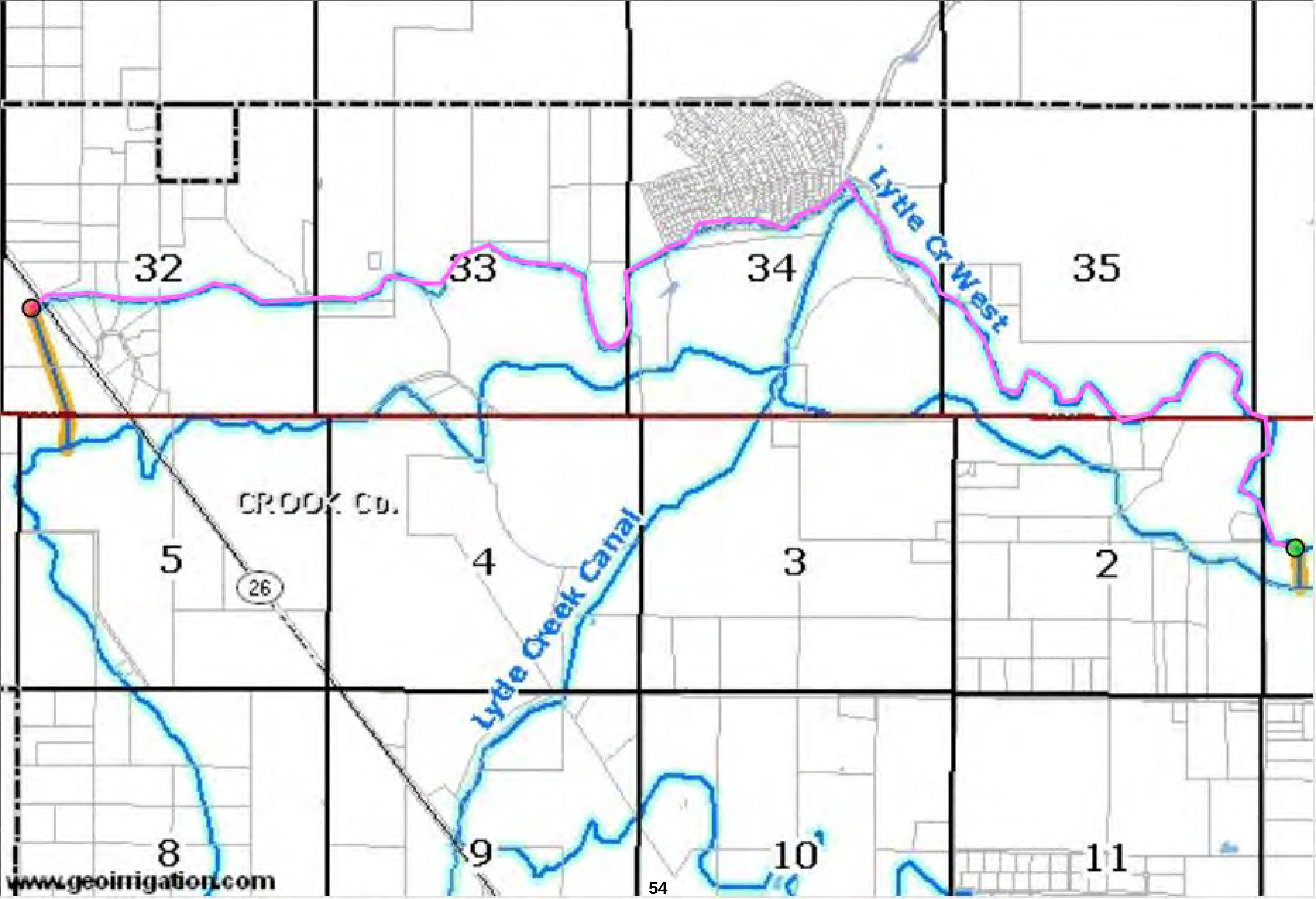
32
33
34
35
Lytle Cr West
CROOK Co.
5
26
4
Lytle Creek Canal
3
2
8
9
10
11
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DELIVERABLES TAB 1 – 381 Lateral

Ochoco Irrigation District
381-V Lateral

Labor

Description	Unit Price	Unit	Extended
Headworks	$ 25.00	$ 96.00	$ 2,400.00
Lay Pipe	$ 25.00	$ 1,500.00	$ 37,500.00
Outlet	$ 25.00	$ 72.00	$ 1,800.00
	$ 25.00		$ -
	$ 25.00		$ -
	$ 25.00		$ -
	$ 25.00		$ -
			$ 41,700.00

Equipment

Description			
230 Excavator	100.00	300.00	30,000.00
120 Excavator	75.00	50.00	3,750.00
Backhoe	40.00	300.00	12,000.00
Dozer	55.00	200.00	11,000.00
Pickup	10.00	300.00	3,000.00
Dump Truck	30.00	300.00	9,000.00
			0.00
			68,750.00

Materials

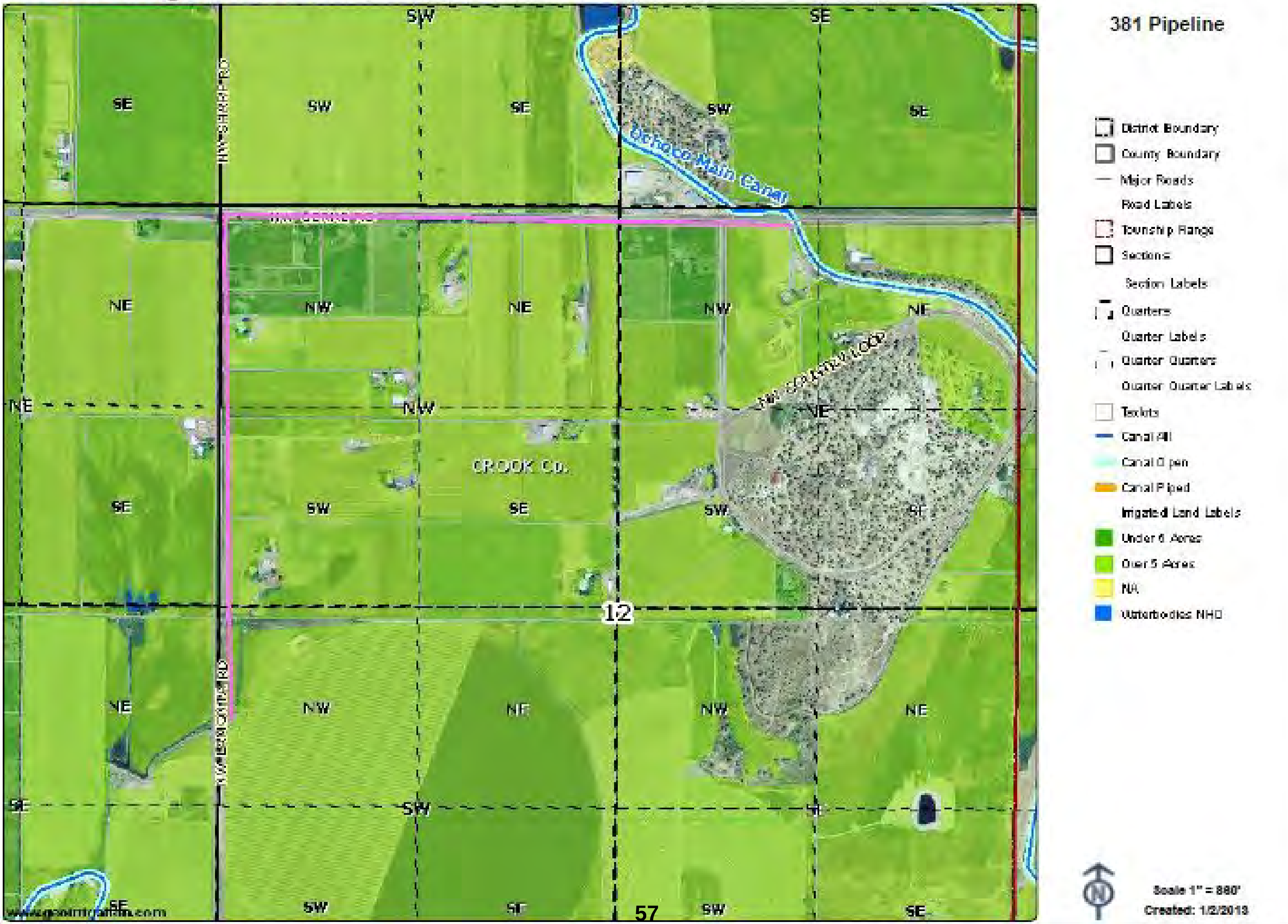
Description			
Headworks -Concrete, HG, Measuring Devise	1.00	$ 5,800.00	$ 5,800.00
14" Pipe	7,122.00	$ 19.58	$ 139,448.76
Fittings	1.00	$ 34,862.19	$ 34,862.19
Deliveries	15.00	$ 5,300.00	$ 79,500.00
Outlet Concrete	1.00	$ 1,000.00	$ 1,000.00
			$ -
			$ -
			$ -
			$ -
			$ 260,610.95

Project Totals

	Labor	$ 41,700.00
	Equipment	$ 68,750.00
	Materials	$ 260,610.95
Contingency at 10%		$ 37,106.10

Project Grand Total $ 408,167.05

Ochoco Irrigation District



DELIVERABLES TAB 1 – 375 Lateral

Ochoco Irrigation District
375-R Estimate

Labor

Description	Unit Price	Unit	Extended
Headworks	$ 25.00	$ 96.00	$ 2,400.00
Lay Pipe	$ 25.00	$ 600.00	$ 15,000.00
Outlet	$ 25.00	$ 72.00	$ 1,800.00
	$ 25.00		$ -
	$ 25.00		$ -
	$ 25.00		$ -
	$ 25.00		$ -
			$ 19,200.00

Equipment

Description			
230 Excavator	100.00	120.00	12,000.00
120 Excavator	75.00	24.00	1,800.00
Backhoe	40.00	120.00	4,800.00
Dozer	55.00	60.00	3,300.00
Pickup	10.00	120.00	1,200.00
Dump Truck	30.00	120.00	3,600.00
			0.00
			26,700.00

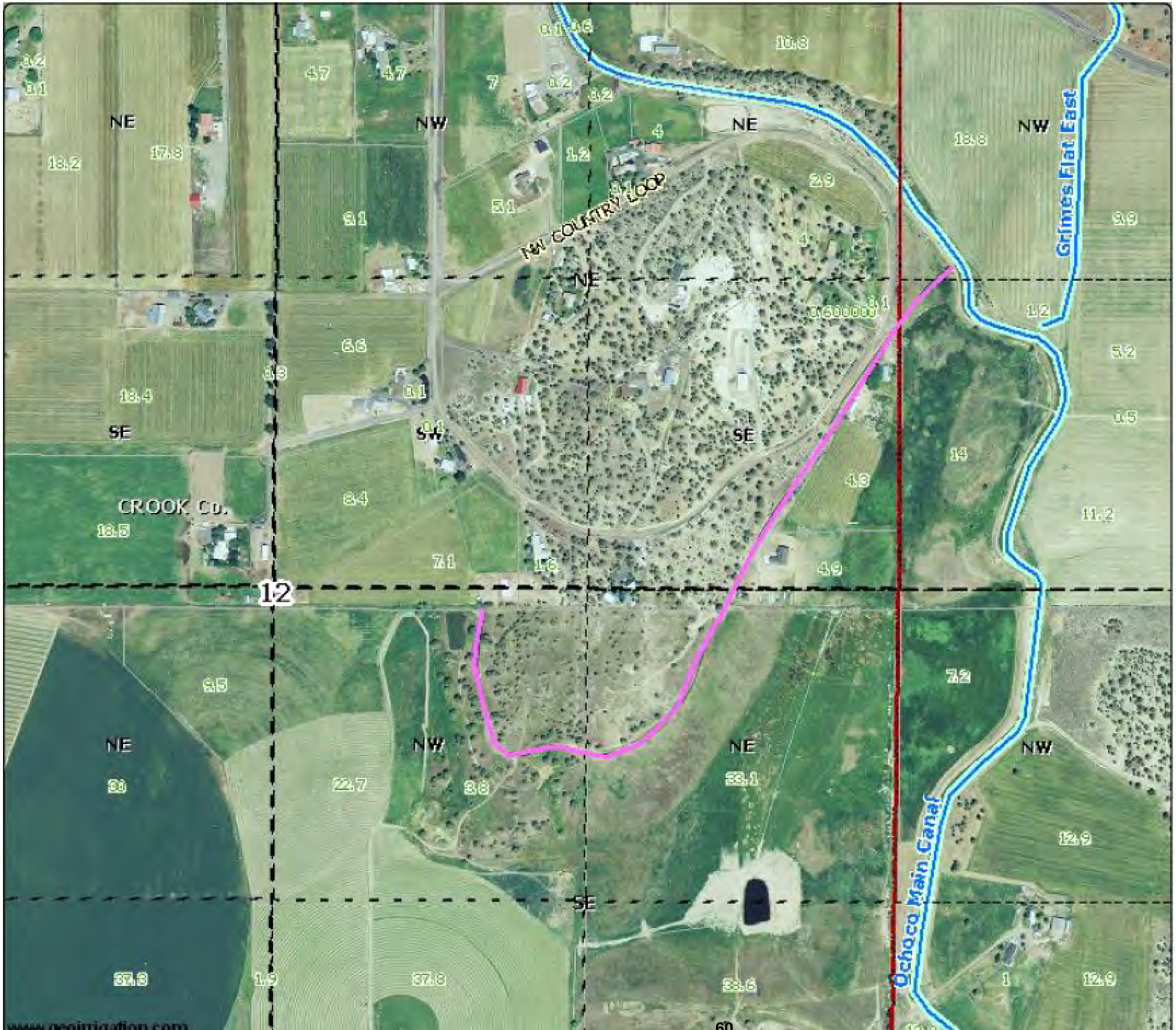
Materials

Description			
Headworks HG, Concrete, Box	1.00	$ 2,200.00	$ 2,200.00
Purchase Pipe 18"	3,642.00	$ 31.81	$ 115,852.02
Purchase Pipe Ftgs	1.00	$ 28,964.83	$ 28,964.83
Outlet concrete	1.00	$ 1,800.00	$ 1,800.00
			$ -
			$ -
			$ -
			$ -
			$ 148,816.85

Project Totals

	Labor	$ 19,200.00
	Equipment	$ 26,700.00
	Materials	$ 148,816.85
Contingency at 10%		$ 19,471.69
Project Grand Total		$ 214,188.54

Ochoco Irrigation District



375 - Pipeline

- District Boundary
- County Boundary
- Major Roads
- Road Labels
- Township Range
- Sections
- Section Labels
- Quarters
- Quarter Labels
- Quarter Quarters
- Quarter Quarter Labels
- Taxlots
- Canal All
- Canal Open
- Canal Piped
- Irrigated Land Labels
- Waterbodies NHD

Scale 1" = 623'
Created: 12/7/2012

DELIVERABLES TAB 1 – 311 Lateral

Ochoco Irrigation District
311-N

Labor

Description	Unit Price	Unit	Extended
Headworks	$ 25.00	$ 72.00	$ 1,800.00
Lay Pipe	$ 25.00	$ 400.00	$ 10,000.00
Outlet	$ 25.00	$ 72.00	$ 1,800.00
	$ 25.00		$ -
	$ 25.00		$ -
	$ 25.00		$ -
	$ 25.00		$ -
			$ 13,600.00

Equipment

Description			
230 Excavator	100.00	80.00	8,000.00
120 Excavator	75.00	24.00	1,800.00
Backhoe	40.00	80.00	3,200.00
Dozer	55.00	40.00	2,200.00
Pickup	10.00	80.00	800.00
Dump Truck	30.00	80.00	2,400.00
			0.00
			18,400.00

Materials

Description			
Headworks HG, Concrete, Box	1.00	$ 2,200.00	$ 2,200.00
Purchase Pipe 16"	2,284.00	$ 25.33	$ 57,853.72
Fittings	1.00	$ 14,465.14	$ 14,465.14
Outlet Concrete	1.00	$ 1,000.00	$ 1,000.00
			$ -
			$ -
			$ -
			$ 75,518.86

Project Totals

	Labor	$ 13,600.00
	Equipment	$ 18,400.00
	Materials	$ 75,518.86
Contingency at 10%		$ 10,751.89

Project Grand Total $ 118,270.75

Ochoco Irrigation District

311 - Pipe line

District Boundary
County Boundary
Major Roads
Road Labels
Township Range
Sections
Section Labels
Quarters
Quarter Labels
Quarter Quarters
Quarter Quarter Labels
Taxlots
Canal All
Canal Open
Canal Piped
Irrigated Land Labels
Waterbodies NHD

Scale 1" = 800'
Created: 12/7/2012

DELIVERABLES TAB 1 – J Lateral

Ochoco Irrigation District
191-J Lateral

Labor

Description	Unit Price	Unit	Extended
Headworks	$ 25.00	$ 96.00	$ 2,400.00
Lay Pipe	$ 25.00	$ 1,000.00	$ 25,000.00
Install outlet	$ 25.00	$ 72.00	$ 1,800.00
	$ 25.00		$ -
	$ 25.00		$ -
	$ 25.00		$ -
	$ 25.00		$ -
			$ 29,200.00

Equipment

Description			
230 Excavator	100.00	200.00	20,000.00
120 Excavator	75.00	24.00	1,800.00
Backhoe	40.00	200.00	8,000.00
Dozer	55.00	100.00	5,500.00
Pickup	10.00	200.00	2,000.00
Dump Truck	30.00	200.00	6,000.00
			0.00
			43,300.00

Materials

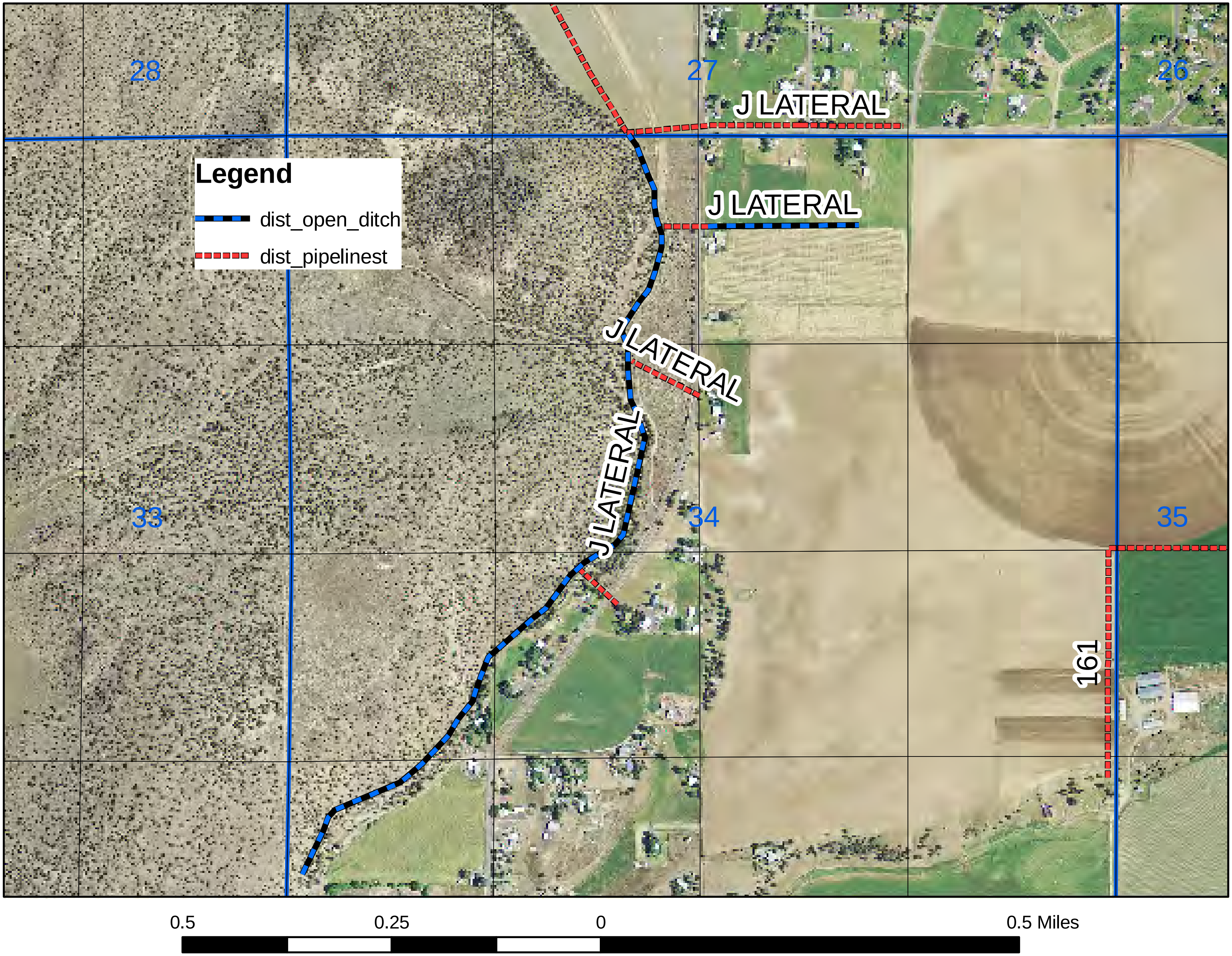
Description			
Headgate	1.00	$ 600.00	$ 600.00
Concrete	1.00	$ 300.00	$ 300.00
Concrete Forming Materials	1.00	$ 300.00	$ 300.00
Concrete Box	1.00	$ 1,000.00	$ 1,000.00
24" Pipe	5,745.00	$ 56.19	$ 322,811.55
Pipe Fittings	1.00	$ 80,709.49	$ 80,709.49
Outlet Gate	1.00	$ 1,200.00	$ 1,200.00
Concrete	1.00	$ 1,000.00	$ 1,000.00
Deliveries	4.00	$ 4,500.00	$ 18,000.00
			$ 425,921.04

Project Totals

	Labor	$ 29,200.00
	Equipment	$ 43,300.00
	Materials	$ 425,921.04
Contingency at 10%		$ 49,842.10

Project Grand Total $ 548,263.14

J-LATERAL PIPELINE



DELIVERABLES TAB 1 – 321 Lateral

Ochoco Irrigation District
321-Lateral

Labor

Description	Unit Price	Unit	Extended
Headworks	$ 25.00	$ 96.00	$ 2,400.00
Lay Pipe	$ 25.00	$ 900.00	$ 22,500.00
Outlet	$ 25.00	$ 72.00	$ 1,800.00
	$ 25.00		$ -
	$ 25.00		$ -
	$ 25.00		$ -
	$ 25.00		$ -
			$ 26,700.00

Equipment

Description			
230 Excavator	100.00	176.00	17,600.00
120 Excavator	75.00	50.00	3,750.00
Backhoe	40.00	176.00	7,040.00
Dozer	55.00	118.00	6,490.00
Pickup	10.00	176.00	1,760.00
Dump Truck	30.00	176.00	5,280.00
			0.00
			41,920.00

Materials

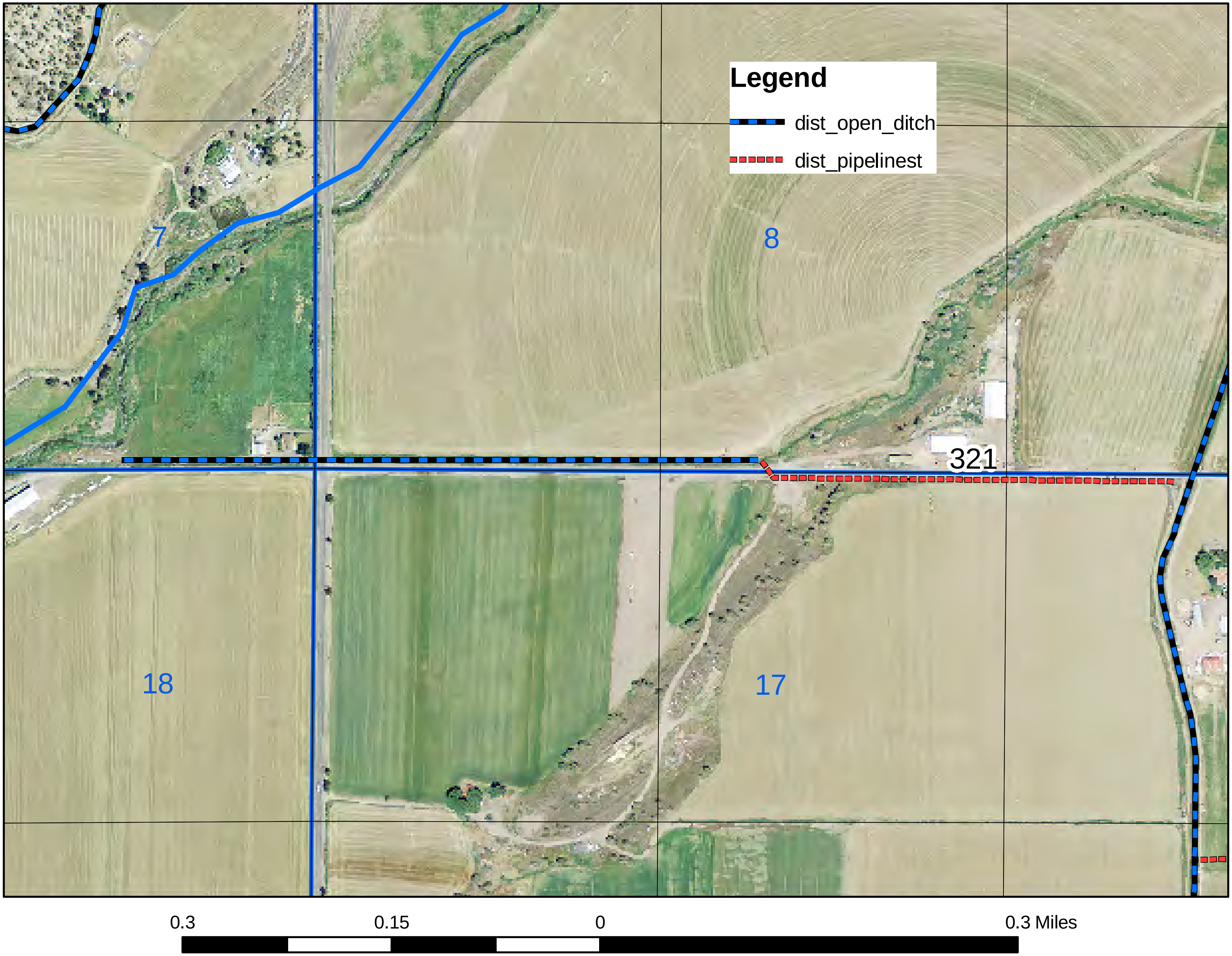
Description			
Headworks -Concrete, HG, Measuring Devise	1.00	$ 5,800.00	$ 5,800.00
12" Pipe	4,201.00	$ 14.58	$ 61,250.58
Fittings	1.00	$ 15,307.00	$ 15,307.00
Deliveries	2.00	$ 5,300.00	$ 10,600.00
Outlet Concrete	1.00	$ 1,000.00	$ 1,000.00
			$ -
			$ -
			$ -
			$ -
			$ 93,957.58

Project Totals

	Labor	$ 26,700.00
	Equipment	$ 41,920.00
	Materials	$ 93,957.58
Contingency at 10%		$ 16,257.76

Project Grand Total $ 178,835.34

321-LATERAL PIPELINE



DELIVERABLES – TAB 2

Cost/Benefit Analysis of Rye Grass Canal Pump-Back

LYTLE CREEK PUMP-BACK PUMPING PLANT - EVALUATION SUMMARY

The Lytle Creek Pump-back Pumping Plant is a proposed new facility conceptually designed to lift water from the Rye Grass Canal to the Ochoco Main canal along the west margins of the Ochoco Irrigation District. Water pumped back to the Ochoco Main canal can be used for irrigation instead of being discharged to the Crooked River as tailwater flow. Diversion from Ochoco Reservoir can, in concept, be reduced by an equivalent pump-back rate and volume.

This evaluation examined three potential pumping concepts; 10 cfs, 15 cfs, and 20 cfs pump-back capacity. Each flow rate concept was analyzed using two potential discharge main diameters. The analysis focused on the use of HDPE pipe in IPS size (references pipe outside diameter) for the majority of pipeline construction. The initial (lower) segment of discharge main was modeled using steel pipe in view of the higher pressures that will be encountered proximal to the pump station. Design development could conceivably adopt HDPE for this segment of discharge main as well.

System curves for the three potential concepts were developed based on and approximate layout of a discharge main following the alignment of Lytle Creek from the confluence of Lytle Creek to the intersection of Lytle Creek and the Ochoco Main Canal. The approximate distance of the discharge main is estimated at 18,454 feet using web-based mapping tools.

Initial pump selections assume that the pumping plant will use one vertical turbine pump to deliver the rated capacity. The 20 cfs concept design and cost estimate assumes use of two equal size vertical turbine pumps to keep individual motor horsepower in the range of available standard equipment operating on 480-V, 3-phase power. Initial pump selections are based on an operating speed of 1,180 rpm in an effort to balance suction head requirements, pump size / no. of bowls, and motor / pump cost.

Table 1 - Concept Design Equipment Summary

Concept Flow Rate	Discharge Main Size	Pump Unit	Description	HP	Rated Capacity	Rated Head	Pump Eff. @ Rated Capacity	HDPE Discharge Main Vel.
10 CFS	20 IN	No. 1	Vertical Turbine	400	4,490 GPM	245 FT	84.5 %	4.2 FPS
	22 IN	No. 1	Vertical Turbine	400	4,490 GPM	228 FT	84.3 %	3.5 FPS
15 CFS	22 IN	No. 1	Vertical Turbine	600	6,730 GPM	266 FT	83.8 %	5.3 FPS
	24 IN	No. 1	Vertical Turbine	600	6,730 GPM	245 FT	83.6 %	4.6 FPS
20 CFS	26 IN	No. 1	Vertical Turbine	400	4,490 GPM	254 FT	83.3 %	
		No. 2	Vertical Turbine	400	4,490 GPM	254 FT	83.3 %	
			Total	800	8,980 GPM			5.3 FPS
	28 IN	No. 1	Vertical Turbine	400	4,490 GPM	237 FT	84.6 %	
		No. 2	Vertical Turbine	400	4,490 GPM	237 FT	84.6 %	
			Total	800	8,980 GPM			4.7 FPS

Narrative

Evaluation of the proposed Lytle Creek Pump-back Pumping Plant examines discharge main pipe diameter, expected energy use, and probable construction cost for three different pump station sizes ranging from 10 to 20 cfs capacity.

The static lift for the proposed Lytle Creek Pump-back Pumping Plant is estimated at 187 feet. Referencing the concept layout of the system, the relatively long discharge main (18,454 feet) makes up approximately 25% the total dynamic head in the pumping system. As a result of discharge main length, the pipe diameter becomes a significant consideration in defining operational cost of the proposed system. Careful selection of discharge main materials and diameter relative to pumping plant rated capacity is critical. The concept designs evaluated here result in fluid velocity ranging from 3.5 to 5.3 feet per second. Below 3 feet per second fluid velocity, deposition of solids in the discharge main could be an concern. Above 5 feet per second fluid velocity, head losses in the pipe system will reflect in rapidly increasing energy use and operating costs.

The evaluation pumping rate and evaluation basis (average annual pumped volume) used in consideration of pumping plant alternatives are based on the unit demand curve derived from flow data on the Crooked River Diversion Canal. The evaluation basis (average annual pumped volume) in comparison to the expected agricultural area / crop demands for the Lytle Creek Pump-back service area can be used as a metric in selection of alternatives.

Average annual energy use shown in Table 2 - Concept Design Evaluation Summary is derived directly from the evaluation basis (average annual pumped volume), head conditions, and pumping plant efficiencies. It can be used to valuate projected energy costs whether the pumping plant is operated on consumer energy rates or millage rate. Depending upon the cost of power to the District at the proposed Lytle Creek Pump - back Pumping Plant, average annual pumping costs may be a significant factor in selection of alternatives and identification of financing mechanisms for satisfying annual operating costs of the system.

Table 2 - Concept Design Evaluation Summary also includes a tabulation of kW-hr per Acre-Foot pumped. Although each alternative has a near-similar energy requirement per unit of water delivered, the 20 cfs system with a 28-inch diameter discharge main has a relatively low unit energy requirement in comparison to all alternatives studied. Examination of discharge main fluid velocity indicates that the same alternative has a relatively high fluid velocity. This relationship is resultant of the wetted perimeter of the discharge main versus cross-sectional area and indicates the larger pump plants could offer reduced unit pumping costs if the discharge main size is precisely coordinated with pumping plant capacity.

The $ per Acre-Foot Pumped values provided in Table 2 - Concept Design Evaluation Summary indicates that the unit cost of pumping for the proposed Lytle Creek Pump-back Pumping Plant is greater than all other pumping plants in the Districts system. The values presented are based on an assumed unit cost of power equal to $0.035 per kW-hr. Depending upon the benefits gained by pump-back and the Districts unit cost of power at the proposed pumping plant, the benefit cost of the proposed project can be evaluated.

The initial cost projection for pumping plant improvements assumes adequate water in the Lytle Creek / Rye Grass Canal system is available during the irrigation season. Initial cost projections assume that line power of adequate capacity is available in the immediate vicinity of the proposed pumping plant. No line item cost for permitting has been included in the opinion of probable construction costs for each alternative. The 10 cfs pumping plant with a 20-inch discharge main has the lowest initial cost projection at $3,483,000. Doubling the system capacity to 20 cfs increases initial cost by 40% as reflected in the $4,856,000 initial cost projection for the 20 cfs pumping plant with a 26-inch discharge main. Referencing the individual itemized cost projections, the discharge main represents approximately 80% of the cost the project. Depending upon the Districts capacity to finance the proposed pumping plant, the initial cost for the system may constrain the capacity of the pumping plant.

Evaluation of unit demand curve and multispeed curves for the initial pump selections suggests that use of a VFD on one pump configurations would be beneficial to matching pump output to seasonal variations in demand.

Table 2 - Concept Design Evaluation Summary

Concept Flow Rate	Discharge Main Size	Evaluation Pumping Rate	Evaluation Basis (Acre-Feet / Year)	Annual Energy Use (kW-hr)	kW-hr per Acre-foot Pumped	$ per Acre-Foot Pumped*	Initial Cost
10 CFS	20 IN	8 cfs	3,140	919,635	293	$10.25	$3,483,000
	22 IN	8 cfs	3,140	872,653	278	$9.73	$3,872,000
15 CFS	22 IN	12 cfs	4,710	1,470,249	312	$10.93	$3,964,000
	24 IN	12 cfs	4,710	1,393,266	296	$10.36	$4,302,000
20 CFS	26 IN	16 cfs	6,280	1,923,812	306	$10.72	$4,856,000
	28 IN	16 cfs	6,280	1,812,601	289	$10.10	$5,249,000

* Valuation of $ per Acre Foot Pumped is based on an assumed cost of energy = $0.035 per kW/hr

Action Recommended for Further Evaluation:

1. **Monitor Lytle Creek / Rye Grass Canal flow**
2. **Identify the service area and expected annual irrigation demand within the expected service area**
3. **Identify and valuate annual benefits of pump-back**
4. **Identify interested stakeholders and initial cost financing**
5. **Identify the preferred pumping plant capacity**
6. **Formulate an operating / maintenance / capitol replacement finance plan based on applicable unit power costs and pumping plant capacity**

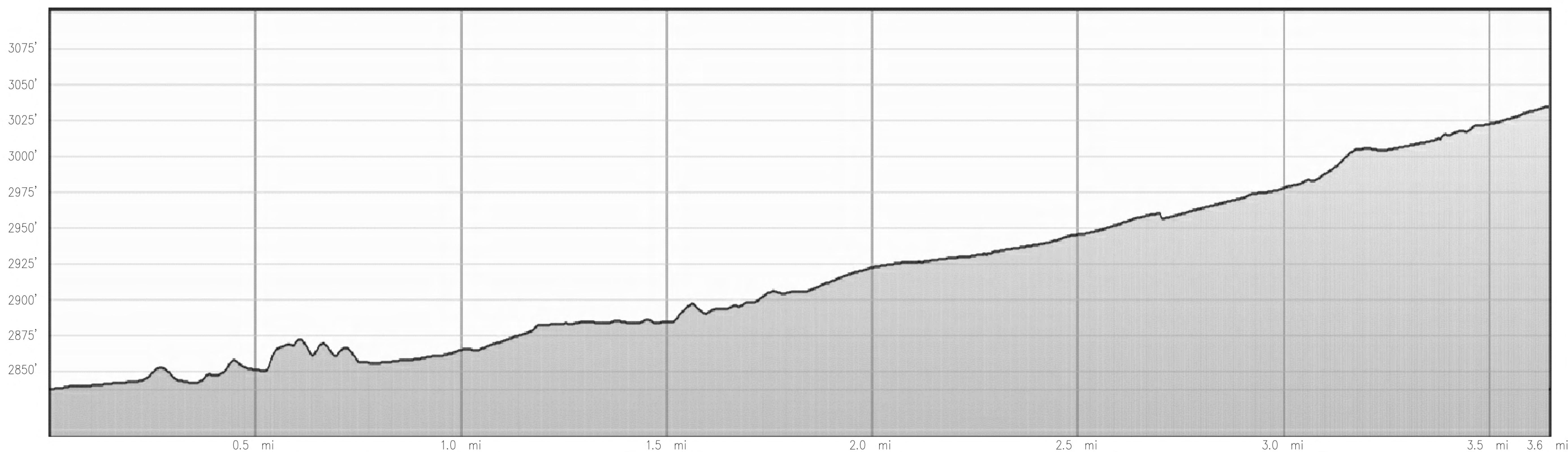
OCHOCO IRRIGATION DIST.
SYSTEMS OPTIMIZATION REVIEW

LYTLE CR. PUMP-BACK PUMPING PLANT
CONCEPT LAYOUT

BLACK ROCK CONSULTING

02.03.2012

FIG. B



OCHOCO IRRIGATION DIST.
SYSTEMS OPTIMIZATION REVIEW

LYTLE CREEK - PUMP-BACK PUMPING PLANT
DISCHARGE MAIN PLAN AND PROFILE

BLACK ROCK CONSULTING

01.30.2012

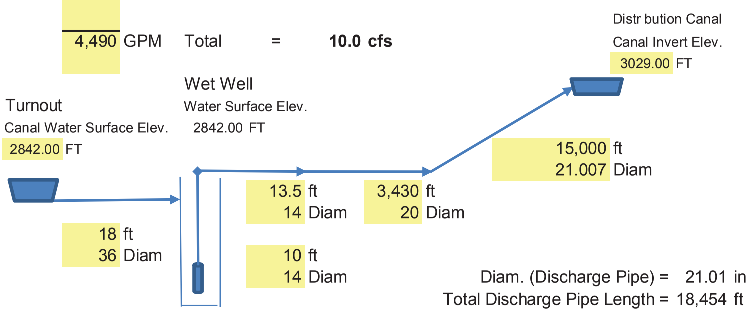
FIG. A

Pump to Canal Head Loss Calculations
Lytle Creek Pump-back Pumping Plant - 10 CFS

4,490 GPM Vertical Turbine Pump No. 1

Static Head = 187.00 FT

4,490 GPM Total = **10.0 cfs**



Diam. (Discharge Pipe) = 21.01 in
Total Discharge Pipe Length = 18,454 ft
Equiv. Pipe Length Valves & Fittings Pump Discharge = 270 ft
Equiv. Pipe Length Valves & Fittings Discharge Header = 10 ft

3.00 ft x 6 ft trash rack to PS Wet Well	Friction Head =	0.27 FT per 1,000 FT	Concrete	
	Dynamic Head =	0.00 FT total	C =	110
14" Column Pipe	Friction Head =	18.17 FT per 1,000 FT	Steel	
(Vel. = 9.4 fps)	Dynamic Head =	0.18 FT total	C =	135
14" Pump Discharge Pipe	Friction Head =	18.17 FT per 1,000 FT	Steel	
(Vel. = 9.4 fps)	Dynamic Head =	0.25 FT total	C =	135
20" Steel Discharge Main	Friction Head =	3.20 FT per 1,000 FT	Steel	
(Vel. = 4.6 fps)	Dynamic Head =	10.99 FT total	C =	135
24" HDPE (21" I.D.) Main	Friction Head =	2.52 FT per 1,000 FT	HDPE	
(Vel. = 4.2 fps)	Dynamic Head =	37.85 FT total	C =	135
Equivalent Pipe Length	Friction Head =	18.17 FT per 1,000 FT	Steel	
Valves & Fittings Pump Discharge	Dynamic Head =	4.91 FT total	C =	135
Equivalent Pipe Length	Friction Head =	3.20 FT per 1,000 FT	Steel	
Valves & Fittings Discharge Main	Dynamic Head =	0.03 FT total	C =	135

Friction Head = 54.21 FT = 23.47 psi

Water Depth in Discharge Canal = 3.00 FT = 1.30 psi

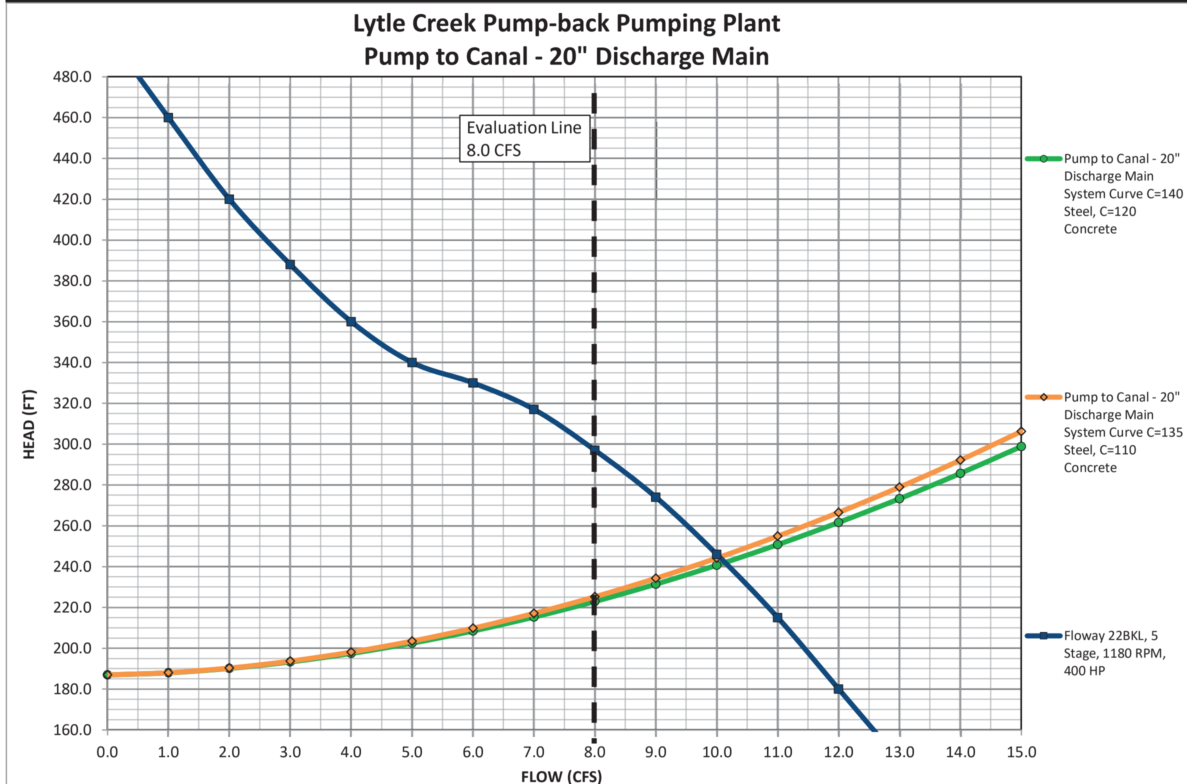
Total Dynamic Head = 244.21 FT = 105.72 psi

Equivalent Pipe Length Totals:

Item	14" Equiv. Length	No. of Units	Total Equiv. Length
14" pump discharge head	90 ft	1 ea	90 ft
14" check valve	130 ft	1 ea	130 ft
14" pump control (butterfly) valve	50 ft	1 ea	50 ft
		Subtotal	270 ft
Item	**20" Equiv. Length**	**No. of Units**	**Total Equiv. Length**
14" x 20" Expander	5 ft	1 ea	5 ft
20" Flap Gate	5 ft	1 ea	5 ft
		Subtotal	10 ft

Lytle Creek Pump-back Pumping Plant
Pump to Canal - 20" Discharge Main System Curve C=135 Steel, C=110 Concrete

Q (gpm)	0	449	898	1,347	1,796	2,245	2,694	3,143	3,592	4,041	4,490	4,939	5,388	5,837	6,286	6,735	7,184	7,633
Q (cfs)	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0
Hf	0.0	1.1	3.4	6.7	11.2	16.5	22.9	30.1	38.3	47.3	57.2	68.0	79.6	92.0	105.2	119.3	134.1	149.8
TDH (ft)	187.0	188.1	190.4	193.7	198.2	203.5	209.9	217.1	225.3	234.3	244.2	255.0	266.6	279.0	292.2	306.3	321.1	336.8
Vel. Disch. (fps)	0.0	0.4	0.8	1.2	1.7	2.1	2.5	2.9	3.3	3.7	4.2	4.6	5.0	5.4	5.8	6.2	6.7	7.1



Floway 22BKL, 5 Stage, 1180 RPM, 400 HP

Q (cfs)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Q (gpm)	0	449	898	1,346	1,795	2,244	2,693	3,142	3,591	4,039	4,488	4,937	5,386	5,835	6,284	6,732	7,181	7,630
Head (ft)	501	460	420	388	360	340	330	317	297	274	246	215	180	145				

Pump Performance Datasheet

Customer	:	Quote number	: 205132
Customer reference	: SOR - Lytle Creek Pump-back	Size	: 22BKL
Item number	: 001	Stages	: 5
Service	: Lytle Creek Pump Back 10 CFS - 20" Discharge Main	Based on curve number	: 22BKL 1180
Quantity	: 1	Date last saved	: 12 Jan 2012 2:54 PM

Operating Conditions

Flow, rated	: 4,490.0 USgpm
Differential head / pressure, rated (requested)	: 245.0 ft
Differential head / pressure, rated (actual)	: 246.1 ft
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: 40.94 ft
Frequency	: 60 Hz

Performance

Speed, rated	: 1,180 rpm
Impeller diameter, rated	: 12.50 in
Impeller diameter, maximum	: 12.50 in
Impeller diameter, minimum	: 11.25 in
Efficiency (bowl / pump)	: 85.44 / 84.54 %
NPSH required / margin required	: 11.82 / 5.00 ft
nq (imp. eye flow) / S (imp. eye flow)	: 77 / 235 Metric units
MCSF	: 1,295.9 USgpm
Head, maximum, rated diameter	: 501.0 ft
Head rise to shutoff	: 102.90 %
Flow, best eff. point (BEP)	: 4,289.0 USgpm
Flow ratio (rated / BEP)	: 104.69 %
Diameter ratio (rated / max)	: 100.00 %
Head ratio (rated dia / max dia)	: 99.54 %
Cq/Ch/Ce [ANSI/HI 9.6.7-2004]	: 1.00 / 1.00 / 1.00
Selection status	: Acceptable

Liquid

Liquid type	: Water - River or Lake, Fresh
Additional liquid description	: Raw Water - Lytle Creek / Rye Grass Canal
Solids diameter, max	: 1.50 in
Solids concentration, by volume	: 0.00 %
Temperature, max	: 68.00 deg F
Fluid density, rated / max	: 1.000 / 1.000 SG
Viscosity, rated	: 1.00 cP
Vapor pressure, rated	: 0.00 psi.a

Material

Material selected	: Cast Iron/Bronze

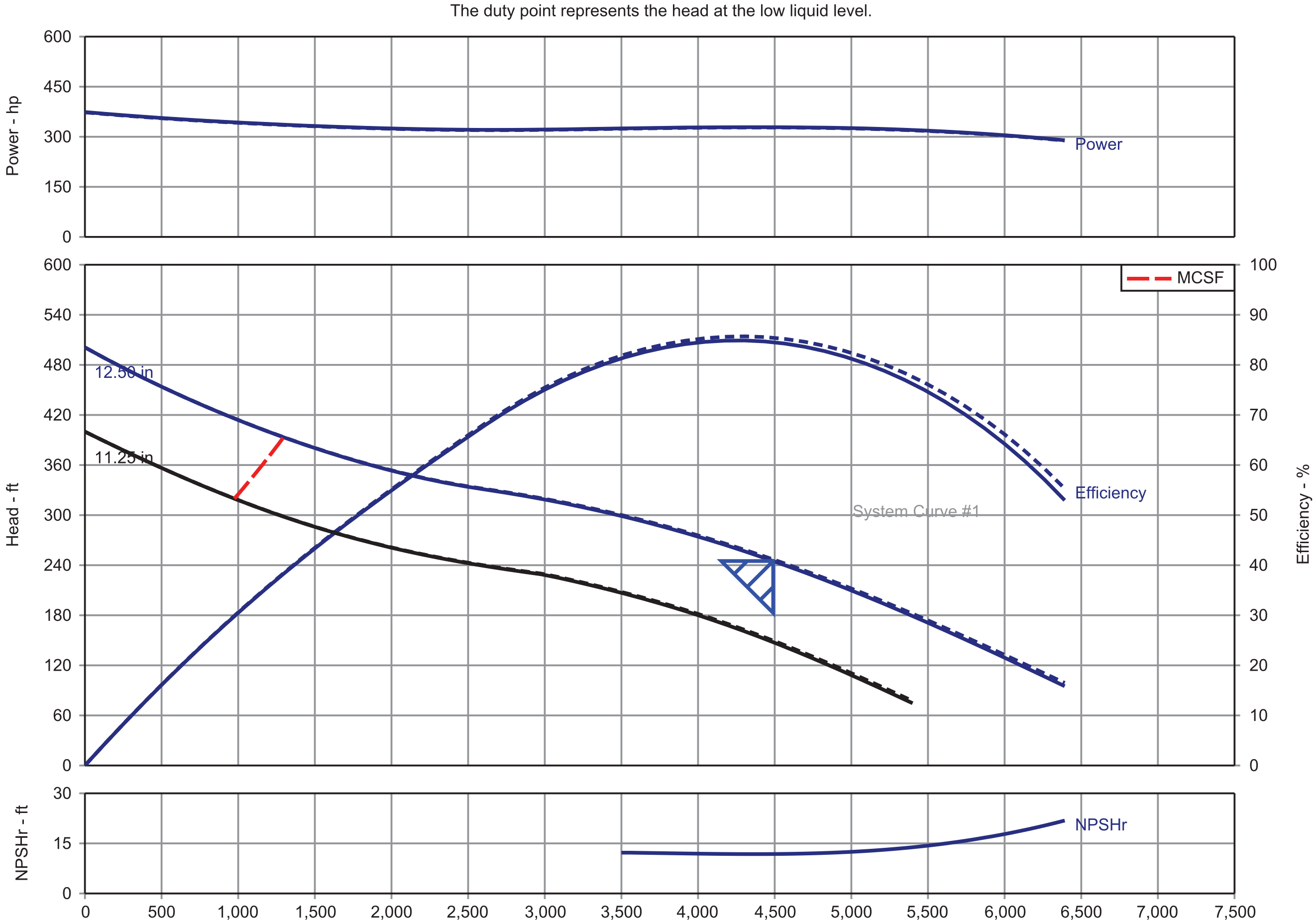
Pressure Data

Maximum working pressure	: 216.9 psi.g
Maximum allowable working pressure	: 261.0 psi.g
Maximum allowable suction pressure	: N/A
Hydrostatic test pressure	: N/A

Driver & Power Data

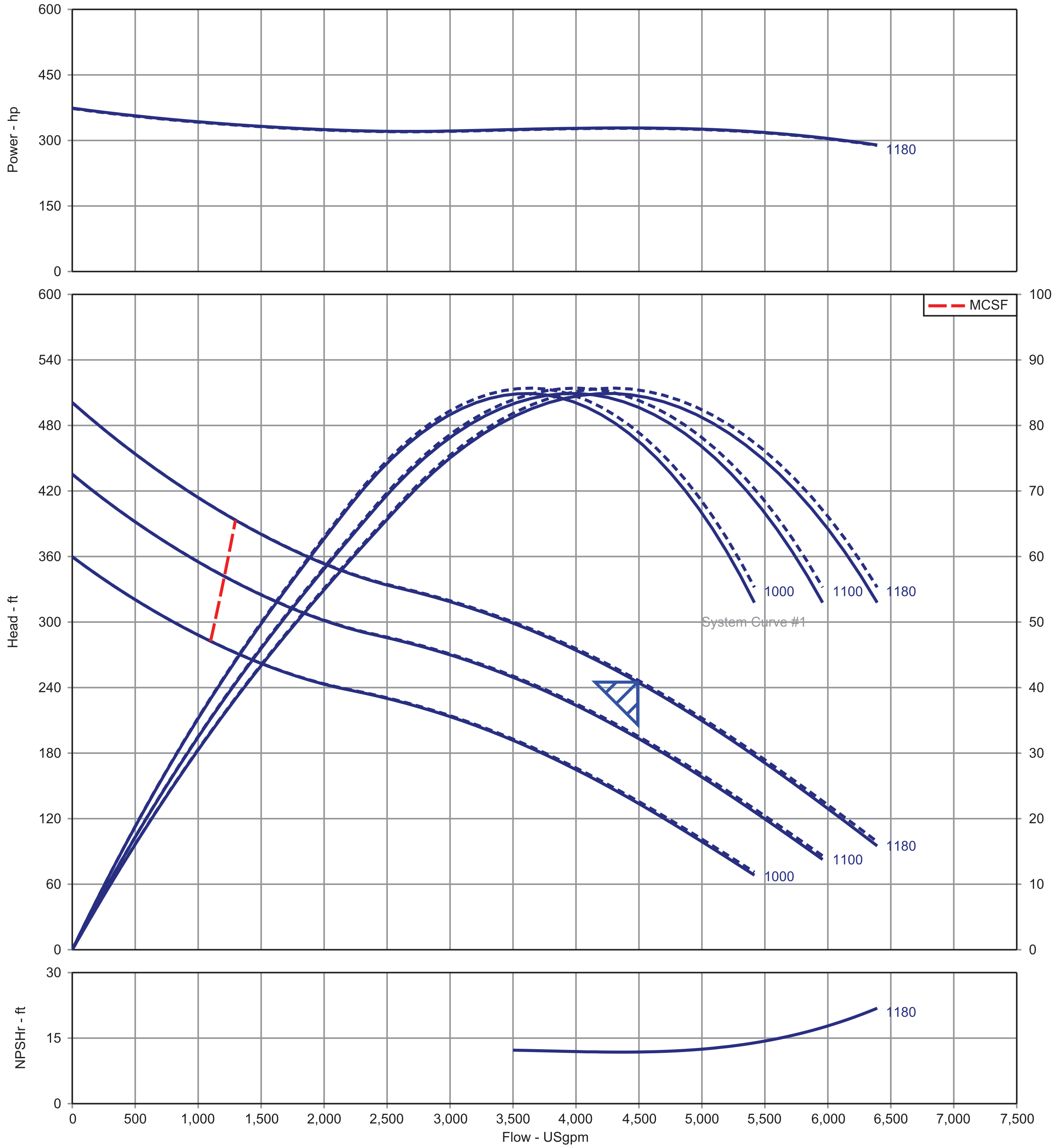
Driver sizing specification	: Max power + 5%
Margin over specification	: 0.00 %
Service factor	: 1.00
Power, hydraulic	: 280 hp
Power (bowl / pump)	: 328 / 329 hp
Power, maximum, rated diameter	: 374 hp
Minimum recommended motor rating	: 400 hp / 298 kW

Pump and bowl (dashed) performance. Bowl adjusted for construction and viscosity.
Pump further adjusted for friction and power losses of lineshaft and thrust bearings. Pump is not adjusted for any static lift.
The duty point represents the head at the low liquid level.



Multi-Speed Performance Curve

Pump and bowl (dashed) performance. Bowl adjusted for construction and viscosity.
Pump further adjusted for friction and power losses of lineshaft and thrust bearings. Pump is not adjusted for any static lift.
The duty point represents the head at the low liquid level.



Customer	:	Pump Type	: 22BKL	Quote number	: 205132
Address	: , ,	# of Stages	: 5	Customer PO #	:
Location	:	Quantity	: 1	CO #	:
Project	: SOR - Lytle Creek Pump-back	Flow	: 4,490.0 USgpm	Item #	: 001
Tag	:	Head	: 245.0 ft	JOL #	:
Bowl/Pump	:	Speed	: 1,180 rpm	Serial #	:
Eff (bowl / pump)	: 85.44 / 84.54 %	Fluid Density	: 1.000 / 1.000 SG	Drawing #	:
Power (bowl / pump)	: 328 / 329 hp	Viscosity	: 1.00 cP	Drawn By	:
NPSH required	: 11.82 ft	Impeller Trim	: 12.50 in	Last Modified	: 12 Jan 2012 2:54 PM

The head and power may be different than that shown in accordance with Hydraulic Institute / API 610 Standards

Additional Notes:

Ochoco Irrigation District - System Optimization Review
Lytle Creek Pump-back Pumping Plant (Construction of New Facilities, 10 CFS, 20-inch HDPE Discharge Main)
Budget Level - Projection of Probable Construction Cost

Item No.	Spec Division	Description	Measurement	Units	Unit Cost	Total Cost
1	0000	Easement Procurement	Acre	13	$3,000.00	$39,000.00
2	1000	Mobilization	LS	1	$78,000.00	$78,000.00
3	1000	Erosion Control	LS	1	$15,000.00	$15,000.00
4	1000	Watering / Dust Control	LS	1	$5,000.00	$5,000.00
5	1000	Construction Staking	LS	1	$12,500.00	$12,500.00
6	1000	Project Management and Coordination	LS	1	$15,000.00	$15,000.00
7	1000	Construction Progress Documentation	LS	1	$7,500.00	$7,500.00
8	1000	Submittal Procedures	LS	1	$7,500.00	$7,500.00
9	1000	Quality Requirements	LS	1	$10,000.00	$10,000.00
10	1000	Selective Demolition	LS	1	$10,000.00	$10,000.00
11	1000	Traffic Control	LS	1	$5,000.00	$5,000.00
12	1000	Project Record Documents	LS	1	$7,500.00	$7,500.00
13	1000	Operations and Maintenance Data	LS	1	$7,500.00	$7,500.00
14	1000	General Commissioning Requirements	LS	1	$7,500.00	$7,500.00
15	2000	Erosion Control Silt Fence	LF	5,000	$2.40	$12,000.00
16	2000	Perimeter Fence, 8 ft coated wire chain link	LF	120	$18.00	$2,160.00
17	2000	Fence Gate	LS	1	$2,500.00	$2,500.00
18	2000	Dewatering	LS	1	$2,500.00	$2,500.00
19	2000	Bulk Excavation	CY	220	$7.00	$1,540.00
20	2000	Hauling	CY	2,370	$12.00	$28,440.00
21	2000	Trench Excavation, 5-8 ft depth trench box	CY	17,090	$7.00	$119,630.00
22	2000	Structural Backfill	CY	50	$38.00	$1,900.00
23	2000	Trench Backfilling	CY	14,940	$3.10	$46,314.00
24	2000	Bore and Jack 28" Steel Casing	LF	60	$190.00	$11,400.00
25	2000	Aggregate Base	CY	10	$38.00	$380.00
26	2000	Surfacing Rock	CY	100	$38.00	$3,800.00
27	2000	AC Pavement Reconstruction	SY	75	$75.00	$5,625.00
28	2000	Access Manhole	EA	18	$7,500.00	$135,000.00
29	2000	Restoration Seeding	AC	13	$1,500.00	$19,500.00
30	3000	Cast-in-Place Concrete	CY	20	$550.00	$11,000.00
31	3000	Misc Cast-in-Place Concrete (thrust and pads)	LS	1	$5,500.00	$5,500.00
32	6000	Handrail	LS	1	$250.00	$250.00
33	6000	Trash Rack	LS	1	$5,000.00	$5,000.00
34	9000	High Performance Coating Systems	LS	1	$5,000.00	$5,000.00
35	11000	Air Release / Vacuum Relief Stations	EA	2	$20,000.00	$40,000.00
36	11000	Line Shaft Turbine Pump and Motor, 400 HP	EA	1	$107,800.00	$107,800.00
37	15000	20-inch Steel Discharge Pipe, poly x poly, welded	LF	3,430	$60.40	$207,172.00
38	15000	24-inch IPS HDPE, DR17 Discharge Pipe, welded	LF	15,000	$60.40	$906,000.00
39	15000	14-inch Discharge Pipe, Fittings, & Accessories	EA	1	$5,000.00	$5,000.00
40	15000	14-inch Butterfly Valve	EA	1	$2,500.00	$2,500.00
41	15000	14-inch Surge Control Check Valve	EA	1	$9,375.00	$9,375.00
42	15000	Flap Gate	EA	1	$6,000.00	$6,000.00
43	16000	Power and Distribution	LS	1	$25,000.00	$25,000.00
44	16000	Grounding Systems	LS	1	$3,000.00	$3,000.00
45	16000	Motor Controls including VFD Driver	LS	1	$25,000.00	$25,000.00
46	17000	Instrumentation and Control	LS	1	$15,000.00	$15,000.00
		Construction Subtotal				$1,959,286.00
		Contractors Overhead and Profit	10%	1	$195,928.60	$195,928.60
		Contractors Bonds and Insurance	2%	1	$43,104.29	$43,104.29
		Construction Contingency	30%	1	$587,785.80	$587,785.80
		Construction Total				$2,786,104.69
		Engineering, Administration	25%	1	$696,526.17	
		Total				**$3,482,630.87**

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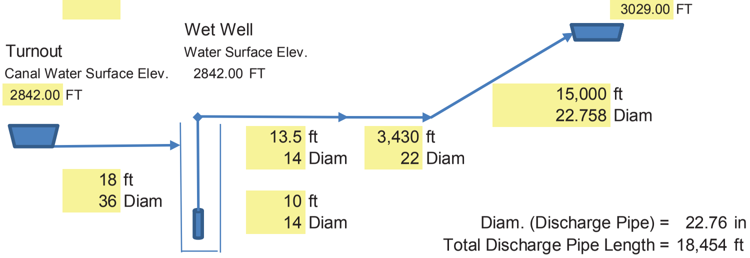
Pump to Canal Head Loss Calculations
Lytle Creek Pump-back Pumping Plant - 10 CFS

4,490 GPM Vertical Turbine Pump No. 1

Static Head = 187.00 FT

4,490 GPM Total = **10.0 cfs**



Diam. (Discharge Pipe) = 22.76 in
Total Discharge Pipe Length = 18,454 ft
Equiv. Pipe Length Valves & Fittings Pump Discharge = 270 ft
Equiv. Pipe Length Valves & Fittings Discharge Header = 10 ft

3.0 ft x 6 ft trash rack to PS Wet Well	Friction Head =	0.27 FT per 1,000 FT	Concrete
	Dynamic Head =	0.00 FT total	C = 110
14" Column Pipe	Friction Head =	18.17 FT per 1,000 FT	Steel
(Vel. = 9.4 fps)	Dynamic Head =	0.18 FT total	C = 135
14" Pump Discharge Piping	Friction Head =	18.17 FT per 1,000 FT	Steel
(Vel. = 9.4 fps)	Dynamic Head =	0.25 FT total	C = 135
22" Steel Discharge Main	Friction Head =	2.02 FT per 1,000 FT	Steel
(Vel. = 3.8 fps)	Dynamic Head =	6.91 FT total	C = 135
26" HDPE (22.758" I.D.) Main	Friction Head =	1.71 FT per 1,000 FT	HDPE
(Vel. = 3.5 fps)	Dynamic Head =	25.64 FT total	C = 135
Equivalent Pipe Length	Friction Head =	18.17 FT per 1,000 FT	Steel
Valves & Fittings Pump Discharge	Dynamic Head =	4.91 FT total	C = 135
Equivalent Pipe Length	Friction Head =	2.02 FT per 1,000 FT	Steel
Valves & Fittings Discharge Main	Dynamic Head =	0.02 FT total	C = 135

Friction Head = 37.91 FT = 16.41 psi

Water Depth in Discharge Canal = 3.00 FT = 1.30 psi

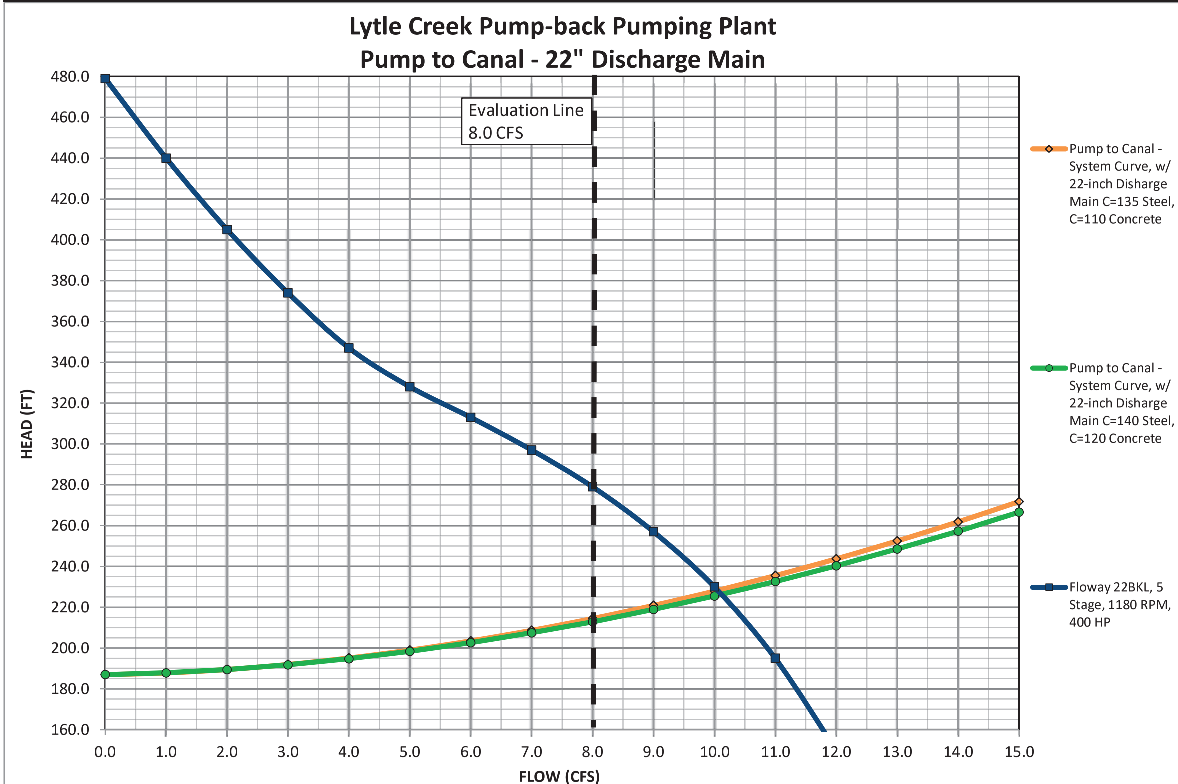
Total Dynamic Head = 227.91 FT = 98.66 psi

Equivalent Pipe Length Totals:

Item	14" Equiv. Length	No. of Units	Total Equiv. Length
14" pump discharge head	90 ft	1 ea	90 ft
14" check valve	130 ft	1 ea	130 ft
14" pump control (butterfly) valve	50 ft	1 ea	50 ft
		Subtotal	270 ft
Item	**22" Equiv. Length**	**No. of Units**	**Total Equiv. Length**
14" x 22" Expander	5 ft	1 ea	5 ft
22" Flap Gate	5 ft	1 ea	5 ft
		Subtotal	10 ft

Lytle Creek Pump-back Pumping Plant
Pump to Canal - System Curve, w/ 22-inch Disharge Main C=135 Steel, C=110 Concrete

Q (gpm)	0	449	898	1,347	1,796	2,245	2,694	3,143	3,592	4,041	4,490	4,939	5,388	5,837	6,286	6,735	7,184	7,633
Q (cfs)	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0
Hf	0.0	0.8	2.5	5.0	8.2	12.0	16.5	21.7	27.5	33.9	40.9	48.5	56.7	65.5	74.8	84.8	95.2	106.3
TDH (ft)	187.0	187.8	189.5	192.0	195.2	199.0	203.5	208.7	214.5	220.9	227.9	235.5	243.7	252.5	261.8	271.8	282.2	293.3
Vel. Disch. (fps)	0.0	0.4	0.7	1.1	1.4	1.8	2.1	2.5	2.8	3.2	3.5	3.9	4.2	4.6	5.0	5.3	5.7	6.0



Floway 22BKL, 5 Stage, 1180 RPM, 400 HP

Q (cfs)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Q (gpm)	0	449	898	1,346	1,795	2,244	2,693	3,142	3,591	4,039	4,488	4,937	5,386	5,835	6,284	6,732	7,181	7,630
Head (ft)	479	440	405	374	347	328	313	297	279	257	230	195	150					

Pump Performance Datasheet

Customer	:	Quote number	: 205132
Customer reference	: SOR - Lytle Creek Pump-back	Size	: 22BKL
Item number	: 001	Stages	: 5
Service	: Lytle Creek Pump Back 10 CFS - 22" Discharge Main	Based on curve number	: 22BKL 1180
Quantity	: 1	Date last saved	: 12 Jan 2012 3:05 PM

Operating Conditions

Flow, rated	: 4,490.0 USgpm
Differential head / pressure, rated (requested)	: 228.0 ft
Differential head / pressure, rated (actual)	: 230.3 ft
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: 40.94 ft
Frequency	: 60 Hz

Performance

Speed, rated	: 1,180 rpm
Impeller diameter, rated	: 12.28 in
Impeller diameter, maximum	: 12.50 in
Impeller diameter, minimum	: 11.25 in
Efficiency (bowl / pump)	: 85.24 / 84.29 %
NPSH required / margin required	: 11.80 / 5.00 ft
nq (imp. eye flow) / S (imp. eye flow)	: 77 / 235 Metric units
MCSF	: 1,235.1 USgpm
Head, maximum, rated diameter	: 479.2 ft
Head rise to shutoff	: 108.44 %
Flow, best eff. point (BEP)	: 4,233.8 USgpm
Flow ratio (rated / BEP)	: 106.05 %
Diameter ratio (rated / max)	: 98.25 %
Head ratio (rated dia / max dia)	: 92.69 %
Cq/Ch/Ce [ANSI/HI 9.6.7-2004]	: 1.00 / 1.00 / 1.00
Selection status	: Acceptable

Liquid

Liquid type	: Water - River or Lake, Fresh
Additional liquid description	: Raw Water - Lytle Creek / Rye Grass Canal
Solids diameter, max	: 1.50 in
Solids concentration, by volume	: 0.00 %
Temperature, max	: 68.00 deg F
Fluid density, rated / max	: 1.000 / 1.000 SG
Viscosity, rated	: 1.00 cP
Vapor pressure, rated	: 0.00 psi.a

Material

Material selected	: Cast Iron/Bronze

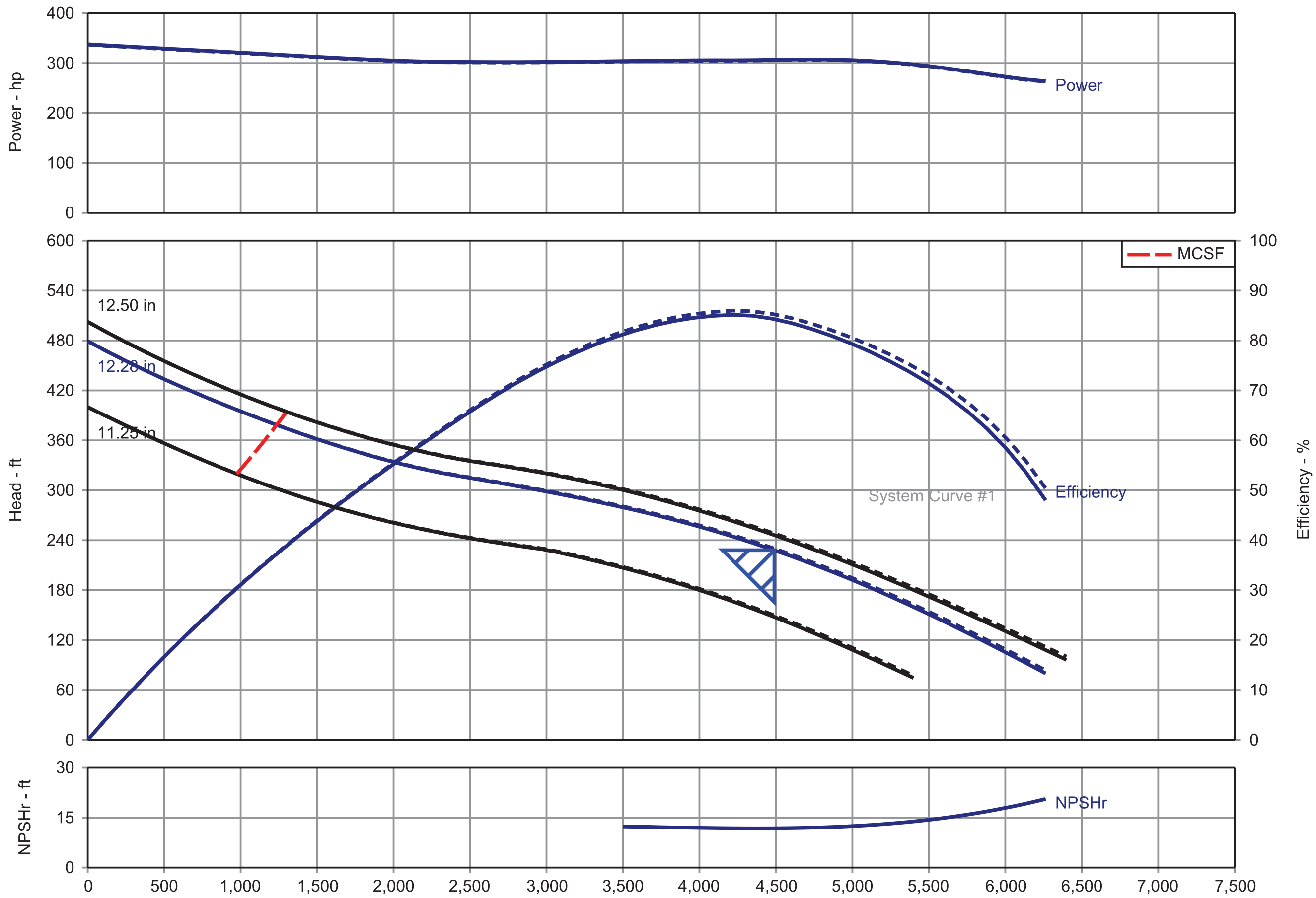
Pressure Data

Maximum working pressure	: 207.5 psi.g
Maximum allowable working pressure	: 261.0 psi.g
Maximum allowable suction pressure	: N/A
Hydrostatic test pressure	: N/A

Driver & Power Data

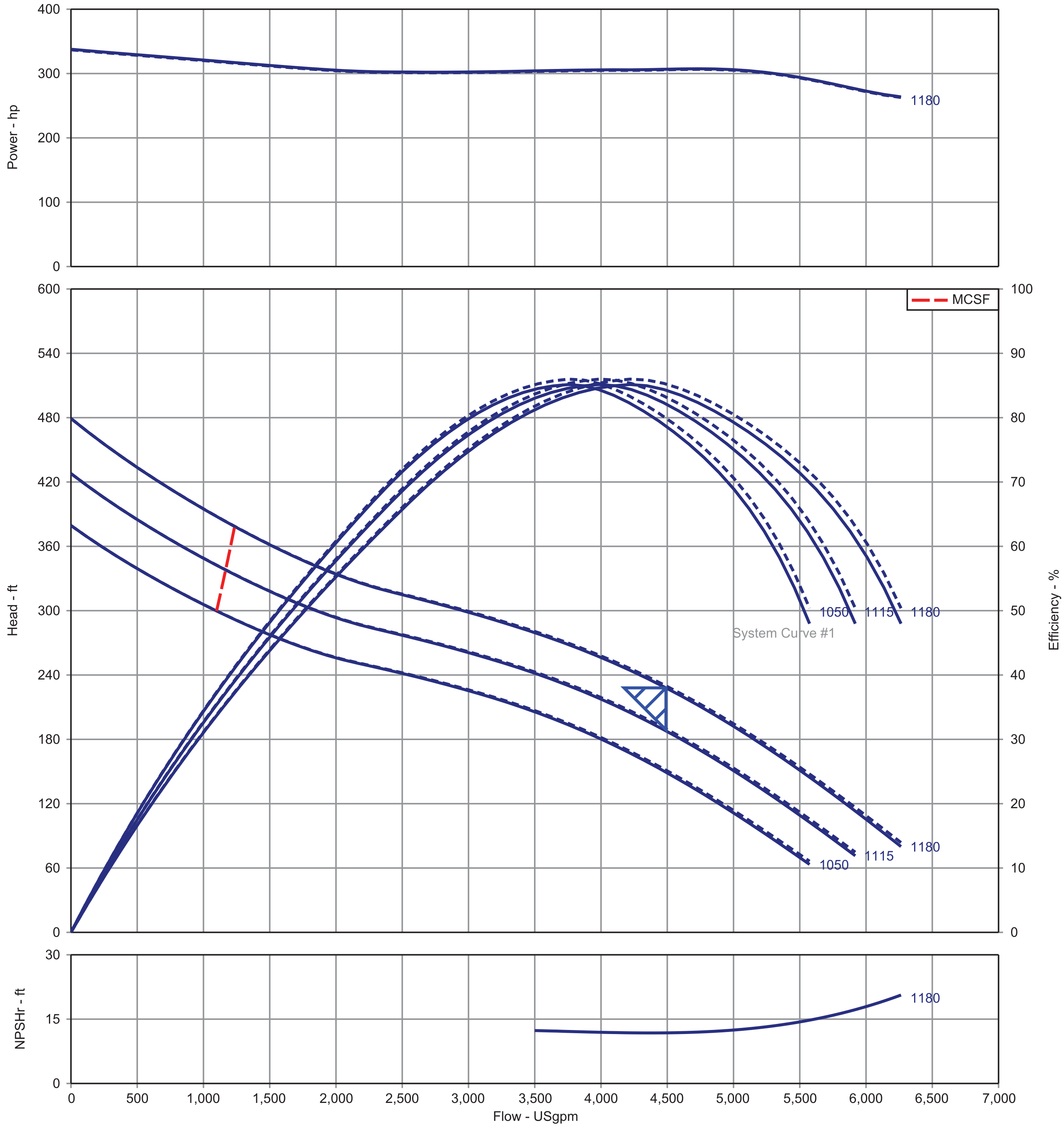
Driver sizing specification	: Max power + 5%
Margin over specification	: 0.00 %
Service factor	: 1.00
Power, hydraulic	: 261 hp
Power (bowl / pump)	: 306 / 307 hp
Power, maximum, rated diameter	: 338 hp
Minimum recommended motor rating	: 400 hp / 298 kW

Pump and bowl (dashed) performance. Bowl adjusted for construction and viscosity.
Pump further adjusted for friction and power losses of lineshaft and thrust bearings. Pump is not adjusted for any static lift.
The duty point represents the head at the low liquid level.



Multi-Speed Performance Curve

Pump and bowl (dashed) performance. Bowl adjusted for construction and viscosity.
Pump further adjusted for friction and power losses of lineshaft and thrust bearings. Pump is not adjusted for any static lift.
The duty point represents the head at the low liquid level.



Customer	:	Pump Type	: 22BKL	Quote number	: 205132
Address	: , ,	# of Stages	: 5	Customer PO #	:
Location	:	Quantity	: 1	CO #	:
Project	: SOR - Lytle Creek Pump-back	Flow	: 4,490.0 USgpm	Item #	: 001
Tag	:	Head	: 228.0 ft	JOL #	:
Bowl/Pump	:	Speed	: 1,180 rpm	Serial #	:
Eff (bowl / pump)	: 85.24 / 84.29 %	Fluid Density	: 1.000 / 1.000 SG	Drawing #	:
Power (bowl / pump)	: 306 / 307 hp	Viscosity	: 1.00 cP	Drawn By	:
NPSH required	: 11.80 ft	Impeller Trim	: 12.28 in	Last Modified	: 12 Jan 2012 3:05 PM

The head and power may be different than that shown in accordance with Hydraulic Institute / API 610 Standards

Additional Notes:

Ochoco Irrigation District - System Optimization Review
Lytle Creek Pump-back Pumping Plant (Construction of New Facilities, 10 CFS, 22-inch HDPE Discharge Main)
Budget Level - Projection of Probable Construction Cost

Item No.	Spec Division	Description	Measurement	Units	Unit Cost	Total Cost
1	0000	Easement Procurement	Acre	13	$3,000.00	$39,000.00
2	1000	Mobilization	LS	1	$87,000.00	$87,000.00
3	1000	Erosion Control	LS	1	$15,000.00	$15,000.00
4	1000	Watering / Dust Control	LS	1	$5,000.00	$5,000.00
5	1000	Construction Staking	LS	1	$12,500.00	$12,500.00
6	1000	Project Management and Coordination	LS	1	$15,000.00	$15,000.00
7	1000	Construction Progress Documentation	LS	1	$7,500.00	$7,500.00
8	1000	Submittal Procedures	LS	1	$7,500.00	$7,500.00
9	1000	Quality Requirements	LS	1	$10,000.00	$10,000.00
10	1000	Selective Demolition	LS	1	$10,000.00	$10,000.00
11	1000	Traffic Control	LS	1	$5,000.00	$5,000.00
12	1000	Project Record Documents	LS	1	$7,500.00	$7,500.00
13	1000	Operations and Maintenance Data	LS	1	$7,500.00	$7,500.00
14	1000	General Commissioning Requirements	LS	1	$7,500.00	$7,500.00
15	2000	Erosion Control Silt Fence	LF	5,000	$2.40	$12,000.00
16	2000	Perimeter Fence, 8 ft coated wire chain link	LF	120	$18.00	$2,160.00
17	2000	Fence Gate	LS	1	$2,500.00	$2,500.00
18	2000	Dewatering	LS	1	$2,500.00	$2,500.00
19	2000	Bulk Excavation	CY	220	$7.00	$1,540.00
20	2000	Hauling	CY	2,740	$12.00	$32,880.00
21	2000	Trench Excavation, 5-8 ft depth trench box	CY	18,245	$7.00	$127,715.00
22	2000	Structural Backfill	CY	50	$38.00	$1,900.00
23	2000	Trench Backfilling	CY	15,725	$3.10	$48,747.50
24	2000	Bore and Jack 30" Steel Casing	LF	60	$200.00	$12,000.00
25	2000	Aggregate Base	CY	10	$38.00	$380.00
26	2000	Surfacing Rock	CY	100	$38.00	$3,800.00
27	2000	AC Pavement Reconstruction	SY	75	$75.00	$5,625.00
28	2000	Access Manhole	EA	18	$7,500.00	$135,000.00
29	2000	Restoration Seeding	AC	13	$1,500.00	$19,500.00
30	3000	Cast-in-Place Concrete	CY	20	$550.00	$11,000.00
31	3000	Misc Cast-in-Place Concrete (thrust and pads)	LS	1	$5,500.00	$5,500.00
32	6000	Handrail	LS	1	$250.00	$250.00
33	6000	Trash Rack	LS	1	$5,000.00	$5,000.00
34	9000	High Performance Coating Systems	LS	1	$5,000.00	$5,000.00
35	11000	Air Release / Vacuum Relief Stations	EA	2	$20,000.00	$40,000.00
36	11000	Line Shaft Turbine Pump and Motor, 400 HP	EA	1	$107,800.00	$107,800.00
37	15000	20-inch Steel Discharge Pipe, poly x poly, welded	LF	3,430	$70.96	$243,392.80
38	15000	26-inch IPS HDPE, DR17 Discharge Pipe, welded	LF	15,000	$70.96	$1,064,400.00
39	15000	14-inch Discharge Pipe, Fittings, & Accessories	EA	1	$5,000.00	$5,000.00
40	15000	14-inch Butterfly Valve	EA	1	$2,500.00	$2,500.00
41	15000	14-inch Surge Control Check Valve	EA	1	$9,375.00	$9,375.00
42	15000	Flap Gate	EA	1	$6,000.00	$6,000.00
43	16000	Power and Distribution	LS	1	$25,000.00	$25,000.00
44	16000	Grounding Systems	LS	1	$3,000.00	$3,000.00
45	16000	Motor Controls including VFD Driver	LS	1	$25,000.00	$25,000.00
46	17000	Instrumentation and Control	LS	1	$15,000.00	$15,000.00
		Construction Subtotal				$2,178,465.30
		Contractors Overhead and Profit	10%	1	$217,846.53	$217,846.53
		Contractors Bonds and Insurance	2%	1	$47,926.24	$47,926.24
		Construction Contingency	30%	1	$653,539.59	$653,539.59
		Construction Total				$3,097,777.66
		Engineering, Administration	25%	1	$774,444.41	
		Total				**$3,872,222.07**

VFD Analysis

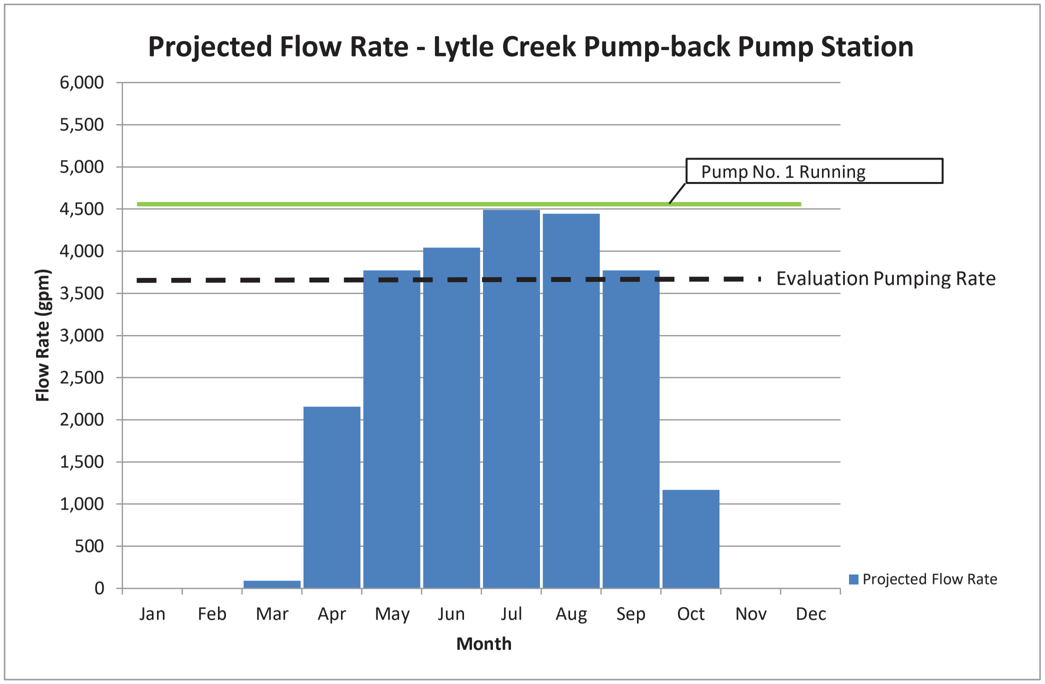
Pump to Canal Head Loss Calculations
Lytle Creek Pump-back Pumping Plant

4,490	GPM	Vertical Turbine Pump No. 1		
4,490	GPM	Total	=	**10.0 cfs**

Proposed PS Design Flow Rate = 4,490 gpm

Month	% of Max Flow Rate	Projected Flow Rate
Jan	0%	0
Feb	0%	0
Mar	2%	90
Apr	48%	2,155
May	84%	3,772
Jun	90%	4,041
Jul	100%	4,490
Aug	99%	4,445
Sep	84%	3,772
Oct	26%	1,167
Nov	0%	0
Dec	0%	0

Evaluation Pumping Rate = 3,588 gpm
8.0 cfs



Notes: The Lytle Creek Pump-back Pumping Plant rated at 10 CFS capacity includes (1) Turbine Pump as proposed. To optimize water delivery to crop requirement and reduce energy use, VFD operation of Pump No. 1 would provide benefit.

Wire to Water Energy Calculator

Ochoco Irrigation District - SOR

Lytle Creek Pump-back Pumping Plant - 10 CFS

Source: PumpTech Inc.

2425 SE Ochoco Street

Portland, OR 97222

503-659-6230

OPERATIONAL AND EQUIPMENT DATA

	22" Discharge Main		20" Discharge Main	
	No. 1 - Weir Floway 22BKL, 5 Stage, 1180 RPM, 400 HP		No. 1 - Weir Floway 22BKL, 5 Stage, 1180 RPM, 400 HP	
Discharge Main Length	18,430		18,430	
Pump Operation - Hours / Day	24		24	
Pump Operation - Days / Year	198		198	
Pump Flow - GPM (Evaluation Pump Rate)	3,588		3,588	
Pump Flow - CFS	8.0		8.0	
Total Annual Volume - Acre feet	3,140		3,140	
Pump Head - Feet	213.0	*	225.0	*
Ave. Pump Efficiency - %	84.3%	**	84.5%	**
Ave. Motor Efficiency - %	93.0%	***	93.0%	***
Energy Cost in $/kW-hr	$0.035		$0.035	

* Pump head based on system curve for evaluation pumping rate using the stated discharge main diameter.

** Pump efficiency based on published pump efficiency selected units operating at rated capacity and head.

*** Motor efficiency base on use of premium efficiency induction type motors with a 93% efficiency rating.

RESULTS

	22" Discharge Main	20" Discharge Main
BHP At Design Point	228.9	241.3
Wire to Water Efficiency - %	78.4%	78.6%
kW-hr per Year	872,653	919,635
Annual Energy Cost	$30,542.86	$32,187.22
kW-hr Per 1,000 Gallons Pumped	0.853	0.899
Cost Per 1,000 Gallons Pumped	$0.030	$0.031
kW-hr per Acre Foot Pumped	278	293
Cost Per Acre Foot Pumped	$9.73	$10.25

PAYBACK

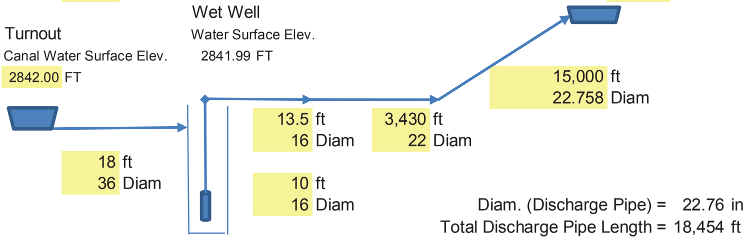
Annual Savings with use of larger pipe - kW-hr			46,982	
Annual Savings with use of larger pipe - $$			$1,644.36	
Annual Savings with use of larger pipe - %			5.11%	
Cost of 22-inch Discharge Main	$60.96	(cost / lf raw material)	$1,123,492.80	
Cost of 20-inch Discharge Main	$50.40	(cost / lf raw material)	$928,872.00	
Payback with use of larger pipe - Years			118.4	
Total Cost of Pumping Plant		$3,872,000.00 *	$3,483,000.00	*

* Estimated cost of pumping plant construction complete including (1) pump and VFD driver.

Pump to Canal Head Loss Calculations
Lytle Creek Pump-back Pumping Plant - 15 CFS

6,730 GPM	Vertical Turbine Pump No. 1	
6,730 GPM	Total =	**15.0 cfs**

Static Head = 187.00 FT



Diam. (Discharge Pipe) = 22.76 in
Total Discharge Pipe Length = 18,454 ft
Equiv. Pipe Length Valves & Fittings Pump Discharge = 325 ft
Equiv. Pipe Length Valves & Fittings Discharge Main = 10 ft

3.0 ft x 6 ft trash rack to PS Wet Well	Friction Head = 0.57 FT per 1,000 FT	Concrete
	Dynamic Head = 0.01 FT total	C = 110
16" Column Pipe	Friction Head = 20.07 FT per 1,000 FT	Steel
(Vel. = 10.7 fps)	Dynamic Head = 0.20 FT total	C = 135
16" Pump Discharge Piping	Friction Head = 20.07 FT per 1,000 FT	Steel
(Vel. = 10.7 fps)	Dynamic Head = 0.27 FT total	C = 135
22" Steel Discharge Main	Friction Head = 4.26 FT per 1,000 FT	Steel
(Vel. = 5.7 fps)	Dynamic Head = 14.62 FT total	C = 135
26" HDPE (22.758" I.D.) Main	Friction Head = 3.61 FT per 1,000 FT	HDPE
(Vel. = 5.3 fps)	Dynamic Head = 54.21 FT total	C = 135
Equivalent Pipe Length	Friction Head = 20.07 FT per 1,000 FT	Steel
Valves & Fittings Pump Discharge	Dynamic Head = 6.52 FT total	C = 135
Equivalent Pipe Length	Friction Head = 4.26 FT per 1,000 FT	Steel
Valves & Fittings Discharge Main	Dynamic Head = 0.04 FT total	C = 135

Friction Head = 75.86 FT = 32.84 psi

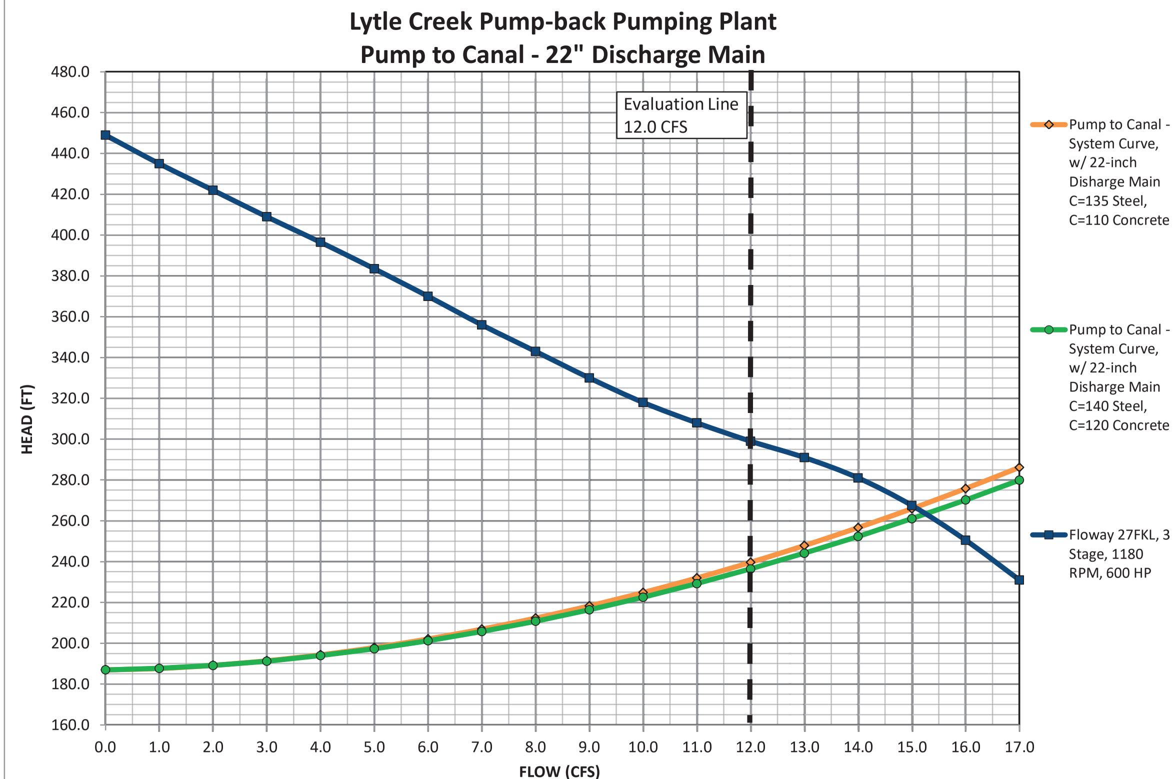
Water Depth in Discharge Canal = 3.00 FT = 1.30 psi

Total Dynamic Head = 265.87 FT = 115.09 psi

Equivalent Pipe Length Totals:			
Item	16" Equiv. Length	No. of Units	Total Equiv. Length
16" pump discharge head	90 ft	1 ea	90 ft
16" check valve	180 ft	1 ea	180 ft
16" pump control (butterfly) valve	55 ft	1 ea	55 ft
		Subtotal	325 ft
Item	22" Equiv. Length	No. of Units	Total Equiv. Length
16"x22" Expander	5 ft	1 ea	5 ft
22" Flap Gate	5 ft	1 ea	5 ft
		Subtotal	10 ft

Lytle Creek Pump-back Pumping Plant
Pump to Canal - System Curve, w/ 22-inch Disharge Main C=135 Steel, C=110 Concrete

Q (gpm)	0	449	898	1,347	1,796	2,245	2,694	3,143	3,592	4,041	4,490	4,939	5,388	5,837	6,286	6,735	7,184	7,633
Q (cfs)	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0
Hf	0.0	0.7	2.2	4.5	7.4	11.0	15.1	19.9	25.3	31.3	37.9	45.0	52.7	60.9	69.7	79.0	88.8	99.2
TDH (ft)	187.0	187.7	189.2	191.5	194.4	198.0	202.1	206.9	212.3	218.3	224.9	232.0	239.7	247.9	256.7	266.0	275.8	286.2
Vel. Disch. (fps)	0.0	0.4	0.7	1.1	1.4	1.8	2.1	2.5	2.8	3.2	3.5	3.9	4.2	4.6	5.0	5.3	5.7	6.0



Floway 27FKL, 3 Stage, 1180 RPM, 600 HP																		
Q (cfs)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Q (gpm)	0	449	898	1,346	1,795	2,244	2,693	3,142	3,591	4,039	4,488	4,937	5,386	5,835	6,284	6,732	7,181	7,630
Head (ft)	449	435	422	409	397	384	370	356	343	330	318	308	299	291	281	268	251	231

Pump Performance Datasheet

Customer	:	Quote number	: 205132
Customer reference	: SOR - Lytle Creek Pump-back	Size	: 27FKL
Item number	: 001	Stages	: 3
Service	: Lytle Creek Pump Back 15 CFS - 22" Discharge Main	Based on curve number	: 27FKL 1180
Quantity	: 1	Date last saved	: 12 Jan 2012 3:17 PM

Operating Conditions

Flow, rated	: 6,730.0 USgpm
Differential head / pressure, rated (requested)	: 266.0 ft
Differential head / pressure, rated (actual)	: 267.2 ft
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: 40.94 ft
Frequency	: 60 Hz

Performance

Speed, rated	: 1,180 rpm
Impeller diameter, rated	: 15.88 in
Impeller diameter, maximum	: 16.87 in
Impeller diameter, minimum	: 14.88 in
Efficiency (bowl / pump)	: 85.05 / 83.80 %
NPSH required / margin required	: 24.65 / 5.00 ft
nq (imp. eye flow) / S (imp. eye flow)	: 69 / 174 Metric units
MCSF	: 1,787.3 USgpm
Head, maximum, rated diameter	: 448.5 ft
Head rise to shutoff	: 66.57 %
Flow, best eff. point (BEP)	: 7,478.0 USgpm
Flow ratio (rated / BEP)	: 90.00 %
Diameter ratio (rated / max)	: 94.07 %
Head ratio (rated dia / max dia)	: 84.75 %
Cq/Ch/Ce [ANSI/HI 9.6.7-2004]	: 1.00 / 1.00 / 1.00
Selection status	: Acceptable

Liquid

Liquid type	: Water - River or Lake, Fresh
Additional liquid description	: Raw Water - Lytle Creek / Rye Grass Canal
Solids diameter, max	: 1.50 in
Solids concentration, by volume	: 0.00 %
Temperature, max	: 68.00 deg F
Fluid density, rated / max	: 1.000 / 1.000 SG
Viscosity, rated	: 1.00 cP
Vapor pressure, rated	: 0.00 psi.a

Material

Material selected	: Cast Iron/Bronze

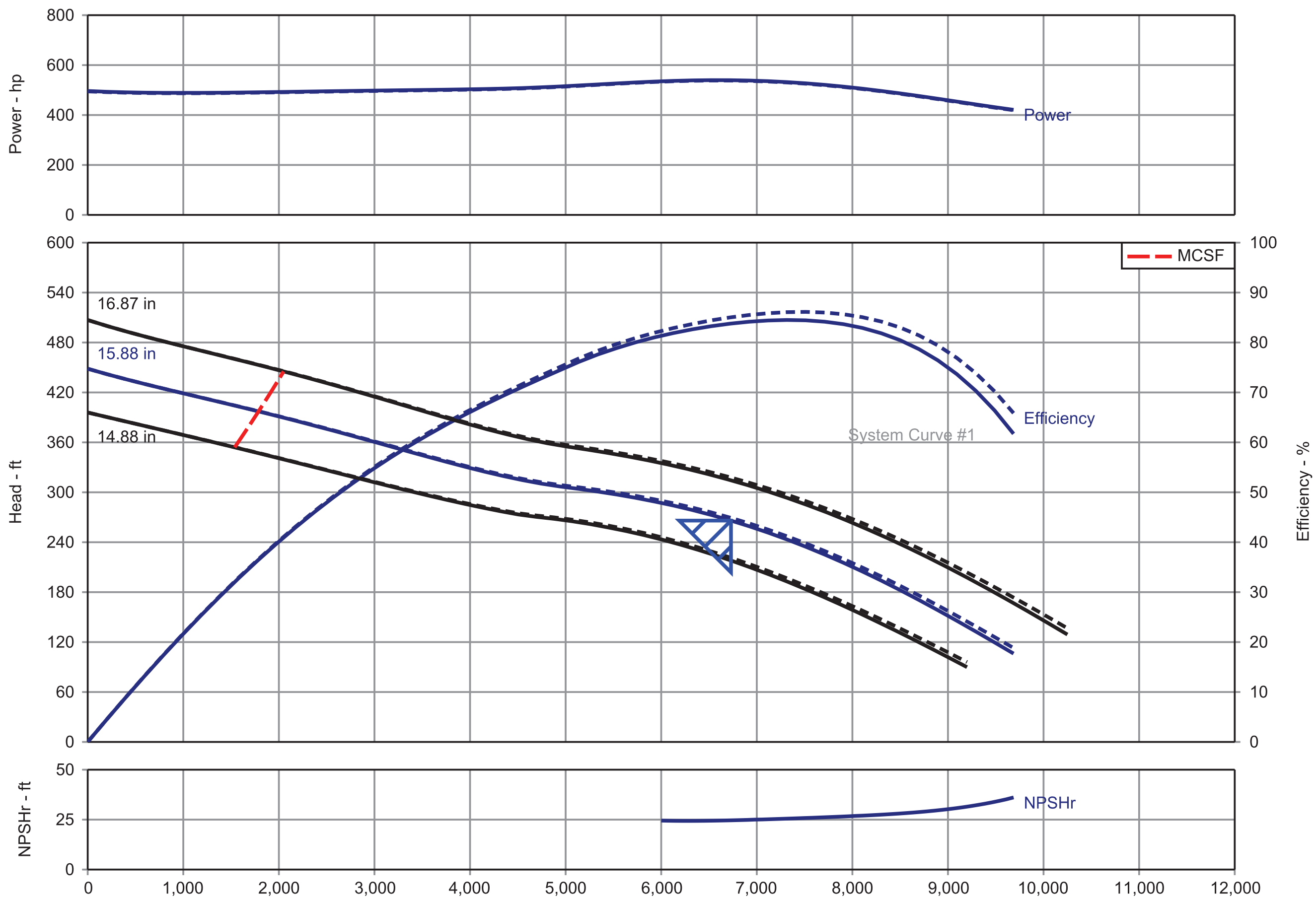
Pressure Data

Maximum working pressure	: 194.1 psi.g
Maximum allowable working pressure	: 309.0 psi.g
Maximum allowable suction pressure	: N/A
Hydrostatic test pressure	: N/A

Driver & Power Data

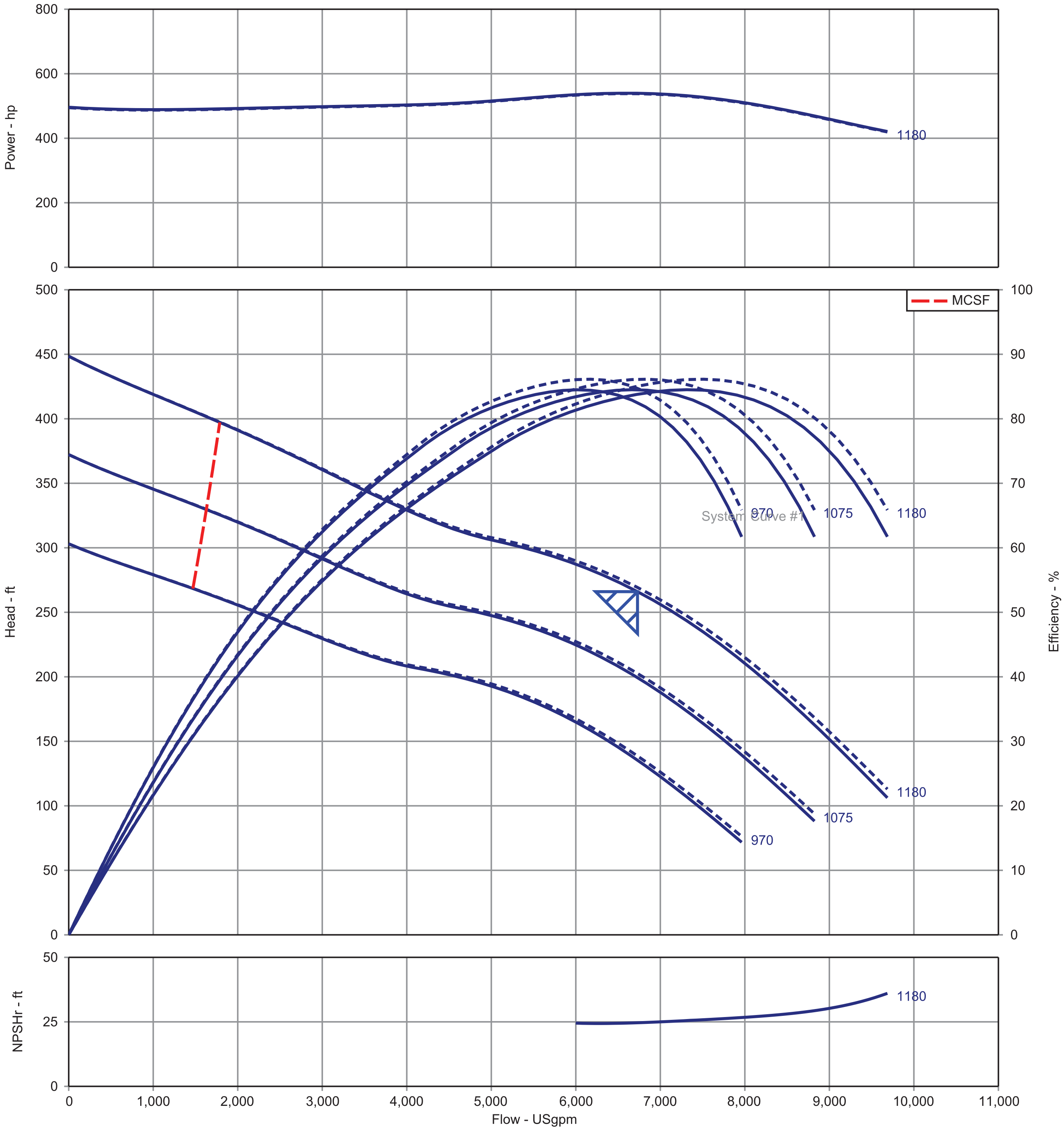
Driver sizing specification	: Max power + 5%
Margin over specification	: 0.00 %
Service factor	: 1.00
Power, hydraulic	: 458 hp
Power (bowl / pump)	: 538 / 539 hp
Power, maximum, rated diameter	: 540 hp
Minimum recommended motor rating	: 600 hp / 447 kW

Pump and bowl (dashed) performance. Bowl adjusted for construction and viscosity.
Pump further adjusted for friction and power losses of lineshaft and thrust bearings. Pump is not adjusted for any static lift.
The duty point represents the head at the low liquid level.



Multi-Speed Performance Curve

Pump and bowl (dashed) performance. Bowl adjusted for construction and viscosity.
Pump further adjusted for friction and power losses of lineshaft and thrust bearings. Pump is not adjusted for any static lift.
The duty point represents the head at the low liquid level.



Customer	:	Pump Type	: 27FKL	Quote number	: 205132
Address	: , ,	# of Stages	: 3	Customer PO #	:
Location	:	Quantity	: 1	CO #	:
Project	: SOR - Lytle Creek Pump-back	Flow	: 6,730.0 USgpm	Item #	: 001
Tag	:	Head	: 266.0 ft	JOL #	:
Bowl/Pump	:	Speed	: 1,180 rpm	Serial #	:
Eff (bowl / pump)	: 85.05 / 83.80 %	Fluid Density	: 1.000 / 1.000 SG	Drawing #	:
Power (bowl / pump)	: 538 / 539 hp	Viscosity	: 1.00 cP	Drawn By	:
NPSH required	: 24.65 ft	Impeller Trim	: 15.88 in	Last Modified	: 12 Jan 2012 3:17 PM

The head and power may be different than that shown in accordance with Hydraulic Institute / API 610 Standards

Additional Notes:

Ochoco Irrigation District - System Optimization Review
Lytle Creek Pump-back Pumping Plant (Construction of New Facilities, 15 CFS, 22-inch HDPE Discharge Main)
Budget Level - Projection of Probable Construction Cost

Item No.	Spec Division	Description	Measurement	Units	Unit Cost	Total Cost
1	0000	Easement Procurement	Acre	13	$3,000.00	$39,000.00
2	1000	Mobilization	LS	1	$89,000.00	$89,000.00
3	1000	Erosion Control	LS	1	$15,000.00	$15,000.00
4	1000	Watering / Dust Control	LS	1	$5,000.00	$5,000.00
5	1000	Construction Staking	LS	1	$12,500.00	$12,500.00
6	1000	Project Management and Coordination	LS	1	$15,000.00	$15,000.00
7	1000	Construction Progress Documentation	LS	1	$7,500.00	$7,500.00
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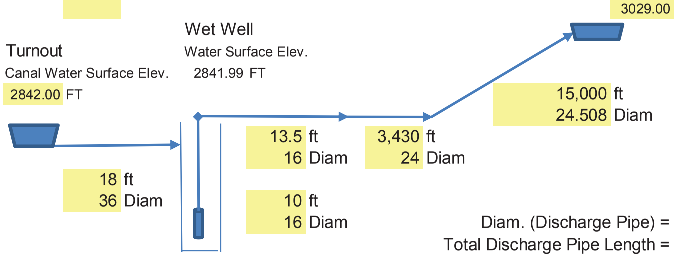
10	1000	Selective Demolition	LS	1	$10,000.00	$10,000.00
11	1000	Traffic Control	LS	1	$5,000.00	$5,000.00
12	1000	Project Record Documents	LS	1	$7,500.00	$7,500.00
13	1000	Operations and Maintenance Data	LS	1	$7,500.00	$7,500.00
14	1000	General Commissioning Requirements	LS	1	$7,500.00	$7,500.00
15	2000	Erosion Control Silt Fence	LF	5,000	$2.40	$12,000.00
16	2000	Perimeter Fence, 8 ft coated wire chain link	LF	120	$18.00	$2,160.00
17	2000	Fence Gate	LS	1	$2,500.00	$2,500.00
18	2000	Dewatering	LS	1	$2,500.00	$2,500.00
19	2000	Bulk Excavation	CY	220	$7.00	$1,540.00
20	2000	Hauling	CY	2,740	$12.00	$32,880.00
21	2000	Trench Excavation, 5-8 ft depth trench box	CY	18,245	$7.00	$127,715.00
22	2000	Structural Backfill	CY	50	$38.00	$1,900.00
23	2000	Trench Backfilling	CY	15,725	$3.10	$48,747.50
24	2000	Bore and Jack 30" Steel Casing	LF	60	$200.00	$12,000.00
25	2000	Aggregate Base	CY	10	$38.00	$380.00
26	2000	Surfacing Rock	CY	100	$38.00	$3,800.00
27	2000	AC Pavement Reconstruction	SY	75	$75.00	$5,625.00
28	2000	Access Manhole	EA	18	$7,500.00	$135,000.00
29	2000	Restoration Seeding	AC	13	$1,500.00	$19,500.00
30	3000	Cast-in-Place Concrete	CY	20	$550.00	$11,000.00
31	3000	Misc Cast-in-Place Concrete (thrust and pads)	LS	1	$5,500.00	$5,500.00
32	6000	Handrail	LS	1	$250.00	$250.00
33	6000	Trash Rack	LS	1	$5,000.00	$5,000.00
34	9000	High Performance Coating Systems	LS	1	$5,000.00	$5,000.00
35	11000	Air Release / Vacuum Relief Stations	EA	2	$20,000.00	$40,000.00
36	11000	Line Shaft Turbine Pump and Motor, 600 HP	EA	1	$157,700.00	$157,700.00
37	15000	22-inch Steel Discharge Pipe, poly x poly, welded	LF	3,430	$70.96	$243,392.80
38	15000	26-inch IPS HDPE, DR17 Discharge Pipe, welded	LF	15,000	$70.96	$1,064,400.00
39	15000	14-inch Discharge Pipe, Fittings, & Accessories	EA	1	$5,000.00	$5,000.00
40	15000	14-inch Butterfly Valve	EA	1	$2,500.00	$2,500.00
41	15000	14-inch Surge Control Check Valve	EA	1	$9,375.00	$9,375.00
42	15000	Flap Gate	EA	1	$6,000.00	$6,000.00
43	16000	Power and Distribution	LS	1	$25,000.00	$25,000.00
44	16000	Grounding Systems	LS	1	$3,000.00	$3,000.00
45	16000	Motor Controls including VFD Driver	LS	1	$25,000.00	$25,000.00
46	17000	Instrumentation and Control	LS	1	$15,000.00	$15,000.00
		Construction Subtotal				$2,230,365.30
		Contractors Overhead and Profit	10%	1	$223,036.53	$223,036.53
		Contractors Bonds and Insurance	2%	1	$49,068.04	$49,068.04
		Construction Contingency	30%	1	$669,109.59	$669,109.59
		Construction Total				$3,171,579.46
		Engineering, Administration	25%	1	$792,894.86	
		Total				**$3,964,474.32**

Pump to Canal Head Loss Calculations
Lytle Creek Pump-back Pumping Plant - 15 CFS

6,730 GPM Vertical Turbine Pump No. 1

Static Head = 187.00 FT

6,730 GPM Total = **15.0 cfs**



Diam. (Discharge Pipe) =	24.51 in
Total Discharge Pipe Length =	18,454 ft
Equiv. Pipe Length Valves & Fittings Pump Discharge =	325 ft
Equiv. Pipe Length Valves & Fittings Discharge Main =	10 ft

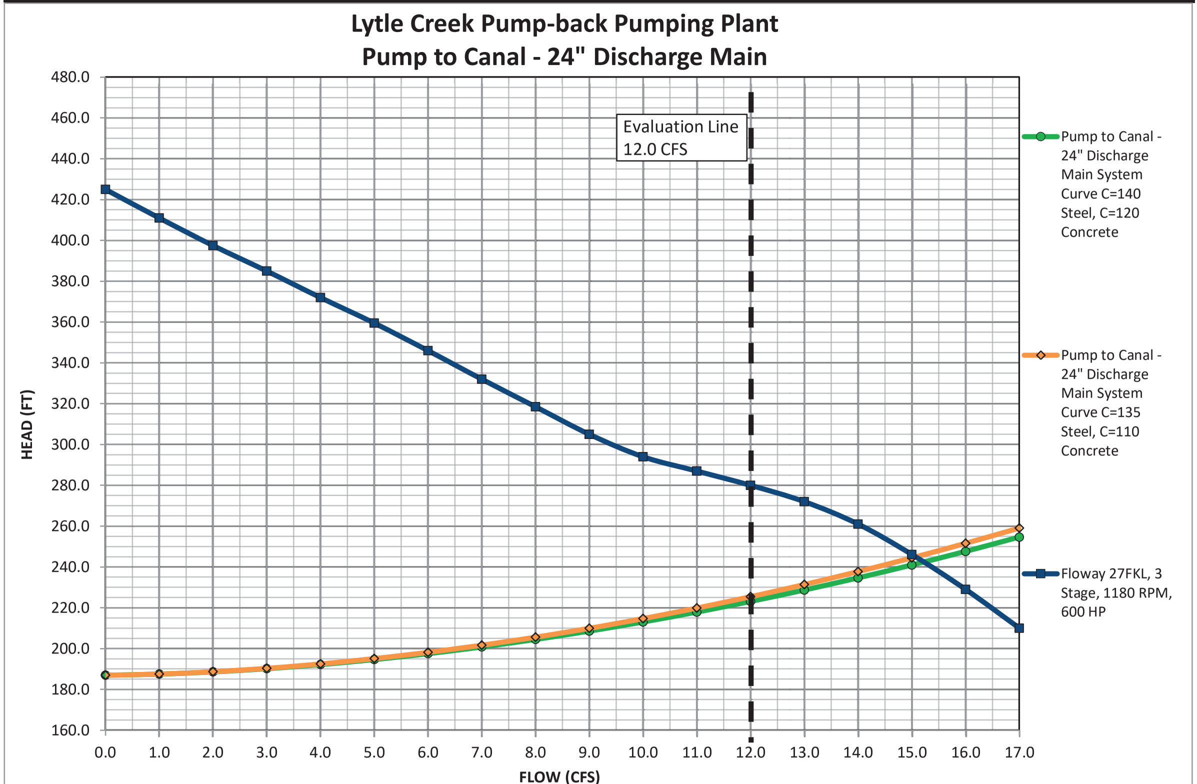
3.00 ft x 6 ft trash rack to PS Wet Well	Friction Head =	0.57 FT per 1,000 FT		Concrete
	Dynamic Head =	0.01 FT total		C = 110
16" Column Pipe	Friction Head =	20.07 FT per 1,000 FT		Steel
(Vel. = 10.7 fps)	Dynamic Head =	0.20 FT total		C = 135
16" Pump Discharge Pipe	Friction Head =	20.07 FT per 1,000 FT		Steel
(Vel. = 10.7 fps)	Dynamic Head =	0.27 FT total		C = 135
24" Steel Discharge Main	Friction Head =	2.79 FT per 1,000 FT		Steel
(Vel. = 4.8 fps)	Dynamic Head =	9.57 FT total		C = 135
28" HDPE (24.508" I.D.) Main	Friction Head =	2.52 FT per 1,000 FT		HDPE
(Vel. = 4.6 fps)	Dynamic Head =	37.80 FT total		C = 135
Equivalent Pipe Length	Friction Head =	20.07 FT per 1,000 FT		Steel
Valves & Fittings Pump Discharge	Dynamic Head =	6.52 FT total		C = 135
Equivalent Pipe Length	Friction Head =	2.79 FT per 1,000 FT		Steel
Valves & Fittings Discharge Main	Dynamic Head =	0.03 FT total		C = 135
	Friction Head =	54.39 FT =	23.55 psi	
	Water Depth in Discharge Canal =	3.00 FT =	1.30 psi	
	Total Dynamic Head =	244.40 FT =	105.80 psi	

Equivalent Pipe Length Totals:

Item	16" Equiv. Length	No. of Units	Total Equiv. Length
16" pump discharge head	90 ft	1 ea	90 ft
16" check valve	180 ft	1 ea	180 ft
16" pump control (gate) valve	55 ft	1 ea	55 ft
		Subtotal	325 ft
Item	**24" Equiv. Length**	**No. of Units**	**Total Equiv. Length**
16"x24" expander	5 ft	1 ea	5 ft
24" Flap Gate	5 ft	1 ea	5 ft

Lytle Creek Pump-back Pumping Plant
Pump to Canal - 24" Discharge Main System Curve C=135 Steel, C=110 Concrete

Q (gpm)	0	449	898	1,347	1,796	2,245	2,694	3,143	3,592	4,041	4,490	4,939	5,388	5,837	6,286	6,735	7,184	7,633
Q (cfs)	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0
Hf	0.0	0.6	1.7	3.4	5.5	8.1	11.2	14.7	18.6	23.0	27.7	32.9	38.5	44.4	50.8	57.5	64.6	72.1
TDH (ft)	187.0	187.6	188.7	190.4	192.5	195.1	198.2	201.7	205.6	210.0	214.7	219.9	225.5	231.4	237.8	244.5	251.6	259.1
Vel. Disch. (fps)	0.0	0.3	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3.1	3.4	3.7	4.0	4.3	4.6	4.9	5.2



Floway 27FKL, 3 Stage, 1180 RPM, 600 HP

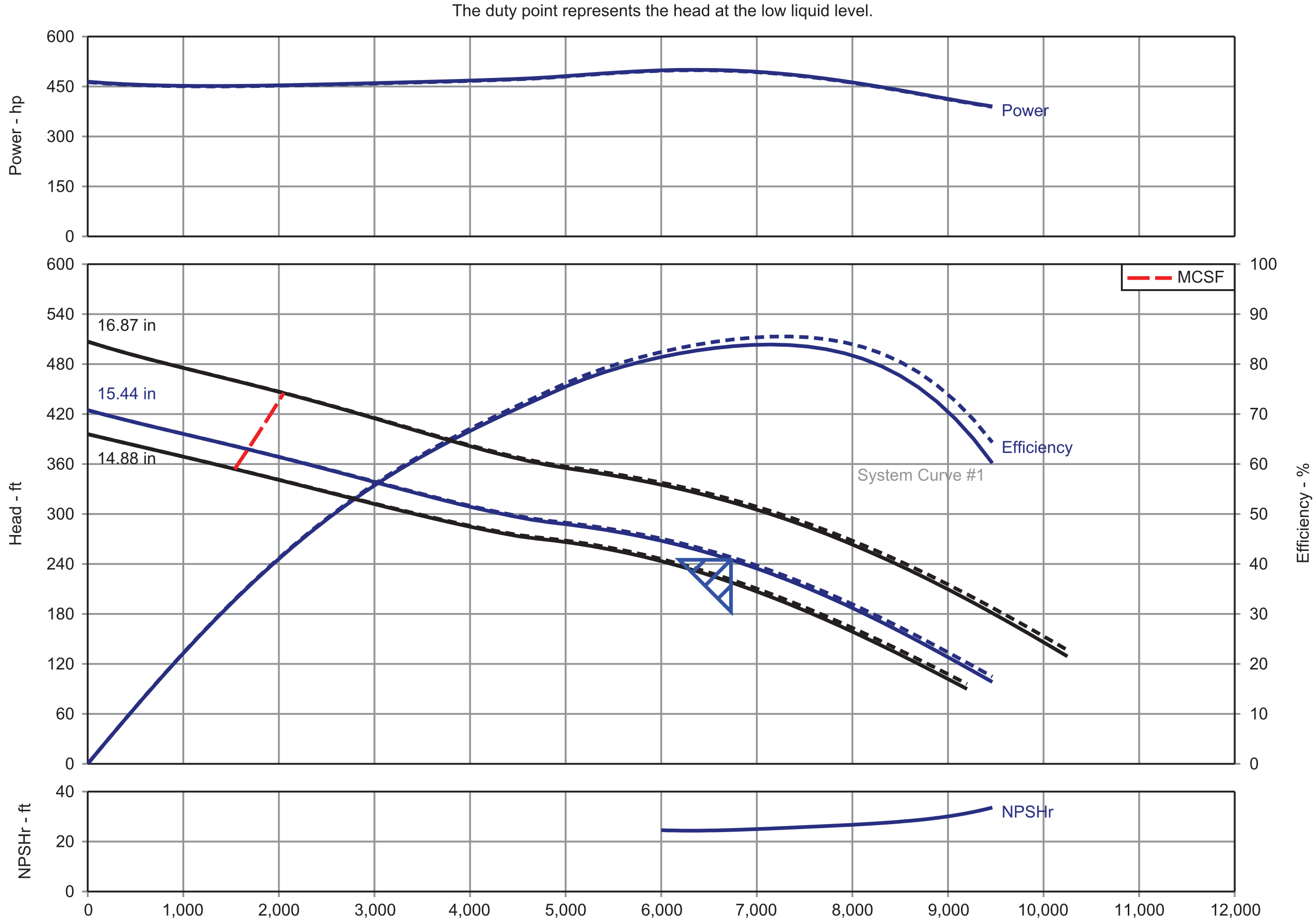
Q (cfs)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Q (gpm)	0	449	898	1,346	1,795	2,244	2,693	3,142	3,591	4,039	4,488	4,937	5,386	5,835	6,284	6,732	7,181	7,630
Head (ft)	425	411	398	385	372	360	346	332	319	305	294	287	280	272	261	246	229	210

Pump Performance Datasheet

Customer	:	Quote number	: 205132
Customer reference	: SOR - Lytle Creek Pump-back	Size	: 27FKL
Item number	: 001	Stages	: 3
Service	: Lytle Creek Pump Back 15 CFS - 24" Discharge Main	Based on curve number	: 27FKL 1180
		Date last saved	: 12 Jan 2012 3:24 PM
Quantity	: 1		

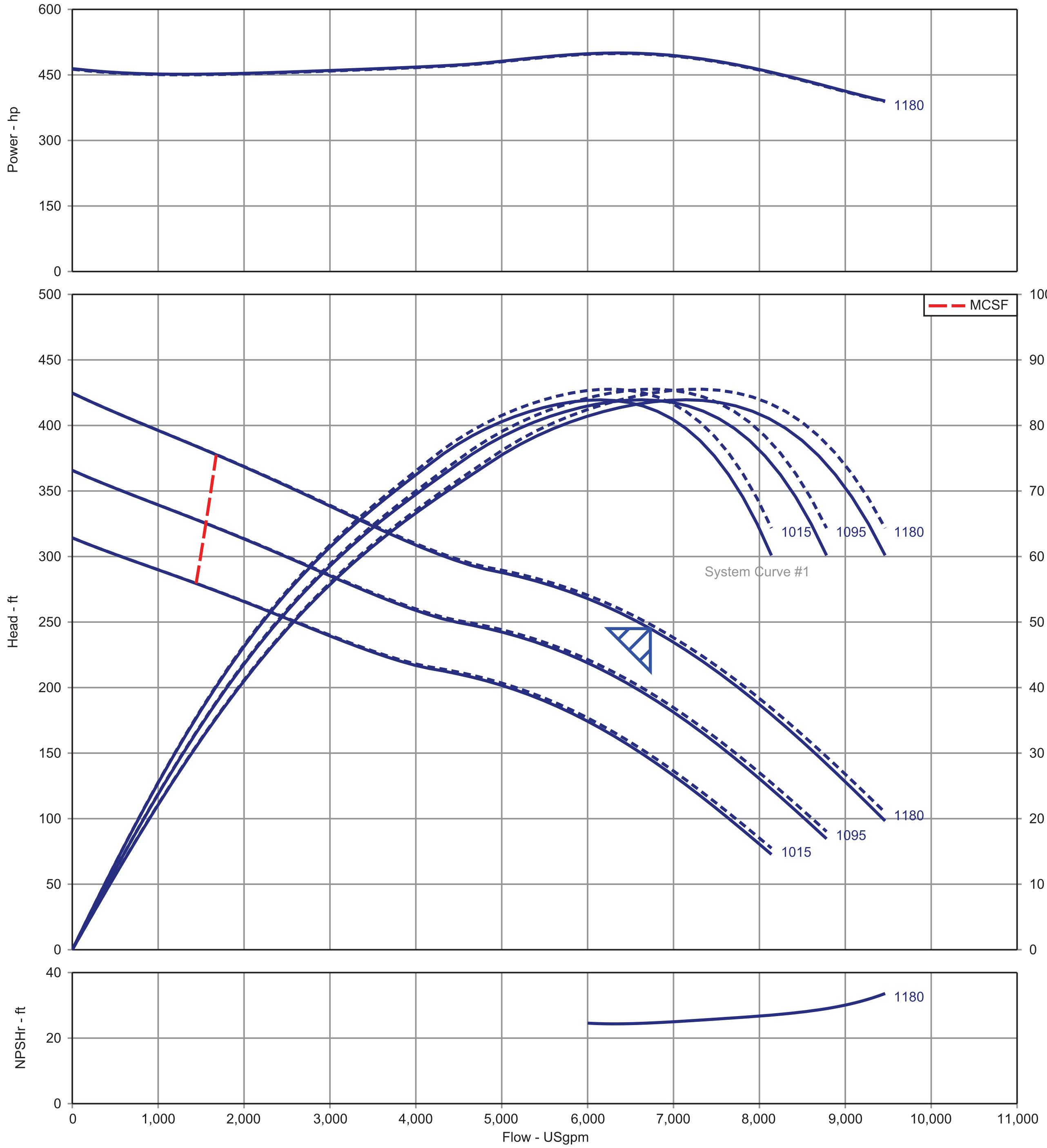
Operating Conditions		Liquid	
Flow, rated	: 6,730.0 USgpm	Liquid type	: Water - River or Lake, Fresh
Differential head / pressure, rated (requested)	: 245.0 ft	Additional liquid description	: Raw Water - Lytle Creek / Rye Grass Canal
Differential head / pressure, rated (actual)	: 246.1 ft	Solids diameter, max	: 1.50 in
Suction pressure, rated / max	: 0.00 / 0.00 psi.g	Solids concentration, by volume	: 0.00 %
NPSH available, rated	: 40.94 ft	Temperature, max	: 68.00 deg F
Frequency	: 60 Hz	Fluid density, rated / max	: 1.000 / 1.000 SG
Performance		Viscosity, rated	: 1.00 cP
Speed, rated	: 1,180 rpm	Vapor pressure, rated	: 0.00 psi.a
Impeller diameter, rated	: 15.44 in	**Material**	
Impeller diameter, maximum	: 16.87 in	Material selected	: Cast Iron/Bronze
Impeller diameter, minimum	: 14.88 in	**Pressure Data**	
Efficiency (bowl / pump)	: 84.89 / 83.56 %	Maximum working pressure	: 183.8 psi.g
NPSH required / margin required	: 24.63 / 5.00 ft	Maximum allowable working pressure	: 309.0 psi.g
nq (imp. eye flow) / S (imp. eye flow)	: 69 / 174 Metric units	Maximum allowable suction pressure	: N/A
MCSF	: 1,676.0 USgpm	Hydrostatic test pressure	: N/A
Head, maximum, rated diameter	: 424.7 ft	**Driver & Power Data**	
Head rise to shutoff	: 71.07 %	Driver sizing specification	: Max power + 5%
Flow, best eff. point (BEP)	: 7,278.6 USgpm	Margin over specification	: 0.00 %
Flow ratio (rated / BEP)	: 92.46 %	Service factor	: 1.00
Diameter ratio (rated / max)	: 91.48 %	Power, hydraulic	: 422 hp
Head ratio (rated dia / max dia)	: 78.14 %	Power (bowl / pump)	: 497 / 498 hp
Cq/Ch/Ce [ANSI/HI 9.6.7-2004]	: 1.00 / 1.00 / 1.00	Power, maximum, rated diameter	: 500 hp
Selection status	: Acceptable	Minimum recommended motor rating	: 600 hp / 447 kW

Pump and bowl (dashed) performance. Bowl adjusted for construction and viscosity.
Pump further adjusted for friction and power losses of lineshaft and thrust bearings. Pump is not adjusted for any static lift.
The duty point represents the head at the low liquid level.



Multi-Speed Performance Curve

Pump and bowl (dashed) performance. Bowl adjusted for construction and viscosity.
Pump further adjusted for friction and power losses of lineshaft and thrust bearings. Pump is not adjusted for any static lift.
The duty point represents the head at the low liquid level.



Customer	:	Pump Type	: 27FKL	Quote number	: 205132
Address	: , ,	# of Stages	: 3	Customer PO #	:
Location	:	Quantity	: 1	CO #	:
Project	: SOR - Lytle Creek Pump-back	Flow	: 6,730.0 USgpm	Item #	: 001
Tag	:	Head	: 245.0 ft	JOL #	:
Bowl/Pump	:	Speed	: 1,180 rpm	Serial #	:
Eff (bowl / pump)	: 84.89 / 83.56 %	Fluid Density	: 1.000 / 1.000 SG	Drawing #	:
Power (bowl / pump)	: 497 / 498 hp	Viscosity	: 1.00 cP	Drawn By	:
NPSH required	: 24.63 ft	Impeller Trim	: 15.44 in	Last Modified	: 12 Jan 2012 3:24 PM

The head and power may be different than that shown in accordance with Hydraulic Institute / API 610 Standards
Additional Notes:

Ochoco Irrigation District - System Optimization Review
Lytle Creek Pump-back Pumping Plant (Construction of New Facilities, 15 CFS, 24-inch HDPE Discharge Main)
Budget Level - Projection of Probable Construction Cost

Item No.	Spec Division	Description	Measurement	Units	Unit Cost	Total Cost
1	0000	Easement Procurement	Acre	13	$3,000.00	$39,000.00
2	1000	Mobilization	LS	1	$97,000.00	$97,000.00
3	1000	Erosion Control	LS	1	$15,000.00	$15,000.00
4	1000	Watering / Dust Control	LS	1	$5,000.00	$5,000.00
5	1000	Construction Staking	LS	1	$12,500.00	$12,500.00
6	1000	Project Management and Coordination	LS	1	$15,000.00	$15,000.00
7	1000	Construction Progress Documentation	LS	1	$7,500.00	$7,500.00
8	1000	Submittal Procedures	LS	1	$7,500.00	$7,500.00
9	1000	Quality Requirements	LS	1	$10,000.00	$10,000.00
10	1000	Selective Demolition	LS	1	$10,000.00	$10,000.00
11	1000	Traffic Control	LS	1	$5,000.00	$5,000.00
12	1000	Project Record Documents	LS	1	$7,500.00	$7,500.00
13	1000	Operations and Maintenance Data	LS	1	$7,500.00	$7,500.00
14	1000	General Commissioning Requirements	LS	1	$7,500.00	$7,500.00
15	2000	Erosion Control Silt Fence	LF	5,000	$2.40	$12,000.00
16	2000	Perimeter Fence, 8 ft coated wire chain link	LF	120	$18.00	$2,160.00
17	2000	Fence Gate	LS	1	$2,500.00	$2,500.00
18	2000	Dewatering	LS	1	$2,500.00	$2,500.00
19	2000	Bulk Excavation	CY	220	$7.00	$1,540.00
20	2000	Hauling	CY	3,140	$12.00	$37,680.00
21	2000	Trench Excavation, 5-8 ft depth trench box	CY	19,440	$7.00	$136,080.00
22	2000	Structural Backfill	CY	50	$38.00	$1,900.00
23	2000	Trench Backfilling	CY	16,520	$3.10	$51,212.00
24	2000	Bore and Jack 32" Steel Casing	LF	60	$225.00	$13,500.00
25	2000	Aggregate Base	CY	10	$38.00	$380.00
26	2000	Surfacing Rock	CY	100	$38.00	$3,800.00
27	2000	AC Pavement Reconstruction	SY	75	$75.00	$5,625.00
28	2000	Access Manhole	EA	18	$7,500.00	$135,000.00
29	2000	Restoration Seeding	AC	13	$1,500.00	$19,500.00
30	3000	Cast-in-Place Concrete	CY	20	$550.00	$11,000.00
31	3000	Misc Cast-in-Place Concrete (thrust and pads)	LS	1	$5,500.00	$5,500.00
32	6000	Handrail	LS	1	$250.00	$250.00
33	6000	Trash Rack	LS	1	$5,000.00	$5,000.00
34	9000	High Performance Coating Systems	LS	1	$5,000.00	$5,000.00
35	11000	Air Release / Vacuum Relief Stations	EA	2	$20,000.00	$40,000.00
36	11000	Line Shaft Turbine Pump and Motor, 600 HP	EA	1	$157,700.00	$157,700.00
37	15000	24-inch Steel Discharge Pipe, poly x poly, welded	LF	3,430	$79.89	$274,022.70
38	15000	28-inch IPS HDPE, DR17 Discharge Pipe, welded	LF	15,000	$79.89	$1,198,350.00
39	15000	14-inch Discharge Pipe, Fittings, & Accessories	EA	1	$5,000.00	$5,000.00
40	15000	14-inch Butterfly Valve	EA	1	$2,500.00	$2,500.00
41	15000	14-inch Surge Control Check Valve	EA	1	$9,375.00	$9,375.00
42	15000	Flap Gate	EA	1	$6,000.00	$6,000.00
43	16000	Power and Distribution	LS	1	$25,000.00	$25,000.00
44	16000	Grounding Systems	LS	1	$3,000.00	$3,000.00
45	16000	Motor Controls including VFD Driver	LS	1	$25,000.00	$25,000.00
46	17000	Instrumentation and Control	LS	1	$15,000.00	$15,000.00
		Construction Subtotal				$2,420,074.70
		Contractors Overhead and Profit	10%	1	$242,007.47	$242,007.47
		Contractors Bonds and Insurance	2%	1	$53,241.64	$53,241.64
		Construction Contingency	30%	1	$726,022.41	$726,022.41
		Construction Total				$3,441,346.22
		Engineering, Administration	25%	1	$860,336.56	
		Total				**$4,301,682.78**

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VFD Analysis

Pump to Canal Head Loss Calculations
Lytle Creek Pump-back Pumping Plant

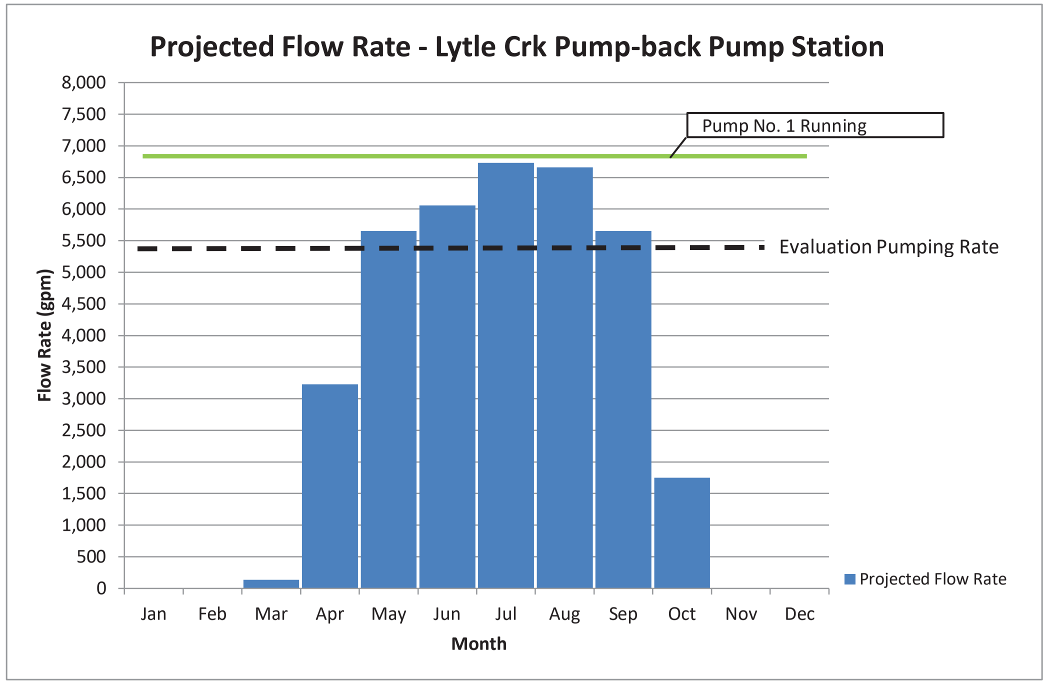
6,730 GPM   Vertical Turbine Pump No. 1

6,730 GPM   Total   =   **15.0 cfs**

Proposed PS Design Flow Rate =   6,730 gpm

Month	% of Max Flow Rate	Projected Flow Rate
Jan	0%	0
Feb	0%	0
Mar	2%	135
Apr	48%	3,230
May	84%	5,653
Jun	90%	6,057
Jul	100%	6,730
Aug	99%	6,663
Sep	84%	5,653
Oct	26%	1,750
Nov	0%	0
Dec	0%	0

Evaluation Pumping Rate =   5,378 gpm
12.0 cfs



Notes: The proposed Lytle Creek Pump-back Pumping Plant as proposed includes (2) Turbine Pumps. To optimize water delivery to crop requirement and reduce energy use, VFD operation of Pump No. 1 would provide benefit.

Wire to Water Energy Calculator

Ochoco Irrigation District - SOR

Lytle Creek Pump-back Pumping Plant - 15 CFS

Source: PumpTech Inc.

2425 SE Ochoco Street

Portland, OR 97222

503-659-6230

OPERATIONAL AND EQUIPMENT DATA

	24" Discharge Main		22" Discharge Main	
	No. 1 - Weir Floway 27 FKL, 3 Stage, 1180 RPM, 600 HP		No. 1 - Weir Floway 27 FKL, 3 Stage, 1180 RPM, 600 HP	
Discharge Main Length	18,430		18,430	
Pump Operation - Hours / Day	24		24	
Pump Operation - Days / Year	198		198	
Pump Flow - GPM (Evaluation Pump Rate)	5,378		5,378	
Pump Flow - CFS	12.0		12.0	
Total Annual Volume - Acre feet	4,710		4,710	
Pump Head - Feet	225.0	*	238.0	*
Ave. Pump Efficiency - %	83.6%	**	83.8%	**
Ave. Motor Efficiency - %	93.0%	***	93.0%	***
Energy Cost in $/kW-hr	$0.035		$0.035	

* Pump head based on system curve for evaluation pumping rate using the stated discharge main diameter.

** Pump efficiency based on published pump efficiency selected units operating at rated capacity and head.

*** Motor efficiency base on use of premium efficiency induction type motors with a 93% efficiency rating.

RESULTS

	24" Discharge Main	22" Discharge Main
BHP At Design Point	365.5	385.7
Wire to Water Efficiency - %	77.7%	77.9%
kW-hr per Year	1,393,266	1,470,249
Annual Energy Cost	$48,764.32	$51,458.71
kW-hr Per 1,000 Gallons Pumped	0.909	0.959
Cost Per 1,000 Gallons Pumped	$0.032	$0.034
kW-hr per Acre Foot Pumped	296	312
Cost Per Acre Foot Pumped	$10.36	$10.93

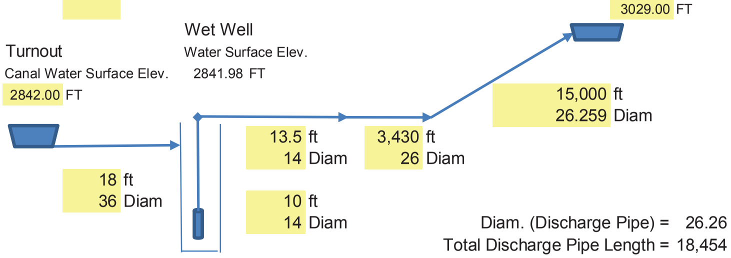
PAYBACK

Annual Savings with use of larger pipe - kW-hr				76,982	
Annual Savings with use of larger pipe - $$				$2,694.39	
Annual Savings with use of larger pipe - %				5.24%	
Cost of 24-inch Discharge Main	$69.89	(cost / lf raw material)		$1,288,072.70	
Cost of 22-inch Discharge Main	$60.96	(cost / lf raw material)		$1,123,492.80	
Payback with use of larger pipe - Years				61.1	
Total Cost of Pumping Plant			$4,302,000.00 *	$3,964,000.00	*

* Estimated cost of pumping plant construction complete including (1) pump and VFD driver.

Pump to Canal Head Loss Calculations
Lytle Creek Pump-back Pumping Plant - 20 CFS

4,490 GPM	Vertical Turbine Pump No. 1	
4,490 GPM	Vertical Turbine Pump No. 2	
		Static Head = 187.00 FT
8,980 GPM	Total =	20.0 cfs



Diam. (Discharge Pipe) = 26.26 in
Total Discharge Pipe Length = 18,454 ft
Equiv. Pipe Length Valves & Fittings Pump Discharge = 270 ft
Equiv. Pipe Length Valves & Fittings Discharge Main = 165 ft

3.00 ft x 6 ft trash rack to PS Wet Well	Friction Head =	0.97 FT per 1,000 FT	Concrete
	Dynamic Head =	0.02 FT total	C = 110
14" Column Pipe	Friction Head =	18.17 FT per 1,000 FT	Steel
(Vel. = 9.4 fps)	Dynamic Head =	0.18 FT total	C = 135
14" Pump Discharge Pipe	Friction Head =	18.17 FT per 1,000 FT	Steel
(Vel. = 9.4 fps)	Dynamic Head =	0.25 FT total	C = 135
26" Steel Discharge Main	Friction Head =	3.22 FT per 1,000 FT	Steel
(Vel. = 5.4 fps)	Dynamic Head =	11.06 FT total	C = 135
30" HDPE (26.259" I.D.) Main	Friction Head =	3.07 FT per 1,000 FT	HDPE
(Vel. = 5.3 fps)	Dynamic Head =	46.07 FT total	C = 135
Equivalent Pipe Length	Friction Head =	18.17 FT per 1,000 FT	Steel
Valves & Fittings Pump Discharge	Dynamic Head =	4.91 FT total	C = 135
Equivalent Pipe Length	Friction Head =	3.22 FT per 1,000 FT	Steel
Valves & Fittings Discharge Main	Dynamic Head =	0.53 FT total	C = 135
	Friction Head =	62.99 FT =	27.27 psi
	Water Depth in Discharge Canal =	3.00 FT =	1.30 psi
	Total Dynamic Head =	253.01 FT =	109.53 psi

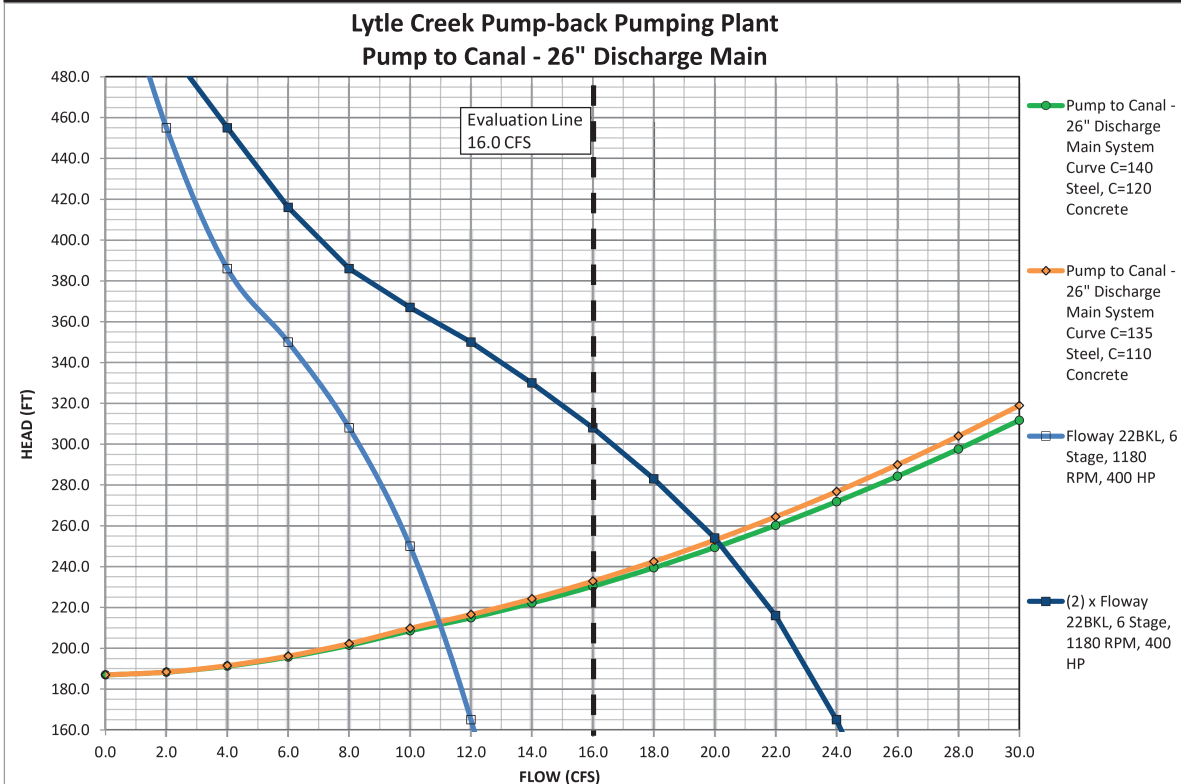
Equivalent Pipe Length Totals:

Item	14" Equiv. Length	No. of Units	Total Equiv. Length
14" pump discharge head	90 ft	1 ea	90 ft
14" check valve	130 ft	1 ea	130 ft
14" pump control (butterfly) valve	50 ft	1 ea	50 ft
		Subtotal	270 ft

Item	26" Equiv. Length	No. of Units	Total Equiv. Length
26"x26"x26" tee branch flow	130 ft	1 ea	130 ft
14"x26" Expander	30 ft	1 ea	30 ft
26" Flap Gate	5 ft	1 ea	5 ft
		Subtotal	165 ft

Lytle Creek Pump-back Pumping Plant
Pump to Canal - 26" Discharge Main System Curve C=135 Steel, C=110 Concrete

Q (gpm)	0	898	1,796	2,694	3,592	4,490	5,388	6,286	7,184	8,082	8,980	9,878	10,776	11,674	12,572	13,470	14,368	15,266
Q (cfs)	0.0	2.0	4.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0	22.0	24.0	26.0	28.0	30.0	32.0	34.0
Hf	0.0	1.4	4.5	9.2	15.3	22.8	29.6	37.2	45.9	55.5	66.0	77.4	89.7	102.9	117.0	131.9	147.7	164.4
TDH (ft)	187.0	188.4	191.5	196.2	202.3	209.8	216.6	224.2	232.9	242.5	253.0	264.4	276.7	289.9	304.0	318.9	334.7	351.4
Vel. Disch. (fps)	0.0	0.5	1.1	1.6	2.1	2.7	3.2	3.7	4.3	4.8	5.3	5.9	6.4	6.9	7.4	8.0	8.5	9.0



Floway 22BKL, 6 Stage, 1180 RPM, 400 HP

Q (cfs)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
Q (gpm)	0	898	1,795	2,693	3,591	4,488	5,386	6,284	7,181	8,079	8,977	9,874	10,772	11,670	12,567	13,465	14,363	15,260
Head (ft)	551	455	386	350	308	250	165	50										

(2) x Floway 22BKL, 6 Stage, 1180 RPM, 400 HP

Q (cfs)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
Q (gpm)	0	898	1,795	2,693	3,591	4,488	5,386	6,284	7,181	8,079	8,977	9,874	10,772	11,670	12,567	13,465	14,363	15,260
Head (ft)	501	495	455	416	386	367	350	330	308	283	254	216	165	100	50			

Pump Performance Datasheet

Customer	:	Quote number	: 205132
Customer reference	: SOR - Lytle Creek Pump-back	Size	: 22BKL
Item number	: 001	Stages	: 6
Service	: Lytle Creek Pump Back 20 CFS - 26" Discharge Main	Based on curve number	: 22BKL 1180
Quantity	: 2	Date last saved	: 12 Jan 2012 3:33 PM

Operating Conditions

Flow, rated	: 4,490.0 USgpm
Differential head / pressure, rated (requested)	: 253.0 ft
Differential head / pressure, rated (actual)	: 254.3 ft
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: 40.94 ft
Frequency	: 60 Hz

Performance

Speed, rated	: 1,180 rpm
Impeller diameter, rated	: 12.03 in
Impeller diameter, maximum	: 12.50 in
Impeller diameter, minimum	: 11.25 in
Efficiency (bowl / pump)	: 84.11 / 83.27 %
NPSH required / margin required	: 11.77 / 5.00 ft
nq (imp. eye flow) / S (imp. eye flow)	: 77 / 235 Metric units
MCSF	: 1,174.5 USgpm
Head, maximum, rated diameter	: 550.6 ft
Head rise to shutoff	: 116.05 %
Flow, best eff. point (BEP)	: 4,162.0 USgpm
Flow ratio (rated / BEP)	: 107.88 %
Diameter ratio (rated / max)	: 96.25 %
Head ratio (rated dia / max dia)	: 85.62 %
Cq/Ch/Ce [ANSI/HI 9.6.7-2004]	: 1.00 / 1.00 / 1.00
Selection status	: Acceptable

Liquid

Liquid type	: Water - River or Lake, Fresh
Additional liquid description	: Raw Water - Lytle Creek / Rye Grass Canal
Solids diameter, max	: 1.50 in
Solids concentration, by volume	: 0.00 %
Temperature, max	: 68.00 deg F
Fluid density, rated / max	: 1.000 / 1.000 SG
Viscosity, rated	: 1.00 cP
Vapor pressure, rated	: 0.00 psi.a

Material

Material selected	: Cast Iron/Bronze

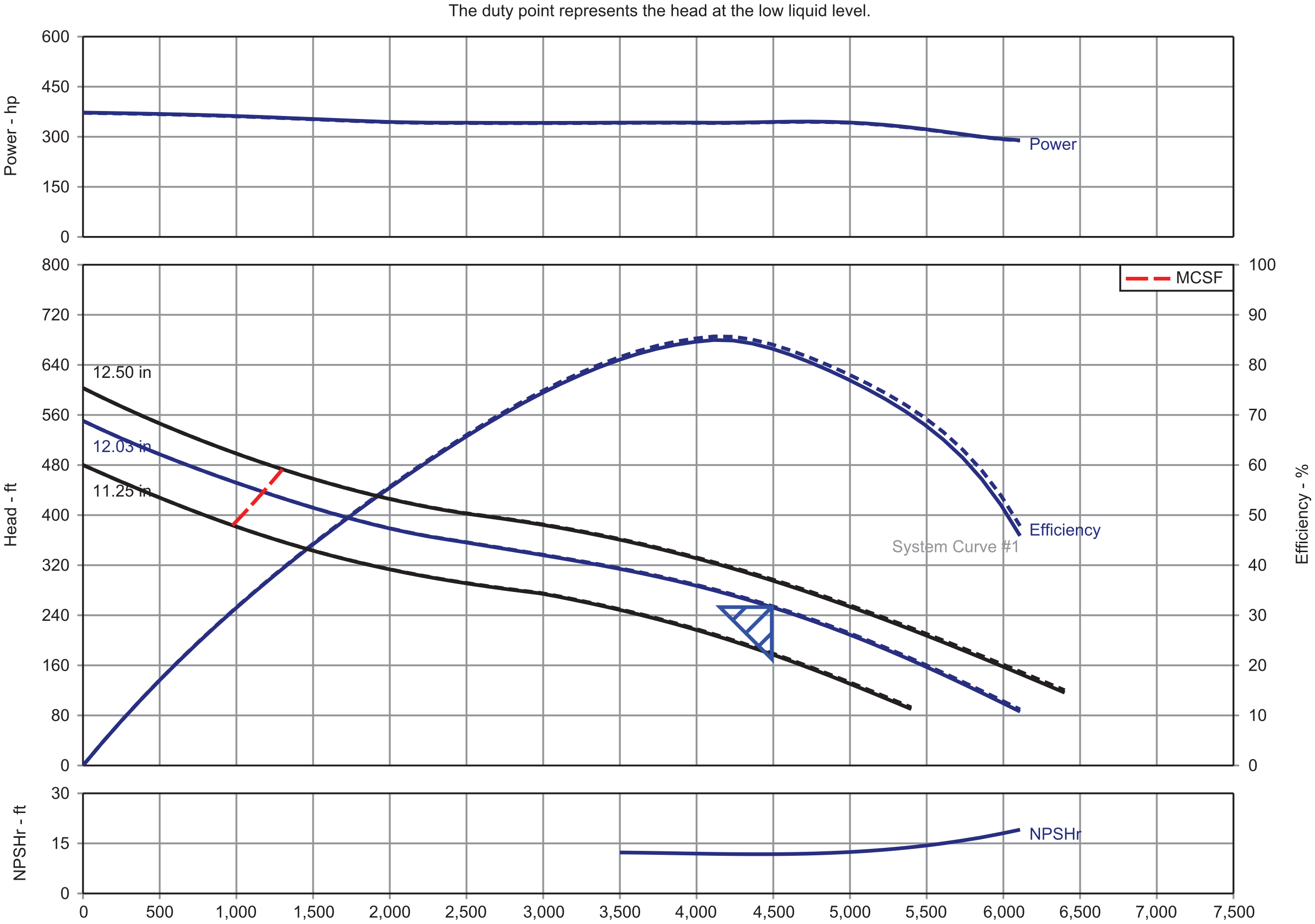
Pressure Data

Maximum working pressure	: 238.4 psi.g
Maximum allowable working pressure	: 261.0 psi.g
Maximum allowable suction pressure	: N/A
Hydrostatic test pressure	: N/A

Driver & Power Data

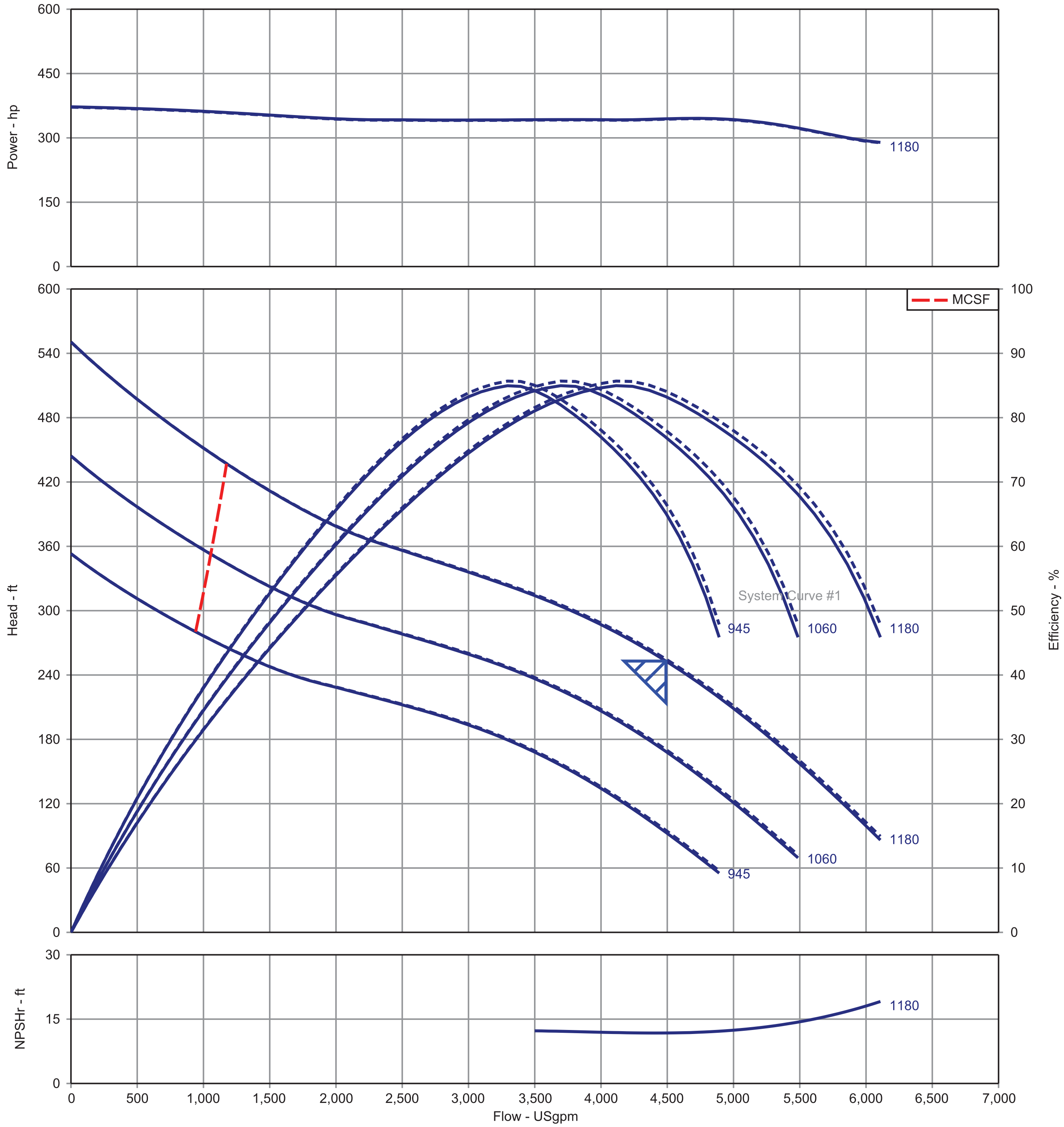
Driver sizing specification	: Max power + 5%
Margin over specification	: 0.00 %
Service factor	: 1.00
Power, hydraulic	: 289 hp
Power (bowl / pump)	: 344 / 345 hp
Power, maximum, rated diameter	: 373 hp
Minimum recommended motor rating	: 400 hp / 298 kW

Pump and bowl (dashed) performance. Bowl adjusted for construction and viscosity.
Pump further adjusted for friction and power losses of lineshaft and thrust bearings. Pump is not adjusted for any static lift.
The duty point represents the head at the low liquid level.



Multi-Speed Performance Curve

Pump and bowl (dashed) performance. Bowl adjusted for construction and viscosity.
Pump further adjusted for friction and power losses of lineshaft and thrust bearings. Pump is not adjusted for any static lift.
The duty point represents the head at the low liquid level.



Customer	:	Pump Type	: 22BKL	Quote number	: 205132
Address	: , ,	# of Stages	: 6	Customer PO #	:
Location	:	Quantity	: 2	CO #	:
Project	: SOR - Lytle Creek Pump-back	Flow	: 4,490.0 USgpm	Item #	: 001
Tag	:	Head	: 253.0 ft	JOL #	:
Bowl/Pump	:	Speed	: 1,180 rpm	Serial #	:
Eff (bowl / pump)	: 84.11 / 83.27 %	Fluid Density	: 1.000 / 1.000 SG	Drawing #	:
Power (bowl / pump)	: 344 / 345 hp	Viscosity	: 1.00 cP	Drawn By	:
NPSH required	: 11.77 ft	Impeller Trim	: 12.03 in	Last Modified	: 12 Jan 2012 3:33 PM

The head and power may be different than that shown in accordance with Hydraulic Institute / API 610 Standards

Additional Notes:

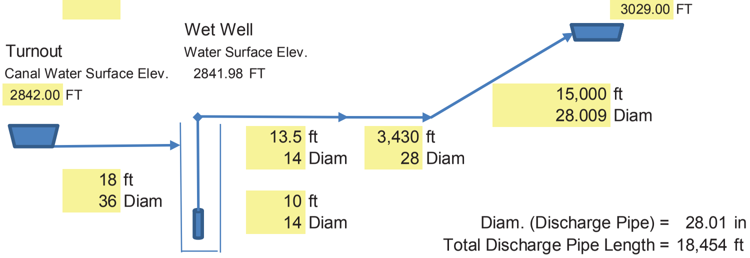
Ochoco Irrigation District - System Optimization Review
Lytle Creek Pump-back Pumping Plant (Construction of New Facilities, 20 CFS, 26-inch HDPE Discharge Main)
Budget Level - Projection of Probable Construction Cost

Item No.	Spec Division	Description	Measurement	Units	Unit Cost	Total Cost
1	0000	Easement Procurement	Acre	13	$3,000.00	$39,000.00
2	1000	Mobilization	LS	1	$109,000.00	$109,000.00
3	1000	Erosion Control	LS	1	$15,000.00	$15,000.00
4	1000	Watering / Dust Control	LS	1	$5,000.00	$5,000.00
5	1000	Construction Staking	LS	1	$12,500.00	$12,500.00
6	1000	Project Management and Coordination	LS	1	$15,000.00	$15,000.00
7	1000	Construction Progress Documentation	LS	1	$7,500.00	$7,500.00
8	1000	Submittal Procedures	LS	1	$7,500.00	$7,500.00
9	1000	Quality Requirements	LS	1	$10,000.00	$10,000.00
10	1000	Selective Demolition	LS	1	$10,000.00	$10,000.00
11	1000	Traffic Control	LS	1	$5,000.00	$5,000.00
12	1000	Project Record Documents	LS	1	$7,500.00	$7,500.00
13	1000	Operations and Maintenance Data	LS	1	$7,500.00	$7,500.00
14	1000	General Commissioning Requirements	LS	1	$7,500.00	$7,500.00
15	2000	Erosion Control Silt Fence	LF	5,000	$2.40	$12,000.00
16	2000	Perimeter Fence, 8 ft coated wire chain link	LF	120	$18.00	$2,160.00
17	2000	Fence Gate	LS	1	$2,500.00	$2,500.00
18	2000	Dewatering	LS	1	$2,500.00	$2,500.00
19	2000	Bulk Excavation	CY	220	$7.00	$1,540.00
20	2000	Hauling	CY	3,575	$12.00	$42,900.00
21	2000	Trench Excavation, 5-8 ft depth trench box	CY	20,675	$7.00	$144,725.00
22	2000	Structural Backfill	CY	50	$38.00	$1,900.00
23	2000	Trench Backfilling	CY	17,320	$3.10	$53,692.00
24	2000	Bore and Jack 34" Steel Casing	LF	60	$250.00	$15,000.00
25	2000	Aggregate Base	CY	10	$38.00	$380.00
26	2000	Surfacing Rock	CY	100	$38.00	$3,800.00
27	2000	AC Pavement Reconstruction	SY	75	$75.00	$5,625.00
28	2000	Access Manhole	EA	18	$7,500.00	$135,000.00
29	2000	Restoration Seeding	AC	13	$1,500.00	$19,500.00
30	3000	Cast-in-Place Concrete	CY	20	$550.00	$11,000.00
31	3000	Misc Cast-in-Place Concrete (thrust and pads)	LS	1	$5,500.00	$5,500.00
32	6000	Handrail	LS	1	$250.00	$250.00
33	6000	Trash Rack	LS	1	$5,000.00	$5,000.00
34	9000	High Performance Coating Systems	LS	1	$5,000.00	$5,000.00
35	11000	Air Release / Vacuum Relief Stations	EA	2	$20,000.00	$40,000.00
36	11000	Line Shaft Turbine Pump and Motor, 400 HP	EA	2	$107,800.00	$215,600.00
37	15000	26-inch Steel Discharge Pipe, poly x poly, welded	LF	3,430	$89.50	$306,985.00
38	15000	30-inch IPS HDPE, DR17 Discharge Pipe, welded	LF	15,000	$89.50	$1,342,500.00
39	15000	14-inch Discharge Pipe, Fittings, & Accessories	EA	2	$5,000.00	$10,000.00
40	15000	14-inch Butterfly Valve	EA	2	$2,500.00	$5,000.00
41	15000	14-inch Surge Control Check Valve	EA	2	$9,375.00	$18,750.00
42	15000	Flap Gate	EA	1	$6,000.00	$6,000.00
43	16000	Power and Distribution	LS	1	$30,000.00	$30,000.00
44	16000	Grounding Systems	LS	1	$3,000.00	$3,000.00
45	16000	Motor Controls including VFD Driver	LS	1	$50,000.00	$50,000.00
46	17000	Instrumentation and Control	LS	1	$15,000.00	$15,000.00
		Construction Subtotal				$2,731,807.00
		Contractors Overhead and Profit	10%	1	$273,180.70	$273,180.70
		Contractors Bonds and Insurance	2%	1	$60,099.75	$60,099.75
		Construction Contingency	30%	1	$819,542.10	$819,542.10
		Construction Total				$3,884,629.55
		Engineering, Administration	25%	1	$971,157.39	
		Total				**$4,855,786.94**

Pump to Canal Head Loss Calculations
Lytle Creek Pump-back Pumping Plant - 20 CFS

4,490	GPM	Vertical Turbine Pump No. 1	
4,490	GPM	Vertical Turbine Pump No. 2	
8,980	GPM	Total =	20.0 cfs

Static Head = 187.00 FT



Diam. (Discharge Pipe) = 28.01 in
Total Discharge Pipe Length = 18,454 ft
Equiv. Pipe Length Valves & Fittings Pump Discharge = 270 ft
Equiv. Pipe Length Valves & Fittings Discharge Main = 180 ft

3.0 ft x 6 ft trash rack to PS Wet Well	Friction Head =	0.97 FT per 1,000 FT	Concrete
	Dynamic Head =	0.02 FT total	C = 110
14" Column Pipe	Friction Head =	18.17 FT per 1,000 FT	Steel
(Vel. = 9.4 fps)	Dynamic Head =	0.18 FT total	C = 135
14" Pump Discharge Piping	Friction Head =	18.17 FT per 1,000 FT	Steel
(Vel. = 9.4 fps)	Dynamic Head =	0.25 FT total	C = 135
28" Steel Discharge Pipe	Friction Head =	2.25 FT per 1,000 FT	Steel
(Vel. = 4.7 fps)	Dynamic Head =	7.71 FT total	C = 135
32" HDPE (28.009" I.D.) Main	Friction Head =	2.24 FT per 1,000 FT	HDPE
(Vel. = 4.7 fps)	Dynamic Head =	33.66 FT total	C = 135
Equivalent Pipe Length	Friction Head =	18.17 FT per 1,000 FT	Steel
Valves & Fittings Pump Discharge	Dynamic Head =	4.91 FT total	C = 135
Equivalent Pipe Length	Friction Head =	2.25 FT per 1,000 FT	Steel
Valves & Fittings Discharge Main	Dynamic Head =	0.40 FT total	C = 135
	Friction Head =	47.11 FT =	20.39 psi
	Water Depth in Discharge Canal =	3.00 FT =	1.30 psi
	Total Dynamic Head =	237.12 FT =	102.65 psi

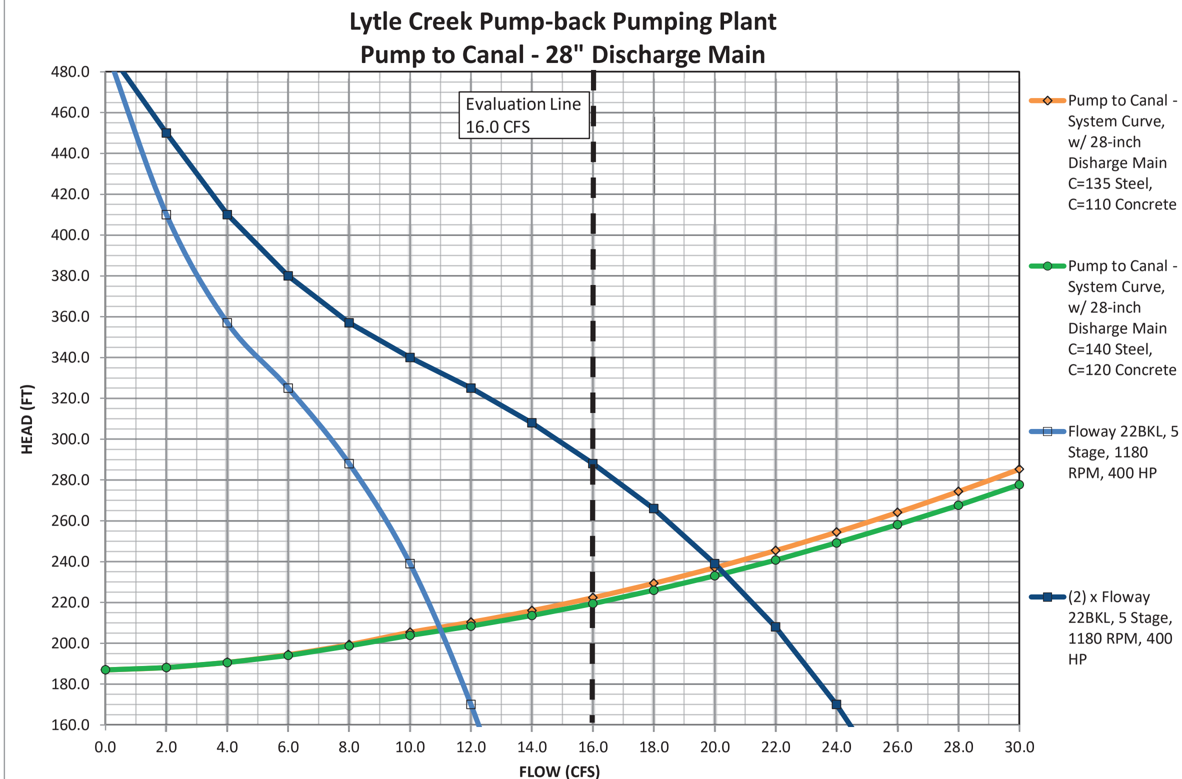
Equivalent Pipe Length Totals:

Item	14" Equiv. Length	No. of Units	Total Equiv. Length
14" pump discharge head	90 ft	1 ea	90 ft
14" check valve	130 ft	1 ea	130 ft
14" pump control (butterfly) valve	50 ft	1 ea	50 ft
		Subtotal	270 ft

Item	28" Equiv. Length	No. of Units	Total Equiv. Length
28"x28"x28" tee branch flow	140 ft	1 ea	140 ft
14"x28" Expander	35 ft	1 ea	35 ft
28" Flap Gate	5 ft	1 ea	5 ft
		Subtotal	180 ft

Lytle Creek Pump-back Pumping Plant
Pump to Canal - System Curve, w/ 28-inch Disharge Main C=135 Steel, C=110 Concrete

Q (gpm)	0	898	1,796	2,694	3,592	4,490	5,388	6,286	7,184	8,082	8,980	9,878	10,776	11,674	12,572	13,470	14,368	15,266
Q (cfs)	0.0	2.0	4.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0	22.0	24.0	26.0	28.0	30.0	32.0	34.0
Hf	0.0	1.2	3.7	7.5	12.4	18.4	23.4	29.0	35.4	42.4	50.1	58.5	67.5	77.1	87.4	98.3	109.8	122.0
TDH (ft)	187.0	188.2	190.7	194.5	199.4	205.4	210.4	216.0	222.4	229.4	237.1	245.5	254.5	264.1	274.4	285.3	296.8	309.0
Vel. Disch. (fps)	0.0	0.5	0.9	1.4	1.9	2.3	2.8	3.3	3.7	4.2	4.7	5.1	5.6	6.1	6.5	7.0	7.5	7.9



Floway 22BKL, 5 Stage, 1180 RPM, 400 HP

Q (cfs)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
Q (gpm)	0	898	1,795	2,693	3,591	4,488	5,386	6,284	7,181	8,079	8,977	9,874	10,772	11,670	12,567	13,465	14,363	15,260
Head (ft)	492	410	357	325	288	239	170	85										

(2) x Floway 22BKL, 5 Stage, 1180 RPM, 400 HP

Q (cfs)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
Q (gpm)	0	898	1,795	2,693	3,591	4,488	5,386	6,284	7,181	8,079	8,977	9,874	10,772	11,670	12,567	13,465	14,363	15,260
Head (ft)	492	450	410	380	357	340	325	308	288	266	239	208	170	125	90			

Pump Performance Datasheet

Customer	:	Quote number	: 205132
Customer reference	: SOR - Lytle Creek Pump-back	Size	: 22BKL
Item number	: 001	Stages	: 5
Service	: Lytle Creek Pump Back 20 CFS - 28" Discharge Main	Based on curve number	: 22BKL 1180
		Date last saved	: 12 Jan 2012 3:45 PM
Quantity	: 2		

Operating Conditions

Flow, rated	: 4,490.0 USgpm
Differential head / pressure, rated (requested)	: 238.0 ft
Differential head / pressure, rated (actual)	: 239.4 ft
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: 40.94 ft
Frequency	: 60 Hz

Performance

Speed, rated	: 1,180 rpm
Impeller diameter, rated	: 12.41 in
Impeller diameter, maximum	: 12.50 in
Impeller diameter, minimum	: 11.25 in
Efficiency (bowl / pump)	: 85.47 / 84.55 %
NPSH required / margin required	: 11.81 / 5.00 ft
nq (imp. eye flow) / S (imp. eye flow)	: 77 / 235 Metric units
MCSF	: 1,270.6 USgpm
Head, maximum, rated diameter	: 491.8 ft
Head rise to shutoff	: 104.98 %
Flow, best eff. point (BEP)	: 4,268.1 USgpm
Flow ratio (rated / BEP)	: 105.20 %
Diameter ratio (rated / max)	: 99.25 %
Head ratio (rated dia / max dia)	: 96.72 %
Cq/Ch/Ce [ANSI/HI 9.6.7-2004]	: 1.00 / 1.00 / 1.00
Selection status	: Acceptable

Liquid

Liquid type	: Water - River or Lake, Fresh
Additional liquid description	: Raw Water - Lytle Creek / Rye Grass Canal
Solids diameter, max	: 1.50 in
Solids concentration, by volume	: 0.00 %
Temperature, max	: 68.00 deg F
Fluid density, rated / max	: 1.000 / 1.000 SG
Viscosity, rated	: 1.00 cP
Vapor pressure, rated	: 0.00 psi.a

Material

Material selected	: Cast Iron/Bronze

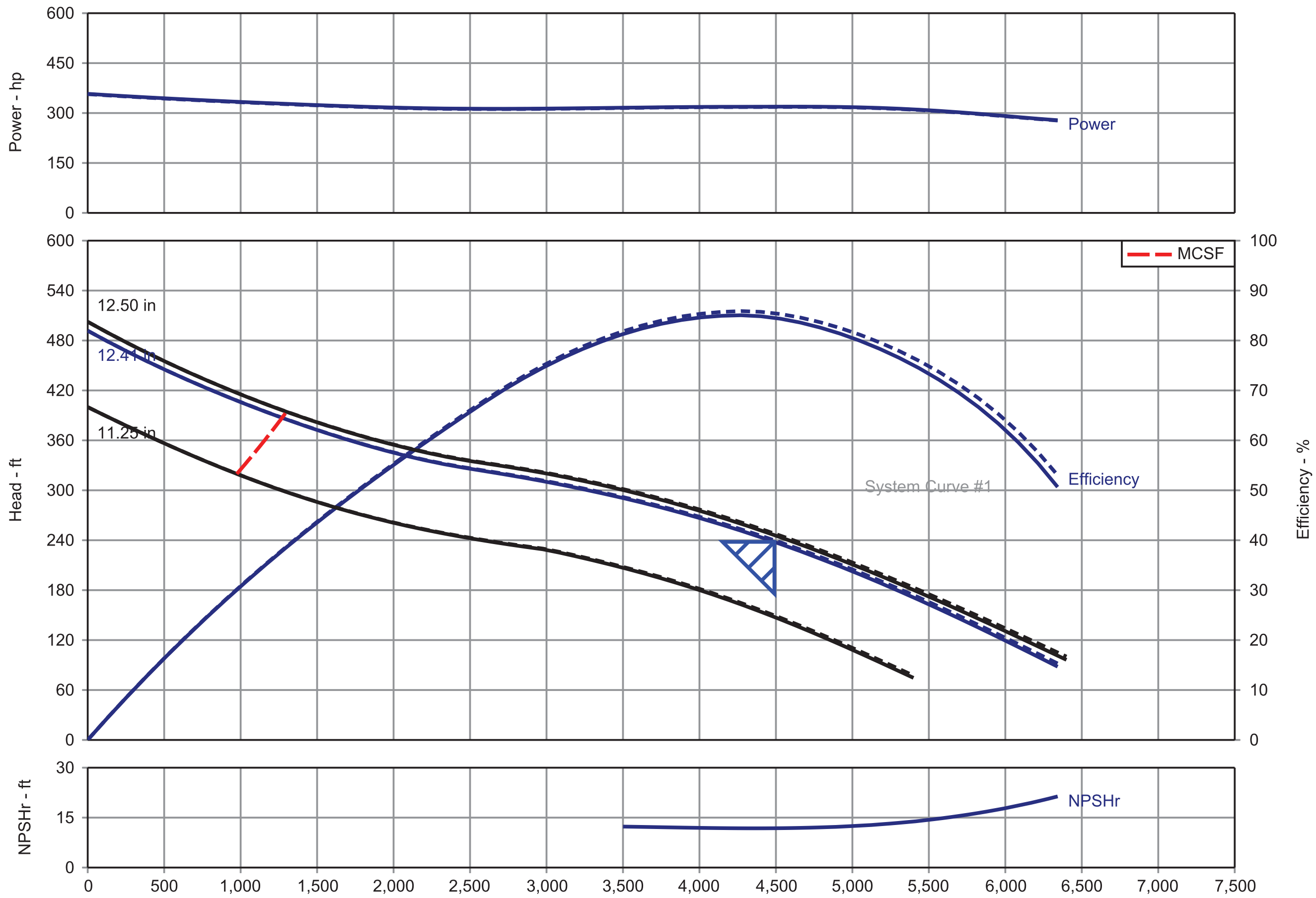
Pressure Data

Maximum working pressure	: 212.9 psi.g
Maximum allowable working pressure	: 261.0 psi.g
Maximum allowable suction pressure	: N/A
Hydrostatic test pressure	: N/A

Driver & Power Data

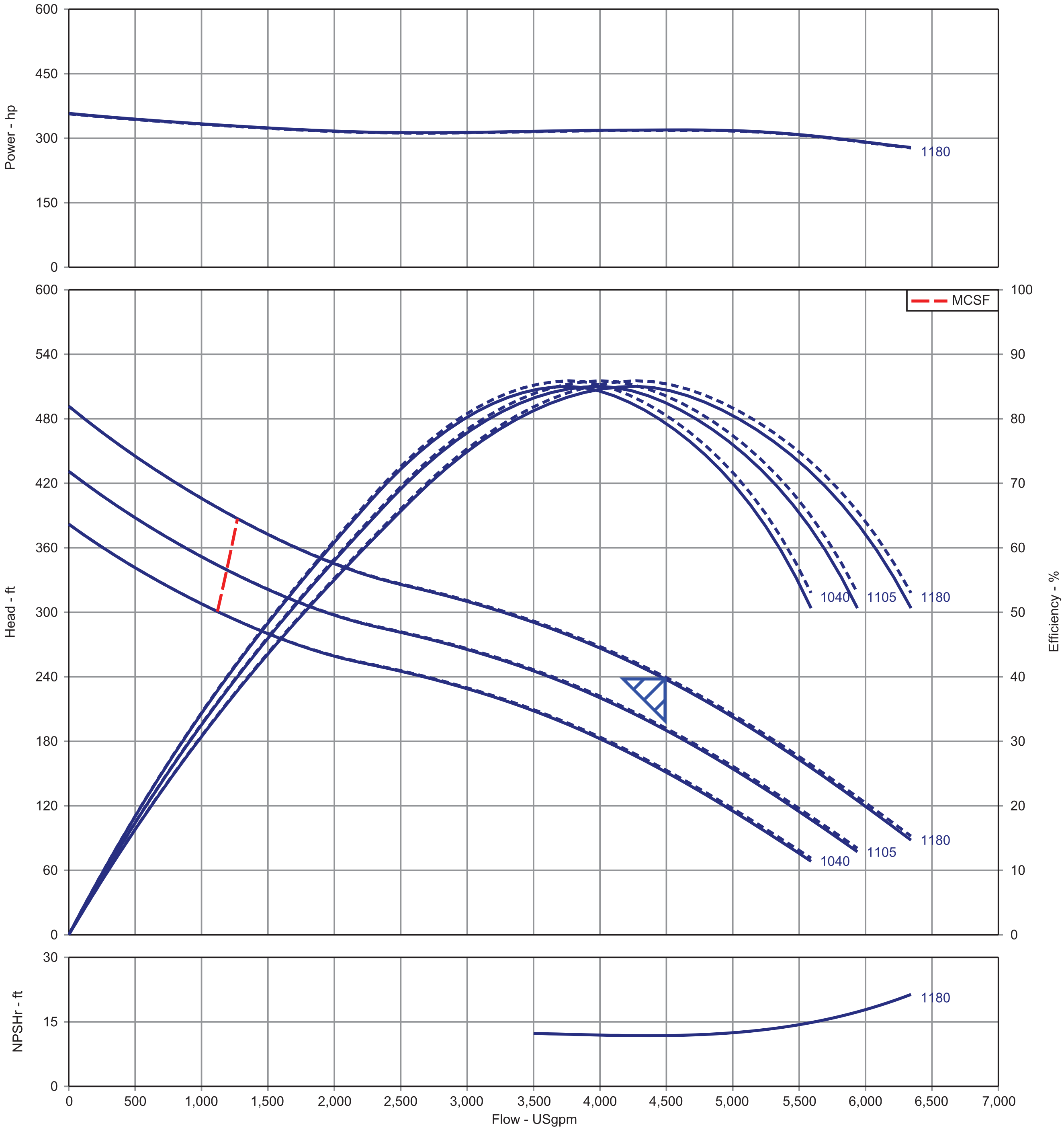
Driver sizing specification	: Max power + 5%
Margin over specification	: 0.00 %
Service factor	: 1.00
Power, hydraulic	: 272 hp
Power (bowl / pump)	: 318 / 319 hp
Power, maximum, rated diameter	: 358 hp
Minimum recommended motor rating	: 400 hp / 298 kW

Pump and bowl (dashed) performance. Bowl adjusted for construction and viscosity.
Pump further adjusted for friction and power losses of lineshaft and thrust bearings. Pump is not adjusted for any static lift.
The duty point represents the head at the low liquid level.



Multi-Speed Performance Curve

Pump and bowl (dashed) performance. Bowl adjusted for construction and viscosity.
Pump further adjusted for friction and power losses of lineshaft and thrust bearings. Pump is not adjusted for any static lift.
The duty point represents the pump performance head.



Customer	:	Pump Type	: 22BKL	Quote number	: 205132
Address	: , ,	# of Stages	: 5	Customer PO #	:
Location	:	Quantity	: 2	CO #	:
Project	: SOR - Lytle Creek Pump-back	Flow	: 4,490.0 USgpm	Item #	: 001
Tag	:	Head	: 238.0 ft	JOL #	:
Bowl/Pump	:	Speed	: 1,180 rpm	Serial #	:
Eff (bowl / pump)	: 85.47 / 84.52 %	Fluid Density	: 1.000 / 1.000 SG	Drawing #	:
Power (bowl / pump)	: 318 / 319 hp	Viscosity	: 1.00 cP	Drawn By	:
NPSH required	: 11.81 ft	Impeller Trim	: 12.41 in	Last Modified	: 12 Jan 2012 3:53 PM

The head and power may be different than that shown in accordance with Hydraulic Institute / API 610 Standards
Additional Notes:

Ochoco Irrigation District - System Optimization Review
Lytle Creek Pump-back Pumping Plant (Construction of New Facilities, 20 CFS, 28-inch HDPE Discharge Main)
Budget Level - Projection of Probable Construction Cost

Item No.	Spec Division	Description	Measurement	Units	Unit Cost	Total Cost
1	0000	Easement Procurement	Acre	13	$3,000.00	$39,000.00
2	1000	Mobilization	LS	1	$118,000.00	$118,000.00
3	1000	Erosion Control	LS	1	$15,000.00	$15,000.00
4	1000	Watering / Dust Control	LS	1	$5,000.00	$5,000.00
5	1000	Construction Staking	LS	1	$12,500.00	$12,500.00
6	1000	Project Management and Coordination	LS	1	$15,000.00	$15,000.00
7	1000	Construction Progress Documentation	LS	1	$7,500.00	$7,500.00
8	1000	Submittal Procedures	LS	1	$7,500.00	$7,500.00
9	1000	Quality Requirements	LS	1	$10,000.00	$10,000.00
10	1000	Selective Demolition	LS	1	$10,000.00	$10,000.00
11	1000	Traffic Control	LS	1	$5,000.00	$5,000.00
12	1000	Project Record Documents	LS	1	$7,500.00	$7,500.00
13	1000	Operations and Maintenance Data	LS	1	$7,500.00	$7,500.00
14	1000	General Commissioning Requirements	LS	1	$7,500.00	$7,500.00
15	2000	Erosion Control Silt Fence	LF	5,000	$2.40	$12,000.00
16	2000	Perimeter Fence, 8 ft coated wire chain link	LF	120	$18.00	$2,160.00
17	2000	Fence Gate	LS	1	$2,500.00	$2,500.00
18	2000	Dewatering	LS	1	$2,500.00	$2,500.00
19	2000	Bulk Excavation	CY	220	$7.00	$1,540.00
20	2000	Hauling	CY	4,040	$12.00	$48,480.00
21	2000	Trench Excavation, 5-8 ft depth trench box	CY	21,950	$7.00	$153,650.00
22	2000	Structural Backfill	CY	50	$38.00	$1,900.00
23	2000	Trench Backfilling	CY	18,130	$3.10	$56,203.00
24	2000	Bore and Jack 36" Steel Casing	LF	60	$250.00	$15,000.00
25	2000	Aggregate Base	CY	10	$38.00	$380.00
26	2000	Surfacing Rock	CY	100	$38.00	$3,800.00
27	2000	AC Pavement Reconstruction	SY	75	$75.00	$5,625.00
28	2000	Access Manhole	EA	18	$7,500.00	$135,000.00
29	2000	Restoration Seeding	AC	13	$1,500.00	$19,500.00
30	3000	Cast-in-Place Concrete	CY	20	$550.00	$11,000.00
31	3000	Misc Cast-in-Place Concrete (thrust and pads)	LS	1	$5,500.00	$5,500.00
32	6000	Handrail	LS	1	$250.00	$250.00
33	6000	Trash Rack	LS	1	$5,000.00	$5,000.00
34	9000	High Performance Coating Systems	LS	1	$5,000.00	$5,000.00
35	11000	Air Release / Vacuum Relief Stations	EA	2	$20,000.00	$40,000.00
36	11000	Line Shaft Turbine Pump and Motor, 400 HP	EA	2	$107,800.00	$215,600.00
37	15000	28-inch Steel Discharge Pipe, poly x poly, welded	LF	3,430	$100.10	$343,343.00
38	15000	32-inch IPS HDPE, DR17 Discharge Pipe, welded	LF	15,000	$100.10	$1,501,500.00
39	15000	14-inch Discharge Pipe, Fittings, & Accessories	EA	2	$5,000.00	$10,000.00
40	15000	14-inch Butterfly Valve	EA	2	$2,500.00	$5,000.00
41	15000	14-inch Surge Control Check Valve	EA	2	$9,375.00	$18,750.00
42	15000	Flap Gate	EA	1	$6,000.00	$6,000.00
43	16000	Power and Distribution	LS	1	$30,000.00	$30,000.00
44	16000	Grounding Systems	LS	1	$3,000.00	$3,000.00
45	16000	Motor Controls including VFD Driver	LS	1	$50,000.00	$50,000.00
46	17000	Instrumentation and Control	LS	1	$15,000.00	$15,000.00
		Construction Subtotal				$2,953,181.00
		Contractors Overhead and Profit	10%	1	$295,318.10	$295,318.10
		Contractors Bonds and Insurance	2%	1	$64,969.98	$64,969.98
		Construction Contingency	30%	1	$885,954.30	$885,954.30
		Construction Total				$4,199,423.38
		Engineering, Administration	25%	1	$1,049,855.85	
		Total				**$5,249,279.23**

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VFD Analysis

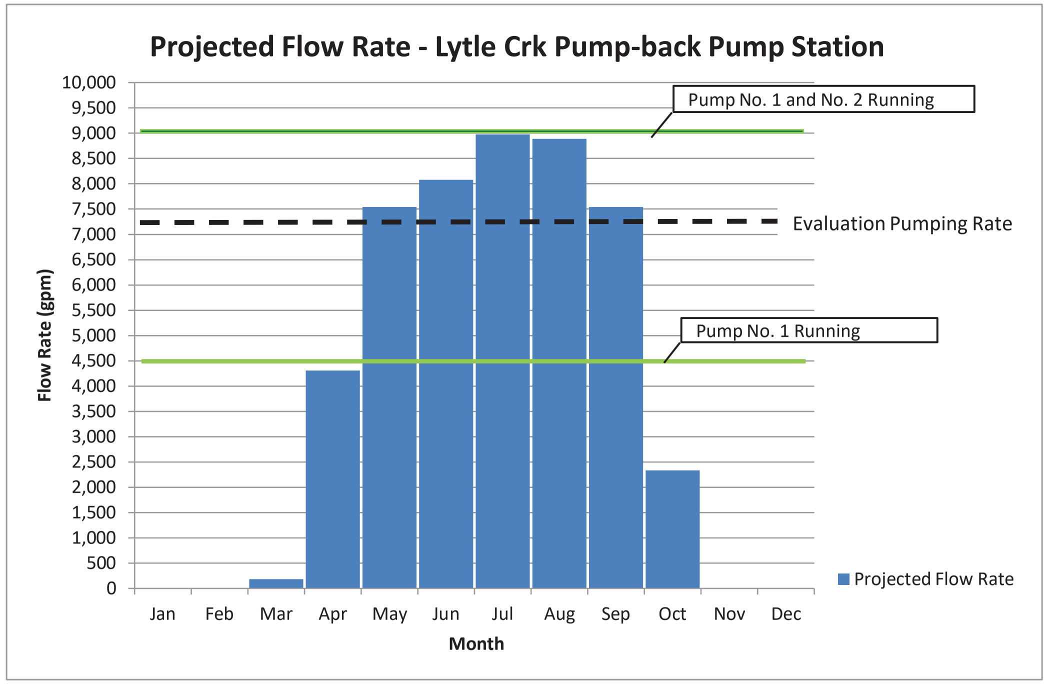
Pump to Canal Head Loss Calculations
Lytle Creek Pump-back Pumping Plant

4,490	GPM	Vertical Turbine Pump No. 1		
4,490	GPM	Vertical Turbine Pump No. 2		
8,980	GPM	Total	=	**20.0 cfs**

Proposed PS Design Flow Rate = 8,980 gpm

Month	% of Max Flow Rate	Projected Flow Rate
Jan	0%	0
Feb	0%	0
Mar	2%	180
Apr	48%	4,310
May	84%	7,543
Jun	90%	8,082
Jul	100%	8,980
Aug	99%	8,890
Sep	84%	7,543
Oct	26%	2,335
Nov	0%	0
Dec	0%	0

Evaluation Pumping Rate = 7,176 gpm
16.0 cfs



Notes: The proposed Lytle Creek Pump-back Pumping Plant as proposed includes (2) Turbine Pumps. To optimize water delivery to crop requirement and reduce energy use, VFD operation of Pump No. 1 would provide benefit.

Wire to Water Energy Calculator

Ochoco Irrigation District - SOR

Lytle Creek Pump-back Pumping Plant - 20 CFS

Source: PumpTech Inc.

2425 SE Ochoco Street

Portland, OR 97222

503-659-6230

OPERATIONAL AND EQUIPMENT DATA

	28" Discharge Main		26" Discharge Main	
	No. 1 - Weir Floway 22 BKL, 5 Stage, 1180 RPM, 400 HP		No. 1 - Weir Floway 22 BKL, 6 Stage, 1180 RPM, 400 HP	
	No. 2 - Weir Floway 22 BKL, 5 Stage, 1180 RPM, 400 HP		No. 2 - Weir Floway 22 BKL, 6 Stage, 1180 RPM, 400 HP	
Discharge Main Length	18,430		18,430	
Pump Operation - Hours / Day	24		24	
Pump Operation - Days / Year	198		198	
Pump Flow - GPM (Evaluation Pump Rate)	7,176		7,176	
Pump Flow - CFS	16.0		16.0	
Total Annual Volume - Acre feet	6,280		6,280	
Pump Head - Feet	222.0	*	232.0	*
Ave. Pump Efficiency - %	84.6%	**	83.3%	**
Ave. Motor Efficiency - %	93.0%	***	93.0%	***
Energy Cost in $/kW-hr	$0.035		$0.035	

* Pump head based on system curve for evaluation pumping rate using the stated discharge main diameter.

** Pump efficiency based on published pump efficiency of selected units operating at rated capacity and head.

*** Motor efficiency base on use of premium efficiency induction type motors with a 93% efficiency rating.

RESULTS

	28" Discharge Main	26" Discharge Main
BHP At Design Point	475.5	504.7
Wire to Water Efficiency - %	78.7%	77.5%
kW-hr per Year	1,812,601	1,923,812
Annual Energy Cost	$63,441.03	$67,333.41
kW-hr Per 1,000 Gallons Pumped	0.886	0.940
Cost Per 1,000 Gallons Pumped	$0.031	$0.033
kW-hr per Acre Foot Pumped	289	306
Cost Per Acre Foot Pumped	$10.10	$10.72

PAYBACK

Annual Savings with use of larger pipe - kW-hr				111,211	
Annual Savings with use of larger pipe - $$				$3,892.38	
Annual Savings with use of larger pipe - %				5.78%	
Cost of 28-inch Discharge Main	$90.10	(cost / lf raw material)		$1,660,543.00	
Cost of 26-inch Discharge Main	$79.50	(cost / lf raw material)		$1,465,185.00	
Payback with use of larger pipe - Years				50.2	
Total Cost of Pumping Plant		$5,249,000.00	*	$4,856,000.00	*

* Estimated cost of pumping plant construction complete including (2) pumps and (2) VFD drivers.

DELIVERABLES – TAB 3

Ranked List of Measurement/Telemetry Needs

I. Measurement and Telemetry

The Ochoco Irrigation District has historically utilized a variety of measurement and telemetry devices. Main diversion sites (Ochoco Reservoir, Ochoco Creek at Ochoco Reservoir and Crooked River Diversion Canal headworks) include telemetry uplinks to the United States Bureau of Reclamation's HYDROMET site. Other sites either have local telemetry or data collection devices or are simply read from fixed staff gauges. A list of existing telemetry sites is provided in the table below.
Mapping of existing telemetry sites is indicated on the System Optimization Review Base Map.

Through this SOR program, the District has further evaluated its existing measurement locations and has considered a variety of new sites and the associated telemetry that would enhance its ability to understand, maintain a record of, and make decisions related to tail-water and in-district flow rates. Four of these identified sites are to be constructed and/or enhanced with telemetry data collection capability. Six other sites (ranked #5-#10) are desired and are to be constructed in the future subject to funding and staff availability for construction.

OCHOCO IRRIGATION DISTRICT TELEMETRY

Ochoco Irrigation District System Optimization Review

December, 2012 Black Rock Consulting

Site Description	Type of Measurement Section	Telemetry In lace	SOR Action to Install Telemetry	Future Action Rank
EXISTING TELEMETRY TES:				
OchocoĀMainĀ@ĀReservoir.	Rated Section	Yes - Hydromet		
Ochoco Creek @ Reservoir	Cipoletti Weir	Yes - Hydromet		
Crooked River Diversion Canal	Rated Section	Yes - Hydromet		
Johnson reek mp at Discharge	Rectangular Weir	No		
Johnson reek anal At Return	Rectangular Weir	No		
Ochoco Main @ Lytle Creek Spill	Rectangular Weir	Yes		
Lytle Creek at Gerke Rd	Ramp Flume	Yes		
Gap Spill at Crooked River	Ramp Flume	Yes		
Crooked River Check Below Pump ection 13	Rectangular Weir	No		
Crooked River Distribution Spill to Lytle Creek	Ramp Flume	Yes		
Ryegrass Spill to McKay	Rectangular Weir	No		
PROPOSED TELEMETRY SITES:				
Head of Ochoco Main Canal	Ramp Flume (Not Existing)	No	Yes	#4
Jones Dam	Rectangular Weir	No	Yes	#2
Lytle Creek - Campbell Ranch Road	Rectangular Weir	No	Yes	#3
Crooked River Diversion Canal	Rectangular Weir	No	Yes	#1
@ Ochoco Creek Combs Flat				
Reynolds Dam	Rectangular Weir	No		#5
D-2 Drain	Rectangular Weir	No		#8
D-8 Drain to McKay	Rectangular Weir	No		#9
Johnson Creek	Rectangular Weir	No		#10
Grimes Flat West	Rectangular Weir	No		#6
Grimes Flat East	Rectangular Weir	No		#7

DELIVERABLES – TAB 4

Cost/Benefit Analysis of Moving Crooked River Diversion 6 Miles Downstream

BARNES BUTTE PUMPING PLANT NEW SITE ON CROOKED RIVER

ALT 3: 63-INCH HDPE - EVALUATION SUMMARY

The current Barnes Butte pump site is at the foot of Barnes Butte, about 0.75 miles east of the Prineville city limits. The Barnes Butte facility was originally designed for 115.5 cubic feet per second (CFS) at 82 feet total dynamic head (TDH). The original installation circa 1961 was comprised of (4) horizontal split case pumps with synchronous motors totaling 1,500 HP. A fifth 300 HP, horizontal split case pump was added at a later date. The current facility consisting of five pumping units totaling 1,800 horsepower lifts approximately 135 CFS at 86 feet TDH from the end of the Crooked River diversion canal to the head of the distribution canal. The discharge main consists of approximately 1,600 feet of 54-inch I.D. concrete pipe.

Original Design

Pump Unit	Description	HP	Rated Capacity	Rated Head	Pump Eff. @ Rated Capacity	Pipe Size	Discharge Pipe Vel.	Discharge Main Vel.
No. 1	Horizontal Split Case	500	17,300 GPM	82 FT	84 %	24 IN	12.3 FPS	
No. 2	Horizontal Split Case	500	17,300 GPM	82 FT	84 %	24 IN	12.3 FPS	
No. 3	Horizontal Split Case	250	8,640 GPM	82 FT	80 %	16 IN	13.8 FPS	
No. 4	Horizontal Split Case	250	8,640 GPM	82 FT	80 %	16 IN	13.8 FPS	
Total		1,500	51,880 GPM	82 FT		54 IN		7.3 FPS

Current Condition (Ref. Initial Pump Evaluation BPA, 2010)

Pump Unit	Description	HP	Test Capacity	Test Head	Pump Eff. @ Test Capacity	Pipe Size	Discharge Pipe Vel.	Discharge Main Vel.
No. 1	Horizontal Split Case	500	17,431 GPM *	73 FT *	80 % *	24 IN	12.4 FPS	
No. 2	Horizontal Split Case	500	16,633 GPM *	76 FT *	79 %	24 IN	11.8 FPS	
No. 3	Horizontal Split Case	250	9,460 GPM	77 FT	80 % **	16 IN	15.1 FPS	
No. 4	Horizontal Split Case	250	7,910 GPM *	75 FT *	80 % **	16 IN	12.6 FPS	
No. 5	Horizontal Split Case	300	9,037 GPM	76 FT	68 %	16 IN	14.4 FPS	
Total		1,800	60,471 GPM			54 IN		8.5 FPS

* Minimum value of (2) test data points, ref. Initial Pump Evaluation, BPA, 2010

** Measured pump efficiency at the test capacity was greater than the factory curve. Factory curve data for efficiency at rated capacity used in evaluating pumping plant efficiency.

Alternate Equipment (Replace existing pump station with (5) vertical turbines at new location on Crooked River and installation of a new 63-inch HDPE discharge main)

Pump Unit	Description	HP	Rated Capacity	Rated Head	Pump Eff. @ Rated Capacity	Pipe Size	Discharge Pipe Vel.	Discharge Main Vel.
No. 1	Vertical Turbine	600	15,300 GPM	137 FT	88.2 %	24 IN	10.9 FPS	
No. 2	Vertical Turbine	600	15,300 GPM	137 FT	88.2 %	24 IN	10.9 FPS	
No. 3	Vertical Turbine	600	15,300 GPM	137 FT	88.2 %	24 IN	10.9 FPS	
No. 4	Vertical Turbine	600	15,300 GPM	137 FT	88.2 %	24 IN	10.9 FPS	
No. 5	Vertical Turbine	600	15,300 GPM	137 FT	88.2 %	24 IN	10.9 FPS	
Total		3,000	76,500 GPM	137 FT		63 IN		9.8 FPS

Narrative

Initial evaluation of alternatives for a new Barnes Butte Pumping Plant on the Crooked River examined four potential options related to the size and diameter of the discharge main. Alternative 1 proposed 63-inch HDPE for new discharge main piping, slip lining the existing Barnes Butte inlet pipe with 54-inch HDPE, and using the existing 54-inch concrete discharge pipe to the outlet at the distribution canal. Alternative 1 was dismissed due to velocity, head loss, and energy requirements incurred in the 54-inch pipe sections. Alternative 2 proposed 63-inch HDPE for the new discharge pipe, replacing the existing Barnes Butte inlet pipe alignment with 63-inch HDPE, and using the existing 54-inch concrete discharge pipe to the outlet at the distribution canal. Alternative 2 was dismissed due to velocity, head loss, and energy requirements incurred by 54-inch pipe. Alternative 3 (Alt 3) discussed here proposes using 63-inch HDPE for the entire length of the discharge main from the new pump station location to the outlet at the distribution canal. The existing Barnes Butte inlet pipe alignment and existing 54-inch concrete discharge pipe to the outlet at the distribution canal would be replaced with the new 63-inch HDPE pipe. Alternative 4 (Alt 4) is evaluated in a separate section. Alt 4 proposes new 72-inch steel discharge pipe including full replacement of existing pipe on the existing Barnes Butte inlet and discharge alignment.

Evaluation of the Barnes Butte New Site on the Crooked River - Alt 3 examines potential energy efficiency gained by constructing a new Barnes Butte Pumping Plant at a new pump station location on the Crooked River near the southwest corner of the Crook County Fairgrounds property. The new pumping plant would be served by a newly constructed diversion, fish screen, and approximately 1,200 feet of 96-inch pump station inlet pipe. The new pumping plant would utilize (5) new vertical turbine pumps. New pumps would be installed in a newly constructed wet well configuration. The concept layout of the Barnes Butte New Alt. 3 wet well is similar to the configuration shown in the Barnes Butte Reconstruction analysis. The new pumping plant would be connected to a new discharge main consisting of approximately 3,762 feet of nominal 63-inch HDPE pipe following an alignment east until intersecting the alignment of the existing inlet pipe serving the existing Barnes Butte Pumping Plant. The existing inlet pipe would be replaced with approximately 4,829 feet of nominal 63-inch HDPE pipe continuing north to the alignment of the existing Barnes Butte Pumping Plant discharge main. The existing Barnes Butte Pumping Plant discharge main would be replaced with approximately 1,603 feet of nominal 63-inch HDPE pipe to the current outlet location on the Barnes Butte discharge canal.

New electrical service would be extended from power lines on Fairgrounds Road. New electrical systems including transformer, service entrance, motor starters, controls, and telemetry would be constructed at the new pump station location. New synchronous motors would be installed with the new pumps.

With five new pumps available to meet irrigation season demand variations, integration of variable speed drive equipment into alternate pump equipment would not appear to provide significant energy savings.

The capacity of the reconstructed pump station is anticipated to be approximately 170 CFS at 137 feet TDH.

Wire to water energy analysis is based on the projected capacity of the new Barnes Butte Pumping Plant constructed with new vertical turbine pumps connected to a 63-inch HDPE discharge main. The Barnes Butte Pumping Plant constructed at a new Crooked River location with new vertical turbine pumps is projected to provide a seasonal average flow of 61,134 gpm (136.2 CFS) at 122.4 feet TDH. The existing Barnes Butte Pumping plant in its current condition is projected to yield 136.2 CFS at 86.2 feet TDH.

Action Recommended for Further Evaluation: **Construct new pumping plant at new location on Cooked River, vertical turbine pumps, 63-inch HDPE discharge main**

New No. 1 pump, Vertical Turbine Pump

New No. 2 pump, Vertical Turbine Pump

New No. 3 pump, Vertical Turbine Pump

New No. 4 pump, Vertical Turbine Pump

New No. 5 pump, Vertical Turbine Pump

New pump discharge piping and valves

New electrical service entrance and motor starters

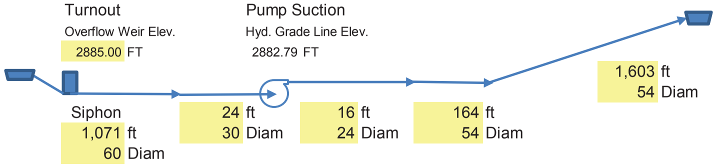
New 63-inch HDPE discharge main

Annual Energy Savings Estimate = **- 1,479,627 kW-hr**

Initial Cost Estimate = **$19,141,000**

Pump to Canal Head Loss Calculations
Barnes Butte Pumping Plant New Site (New Vert. Turbine PS on Crooked River)

17,300	GPM	Horizontal Split Case Pump No. 1	
17,300	GPM	Horizontal Split Case Pump No. 2	
8,640	GPM	Horizontal Split Case Pump No. 3	Static Head = 68.03 FT
8,640	GPM	Horizontal Split Case Pump No. 4	
	GPM	Horizontal Split Case Pump No. 5	
51,880	GPM	Total = 115.6 cfs	



Diam. (Discharge Pipe) = 54 in
Total Discharge Pipe Length = 1,807 ft
Equiv. Pipe Length Valves & Fittings Pump Discharge = 91 ft
Equiv. Pipe Length Valves & Fittings Discharge Header = 241 ft

60" Siphon Pipe	Friction Head =	2.07 FT per 1,000 FT	Concrete
(Vel. = 5.9 fps)	Dynamic Head =	2.21 FT total	C = 110
30" Inlet Pipe	Friction Head =	5.40 FT per 1,000 FT	Steel
(Vel. = 7.9 fps)	Dynamic Head =	0.13 FT total	C = 135
24" Discharge Piping	Friction Head =	16.00 FT per 1,000 FT	Steel
(Vel. = 12.3 fps)	Dynamic Head =	0.26 FT total	C = 135
54" Header	Friction Head =	2.36 FT per 1,000 FT	Steel
(Vel. = 7.3 fps)	Dynamic Head =	0.39 FT total	C = 135
54" Discharge	Friction Head =	3.45 FT per 1,000 FT	Concrete
(Vel. = 7.3 fps)	Dynamic Head =	5.53 FT total	C = 110
Equivalent Pipe Length	Friction Head =	16.00 FT per 1,000 FT	Steel
Valves & Fittings Pump Discharge	Dynamic Head =	1.46 FT total	C = 135
Equivalent Pipe Length	Friction Head =	2.36 FT per 1,000 FT	Steel
Valves & Fittings Discharge Header	Dynamic Head =	0.57 FT total	C = 135
	Friction Head =	8.33 FT =	3.60 psi
	Water Depth in Discharge Canal =	4.07 FT =	1.76 psi
	Total Dynamic Head =	82.64 FT =	35.78 psi

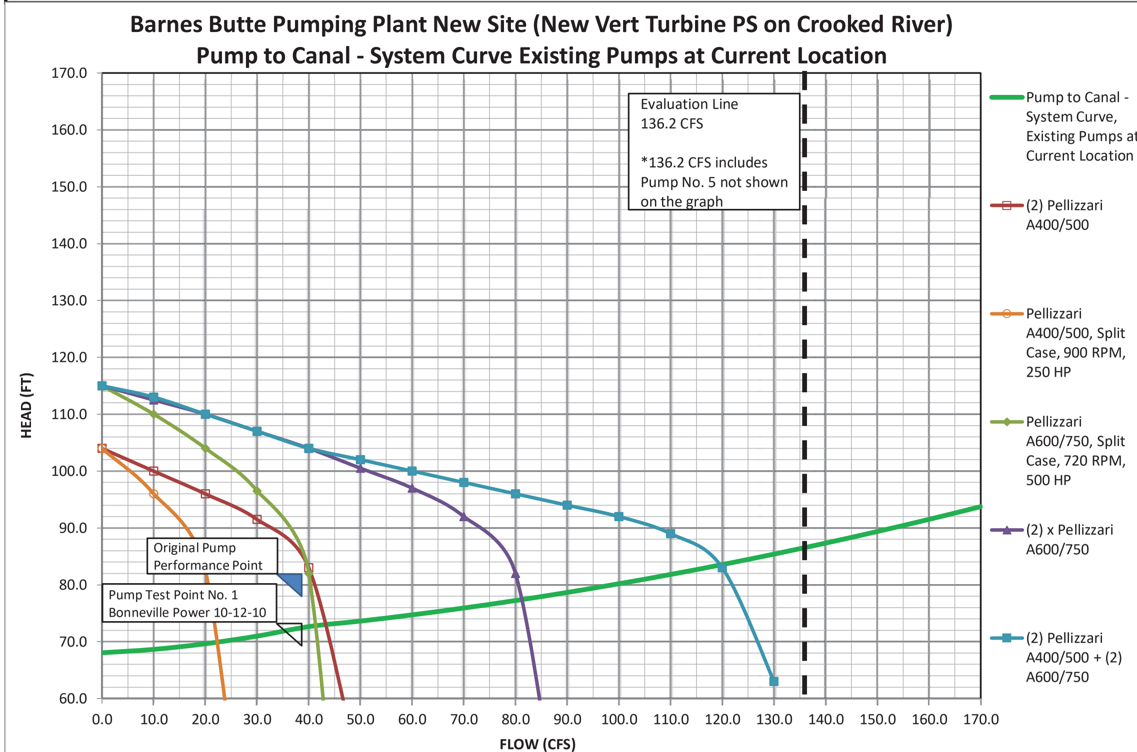
Equivalent Pipe Length Totals:

Item	24" Equiv. Length	No. of Units	Total Equiv. Length
60" to 30" square edged inlet	85 ft	1 ea	85 ft
30" pump isolation (gate) valve	3 ft	1 ea	3 ft
24" pump control (gate) valve	3 ft	1 ea	3 ft
30-inch 30 degree bend	20 ft	0 ea	0 ft
		Subtotal	91 ft

Item	54" Equiv. Length	No. of Units	Total Equiv. Length
24"x54" tee branch flow	40 ft	1 ea	40 ft
54" flow meter	1 ft	1 ea	1 ft
54"x24" tee in-line flow	30 ft	4 ea	120 ft
54"x60" expander	5 ft	1 ea	5 ft
54" 45 bend	20 ft	2 ea	40 ft
54" 11.25 bend	10 ft	2 ea	20 ft
54" flap gate	15 ft	1 ea	15 ft
		Subtotal	241 ft

Barnes Butte Pumping Plant New Site (New Vertical Turbine PS on Crooked River)
Pump to Canal - System Curve, Existing Pumps at Current Location

Q (gpm)	0	4,488	8,976	13,464	17,952	22,440	26,928	31,416	35,904	40,392	44,880	49,368	53,856	58,344	62,832	67,320	71,808	76,296
Q (cfs)	0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0	170.0
Hf	0.0	0.6	1.6	2.9	4.6	5.6	6.7	7.9	9.2	10.6	12.1	13.8	15.5	17.4	19.3	21.3	23.5	25.7
TDH (ft)	68.0	68.6	69.6	71.0	72.6	73.6	74.7	75.9	77.2	78.6	80.2	81.8	83.6	85.4	87.3	89.4	91.5	93.7
Vel. Disch. (fps)	0.0	0.6	1.3	1.9	2.5	3.1	3.8	4.4	5.0	5.7	6.3	6.9	7.5	8.2	8.8	9.4	10.1	10.7



Pellizzari A400/500, Split Case, 900 RPM, 250 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	104	96	83	10														

(2) Pellizzari A400/500

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	104	100	96	92	83	47	10											

Pellizzari A600/750, Split Case, 720 RPM, 500 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	115	110	104	97	82	-20												

(2) x Pellizzari A600/750

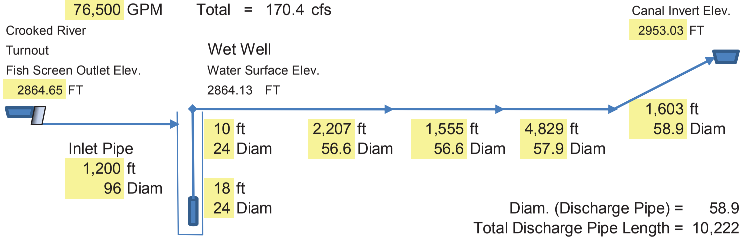
Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	115	113	110	107	104	101	97	92	82	29	-20							

(2) Pellizzari A400/500 + (2) A600/750

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	115	113	110	107	104	102	100	98	96	94	92	89	83	63				

Pump to Canal Head Loss Calculations - ALT 3 HDPE 63-inch ENTIRE LENGTH
Barnes Butte Pumping Plant New Site (new vert. turbine PS on Crooked River)

15,300 GPM	Vertical Turbine Pump No. 1		
15,300 GPM	Vertical Turbine Pump No. 2		
15,300 GPM	Vertical Turbine Pump No. 3	Static Head =	88.38 FT
15,300 GPM	Vertical Turbine Pump No. 4		
15,300 GPM	Vertical Turbine Pump No. 5		
76,500 GPM	Total = 170.4 cfs		



Diam. (Discharge Pipe) =	58.9 in
Total Discharge Pipe Length =	10,222 ft
Equiv. Pipe Length Valves & Fittings Pump Discharge =	370 ft
Equiv. Pipe Length Valves & Fittings Discharge Header =	1243 ft

96" Inlet Pipe	Friction Head =	0.43	FT per 1,000 FT	Concrete
(Vel. = 3.4 fps)	Dynamic Head =	0.52	FT total	C = 110
24" Column Pipe	Friction Head =	12.75	FT per 1,000 FT	Steel
(Vel. = 10.9 fps)	Dynamic Head =	0.23	FT total	C = 135
24" Pump Discharge Piping	Friction Head =	12.75	FT per 1,000 FT	Steel
(Vel. = 10.9 fps)	Dynamic Head =	0.13	FT total	C = 135
63" HDPE Discharge Main	Friction Head =	3.85	FT per 1,000 FT	HDPE, DR2
(Vel. = 9.8 fps)	Dynamic Head =	8.50	FT total	C = 135
63" HDPE Discharge Main	Friction Head =	3.25	FT per 1,000 FT	HDPE, DR2
(Vel. = 8.9 fps)	Dynamic Head =	5.05	FT total	C = 135
63" HDPE Discharge Main	Friction Head =	2.91	FT per 1,000 FT	HDPE, DR2(
(Vel. = 8.5 fps)	Dynamic Head =	14.05	FT total	C = 135
63" HDPE Discharge Main	Friction Head =	2.68	FT per 1,000 FT	HDPE, DR3:
(Vel. = 8.2 fps)	Dynamic Head =	4.29	FT total	C = 135
Equivalent Pipe Length Valves & Fittings Pump Discharge	Friction Head =	12.75	FT per 1,000 FT	Steel
	Dynamic Head =	4.72	FT total	C = 135
Equivalent Pipe Length Valves & Fittings Discharge Header	Friction Head =	3.85	FT per 1,000 FT	Steel
	Dynamic Head =	4.79	FT total	C = 135

Friction Head =	41.75	FT =	18.08 psi
Water Depth in Discharge Canal =	5.48	FT =	2.37 psi
Total Dynamic Head =	136.13	FT =	58.93 psi

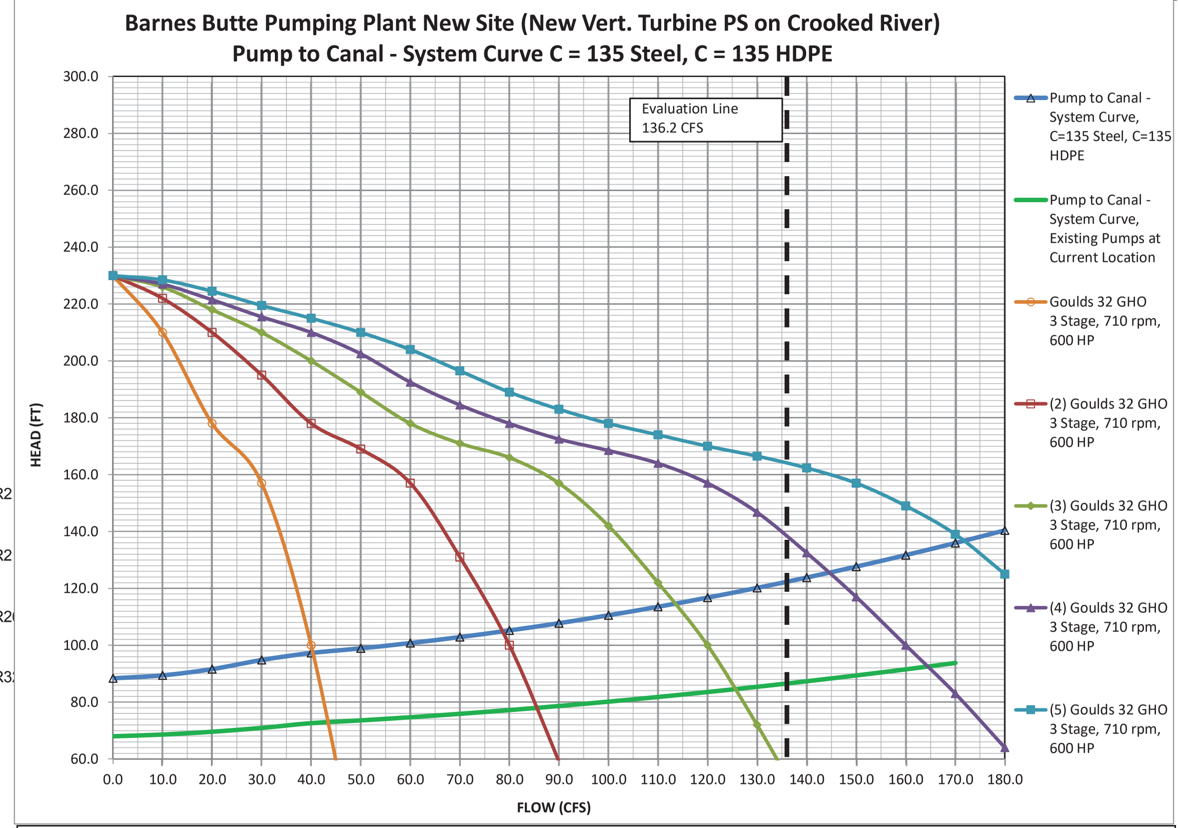
Equivalent Pipe Length Totals:

Item	24" Equiv. Length	No. of Units	Total Equiv. Length
24" pump discharge head	250 ft	1 ea	250 ft
24" pump control (butterfly) valve	80 ft	1 ea	80 ft
24" 45 bend	40 ft	1 ea	40 ft
		Subtotal	370 ft

Item	54" Equiv. Length	No. of Units	Total Equiv. Length
24"x54" tee branch flow	290 ft	1 ea	290 ft
54" flow meter	8 ft	1 ea	8 ft
24"x30" tee in-line flow	90 ft	4 ea	360 ft
54" reducer / expander	80 ft	2 ea	160 ft
54" 45 bend	90 ft	3 ea	270 ft
54" 11.25 bend	45 ft	3 ea	135 ft
54" flap gate	20 ft	1 ea	20 ft
		Subtotal	1243 ft

Barnes Butte Pumping Plant New Site
Pump to Canal - System Curve, C=135 Steel, C=135 HDPE

Q (gpm)	0	4,488	8,976	13,464	17,952	22,440	26,928	31,416	35,904	40,392	44,880	49,368	53,856	58,344	62,832	67,320	71,808	76,301	80,789
Q (cfs)	0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0	170.0	180.0
Hf	0.0	1.0	3.2	6.4	8.9	10.5	12.4	14.5	16.8	19.4	22.2	25.2	28.4	31.8	35.4	39.3	43.3	47.6	52.0
TDH (ft)	88.4	89.4	91.6	94.8	97.3	98.9	100.8	102.9	105.2	107.8	110.5	113.5	116.7	120.2	123.8	127.6	131.7	135.9	140.4
Vel. Disch. (fps)	0.0	0.5	1.1	1.6	2.1	2.6	3.2	3.7	4.2	4.8	5.3	5.8	6.3	6.9	7.4	7.9	8.5	9.0	9.5



Goulds 32 GHO 3 Stage, 710 rpm, 600 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302	80,790
Head (ft)	230	210	178	157	100	15													

(2) Goulds 32 GHO 3 Stage, 710 rpm, 600 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302	80,790
Head (ft)	230	222	210	195	178	169	157	131	100	59	15								

(3) Goulds 32 GHO 3 Stage, 710 rpm, 600 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302	80,790
Head (ft)	230	226	218	210	200	189	178	171	166	157	142	122	100	72	42	15			

(4) Goulds 32 GHO 3 Stage, 710 rpm, 600 HP

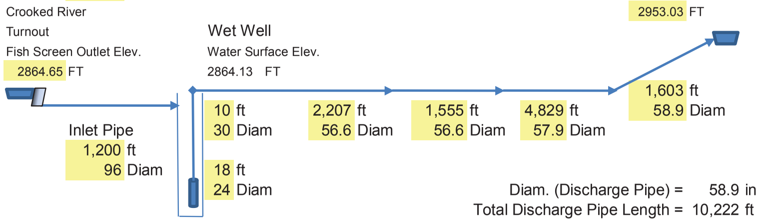
Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302	80,790
Head (ft)	230	227	222	216	210	203	193	185	178	173	169	164	157	147	133	117	100	83	64

(5) Goulds 32 GHO 3 Stage, 710 rpm, 600 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302	80,790
Head (ft)	230	229	225	220	215	210	204	197	189	183	178	174	170	167	162	157	149	139	125

Pump to Canal Head Loss Calculations - ALT 3 HDPE 63-INCH ENTIRE LENGTH
Barnes Butte Pumping Plant New Site (New Vert. Turbine PS on Crooked River)

15,300 GPM	Vertical Turbine Pump No. 1	
15,300 GPM	Vertical Turbine Pump No. 2	
15,300 GPM	Vertical Turbine Pump No. 3	Static Head = 88.38 FT
15,300 GPM	Vertical Turbine Pump No. 4	
15,300 GPM	Vertical Turbine Pump No. 5	
76,500 GPM	Total = 170.4 cfs	



Diam. (Discharge Pipe) = 58.9 in
Total Discharge Pipe Length = 10,222 ft
Equiv. Pipe Length Valves & Fittings Pump Discharge = 370 ft
Equiv. Pipe Length Valves & Fittings Discharge Header = 1243 ft

96" Inlet Pipe	Friction Head =	0.43	FT per 1,000 FT	Concrete
(Vel. = 3.4 fps)	Dynamic Head =	0.52	FT total	C = 110
24" Column Pipe	Friction Head =	12.75	FT per 1,000 FT	Steel
(Vel. = 10.9 fps)	Dynamic Head =	0.23	FT total	C = 135
30" Pump Discharge Piping	Friction Head =	4.31	FT per 1,000 FT	Steel
(Vel. = 6.9 fps)	Dynamic Head =	0.04	FT total	C = 135
63" HDPE Discharge Main	Friction Head =	3.85	FT per 1,000 FT	HDPE, DR2
(Vel. = 9.8 fps)	Dynamic Head =	8.50	FT total	C = 135
63" HDPE Discharge Main	Friction Head =	3.25	FT per 1,000 FT	HDPE, DR2
(Vel. = 8.9 fps)	Dynamic Head =	5.05	FT total	C = 135
63" HDPE Discharge Main	Friction Head =	2.91	FT per 1,000 FT	HDPE, DR2(
(Vel. = 8.5 fps)	Dynamic Head =	14.05	FT total	C = 135
63" HDPE Discharge Main	Friction Head =	2.68	FT per 1,000 FT	HDPE, DR3
(Vel. = 8.2 fps)	Dynamic Head =	4.29	FT total	C = 135
Equivalent Pipe Length Valves & Fittings Pump Discharge	Friction Head =	4.31	FT per 1,000 FT	Steel
	Dynamic Head =	1.59	FT total	C = 135
Equivalent Pipe Length Valves & Fittings Discharge Header	Friction Head =	3.85	FT per 1,000 FT	Steel
	Dynamic Head =	4.79	FT total	C = 135

Friction Head =	38.55	FT =	16.69 psi
Water Depth in Discharge Canal =	5.48	FT =	2.37 psi
Total Dynamic Head =	132.92	FT =	57.54 psi

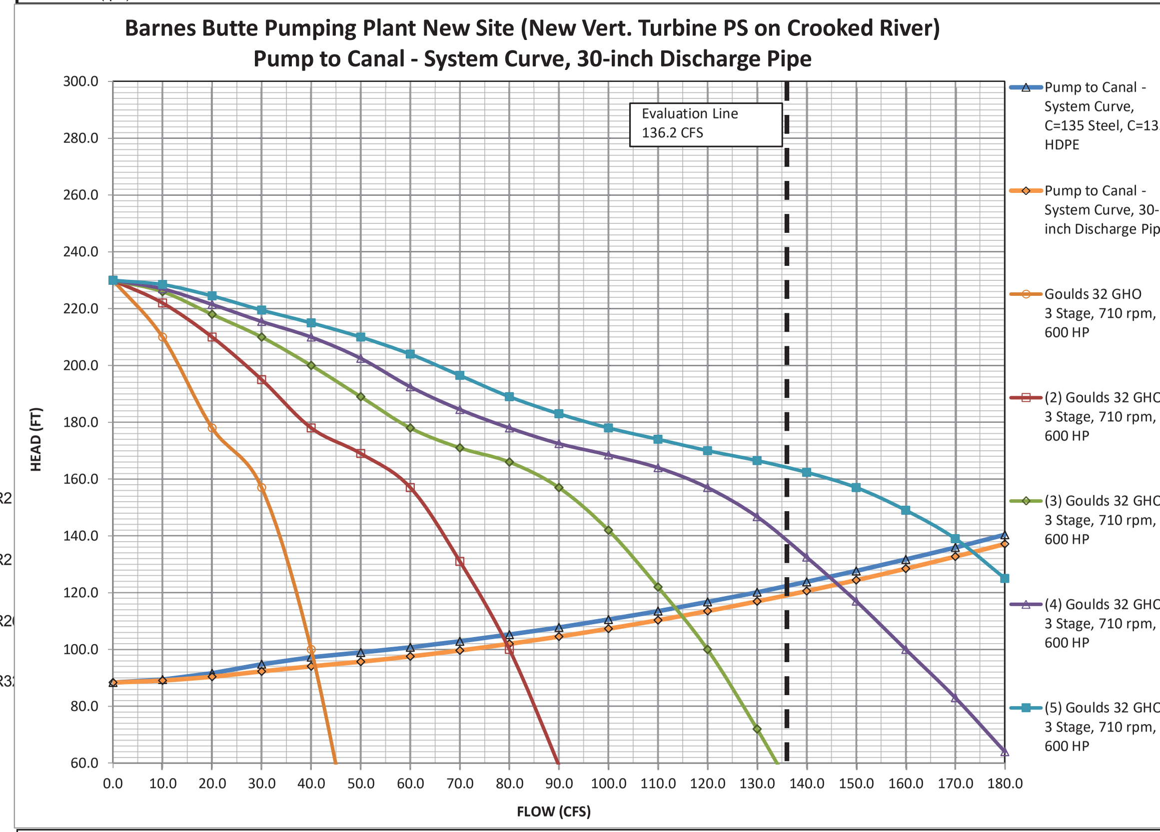
Equivalent Pipe Length Totals:

Item	24" Equiv. Length	No. of Units	Total Equiv. Length
24" pump discharge head	250 ft	1 ea	250 ft
24" pump control (butterfly) valve	80 ft	1 ea	80 ft
24" 45 bend	40 ft	1 ea	40 ft
		Subtotal	370 ft

Item	54" Equiv. Length	No. of Units	Total Equiv. Length
30"x54" tee branch flow	290 ft	1 ea	290 ft
54" flow meter	8 ft	1 ea	8 ft
30"x54" tee in-line flow	90 ft	4 ea	360 ft
54" reducer / expander	80 ft	2 ea	160 ft
54" 45 bend	90 ft	3 ea	270 ft
54" 11.25 bend	45 ft	3 ea	135 ft
54" flap gate	20 ft	1 ea	20 ft
		Subtotal	1243 ft

Barnes Butte Pumping Plant New Site (New Vert. Turbine PS on Crooked River)
Pump to Canal - System Curve, 30-inch Discharge Pipe

Q (gpm)	0	4,488	8,976	13,464	17,952	22,440	26,928	31,416	35,904	40,392	44,880	49,368	53,856	58,344	62,832	67,320	71,808	76,301	80,789
Q (cfs)	0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0	170.0	180.0
Hf	0.0	0.7	2.0	3.9	5.7	7.3	9.2	11.3	13.6	16.2	18.9	21.9	25.2	28.6	32.2	36.0	40.1	44.3	48.8
TDH (ft)	88.4	89.1	90.4	92.3	94.1	95.7	97.6	99.7	102.0	104.6	107.3	110.3	113.5	117.0	120.6	124.4	128.5	132.7	137.2
Vel. Disch. (fps)	0.0	0.5	1.1	1.6	2.1	2.6	3.2	3.7	4.2	4.8	5.3	5.8	6.3	6.9	7.4	7.9	8.5	9.0	9.5



Goulds 32 GHO 3 Stage, 710 rpm, 600 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302	80,790
Head (ft)	230	210	178	157	100	15													

(2) Goulds 32 GHO 3 Stage, 710 rpm, 600 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302	80,790
Head (ft)	230	222	210	195	178	169	157	131	100	59	15								

(3) Goulds 32 GHO 3 Stage, 710 rpm, 600 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302	80,790
Head (ft)	230	226	218	210	200	189	178	171	166	157	142	122	100	72	42	15			

(4) Goulds 32 GHO 3 Stage, 710 rpm, 600 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302	80,790
Head (ft)	230	227	222	216	210	203	193	185	178	173	169	164	157	147	133	117	100	83	64

(5) Goulds 32 GHO 3 Stage, 710 rpm, 600 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302	80,790
Head (ft)	230	229	225	220	215	210	204	197	189	183	178	174	170	167	162	157	149	139	125

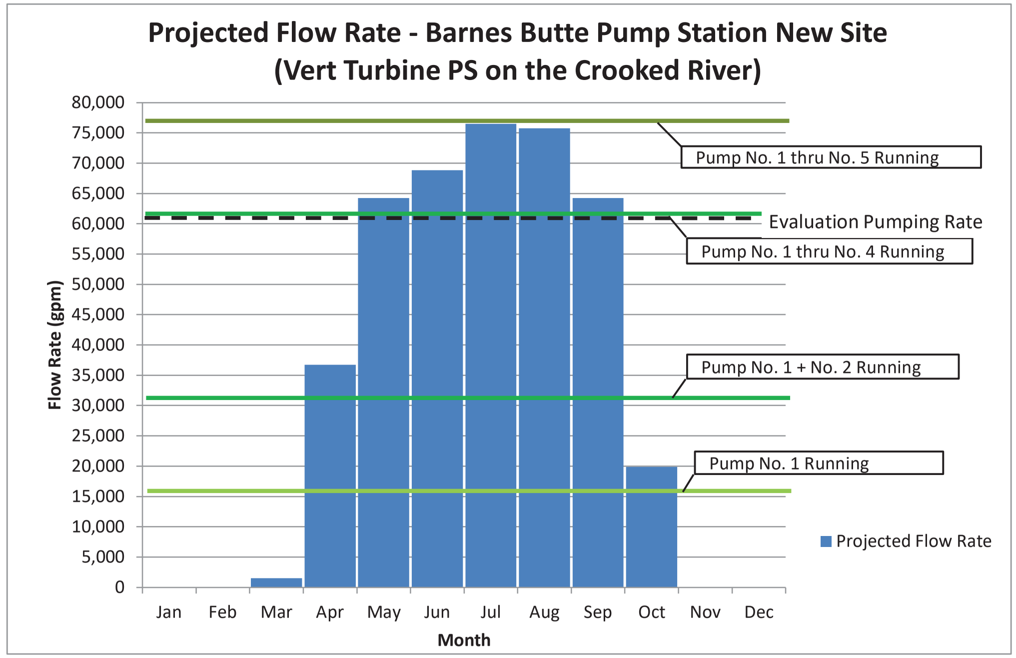
Pump to Canal Head Loss Calculations
Barnes Butte Pumping Plant New Site (New Vert. Turbine PS on the Crooked River)

15,300	GPM	Vertical Turbine Pump No. 1		
15,300	GPM	Vertical Turbine Pump No. 2		
15,300	GPM	Vertical Turbine Pump No. 3		
15,300	GPM	Vertical Turbine Pump No. 4		
15,300	GPM	Vertical Turbine Pump No. 5		
76,500	GPM	Total	=	170.4 cfs

Proposed PS Design Flow Rate = 76,500 gpm

Month	% of Max Flow Rate	Projected Flow Rate
Jan	0%	0
Feb	0%	0
Mar	2%	1,530
Apr	48%	36,720
May	84%	64,260
Jun	90%	68,850
Jul	100%	76,500
Aug	99%	75,735
Sep	84%	64,260
Oct	26%	19,890
Nov	0%	0
Dec	0%	0

Evaluation Pumping Rate = 61,134 gpm
136.2 cfs



Notes: Barnes Butte PS constructed at a new site with (5) new Vertical Turbine Pumps. VFD operation may provide benefit toward reducing energy use and optimizing water delivery to crop requirement. More detailed analysis should be conducteed to examaine selection of new pumps with flow rates that alow their combined use to reasonably match projected seasonal demand requirements.

Ochoco Irrigation District

Barnes Butte PS New Alt 3 (Construction of new facilities on Crooked River - Alt 3 HDPE 63-inch)

Budget Level - Projection of Probable Construction Cost

Item No.	Spec Division	Description	Measurement	Units	Unit Cost	Total Cost
1	1000	Mobilization	LS	1	$538,000.00	$538,000.00
2	1000	Erosion Control	LS	1	$25,000.00	$25,000.00
3	1000	Watering / Dust Control	LS	1	$25,000.00	$25,000.00
4	1000	Construction Staking	LS	1	$12,500.00	$12,500.00
5	1000	Project Management and Coordination	LS	1	$25,000.00	$25,000.00
6	1000	Construction Progress Documentation	LS	1	$25,000.00	$25,000.00
7	1000	Submittal Procedures	LS	1	$25,000.00	$25,000.00
8	1000	Quality Requirements	LS	1	$25,000.00	$25,000.00
9	1000	Selective Demolition	LS	1	$100,000.00	$100,000.00
10	1000	Traffic Control	LS	1	$50,000.00	$50,000.00
11	1000	Project Record Documents	LS	1	$25,000.00	$25,000.00
12	1000	Operations and Maintenance Data	LS	1	$15,000.00	$15,000.00
13	1000	General Commissioning Requirements	LS	1	$20,000.00	$20,000.00
14	2000	Erosion Control Silt Fence	LF	3,000	$2.40	$7,200.00
15	2000	Perimeter Fence, 8 ft coated wire chain link	LF	1,000	$18.00	$18,000.00
16	2000	Fence Gate	LS	1	$2,500.00	$2,500.00
17	2000	Dewatering	LS	1	$30,000.00	$30,000.00
18	2000	Bulk Excavation	CY	1,145	$7.00	$8,015.00
19	2000	Hauling	CY	1,145	$12.00	$13,740.00
20	2000	Trench Excavation, 8-12 ft depth trench box	CY	35,150	$7.00	$246,050.00
21	2000	Structural Backfill	CY	270	$38.00	$10,260.00
22	2000	Trench Backfilling	CY	35,150	$3.10	$108,965.00
23	2000	Aggregate Base	CY	250	$38.00	$9,500.00
24	2000	Surfacing Rock	CY	200	$38.00	$7,600.00
25	2000	AC Pavement Reconstruction	SY	8000	$75.00	$600,000.00
26	2000	Access Manhole	EA	24	$7,500.00	$180,000.00
27	2000	Restoration Seeding	AC	5	$1,500.00	$7,500.00
28	3000	Cast-in-Place Concrete	CY	160	$550.00	$88,000.00
29	3000	Misc Cast-in-Place Concrete (thrust and pads)	LS	1	$27,500.00	$27,500.00
30	6000	Handrail	LS	1	$6,000.00	$6,000.00
31	6000	Hatches	LS	1	$5,000.00	$5,000.00
32	6000	Trash Rack	LS	1	$50,000.00	$50,000.00
33	9000	High Performance Coating Systems	LS	1	$15,000.00	$15,000.00
34	11000	River Diversion and Fish Screen	LS	1	$1,500,000.00	$1,500,000.00
35	11000	Air Release / Vacuum Relief Stations	EA	4	$25,000.00	$100,000.00
36	11000	Turnout Structures	EA	2	$75,000.00	$150,000.00
37	11000	Line Shaft Turbine Pump and Motor, 600 HP	EA	5	$220,000.00	$1,100,000.00
38	15000	96-inch RSC 250 Weholite Inlet Pipe	LF	1,200	$635.00	$762,000.00
39	15000	60-inch Steel Discharge Piping	LF	100	$250.00	$25,000.00
40	15000	63-inch HDPE Discharge Pipe	LF	10,194	$331.50	$3,379,311.00
41	15000	24-inch Discharge Pipe, Fittings, & Accessories	EA	4	$25,000.00	$100,000.00
42	15000	24-inch Electric Motor Actuated Butterfly Valves	EA	4	$19,750.00	$79,000.00
43	15000	Hydraulic Slide Gate	EA	1	$10,000.00	$10,000.00
44	16000	Power and Distribution	LS	1	$598,120.00	$598,120.00
45	16000	Grounding Systems	LS	1	$28,440.00	$28,440.00
46	16000	Conduit and Conductors	LS	1	$81,370.00	$81,370.00
47	16000	Motor Controls	LS	1	$428,650.00	$428,650.00
48	17000	Instrumentation and Control	LS	1	$75,000.00	$75,000.00
		Construction Subtotal				$10,768,221.00
		Contractors Overhead and Profit	10%	1	$1,076,822.10	$1,076,822.10
		Contractors Bonds and Insurance	2%	1	$236,900.86	$236,900.86
		Construction Contingency	30%	1	$3,230,466.30	$3,230,466.30
		Construction Total				$15,312,410.26
		Engineering, Administration	25%	1	$3,828,102.57	
		Total				**$19,140,512.83**

Wire to Water Energy Calculator

Ochoco Irrigation District - SOR

Barnes Butte Pumping Plant - New Site at Crooked River: Alt 3 - HDPE 63-inch

Source: PumpTech Inc.

2425 SE Ochoco Street

Portland, OR 97222

503-659-6230

OPERATIONAL AND EQUIPMENT DATA

	Replacement Pumps		Existing Pumps	
	No. 1 - Goulds 32 GHO 3 Stage, 710 rpm, 600 HP		No. 1 - Pellizzari A600/750, Split Case, 720 RPM, 500 HP *	
	No. 2 - Goulds 32 GHO 3 Stage, 710 rpm, 600 HP		No. 2 - Pellizzari A600/750, Split Case, 720 RPM, 500 HP *	
	No. 3 - Goulds 32 GHO 3 Stage, 710 rpm, 600 HP		No. 3 - Pellizzari A400/500, Split Case, 880 RPM, 250 HP *	
	No. 4 - Goulds 32 GHO 3 Stage, 710 rpm, 600 HP		No. 4 - Pellizzari A400/500, Split Case, 880 RPM, 250 HP *	
	No. 5 - Goulds 32 GHO 3 Stage, 710 rpm, 600 HP		No. 5 - Wilson Snyder 16BAZ, Split Case, 880 RPM, 300 HP	
Pump Operation - Hours / Day	24		24	
Pump Operation - Days / Year	198		198	
Pump Flow - GPM (Evaluation Pump Rate)	61,134		61,134	
Pump Flow - CFS	136.2		136.2	
Total Annual Volume - Acre feet	53,500		53,500	
Pump Head - Feet	122.4	*	86.2	
Ave. Pump Efficiency - %	88.2%		77.1%	**
Ave. Motor Efficiency - %	96.3%		95.5%	***
Energy Cost in $/kW-hr	$0.035		$0.035	

* Estimated Pumping head assumes pump discharge piping, and valves are 24-inch. Estimated motor efficiency assumes synchronous motors.

* Pump Make and model per original construction submittals, 1963

** Pump efficiency assumed to be similar to efficiency of original equipment as supplied. Initial Pump Evaluation test data indicates pump efficiency for tested units greater than construction submittal efficiency curves.

*** Source: Initial Pump Evaluation test data.

RESULTS

	Replacement Pumps	Existing Pumps
BHP At Design Point	2,142.4	1,726.0
Wire to Water Efficiency - %	85%	74%
KW-hr per Year	7,886,593	6,406,966
Annual Energy Cost	$276,030.76	$224,243.80
KW-hr Per 1,000 Gallons Pumped	0.452	0.368
Cost Per 1,000 Gallons Pumped	$0.016	$0.013
kW-hr per Acre Foot Pumped	147	120
Cost Per Acre Foot Pumped	$5.16	$4.19

PAYBACK

Annual Savings - kW-hr	-1,479,627
Annual Savings - $$	-$51,786.96
Annual Savings - %	-23.09%
Cost of Replacement Pump Sta *	$19,141,000.00
Cost of Existing Pumps	$0.00
Payback - Years	N/A

* Estimated cost assumes new pump station on Crooked River with, new intake and fish screen assembly, HDPE 96-inch inlet piping, new pumping wet well, (5) vertical turbine pumps, 24-inch pump control valves, and HDPE 63-inch discharge piping

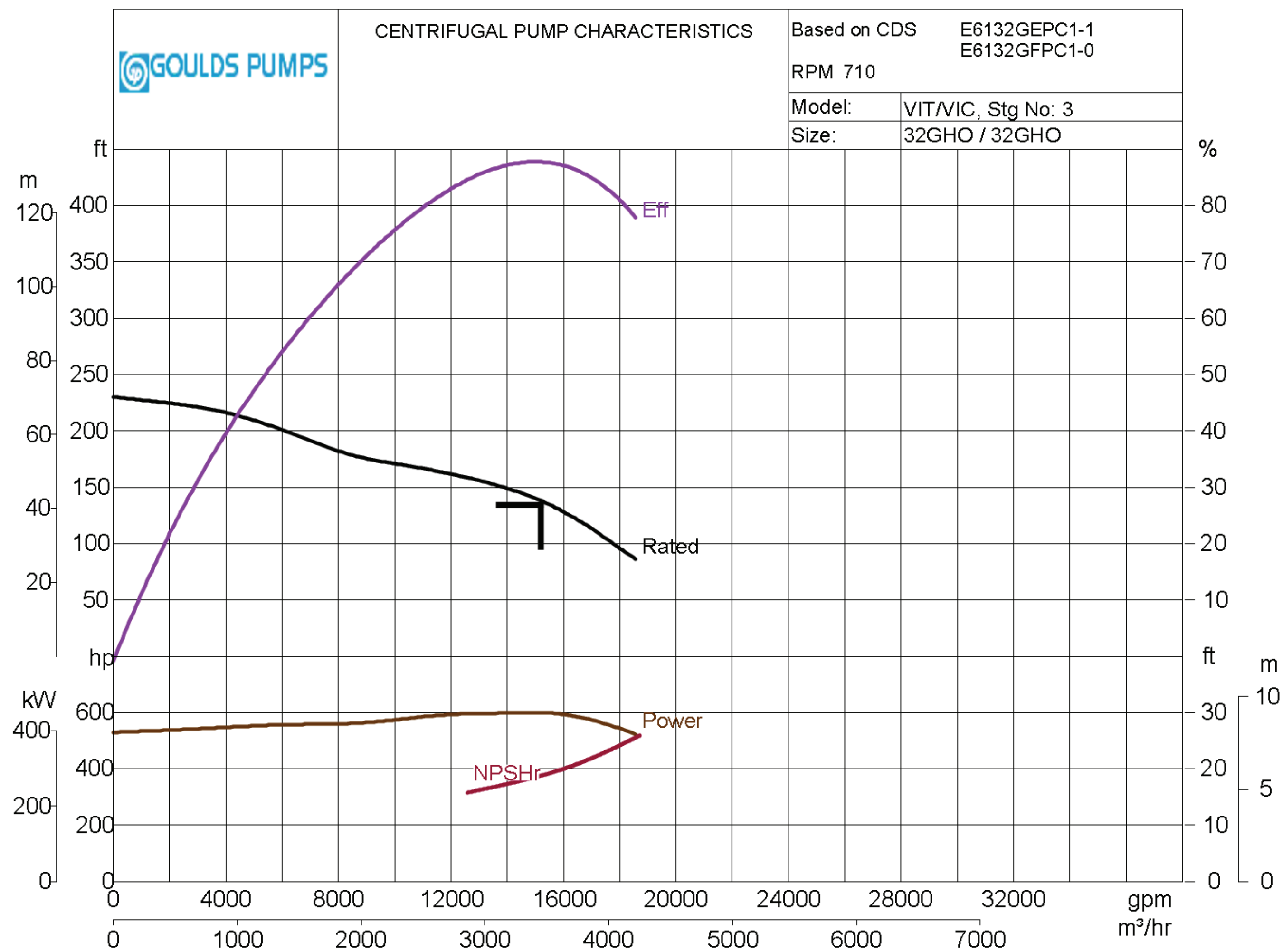
Model: VIT	Size: 32GHO	60Hz	RPM: 710	Stages: 3

Job/Inq.No. :	Barnes Butte New - Alt 3				
Purchaser :	SOR				
End User :		Issued by :		Rev. :	0
Item/Equip.No. :	Barnes Butte New - Alt 3	Quotation No. :	OID	Date :	12/26/2011
Service :	Irrigation - Raw Water				
Order No. :					

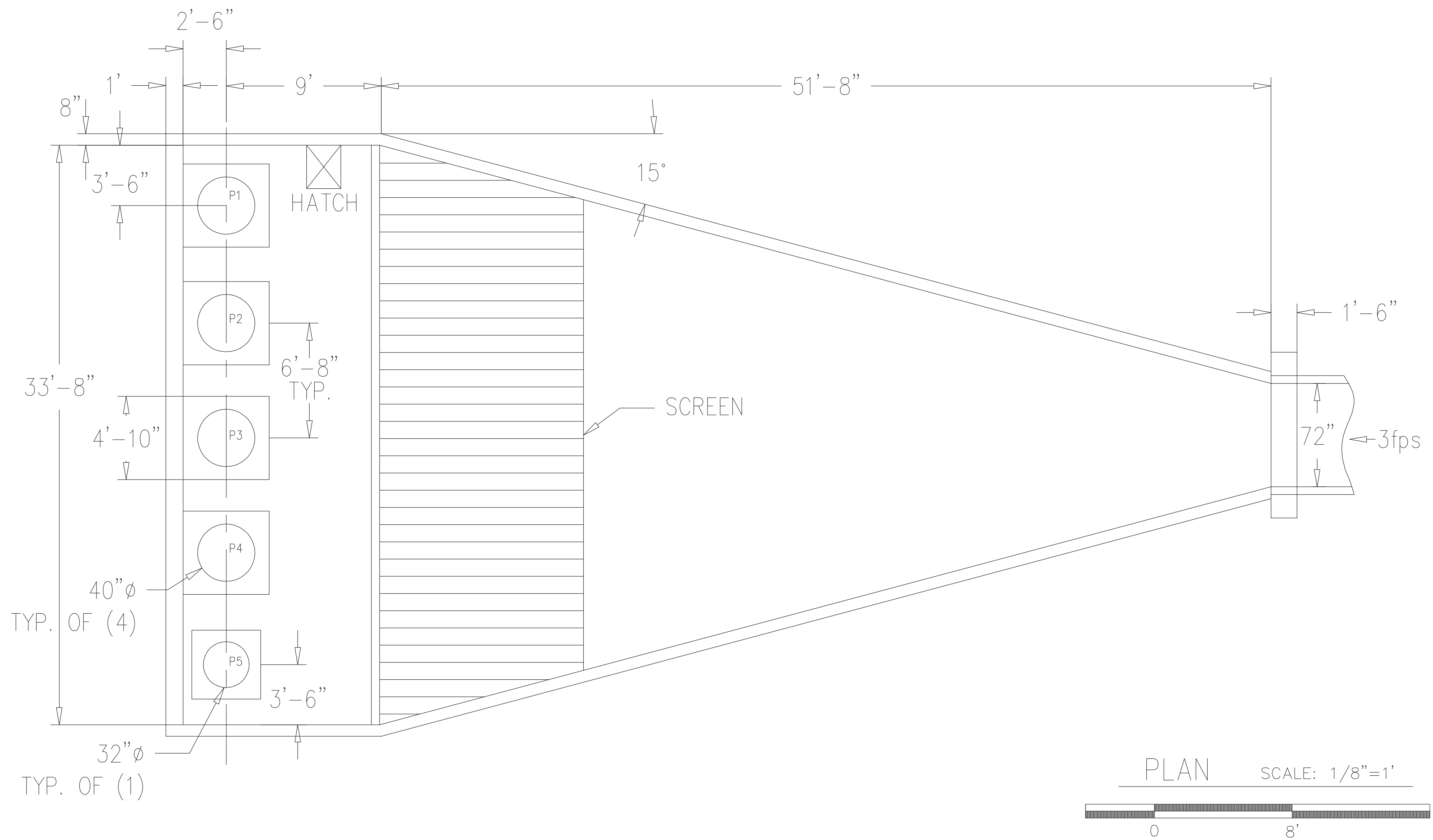
Operating Conditions / **Pump Performance**

Liquid:	Water	Published Efficiency:	88.2 %	Specific Speed 1st stg:	4,089 gpm(US) ft
Temp.:	70.0 deg F	Rated Pump Efficiency:	88.2 %	Specific Speed Adl stg:	
S.G./Visc.:	1.000/1.000 cp	Rated Total Power:	599.3 hp	Min. Hydraulic Flow:	6,825.3 gpm
Flow:	15,300.0 gpm	Non-Overloading Power:	599.8 hp	Min. Thermal Flow:	N/A
TDH:	137.0 ft	Imp. Dia. First 1 Stg(s):	20.88 in	Imp. Dia. Adl Stg(s):	19.11 in
NPSHa:	0.0 ft	NPSHr:	18.9 ft		
Solid size:	2.0000 in	Shut off Head:	230.3 ft		
% Susp. Solids (by wtg):		Vapor Press:			
Max. Solids Size:	2.1900 in				

Notes: 1. The Mechanical seal increased drag effect on power and efficiency is not included, unless the correction is shown in the appropriate field above. 2. Magnetic drive eddy current on power and efficiency is not included. 3. Elevated temperature effects on performance are not included. 4. Non Overloading power does not reflect v-belt/gear losses.



BARNES BUTTE REMODEL USING 5 VERTICAL TURBINE PUMPS
4 PUMPS @ 35.65 cfs AND 1 PUMP @ 12.40 cfs



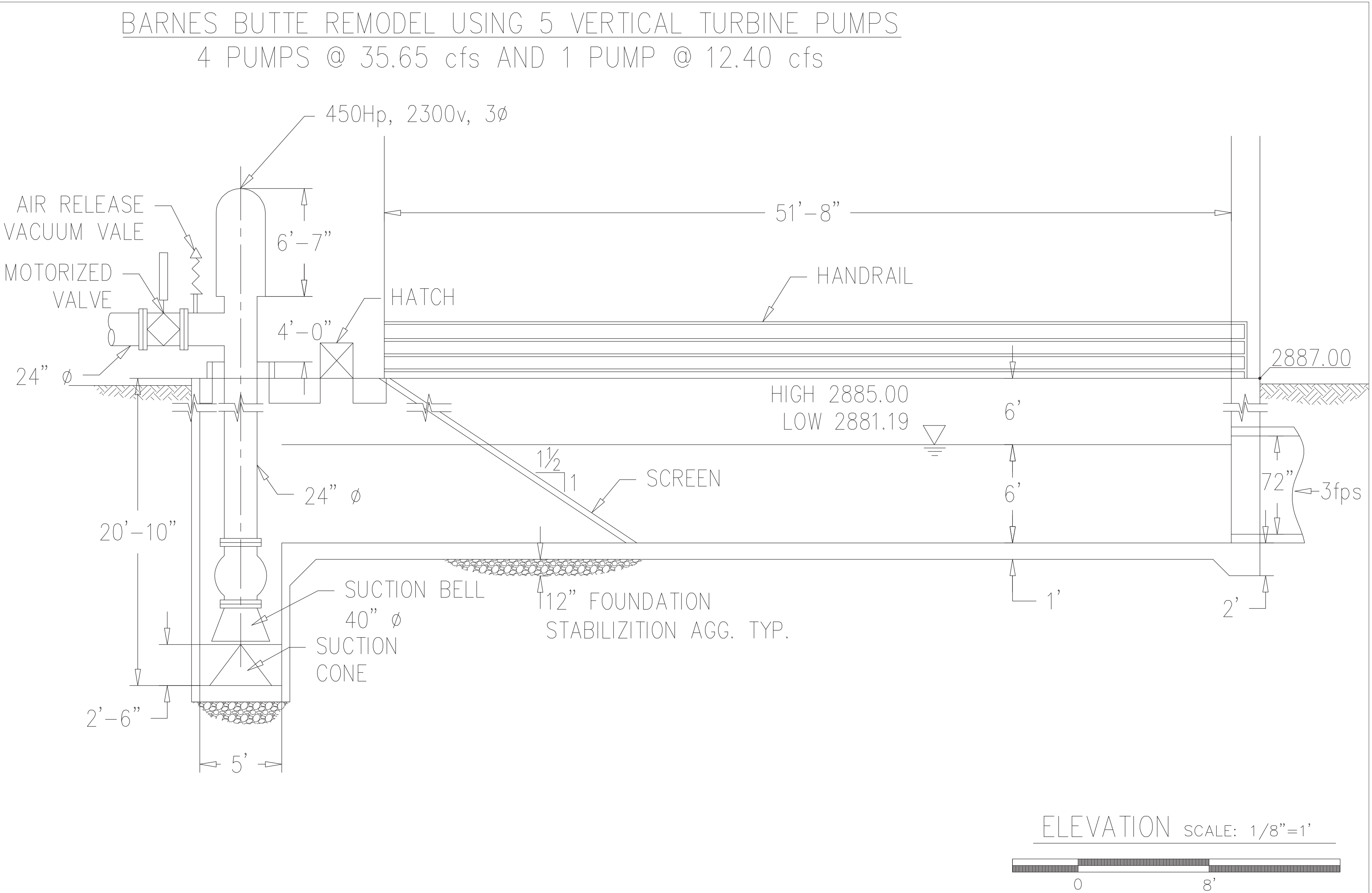
OCHOCO IRRIGATION DIST.
SYSTEMS OPTIMIZATION REVIEW

BARNES BUTTE PUMPING PLANT RECONSTRUCTION

BLACK ROCK CONSULTING

01.02.2012

FIG. A



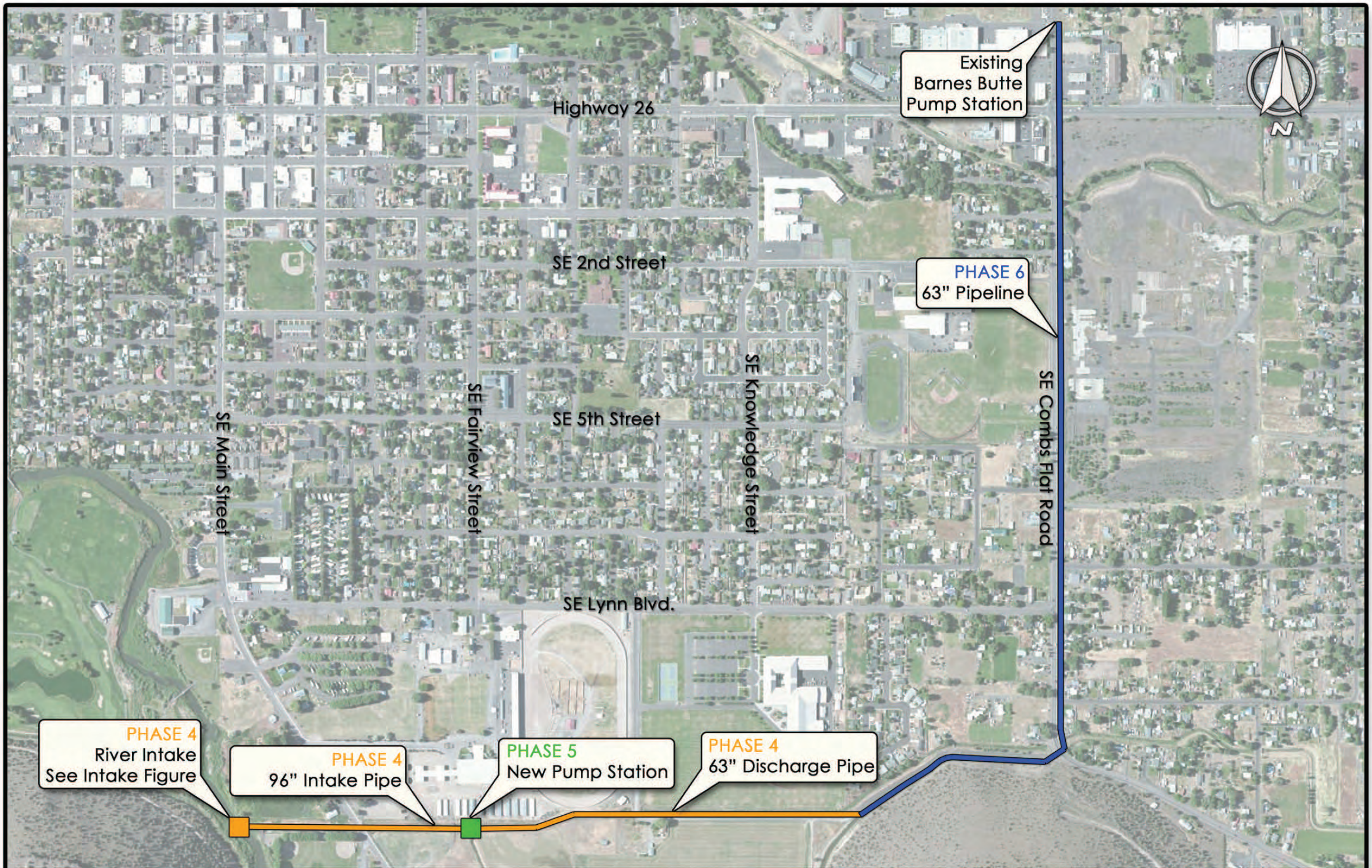
OCHOCO IRRIGATION DIST.
SYSTEMS OPTIMIZATION REVIEW

BARNES BUTTE PUMPING PLANT RECONSTRUCTION

BLACK ROCK CONSULTING

01.02.2012

FIG. B



Ochoco Irrigation District Crooked River Supply Improvements
Exhibit 1

BLACK ROCK CONSULTING

Ochoco Irrigation District Crooked River Supply Improvements
Exhibit 2

BLACK ROCK CONSULTING

OCHOCO IRRIGATION DIST.
SYSTEMS OPTIMIZATION REVIEW

NEW CROOKED RIVER INTAKE CONCEPT

BLACK ROCK CONSULTING

02.01.2012

FIG. A

Ochoco Irrigation District
Phased Cost Estimate New Crooked River Intake and Pump Station System to Hudspeth Siphon Intake
Budget Level - Projection of Probable Construction Cost by Phase

Item No.	Spec Division	Description	Measurement	Units	Unit Cost	Total Cost	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6
1	1000	Mobilization	LS	1	$538,000.00	$538,000.00		80,700		60,000	74,500	322,800
2	1000	Erosion Control	LS	1	$25,000.00	$25,000.00		3,750		3,000	3,250	15,000
3	1000	Watering / Dust Control	LS	1	$25,000.00	$25,000.00		3,750		3,000	3,250	15,000
4	1000	Construction Staking	LS	1	$12,500.00	$12,500.00		1,875		2,000	1,125	7,500
5	1000	Project Management and Coordination	LS	1	$25,000.00	$25,000.00		3,750		3,000	3,250	15,000
6	1000	Construction Progress Documentation	LS	1	$25,000.00	$25,000.00		3,750		3,000	3,250	15,000
7	1000	Submittal Procedures	LS	1	$25,000.00	$25,000.00		3,750		3,000	3,250	15,000
8	1000	Quality Requirements	LS	1	$25,000.00	$25,000.00		3,750		3,000	3,250	15,000
9	1000	Selective Demolition	LS	1	$100,000.00	$100,000.00		15,000			25,000	60,000
10	1000	Traffic Control	LS	1	$50,000.00	$50,000.00		7,500		6,000	6,500	30,000
11	1000	Project Record Documents	LS	1	$25,000.00	$25,000.00		3,750		3,000	3,250	15,000
12	1000	Operations and Maintenance Data	LS	1	$15,000.00	$15,000.00		2,250		2,000	1,750	9,000
13	1000	General Commissioning Requirements	LS	1	$20,000.00	$20,000.00		3,000			5,000	12,000
14	2000	Erosion Control Silt Fence	LF	3,000	$2.40	$7,200.00		1,080			1,800	4,320
15	2000	Perimeter Fence, 8 ft coated wire chain link	LF	1,000	$18.00	$18,000.00					18,000	
16	2000	Fence Gate	LS	1	$2,500.00	$2,500.00					2,500	
17	2000	Dewatering	LS	1	$30,000.00	$30,000.00					30,000	
18	2000	Bulk Excavation	CY	1,145	$7.00	$8,015.00					8,015	
19	2000	Hauling	CY	1,145	$12.00	$13,740.00		2,061			3,435	8,244
20	2000	Trench Excavation, 8-12 ft depth trench box	CY	35,150	$7.00	$246,050.00		36,908		61,512		147,630
21	2000	Structural Backfill	CY	270	$38.00	$10,260.00					10,260	
22	2000	Trench Backfilling	CY	35,150	$3.10	$108,965.00		16,345		27,241		65,379
23	2000	Aggregate Base	CY	250	$38.00	$9,500.00						9,500
24	2000	Surfacing Rock	CY	200	$38.00	$7,600.00						7,600
25	2000	AC Pavement Reconstruction	SY	8000	$75.00	$600,000.00						600,000
26	2000	Access Manhole	EA	24	$7,500.00	$180,000.00		27,000		45,000		108,000
27	2000	Restoration Seeding	AC	5	$1,500.00	$7,500.00		500			2,500	4,500
28	3000	Cast-in-Place Concrete	CY	160	$550.00	$88,000.00					88,000	
29	3000	Misc Cast-in-Place Concrete (thrust and pads)	LS	1	$27,500.00	$27,500.00					27,500	
30	6000	Handrail	LS	1	$6,000.00	$6,000.00					6,000	
31	6000	Hatches	LS	1	$5,000.00	$5,000.00					5,000	
32	6000	Trash Rack	LS	1	$50,000.00	$50,000.00					50,000	
33	9000	High Performance Coating Systems	LS	1	$15,000.00	$15,000.00					15,000	
34	11000	River Diversion and Fish Screen	LS	1	$1,500,000.00	$1,500,000.00				1,500,000		
35	11000	Air Release / Vacuum Relief Stations	EA	4	$25,000.00	$100,000.00		25,000		25,000		50,000
36	11000	Turnout Structures	EA	2	$75,000.00	$150,000.00				75,000		75,000
37	11000	Line Shaft Turbine Pump and Motor, 600 HP	EA	5	$220,000.00	$1,100,000.00					1,100,000	
38	15000	96-inch RSC 250 Weholite Inlet Pipe	LF	1,200	$635.00	$762,000.00				762,000		
39	15000	60-inch Steel Discharge Piping	LF	100	$250.00	$25,000.00					25,000	
40	15000	63-inch HDPE Discharge Pipe	LF	10,194	$331.50	$3,379,311.00		525,428		844,662		2,009,222
41*	15000	72-inch Weholite Gravity System	LF	4,950	$730.00	See Right			3,613,500			
42	15000	24-inch Discharge Pipe, Fittings, & Accessories	EA	4	$25,000.00	$100,000.00					100,000	
43	15000	24-inch Electric Motor Actuated Butterfly Valves	EA	4	$19,750.00	$79,000.00					79,000	
44	15000	Hydraulic Slide Gate	EA	1	$10,000.00	$10,000.00					10,000	
45	16000	Power and Distribution	LS	1	$598,120.00	$598,120.00					598,120	
46	16000	Grounding Systems	LS	1	$28,440.00	$28,440.00					28,440	
47	16000	Conduit and Conductors	LS	1	$81,370.00	$81,370.00					81,370	
48	16000	Motor Controls	LS	1	$428,650.00	$428,650.00					428,650	
49	17000	Instrumentation and Control	LS	1	$75,000.00	$75,000.00					75,000	
		Construction Subtotal				$10,768,221.00		770,897	3,613,500	3,431,415	2,930,215	3,635,695
		Contractors Overhead and Profit	10%	1	$1,076,822.10	$1,076,822.10		77,090	361,350	343,142	293,022	363,569
		Contractors Bonds and Insurance	2%	1	$236,900.86	$236,900.86		15,418	72,270	68,628	58,604	72,714
		Construction Contingency	30%	1	$3,230,466.30	$3,230,466.30		231,269	1,084,050	1,029,425	879,065	1,090,708
		Construction Total				$15,312,410.26		1,094,673	5,131,170	4,872,609	4,160,905	5,162,686
		Engineering, Administration	25%	1	$3,828,102.57		$1,531,241.03	$164,201	$1,282,793	$677,514	$677,514	$774,403
		Total				**$19,140,512.83**	$1,531,241	$1,258,874	$6,413,963	$5,550,123	$4,838,419	$5,937,089
										GRAND TOTAL		**$25,529,708**

41* Note: This item is not included in the Total Cost column. Its value is intened to cover the total cost of pipe installation with the exception of overhead and profit, bonds and insurance, construction contingency, engineering, admin as indicated on the Phase 3 column.

R&W
ENGINEERING, INC.
"Engineering Integrated Solutions"

February 24, 2012 1164.002.001

Black Rock Consulting, Inc.
20380 Halfway Road, Suite #1
Bend, Oregon 97701

Attention: David Prull

Subject: Barnes Butte Pump Station, Modernization Cost Estimate

David:

R&W Engineering has completed work on the cost estimate to modernize the Barnes Butte Pump Station. Our estimate is based on the following:

Project Understanding:

R&W's understanding of the project is based upon instructions from Black Rock Consulting to provide a construction estimate to replace the service transformer, motor controls and grounding for the Barnes Butte Pump Station to provide improved energy efficiency, reliability and ease of maintenance. Cost of replacing existing synchronous motors is not included in this estimate. Cost of replacement motors is assumed to be included as a part of the cost of the new pumping equipment.

The existing Bureau of Reclamation drawings, "Barnes Butte Pumping Plant" dated March, 1960 sheets 113-D-154, 155, 147, 202, 203, 204, and 218 were used to estimate the magnitude of the work. These drawings were used to estimate the labor and materials shown on the estimating sheets attached. In addition R&W Engineering made a visit to the site to observe the condition of the existing installation.

In order to provide the most accurate pricing possible for the high value materials, the ABB oil filled transformer and Myers motor controls; R&W obtained quotes for these items directly from the local manufacturer's factory representative. See attached exhibits for copies of these quotations.

Engineering estimates or cost opinions are typically prepared using a nationally recognized service such as Means Estimating Guide however these guides are developed for commercial and light industrial projects, not pump stations. R&W worked with an IBEW electrical contractor to produce this estimate using up-to-date pricing for materials and labor hours. Pricing for 5 kV cable was based upon take off quantities. These measures should provide a reasonable level of accuracy however in a bid situation a price swing of +/- 25% might be possible.

Scope of Work:

1. Mobilize/Demobilize - Equipment and subsistence to support a crew of three electricians and subcontractors during a 3-month construction timeline. Includes site support equipment and training as well as a $3,500 allowance for any permits required for the work.

2. New Power Transformer – Remove existing, provide and install new ABB power transformer. Modify existing copper bus on the high side of the transformer to accommodate the high side bushing location. Remove and replace low side connection with new 500 MCM copper, 5 kV cable to new MCC.

3. New Motor Control Center – Remove existing, provide and install new Myers medium voltage motor control center, (MCC).

4. Remove and Replace Pump Motor Feeders – Remove existing feeders, provide and install new medium voltage feeders from new MCC to pumps #1 - #5. New feeders are sized to match existing. It is assumed that the existing conduits are suitable for reuse.

5. Grounding – Remove existing fence, provide and install a new 30' x 35' chain link fence around the existing substation. Provide and install 300' of new #4/0, 19 strand copper grounding conductor below grade including new connections to the fence.

6. Equipment Disposal – Load and haul existing power transformer and MCC from Pump Station to a location in or around Bend, Oregon.

Our estimate is based on the following assumptions:

1. All work to be performed in 2012.

2. The terms and conditions in the quotations provided by ABB and Myers are acceptable.

3. All work to occur in one mobilization.

4. Estimate assumes that all work items will be performed. The individual breakout budgets are to illustrate the work associated with each task.

5. All medium voltage cable is 5/8 kV, MV-105 shielded copper cable.

6. No new foundations or civil work is included. It is assumed that the existing metal awning will be reused.

7. The estimate includes costs to have ABB perform one set of special tests listed in the Testing Section of their transformer quotation.

8. No costs have been included for any new 600 volt power or control cabling from the MCC to the pumps or other equipment.

9. No engineering costs have been included.

Prepared by: James E. Mitchell, PE

R&W Engineering, Inc.
9615 SW Allen Blvd., Suite 107
Beaverton, Oregon 97005
503-292-6000

REGISTERED PROFESSIONAL ENGINEER
9751
OREGON
JULY 14, 1978
JAMES E. MITCHELL
2/24/12
EXP. 12-31-13

Enclosures:

Detailed Cost Estimate

One Line Diagram

ABB Transformer Quote

Myers Motor Control Quote

DETAILED COST ESTIMATE

BARNES BUTTE PUMP STATION	PROJECT NUMBER	1164.002.001	
PREPARED BY R&W ENGINEERING	DIVISION	16 - Electrical	
DATE 2/10/2012	HOURLY LABOR RATE	$82.00	
	LABOR MULTIPLIER	1.00	MAT'L MULTIPLIER 1.00

ITEM NO.	DESCRIPTION	QTY	UNITS		UNIT LABOR HOURS	TOTAL LABOR COST	TOTAL MATERIAL COST	TOTAL COST
	SUMMARY							
1	Mobilize/Demobilize and Equipment	1	Lot		260	$21,200	$27,500	$48,700
2	Transformer	1	Lot		210	$17,100	$45,100	$62,200
3	MCC	1	Lot		450	$36,800	$234,600	$271,400
4	Pump Feeders	1	Lot		520	$42,100	$9,500	$51,600
5	Grounding	1	Lot		130	$10,300	$7,700	$18,000
6	Equipment Disposal	1	Lot		50	$4,000	$10,000	$14,000
7								
8								
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10								
TOTAL MATERIAL COST				$335,000				
TOTAL LABOR HOURS				1,620				SHEET
TOTAL LABOR COST				$132,000				TOTAL
								$467,000
PLUS 10% OVERHEAD AND PROFIT				$46,700				
TOTAL WITH OVERHEAD AND PROFIT				$513,700				
PLUS 2% BONDING AND INSURANCE				$10,274				
PLUS 30% CONTINGENCY				$157,192				
TOTAL ESTIMATED CONSTRUCTION COST								$681,000

Summary

DETAILED COST ESTIMATE

BARNES BUTTE PUMP STATION	PROJECT NUMBER	1164.002.001		
PREPARED BY R&W ENGINEERING	DIVISION	16 - Electrical		
DATE 2/10/2012	HOURLY LABOR RATE	$82.00		
	LABOR MULTIPLIER	1.00	MAT'L MULTIPLIER	1.00

ITEM NO.	DESCRIPTION	QTY	UNITS	UNIT MATERIAL COST	UNIT LABOR HOURS	TOTAL LABOR COST	TOTAL MATERIAL COST	TOTAL COST
1	Mobilize	1	LS		48	$3,936.00		$3,936.00
2	Telephone	1	LS	$375.00			$375.00	$375.00
3	Fork Lift	1	LS	$10,500.00			$10,500.00	$10,500.00
4	Excavator	1	LS	$2,000.00			$2,000.00	$2,000.00
5	Fuel	1	LS	$2,000.00			$2,000.00	$2,000.00
6	Lodging	60	DAY	$85.00			$5,100.00	$5,100.00
7	Site Training	1	LS		27	$2,214.00		$2,214.00
8	Equipment	1	LS	$1,500.00			$1,500.00	$1,500.00
9	Misc Material	1	LS	$2,500.00			$2,500.00	$2,500.00
10	Misc Labor	1	LS		135	$11,070.00		$11,070.00
11	Permit	1	LS	$3,500.00			$3,500.00	$3,500.00
12	Demobilize	1	LS		48	$3,936.00		$3,936.00
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TOTAL MATERIAL COST				$27,500		$27,500		
TOTAL LABOR HOURS				260		260		SHEET
TOTAL LABOR COST				$21,200		$21,200		TOTAL
								$48,700

Mod-Demob-Equip

DETAILED COST ESTIMATE

BARNES BUTTE PUMP STATION	PROJECT NUMBER	1164.002.001	
PREPARED BY R&W ENGINEERING	DIVISION	16 - Electrical	
DATE 2/10/2012	HOURLY LABOR RATE	$82.00	
	LABOR MULTIPLIER	1.00	MAT'L MULTIPLIER 1.00

ITEM NO.	DESCRIPTION	QTY	UNITS	UNIT MATERIAL COST	UNIT LABOR HOURS	TOTAL LABOR COST	TOTAL MATERIAL COST	TOTAL COST
1	NEW TRANSFORMER	1	EA	$24,228.00			$24,228.00	$24,228.00
2	SET TRNSF	1	EA	$100.00	15	$1,230.00	$100.00	$1,330.00
3	INSTALL ARRESTERS	6	EA	$50.00	2	$984.00	$300.00	$1,284.00
4	INSTALL HV BUSHINGS	3	EA	$50.00	4.5	$1,107.00	$150.00	$1,257.00
5	MOD HV BUS	3	EA	$500.00	4	$984.00	$1,500.00	$2,484.00
6	5KV 500 MCM FEEDERS	600	FT	$12.49	0.125	$6,150.00	$7,491.00	$13,641.00
7	5KV 500 MCM TERMINATIONS	6	EA	$84.00	3	$1,476.00	$504.00	$1,980.00
8	NEW 4" GRC RISERS	2	EA	$1,000.00	18	$2,952.00	$2,000.00	$4,952.00
9	120 VAC CONN TO TRANSF	1	EA	$750.00	27	$2,214.00	$750.00	$2,964.00
10	TRANSF FACTORY TESTS	1	LS	$8,000.00			$8,000.00	$8,000.00
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TOTAL MATERIAL COST	$45,100	$45,100		
TOTAL LABOR HOURS	210	210		SHEET
TOTAL LABOR COST	$17,100	$17,100		TOTAL
				$62,200

Transformer

DETAILED COST ESTIMATE

BARNES BUTTE PUMP STATION	PROJECT NUMBER	1164.002.001	
PREPARED BY R&W ENGINEERING	DIVISION	16 - Electrical	
DATE 2/10/2012	HOURLY LABOR RATE	$82.00	
	LABOR MULTIPLIER	1.00	MAT'L MULTIPLIER 1.00

ITEM NO.	DESCRIPTION	QTY	UNITS	UNIT MATERIAL COST	UNIT LABOR HOURS	TOTAL LABOR COST	TOTAL MATERIAL COST	TOTAL COST
1	MYERS MCC	1	EA	$228,525.00			$228,525.00	$228,525.00
2	SET MCC	10	EA	$150.00	12	$9,840.00	$1,500.00	$11,340.00
3	PUMP CONTROL RETERM	200	EA	$10.00	1	$16,400.00	$2,000.00	$18,400.00
4	TRANSF CONTROL WIRING	1	EA	$750.00	27	$2,214.00	$750.00	$2,964.00
5	TRANSF CONTROL TERM	50	EA	$5.00	0.5	$2,050.00	$250.00	$2,300.00
6	NEW STA SERV PANEL	1	EA	$1,500.00	16	$1,312.00	$1,500.00	$2,812.00
7	START UP AND TESTING	5	EA		12	$4,920.00		$4,920.00
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TOTAL MATERIAL COST	$234,600		$234,600	
TOTAL LABOR HOURS	450		450	SHEET
TOTAL LABOR COST	$36,800		$36,800	TOTAL
				$271,400

Motor Control

DETAILED COST ESTIMATE

BARNES BUTTE PUMP STATION	PROJECT NUMBER	1164.002.001	
PREPARED BY R&W ENGINEERING	DIVISION	16 - Electrical	
DATE 2/10/2012	HOURLY LABOR RATE	$82.00	
	LABOR MULTIPLIER	1.00	MAT'L MULTIPLIER 1.00

ITEM NO.	DESCRIPTION	QTY	UNITS	UNIT MATERIAL COST	UNIT LABOR HOURS	TOTAL LABOR COST	TOTAL MATERIAL COST	TOTAL COST
	PUMP FEEDERS							
1	5KV MV-105 CABLE, #1	1200	FT	$2.62	0.13	$12,792.00	$3,144.00	$15,936.00
2	5KV MV-105 CABLE, #4	1000	FT	$2.04	0.125	$10,250.00	$2,040.00	$12,290.00
3	5KV #1 TERMINATION KIT	18	EA	$56.10	2	$2,952.00	$1,009.80	$3,961.80
4	5KV #4 TERMINATION KIT	12	EA	$52.15	2	$1,968.00	$625.80	$2,593.80
5	DEMO FEEDERS	6	LS	$250.00	27	$13,284.00	$1,500.00	$14,784.00
6	#1/0 XHHW CABLE	450	FT	$2.23	0.015	$553.50	$1,003.50	$1,557.00
7	#1/0 TERMINATIONS	6	EA	$25.00	0.5	$246.00	$150.00	$396.00
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TOTAL MATERIAL COST				$9,500		$9,500		
TOTAL LABOR HOURS				520		520		SHEET
TOTAL LABOR COST				$42,100		$42,100		TOTAL
								$51,600

Pump Feeders

DETAILED COST ESTIMATE

BARNES BUTTE PUMP STATION	PROJECT NUMBER	1164.002.001	
PREPARED BY R&W ENGINEERING	DIVISION	16 - Electrical	
DATE 2/10/2012	HOURLY LABOR RATE	$82.00	
	LABOR MULTIPLIER	1.00	MAT'L MULTIPLIER 1.00

ITEM NO.	DESCRIPTION	QTY	UNITS	UNIT MATERIAL COST	UNIT LABOR HOURS	TOTAL LABOR COST	TOTAL MATERIAL COST	TOTAL COST
	GROUNDING							
1	FENCE DEMO	1	LS		6	$492.00		$492.00
2	FENCE INSTALLATION	130	FT	$25.00			$3,250.00	$3,250.00
3	4/0 BARE COPPER, 19 STRAND	300	FT	$4.00	0.025	$615.00	$1,200.00	$1,815.00
4	CADWELD T	10	EA	$20.00	1	$820.00	$200.00	$1,020.00
5	CADWELD X	3	EA	$20.00	1	$246.00	$60.00	$306.00
6	3/4" 10' GROUND ROD	3	EA	$35.00	2	$492.00	$105.00	$597.00
7	CADWELD GR	3	EA	$20.00	1	$246.00	$60.00	$306.00
8	FENCE CONNECTION	10	EA	$125.00	3	$2,460.00	$1,250.00	$3,710.00
9	TRENCH AND BACKFILL	300	FT	$5.00	0.2	$4,920.00	$1,500.00	$6,420.00
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TOTAL MATERIAL COST				$7,700		$7,700		
TOTAL LABOR HOURS				130		130		SHEET
TOTAL LABOR COST				$10,300		$10,300		TOTAL
								$18,000

Grounding

DETAILED COST ESTIMATE

BARNES BUTTE PUMP STATION
PREPARED BY R&W ENGINEERING
DATE 2/10/2012

PROJECT NUMBER 1164.002.001
DIVISION 16 - Electrical
HOURLY LABOR RATE $82.00
LABOR MULTIPLIER 1.00 MAT'L MULTIPLIER 1.00

ITEM NO.	DESCRIPTION	QTY	UNITS	UNIT MATERIAL COST	UNIT LABOR HOURS	TOTAL LABOR COST	TOTAL MATERIAL COST	TOTAL COST
	EQUIPMENT DISPOSAL							
1								
2	Electrical Crew	1	LS		48	$3,936.00		$3,936.00
3								
4	Rigging and Trucking to Bend	1	LS	$10,000.00			$10,000.00	$10,000.00
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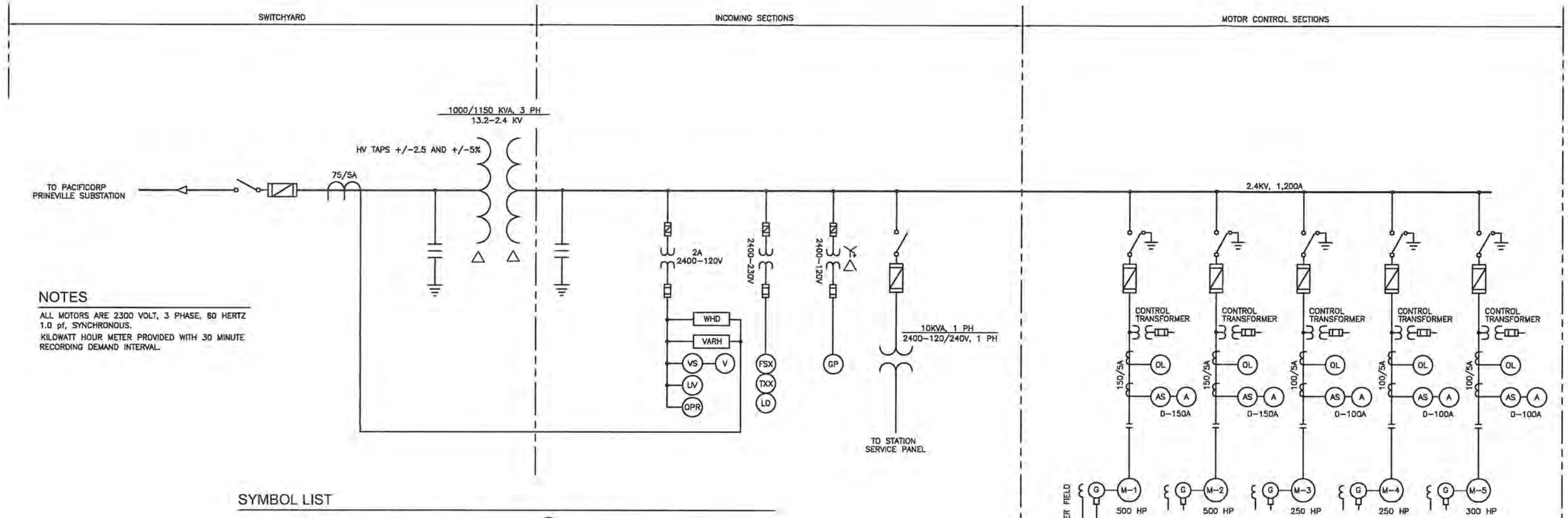
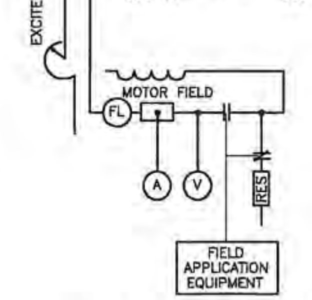
TOTAL MATERIAL COST				$10,000		$10,000		
TOTAL LABOR HOURS				50		50		SHEET
TOTAL LABOR COST				$4,000		$4,000		TOTAL
								$14,000

Eq Disposal



NOTES

ALL MOTORS ARE 2300 VOLT, 3 PHASE, 60 HERTZ 1.0 pf, SYNCHRONOUS.
KILOWATT HOUR METER PROVIDED WITH 30 MINUTE RECORDING DEMAND INTERVAL.



TYPICAL FOR ALL SYNCH MOTORS

SYMBOL LIST

LIGHTNING ARRESTOR	A — AMMETER
DISCONNECT SWITCH	AS — AMMETER SWITCH
CURRENT LIMITING FUSE	V — VOLT METER
STANDARD FUSE	VS — VOLT METER SWITCH
AMMETER SHUNT	UV — UNDERVOLTAGE RELAY
CONTACTOR	OPR — OUT-OF-PHASE RELAY
RHEOSTAT	GP — GROUND DETECTOR RELAY
POTENTIAL TRANSFORMER	OL — OVERLOAD RELAY
CURRENT TRANSFORMER	FL — FIELD LOSS RELAY
UTILITY INTERCONNECTION	FSX — FLOAT SWITCH AUXILIARY
POWER TRANSFORMER	TXX — POWER TRANSF AUXILIARY RELAY
	LO — LOCKOUT RELAY
	WHD — KILOWATT HOUR DEMAND METER
	VARH — KILOVAR HOUR METER

1 E01 ONE LINE DIAGRAM
SCALE: NONE

REV	DATE	DESCRIPTION	BY	REV	DATE	DESCRIPTION	BY
			TBC				

R&W ENGINEERING, INC.
"Engineering Integrated Solutions"
6815 S.W. Allen Blvd., Suite 107
Beaverton, Oregon 97005
Phone: (503) 292-6000
Fax: (503) 726-3328
E-mail: rweng@rweng.com
Project No.: 1154.002.001
Contact: J. MITCHELL

OCHOCO IRRIGATION DISTRICT
SYSTEM OPTIMIZATION REVIEW

BARNES BUTTE PUMP STATION
ONE LINE DIAGRAM

DESIGNED	JEM
DRAWN	KT
CHECKED	JEM
DATE	2/10/2012
DRAWING NO.	E01
SHEET 1 OF 1	

ABB

Neg #: 12Q1465608	Resource Engineered Products LLC / Crooked River Pump Station - Budget

To:

Resource Engineered Products LLC

1665 SW Midvale Road
Portland
OR 97219

Phone:
Fax:

From:

Michael Cardenas

ABB Inc.

Phone: 573-659-6234
Fax: 573-659-6275
Email: michael.z.cardenas@us.abb.com

We are pleased to offer you this quote.

Best regards,

Michael Cardenas
Sales Engineer
ABB – Jefferson City, MO

PRELIMINARY DRAFT: This ABB budgetary offer is preliminary and not final and as such is non-binding. It is tendered for discussion only and does not constitute a firm offer and is subject to change at any time without notice.

General Comments and Exceptions

- 1/25/12:
  Surge arresters are quoted as distribution class.

Neg #: 12Q1465608	Resource Engineered Products LLC / Crooked River Pump Station - Budget

Item	Alt	Qty	Description	Price Each (USD)
10		1	1000/1120/1288 KVA Liquid Filled Secondary Unit Substation DTR 2401, Jefferson City, USA (9AAE300179), PDC: 9AAC30400228, DTAN-L3M146	24,228

ABB

Neg #: 12Q1465608	Resource Engineered Products LLC / Crooked River Pump Station - Budget

ITEM	QTY	kVA	EACH (USD)	Conductor	%Z	Shipment
10	1	1000/1120/1288	24,228	Al/Al	5.81	9-11 Weeks

Description:

Type	:	Liquid-Filled Secondary Unit Substation
Fluid	:	Mineral Oil
Core	:	Grain Oriented Steel
Phase	:	3 Phase
Frequency	:	60 Hz
Average Winding Rise	:	55/65 °C
Ambient Temperature	:	30 °C
High Voltage	:	13200 Delta
High Voltage Taps	:	+2 -2 2.5%
High Voltage BIL	:	95kV BIL
Low Voltage	:	2400 Delta
Low Voltage BIL	:	45kV BIL
Color	:	ANSI 61 gray paint (Munsell 8.3G 6.1/0.54)

Features (included in price):

TANK & CABINET
- 120V Control Power Provided By Customer
- Fan Control Switch - Manual ON/AUTO/OFF
- Sidewall Mounted On Front HV (Segment-3)
- Control Box Large 24 x 26 x 12
- Hex-head cabinet handle bolt

BUSHINGS
- 2-hole spade HV terminals (live front) x 3
- HV porcelain live front bushings (live front) x 3
- 6-hole integral spade bushings x 3
- Sidewall Mounted On Front LV (Segment-1)

ARRESTERS
- 18 kV live front arrester - shipped detail in cabinet x 3

MONITORING
- Dial type thermometer with alarm contacts
- Liquid level gauge with 3" dial face
- Pressure relief valve

FITTINGS
- Drain valve and sampler

ABB

Neg #: 12Q1465608	Resource Engineered Products LLC / Crooked River Pump Station - Budget

Terms and Conditions:

- Quote validity period: 30 days
- Payment Terms: Payment is due Net 30 Days from invoice date.
- Freight Terms: Shipment is FCA - Free Carrier (OR, US)
- Warranty: 18 months from delivery or 12 months from commissioning, whichever occurs first.

Shipments:

- Lead times (ex-works shipments) are subject to change based on availability of production space and/or materials at time of order. Please contact your ABB representative to confirm the lead time at order entry.
- Approval order lead time will be confirmed after receipt of approval and release for manufacturing.
- Transportation costs based on truckload quantities with one stop within the 48 contiguous States of the United States. Multiple stops will be charged a minimum of $150 per stop.
- Packaging and handling beyond what is stated in the quote, including blue water transport, are at the expense of the purchaser.
- Shipments by dedicated truck must be specified as such on the purchase order and billed accordingly.
- Quote does not include installation, training and field testing unless noted otherwise.
- For destinations outside of the United States, purchaser is to identify seller for customs reporting as ABB Inc, 150 Ardmore Blvd. Suite 401, Pittsburgh, PA 15221, Attention: International Contracts Management.

Price Validity:

- Prices are valid for the quantities stated in this quote subject to change for orders less than quoted.
- Approval order pricing is firm for 30 days after initial mailing date of approval drawings. Orders not released for manufacture within 30 days of the initial drawing date are subject to price adjustment.
- Prices and lead time are subject to change should there be changes to specifications, configurations and accessories.

Approval Drawings:

- Purchaser to provide e-mail address at time of order entry for transmission of drawings.
- Drawing lead times typically 3 - 4 weeks after receipt of order for Padmount transformers.
- Drawing lead times typically 5 - 6 weeks after receipt of order for Secondary Unit Substation transformers.
- Drawings in less than typical lead time are available upon request and will be priced accordingly.
- Drawings can be supplied in "pdf" format at customer request

NEC & NFPA Exception:

Product will be designed, built and tested in accordance with ANSI, NEMA and IEEE (and UL if applicable) standards. Cabinetry is designed in accordance with NEMA 3R unless stated otherwise in the body of the quote. Exception is taken to NEC & NFPA as compliance is the responsibility of the installing contractor and/or end user.

Testing:

- Routine production tests are in accordance with IEEE C57.12.00.
- Fluid supply is regularly tested for PCB content.
- Nameplates state "Filled with non-PCB fluid that contains less than 1 ppm at time of manufacture."
- Comprehensive leak testing is completed on all products.
- Computer generated certified test reports provided as standard.

Neg #: 12Q1465608	Resource Engineered Products LLC / Crooked River Pump Station - Budget

Special Test Price Adders:

- Chop Wave at $1,000 net each.
- Temperature Rise (base rating only) at $2,000 net each.
- Temperature Rise (base rating plus max) at $3,000 net each.
- Sound Level for product rated less than 2000 kVA at $1,000 net each
- Power Factor at $1,000 net each.
- Witness Testing at $2,000 net each. (may be of a similar unit depending on availability of product at time of testing)

General Notes:

- Order should reference this negotiation number and applicable items.
- Extended warranty available upon request and will be priced accordingly.
- Units are quoted for normal service conditions as defined by ANSI/IEEE standards.
- Notify ABB should unit(s) be subject to harmonics, motor starting, shovel duty or other.
- Accessories not included with the product are T-Ops, secondary terminating lugs, grounding lugs, padlocks, wrenches and warning signs unless noted otherwise in the quote.
- UL labeling and FM certification are available for most configurations upon request.
- Nameplates are laser etched anodized aluminum.
- Penta-head door fastening bolt compliant to ANSI C57.12.28-1998.
- Door fastening hardware made of stainless steel or silicon bronze.
- Paint system is compliant with ANSI/IEEE C57.12.28.
- Ground pads are made of stainless steel.
- General, dimensional and installation instructions can be found at www.abb.us/transformers and select Liquid Filled
- Order status can be found at www.abbdtd.com.

ABB INC.

GENERAL TERMS AND CONDITIONS OF SALE

1. General. The terms and conditions contained herein, together with any additional or different terms contained in ABB's Proposal, if any, submitted to Purchaser (which Proposal shall control over any conflicting terms), constitute the entire agreement (the 'Agreement') between the parties with respect to the order and supersede all prior communications and agreements regarding the order. Acceptance by ABB of the order, or Purchaser's acceptance of ABB's Proposal, is expressly limited to and conditioned upon Purchaser's acceptance of these terms and conditions, payment for or acceptance of any performance by ABB being acceptance. These terms and conditions may not be changed or superseded by any different or additional terms and conditions proposed by Purchaser to which terms ABB hereby objects. Unless the context otherwise requires, the term 'Equipment' as used herein means all of the equipment, parts, accessories sold, and all software and software documentation, if any, licensed to Purchaser by ABB ('Software') under the order. Unless the context otherwise requires, the term 'Services' as used herein means all labor, supervisory, technical and engineering, installation, repair, consulting or other services provided by ABB under the order. As used herein, the term 'Purchaser' shall include the initial end use of the Equipment and/or services; provided, however, that Paragraph 13(a) shall apply exclusively to the initial end user.

2. Prices.

(a) Unless otherwise specified in writing, all Proposals expire thirty (30) days from the date thereof.

(b) Unless otherwise stated herein, Services prices are based on normal business hours (8 a.m. to 5 p.m. Monday through Friday). Overtime and Saturday hours will be billed at one and one-half (1 1/2) times the hourly rate; and Sunday hours will be billed at two (2) times the hourly rate; holiday hours will be billed at three (3) times the hourly rate. If a Services rate sheet is attached hereto, the applicable Services rates shall be those set forth in the rate sheet. Rates are subject to change without notice.

(c) The price does not include any federal, state or local property, license, privilege, sales, use, excise, gross receipts, or other like taxes which may now or hereafter be applicable. Purchaser agrees to pay or reimburse any such taxes which ABB or its suppliers are required to pay or collect. If Purchaser is exempt from the payment of any tax or holds a direct payment permit, Purchaser shall, upon order placement, provide ABB a copy, acceptable to the relevant governmental authorities of any such certificate or permit.

(d) The price includes customs duties and other importation or exportation fees, if any, at the rates in effect on the date of ABB' s Proposal. Any change after that date in such duties, fees, or rates, shall increase the price by ABB's additional cost.

3. Payment.

(a) Unless specified to the contrary in writing by ABB, payment terms are net cash, payable without offset, in United States Dollars, 30 days from date of invoice by wire transfer to the account designated by ABB in the Proposal.

(b) If in the judgment of ABB the financial condition of Purchaser at any time prior to delivery does not justify the terms of payment specified, ABB may require payment in advance, payment security satisfactory to ABB, or may terminate the order, whereupon ABB shall be entitled to receive reasonable cancellation charges. If delivery is delayed by Purchaser, payment shall be due on the date ABB is prepared to make delivery. Delays in delivery or nonconformities in any installments delivered shall not relieve Purchaser of its obligation to accept and pay for remaining installments.

(c) Purchaser shall pay, in addition to the overdue payment, a late charge equal to the lesser of 1 1/2% per month or any part thereof or the highest applicable rate allowed by law on all such overdue amounts plus ABB's attorneys' fees and court costs incurred in connection with collection.

4. Changes.

(a) Any changes requested by Purchaser affecting the ordered scope of work must be accepted by ABB and resulting adjustments to affected provisions, including price, schedule, and guarantees mutually agreed in writing prior to implementation of the change.

(b) ABB may, at its expense, make such changes in the Equipment or Services as it deems necessary, in its sole discretion, to conform the Equipment or Services to the applicable specifications. If Purchaser objects to any such changes, ABB shall be relieved of its obligation to conform to the applicable specifications to the extent that conformance may be affected by such objection.

5. Delivery.

(a) All Equipment manufactured, assembled or warehoused in the continental United States is delivered F.O.B. point of shipment. Equipment shipped from outside the continental United States is delivered F.O.B. United States port of entry. Purchaser shall be responsible for any and all demurrage or detention charges.

(b) If the scheduled delivery of Equipment is delayed by Purchaser or by Force Majeure, ABB may move the Equipment to storage for the account of and at the risk of Purchaser whereupon it shall be deemed to be delivered.

(c) Shipping and delivery dates are contingent upon Purchaser's timely approvals and delivery by Purchaser of any documentation required for ABB's performance hereunder.

(d) Claims for shortages or other errors in delivery must be made in writing to ABB within ten days of delivery. Equipment may not be returned except with the prior written consent of and subject to terms specified by ABB. Claims for damage after delivery shall be made directly by Purchaser with the common carrier.

6. Title & Risk of Loss. Except with respect to Software (for which title shall not pass, use being licensed) title to Equipment shall remain in ABB until fully paid for. Notwithstanding any agreement with respect to delivery terms or payment of transportation charges, risk of loss or damage shall pass to Purchaser upon delivery.

7. Inspection, Testing and Acceptance.

(a) Any inspection by Purchaser of Equipment on ABB's premises shall be scheduled in advance to be performed during normal working hours.

(b) If the order provides for factory acceptance testing, ABB shall notify Purchaser when ABB will conduct such testing prior to shipment. Unless Purchaser states specific objections in writing within ten (10) days after completion of factory acceptance testing, completion of the acceptance test constitutes Purchaser's factory acceptance of the Equipment and its authorization for shipment.

(c) If the order provides for site acceptance testing, testing will be performed by ABB personnel to verify that the Equipment has arrived at site complete, without physical damage, and in good operating condition. Completion of site acceptance testing constitutes full and final acceptance of the Equipment. If, through no fault of ABB, acceptance testing is not completed within thirty (30) days after arrival of the Equipment at the site, the site acceptance test shall be deemed completed and the Equipment shall be deemed accepted.

8. Warranties and Remedies.

(a) Equipment and Services Warranty. ABB warrants that Equipment (excluding Software, which is warranted as specified in paragraph (d) below) shall be delivered free of defects in material and workmanship and that Services shall be free of defects in workmanship. The Warranty Remedy Period for Equipment (excluding Software, Spare Parts and Refurbished or Repaired Parts) shall end twelve (12) months after installation or eighteen (18) months after date of shipment, whichever first occurs. The Warranty Remedy Period for new spare parts shall end twelve (12) months after date of shipment. The Warranty Remedy Period for refurbished or repaired parts shall end ninety (90) days after date of shipment. The Warranty Remedy Period for Services shall end ninety (90) days after the date of completion of Services.

(b) Equipment and Services Remedy. If a nonconformity to the foregoing warranty is discovered in the Equipment or Services during the applicable Warranty Remedy Period, as specified above, under normal and proper use and provided the Equipment has been properly stored, installed, operated and maintained and written notice of such nonconformity is provided to ABB promptly after such discovery and within the applicable Warranty Remedy Period, ABB shall, at its option, either (i) repair or replace the nonconforming portion of the Equipment or re-perform the nonconforming Services or (ii) refund the portion of the price applicable to the nonconforming portion of Equipment or Services. If any portion of the Equipment or Services so repaired, replaced or re-performed fails to conform to the foregoing warranty, and written notice of such nonconformity is provided to ABB promptly after discovery and within the original Warranty Remedy Period applicable to such Equipment or Services or 30 days from completion of such repair, replacement or re-performance, whichever is later, ABB will repair or replace such nonconforming Equipment or re-perform the nonconforming Services. The original Warranty Remedy Period shall not otherwise be extended.

(c) Exceptions. ABB shall not be responsible for providing working access to the nonconforming Equipment, including disassembly and re assembly of non-ABB supplied equipment, or for providing transportation to or from any repair facility, all of which shall be at Purchaser's risk and expense. ABB shall have no obligation hereunder with respect to any Equipment which (i) has been improperly repaired or altered; (ii) has been subjected to misuse, negligence or accident; (iii) has been used in a manner contrary to ABB's instructions; (iv) is comprised of materials provided by or a design specified by Purchaser; or (v) has failed as a result of ordinary wear and tear. Equipment supplied by ABB but manufactured by others is warranted only to the extent of the manufacturer' s warranty, and only the remedies, if any, provided by the manufacturer will be allowed.

(d) Software Warranty and Remedies. ABB warrants that, except as specified below, the Software will, when properly installed, execute in accordance with ABB's published specification. If a nonconformity to the foregoing warranty is discovered during the period ending one (1) year after the date of shipment and written notice of such nonconformity is provided to ABB promptly after such discovery and within that period, including a description of the nonconformity and complete information about the manner of its discovery, ABB shall correct the nonconformity by, at its option, either (i) modifying or making available to the Purchaser instructions for modifying the Software; or (ii) making available at ABB's facility necessary corrected or replacement programs. ABB shall have no obligation with respect to any nonconformities resulting from (i) unauthorized modification of the Software or (ii) Purchaser-supplied software or interfacing. ABB does not warrant that the functions contained in the software will operate in combinations which may be selected for use by the Purchaser, or that the software products are free from errors in the nature of what is commonly categorized by the computer industry as 'bugs'.

(e) THE FOREGOING WARRANTIES ARE EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES OF QUALITY AND PERFORMANCE, WHETHER WRITTEN, ORAL OR IMPLIED, AND ALL OTHER WARRANTIES INCLUDING ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR USAGE OF TRADE ARE HEREBY DISCLAIMED. THE REMEDIES STATED HEREIN CONSTITUTE PURCHASER' S EXCLUSIVE REMEDIES AND ABB' S ENTIRE LIABILITY FOR ANY BREACH OF WARRANTY.

9. Patent Indemnity.

(a) ABB shall defend at its own expense any action brought against Purchaser alleging that the Equipment or the use of the Equipment to practice any process for which such Equipment is specified by ABB (a " Process") directly infringes any claim of a patent of the United States of America and to pay all damages and costs finally awarded in any such action, provided that Purchaser has given ABB prompt written notice of such action, all necessary assistance in the defense thereof and the right to control all aspects of the defense thereof including the right to settle or otherwise terminate such action in behalf of Purchaser.

(b) ABB shall have no obligation hereunder and this provision shall not apply to: (i) any other equipment or processes, including Equipment or Processes which have been modified or combined with other equipment or process not supplied by ABB; (ii) any Equipment or Process supplied according to a design, other than an ABB design, required by Purchaser; (iii) any products manufactured by the Equipment or Process; (iv) any patent issued after the date hereof; or (v) any action settled or otherwise terminated without the prior written consent of ABB.

(c) If, in any such action, the Equipment is held to constitute an infringement, or the practice of any Process using the Equipment is finally enjoined, ABB shall, at its option and its own expense, procure for Purchaser the right to continue using said Equipment; or modify or replace it with non infringing equipment or, with Purchaser's assistance, modify the Process so that it becomes non infringing; or remove it and refund the portion of the price allocable to the infringing Equipment. THE FOREGOING PARAGRAPHS STATE THE ENTIRE LIABILITY OF ABB AND EQUIPMENT MANUFACTURER FOR ANY PATENT INFRINGEMENT.

(d) To the extent that said Equipment or any part thereof is modified by Purchaser, or combined by Purchaser with equipment or processes not furnished hereunder (except to the extent that ABB is a contributory infringer) or said Equipment or any part thereof is used by Purchaser to perform a process not furnished hereunder by ABB or to produce an article, and by reason of said modification, combination, performance or production, an action is brought against ABB, Purchaser shall defend and indemnify ABB in the same manner and to the same extent that ABB would be obligated to indemnify Purchaser under this 'Patent Indemnity' provision.

10. Limitation of Liability.

(a) In no event shall ABB, its suppliers or subcontractors be liable for special, indirect, incidental or consequential damages, whether in contract, warranty, tort, negligence, strict liability or otherwise, including, but not limited to, loss of profits or revenue, loss of use of the Equipment or any associated equipment, cost of capital, cost of substitute equipment, facilities or services, downtime costs, delays, and claims of customers of the Purchaser or other third parties for any damages. ABB's liability for any claim whether in contract, warranty, tort, negligence, strict liability, or otherwise for any loss or damage arising out of, connected with, or resulting from this Agreement or the performance or breach thereof, or from the design, manufacture, sale, delivery, resale, repair, replacement, installation, technical direction of installation, inspection, operation or use of any equipment covered by or furnished under this Agreement, or from any services rendered in connection therewith, shall in no case (except as provided in the section entitled 'Patent Indemnity') exceed one-half (1/2) of the purchase price allocable to the Equipment or part thereof or Services which gives rise to the claim.

(b) All causes of action against ABB arising out of or relating to this Agreement or the performance or breach hereof shall expire unless brought within one year of the time of accrual thereof.

(c) In no event, regardless of cause, shall ABB be liable for penalties or penalty clauses of any description or for indemnification of Purchaser or others for costs, damages, or expenses arising out of or related to the Equipment and/Services.

11. Laws and Regulations. ABB does not assume any responsibility for compliance with federal, state or local laws and regulations, except as expressly set forth herein, and compliance with any laws and regulations relating to the operation or use of the Equipment or Software is the sole responsibility of the Purchaser. All laws and regulations referenced herein shall be those in effect as of the Proposal date. In the event of any subsequent revisions or changes thereto, ABB assumes no responsibility for compliance therewith. If Purchaser desires a modification as a result of any such change or revision, it shall be treated as a change per Article 4. Nothing contained herein shall be construed as imposing responsibility or liability upon ABB for obtaining any permits, licenses or approvals from any agency required in connection with the supply, erection or operation of the Equipment. This Agreement shall be governed by the laws of the State of New York, but excluding the provisions of the United Nations Convention on Contracts for the International Sale of Goods and excluding New York law with respect to conflicts of law. Purchaser agrees that all causes of action against ABB under this Agreement shall be brought in the State Courts of the State of New York, or the U.S. District Court for the Southern District of New York. If any provision hereof, partly or completely, shall be held invalid or unenforceable, such invalidity or unenforceability shall not affect any other provision or portion hereof and these terms shall be construed as if such invalid or unenforceable provision or portion

thereof had never existed.

12. OSHA. ABB warrants that the Equipment will comply with the relevant standards of the Occupational Safety and Health Act of 1970 ('OSHA') and the regulations promulgated thereunder as of the date of the Proposal. Upon prompt written notice from the Purchaser of a breach of this warranty, ABB will replace the affected part or modify it so that it conforms to such standard or regulation. ABB's obligation shall be limited to such replacement or modification. In no event shall ABB be responsible for liability arising out of the violation of any OSHA standards relating to or caused by Purchaser's design, location, operation, or maintenance of the Equipment, its use in association with other equipment of Purchaser, or the alteration of the Equipment by any party other than ABB.

13. Software License.
(a) ABB owns all rights in or has the right to sublicense all of the Software, if any, to be delivered to Purchaser under this Agreement. As part of the sale made hereunder Purchaser hereby obtains a limited license to use the Software, subject to the following: (i) The Software may be used only in conjunction with equipment specified by ABB; (ii) The Software shall be kept strictly confidential; (iii) The Software shall not be copied, reverse engineered, or modified; (iv) The Purchaser's right to use the Software shall terminate immediately when the specified equipment is no longer used by the Purchaser or when otherwise terminated, e.g. for breach, hereunder; and (v) the rights to use the Software are non-exclusive and non-transferable, except with ABB's prior written consent.
(b) Nothing in this Agreement shall be deemed to convey to Purchaser any title to or ownership in the Software or the intellectual property contained therein in whole or in part, nor to designate the Software a 'work made for hire' under the Copyright Act, nor to confer upon any person who is not a named party to this Agreement any right or remedy under or by reason of this Agreement. In the event of termination of this License, Purchaser shall immediately cease using the Software and, without retaining any copies, notes or excerpts thereof, return to ABB the Software and all copies thereof and shall remove all machine readable Software from all of Purchaser's storage media.

14. Inventions and Information. Unless otherwise agreed in writing by ABB and Purchaser, all right, title and interest in any inventions, developments, improvements or modifications of or for Equipment and Services shall remain with ABB. Any design, manufacturing drawings or other information submitted to the Purchaser remains the exclusive property of ABB. Purchaser shall not, without ABB's prior written consent, copy or disclose such information to a third party. Such information shall be used solely for the operation or maintenance of the Equipment and not for any other purpose, including the duplication thereof in whole or in part.

15. Force Majeure. ABB shall neither be liable for loss, damage, detention or delay nor be deemed to be in default for failure to perform when prevented from doing so by causes beyond its reasonable control including but not limited to acts of war (declared or undeclared), Acts of God, fire, strike, labor difficulties, acts or omissions of any governmental authority or of Purchaser, compliance with government regulations, insurrection or riot, embargo, delays or shortages in transportation or inability to obtain necessary labor, materials, or manufacturing facilities from usual sources or from defects or delays in the performance of its suppliers or subcontractors due to any of the foregoing enumerated causes. In the event of delay due to any such cause, the date of delivery will be extended by period equal to the delay plus a reasonable time to resume production, and the price will be adjusted to compensate ABB for such delay.

16. Cancellation. Any order may be cancelled by Purchaser only upon prior written notice and payment of termination charges, including but not limited to, all costs identified to the order incurred prior to the effective date of notice of termination and all expenses incurred by ABB attributable to the termination, plus a fixed sum of ten (10) percent of the final total price to compensate for disruption in scheduling, planned production and other indirect costs.

17. Termination. No termination by Purchaser for default shall be effective unless, within fifteen (15) days after receipt by ABB of Purchaser's written notice specifying such default, ABB shall have failed to initiate and pursue with due diligence correction of such specified default.

18. Export Control.
(a) Purchaser represents and warrants that the Equipment and Services provided hereunder and the 'direct product' thereof are intended for civil use only and will not be used, directly or indirectly, for the production of chemical or biological weapons or of precursor chemicals for such weapons, or for any direct or indirect nuclear end use. Purchaser agrees not to disclose, use, export or re-export, directly or indirectly, any information provided by ABB or the 'direct product' thereof as defined in the Export Control Regulations of the United States Department of Commerce, except in compliance with such Regulations.
(b) If applicable, ABB shall file for a U.S. export license, but only after appropriate documentation for the license application has been provided by Purchaser. Purchaser shall furnish such documentation within a reasonable time after order acceptance. Any delay in obtaining such license shall suspend performance of this Agreement by ABB. If an export license is not granted or, if once granted, is thereafter revoked or modified by the appropriate authorities, this Agreement may be canceled by ABB without liability for damages of any kind resulting from such cancellation. At ABB's request, Purchaser shall provide to ABB a Letter of

Assurance and End-User Statement in a form reasonably satisfactory to ABB.

19. Assignment. Any assignment of this Agreement or of any rights or obligations under the Agreement without prior written consent of ABB shall be void.

20. Nuclear Insurance – Indemnity. For applications in nuclear projects, the Purchaser and/or its end user customer shall have complete insurance protection against liability and property damage resulting from a nuclear incident to and shall indemnify ABB, its subcontractors, suppliers and vendors against all claims resulting from a nuclear incident.

21. Resale. If Purchaser resells any of the Equipment, the sale terms shall limit ABB's liability to the buyer to the same extent that ABB's liability to Purchaser is limited hereunder.

22. Entire Agreement. This Agreement constitutes the entire agreement between ABB and Purchaser. There are no agreements, understandings, restrictions, warranties, or representations between ABB and Purchaser other than those set forth herein or herein provided.

Ratings

150-3000 kVA, 3 phase, 60 hertz standard, 50 hertz optional

High Voltages (150 kv BIL and below): 4160 through 34,500Δ

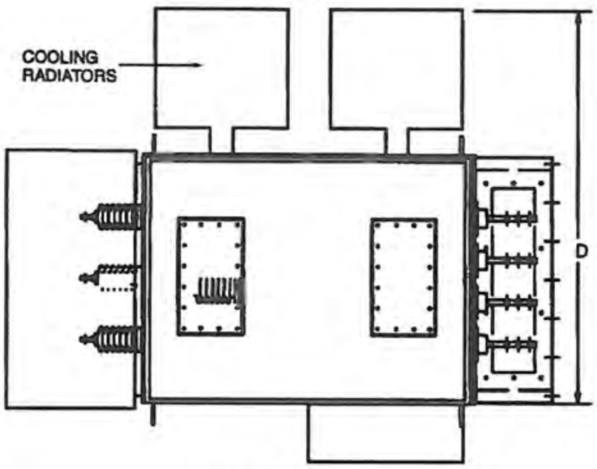
Low Voltages (60 kv BIL and below):

- **150 kVA through 1000 kVA:** 2300Δ, 2400Y/1385 to 4160Δ, 4160Y/2400, 480Y/277, 480Δ, 208Y/120
- **1500 kVA through 3000 kVA:** 2300Δ, 2400Y/1385 to 4160Δ, 4160Y/2400, 480Y/277, 480Δ

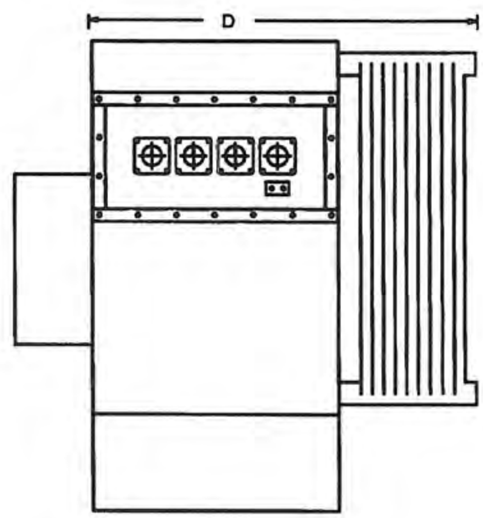
Design Dimensions

(All dimensions are approximate. Dimensions may change to meet specific customer requirements.)

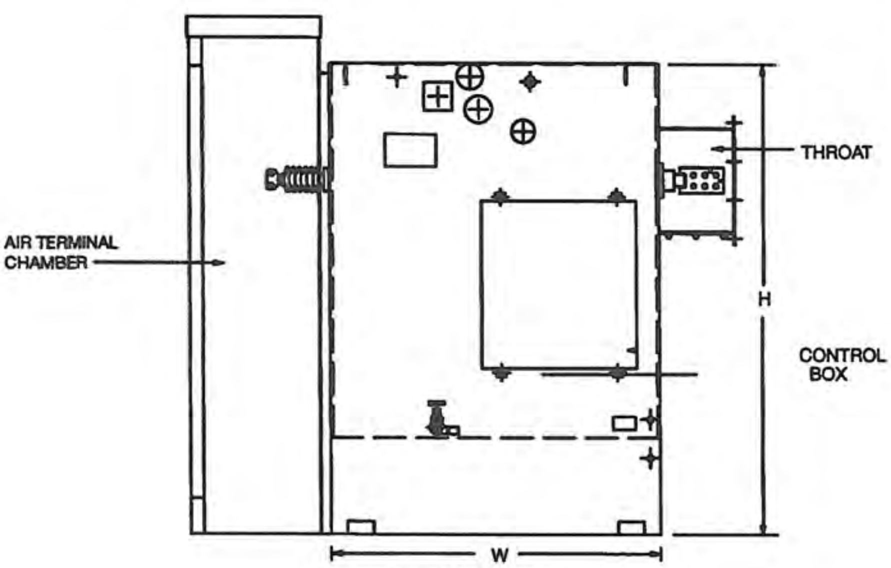
kVA	W Inches	H Inches	D Inches	Wt. lbs.	Gal. of Oil
225	46	73	50.5	5870	480
300	46	73	50.5	6035	477
500	50	73	52.2	7192	517
750	53	73	50.5	9150	566
1000	62	73	71	10521	642
1500	66	73	67.4	12427	665
2000	69	73	67.4	15021	668
2500	69	73	93.1	17334	662
3000	69	85	93.1	19000	699



TOP VIEW



RIGHT VIEW



FRONT VIEW

NOTE: Tank Reference dimensions only. Flanges and coordination not included in dimension W.

ABB

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Distribution Transformers
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Jefferson City, MO 65101
USA
Phone +1 573 634 2111
Fax +1 573 659 6275
www.abb.com/transformers

February 6, 2012

Budgetary Quote #13783-CA1R1

Resource Engineered Products
Email: Howard@repllc.net

Project: US Department of the Interior Bureau of Reclamation – Barnes Buttes Pumping Plant
Reference: MPP Quote #13783-CA1R1
2/6/12 Revised scope of work and sell price

Attn: Mr. Howard Huisel,

Myers Power Products, Inc. is pleased to provide the following scope of work and sell price for the referenced project:

ITEM 1	SEE BILL OF MATERIAL ATTACHED
Sell Price:	**$228,525.00 net, taxes excluded** *Note 1: Pricing quoted is for contemplated delivery by 08/2012; delivery exceeding 60 days beyond the estimated delivery date may be subject to a price escalation.*
Validity:	30 Days
Terms:	Progress Payment Terms; 100% Standby Letter of Credit N30 Pending Credit Approval; No Retentions Allowed *Progress Payment Schedule* *20% Upon Submittal of Drawings for Review / Approval* *30% Release for Fabrication* *30% Manufacturing Complete* *10% Ready for Test* *10% Shipment*
Freight:	FOB Factory to Pineville, OR; Offloading by others ***Note 1: Free and clear access by common carrier and any/all necessary traffic Control to be secured by customer.*** ***Note 2:Freight estimated at $2000 for shipment by 08/2012; freight charges in Excess of this estimate shall be borne by Buyer; surcharges and excess charges Beyond the control of supplier shall be borne by Buyer.***
Drawings:	6 – 8 Weeks ARO ****1 Electronic and (3) Hard Copy sets included*** ****For additional copies add $100.00 ea. to the sell price***
Customer Approval:	2 Weeks

Corporate Headquarters: 2950 E. Philadelphia Street, Ontario, California 91761 • Tel: (909) 923-1800 • Fax: (909) 923-1806
www.myerspowerproducts.com

Budgetary Quote #13783-CA1R1

Shipment:	14 – 16 Weeks ADA. Schedule based on receipt of PO NLT 2/13/12 *If PO is not received by the above date the order will be scheduled based on the Next available production slot*
Warranty:	12 months after energization or 18 months after shipment, which ever occurs first; Myers Power Products, Inc. standard terms and conditions of sale shall apply
Note:	Myers Power Products, Inc. standard terms and conditions of sale shall apply to the entire agreement. *Myers does not accept any Liquidated Damages or Back Charges*

We thank you for the opportunity to be of service and we look forward to working with you on this project. If you have any questions or require additional information, please contact Tony Williams or myself at 951-520-1900.

Kindest Regards,

Patrice Davezan
Estimating Manager

Corporate Headquarters: 2950 E. Philadelphia Street, Ontario, California 91761 • Tel: (909) 923-1800 • Fax: (909) 923-1806
www.myerspowerproducts.com

RESOURCE ENGINEERED PRODUCTS
US DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION
BARNES BUTTES PUMPING PLANT
MPP BUDGETARY QUOTE #13783-CA1R1

QTY	DESCRIPTION
1	**Medium Voltage Motor Control, Nema 3R Non-Walkin 2400V 1200A**
1	Section #1: -Incoming
1	Section #2: L/A's - Station Class 2 - P.T.'s 450VA w/Sw. Voltmeter w/Sw. U.V. Relay, Ph. Reversal Relay KWH/VAR Meter's
1	Section #3: 2kVA CPT w/ Switch L/O Relay P.L.'s
1	Section #4: 2 - P.T.'s 450VA w/Sw. Gnd. Detector Relay
1	Section #5: 10kVA Aux. Transformer Single Phase Provisional Space for Station Service Panel (Panel Not Included)
5	Section #6 - #9: 400A FLA 1-187, FVRN - Stab-in Contactor EMR3000 O/C Relay GFCT 50/% 3X Synchronous Panel Ammeter w/Sw. Red/Run P.L. Timing Relay, 2 C.R.'s Starter Isolation Sw. C/L Fuses C.T.'s Main Contactor Sola Transformer Variable Transformer Volt trap Voltage Suppressor Rectifier L.V. Control Compartment Brushless Type Field Panel Standard Lift Truck

Corporate Headquarters: 2950 E. Philadelphia Street, Ontario, California 91761 • Tel: (909) 923-1800 • Fax: (909) 923-1806
www.myerspowerproducts.com

RESOURCE ENGINEERED PRODUCTS
US DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION
BARNES BUTTES PUMPING PLANT
MPP BUDGETARY QUOTE #13783-CA1R1

COMMENTS / CLARIFICATIONS

1. Scope of work is per attached bill of material only. There were no plans or specifications available at time of bid.
2. Field excitation current must be provided prior to order entry.
3. Scope does not include startup or training.

Corporate Headquarters: 2950 E. Philadelphia Street, Ontario, California 91761 • Tel: (909) 923-1800 • Fax: (909) 923-1806
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GENERAL TERMS AND CONDITIONS OF SALE

MYERS POWER PRODUCTS, INC. is referred to herein as "Seller". The person, firm, or corporation to whom or which these Standard Terms and Conditions of Sale apply is called "Purchaser". The MYERS products covered by these terms are referred to herein as the "Products". These Standard Terms and Conditions of Sale are referred to herein as "Terms and Conditions" and shall remain in full force and effect unless superceded by "Special Terms and Conditions" as submitted by Myers Power Products.

(1) **TERMS OF OFFER (QUOTATION)** - This quotation constitutes an offer to sell according to the terms set forth herein. Unless otherwise indicated this offer shall remain open for thirty (30) days only from the date of this quotation, and shall be deemed accepted by the purchaser only upon receipt and acceptance by the seller of a purchase order from the purchaser. Acceptance of this offer by the purchaser is expressly limited to the terms hereof and in the event that the purchase order from the purchaser states terms additional to or different from those set forth herein, this offer shall be deemed a notice of objection to such additional or different terms and rejection thereof. Any acknowledgment sent by the seller to the purchaser subsequent to the seller's receipt of a purchase order from the purchaser shall not be deemed to be an acceptance by the seller of any offer by the purchaser, and shall not alter the Terms and Conditions of this offer.

(2) **PRICES AND TERM** - These products are sold F.O.B. point of shipment.

1. Published prices cover standard domestic packing only.
2. Unless otherwise indicated, terms of payment are net thirty (30) days from date of shipment.
3. Payments not made when due shall bear interest at 2% per month until payment is made.
4. Minimum charge on any order is two hundred and fifty dollars ($250.00) plus transportation costs.
5. When drawings for approval are required for any Product(s), the drawings applicable to those Products must be returned within 30 calendar days from the date of the original mailing of the drawings by Seller. The return drawings must be released for manufacture and shipment and must be marked "APPROVED" or "APPROVED AS NOTED." Drawing re-submittals which are required for any other reason than to correct Seller errors will not extend the 30-day period.
6. If the Buyer initiates or in anyway causes delays in shipment, provision of Services or return of approval drawings beyond the periods stated above, the price of the Products or Services shall be increased a minimum of 1% per month or fraction thereof up to a maximum of 18 months from the date of the Buyer's order. For delays resulting in shipment or provision of Services beyond 18 months from the date of the Buyer's order, the price must be renegotiated.

Prices are subject to change without notice. Unless otherwise indicated seller reserves the right to invoice at prices in effect on date of shipment.

(3) **PAYMENTS** - Unless otherwise indicated, pro rata payments shall become due as shipments are made. If shipments are delayed by the purchaser, then payments shall become due on the date that the seller is prepared to make shipment. If the work to be performed hereunder is delayed by the purchaser, payments shall be made based on the purchase price and the percentage of completion. Equipment held for the purchaser shall be at the risk and expense of the purchaser. If the financial condition of the purchaser at any time does not, in the judgment of the seller, justify continuance of the work to be performed by the seller hereunder on the terms of payment as agreed upon, the seller may require full or partial payment in advance or shall be entitled to cancel any order then outstanding and shall receive reimbursement for its reasonable and proper cancellation charges, and in the event of bankruptcy or insolvency of the purchaser or in the event any proceeding is brought against the purchaser, voluntarily or involuntarily, under the bankruptcy or any insolvency laws, the seller shall be entitled to cancel any order then outstanding at any time during the period allowed for filing claims against the estate and shall receive reimbursement for its reasonable and proper cancellation charges.

(4) **DELAYED PAYMENT** - If payments are not made in accordance with these terms, a service charge will without prejudice to the right of Seller to immediate payment, be added in an amount equal to the lower of 2% per month or fraction thereof or the highest legal rate on the unpaid balance. A grace period for the first month is 15 days.

(5) **FINANCIAL CONDITION OF BUYER** - If the financial condition of the Buyer at any time is such as to give the Seller, in its sole judgment, reasonable grounds for insecurity concerning Buyer's ability to perform its obligations under this Agreement, Seller may require full or partial payment in advance and suspend performance hereunder, until such payment has been received. Failure to furnish such payment within ten (10) days of demand by Seller shall constitute a breach of this Agreement.

(6) **COLLECTION COSTS** - Buyer shall pay to Seller reasonable costs of collection of money due and unpaid, including reasonable attorney's fees.

(7) **TAXES** - The amount of any federal, state or municipal tax applicable to the product, which the seller shall be required to pay, either on its behalf or on behalf of the purchaser, shall be added to the prices contained herein and paid by the purchaser unless stated otherwise.

(8) **DRAWING APPROVAL** - Seller will design the Products in line with, in Seller's judgment, good commercial practice. If at drawing approval Buyer makes changes outside of the design as covered in their specifications, Seller will then be paid reasonable charges and allowed a commensurate delay in shipping date based on the changes made.

(9) **DELIVERY** - Delivery dates are estimates of approximate dates of delivery, not a guarantee of a particular day of delivery, and are based on the prompt receipt of all necessary information from the purchaser and return of approval drawings within two (2) weeks after submittal when applicable. Furthermore, delivery dates are based on an assumed ration of acceptances. If this assumption should prove incorrect, the seller may have to allocate its production time and thereby adjust the delivery dates. Customer's failure to receive goods within a reasonable period of time may result in a price increase at the discretion of Seller.

(10) **PREPAID FREIGHT DELIVERY** - The method and route of all prepaid freight shipments are optional with the seller. Where the purchaser specifies that shipment be made other than the usual method and route of shipment, the additional expense will be borne by the purchaser.
If destination may be reached in part by boat shipment only, water shipment will be made at the purchaser's expense collect. In addition to the water shipping charges, cartage to the boat will be made at purchaser's expense. If shipment is accepted by the purchaser at one destination and re-forwarded by him, the re-forwarding is at the purchaser's expense. No allowance will be made for freight if purchaser accepts shipments at the factory or if collect shipments are requested.

(11) **TITLE AND INSURANCE** - Title to the product(s) and risk of loss or Damage shall pass to Purchaser at the F.O.B. point, except that a security interest in the product(s) and proceeds and any replacement shall remain in Seller, regardless of mode of attachment to realty or other property, until the full price has been paid in cash. Purchaser agrees to do all acts necessary to perfect and maintain said security interest, and to protect Seller's interest by adequately insuring the product(s) against loss or damage from any external cause with Seller named as insured or co-insured.

(12) **FORCE MAJEURE** - The seller shall not be liable to the purchaser for any failure or delay in complying with the Terms and Conditions of this agreement if such failure or delay shall be due to any act of God, nature or the public enemy, accident, explosion, operation malfunction or interruption, fire, storm, earthquake, flood, drought, perils of the sea, strikes, lockouts, labor disputes, riots, sabotage, embargo, war (whether or not declared and whether or not the United States is a participant), federal, state, or municipal legal restriction or limitation or compliance therewith, failure or delay of transportation, shortage of, or inability to obtain raw materials, supplies, equipment, fuel, power, labor or other operational necessities, interruption or curtailment of power of other energy or fuel supply or any other circumstances of a similar nature beyond the reasonable control of the seller. In this connection, the seller shall not be required to resolve labor disputes or disputes with supplier of raw materials, supplies, equipment, fuel or power, but may in accordance with its best interest do so. This section shall be cumulative with the provisions of the applicable section of the Uniform Commercial Code, or similar laws, enacted in the state described in the paragraph captioned "Governing Laws", relating to excuse of seller by reason of the failure of presupposed conditions.

(13) **CLAIMS FOR SHORTAGES OR SHIPPING DAMAGES** - Any material received damaged must be so noted on the delivery receipt by the delivering carrier at time of delivery and reported to the seller no later than seven (7) days after receipt of shipment. Concealed damage claims must be reported and confirmed in writing to the delivering carrier no later than ten (10) days from date shipment was originally received in accordance with ICC regulations. Claims for shortage material, in writing, must be made to the seller within twenty (20) days after receipt of shipment. For any claims under this Paragraph (13) for which the seller may be liable, the purchaser's exclusive remedy shall be the repair or replacement, F.O.B. factory, as the seller may elect, of such material and NO in and out charges are allowed.

GENERAL TERMS AND CONDITIONS OF SALE

(14) **CONCEALED DAMAGE** - Except in the event of F.O.B. destination shipments, Seller will not participate in any settlement of claims for concealed damage.

When shipment has been made on an F.O.B. destination basis, the Buyer must unpack immediately and, if damage is discovered must:

1. Not move the Products from the point of examination.
2. Retain shipping container and packing material.
3. Notify the carrier in writing of any apparent damage.
4. Notify Seller representative within 72 hours of delivery.
5. Send Seller a copy of the carrier's inspection report.

(15) **RETURN OF MATERIAL** - The seller's permission must be obtained in writing before any products are returned to it by the purchaser for any reason whatsoever. If products are returned without such permission, purchaser authorizes the seller, in addition to such other remedies as it may have, to hold the returned products at purchaser's sole risk and expense. When the purchaser requests authorization to return material for reasons of his own, the purchaser will be charged for placing the returned goods in salable condition, restocking charges and for any outgoing and incoming transportation paid by the seller.

(16) **STORAGE** - Any item of the product(s) on which manufacture or shipment is delayed by causes within Purchaser's control, or by causes which affect Purchaser's ability to receive the product(s), may be placed in storage for an agreed upon amount by Seller for Purchaser, account and risk.

(17) **WARRANTY** - Seller warrants title to the product(s) and, except as noted below with respect to items not of Sellers manufacture, also warrants the product(s) on date of shipment to Purchaser, to be of the kind and quality described herein, merchantable, and free of defects in workmanship and material.

THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES, INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS, AND CONSTITUTES THE ONLY WARRANTY OF SELLER WITH RESPECT TO THE PRODUCT(S).

If within one year from date of initial operation, but not more then eighteen months from date of shipment by Seller of any item of product(s), Purchaser discovers that such Item was not as warranted above and promptly notifies Seller in writing thereof, Seller shall remedy such nonconformance by, at Seller's option, adjustment or repair or replacement of the item and any affected part of the product(s). Purchaser shall assume all responsibility and expense for removal, reinstallation, and freight in connection with the foregoing remedies. The same obligations and conditions shall extend to replacement parts furnished by Seller hereunder. Seller shall have the right of disposal of parts replaced by it.

ANY SEPARATELY LISTED ITEM OF THE PRODUCT(S) WHICH IS NOT MANUFACTURED BY SELLER IS NOT WARRANTED BY SELLER, and shall be covered only by the express warranty, if any, of the manufacturer thereof.

THIS STATES PURCHASER'S EXCLUSIVE REMEDY AGAINST SELLER AND ITS SUPPLIERS RELATING TO THE PRODUCT(S), WHETHER IN CONTRACT OR IN TORT OR UNDER ANY OTHER LEGAL THEORY, AND WHETHER ARISING COST OF WARRANTIES, REPRESENTATIONS, INSTRUCTIONS, INSTALLATIONS OR DEFECTS FROM ANY CAUSE. Seller and its suppliers shall have no obligation as to any product which has been improperly stored or handled, or which has not been operated or maintained according to instructions in Seller or supplier furnished manuals.

(18) **WARRANTY FOR SERVICES** - Seller warrants that the Services performed by it hereunder will be performed in accordance with generally accepted professional standards.

The Services, which do not so conform shall be corrected by Seller upon notification in writing by the Buyer within one (1) year after completion of the Services. Unless otherwise agreed to in writing by Seller, Seller assumes no responsibility with respect to the suitability of the Buyer's equipment or with respect to any latent defects in the same. This warranty does not cover damage to Buyer's equipment, components or parts resulting in whole or in part from improper maintenance or operation or from their deteriorated condition. Buyer will, at its cost, provide Seller with unobstructed access to the defective Services, as well as adequate free working space in the immediate vicinity of the defective Services and such facilities and systems, including, without limitation, docks, cranes and utility disconnects and connects, as may be necessary in order that Seller may perform its warranty obligations. The conducting of any tests shall be mutually agreed upon and Seller shall be notified of, and may be present at, all tests that may be made.

Extended Warranties may be purchased prior to shipping for a fee. Fees for Extended Warranties are calculated on a project analysis basis but in no case shall be less than 3% per year for each year the warranty is extended up to a maximum of 5 years.

(19) **CANCELLATIONS** - Cancellations or modifications of an order by the purchaser will only be accepted by the seller in writing and on the basis that the seller will be paid for expenses incurred up to the time that the cancellation or modification is accepted by the seller. A minimum charge of $500.00 will be assessed. Unless otherwise provided, if there has been an accumulation of materials engineering or drafting, the cancellation will be based on actual costs incurred, plus a reasonable allowance for overhead and profit up to 100% of selling price.

(20) **LIQUIDATED DAMAGES** - Contracts which include liquidated damage clauses for failure to meet shipping or job completion promises are not acceptable or binding on Seller, unless such clauses are specifically accepted in writing by an authorized representative of the Seller at its headquarters office.

(21) **BACKCHARGES AND ALTERATIONS** - The seller will not be responsible for any backcharges to correct any possible manufacturing error, or any modifications to meet existing conditions or for any reason whatsoever unless authorized by the seller in writing. Any field problem should be reported to MYERS POWER PRODUCTS.

(22) **LIMITATION OF LIABILITY** - The purchaser's exclusive remedy on any claim of any kind for any loss or damage arising out of, connected with, or resulting from this contract, or from the performance or breach thereof, or from the design, manufacture, sale, delivery, resale, or repair or use of any products covered by or furnished under the contract, including but not limited to any claim of negligence or other tortious breach, shall be the repair or replacement, F.O.B. factory, as the seller may elect, or the product or part thereof giving rise to such claim, except that the seller's liability for such repair or replacement shall in no event exceed the contract price allocable to the products or part thereof which gives arise to the claim. THE SELLER SHALL IN NO EVENT BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.

(23) **GENERAL** - Any assignment of the order, or any rights hereunder, by the purchaser without written consent of the seller shall be void. The provisions of any contract resulting from the order are for the benefit of the parties thereto and not for any other person. No waiver, alteration, or modification of any of the provisions hereof shall be binding unless in writing and signed by a duly authorized representative of the seller.
ANY PURCHASE ORDER PURSUANT TO THE ACCOMPANYING QUOTATION SHALL BE SUBJECT TO THE APPROVAL OF SELLER'S CREDIT DEPARTMENT AND SHALL NOT RESULT IN A CONTRACT UNTIL IT IS ACCEPTED AND ACKNOWLEDGED BY SELLER AT SELLER'S FACILITY.

(24) **AUTHORITY OF SELLER'S AGENTS** – No agent, employee or representative of the seller has any authority to bind the Seller to any affirmation, representation or warranty concerning the goods sold under this Agreement, and unless the affirmation, representation, or warranty made by an agent employee or representative is specifically included herein, it has not formed a part of the basis of this bargain and shall not in any way be enforceable.

(25) **PROPRIETARY RIGHTS** – The sale of the goods hereunder to Buyer shall in no way be deemed to confer upon Buyer any right, interest or license in any patents or patent applications Seller may have covering the goods by Seller retains for itself all proprietary rights in and to all designs, engineering details and other data and materials pertaining to any goods supplied Seller and to all discoveries, inventions, patents, and other proprietary rights arising out of the work done in connection with the goods or with any and all products developed as a result thereof, including the sole right to manufacture any and all such products. Buyer warrants that he will not divulge, disclose, or in any way make use of such information (as built drawings, software and design information), and that it will not manufacture or engage to have manufactured such products.

(26) **GOVERNING LAW** - Any contract formed pursuant to this quotation shall be governed by and construed in accordance with the laws of the State of California.

(27) These Terms & Conditions shall remain in full force and effect and shall be deemed as accepted upon receipt of Purchase Order from Purchaser unless superceded by a modified T&C, specified and agreed in writing by an Officer of the Company of both Purchaser and Seller.

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(1) **TERMS OF OFFER (QUOTATION)** - This quotation constitutes an offer to sell according to the terms set forth herein. Unless otherwise indicated this offer shall remain open for thirty (30) days only from the date of this quotation, and shall be deemed accepted by the purchaser only upon receipt and acceptance by the seller of a purchase order from the purchaser. Acceptance of this offer by the purchaser is expressly limited to the terms hereof and in the event that the purchase order from the purchaser states terms additional to or different from those set forth herein, this offer shall be deemed a notice of objection to such additional or different terms and rejection thereof. Any acknowledgment sent by the seller to the purchaser subsequent to the seller's receipt of a purchase order from the purchaser shall not be deemed to be an acceptance by the seller of any offer by the purchaser, and shall not alter the Terms and Conditions of this offer.

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4. Minimum charge on any order is two hundred and fifty dollars ($250.00) plus transportation costs.
5. When drawings for approval are required for any Product(s), the drawings applicable to those Products must be returned within 30 calendar days from the date of the original mailing of the drawings by Seller. The return drawings must be released for manufacture and shipment and must be marked "APPROVED" or "APPROVED AS NOTED." Drawing re-submittals which are required for any other reason than to correct Seller errors will not extend the 30-day period.
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(7) **TAXES** - The amount of any federal, state or municipal tax applicable to the product, which the seller shall be required to pay, either on its behalf or on behalf of the purchaser, shall be added to the prices contained herein and paid by the purchaser unless stated otherwise.

(8) **DRAWING APPROVAL** - Seller will design the Products in line with, in Seller's judgment, good commercial practice. If at drawing approval Buyer makes changes outside of the design as covered in their specifications, Seller will then be paid reasonable charges and allowed a commensurate delay in shipping date based on the changes made.

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If destination may be reached in part by boat shipment only, water shipment will be made at the purchaser's expense collect. In addition to the water shipping charges, cartage to the boat will be made at purchaser's expense. If shipment is accepted by the purchaser at one destination and re-forwarded by him, the re-forwarding is at the purchaser's expense. No allowance will be made for freight if purchaser accepts shipments at the factory or if collect shipments are requested.

(11) **TITLE AND INSURANCE** - Title to the product(s) and risk of loss or Damage shall pass to Purchaser at the F.O.B. point, except that a security interest in the product(s) and proceeds and any replacement shall remain in Seller, regardless of mode of attachment to realty or other property, until the full price has been paid in cash. Purchaser agrees to do all acts necessary to perfect and maintain said security interest, and to protect Seller's interest by adequately insuring the product(s) against loss or damage from any external cause with Seller named as insured or co-insured.

(12) **FORCE MAJEURE** - The seller shall not be liable to the purchaser for any failure or delay in complying with the Terms and Conditions of this agreement if such failure or delay shall be due to any act of God, nature or the public enemy, accident, explosion, operation malfunction or interruption, fire, storm, earthquake, flood, drought, perils of the sea, strikes, lockouts, labor disputes, riots, sabotage, embargo, war (whether or not declared and whether or not the United States is a participant), federal, state, or municipal legal restriction or limitation or compliance therewith, failure or delay of transportation, shortage of, or inability to obtain raw materials, supplies, equipment, fuel, power, labor or other operational necessities, interruption or curtailment of power of other energy or fuel supply or any other circumstances of a similar nature beyond the reasonable control of the seller. In this connection, the seller shall not be required to resolve labor disputes or disputes with supplier of raw materials, supplies, equipment, fuel or power, but may in accordance with its best interest do so. This section shall be cumulative with the provisions of the applicable section of the Uniform Commercial Code, or similar laws, enacted in the state described in the paragraph captioned "Governing Laws", relating to excuse of seller by reason of the failure of presupposed conditions.

(13) **CLAIMS FOR SHORTAGES OR SHIPPING DAMAGES** - Any material received damaged must be so noted on the delivery receipt by the delivering carrier at time of delivery and reported to the seller no later than seven (7) days after receipt of shipment. Concealed damage claims must be reported and confirmed in writing to the delivering carrier no later than ten (10) days from date shipment was originally received in accordance with ICC regulations. Claims for shortage material, in writing, must be made to the seller within twenty (20) days after receipt of shipment. For any claims under this Paragraph (13) for which the seller may be liable, the purchaser's exclusive remedy shall be the repair or replacement, F.O.B. factory, as the seller may elect, of such material and NO in and out charges are allowed.

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When shipment has been made on an F.O.B. destination basis, the Buyer must unpack immediately and, if damage is discovered must:

1. Not move the Products from the point of examination.
2. Retain shipping container and packing material.
3. Notify the carrier in writing of any apparent damage.
4. Notify Seller representative within 72 hours of delivery.
5. Send Seller a copy of the carrier's inspection report.

(15) **RETURN OF MATERIAL** - The seller's permission must be obtained in writing before any products are returned to it by the purchaser for any reason whatsoever. If products are returned without such permission, purchaser authorizes the seller, in addition to such other remedies as it may have, to hold the returned products at purchaser's sole risk and expense. When the purchaser requests authorization to return material for reasons of his own, the purchaser will be charged for placing the returned goods in salable condition, restocking charges and for any outgoing and incoming transportation paid by the seller.

(16) **STORAGE** - Any item of the product(s) on which manufacture or shipment is delayed by causes within Purchaser's control, or by causes which affect Purchaser's ability to receive the product(s), may be placed in storage for an agreed upon amount by Seller for Purchasers account and risk.

(17) **WARRANTY** - Seller warrants title to the product(s) and, except as noted below with respect to items not of Sellers manufacture, also warrants the product(s) on date of shipment to Purchaser, to be of the kind and quality described herein, merchantable, and free of defects in workmanship and material.

THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES, INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS, AND CONSTITUTES THE ONLY WARRANTY OF SELLER WITH RESPECT TO THE PRODUCT(S).

If within one year from date of initial operation, but not more then eighteen months from date of shipment by Seller of any item of product(s), Purchaser discovers that such Item was not as warranted above and promptly notifies Seller in writing thereof, Seller shall remedy such nonconformance by, at Seller's option, adjustment or repair or replacement of the item and any affected part of the product(s). Purchaser shall assume all responsibility and expense for removal, reinstallation, and freight in connection with the foregoing remedies. The same obligations and conditions shall extend to replacement parts furnished by Seller hereunder. Seller shall have the right of disposal of parts replaced by it.

ANY SEPARATELY LISTED ITEM OF THE PRODUCT(S) WHICH IS NOT MANUFACTURED BY SELLER IS NOT WARRANTED BY SELLER, and shall be covered only by the express warranty, if any, of the manufacturer thereof.

THIS STATES PURCHASER'S EXCLUSIVE REMEDY AGAINST SELLER AND ITS SUPPLIERS RELATING TO THE PRODUCT(S), WHETHER IN CONTRACT OR IN TORT OR UNDER ANY OTHER LEGAL THEORY, AND WHETHER ARISING COST OF WARRANTIES, REPRESENTATIONS, INSTRUCTIONS, INSTALLATIONS OR DEFECTS FROM ANY CAUSE. Seller and its suppliers shall have no obligation as to any product which has been improperly stored or handled, or which has not been operated or maintained according to instructions in Seller or supplier furnished manuals.

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The Services, which do not so conform shall be corrected by Seller upon notification in writing by the Buyer within one (1) year after completion of the Services. Unless otherwise agreed to in writing by Seller, Seller assumes no responsibility with respect to the suitability of the Buyer's equipment or with respect to any latent defects in the same. This warranty does not cover damage to Buyer's equipment, components or parts resulting in whole or in part from improper maintenance or operation or from their deteriorated condition. Buyer will, at its cost, provide Seller with unobstructed access to the defective Services, as well as adequate free working space in the immediate vicinity of the defective Services and such facilities and systems, including, without limitation, docks, cranes and utility disconnects and connects, as may be necessary in order that Seller may perform its warranty obligations. The conducting of any tests shall be mutually agreed upon and Seller shall be notified of, and may be present at, all tests that may be made.

Extended Warranties may be purchased prior to shipping for a fee. Fees for Extended Warranties are calculated on a project analysis basis but in no case shall be less than 3% per year for each year the warranty is extended up to a maximum of 5 years.

(19) **CANCELLATIONS** - Cancellations or modifications of an order by the purchaser will only be accepted by the seller in writing and on the basis that the seller will be paid for expenses incurred up to the time that the cancellation or modification is accepted by the seller. A minimum charge of $500.00 will be assessed. Unless otherwise provided, if there has been an accumulation of materials engineering or drafting, the cancellation will be based on actual costs incurred, plus a reasonable allowance for overhead and profit up to 100% of selling price.

(20) **LIQUIDATED DAMAGES** - Contracts which include liquidated damage clauses for failure to meet shipping or job completion promises are not acceptable or binding on Seller, unless such clauses are specifically accepted in writing by an authorized representative of the Seller at its headquarters office.

(21) **BACKCHARGES AND ALTERATIONS** - The seller will not be responsible for any backcharges to correct any possible manufacturing error, or any modifications to meet existing conditions or for any reason whatsoever unless authorized by the seller in writing. Any field problem should be reported to MYERS POWER PRODUCTS.

(22) **LIMITATION OF LIABILITY** - The purchaser's exclusive remedy on any claim of any kind for any loss or damage arising out of, connected with, or resulting from this contract, or from the performance or breach thereof, or from the design, manufacture, sale, delivery, resale, or repair or use of any products covered by or furnished under the contract, including but not limited to any claim of negligence or other tortious breach, shall be the repair or replacement, F.O.B. factory, as the seller may elect, or the product or part thereof giving rise to such claim, except that the seller's liability for such repair or replacement shall in no event exceed the contract price allocable to the products or part thereof which gives arise to the claim. THE SELLER SHALL IN NO EVENT BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.

(23) **GENERAL** - Any assignment of the order, or any rights hereunder, by the purchaser without written consent of the seller shall be void. The provisions of any contract resulting from the order are for the benefit of the parties thereto and not for any other person. No waiver, alteration, or modification of any of the provisions hereof shall be binding unless in writing and signed by a duly authorized representative of the seller.
ANY PURCHASE ORDER PURSUANT TO THE ACCOMPANYING QUOTATION SHALL BE SUBJECT TO THE APPROVAL OF SELLER'S CREDIT DEPARTMENT AND SHALL NOT RESULT IN A CONTRACT UNTIL IT IS ACCEPTED AND ACKNOWLEDGED BY SELLER AT SELLER'S FACILITY.

(24) **AUTHORITY OF SELLER'S AGENTS** – No agent, employee or representative of the seller has any authority to bind the Seller to any affirmation, representation or warranty concerning the goods sold under this Agreement, and unless the affirmation, representation, or warranty made by an agent employee or representative is specifically included herein, it has not formed a part of the basis of this bargain and shall not in any way be enforceable.

(25) **PROPRIETARY RIGHTS** – The sale of the goods hereunder to Buyer shall in no way be deemed to confer upon Buyer any right, interest or license in any patents or patent applications Seller may have covering the goods by Seller retains for itself all proprietary rights in and to all designs, engineering details and other data and materials pertaining to any goods supplied Seller and to all discoveries, inventions, patents, and other proprietary rights arising out of the work done in connection with the goods or with any and all products developed as a result thereof, including the sole right to manufacture any and all such products. Buyer warrants that he will not divulge, disclose, or in any way make use of such information (as built drawings, software and design information), and that it will not manufacture or engage to have manufactured such products.

(26) **GOVERNING LAW** - Any contract formed pursuant to this quotation shall be governed by and construed in accordance with the laws of the State of California.

(27) These Terms & Conditions shall remain in full force and effect and shall be deemed as accepted upon receipt of Purchase Order from Purchaser unless superceded by a modified T&C, specified and agreed in writing by an Officer of the Company of both Purchaser and Seller.

CANCELLATION POLICY

An order may be canceled by the purchaser only upon the written notice and upon payment to the company of reasonable and proper cancellation charges. The expenses to be covered by these charges would include an unrecoverable cost incurred by the company. In addition, a one-time charge will be made to compensate for lost profits, disruptions in schedules, planned production and other indirect costs. It is recognized that it is impossible to determine exactly these indirect costs. As such, it is agreed that the one time charge is acceptable and proper. Total cancellation charges will be calculated as follows:

Order Entry:
After receipt of an order at the factory and order processing, but prior to the start of engineering, there will be a one time 5 percent charge with a minimum of $1,000.00 for any one order.

Release for Engineering:

After an order has been released for engineering, there will be a one time 10 percent charge for cancellation plus any actual costs incurred including vendor cancellation charges, engineering labor expended plus costs associated with engineering overhead, selling, general and administrative expenses.

Release for manufacture:

After an order has been released for manufacture and scheduled for production, there will be a one time 10 percent charge for cancellation plus any actual costs incurred including, but not limited to vendor cancellation charges, all materials received or expended, shop and engineering labor plus costs associated with manufacturing and engineering overhead, selling, general and administrative expenses.

Cancellations within 61-90 days of scheduled completion:

Cancellation charge will be a minimum of 50 percent of the contract value.

Cancellation within 31-60 days of the scheduled completion:

Cancellation charge will be a minimum of 75 percent of the contract value.

Cancellation within 30 of the scheduled completion:

Cancellation charge will be 100 percent of the contract value

In addition to the above charges, a reasonable profit of 10 percent will be allowed and payable against all identified costs incurred by the time of cancellation. Cancellation costs will be due and payable within 30 days of submittal of a proper invoice for such costs. Any amounts not paid within 30 days will be subject to late charges of 1 1/2 percent per month for each fraction of a month that payment is received late at MPP.

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DELIVERABLES – TAB 5

Cost/Benefit Analysis of Modernizing Barnes Butte Pump Plant, Ochoco Relift Pump Plant, and Other Smaller District Plants

Ochoco Irrigation District Pumping Plant Evaluation Summary

1.0 GENERAL

1.1. EXISTING PUMPING PLANT SUMMARY

Seven existing pumping plants within the Ochoco Irrigation District were examined for optimization potential. The Ochoco Relift Pumping Plant consists of two discrete pumping plants and discharge mains that were examined separately; Ochoco Relift 42-inch and Ochoco Relift 24-inch. The existing pumping plants are summarized in Table 1.

Table 1 - Existing Pumping Plant Summary

DESIGNATION	NUMBER OF UNITS	TOTAL NAMEPLATE CAPACITY OF CURRENT EQUIPMENT (CFS) *	TOTAL DYNAMIC HEAD AT TOTAL NAMEPLATE CAPACITY (FT) **	TOTAL NAMEPLATE HORSEPOWER OF CURRENT EQUIPMENT (HORSEPOWER)
Barnes Butte	5	135.6	86	1,800
Ochoco Relift - 42-inch Discharge Main	4	78.0	104	1,300
Ochoco Relift - 24-inch Discharge Main	2	20.1	103	250
Johnson Creek	2	18.5	136	375
Grimes Flat	3	20.1	83	275
Combs Flat	2	10.8	159	225
McKay Creek (West McKay)	1	3.0	49	25
Tunnel	1	3.8	93	75

* Total nameplate capacity of pumping plants reported as the sum of pump nameplate capacity for individual pumps.

** TDH as modeled at Total Nameplate Capacity.

1.2. EVALUATION PROCEDURE

Existing pumping plants within the Ochoco Irrigation District delivery system were examined to identify potential energy savings opportunities. The evaluation work consisted of;

a) Examination of records (drawings, specifications, product data, and studies) from the original pumping plant construction work and subsequent studies
b) Field reconnaissance of existing conditions at the pumping plant site
c) Review of Initial Pump Evaluation test data prepared by Bonneville Power Administration
d) Preparation of system curves for original, existing and improved conditions
e) Selection of alternate pump equipment to fit the improved conditions system curve
f) Opinion of probable construction costs for installation of alternate equipment
g) Preparation of a unit demand curve for monthly water delivery

h) Evaluation of annual energy savings for operation of alternate equipment versus existing equipment
i) Evaluation of 20-year energy savings as compared to initial cost of installing alternate equipment.

2.0 BACKGROUND DATA

2.1. CONSTRUCTION RECORDS, PRODUCT DATA, AND STUDIES

Construction record furnished by Ochoco Irrigation District consisted of;

a) *Ochoco Relift and Barnes Buttes Pumping Plant and Discharge Lines, Crooked River Project, Oregon,* United States Department of the Interior Bureau of Reclamation, 1960. The document consisted of a bound booklet with contents listed as Schedule, General Provisions, Specifications and Drawings.
b) *Earthwork, Pipelines and Structures for Six Pumping Plants, Crooked River Extension Crooked Rover Project, Oregon,* United States Department of the Interior Bureau of Reclamation Region 1, 1966. The document consisted of a bound booklet with contents listed as Schedule, General Provisions, Specifications and Drawings.
c) Product Data - consisted of an incomplete record of original pump curve data, certified factory curves for pumps, and motor name plate data. The record did not include pump curves for some of the pumps that have been replaced, or upsized since original construction.
d) *Alternative Evaluation and Preliminary Design OID/BOR Conveyance Reconstruction,* W&H Pacific, 2006. The document consisted of a bound booklet with contents evaluating construction of a replacement discharge main from the Barnes Butte Pumping Plant along a new alignment and extension of the discharge main approximately 5,050 feet to replace open canal through private property planned for residential development.

2.2. FIELD RECONAISANCE

Field reconnaissance of existing pumping plants consisted of;

a) General exploration and examination of pumping plant sites 1-26-10
b) Reconnaissance level elevation survey and distance measurements along discharge main alignments, collection of pump and motor nameplate data, and photos 4-29-11

2.3. INITIAL PUMP EVALUATION TEST DATA BY BONNEVILLE POWER ADMINISTRATION

Bonneville Power Administration conducted an initial pump evaluation of the Barnes Butte, Johnson Creek, Grimes, Ochoco Relift 42-inch, and Ochoco Relift 24-inch pumping plants during the period 10-12-10 through 10-14-10. The evaluation testing generally consisted of measurement of pump discharge pressure, flow rate, and motor efficiency for each pump at the referenced sites. The evaluations were summarized in tabulated test data reports. The test data reports are included in individual sections of the Pumping Plant Evaluations that follow.

2.4. SYSTEM CURVES

System curves for individual pumping plants were generated by using Hazen Williams friction loss formula in excel spreadsheet format. Individual segments of the pumping plant discharge were analyzed and aggregated including suction pipe (where applicable), column pipe, pump discharge pipe, and discharge main. Minor losses including wyes, bends, valves, and gates were valuated separately and included in the total dynamic head for each system curve. For each pumping plant, three discrete curves were generated;

a) *System Curve Original Design (Hazen-Williams C-Value = 140 Steel and C = 120 Concrete).* These curves include the original pump performance curves, if available, the original pump performance point(s) from construction documents, and test data point(s) from the Initial Pump Evaluation conducted by Bonneville Power. These curves are intended to proof the modeled system curve against the original pump performance point and pumping plant performance data published in pumping plant construction documents.
b) *System Curve C = 135 Steel, C = 110 Concrete*. These curves included a reduced C-value indicative of degraded pipe materials and suggestive of the expected current operating condition. The curves also include proposed alternate pump curves showing the expected pumping capacity of alternate pumping equipment.
c) *System Curve (Improved Configuration).* These curves include the C = 135 Steel, and C = 110 Concrete indicative of degraded pipe material in the discharge main. These curves also include modeling of increased pump discharge pipe and valve sizes intended to reduce long-term operating expenses by reducing friction losses immediately downstream of the pumps.

2.5. SELECTION OF ALTERNATIVE PUMPING EQUIPMENT

Most of the pumping equipment in the Districts' asset inventory is in excess of 40 years old. Although most pumps have been refurbished, and some replaced, the performance requirement for most pumping plants has changed since original design criteria was established. In most cases, the pumping plant output has been increased without modification of pump discharge piping, control valves, or discharge main. Existing pumping equipment, discharge piping and control valves could be replaced to better match the current performance requirements of the pumping plants and improve operational efficiency.

Alternative pumping equipment was selected to meet the flow and total dynamic head condition modeled system curves using C= 140 Steel and C = 120 Concrete. The target pump performance points are taken from *System Curve (Improved Condition)* analysis and utilize increased suction piping diameter, increased discharge piping diameter, and increased control and check valve size to reduce minor (friction) losses. The following upper limit values for fluid velocity in system elements were used in developing the *System Curve (Improved Condition)* analysis;

- Pump Suction Piping (for split case inline and split case suction lift): 12.5 feet per second
- Pump discharge piping and valves (including column pipe for turbine pumps): 12.5 feet per second
- Discharge headers and discharge mains: 10.0 feet per second

In all cases where pump configurations and existing piping limitations were not significant constraints, pump suction, pump discharge, and valve selections for *System Curve (Improved Condition)* were made to target fluid velocity between 6.0 and 8.5 feet per second.

Web-based pump selection programs were used to identify candidate pumping equipment.

- http://www.epumpflo.com
- http://www.weirminerals.com
- http://www.flowserve.com

- http://eprism.gouldspumps.com/prism/
- http://www.gouldsintellitronic.com

2.6. OPINION OF PROBABLE CONSTRUCTION COSTS

An opinion of probable construction cost was developed to establish an initial cost baseline for installation of alternative pumping equipment at individual pump stations. In two cases, Combs Flat Pumping Plant and McKay Pumping Plant, the opinion of probable construction cost includes only the cost of replacing pump discharge piping and valves. For the Barnes Butte Pumping Plant Rebuild alternative, the opinion of probable construction cost includes installation of new impellers in existing pump volutes along with replacing pump trim, valves, and pump discharge piping.

Opinion of probable construction cost is developed according to the general format of the Construction Standards Institute with Division 1 including general elements of a construction contract including Mobilization, Project Management and Coordination, Submittal Procedures, Project Record Documents, Operation and Maintenance Data, and General Commissioning Requirements.

Opinion of probable construction cost includes discrete line items for significant elements of the project work including for example replacement pumps, replacement valves, motor controls, etc.. Budgetary cost quotations for alternative pump selections were solicited from PumpTech, Inc., Portland, Oregon. Budget cost quotations for replacement valves were solicited from Val-matic Valve and Manufacturing Corp, Elmhurst, Illinois. The cost of modernizing electrical systems at the Barnes Butte Pumping Plant was evaluated by R&W Engineering, Portland, Oregon. For Barnes Butte Pumping Plant alternatives and analysis of Ochoco Relift 42-inch Discharge Main equipment, electrical element costs were derived from scaling the cost of Barnes Butte electrical modernization relative to total motor horsepower.

Construction Total cost values provided in the opinion of probable construction cost were derived from the project construction subtotal with line item multipliers added;

- Contractor Overhead and Profit: 10%
- Contractors Bond and Insurance: 2%
- Construction Contingency: 30%

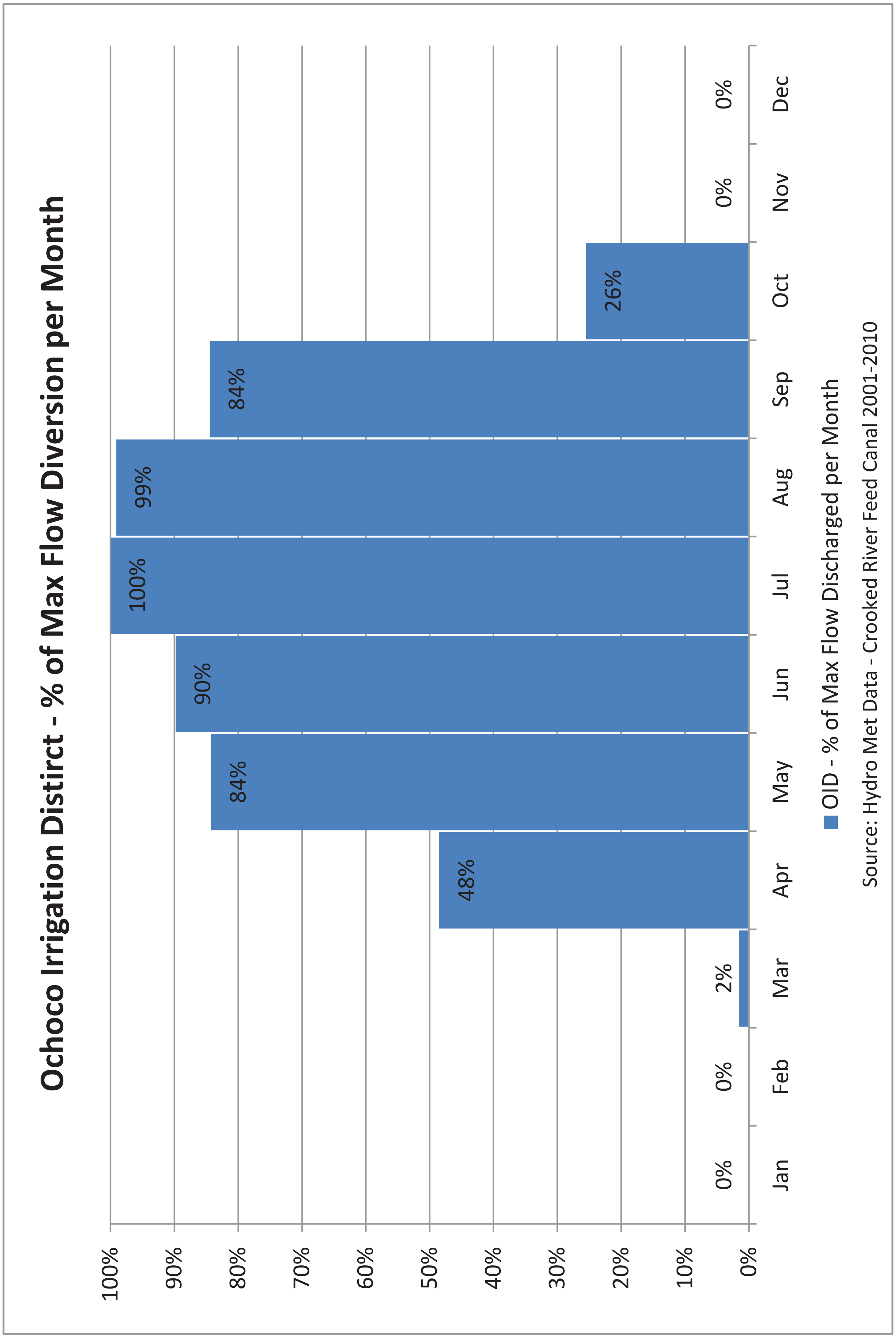
Total cost values provided in the opinion of probable construction cost were derived from the project construction total with a line item multipliers addition;

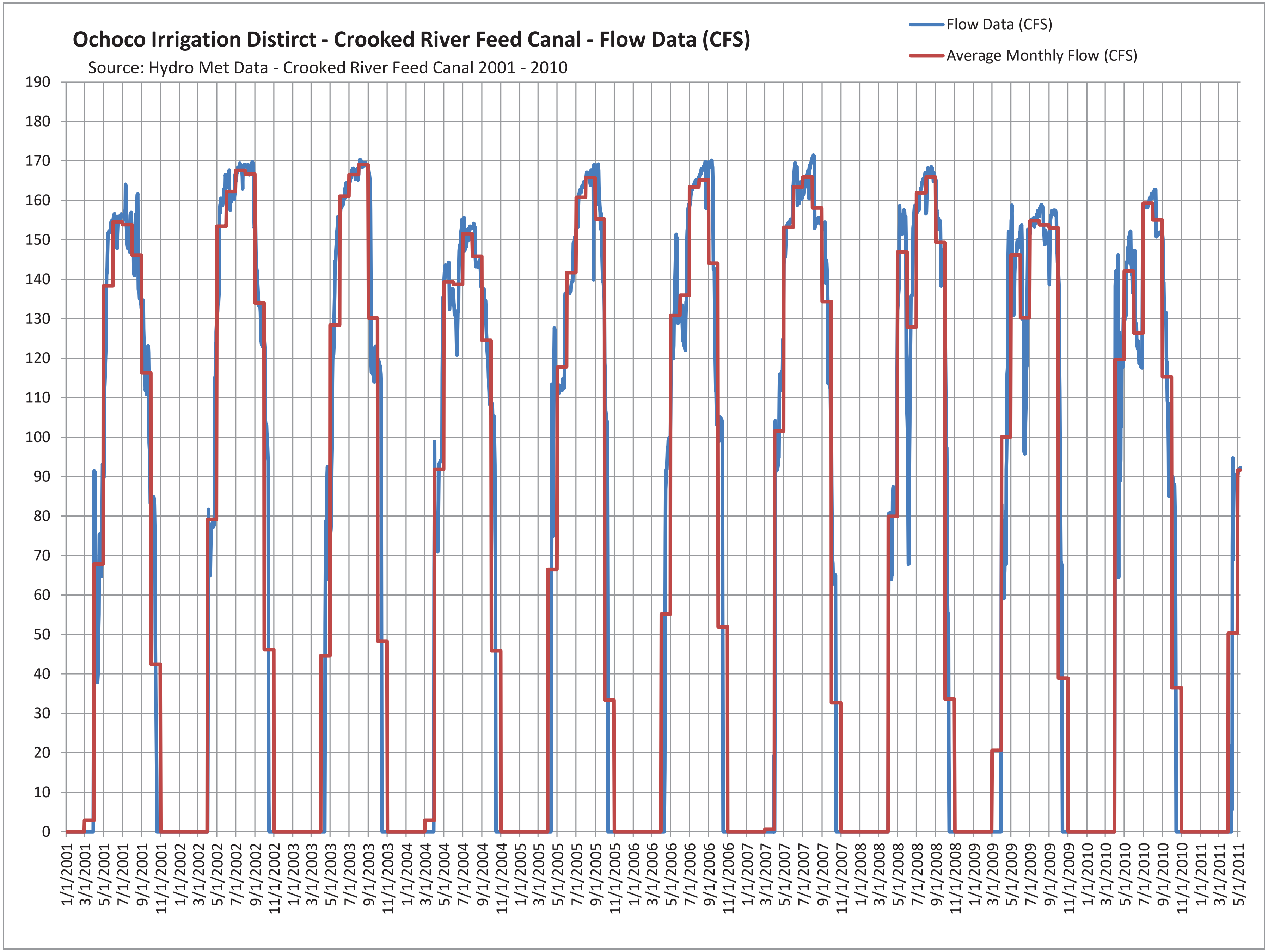
- Engineering and Administration: 25%

2.7. UNIT DEMAND CURVE

The Ochoco Irrigation District pumping plants are only operated during irrigation season to supply water for agricultural demand. After an irrigation delivery system start-up in late March, irrigation demand increases rapidly through April and May, peaks in July and tapers to shut-off through October. Flow data from the Crooked River Feed Canal during a ten year period 2001 to 2011was reduced to establish a unit demand curve for analysis of individual pump station operation. The current pumping plant capacity was matched to the peak demand period and the annual output of individual pumping plants was derived from the unit demand curve over time.

Figure 1 and Figure 2 are plotted data for the Crooked River Feed Canal diversion.


Ochoco Irrigation District - % of Max Flow Diversion per Month
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0%
0%
2%
48%
84%
90%
100%
99%
84%
26%
0%
0%
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
OID - % of Max Flow Discharged per Month
Source: Hydro Met Data - Crooked River Feed Canal 2001-2010



Ochoco Irrigation Distirct - Crooked River Feed Canal - Flow Data (CFS)
Source: Hydro Met Data - Crooked River Feed Canal 2001 - 2010
Flow Data (CFS)
Average Monthly Flow (CFS)
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1/1/2001
3/1/2001
5/1/2001
7/1/2001
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7/1/2010
9/1/2010
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1/1/2011
3/1/2011
5/1/2011

2.8. EVALUATION OF ANNUAL ENERGY SAVINGS

Wire to water energy calculations were prepared for each pump station to compare projected annual energy use of alternative equipment against the projected annual energy use of existing equipment in its current condition. The evaluation pumping rate was derived by assigning the expected capacity of alternate equipment to the maximum value of the unit demand curve, and calculating the average pumping rate over the duration of the irrigation season. For example, over the 198 days of a typical irrigation season a pump station is modeled to start at approximately 58% capacity for the 30 days of April, run at full capacity for the 31 days of July, and be turned down to 26% of capacity for the first 15 days of October. Over the 198 days of the irrigation season, operating the pumping plant at the average annual pumping rate (approximately 80% of the station capacity) each day would yield approximately the same volume of water.

The evaluation line (average annual pumping rate) shown on system curves indicates the corresponding pumping head of the system. The pump head used in wire-to-water energy calculations was taken from the *System Curve C = 135 Steel, C = 110 Concrete* for existing pump conditions, and *System Curve* (*Improved Conditions*) for alternative pump and piping conditions. The lower pumping head condition for alternative pump and pipe conditions generally reflects reduced friction loss expected from proposed pump discharge pipe and control valves. Pump efficiency, motor efficiency, and energy cost for existing pumping equipment is generally taken from Initial Pump Evaluation test data by Bonneville Power Administration or assumed similar conditions. Pump efficiency for replacement pumps is taken from alternative pump selection data sheets. Motor efficiency for replacement pumps is assumed to be 93% (Premium - High Efficiency) for induction motors, and 96% for synchronous motors.

2.9. EVALUATION OF 20-YEAR ENERGY SAVINGS

Table 2 - Summary of Pumping Plant Capacity, Estimated Energy Savings, and Cost provides an overview of the pumping plant performance.

- Flow Rate Original Design - shown in Table 2 provides a reference for the peak flow rate expected in the original design, layout, and selection of equipment. The diameter of original pump discharge piping and valves, and the diameter of the discharge main were selected based the flow rate of the original design. Some of these original design elements may be undersized where additional or larger pump equipment has been added over time.
- Flow Rate Current Equipment - shown in Table 2 is the sum of individual pump output published in the Initial Pump Evaluation test data by Bonneville Power Administration in October of 2010. The true pumping plant maximum output is likely somewhat less than the aggregate flow rate of individual pumps. Where no data was collected by Bonneville Power Administration, the flow rate of current equipment is taken from representative pump curve data plotted on *System Curve C = 135 Steel, C = 110 Concrete* graphs. No total flow rate measurements for existing equipment were made as part of this study.
- Flow Rate Alternative Equipment - shown in Table 2 is the estimated flow rate from the pumping plant with alternative equipment installed. The flow rate is taken from the *System Curve (Improved Conditions*). The target aggregate flow for alternative pump selections is based on the rated flow from the original pumping plant design plus any improvements (pump additions or replacements) that were made since the pumping plant was originally constructed.
- Evaluation Pumping Rate - shown in Table 2 is the annual average pumping rate of alternative equipment. The value is derived by assigning the expected capacity of alternate equipment to the

maximum value of the unit demand curve, and calculating the average pumping rate over the duration of the irrigation season.

- Evaluation Basis - shown in Table 2 is the projected total volume of water that will be pumped by alternative pumping equipment over a typical irrigation season. The value is the average pumping rate of alternative equipment multiplied by the typical irrigation period (198 days).
- Estimated Annual Energy Savings - shown in Table 2 is the estimated annual kilowatt-hour savings of alternative pumping equipment as compared to existing pump equipment in its current condition operated at the evaluation pumping rate for a typical irrigation season. The estimated annual energy savings is taken directly from the wire-to-water energy comparisons for each pumping plant.
- Projected Construction Cost Alternative Equipment - shown in Table 2 is the opinion of initial cost for installation of alternative pumping equipment.
- Benefit Cost Ratio - shown in Table 2 is a simple ratio of the benefit (annual kW-hr savings x 20 years x $0.035 per kW-hr) divided by the initial cost of alternative pumping equipment. In comparing two projects to install alternative pumping equipment, the project with a higher ratio is expected to have a more favorable return on cost of the initial investment.

TABLE 2 - SUMMARY OF PUMPING PLANT CAPACITY, ESTIMATED ENERGY SAVINGS, AND COST

	Flow Rate Original Design	Flow Rate Current Equipment	Flow Rate Alternative Equipment	Evaluation Pumping Rate	Evaluation Basis	Estimated Annual Energy Savings	Projected Construction Cost Alternative Equipment	Benefit Cost Ratio (Value of kW-hr Savings over 20 years / Initial Cost) *
I.D. / PUMPING PLANT	CFS	CFS	CFS	CFS	Acre-Ft / year	kW-hr per year	$	
1 Barnes Butte								
a. Rebuild Pumps w/ New Impellers	120.0	134.7	135.6	108.4	42,570	497,702	2,971,000	0.117
b. Retrofit PS w/ New Split Case Pumps	120.0	134.7	155.3	124.1	48,740	841,206	2,988,000	0.197
c. Reconstruct PS w/ Vertical Turbines	120.0	134.7	155.1	123.9	48,670	642,950	4,261,000	0.106
d New PS @ Crooked River - 63" HDPE	-	-	170.4	136.2	53,500	-1,479,627	19,141,000	-0.054
e. New PS @ Crooked River - 72" Steel	-	-	170.4	136.2	53,500	-458,365	20,634,000	-0.016
2 Relift								
a. 42-inch Discharge Line	66.0	72.9	78.0	62.4	24,490	464,689	1,932,000	0.168
b. 24-inch Discharge Line	Data not available	16.4	17.8	14.2	5,590	106,967	285,000	0.263
3 Johnson Creek	13.9	16.3	16.4	13.1	5,160	421,466	291,000	1.014
4 Grimes Flat	17.0	15.5	21.9	17.5	6,890	306,239	343,000	0.625
5 Combs Flat	5.8	10.4	10.8	8.6	3,380	53,822	115,000	0.328
6 McKay	3.0	3.0	3.0	2.4	940	2,782	27,900	0.070
7 Tunnel	7.8	3.7	3.8	3.0	1,190	52,977	107,000	0.347

* Value of kW-hr based on an energy cost of $0.035 / kW-hr

3.0 CONCLUSION

3.1. RANKING OF PUMPING PLANT IMPROVEMENT PROJECTS

The pumping plants ranked in terms of their estimated annual energy savings are presented in Table 3. The estimated annual energy savings is the calculated kW-hr savings of running the alternative pumping equipment in lieu of the existing pumping equipment in its existing condition during the course of a typical irrigation season. The ranking does not include any consideration of the initial cost of pumping plant modification.

Because the calculated energy savings for an alternative is based on the average annual pumping rate specific to that alternative, comparison of multiple alternatives for the same pumping plant requires additional consideration. Additional comparison of three alternatives at the existing Barnes Butte Pumping Plant site, and two alternatives at the New Barnes Butte Pumping Plant site are presented later in the text.

Table 3 - Ranking of Pumping Plant Improvements: KW Savings

Ranking	Pumping Plant	Estimated Annual Energy Savings
#1	Barnes Butte Retrofit (new horizontal split case pumps)	841,206 kW-hr
#2	Barnes Butte Reconstruction (new wet well & vertical turbine pumps)	642,950 kW-hr
#3	Barnes Butte Rebuild (rebuild existing horizontal split case pumps)	497,702 kW-hr
#4	Ochoco Relift 42-inch	464,689 kW-hr
#5	Johnson Creek	421,466 kW-hr
#6	Grimes Flat	306,239 kW-hr
#7	Ochoco Relift 24-inch	106,967 kW-hr
#8	Combs Flat	53,822 kW-hr
#9	Tunnel	52,977 kW-hr
#10	McKay	2,782 kW-hr
#11	Barnes Butte New (72-inch Steel, vertical turbines)	- 458,365 kW-hr
#12	Barnes Butte New (63-inch HDPE, vertical turbines)	- 1,479,627 kW-hr

Table 4 below, presents the pumping plants ranked in terms of their projected Benefit Cost Ratio. In this simplified analysis the present worth of energy savings benefits (kW-hr savings over a 20 year operating period at a rate of $0.035 / kW-hr) is divided by the present worth of the anticipated capital cost. Operation and maintenance costs, replacement financing costs, environmental benefits, inflation, cost escalation and other consequential and inconsequential costs factors are not included in this simplified analysis. Projects with a ratio greater than 1.0 are generally considered beneficial on a simple cost basis.

Table 4 - Ranking Pumping Plant Improvements: Benefit Cost Ratio

RANKING	PUMPING PLANT	INITIAL COST	ESTIMATED ANNUAL ENERGY SAVINGS	BENEFIT COST RATIO
#1	Johnson Creek	$291,000	421,466 kW-hr	1.014
#2	Grimes Flat	$343,000	306,239 kW-hr	0.625
#3	Tunnel	$107,000	52,977 kW-hr	0.347
#4	Combs Flat	$115,000	53,822 kW-hr	0.328
#5	Ochoco Relift 24-inch	$285,000	106,967 kW-hr	0.263
#6	Barnes Butte Retrofit	$2,988,000	841,206 kW-hr	0.197
#7	Ochoco Relift 42-inch	$1,932,000	464,689 kW-hr	0.168
#8	Barnes Butte Rebuild	$2,971,000	497,702 kW-hr	0.117
#9	Barnes Butte Reconstruction	$4,261,000	642,950 kW-hr	0.106
#10	McKay	$27,900	2,782 kW-hr	0.070
#11	Barnes Butte New 72-inch Steel	$20,634,000	- 458,365 kW-hr	- 0.016
#12	Barnes Butte New 63-inch HDPE	$19,141,000	- 1,479,627 kW-hr	- 0.054

3.2. BARNES BUTTE PUMPING PLANT ALTERNATIVES COMPARISON - EXISTING SITE

The three alternatives examined for the Barnes Butte Pumping Plant at its present location all provide improvements to the capacity and efficiency of the system relative to its current condition. However, the three alternative pump configurations provide different pumping capacities as a result of pump style, size, and piping connections. A direct comparison of estimated annual energy savings does not account for the variations in evaluation pumping rate.

If placed into service, a Retrofit Barnes Butte plant and a Reconstructed Barnes Butte plant will likely be used to pump more water and ultimately use more energy than the current pumping plant as-is or rebuilt. A more realistic comparison of pumping plant alternatives includes the evaluation pumping rate (cfs), evaluation basis (acre-feet/year), annual energy use (kW-hr), cost per acre-foot pumped (kW-hr/acre-foot and $/acre-foot), and initial cost. Table 5 provides the comparative data.

Table 5 - Comparison of Barnes Butte Pumping Plant Alternatives - Existing Site

PUMPING PLANT	EVALUATION PUMPING RATE (CFS)	EVALUATION BASIS (ACRE-FEET/YEAR)	ANNUAL ENERGY USE (KW-HR)	KW-HR PER ACRE-FOOT PUMPED	$ PER ACRE-FOOT PUMPED *	INITIAL COST
Barnes Butte Retrofit	124.1 CFS	48,740 acre-ft/yr	4,847,281 kW-hr	99 kW-hr	$3.48 / acre-ft	$2,988,000
Barnes Butte Reconstruction	123.9 CFS	48,670 acre-ft/yr	5,037,368 kW-hr	103 kW-hr	$3.62 / acre-ft	$4,261,000
Barnes Butte Rebuild	108.4 CFS	42,570 acre-ft/yr	4,323,453 kW-hr	102 kW-hr	$3.55 / acre-ft	$2,971,000
Barnes Butte Existing Condition	108.4 CFS	42,570 acre-ft/yr	4,821,155 kW-hr	113 kW-hr	$3.96 / acre-ft	$0

* $ per acre-foot pumped based on an energy cost of $0.035 / kW-hr.

Referencing the data in Table 5, retrofitting the Barnes Butte Pumping Plant with new horizontal split case pumps provides the greatest rate and annual volume of water at the lowest unit cost. The initial investment is marginally more expensive than rebuilding the existing pumps. On an annual basis, the retrofitted pumping plant is likely to use slightly more power than the existing plant in its current condition because the retrofitted pumping plant is likely to be operated at greater capacity than the existing. The additional pumped volume is available to supply irrigated land in the McKay basin to relieve irrigation withdrawal from McKay Creek.

3.3. BARNES BUTTE PUMPING PLANT ALTERNATIVES COMPARISON - NEW SITE

The two alternatives examined for the Barnes Butte Pumping Plant at a new location on the Crooked River both provide improvements to the capacity and efficiency of the Barnes Butte Pumping Plant relative to its current condition. The two pumping plant alternatives at the new site require a longer force main and greater lift than the Barnes Butte Plant at its current location. Additionally, the two alternatives feature different discharge main sizes that result in substantially different energy requirements for pumping plant operation on an annual basis.

If placed into service, a New Barnes Butte Pumping Plant - 72-inch Steel or a New Barnes Butte Pumping Plant - 63-inch HDPE will likely be used to pump more water and ultimately use more energy than the current pumping plant as-is or refurbished in some manner. Comparison of pumping plant alternatives at the new site includes the evaluation pumping rate (cfs), evaluation basis (acre-feet/year), annual energy use (kW-hr), cost per acre-foot pumped (kW-hr/acre-foot and $/acre-foot), and initial cost. Table 6 provides the comparative data. Data from existing site alternatives is also shown.

Table 6 - Comparison of Barnes Butte Pumping Plant Alternatives - New Site

Pumping Plant	Evaluation Pumping Rate (CFS)	Evaluation Basis (Acre-feet/Year)	Annual Energy Use (kW-hr)	kW-hr per Acre-foot Pumped	$ per Acre-foot Pumped	Initial Cost
Barnes Butte New 72-inch Steel	136.2 CFS	53,500 acre-ft/yr	6,865,331 kW-hr	128 kW-hr	$4.49 / acre-ft	$20,634,000
Barnes Butte New 63-inch HDPE	136.2 CFS	53,500 acre-ft/yr	7,886,593 kW-hr	147 kW-hr	$5.16 / acre-ft	$19,141,000
Barnes Butte Retrofit	124.1 CFS	48,740 acre-ft/yr	4,847,281 kW-hr	99 kW-hr	$3.48 / acre-ft	$2,988,000
Barnes Butte Reconstruction	123.9 CFS	48,670 acre-ft/yr	5,037,368 kW-hr	103 kW-hr	$3.62 / acre-ft	$4,261,000
Barnes Butte Rebuild	108.4 CFS	42,570 acre-ft/yr	4,323,453 kW-hr	102 kW-hr	$3.55 / acre-ft	$2,971,000
Barnes Butte Existing Condition	108.4 CFS	42,570 acre-ft/yr	4,821,155 kW-hr	113 kW-hr	$3.96 / acre-ft	$0

Referencing the data in Table 6, the New Barnes Butte Pumping Plant - 72-inch Steel alternative provides a lower unit cost for water than the 63-inch Alternative. Including all Barnes Butte Pumping Plant options, the New Barnes Butte Pumping Plant - 72-inch Steel alternative provides the greatest pumping rate and annual volume of water. The additional volume is available to supply irrigated land along the discharge main and to the McKay basin to relieve irrigation withdrawal from McKay Creek. The New Barnes Butte Pumping Plant - 72-inch Steel alternative also increases flow in approximately 5 miles of the Crooked River as the new site is downstream of the current Barnes Butte Pumping Plant inlet pipe turn-out. The initial investment in the New Barnes Butte Pumping Plant - 72-inch Steel alternative is substantially more expensive than retrofitting the existing Barnes Butte Pumping Plant. On an annual basis, the New Barnes Butte Pumping Plant - 72-inch Steel alternative is likely to use substantially more power on a unit cost and annual aggregate basis than the existing Barnes Butte Pumping Plant in its current condition or after retrofit.

3.4. CONCLUSION

Further evaluation of potential energy savings and funding / cost recovery investigations are recommended for the Barnes Butte Retrofit, Ochoco Relift 42-inch, Ochoco Relift 24-inch, Johnson Creek, Grimes Flat, Combs Flat, and Tunnel pumping plants. The estimated initial cost of all improvement work is $6,061,000 with an estimated energy savings over a 20-year period equal to 28,123,200 kW-hr not including any over-all energy reduction from operation of the Retrofit Barnes Butte Pumping Plant as described in Section 3.2 above.*

PUMPING PLANT	INITIAL COST	ESTIMATED ANNUAL ENERGY SAVINGS
Barnes Butte Retrofit	$2,988,000	0 kW-hr *
Ochoco Relift 42-inch	$1,932,000	464,689 kW-hr
Johnson Creek	$291,000	421,466 kW-hr
Grimes Flat	$343,000	306,239 kW-hr
Ochoco Relift 24-inch	$285,000	106,967 kW-hr
Combs Flat	$115,000	53,822 kW-hr
Tunnel	$107,000	52,977 kW-hr
Total	**$6,061,000**	**1,406,160 kW-hr**

BARNES BUTTE PUMPING PLANT REBUILD - EVALUATION SUMMARY

The Barnes Butte Pumping Plant is located at the foot of Barnes Butte, about 0.75 miles east of the city limits of Prineville. The Barnes Butte facility was originally designed for 115.5 cubic feet per second (CFS) at 82 feet total dynamic head (TDH). The original installation circa 1961 was comprised of (4) horizontal split case pumps with synchronous motors totaling 1,500 HP. At a later date, a fifth 300 HP horizontal split case pump was added. The current facility with five pumping units totaling 1,800 horsepower is designed to lift approximately 135 CFS at 86 feet TDH from the end of the Crooked River diversion canal to the head of the distribution canal. The discharge main consists of approximately 1,600 feet of 54-inch I.D. concrete pipe.

Original Design

Pump Unit	Description	HP	Rated Capacity	Rated Head	Pump Eff. @ Rated Capacity	Pipe Size	Pump Discharge Vel.	Discharge Main Vel.
No. 1	Horizontal Split Case	500	17,300 GPM	82 FT	84 %	24 IN	12.3 FPS	
No. 2	Horizontal Split Case	500	17,300 GPM	82 FT	84 %	24 IN	12.3 FPS	
No. 3	Horizontal Split Case	250	8,640 GPM	82 FT	80 %	16 IN	13.8 FPS	
No. 4	Horizontal Split Case	250	8,640 GPM	82 FT	80 %	16 IN	13.8 FPS	
Total		1,500	51,880 GPM	82 FT		54 IN		7.3 FPS

Current Condition (Ref. Initial Pump Evaluation BPA, 2010)

Pump Unit	Description	HP	Test Capacity	Test Head	Pump Eff. @ Test Capacity	Pipe Size	Pump Discharge Vel.	Discharge Main Vel.
No. 1	Horizontal Split Case	500	17,431 GPM *	73 FT *	80 % *	24 IN	12.4 FPS	
No. 2	Horizontal Split Case	500	16,633 GPM *	76 FT *	79 %	24 IN	11.8 FPS	
No. 3	Horizontal Split Case	250	9,460 GPM	77 FT	80 % **	16 IN	15.1 FPS	
No. 4	Horizontal Split Case	250	7,910 GPM *	75 FT *	80 % **	16 IN	12.6 FPS	
No. 5	Horizontal Split Case	300	9,037 GPM	76 FT	68 %	16 IN	14.4 FPS	
Total		1,800	60,471 GPM	76 FT		54 IN		8.5 FPS

* Minimum value of (2) test data points, ref. Initial Pump Evaluation, BPA, 2010

** Measured pump efficiency at the test capacity was greater than the factory curve. Factory curve data for efficiency at rated capacity used in evaluating pumping plant efficiency.

Alternate Equipment (Rebuild Existing Pumps, Pump Discharge Piping and Valves)

Pump Unit	Description	HP	Rated Capacity	Rated Head	Pump Eff. @ Rated Capacity	Pipe Size	Pump Discharge Vel.	Discharge Main Vel.
No. 1	Horizontal Split Case	500	17,300 GPM	85 FT	84 %	30 IN	7.9 FPS	
No. 2	Horizontal Split Case	500	17,300 GPM	85 FT	84 %	30 IN	7.9 FPS	
No. 3	Horizontal Split Case	250	8,640 GPM	85 FT	80 %	18 IN	10.9 FPS	
No. 4	Horizontal Split Case	250	8,640 GPM	85 FT	80 %	18 IN	10.9 FPS	
No. 5	Horizontal Split Case	300	9,000 GPM	85 FT	88 %	18 IN	11.3 FPS	
Total		1,800	60,880 GPM	85 FT		54 IN		8.5 FPS

Narrative

Evaluation of the Barnes Butte Pumping Plant rebuild examines potential energy efficiency improvements gained by rebuilding existing pumps at the existing Barnes Butte Pumping Plant. Rebuilt pumps would be fitted with new cast impellers, shaft, bearings and seals. Existing pump volutes would remain as is.

Electrical systems would be rebuilt from service entrance through motor starters. The existing synchronous motors would be reused as is.

Evaluation of potential energy savings assumes pump discharge piping and valves are increased in size to reduce velocity and friction losses.

With five pumps available for to meet irrigation season demand variations, integration of variable speed drive equipment into alternate pump equipment would not appear to provide significant energy savings.

The capacity of the rebuilt pump station is anticipated to be approximately 60,880 gpm (136 CFS) at 85 feet TDH.

Wire to water energy analysis is based on the projected capacity of the Barnes Butte Pumping Plant utilizing the existing pumps fitted with new impellers, and larger pump discharge pipe and valves. The Barnes Butte Pumping Plant with rebuilt split case horizontal pumps is projected to provide a seasonal average flow of 48,652 gpm (108.4 CFS) at 80.3 feet TDH. The existing Barnes Butte Pumping plant in its current condition is projected to yield 108.4 CFS at 81.4 feet TDH.

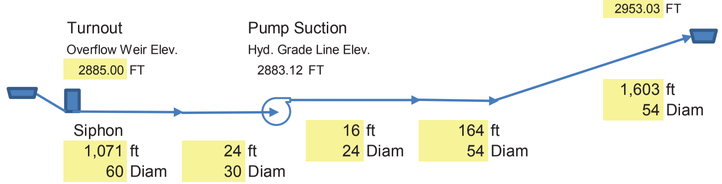
Action Recommended for Further Evaluation: **Rebuild No. 1 pump with new impeller**
Rebuild No. 2 pump with new impeller
Rebuild No. 3 pump with new impeller
Rebuild No. 4 pump with new impeller
Rebuild No. 5 pump with new impeller
Replace pump discharge piping and valves
Replace electrical service entrance and motor starters

Annual Energy Savings Estimate = 497,702 KW

Initial Cost Estimate = $2,971,000

Pump to Canal Head Loss Calculations
Barnes Butte Pumping Plant Rebuild (Rebuild existing pumps with new impellers)

17,300 GPM	Horizontal Split Case Pump No. 1	
17,300 GPM	Horizontal Split Case Pump No. 2	
8,640 GPM	Horizontal Split Case Pump No. 3	Static Head = 68.03 FT
8,640 GPM	Horizontal Split Case Pump No. 4	
0 GPM	Horizontal Split Case Pump No. 5	
51,880 GPM	Total = 115.6 cfs	



Diam. (Discharge Pipe) =	54 in
Total Discharge Pipe Length =	1,807 ft
Equiv. Pipe Length Valves & Fittings Pump Discharge =	91 ft
Equiv. Pipe Length Valves & Fittings Discharge Header =	241 ft

60" Siphon Pipe	Friction Head =	1.76 FT per 1,000 FT	Concrete
(Vel. = 5.9 fps)	Dynamic Head =	1.88 FT total	C = 120
30" Inlet Pipe	Friction Head =	5.05 FT per 1,000 FT	Steel
(Vel. = 7.9 fps)	Dynamic Head =	0.12 FT total	C = 140
24" Discharge Piping	Friction Head =	14.96 FT per 1,000 FT	Steel
(Vel. = 12.3 fps)	Dynamic Head =	0.24 FT total	C = 140
54" Header	Friction Head =	2.21 FT per 1,000 FT	Steel
(Vel. = 7.3 fps)	Dynamic Head =	0.36 FT total	C = 140
54" Discharge	Friction Head =	2.94 FT per 1,000 FT	Concrete
(Vel. = 7.3 fps)	Dynamic Head =	4.71 FT total	C = 120
Equivalent Pipe Length Valves & Fittings Pump Discharge	Friction Head =	14.96 FT per 1,000 FT	Steel
	Dynamic Head =	1.36 FT total	C = 140
Equivalent Pipe Length Valves & Fittings Discharge Header	Friction Head =	2.21 FT per 1,000 FT	Steel
	Dynamic Head =	0.53 FT total	C = 140
	Friction Head =	7.32 FT =	3.17 psi
	Water Depth in Discharge Canal =	4.07 FT =	1.76 psi
	Total Dynamic Head =	81.31 FT =	35.20 psi

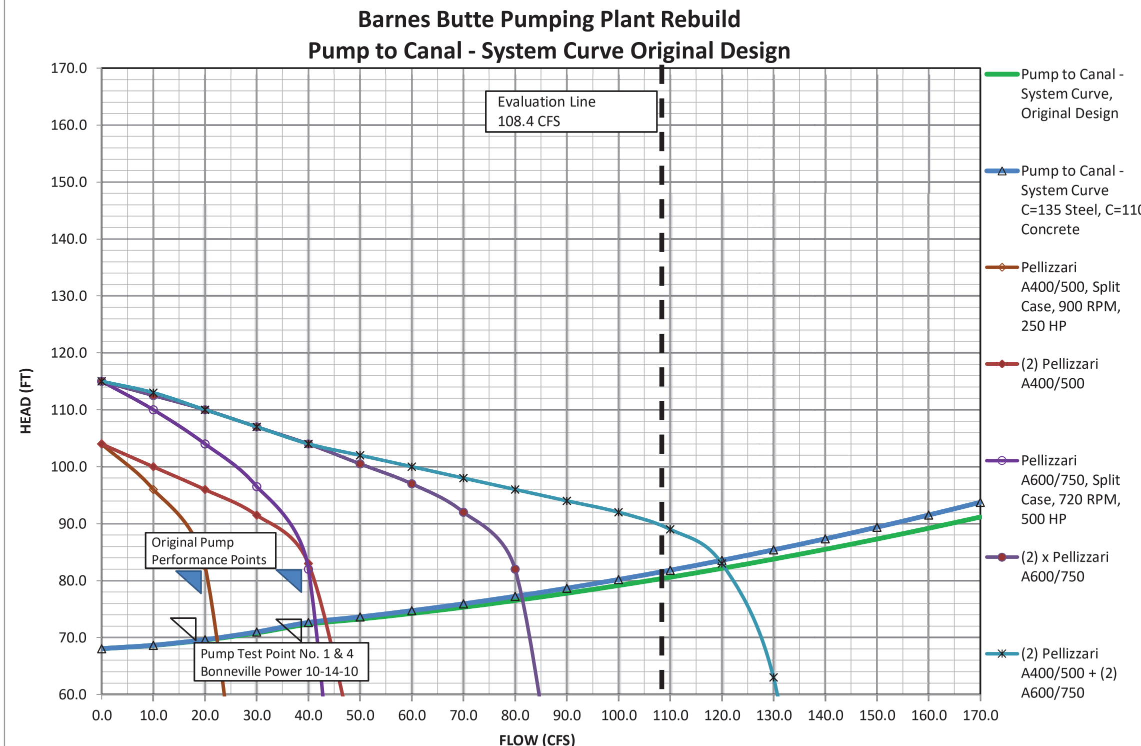
Equivalent Pipe Length Totals:

Item	24" Equiv. Length	No. of Units	Total Equiv. Length
60" to 30" square edged inlet	85 ft	1 ea	85 ft
30" pump isolation (gate) valve	3 ft	1 ea	3 ft
24" pump control (gate) valve	3 ft	1 ea	3 ft
		Subtotal	91 ft

Item	54" Equiv. Length	No. of Units	Total Equiv. Length
24"x54" tee branch flow	40 ft	1 ea	40 ft
54" flow meter	1 ft	1 ea	1 ft
54"x24" tee in-line flow	30 ft	4 ea	120 ft
54"x60" expander	5 ft	1 ea	5 ft
54" 45 bend	20 ft	2 ea	40 ft
54" 11.25 bend	10 ft	2 ea	20 ft
54" flap gate	15 ft	1 ea	15 ft
		Subtotal	241 ft

Barnes Butte Pumping Plant Rebuild (Rebuild existing pumps with new impellers)
Pump to Canal - System Curve, Original Design

Q (gpm)	0	4,488	8,976	13,464	17,952	22,440	26,928	31,416	35,904	40,392	44,880	49,368	53,856	58,344	62,832	67,320	71,808	76,296
Q (cfs)	0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0	170.0
Hf	0.0	0.6	1.5	2.8	4.3	5.2	6.2	7.3	8.5	9.7	11.1	12.5	14.1	15.7	17.4	19.2	21.1	23.1
TDH (ft)	68.0	68.6	69.5	70.8	72.3	73.2	74.2	75.3	76.5	77.8	79.1	80.6	82.1	83.8	85.5	87.3	89.2	91.1
Vel. Disch. (fps)	0.0	0.6	1.3	1.9	2.5	3.1	3.8	4.4	5.0	5.7	6.3	6.9	7.5	8.2	8.8	9.4	10.1	10.7



Pellizzari A400/500, Split Case, 900 RPM, 250 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	104	96	83	10														

(2) Pellizzari A400/500

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	104	100	96	92	83	47	10											

Pellizzari A600/750, Split Case, 720 RPM, 500 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	115	110	104	97	82	-20												

(2) x Pellizzari A600/750

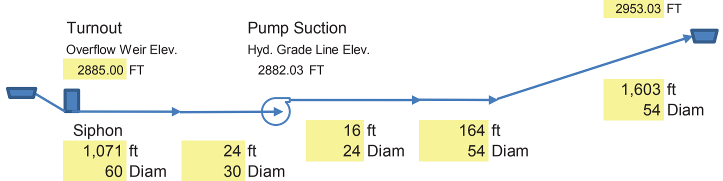
Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	115	113	110	107	104	101	97	92	82	29	-20							

(2) Pellizzari A400/500 + (2) A600/750

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	115	113	110	107	104	102	100	98	96	94	92	89	83	63	10			

Pump to Canal Head Loss Calculations
Barnes Butte Pumping Plant Rebuild (Rebuild existing pumps with new impellers)

17,300	GPM	Horizontal Split Case Pump No. 1	
17,300	GPM	Horizontal Split Case Pump No. 2	
8,640	GPM	Horizontal Split Case Pump No. 3	Static Head = 68.03 FT
8,640	GPM	Horizontal Split Case Pump No. 4	
9,000	GPM	Horizontal Split Case Pump No. 5	
60,880	GPM	Total = 135.6 cfs	



Diam. (Discharge Pipe) =	54 in
Total Discharge Pipe Length =	1,807 ft
Equiv. Pipe Length Valves & Fittings Pump Discharge =	91 ft
Equiv. Pipe Length Valves & Fittings Discharge Header =	241 ft

60" Siphon Pipe	Friction Head =	2.78 FT per 1,000 FT	Concrete
(Vel. = 6.9 fps)	Dynamic Head =	2.97 FT total	C = 110
30" Inlet Pipe	Friction Head =	5.40 FT per 1,000 FT	Steel
(Vel. = 7.9 fps)	Dynamic Head =	0.13 FT total	C = 135
24" Discharge Piping	Friction Head =	16.00 FT per 1,000 FT	Steel
(Vel. = 12.3 fps)	Dynamic Head =	0.26 FT total	C = 135
54" Header	Friction Head =	3.17 FT per 1,000 FT	Steel
(Vel. = 8.5 fps)	Dynamic Head =	0.52 FT total	C = 135
54" Discharge	Friction Head =	4.64 FT per 1,000 FT	Concrete
(Vel. = 8.5 fps)	Dynamic Head =	7.43 FT total	C = 110
Equivalent Pipe Length	Friction Head =	16.00 FT per 1,000 FT	Steel
Valves & Fittings Pump Discharge	Dynamic Head =	1.46 FT total	C = 135
Equivalent Pipe Length	Friction Head =	3.17 FT per 1,000 FT	Steel
Valves & Fittings Discharge Header	Dynamic Head =	0.76 FT total	C = 135
	Friction Head =	10.56 FT =	4.57 psi
	Water Depth in Discharge Canal =	4.78 FT =	2.07 psi
	Total Dynamic Head =	86.34 FT =	37.38 psi

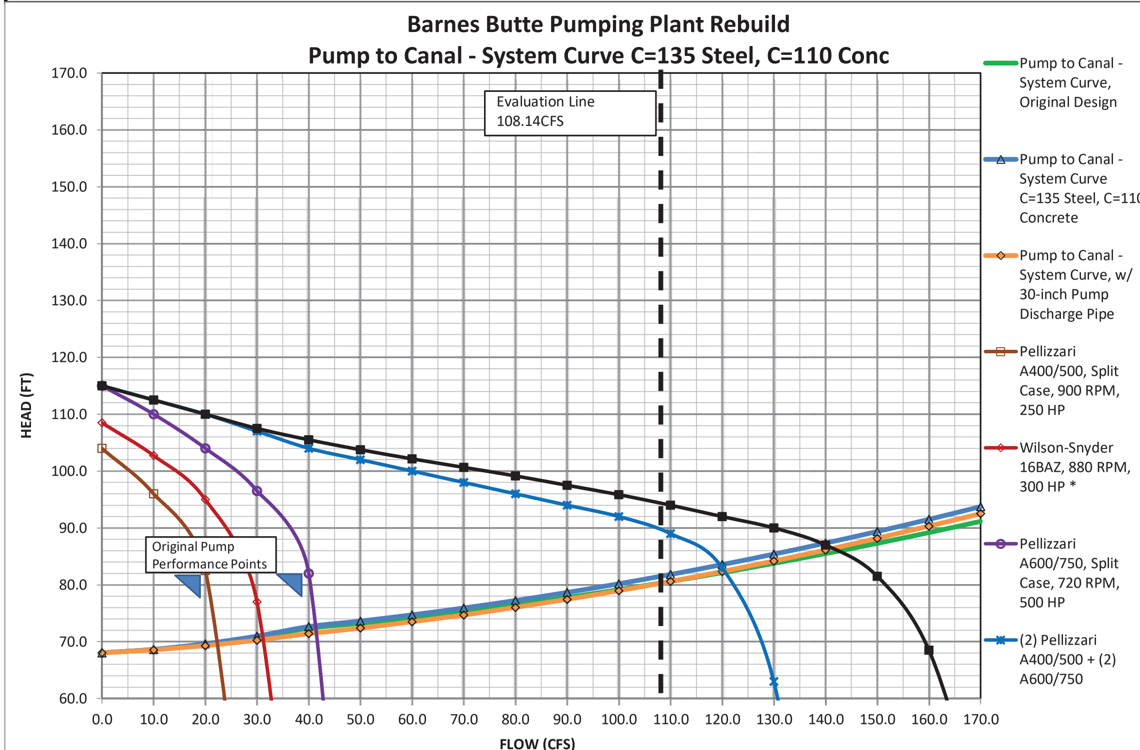
Equivalent Pipe Length Totals:

Item	24" Equiv. Length	No. of Units	Total Equiv. Length
60" to 30" square edged inlet	85 ft	1 ea	85 ft
30" pump isolation (gate) valve	3 ft	1 ea	3 ft
24" pump control (gate) valve	3 ft	1 ea	3 ft
		Subtotal	91 ft

Item	54" Equiv. Length	No. of Units	Total Equiv. Length
24"x54" tee branch flow	40 ft	1 ea	40 ft
54" flow meter	1 ft	1 ea	1 ft
54"x24" tee in-line flow	30 ft	4 ea	120 ft
54"x60" expander	5 ft	1 ea	5 ft
54" 45 bend	20 ft	2 ea	40 ft
54" 11.25 bend	10 ft	2 ea	20 ft
54" flap gate	15 ft	1 ea	15 ft
		Subtotal	241 ft

Barnes Butte Pumping Plant Rebuild (Rebuild existing pumps with new impellers)
Pump to Canal - System Curve C=135 Steel, C=110 Concrete

Q (gpm)	0	4,488	8,976	13,464	17,952	22,440	26,928	31,416	35,904	40,392	44,880	49,368	53,856	58,344	62,832	67,320	71,808	76,296
Q (cfs)	0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0	170.0
Hf	0.0	0.6	1.6	2.9	4.6	5.6	6.7	7.9	9.2	10.6	12.1	13.8	15.5	17.4	19.3	21.3	23.5	25.7
TDH (ft)	68.0	68.6	69.6	71.0	72.6	73.6	74.7	75.9	77.2	78.6	80.2	81.8	83.6	85.4	87.3	89.4	91.5	93.7
Vel. Disch. (fps)	0.0	0.6	1.3	1.9	2.5	3.1	3.8	4.4	5.0	5.7	6.3	6.9	7.5	8.2	8.8	9.4	10.1	10.7



Pellizzari A400/500, Split Case, 900 RPM, 250 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	104	96	83	10														

Wilson-Snyder 16BAZ, 880 RPM, 300 HP *

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	109	103	95	77	0													

Pellizzari A600/750, Split Case, 720 RPM, 500 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	115	110	104	97	82	-20												

(2) Pellizzari A400/500 + (2) A600/750

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	115	113	110	107	104	102	100	98	96	94	92	89	83	63	10			

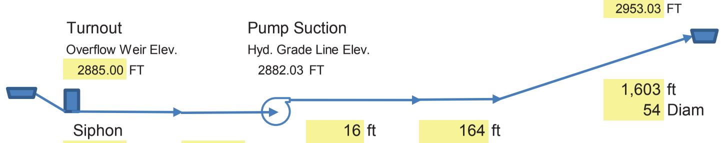
(2) Pellizzari A400/500 + (2) A600/750 + (1) Wilson-Snyder 16BAZ

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	115	113	110	108	106	104	102	101	99	98	96	94	92	90	87	82	69	40

* Pump curve for Wilson-Snyder 16BAZ not available. Curve shown is estimated curve based on design point 9,000 gpm @ 94 feet TDH

Pump to Canal Head Loss Calculations
Barnes Butte Pumping Plant Rebuild (Rebuild existing pumps with new impellers)

17,300	GPM	Horizontal Split Case Pump No. 1		
17,300	GPM	Horizontal Split Case Pump No. 2		
8,640	GPM	Horizontal Split Case Pump No. 3	Static Head =	68.03 FT
8,640	GPM	Horizontal Split Case Pump No. 4		
9,000	GPM	Horizontal Split Case Pump No. 5		
60,880	GPM	Total = 135.6 cfs		



Diam. (Discharge Pipe) =	54	in
Total Discharge Pipe Length =	1,807	ft
Equiv. Pipe Length Valves & Fittings Pump Discharge =	91	ft
Equiv. Pipe Length Valves & Fittings Discharge Header =	241	ft

60" Siphon Pipe	Friction Head =	2.78 FT per 1,000 FT	Concrete
(Vel. = 6.9 fps)	Dynamic Head =	2.97 FT total	C = 110
30" Inlet Pipe	Friction Head =	5.40 FT per 1,000 FT	Steel
(Vel. = 7.9 fps)	Dynamic Head =	0.13 FT total	C = 135
30" Discharge Piping	Friction Head =	5.40 FT per 1,000 FT	Steel
(Vel. = 7.9 fps)	Dynamic Head =	0.09 FT total	C = 135
54" Header	Friction Head =	3.17 FT per 1,000 FT	Steel
(Vel. = 8.5 fps)	Dynamic Head =	0.52 FT total	C = 135
54" Discharge	Friction Head =	4.64 FT per 1,000 FT	Concrete
(Vel. = 8.5 fps)	Dynamic Head =	7.43 FT total	C = 110
Equivalent Pipe Length	Friction Head =	5.40 FT per 1,000 FT	Steel
Valves & Fittings Pump Discharge	Dynamic Head =	0.49 FT total	C = 135
Equivalent Pipe Length	Friction Head =	3.17 FT per 1,000 FT	Steel
Valves & Fittings Discharge Header	Dynamic Head =	0.76 FT total	C = 135
	Friction Head =	9.42 FT =	4.08 psi
	Water Depth in Discharge Canal =	4.78 FT =	2.07 psi
	Total Dynamic Head =	85.21 FT =	36.89 psi

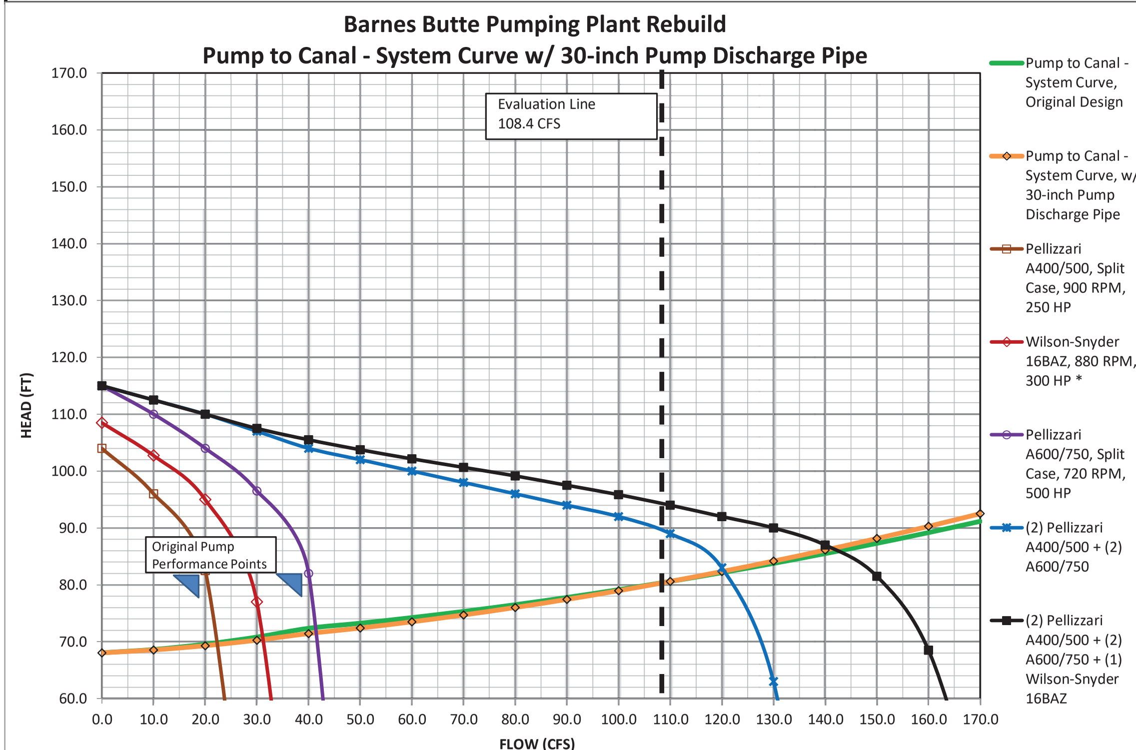
Equivalent Pipe Length Totals:

Item	30" Equiv. Length	No. of Units	Total Equiv. Length
60" to 30" square edged inlet	85 ft	1 ea	85 ft
30" pump isolation (gate) valve	3 ft	1 ea	3 ft
24" pump control (gate) valve	3 ft	1 ea	3 ft
		Subtotal	91 ft

Item	54" Equiv. Length	No. of Units	Total Equiv. Length
30"x54" tee branch flow	40 ft	1 ea	40 ft
54" flow meter	1 ft	1 ea	1 ft
54"x30" tee in-line flow	30 ft	4 ea	120 ft
54"x60" expander	5 ft	1 ea	5 ft
54" 45 bend	20 ft	2 ea	40 ft
54" 11.25 bend	10 ft	2 ea	20 ft
54" flap gate	15 ft	1 ea	15 ft
		Subtotal	241 ft

Barnes Butte Pumping Plant Rebuild (Rebuild existing pumps with new pumps)
Pump to Canal - System Curve, w/ 30-inch Pump Discharge Pipe

Q (gpm)	0	4,488	8,976	13,464	17,952	22,440	26,928	31,416	35,904	40,392	44,880	49,368	53,856	58,344	62,832	67,320	71,808	76,296
Q (cfs)	0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0	170.0
Hf	0.0	0.5	1.3	2.2	3.4	4.4	5.5	6.7	8.0	9.4	10.9	12.6	14.3	16.1	18.1	20.1	22.3	24.5
TDH (ft)	68.0	68.5	69.3	70.2	71.4	72.4	73.5	74.7	76.0	77.4	79.0	80.6	82.3	84.2	86.1	88.2	90.3	92.5
Vel. Disch. (fps)	0.0	0.6	1.3	1.9	2.5	3.1	3.8	4.4	5.0	5.7	6.3	6.9	7.5	8.2	8.8	9.4	10.1	10.7



Pellizzari A400/500, Split Case, 900 RPM, 250 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	104	96	83	10														

Wilson-Snyder 16BAZ, 880 RPM, 300 HP *

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	109	103	95	77	0													

Pellizzari A600/750, Split Case, 720 RPM, 500 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	115	110	104	97	82	-20												

(2) Pellizzari A400/500 + (2) A600/750

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	115	113	110	107	104	102	100	98	96	94	92	89	83	63	10			

(2) Pellizzari A400/500 + (2) A600/750 + (1) Wilson-Snyder 16BAZ

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	115	113	110	108	106	104	102	101	99	98	96	94	92	90	87	82	69	40

* Pump curve for Wilson-Snyder 16BAZ not available. Curve shown is estimated curve based on design point 9,000 gpm @ 94 feet TDH

Pump to Canal Head Loss Calculations
Barnes Butte Pumping Plant Rebuild (Rebuild existing pumps with new impellers)

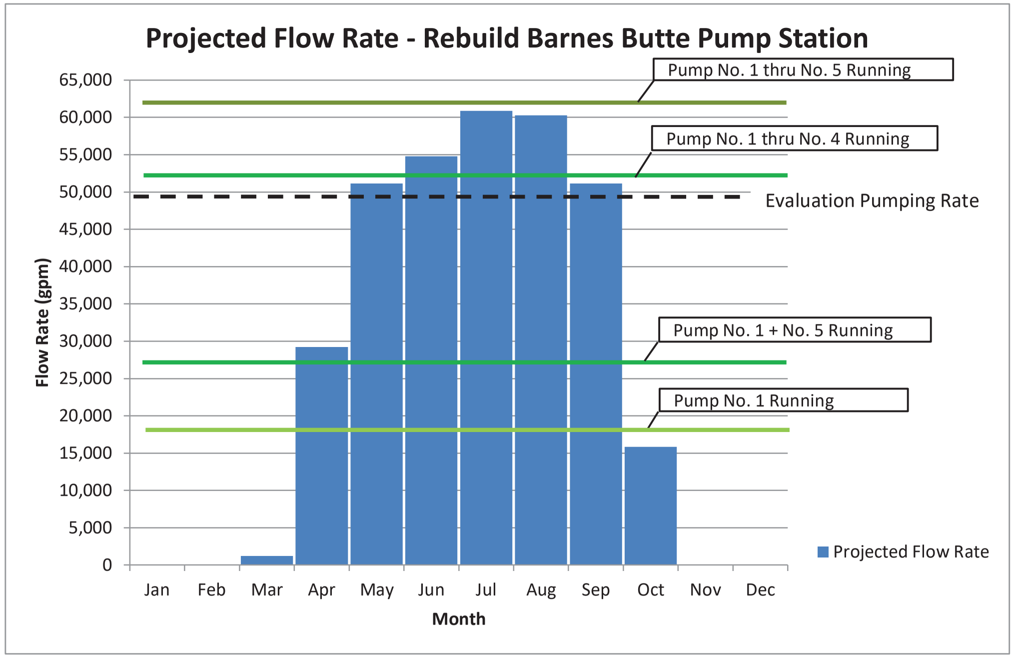
17,300	GPM	Horizontal Split Case Pump No. 1		
17,300	GPM	Horizontal Split Case Pump No. 2		
8,640	GPM	Horizontal Split Case Pump No. 3		
8,640	GPM	Horizontal Split Case Pump No. 4		
9,000	GPM	Horizontal Split Case Pump No. 5		
60,880	GPM	Total	=	135.6 cfs

Rebuilt PS Projected Flow Rate = 60,880 gpm

Month	% of Max Flow Rate	Projected Flow Rate
Jan	0%	0
Feb	0%	0
Mar	2%	1,218
Apr	48%	29,222
May	84%	51,139
Jun	90%	54,792
Jul	100%	60,880
Aug	99%	60,271
Sep	84%	51,139
Oct	26%	15,829
Nov	0%	0
Dec	0%	0

Evaluation Pumping Rate = 48,652 gpm*
108.4 cfs

* Evaluation Pumping Rate = Seasonal Average Flow of Barnes Butte Pumping Plant retroffitted with new horizontal split case pumps.



Notes: Barnes Butte PS is currently fitted with (5) Horizontal Split Case Pumps. VFD operation would not provide significant benefit toward reducing energy use and optimizing water delivery to crop requirement. Rebuilt pumps can be used in combination to reasonably match seasonal demand requirements.

Ochoco Irrigation District
Barnes Butte PS Rebuild (Rebuild existing pumps w/ new impellers)
Budget Level - Projection of Probable Construction Cost

Item No.	Spec Division	Description	Measurement	Units	Unit Cost	Total Cost
1	1000	Mobilization	LS	1	$83,500.00	$83,500.00
2	1000	Erosion Control	LS	1	$500.00	$500.00
3	1000	Watering / Dust Control	LS	1	$1,000.00	$1,000.00
4	1000	Construction Staking	LS	0	$0.00	$0.00
5	1000	Project Management and Coordination	LS	1	$4,000.00	$4,000.00
6	1000	Construction Progress Documentation	LS	1	$4,000.00	$4,000.00
7	1000	Submittal Procedures	LS	1	$4,000.00	$4,000.00
8	1000	Quality Requirements	LS	1	$4,000.00	$4,000.00
9	1000	Selective Demolition	LS	1	$19,000.00	$19,000.00
10	1000	Project Record Documents	LS	1	$4,000.00	$4,000.00
11	1000	Operations and Maintenance Data	LS	1	$4,000.00	$4,000.00
12	1000	General Commissioning Requirements	LS	1	$18,000.00	$18,000.00
13	2000	Erosion Control Silt Fence	LF	1000	$2.40	$2,400.00
14	2000	Perimeter Fence, 8 ft coated wire chain link	LF	0	$18.00	$0.00
15	2000	Fence Gate	LS	1	$2,500.00	$2,500.00
16	2000	Dewatering	LS	1	$500.00	$500.00
17	2000	Bulk Excavation	CY	50	$7.00	$350.00
18	2000	Hauling	CY	50	$12.00	$600.00
19	2000	Structural Backfill	CY	50	$38.00	$1,900.00
20	2000	Aggregate Base	CY	10	$38.00	$380.00
21	2000	Surfacing Rock	CY	50	$38.00	$1,900.00
22	3000	Cast-in-Place Concrete	CY	10	$550.00	$5,500.00
23	3000	Misc Cast-in-Place Concrete (thrust and pads)	LS	1	$5,000.00	$5,000.00
24	9000	High Performance Coating Systems	LS	1	$10,000.00	$10,000.00
25	11000	Split Case Rebuild and New Motor, 500 HP	EA	2	$190,000.00	$380,000.00
26	11000	Split Case Rebuild and New Motor, 300 HP	EA	1	$135,000.00	$135,000.00
27	11000	Split Case Rebuild and New Motor, 250 HP	EA	2	$120,000.00	$240,000.00
28	15000	30-inch Handwheel Operated Butterfly Valves	EA	2	$13,125.00	$26,250.00
29	15000	30-inch Discharge Pipe, Fittings, & Accessories	EA	2	$25,000.00	$50,000.00
30	15000	30-inch Electric Motor Operated Butterfly Valves	EA	2	$21,500.00	$43,000.00
31	15000	18-inch Handwheel Operated Butterfly Valves	EA	3	$3,625.00	$10,875.00
32	15000	18-inch Discharge Pipe, Fittings, & Accessories	EA	3	$20,000.00	$60,000.00
33	15000	18-inch Electric Motor Operated Butterfly Valves	EA	3	$13,750.00	$41,250.00
34	15000	Automatic Priming System	EA	1	$30,000.00	$30,000.00
35	16000	Power and Distribution	LS	1	$62,100.00	$62,100.00
36	16000	Grounding Systems	LS	1	$18,000.00	$18,000.00
37	16000	Conduit and Conductors	LS	1	$51,500.00	$51,500.00
38	16000	Motor Controls	LS	1	$271,300.00	$271,300.00
39	17000	Instrumentation and Control	LS	1	$75,000.00	$75,000.00
		Construction Subtotal				$1,671,305.00
		Contractors Overhead and Profit	10%	1	$167,130.50	$167,130.50
		Contractors Bonds and Insurance	2%	1	$36,768.71	$36,768.71
		Construction Contingency	30%	1	$501,391.50	$501,391.50
		Construction Total				$2,376,595.71
		Engineering, Administration	25%	1	$594,148.93	
		Total				**$2,970,744.64**

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Wire to Water Energy Calculator

Ochoco Irrigation District - SOR

Barnes Butte Pumping Plant Rebuild (Existing pumps rebuilt w/ new impellers)

Source: PumpTech Inc.

2425 SE Ochoco Street

Portland, OR 97222

503-659-6230

OPERATIONAL AND EQUIPMENT DATA

	Rebuilt Pumps		Existing Pumps	
	No. 1 - Pellizzari A600/750, Split Case, 720 RPM, 500 HP *		No. 1 - Pellizzari A600/750, Split Case, 720 RPM, 500 HP *	
	No. 2 - Pellizzari A600/750, Split Case, 720 RPM, 500 HP *		No. 2 - Pellizzari A600/750, Split Case, 720 RPM, 500 HP *	
	No. 3 - Pellizzari A400/500, Split Case, 880 RPM, 250 HP *		No. 3 - Pellizzari A400/500, Split Case, 880 RPM, 250 HP *	
	No. 4 - Pellizzari A400/500, Split Case, 880 RPM, 250 HP *		No. 4 - Pellizzari A400/500, Split Case, 880 RPM, 250 HP *	
	No. 5 - Wilson Snyder 16BAZ, Split Case, 880 RPM, 300 HP *		No. 5 - Wilson Snyder 16BAZ, Split Case, 880 RPM, 300 HP	
Pump Operation - Hours / Day	24		24	
Pump Operation - Days / Year	198		198	
Pump Flow - GPM (Evaluation Pump Rate)	48,652		48,652	
Pump Flow - CFS	108.4		108.4	
Total Annual Volume - Acre feet	42,570		42,570	
Pump Head - Feet	80.3	**	81.4	
Ave. Pump Efficiency - %	84.0%		77.0%	**
Ave. Motor Efficiency - %	96.3%		95.5%	***
Energy Cost in $/kWH	$0.035		$0.035	

Rebuilt Pumps notes:

* Pump rebuild includes replacement of pump impellers, shafts, bearings, seals, and replacement of pump outlet piping, pump control valves, pump motor, motor starters, and electrical service entrance at the existing pump station footprint.

** Pumping head assumes pump discharge piping and valves increased in size from 24-inch to 30-inch.

Existing Pumps notes:

* Pump Make and model per original construction submittals, 1963

** Pump efficiency estimated to be the average of minimum values recorded on Initial Pump Evaluation test data. Data includes points showing efficiency of pumps greater than construction submittal efficiency curves.

*** Average of motor efficiency values recorded on Initial Pump Evaluation test data.

RESULTS

	Rebuilt Pumps	Existing Pumps
BHP At Design Point	1,174.5	1,298.8
Wire to Water Efficiency - %	81%	74%
KW per Year	4,323,453	4,821,155
Annual Energy Cost	$151,320.86	$168,740.42
KW Per 1,000 Gallons Pumped	0.312	0.348
Cost Per 1,000 Gallons Pumped	$0.011	$0.012
kWh per Acre Foot Pumped	102	113
Cost Per Acre Foot Pumped	$3.55	$3.96

PAYBACK

Annual Savings - kW	497,702
Annual Savings - $$	$17,419.56
Annual Savings - %	10.32%
Cost of Rebuilt Pumps *	$2,971,000.00
Cost of Existing Pumps	$0.00
Payback - Years	171

* Pump rebuild includes replacement of pump impellers, shafts, bearings, seals, and replacement of pump outlet piping, pump control valves, pump motor, motor starters, and electrical service entrance at the existing pump station footprint.

Pump Test Data

Initial Pump Evaluation

Project No.: OCHID-04-10 **Description:** Discharge 2.61 ft above Intake pressure gauge

Pump Station No.: Main Lift **Pump No.:** 1 **Water Source:** Canal **Parallel**

Motor Nameplate

Motor Make:	Pellizzari		
Model No:	APS7000/10		
Serial No:			
Rated Hp:	500		
Rated Voltage:	2300		
Rated Amperage:	100	**Ins. Class:**	None
Full Load RPM:	720	**Code:**	None
Enclosure:	None		
Design:	None		
Frame:			
Service Factor:	1.15		

Pump Nameplate

Pump Make:	Pellizzari		
Type:	Split-Case Centrifugal		
Serial No:	275183		
Model No:	A600/750	**Impeller No:**	
Impeller Dia (in):	19.250	**No. of Stages:**	1
Impeller Dia (in):		**No. of Stages:**	0
Secondary Model No:	None	**Impeller No:**	
Impeller Dia (in):		**No. of Stages:**	0
Impeller Dia (in):		**No. of Stages:**	0
Rated Flow (gpm):	17300		
Rated Head (ft):	82		
Rated RPM:	720		
Column Dia (in):	0.00		
Column Length (ft):	0.0		
Shaft Dia (in):	0.000		
Tube Dia (in):	0.000		
Thrust Factor (lbs/ft):	0.0		
Impeller Wt. (lbs):	0.0		

Utility Meter Nameplate

Make: None **Meter ID:** 35 695 918

Type: Digital **Serial No.:** X9D035695918345K

k_h: 1.2 **PTR:** 120 **CTR:** 15

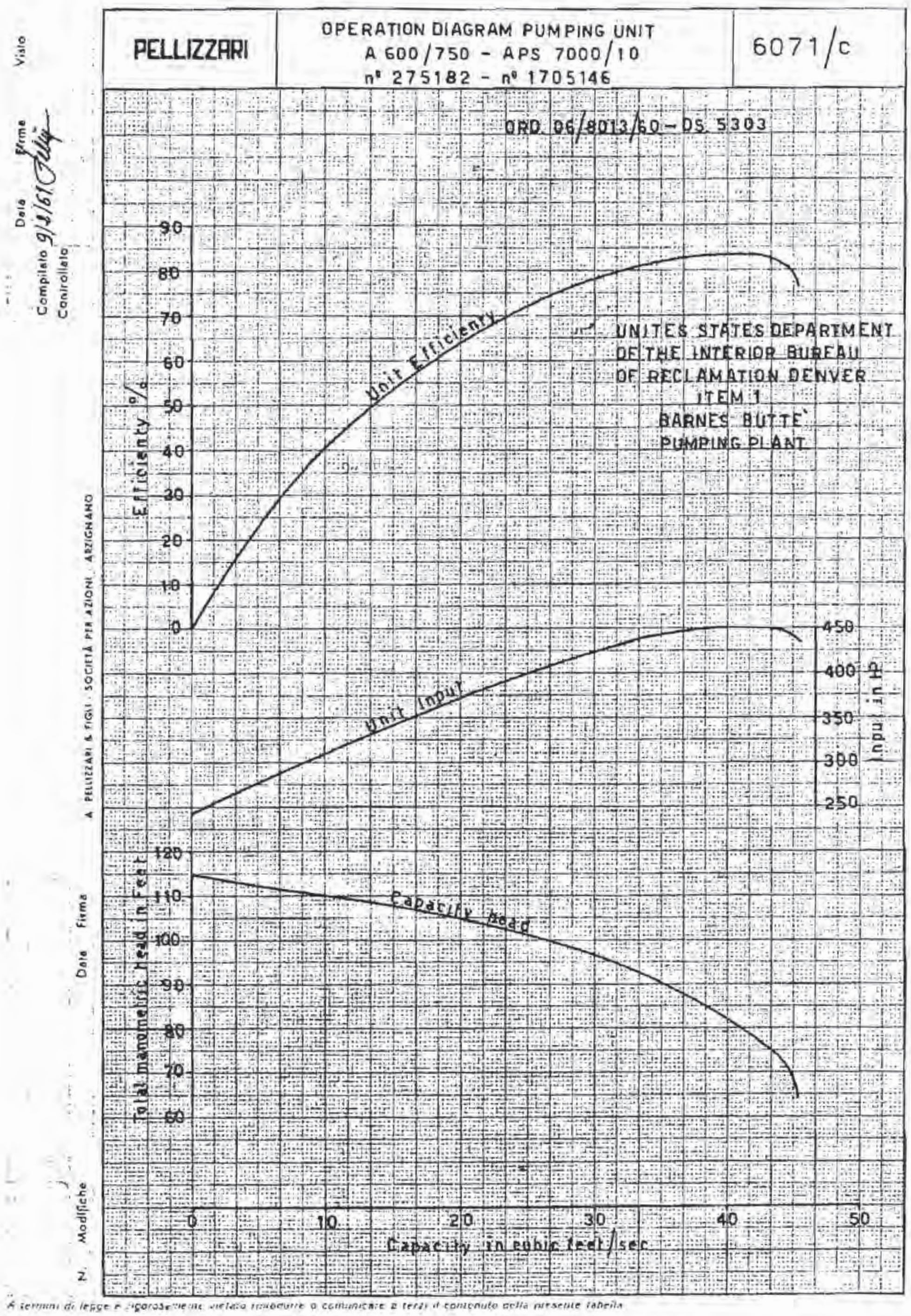
Field Pump Test Data

Test No.	Date	Flow Measurement Device	Flow (gpm)	Pressures Intake (PSI)	Pressures Discharge (PSI)	Pressures Delivered (PSI)	Misc. Losses (ft)	TDH (ft)	Pump RPM
1-1	10/14/201	Transit Time	17,431	-3.5	27.1	27.1	1.5	72.2	
1-2	10/14/201	Transit Time	19,500	-3.5	27.1	27.1	1.9	72.6	

Test No.	Voltages 1-2	Voltages 1-3	Voltages 2-3	Voltages Avg.	Amperages 1	Amperages 2	Amperages 3	Amperages Avg.	Power Factor 1	Power Factor 2	Power Factor 3	Power Factor Avg.	Utility Meter Rev.	Utility Meter Sec.	Motor RPM	Motor % Load
1-1	2300.0	2300.0	2300.0	2300.0	64.5	62.0	66.0	64.2	100.0%			100.0%	5	125.6	720	79.9%
1-2	2300.0	2300.0	2300.0	2300.0	64.5	62.0	66.0	64.2	100.0%			100.0%	5	125.6	720	79.9%

Test No.	Power Calculations Shaft HP	Thrust HP	Water HP	Brake HP	Pump HP	Input kW	Input HP	Utility Meter (kW)	Efficiencies Motor	Pump	Discharge	Delivered
1-1	0.00	0.00	317.8	399.5	399.5	309.6	414.9	309.6	96.3%	79.6%	76.6%	76.6%
1-2	0.00	0.00	357.5	399.5	399.5	309.6	414.9	309.6	96.3%	89.5%	86.2%	86.2%

Note: If a main valve is present, the Delivered Pressure is the pressure after the valve. If no main valve is present, the Delivered Pressure will be the same as the Discharge Pressure.


PELLIZZARI
OPERATION DIAGRAM PUMPING UNIT
A 600/750 - APS 7000/10
n° 275182 - n° 1705146
6071/c
ORD. 06/8013/60 - DS. 5303
UNITES STATES DEPARTMENT
OF THE INTERIOR BUREAU
OF RECLAMATION DENVER
ITEM 1
BARNES BUTTE
PUMPING PLANT
Unit Efficienty
Efficienty %
Unit Input
Unit Input
Capacity head
Total manometric head in Feet
Capacity in cubic feet/sec
0
10
20
30
40
50
60
70
80
90
100
110
120
250
300
350
400
450
Compilato 9/3/61
Controllato
Data
Firme
Visto
Modifiche
N.
A. PELLIZZARI & FIGLI - SOCIETÀ PER AZIONI - ARZIGNANO
A termini di legge è rigorosamente vietato riprodurre o comunicare a terzi il contenuto della presente tabella

Pump Test Data

Initial Pump Evaluation

Project No.: OCHID-04-10 **Description:** Use Test 2-2

Pump Station No.: Main Lift **Pump No.:** 2 **Water Source:** Canal **Parallel**

Motor Nameplate

Motor Make: Pellizzari
Model No: APS7000/10
Serial No:
Rated Hp: 500
Rated Voltage: 2300
Rated Amperage: 100 **Ins. Class:** None
Full Load RPM: 720 **Code:** None
Enclosure: None
Design: None
Frame:
Service Factor: 1.15

Utility Meter Nameplate

Make: None **Meter ID:** 35 695 918
Type: Digital **Serial No.:** X9D035695918345K
k_h: 1.2 **PTR:** 120 **CTR:** 15

Pump Nameplate

Pump Make: Pellizzari
Type: Split-Case Centrifugal
Serial No: 275182
Model No: A600/750 **Impeller No:**
Impeller Dia (in): 19.250 **No. of Stages:** 1
Impeller Dia (in): **No. of Stages:** 0
Secondary Model No: None **Impeller No:**
Impeller Dia (in): **No. of Stages:** 0
Impeller Dia (in): **No. of Stages:** 0
Rated Flow (gpm): 17300
Rated Head (ft): 82
Rated RPM: 720
Column Dia (in): 0.00
Column Length (ft): 0.0
Shaft Dia (in): 0.000
Tube Dia (in): 0.000
Thrust Factor (lbs/ft): 0.0
Impeller Wt. (lbs): 0.0

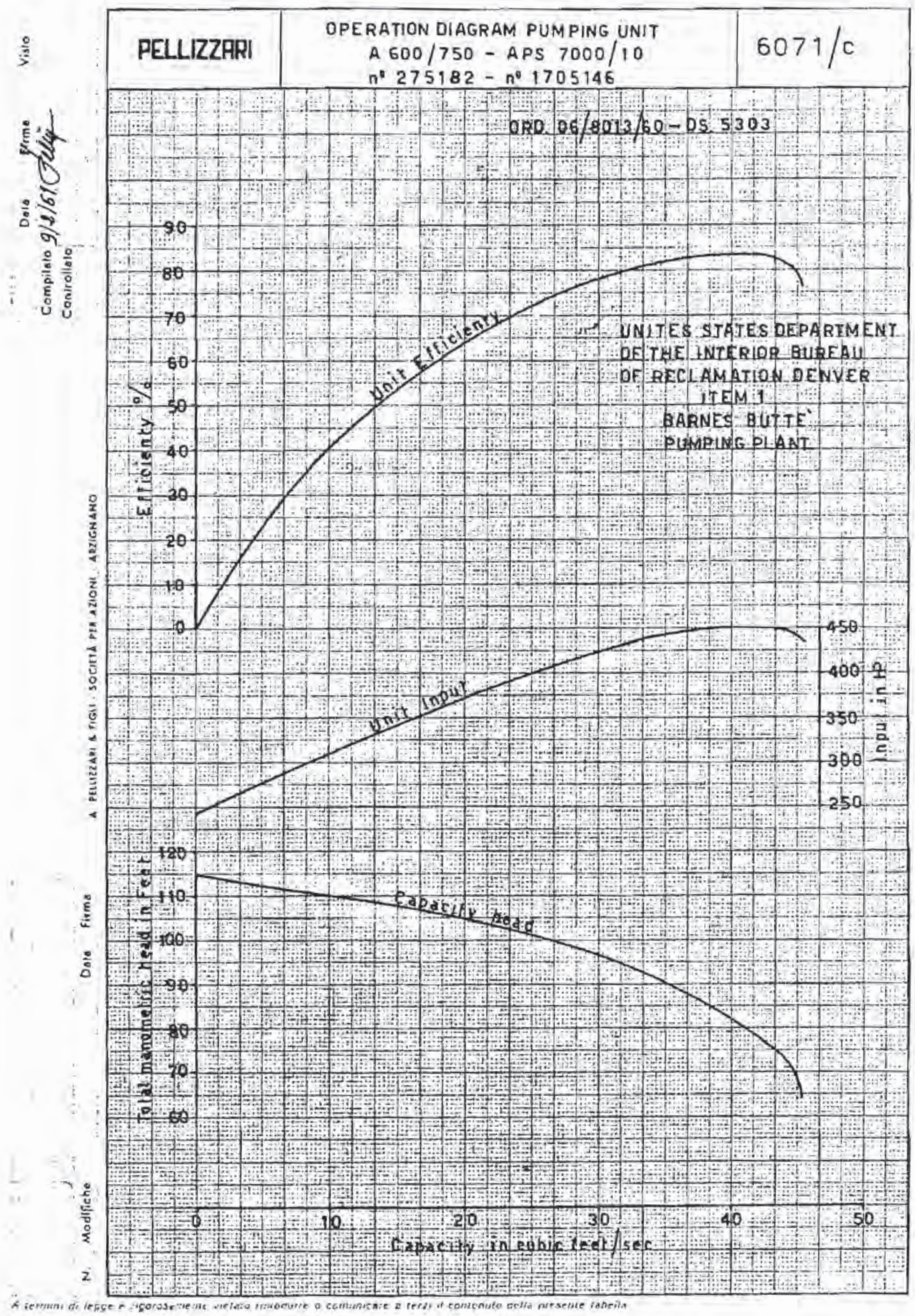
Field Pump Test Data

Test No.	Date	Flow Measurement Device	Flow (gpm)	Pressures Intake (PSI)	Pressures Discharge (PSI)	Pressures Delivered (PSI)	Misc. Losses (ft)	TDH (ft)	Pump RPM
2-1	10/14/201	Transit Time	16,633	-3.7	28.1	28.1	1.4	74.9	720
2-2	10/14/201	Dye Transit-Time	18,600	-3.7	28.1	28.1	1.7	75.2	720

Test No.	Voltages 1-2	Voltages 1-3	Voltages 2-3	Voltages Avg.	Amperages 1	Amperages 2	Amperages 3	Amperages Avg.	Power Factor 1	Power Factor 2	Power Factor 3	Power Factor Avg.	Utility Meter Rev.	Utility Meter Sec.	Motor RPM	Motor % Load
2-1	2300.0	2300.0	2300.0	2300.0	65.0		65.0	65.0	100.0%			100.0%	5	126.3	900	79.4%
2-2	2300.0	2300.0	2300.0	2300.0	65.0		65.0	65.0	100.0%			100.0%	5	126.3		79.4%

Test No.	Shaft HP	Thrust HP	Water HP	Brake HP	Pump HP	Input kW	Input HP	Utility Meter (kW)	Efficiencies Motor	Efficiencies Pump	Efficiencies Discharge	Efficiencies Delivered
2-1	0.00	0.00	314.6	397.2	397.2	307.8	412.5	307.8	96.3%	79.2%	76.2%	76.2%
2-2	0.00	0.00	353.2	397.2	397.2	307.8	412.5	307.8	96.3%	88.9%	85.6%	85.6%

Note: If a main valve is present, the Delivered Pressure is the pressure after the valve. If no main valve is present, the Delivered Pressure will be the same as the Discharge Pressure.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OPERATION DIAGRAM PUMPING UNIT
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ORD. 06/8013/60 - DS. 5303
UNITES STATES DEPARTMENT
OF THE INTERIOR BUREAU
OF RECLAMATION DENVER
ITEM 1
BARNES BUTTE
PUMPING PLANT
Unit Efficienty
Efficienty %
Unit Input
Unit Input
Capacity head
Total manometric head in Feet
Capacity in cubic feet/sec
0
10
20
30
40
50
60
70
80
90
100
110
120
250
300
350
400
450
Visto
Compilato 9/3/61
Controllato
Data
Firma
N.
Modifiche
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Pump Test Data

Initial Pump Evaluation

Project No.: OCHID-04-10 **Description:**

Pump Station No.: Main Lift **Pump No.:** 3 **Water Source:** Canal

Motor Nameplate

Motor Make:	Pellizzari		
Model No:	APS3000/8		
Serial No:			
Rated Hp:	250		
Rated Voltage:	2300		
Rated Amperage:	50	**Ins. Class:**	None
Full Load RPM:	900	**Code:**	None
Enclosure:	None		
Design:	None		
Frame:			
Service Factor:	1.15		

Pump Nameplate

Pump Make:	Pellizzari		
Type:	Split-Case Centrifugal		
Serial No:	275184		
Model No:	A400/500	**Impeller No:**	
Impeller Dia (in):		**No. of Stages:**	1
Impeller Dia (in):		**No. of Stages:**	0
Secondary Model No:	None	**Impeller No:**	
Impeller Dia (in):		**No. of Stages:**	0
Impeller Dia (in):		**No. of Stages:**	0
Rated Flow (gpm):	8640		
Rated Head (ft):	82		
Rated RPM:	900		
Column Dia (in):	0.00		
Column Length (ft):	0.0		
Shaft Dia (in):	0.000		
Tube Dia (in):	0.000		
Thrust Factor (lbs/ft):	0.0		
Impeller Wt. (lbs):	0.0		

Utility Meter Nameplate

Make:	None			**Meter ID:**	35 695 918
Type:	Digital			**Serial No.:**	X9D035695918345K
k_h:	1.2	**PTR:**	120	**CTR:**	15

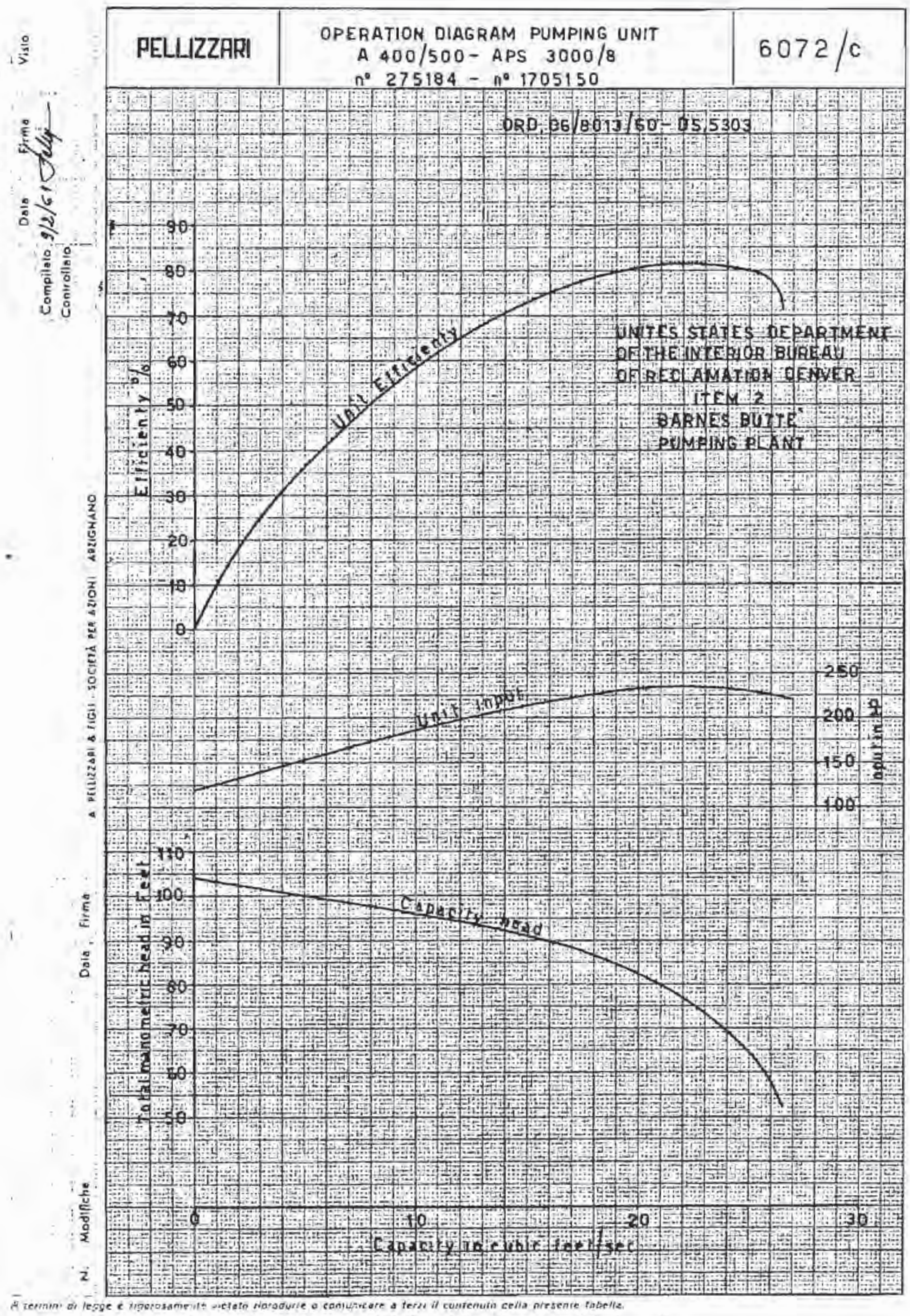
Field Pump Test Data

Test No.	Date	Flow Measurement Device	Flow (gpm)	Pressures Intake (PSI)	Pressures Discharge (PSI)	Pressures Delivered (PSI)	Misc. Losses (ft)	TDH (ft)	Pump RPM
3-1	10/14/201	Transit Time	9,460	-3.5	28.1	28.1	2.4	75.4	900

Test No.	Voltages 1-2	1-3	2-3	Avg.	Amperages 1	2	3	Avg.	Power Factor 1	2	3	Avg.	Utility Meter Rev.	Sec.	Motor RPM	% Load
3-1	2300.0	2300.0	2300.0	2300.0	19.5	20.1	19.2	19.6	100.0%			100.0%	2	104.3	900	76.9%

Test No.	Power Calculations Shaft HP	Thrust HP	Water HP	Brake HP	Pump HP	Input kW	Input HP	Utility Meter (kW)	Efficiencies Motor	Pump	Discharge	Delivered
3-1	0.00	0.00	180.1	192.4	192.4	149.1	199.8	149.1	96.3%	95.2%	91.7%	91.7%

Note: If a main valve is present, the Delivered Pressure is the pressure after the valve. If no main valve is present, the Delivered Pressure will be the same as the Discharge Pressure.


PELLIZZARI
OPERATION DIAGRAM PUMPING UNIT
A 400/500 - APS 3000/8
n° 275184 - n° 1705150
6072/c
ORD. 06/8013/60 - 05.5303
UNITES STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION DENVER
ITEM 2
BARNES BUTTE PUMPING PLANT
Unit Efficiency
Efficiency %
Unit input
input in hp
Capacity head
Total manometric head in Feet
Capacity in cubic feet/sec
A. PELLIZZARI & FIGLI - SOCIETÀ PER AZIONI - ARZIGNANO
A termini di legge è rigorosamente vietato riprodurre o comunicare a terzi il contenuto della presente tabella.

Pump Test Data

Initial Pump Evaluation

Project No.: OCHID-04-10 **Description:** Use Test 4-2

Pump Station No.: Main Lift **Pump No.:** 4 **Water Source:** Canal **Parallel**

Motor Nameplate

Motor Make:	Pellizzari
Model No:	APS3000/8
Serial No:	
Rated Hp:	250
Rated Voltage:	2300
Rated Amperage:	50
Ins. Class:	None
Full Load RPM:	900
Code:	None
Enclosure:	None
Design:	None
Frame:	
Service Factor:	1.15

Utility Meter Nameplate

Make: None **Meter ID:** 35 695 918

Type: Digital **Serial No.:** X9D035695918345K

k_h: 1.2 **PTR:** 120 **CTR:** 15

Pump Nameplate

Pump Make:	Pellizzari
Type:	Split-Case Centrifugal
Serial No:	275185
Model No:	A400/500
Impeller No:	
Impeller Dia (in):	
No. of Stages:	1
Impeller Dia (in):	
No. of Stages:	0
Secondary Model No:	None
Impeller No:	
Impeller Dia (in):	
No. of Stages:	0
Impeller Dia (in):	
No. of Stages:	0
Rated Flow (gpm):	8640
Rated Head (ft):	82
Rated RPM:	900
Column Dia (in):	0.00
Column Length (ft):	0.0
Shaft Dia (in):	0.000
Tube Dia (in):	0.000
Thrust Factor (lbs/ft):	0.0
Impeller Wt. (lbs):	0.0

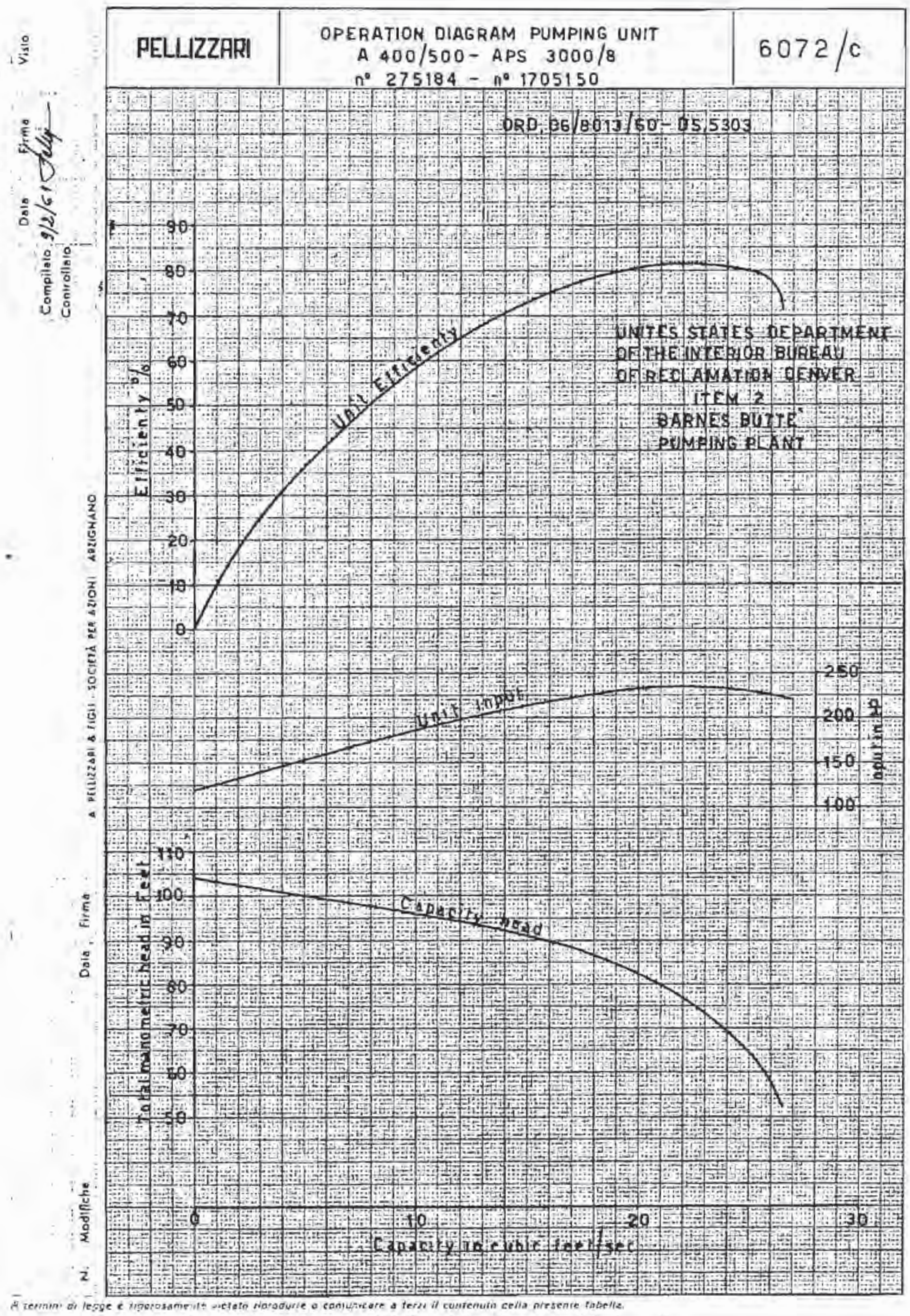
Field Pump Test Data

Test No.	Date	Flow Measurement Device	Flow (gpm)	Pressures Intake (PSI)	Pressures Discharge (PSI)	Pressures Delivered (PSI)	Misc. Losses (ft)	TDH (ft)	Pump RPM
4-1	10/14/201	Transit Time	8,117	-3.3	28.1	28.1	1.7	74.3	900
4-2	10/14/201	Dye Transit-Time	7,910	-3.3	28.1	28.1	1.6	74.2	

Test No.	Voltages 1-2	Voltages 1-3	Voltages 2-3	Voltages Avg.	Amperages 1	Amperages 2	Amperages 3	Amperages Avg.	Power Factor 1	Power Factor 2	Power Factor 3	Power Factor Avg.	Utility Meter Rev.	Utility Meter Sec.	Motor RPM	Motor % Load
4-1	2300.0	2300.0	2300.0	2300.0	19.0		18.0	18.5	100.0%			100.0%	2	106.8	900	75.2%
4-2	2400.0	2400.0	2400.0	2400.0	19.0		18.0	18.5	100.0%			100.0%	2	106.8	900	75.2%

Test No.	Power Calculations Shaft HP	Thrust HP	Water HP	Brake HP	Pump HP	Input kW	Input HP	Utility Meter (kW)	Efficiencies Motor	Pump	Discharge	Delivered
4-1	0.00	0.00	152.3	188.1	188.1	145.6	195.1	145.6	96.4%	82.0%	79.1%	79.1%
4-2	0.00	0.00	148.2	188.1	188.1	145.6	195.1	145.6	96.4%	79.8%	76.9%	76.9%

Note: If a main valve is present, the Delivered Pressure is the pressure after the valve. If no main valve is present, the Delivered Pressure will be the same as the Discharge Pressure.


PELLIZZARI
OPERATION DIAGRAM PUMPING UNIT
A 400/500 - APS 3000/8
n° 275184 - n° 1705150
6072/c
ORD. 06/8013/60 - D5.5303
Compilato 9/2/61
Controllato
Data
Firma
Visto
UNITES STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION DENVER
ITEM 2
BARNES BUTTE PUMPING PLANT
Efficienty %
Unit Efficienty
Unit input
input in HP
Capacity head
Total manometric head in Feet
Capacity in cubic feet/sec
0
10
20
30
40
50
60
70
80
90
100
150
200
250
110
A. PELLIZZARI & FIGLI - SOCIETÀ PER AZIONI - ARZIGNANO
Modifiche
N.
A termini di legge è rigorosamente vietato riprodurre o comunicare a terzi il contenuto della presente tabella.

Pump Test Data

Initial Pump Evaluation

Project No.: OCHID-04-10 **Description:** Intake PSI is estimated at point of connection

Pump Station No.: Main Lift **Pump No.:** 5 **Water Source:** Canal **Parallel**

Motor Nameplate

Motor Make:	None		
Model No:			
Serial No:			
Rated Hp:	300		
Rated Voltage:	2300		
Rated Amperage:		**Ins. Class:**	None
Full Load RPM:	880	**Code:**	None
Enclosure:	None		
Design:	None		
Frame:			
Service Factor:	1.15		

Utility Meter Nameplate

Make: None **Meter ID:** 35 695 918

Type: Digital **Serial No.:** X9D035695918345K

k_h: 1.2 **PTR:** 120 **CTR:** 15

Pump Nameplate

Pump Make:	Wilson-Snyder		
Type:	Split-Case Centrifugal		
Serial No:	16BAZ		
Model No:	None	**Impeller No:**	
Impeller Dia (in):		**No. of Stages:**	0
Impeller Dia (in):		**No. of Stages:**	0
Secondary Model No:	None	**Impeller No:**	
Impeller Dia (in):		**No. of Stages:**	0
Impeller Dia (in):		**No. of Stages:**	0
Rated Flow (gpm):	9000		
Rated Head (ft):	94		
Rated RPM:	880		
Column Dia (in):	0.00		
Column Length (ft):	0.0		
Shaft Dia (in):	0.000		
Tube Dia (in):	0.000		
Thrust Factor (lbs/ft):	0.0		
Impeller Wt. (lbs):	0.0		

Field Pump Test Data

Test No.	Date	Flow Measurement Device	Flow (gpm)	Pressures Intake (PSI)	Pressures Discharge (PSI)	Pressures Delivered (PSI)	Misc. Losses (ft)	TDH (ft)	Pump RPM
5-1	10/14/201	Dye Transit-Time	9,037	-3.3	27.4	27.4	3.6	74.6	900

Test No.	Voltages 1-2	1-3	2-3	Avg.	Amperages 1	2	3	Avg.	Power Factor 1	2	3	Avg.	Utility Meter Rev.	Sec.	Motor RPM	% Load
5-1													3	114.0	884	84.5%

Test No.	Power Calculations Shaft HP	Thrust HP	Water HP	Brake HP	Pump HP	Input kW	Input HP	Utility Meter (kW)	Efficiencies Motor	Pump	Discharge	Delivered
5-1	0.00	0.00	170.2	253.6	253.6	204.6	274.2	204.6	92.5%	67.1%	62.1%	62.1%

Note: If a main valve is present, the Delivered Pressure is the pressure after the valve. If no main valve is present, the Delivered Pressure will be the same as the Discharge Pressure.

Pump Test Summary Data

Project No.: OCHID-04-10

Pump Station	Pump No.	Condition	Test No.	Include	Rated Hp	Flow (gpm)	Intake (PSI)	Discharge (PSI)	Delivery (PSI)	TDH (FT)	Electric Hp	Pump Eff.	Overall Eff.
Main Lift	1	Existing	1-1		500	17,431	-3.5	27.1	27.1	73.3	414.9	79.6%	76.6%
Main Lift	1	Existing	1-2	X	500	19,500	-3.5	27.1	27.1	73.9	414.9	89.5%	86.2%
Main Lift	2	Existing	2-1		500	16,633	-3.7	28.1	28.1	75.8	412.5	79.2%	76.2%
Main Lift	2	Existing	2-2	X	500	18,600	-3.7	28.1	28.1	76.4	412.5	88.9%	85.6%
Main Lift	3	Existing	3-1		250	9,460	-3.5	28.1	28.1	77.0	199.8	95.2%	91.7%
Main Lift	4	Existing	4-1		250	8,117	-3.3	28.1	28.1	75.5	195.1	82.0%	79.1%
Main Lift	4	Existing	4-2	X	250	7,910	-3.3	28.1	28.1	75.3	195.1	79.8%	76.9%
Main Lift	5	Existing	5-1		300	9,037	-3.3	27.4	27.4	76.1	274.2	68.2%	63.1%

BARNES BUTTE PUMPING PLANT RETROFIT - EVALUATION SUMMARY

The Barnes Butte pump site is at the foot of Barnes Butte, about 0.75 miles east of the Prineville city limits. The Barnes Butte facility was originally designed for 115.5 cubic feet per second (CFS) at 82 feet total dynamic head (TDH). The original installation circa 1961 was comprised of (4) horizontal split case pumps with synchronous motors totaling 1,500 HP. A fifth 300 HP, horizontal split case pump was added at a later date. The current facility consisting of the five pumping units totaling 1,800 horsepower is designed to lift approximately 135 CFS at 86 feet TDH from the end of the Crooked River diversion canal to the head of the distribution canal. The discharge main consists of approximately 1,600 feet of 54-inch I.D. concrete pipe.

Original Design

Pump Unit	Description	HP	Rated Capacity	Rated Head	Pump Eff. @ Rated Capacity	Pipe Size	Pump Discharge Vel.	Discharge Main Vel.
No. 1	Horizontal Split Case	500	17,300 GPM	82 FT	84 %	24 IN	12.3 FPS	
No. 2	Horizontal Split Case	500	17,300 GPM	82 FT	84 %	24 IN	12.3 FPS	
No. 3	Horizontal Split Case	250	8,640 GPM	82 FT	80 %	16 IN	13.8 FPS	
No. 4	Horizontal Split Case	250	8,640 GPM	82 FT	80 %	16 IN	13.8 FPS	
Total		1,500	51,880 GPM	82 FT		54 IN		7.3 FPS

Current Condition (Ref. Initial Pump Evaluation BPA, 2010)

Pump Unit	Description	HP	Test Capacity	Test Head	Pump Eff. @ Test Capacity	Pipe Size	Pump Discharge Vel.	Discharge Main Vel.
No. 1	Horizontal Split Case	500	17,431 GPM *	73 FT *	80 % *	24 IN	12.4 FPS	
No. 2	Horizontal Split Case	500	16,633 GPM *	76 FT *	79 %	24 IN	11.8 FPS	
No. 3	Horizontal Split Case	250	9,460 GPM	77 FT	80 % **	16 IN	15.1 FPS	
No. 4	Horizontal Split Case	250	7,910 GPM *	75 FT *	80 % **	16 IN	12.6 FPS	
No. 5	Horizontal Split Case	300	9,037 GPM	76 FT	68 %	16 IN	14.4 FPS	
Total		1,800	60,471 GPM			54 IN		8.5 FPS

* Minimum value of (2) test data points, ref. Initial Pump Evaluation, BPA, 2010

** Measured pump efficiency at the test capacity was greater than the factory curve. Factory curve data for efficiency at rated capacity used in evaluating pumping plant efficiency.

Alternate Equipment (Replace existing pumps in the current pump station location and configuration)

Pump Unit	Description	HP	Rated Capacity	Rated Head	Pump Eff. @ Rated Capacity	Pipe Size	Pump Discharge Vel.	Discharge Main Vel.
No. 1	Horizontal Split Case	500	17,300 GPM	90 FT	88.5 %	30 IN	7.9 FPS	
No. 2	Horizontal Split Case	500	17,300 GPM	90 FT	88.5 %	30 IN	7.9 FPS	
No. 3	Horizontal Split Case	300	11,700 GPM	90 FT	88.5 %	24 IN	8.3 FPS	
No. 4	Horizontal Split Case	300	11,700 GPM	90 FT	88.5 %	24 IN	8.3 FPS	
No. 5	Horizontal Split Case	300	11,700 GPM	90 FT	88.5 %	24 IN	8.3 FPS	
Total		1,900	69,700 GPM	90 FT		54 IN		9.8 FPS

Narrative

Evaluation of the Barnes Butte Pumping Plant Retrofit examines potential energy efficiency improvements gained by retrofitting existing Barnes Butte Pumping Plant with new horizontal split case pumps. New pumps would be installed at the existing pump station location and generally in the same configuration as existing equipment. Pump discharge piping and valve size would be increased to reduce velocity and friction losses.

Electrical systems would be rebuilt from service entrance through motor starters. New synchronous motors would be installed with the new pumps.

With five new pumps available to meet irrigation season demand variations, integration of variable speed drive equipment into alternate pump equipment would not appear to provide significant energy savings.

The capacity of the rebuilt pump station is anticipated to be approximately 69,700 gpm (155 CFS) at 89 feet TDH.

Wire to water energy analysis is based on the projected capacity of the Barnes Butte Pumping Plant retrofitted with new horizontal split case pumps. The Barnes Butte Pumping Plant retrofitted with new horizontal split case pumps is projected to provide a seasonal average flow of 55,700 gpm (124.1 CFS) at 82.9 feet TDH. The existing Barnes Butte Pumping plant in its current condition is projected to yield 124.1 CFS at 84.0 feet TDH.

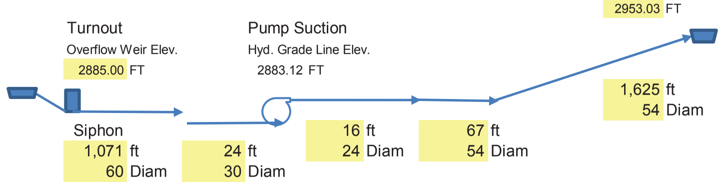
Action Recommended for Further Evaluation: **Retrofit No. 1 Pump with new Horiz. Split Case Pump**
Retrofit No. 2 Pump with new Horiz. Split Case Pump
Retrofit No. 3 Pump with new Horiz. Split Case Pump
Retrofit No. 4 Pump with new Horiz. Split Case Pump
Retrofit No. 5 Pump with new Horiz. Split Case Pump
Replace pump discharge piping and valves
Replace electrical service entrance and motor starters

Annual Energy Savings Estimate = **841,206 kW-hr**

Initial Cost Estimate = **$2,988,000**

Pump to Canal Head Loss Calculations
Barnes Butte Pumping Plant Retrofit (Replace existing pumps with new pumps)

17,300	GPM	Horizontal Split Case Pump No. 1	
17,300	GPM	Horizontal Split Case Pump No. 2	
8,640	GPM	Horizontal Split Case Pump No. 3	Static Head = 68.03 FT
8,640	GPM	Horizontal Split Case Pump No. 4	
0	GPM	Horizontal Split Case Pump No. 5	
51,880	GPM	Total = 115.6 cfs	



Diam. (Discharge Pipe) = 54 in
Total Discharge Pipe Length = 1,732 ft
Equiv. Pipe Length Valves & Fittings Pump Discharge = 91 ft
Equiv. Pipe Length Valves & Fittings Discharge Header = 241 ft

60" Siphon Pipe	Friction Head =	1.76 FT per 1,000 FT	Concrete
(Vel. = 5.9 fps)	Dynamic Head =	1.88 FT total	C = 120
30" Inlet Pipe	Friction Head =	5.05 FT per 1,000 FT	Steel
(Vel. = 7.9 fps)	Dynamic Head =	0.12 FT total	C = 140
24" Discharge Piping	Friction Head =	14.96 FT per 1,000 FT	Steel
(Vel. = 12.3 fps)	Dynamic Head =	0.24 FT total	C = 140
54" Header	Friction Head =	2.21 FT per 1,000 FT	Steel
(Vel. = 7.3 fps)	Dynamic Head =	0.15 FT total	C = 140
54" Discharge	Friction Head =	2.94 FT per 1,000 FT	Concrete
(Vel. = 7.3 fps)	Dynamic Head =	4.77 FT total	C = 120
Equivalent Pipe Length	Friction Head =	14.96 FT per 1,000 FT	Steel
Valves & Fittings Pump Discharge	Dynamic Head =	1.36 FT total	C = 140
Equivalent Pipe Length	Friction Head =	2.21 FT per 1,000 FT	Steel
Valves & Fittings Discharge Header	Dynamic Head =	0.53 FT total	C = 140
	Friction Head =	7.17 FT =	3.10 psi
	Water Depth in Discharge Canal =	4.07 FT =	1.76 psi
	Total Dynamic Head =	81.16 FT =	35.13 psi

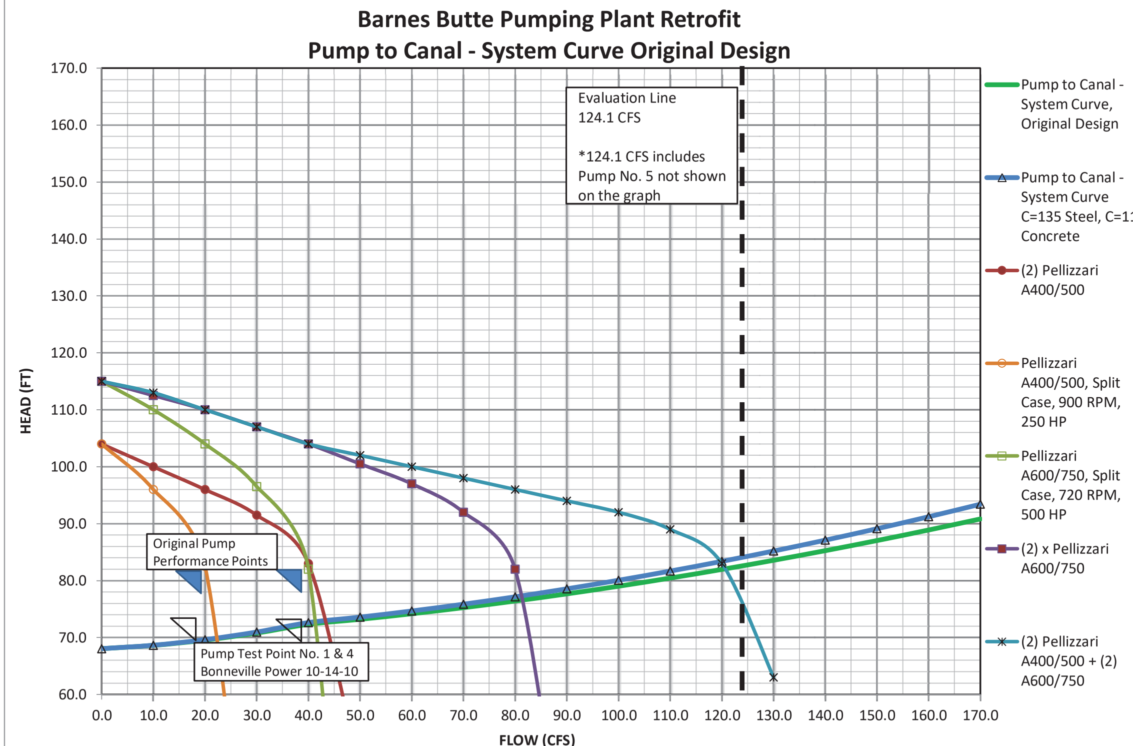
Equivalent Pipe Length Totals:

Item	24" Equiv. Length	No. of Units	Total Equiv. Length
60" to 30" square edged inlet	85 ft	1 ea	85 ft
30" pump isolation (gate) valve	3 ft	1 ea	3 ft
24" pump control (gate) valve	3 ft	1 ea	3 ft
		Subtotal	91 ft

Item	54" Equiv. Length	No. of Units	Total Equiv. Length
24"x54" tee branch flow	40 ft	1 ea	40 ft
54" flow meter	1 ft	1 ea	1 ft
54"x24" tee in-line flow	30 ft	4 ea	120 ft
54"x60" expander	5 ft	1 ea	5 ft
54" 45 bend	20 ft	2 ea	40 ft
54" 11.25 bend	10 ft	2 ea	20 ft
54" flap gate	15 ft	1 ea	15 ft
		Subtotal	241 ft

Barnes Butte Pumping Plant Retrofit (Replace existing pumps with new pumps)
Pump to Canal - System Curve, Original Design

Q (gpm)	0	4,488	8,976	13,464	17,952	22,440	26,928	31,416	35,904	40,392	44,880	49,368	53,856	58,344	62,832	67,320	71,808	76,296
Q (cfs)	0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0	170.0
Hf	0.0	0.6	1.5	2.7	4.3	5.2	6.1	7.2	8.4	9.6	11.0	12.4	13.9	15.5	17.2	19.0	20.9	22.8
TDH (ft)	68.0	68.6	69.5	70.8	72.3	73.2	74.2	75.2	76.4	77.7	79.0	80.4	82.0	83.6	85.3	87.0	88.9	90.8
Vel. Disch. (fps)	0.0	0.6	1.3	1.9	2.5	3.1	3.8	4.4	5.0	5.7	6.3	6.9	7.5	8.2	8.8	9.4	10.1	10.7



Pellizzari A400/500, Split Case, 900 RPM, 250 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	104	96	83	10														

(2) Pellizzari A400/500

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	104	100	96	92	83	47	10											

Pellizzari A600/750, Split Case, 720 RPM, 500 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	115	110	104	97	82	-20												

(2) x Pellizzari A600/750

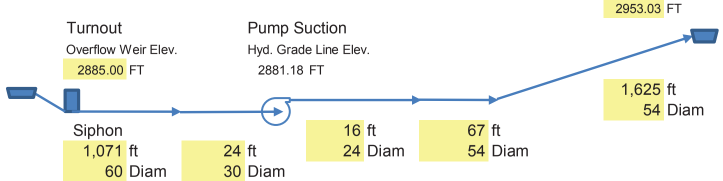
Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	115	113	110	107	104	101	97	92	82	29	-20							

(2) Pellizzari A400/500 + (2) A600/750

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	115	113	110	107	104	102	100	98	96	94	92	89	83	63				

Pump to Canal Head Loss Calculations
Barnes Butte Pumping Plant Retrofit (Replace existing pumps with new pumps)

17,300	GPM	Horizontal Split Case Pump No. 1	
17,300	GPM	Horizontal Split Case Pump No. 2	
11,700	GPM	Horizontal Split Case Pump No. 3	Static Head = 68.03 FT
11,700	GPM	Horizontal Split Case Pump No. 4	
11,700	GPM	Horizontal Split Case Pump No. 5	
69,700	GPM	Total = 155.3 cfs	



Diam. (Discharge Pipe) = 54 in
Total Discharge Pipe Length = 1,732 ft
Equiv. Pipe Length Valves & Fittings Pump Discharge = 91 ft
Equiv. Pipe Length Valves & Fittings Discharge Header = 241 ft

60" Siphon Pipe	Friction Head =	3.57 FT per 1,000 FT	Concrete
(Vel. = 7.9 fps)	Dynamic Head =	3.82 FT total	C = 110
30" Inlet Pipe	Friction Head =	5.40 FT per 1,000 FT	Steel
(Vel. = 7.9 fps)	Dynamic Head =	0.13 FT total	C = 135
24" Discharge Piping	Friction Head =	16.00 FT per 1,000 FT	Steel
(Vel. = 12.3 fps)	Dynamic Head =	0.26 FT total	C = 135
54" Header	Friction Head =	4.08 FT per 1,000 FT	Steel
(Vel. = 9.8 fps)	Dynamic Head =	0.27 FT total	C = 135
54" Discharge	Friction Head =	5.95 FT per 1,000 FT	Concrete
(Vel. = 9.8 fps)	Dynamic Head =	9.67 FT total	C = 110
Equivalent Pipe Length Valves & Fittings Pump Discharge	Friction Head =	16.00 FT per 1,000 FT	Steel
	Dynamic Head =	1.46 FT total	C = 135
Equivalent Pipe Length Valves & Fittings Discharge Header	Friction Head =	4.08 FT per 1,000 FT	Steel
	Dynamic Head =	0.98 FT total	C = 135
	Friction Head =	12.77 FT =	5.53 psi
	Water Depth in Discharge Canal =	5.47 FT =	2.37 psi
	Total Dynamic Head =	90.09 FT =	39.00 psi

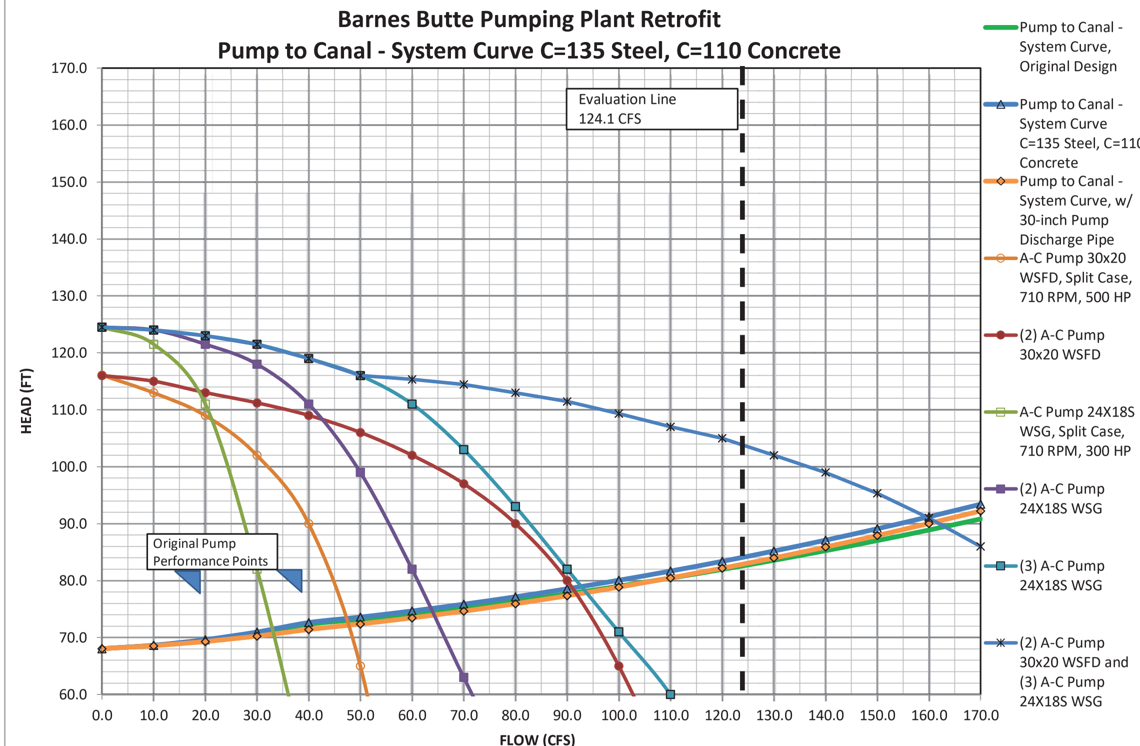
Equivalent Pipe Length Totals:

Item	24" Equiv. Length	No. of Units	Total Equiv. Length
60" to 30" square edged inlet	85 ft	1 ea	85 ft
30" pump isolation (gate) valve	3 ft	1 ea	3 ft
24" pump control (gate) valve	3 ft	1 ea	3 ft
		Subtotal	91 ft

Item	54" Equiv. Length	No. of Units	Total Equiv. Length
24"x54" tee branch flow	40 ft	1 ea	40 ft
54" flow meter	1 ft	1 ea	1 ft
54"x24" tee in-line flow	30 ft	4 ea	120 ft
54"x60" expander	5 ft	1 ea	5 ft
54" 45 bend	20 ft	2 ea	40 ft
54" 11.25 bend	10 ft	2 ea	20 ft
54" flap gate	15 ft	1 ea	15 ft
		Subtotal	241 ft

Barnes Butte Pumping Plant Retrofit (Replace existing pumps with new pumps)
Pump to Canal - System Curve C=135 Steel, C=110 Concrete

Q (gpm)	0	4,488	8,976	13,464	17,952	22,440	26,928	31,416	35,904	40,392	44,880	49,368	53,856	58,344	62,832	67,320	71,808	76,296
Q (cfs)	0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0	170.0
Hf	0.0	0.6	1.6	2.9	4.6	5.5	6.6	7.8	9.1	10.5	12.0	13.6	15.4	17.2	19.1	21.1	23.2	25.4
TDH (ft)	68.0	68.6	69.6	71.0	72.6	73.6	74.7	75.8	77.1	78.6	80.1	81.7	83.4	85.2	87.1	89.1	91.2	93.4
Vel. Disch. (fps)	0.0	0.6	1.3	1.9	2.5	3.1	3.8	4.4	5.0	5.7	6.3	6.9	7.5	8.2	8.8	9.4	10.1	10.7



A-C Pump 30x20 WSFD, Split Case, 710 RPM, 500 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	116	113	109	102	90	65	20											

(2) A-C Pump 30x20 WSFD

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	116	115	113	111	109	106	102	97	90	80	65	45	20					

A-C Pump 24X18S WSG, Split Case, 710 RPM, 300 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	125	122	111	82	45													

(2) A-C Pump 24X18S WSG

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	125	124	122	118	111	99	82	63	45									

(3) A-C Pump 24X18S WSG

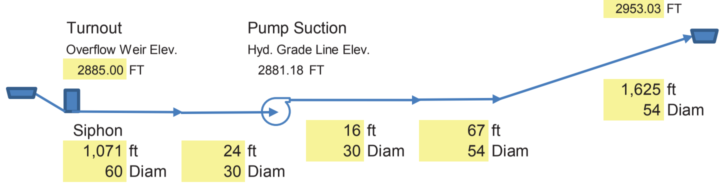
Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	125	124	123	122	119	116	111	103	93	82	71	60	45					

(2) A-C Pump 30x20 WSFD and (3) A-C Pump 24X18S WSG

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	125	124	123	122	119	116	115	114	113	111	109	107	105	102	99	95	91	86

Pump to Canal Head Loss Calculations
Barnes Butte Pumping Plant Retrofit (Replace existing pumps with new pumps)

17,300	GPM	Horizontal Split Case Pump No. 1		
17,300	GPM	Horizontal Split Case Pump No. 2		
11,700	GPM	Horizontal Split Case Pump No. 3	Static Head =	68.03 FT
11,700	GPM	Horizontal Split Case Pump No. 4		
11,700	GPM	Horizontal Split Case Pump No. 5		
69,700	GPM	Total = 155.3 cfs		



Diam. (Discharge Pipe) =	54 in
Total Discharge Pipe Length =	1,732 ft
Equiv. Pipe Length Valves & Fittings Pump Discharge =	91 ft
Equiv. Pipe Length Valves & Fittings Discharge Header =	241 ft

60" Siphon Pipe	Friction Head =	3.57 FT per 1,000 FT	Concrete
(Vel. = 7.9 fps)	Dynamic Head =	3.82 FT total	C = 110
30" Inlet Pipe	Friction Head =	5.40 FT per 1,000 FT	Steel
(Vel. = 7.9 fps)	Dynamic Head =	0.13 FT total	C = 135
30" Discharge Piping	Friction Head =	5.40 FT per 1,000 FT	Steel
(Vel. = 7.9 fps)	Dynamic Head =	0.09 FT total	C = 135
54" Header	Friction Head =	4.08 FT per 1,000 FT	Steel
(Vel. = 9.8 fps)	Dynamic Head =	0.27 FT total	C = 135
54" Discharge	Friction Head =	5.95 FT per 1,000 FT	Concrete
(Vel. = 9.8 fps)	Dynamic Head =	9.67 FT total	C = 110
Equivalent Pipe Length	Friction Head =	5.40 FT per 1,000 FT	Steel
Valves & Fittings Pump Discharge	Dynamic Head =	0.49 FT total	C = 135
Equivalent Pipe Length	Friction Head =	4.08 FT per 1,000 FT	Steel
Valves & Fittings Discharge Header	Dynamic Head =	0.98 FT total	C = 135
	Friction Head =	11.64 FT =	5.04 psi
	Water Depth in Discharge Canal =	5.47 FT =	2.37 psi
	Total Dynamic Head =	88.96 FT =	38.51 psi

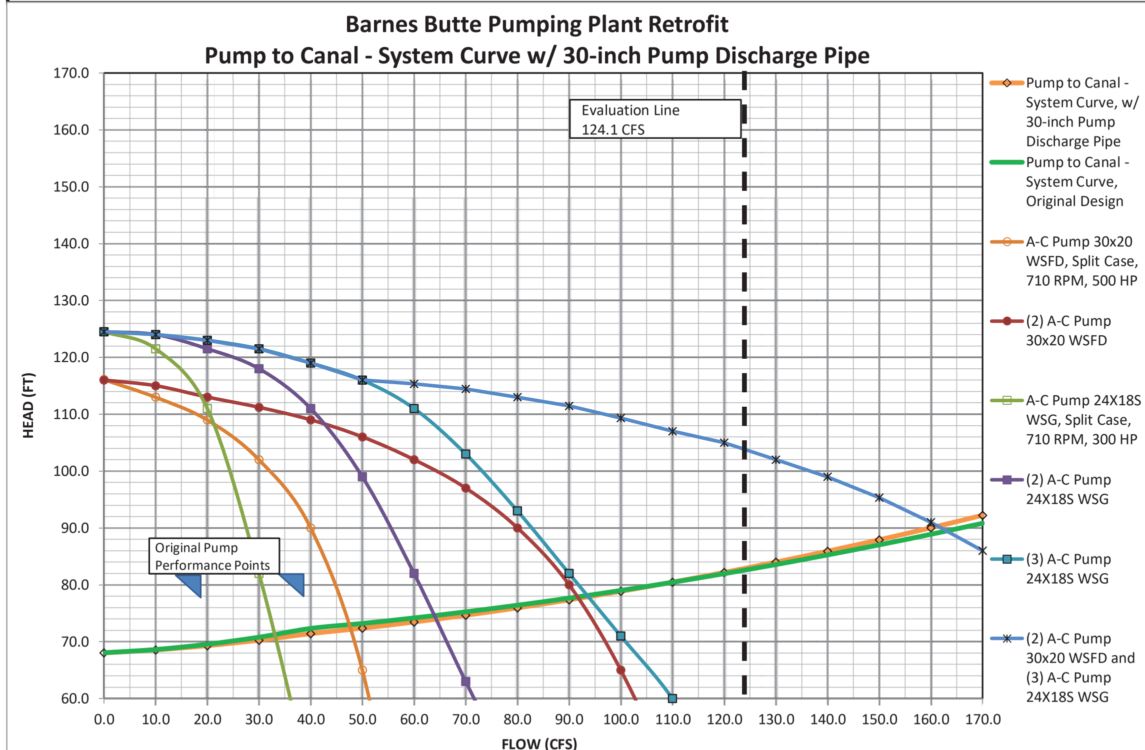
Equivalent Pipe Length Totals:

Item	30" Equiv. Length	No. of Units	Total Equiv. Length
60" to 30" square edged inlet	85 ft	1 ea	85 ft
30" pump isolation (gate) valve	3 ft	1 ea	3 ft
24" pump control (gate) valve	3 ft	1 ea	3 ft
		Subtotal	91 ft

Item	54" Equiv. Length	No. of Units	Total Equiv. Length
30"x54" tee branch flow	40 ft	1 ea	40 ft
54" flow meter	1 ft	1 ea	1 ft
54"x30" tee in-line flow	30 ft	4 ea	120 ft
54"x60" expander	5 ft	1 ea	5 ft
54" 45 bend	20 ft	2 ea	40 ft
54" 11.25 bend	10 ft	2 ea	20 ft
54" flap gate	15 ft	1 ea	15 ft
		Subtotal	241 ft

Barnes Butte Pumping Plant Retrofit (Replace existing pumps with new pumps)
Pump to Canal - System Curve, w/ 30-inch Pump Discharge Pipe

Q (gpm)	0	4,488	8,976	13,464	17,952	22,440	26,928	31,416	35,904	40,392	44,880	49,368	53,856	58,344	62,832	67,320	71,808	76,296
Q (cfs)	0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0	170.0
Hf	0.0	0.5	1.2	2.2	3.4	4.3	5.4	6.6	7.9	9.3	10.8	12.4	14.1	16.0	17.9	19.9	22.0	24.2
TDH (ft)	68.0	68.5	69.3	70.2	71.4	72.4	73.4	74.6	75.9	77.3	78.8	80.5	82.2	84.0	85.9	87.9	90.0	92.2
Vel. Disch. (fps)	0.0	0.6	1.3	1.9	2.5	3.1	3.8	4.4	5.0	5.7	6.3	6.9	7.5	8.2	8.8	9.4	10.1	10.7



A-C Pump 30x20 WSFD, Split Case, 710 RPM, 500 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	116	113	109	102	90	65	20											

(2) A-C Pump 30x20 WSFD

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	116	115	113	111	109	106	102	97	90	80	65	45	20					

A-C Pump 24X18S WSG, Split Case, 710 RPM, 300 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	125	122	111	82	45													

(2) A-C Pump 24X18S WSG

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	125	124	122	118	111	99	82	63	45									

(3) A-C Pump 24X18S WSG

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	125	124	123	122	119	116	111	103	93	82	71	60	45					

(2) A-C Pump 30x20 WSFD and (3) A-C Pump 24X18S WSG

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	125	124	123	122	119	116	115	114	113	111	109	107	105	102	99	95	91	86

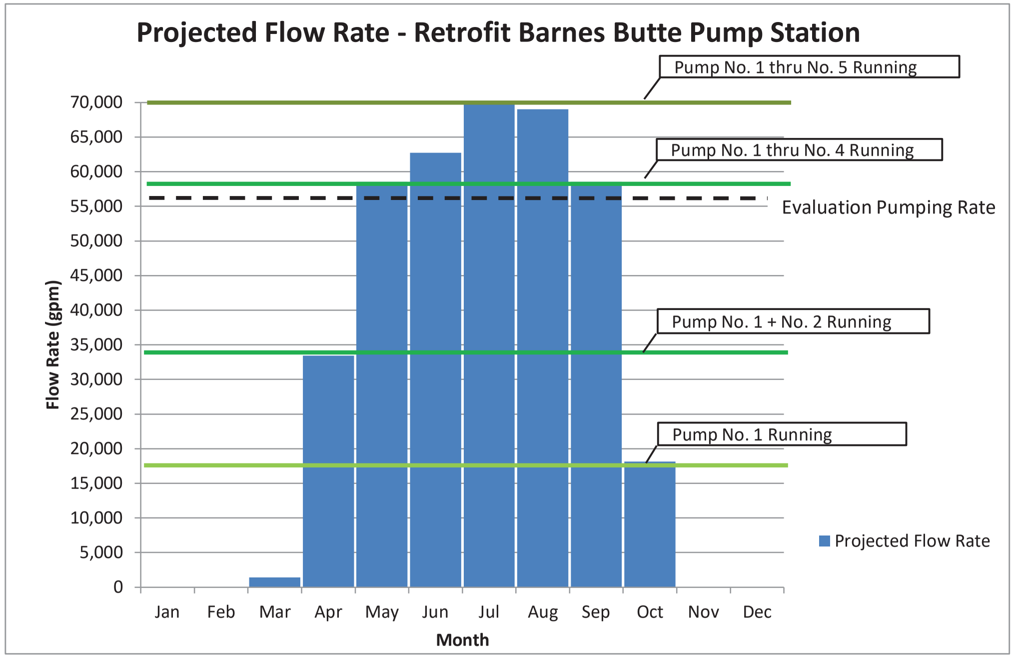
Pump to Canal Head Loss Calculations
Barnes Butte Pumping Plant Retrofit (Replace existing pumps with new pumps)

17,300	GPM	Horizontal Split Case Pump No. 1		
17,300	GPM	Horizontal Split Case Pump No. 2		
11,700	GPM	Horizontal Split Case Pump No. 3		
11,700	GPM	Horizontal Split Case Pump No. 4		
11,700	GPM	Horizontal Split Case Pump No. 5		
69,700	GPM	Total	=	155.3 cfs

Proposed PS Design Flow Rate = 69,700 gpm

Month	% of Max Flow Rate	Projected Flow Rate
Jan	0%	0
Feb	0%	0
Mar	2%	1,394
Apr	48%	33,456
May	84%	58,548
Jun	90%	62,730
Jul	100%	69,700
Aug	99%	69,003
Sep	84%	58,548
Oct	26%	18,122
Nov	0%	0
Dec	0%	0

Evaluation Pumping Rate = 55,700 gpm
124.1 cfs



Notes: Barnes Butte PS when fitted with (5) new Horizontal Split Case Pumps. VFD operation would not provide significant benefit toward reducing energy use and optimizing water delivery to crop requirement. Retrofit pumps can be selected at flow rates that promotes their combined use to reasonably match projected seasonal demand requirements.

Ochoco Irrigation District

Barnes Butte PS Retrofit (Replace existing pumps with new pumps)

Budget Level - Projection of Probable Construction Cost

Item No.	Spec Division	Description	Measurement	Units	Unit Cost	Total Cost
1	1000	Mobilization	LS	1	$84,000.00	$84,000.00
2	1000	Erosion Control	LS	1	$500.00	$500.00
3	1000	Watering / Dust Control	LS	1	$1,500.00	$1,500.00
4	1000	Construction Staking	LS	1	$1,500.00	$1,500.00
5	1000	Project Management and Coordination	LS	1	$4,250.00	$4,250.00
6	1000	Construction Progress Documentation	LS	1	$4,250.00	$4,250.00
7	1000	Submittal Procedures	LS	1	$4,250.00	$4,250.00
8	1000	Quality Requirements	LS	1	$4,250.00	$4,250.00
9	1000	Selective Demolition	LS	1	$28,000.00	$28,000.00
10	1000	Project Record Documents	LS	1	$4,250.00	$4,250.00
11	1000	Operations and Maintenance Data	LS	1	$4,250.00	$4,250.00
12	1000	General Commissioning Requirements	LS	1	$18,000.00	$18,000.00
13	2000	Erosion Control Silt Fence	LF	1,000	$2.40	$2,400.00
14	2000	Perimeter Fence, 8 ft coated wire chain link	LF	250	$18.00	$4,500.00
15	2000	Fence Gate	LS	1	$2,500.00	$2,500.00
16	2000	Dewatering	LS	1	$2,500.00	$2,500.00
17	2000	Bulk Excavation	CY	50	$7.00	$350.00
18	2000	Hauling	CY	50	$12.00	$600.00
19	2000	Structural Backfill	CY	50	$38.00	$1,900.00
20	2000	Aggregate Base	CY	10	$38.00	$380.00
21	2000	Surfacing Rock	CY	50	$38.00	$1,900.00
22	3000	Cast-in-Place Concrete	CY	10	$550.00	$5,500.00
23	3000	Misc Cast-in-Place Concrete (thrust and pads)	LS	1	$5,500.00	$5,500.00
24	9000	High Performance Coating Systems	LS	1	$15,000.00	$15,000.00
25	11000	Split Case Pump and Motor, 500 HP	EA	2	$200,000.00	$400,000.00
26	11000	Split Case Pump and Motor, 300 HP	EA	3	$110,000.00	$330,000.00
27	15000	30-inch Handwheel Operated Butterfly Valves	EA	2	$13,125.00	$26,250.00
28	15000	30-inch Discharge Pipe, Fittings, & Accessories	EA	2	$25,000.00	$50,000.00
29	15000	30-inch Electric Motor Operated Butterfly Valves	EA	2	$21,500.00	$43,000.00
30	15000	24-inch Handwheel Operated Butterfly Valves	EA	3	$4,750.00	$14,250.00
31	15000	24-inch Discharge Pipe, Fittings, & Accessories	EA	3	$20,000.00	$60,000.00
32	15000	24-inch Electric Motor Operated Butterfly Valves	EA	3	$15,800.00	$47,400.00
33	15000	Automatic Priming System	EA	1	$30,000.00	$30,000.00
34	16000	Power and Distribution	LS	1	$62,100.00	$62,100.00
35	16000	Grounding Systems	LS	1	$18,000.00	$18,000.00
36	16000	Conduit and Conductors	LS	1	$51,500.00	$51,500.00
37	16000	Motor Controls	LS	1	$271,300.00	$271,300.00
38	17000	Instrumentation and Control	LS	1	$75,000.00	$75,000.00
		Construction Subtotal				$1,680,830.00
		Contractors Overhead and Profit	10%	1	$168,083.00	$168,083.00
		Contractors Bonds and Insurance	2%	1	$36,978.26	$36,978.26
		Construction Contingency	30%	1	$504,249.00	$504,249.00
		Construction Total				$2,390,140.26
		Engineering, Administration	25%	1	$597,535.07	
		Total				**$2,987,675.33**

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Wire to Water Energy Calculator

Ochoco Irrigation District - SOR

Barnes Butte Pumping Plant Retrofit (Replacement of existing pump equipment)

Source: PumpTech Inc.

2425 SE Ochoco Street

Portland, OR 97222

503-659-6230

OPERATIONAL AND EQUIPMENT DATA

	Replacement Pumps		Existing Pumps	
	No. 1 - A-C Pump 30X20 WSFD, horiz. split case, double suction, 710 RPM, 500 HP *		No. 1 - Pellizzari A600/750, Split Case, 720 RPM, 500 HP *	
	No. 2 - A-C Pump 30X20 WSFD, horiz. split case, double suction, 710 RPM, 500 HP *		No. 2 - Pellizzari A600/750, Split Case, 720 RPM, 500 HP *	
	No. 3 - A-C Pump 24X18S WSG, horiz. split case, double suction, 710 RPM, 300 HP *		No. 3 - Pellizzari A400/500, Split Case, 880 RPM, 250 HP *	
	No. 4 - A-C Pump 24X18S WSG, horiz. split case, double suction, 710 RPM, 300 HP *		No. 4 - Pellizzari A400/500, Split Case, 880 RPM, 250 HP *	
	No. 5 - A-C Pump 24X18S WSG, horiz. split case, double suction, 710 RPM, 300 HP *		No. 5 - Wilson Snyder 16BAZ, Split Case, 880 RPM, 300 HP	
Pump Operation - Hours / Day	24		24	
Pump Operation - Days / Year	198		198	
Pump Flow - GPM (Evaluation Pump Rate)	55,700		55,700	
Pump Flow - CFS	124.1		124.1	
Total Annual Volume - Acre feet	48,740		48,740	
Pump Head - Feet	82.9	**	84.0	
Ave. Pump Efficiency - %	88.5%		77.1%	**
Ave. Motor Efficiency - %	96.3%		95.5%	***
Energy Cost in $/kWH	$0.035		$0.035	

Replacement Pumps notes:

* Pump Replacement includes replacement of pump inlet piping, pumps, pump outlet piping, pump control valves, pump motor, motor starters, and electrical service entrance at the existing pump station footprint.

** Pumping head assumes pump discharge piping and valves increased in size from 24-inch to 30-inch.

Existing Pumps notes:

* Pump Make and model per original construction submittals, 1963

** Pump efficiency estimated to be the average of minimum values recorded on Initial Pump Evaluation test data. Data includes points showing efficiency of pumps greater than construction submittal efficiency curves.

*** Average of motor efficiency values recorded on Initial Pump Evaluation test data.

RESULTS

	Replacement Pumps	Existing Pumps
BHP At Design Point	1,316.8	1,532.4
Wire to Water Efficiency - %	85%	74%
KW per Year	4,847,281	5,688,487
Annual Energy Cost	$169,654.85	$199,097.06
KW Per 1,000 Gallons Pumped	0.305	0.358
Cost Per 1,000 Gallons Pumped	$0.011	$0.013
kWh per Acre Foot Pumped	99	117
Cost Per Acre Foot Pumped	$3.48	$4.08

PAYBACK

Annual Savings - kW	841,206
Annual Savings - $$	$29,442.22
Annual Savings - %	14.79%
Cost of Replacement Pumps *	$2,988,000.00
Cost of Existing Pumps	$0.00
Payback - Years	101

* Pump Replacement includes replacement of pump inlet piping, pumps, pump outlet piping, pump control valves, pump motor, motor starters, and electrical service entrance at the existing pump station footprint.

Pump Test Data

Initial Pump Evaluation

Project No.: OCHID-04-10 **Description:** Discharge 2.61 ft above Intake pressure gauge

Pump Station No.: Main Lift **Pump No.:** 1 **Water Source:** Canal **Parallel**

Motor Nameplate

Motor Make: Pellizzari
Model No: APS7000/10
Serial No:
Rated Hp: 500
Rated Voltage: 2300
Rated Amperage: 100 **Ins. Class:** None
Full Load RPM: 720 **Code:** None
Enclosure: None
Design: None
Frame:
Service Factor: 1.15

Utility Meter Nameplate

Make: None **Meter ID:** 35 695 918
Type: Digital **Serial No.:** X9D035695918345K
k_h: 1.2 **PTR:** 120 **CTR:** 15

Pump Nameplate

Pump Make: Pellizzari
Type: Split-Case Centrifugal
Serial No: 275183
Model No: A600/750 **Impeller No:**
Impeller Dia (in): 19.250 **No. of Stages:** 1
Impeller Dia (in): **No. of Stages:** 0
Secondary Model No: None **Impeller No:**
Impeller Dia (in): **No. of Stages:** 0
Impeller Dia (in): **No. of Stages:** 0
Rated Flow (gpm): 17300
Rated Head (ft): 82
Rated RPM: 720
Column Dia (in): 0.00
Column Length (ft): 0.0
Shaft Dia (in): 0.000
Tube Dia (in): 0.000
Thrust Factor (lbs/ft): 0.0
Impeller Wt. (lbs): 0.0

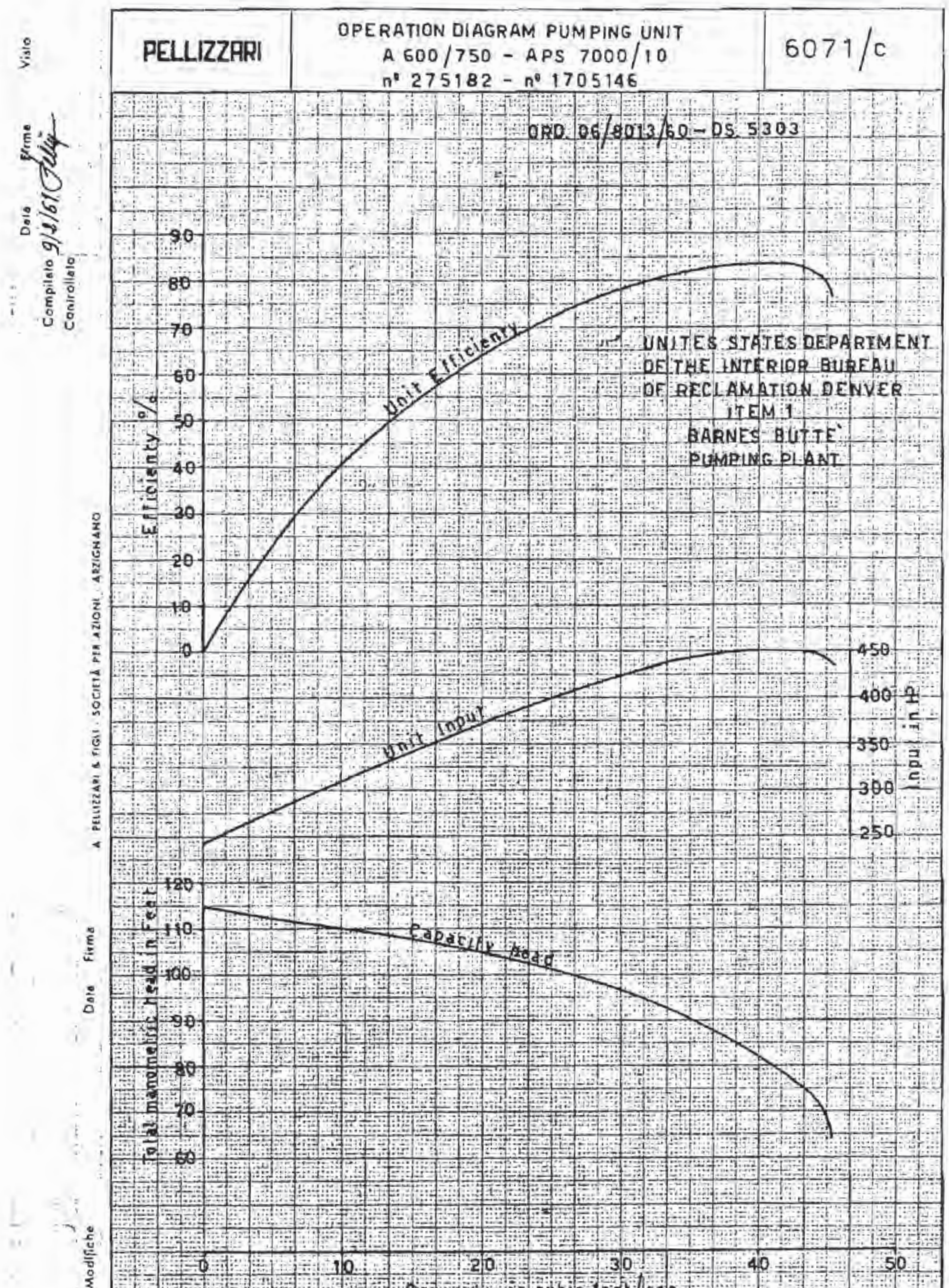
Field Pump Test Data

Test No.	Date	Flow Measurement Device	Flow (gpm)	Pressures Intake (PSI)	Pressures Discharge (PSI)	Pressures Delivered (PSI)	Misc. Losses (ft)	TDH (ft)	Pump RPM
1-1	10/14/201	Transit Time	17,431	-3.5	27.1	27.1	1.5	72.2	
1-2	10/14/201	Transit Time	19,500	-3.5	27.1	27.1	1.9	72.6	

Test No.	Voltages 1-2	1-3	2-3	Avg.	Amperages 1	2	3	Avg.	Power Factor 1	2	3	Avg.	Utility Meter Rev.	Sec.	Motor RPM	% Load
1-1	2300.0	2300.0	2300.0	2300.0	64.5	62.0	66.0	64.2	100.0%			100.0%	5	125.6	720	79.9%
1-2	2300.0	2300.0	2300.0	2300.0	64.5	62.0	66.0	64.2	100.0%			100.0%	5	125.6	720	79.9%

Test No.	Power Calculations Shaft HP	Thrust HP	Water HP	Brake HP	Pump HP	Input kW	Input HP	Utility Meter (kW)	Efficiencies Motor	Pump	Discharge	Delivered
1-1	0.00	0.00	317.8	399.5	399.5	309.6	414.9	309.6	96.3%	79.6%	76.6%	76.6%
1-2	0.00	0.00	357.5	399.5	399.5	309.6	414.9	309.6	96.3%	89.5%	86.2%	86.2%

Note: If a main valve is present, the Delivered Pressure is the pressure after the valve. If no main valve is present, the Delivered Pressure will be the same as the Discharge Pressure.



PELLIZZARI
OPERATION DIAGRAM PUMPING UNIT
A 600/750 - APS 7000/10
n° 275182 - n° 1705146
6071/c
ORD. 06/8013/60 - DS. 5303
UNITES STATES DEPARTMENT
OF THE INTERIOR BUREAU
OF RECLAMATION DENVER
ITEM 1
BARNES BUTTE
PUMPING PLANT
Unit Efficienry
Efficienty %
Unit Input
Unit Input
Capacity head
Total manometric head in Feet
Capacity in cubic feet/sec
Compilato 9/3/61
Controllato
Data
Firma
Visto
Modifiche
A. PELLIZZARI & FIGLI - SOCIETÀ PER AZIONI - ARZIGNANO

Pump Test Data

Initial Pump Evaluation

Project No.: OCHID-04-10 **Description:** Use Test 2-2

Pump Station No.: Main Lift **Pump No.:** 2 **Water Source:** Canal **Parallel**

Motor Nameplate

Motor Make:	Pellizzari		
Model No:	APS7000/10		
Serial No:			
Rated Hp:	500		
Rated Voltage:	2300		
Rated Amperage:	100	**Ins. Class:**	None
Full Load RPM:	720	**Code:**	None
Enclosure:	None		
Design:	None		
Frame:			
Service Factor:	1.15		

Utility Meter Nameplate

Make:	None		**Meter ID:**	35 695 918	
Type:	Digital	**Serial No.:**	X9D035695918345K		
k_h**:**	1.2	**PTR:**	120	**CTR:**	15

Pump Nameplate

Pump Make:	Pellizzari		
Type:	Split-Case Centrifugal		
Serial No:	275182		
Model No:	A600/750	**Impeller No:**	
Impeller Dia (in):	19.250	**No. of Stages:**	1
Impeller Dia (in):		**No. of Stages:**	0
Secondary Model No:	None	**Impeller No:**	
Impeller Dia (in):		**No. of Stages:**	0
Impeller Dia (in):		**No. of Stages:**	0
Rated Flow (gpm):	17300		
Rated Head (ft):	82		
Rated RPM:	720		
Column Dia (in):	0.00		
Column Length (ft):	0.0		
Shaft Dia (in):	0.000		
Tube Dia (in):	0.000		
Thrust Factor (lbs/ft):	0.0		
Impeller Wt. (lbs):	0.0		

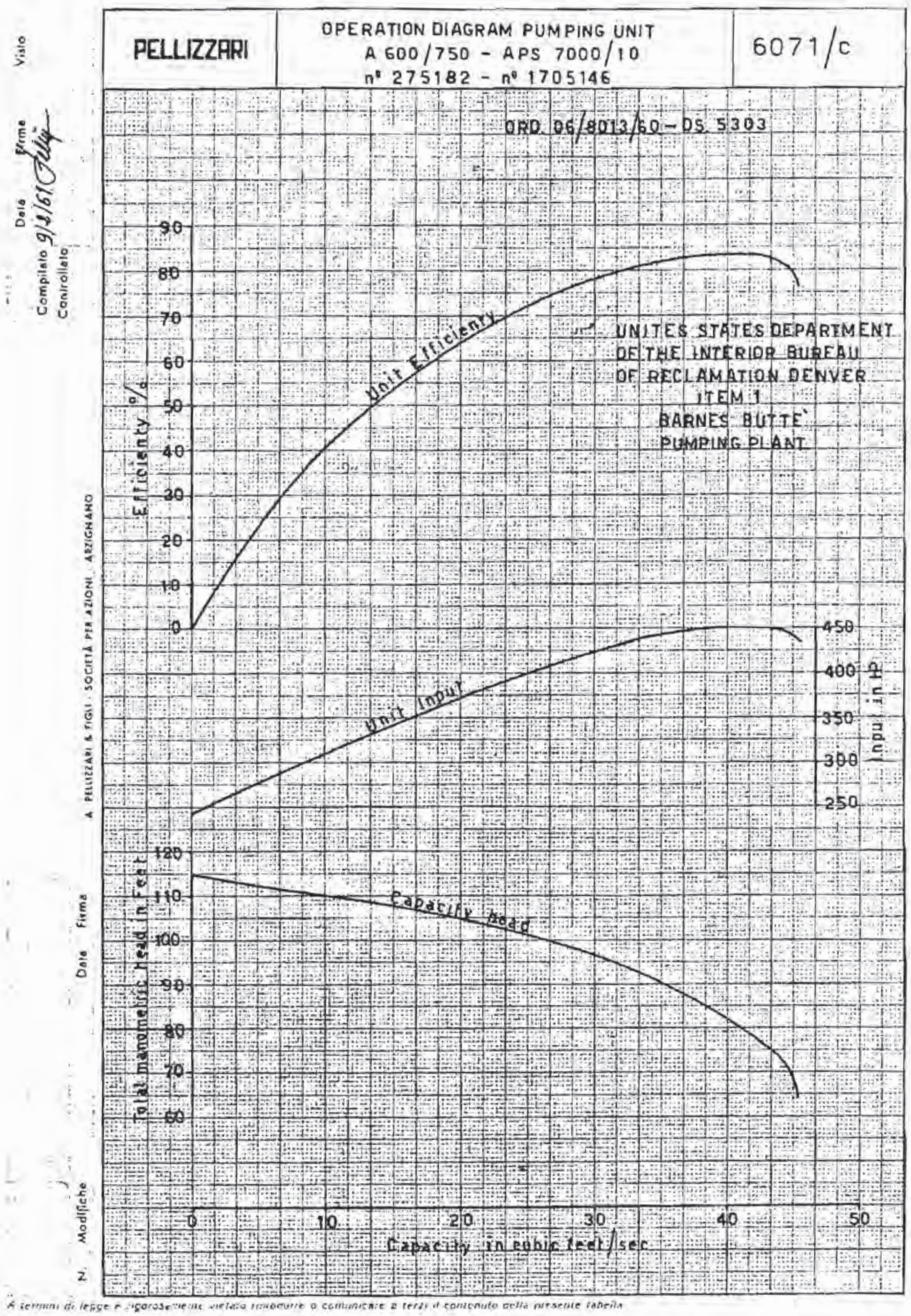
Field Pump Test Data

Test No.	Date	Flow Measurement Device	Flow (gpm)	Pressures Intake (PSI)	Discharge (PSI)	Delivered (PSI)	Misc. Losses (ft)	TDH (ft)	Pump RPM
2-1	10/14/201	Transit Time	16,633	-3.7	28.1	28.1	1.4	74.9	720
2-2	10/14/201	Dye Transit-Time	18,600	-3.7	28.1	28.1	1.7	75.2	720

Test No.	Voltages 1-2	1-3	2-3	Avg.	Amperages 1	2	3	Avg.	Power Factor 1	2	3	Avg.	Utility Meter Rev.	Sec.	Motor RPM	% Load
2-1	2300.0	2300.0	2300.0	2300.0	65.0		65.0	65.0	100.0%			100.0%	5	126.3	900	79.4%
2-2	2300.0	2300.0	2300.0	2300.0	65.0		65.0	65.0	100.0%			100.0%	5	126.3		79.4%

Test No.	Power Calculations Shaft HP	Thrust HP	Water HP	Brake HP	Pump HP	Input kW	Input HP	Utility Meter (kW)	Efficiencies Motor	Pump	Discharge	Delivered
2-1	0.00	0.00	314.6	397.2	397.2	307.8	412.5	307.8	96.3%	79.2%	76.2%	76.2%
2-2	0.00	0.00	353.2	397.2	397.2	307.8	412.5	307.8	96.3%	88.9%	85.6%	85.6%

Note: If a main valve is present, the Delivered Pressure is the pressure after the valve. If no main valve is present, the Delivered Pressure will be the same as the Discharge Pressure.


PELLIZZARI
OPERATION DIAGRAM PUMPING UNIT
A 600/750 - APS 7000/10
n° 275182 - n° 1705146
6071/c
ORD. 06/8013/60 - DS. 5303
UNITES STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION DENVER
ITEM 1
BARNES BUTTE
PUMPING PLANT
Unit Efficienty
Efficienty %
Unit Input
Unit Input
Capacity head
Total manometric head in Feet
Capacity in cubic feet/sec
0
10
20
30
40
50
60
70
80
90
100
110
120
250
300
350
400
450
Compilato
Controllato
Data
Firme
Visto
9/3/61
Modifiche
A. PELLIZZARI & FIGLI - SOCIETÀ PER AZIONI - ARZIGNANO
A termini di legge è rigorosamente vietato riprodurre o comunicare a terzi il contenuto della presente tabella

Pump Test Data

Initial Pump Evaluation

Project No.: OCHID-04-10 **Description:**

Pump Station No.: Main Lift **Pump No.:** 3 **Water Source:** Canal

Motor Nameplate

Motor Make:	Pellizzari		
Model No:	APS3000/8		
Serial No:			
Rated Hp:	250		
Rated Voltage:	2300		
Rated Amperage:	50	**Ins. Class:**	None
Full Load RPM:	900	**Code:**	None
Enclosure:	None		
Design:	None		
Frame:			
Service Factor:	1.15		

Utility Meter Nameplate

Make:	None	**Meter ID:**	35 695 918		
Type:	Digital	**Serial No.:**	X9D035695918345K		
k_h:	1.2	**PTR:**	120	**CTR:**	15

Pump Nameplate

Pump Make:	Pellizzari		
Type:	Split-Case Centrifugal		
Serial No:	275184		
Model No:	A400/500	**Impeller No:**	
Impeller Dia (in):		**No. of Stages:**	1
Impeller Dia (in):		**No. of Stages:**	0
Secondary Model No:	None	**Impeller No:**	
Impeller Dia (in):		**No. of Stages:**	0
Impeller Dia (in):		**No. of Stages:**	0
Rated Flow (gpm):	8640		
Rated Head (ft):	82		
Rated RPM:	900		
Column Dia (in):	0.00		
Column Length (ft):	0.0		
Shaft Dia (in):	0.000		
Tube Dia (in):	0.000		
Thrust Factor (lbs/ft):	0.0		
Impeller Wt. (lbs):	0.0		

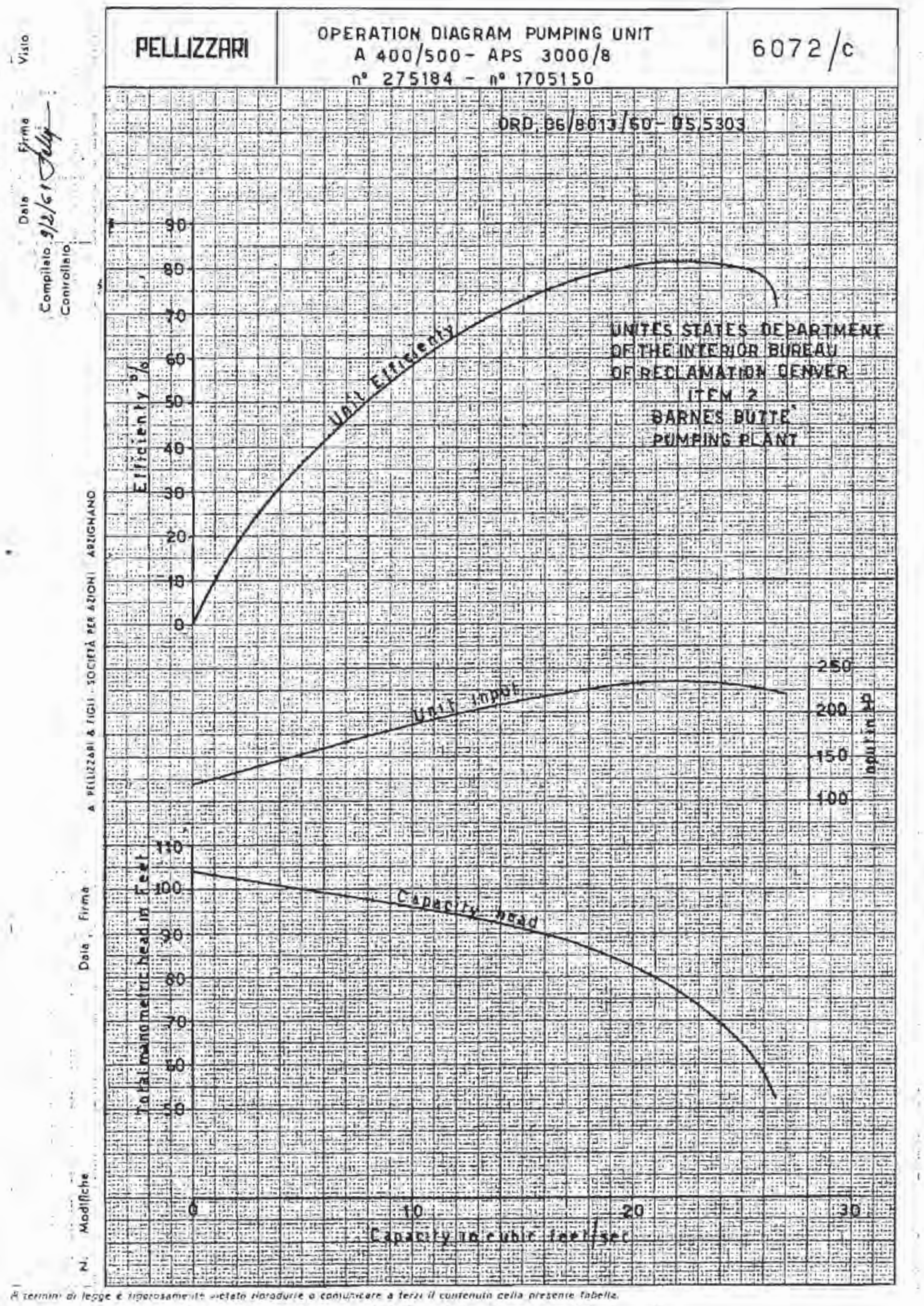
Field Pump Test Data

Test No.	Date	Flow: Measurement Device	Flow (gpm)	Pressures: Intake (PSI)	Discharge (PSI)	Delivered (PSI)	Misc. Losses (ft)	TDH (ft)	Pump RPM
3-1	10/14/201	Transit Time	9,460	-3.5	28.1	28.1	2.4	75.4	900

Test No.	Voltages 1-2	1-3	2-3	Avg.	Amperages 1	2	3	Avg.	Power Factor 1	2	3	Avg.	Utility Meter Rev.	Sec.	Motor RPM	% Load
3-1	2300.0	2300.0	2300.0	2300.0	19.5	20.1	19.2	19.6	100.0%			100.0%	2	104.3	900	76.9%

Test No.	Power Calculations: Shaft HP	Thrust HP	Water HP	Brake HP	Pump HP	Input kW	Input HP	Utility Meter (kW)	Efficiencies: Motor	Pump	Discharge	Delivered
3-1	0.00	0.00	180.1	192.4	192.4	149.1	199.8	149.1	96.3%	95.2%	91.7%	91.7%

Note: If a main valve is present, the Delivered Pressure is the pressure after the valve. If no main valve is present, the Delivered Pressure will be the same as the Discharge Pressure.


PELLIZZARI
OPERATION DIAGRAM PUMPING UNIT
A 400/500 - APS 3000/8
n° 275184 - n° 1705150
6072/c
ORD. 06/8013/60 - D5.5303
UNITES STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION DENVER
ITEM 2
BARNES BUTTE PUMPING PLANT
Unit Efficiency
Efficiency %
0
10
20
30
40
50
60
70
80
90
Unit input
100
150
200
250
Capacity head
Total manometric head in Feet
50
60
70
80
90
100
110
0
10
20
30
Capacity in cubic feet/sec
Compilato
Controllato
Data
Firma
Visto
Modifiche
A. PELLIZZARI & FIGLI - SOCIETÀ PER AZIONI - ARZIGNANO
A termini di legge è rigorosamente vietato riprodurre o comunicare a terzi il contenuto della presente tabella.

Pump Test Data

Initial Pump Evaluation

Project No.: OCHID-04-10 **Description:** Use Test 4-2

Pump Station No.: Main Lift **Pump No.:** 4 **Water Source:** Canal **Parallel**

Motor Nameplate

Motor Make:	Pellizzari		
Model No:	APS3000/8		
Serial No:			
Rated Hp:	250		
Rated Voltage:	2300		
Rated Amperage:	50	**Ins. Class:**	None
Full Load RPM:	900	**Code:**	None
Enclosure:	None		
Design:	None		
Frame:			
Service Factor:	1.15		

Pump Nameplate

Pump Make:	Pellizzari		
Type:	Split-Case Centrifugal		
Serial No:	275185		
Model No:	A400/500	**Impeller No:**	
Impeller Dia (in):		**No. of Stages:**	1
Impeller Dia (in):		**No. of Stages:**	0
Secondary Model No:	None	**Impeller No:**	
Impeller Dia (in):		**No. of Stages:**	0
Impeller Dia (in):		**No. of Stages:**	0
Rated Flow (gpm):	8640		
Rated Head (ft):	82		
Rated RPM:	900		
Column Dia (in):	0.00		
Column Length (ft):	0.0		
Shaft Dia (in):	0.000		
Tube Dia (in):	0.000		
Thrust Factor (lbs/ft):	0.0		
Impeller Wt. (lbs):	0.0		

Utility Meter Nameplate

Make:	None	**Meter ID:**	35 695 918		
Type:	Digital	**Serial No.:**	X9D035695918345K		
k_h:	1.2	**PTR:**	120	**CTR:**	15

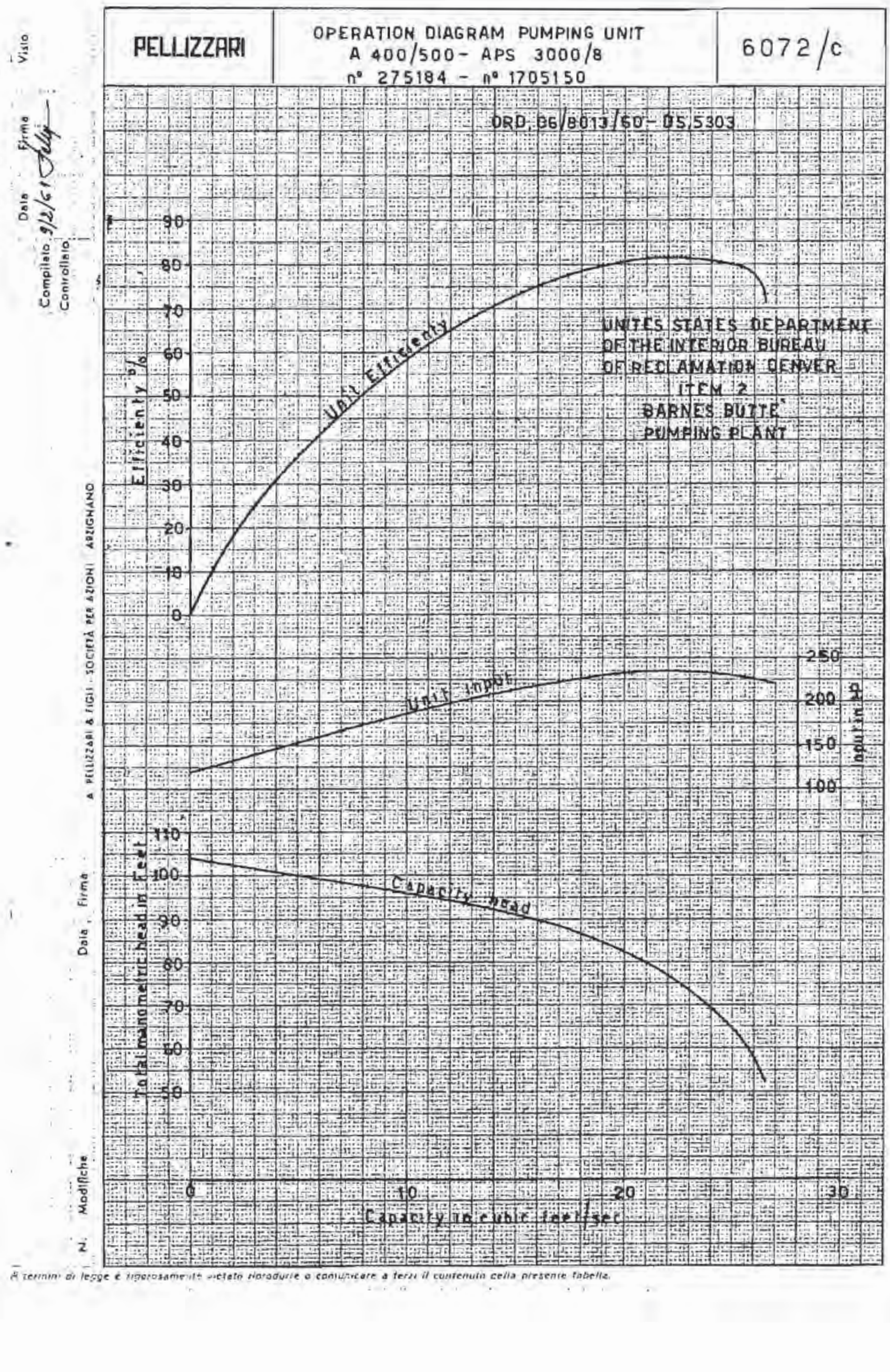
Field Pump Test Data

Test No.	Date	Flow Measurement Device	Flow (gpm)	Pressures Intake (PSI)	Pressures Discharge (PSI)	Pressures Delivered (PSI)	Misc. Losses (ft)	TDH (ft)	Pump RPM
4-1	10/14/201	Transit Time	8,117	-3.3	28.1	28.1	1.7	74.3	900
4-2	10/14/201	Dye Transit-Time	7,910	-3.3	28.1	28.1	1.6	74.2	

Test No.	Voltages 1-2	Voltages 1-3	Voltages 2-3	Voltages Avg.	Amperages 1	Amperages 2	Amperages 3	Amperages Avg.	Power Factor 1	Power Factor 2	Power Factor 3	Power Factor Avg.	Utility Meter Rev.	Utility Meter Sec.	Motor RPM	Motor % Load
4-1	2300.0	2300.0	2300.0	2300.0	19.0		18.0	18.5	100.0%			100.0%	2	106.8	900	75.2%
4-2	2400.0	2400.0	2400.0	2400.0	19.0		18.0	18.5	100.0%			100.0%	2	106.8	900	75.2%

Test No.	Power Calculations Shaft HP	Thrust HP	Water HP	Brake HP	Pump HP	Input kW	Input HP	Utility Meter (kW)	Efficiencies Motor	Pump	Discharge	Delivered
4-1	0.00	0.00	152.3	188.1	188.1	145.6	195.1	145.6	96.4%	82.0%	79.1%	79.1%
4-2	0.00	0.00	148.2	188.1	188.1	145.6	195.1	145.6	96.4%	79.8%	76.9%	76.9%

Note: If a main valve is present, the Delivered Pressure is the pressure after the valve. If no main valve is present, the Delivered Pressure will be the same as the Discharge Pressure.


PELLIZZARI
OPERATION DIAGRAM PUMPING UNIT
A 400/500- APS 3000/8
n° 275184 - n° 1705150
6072/c
ORD. 06/8013/60- D5.5303
UNITES STATES DEPARTMENT
OF THE INTERIOR BUREAU
OF RECLAMATION DENVER
ITEM 2
BARNES BUTTE
PUMPING PLANT
Unit Efficiency
Efficiency %
Unit input
Input in HP
Capacity head
Total manometric head in Feet
Capacity in cubic feet/sec
Compilato
Controllato
Data
Firma
Visto
Modifiche
A. PELLIZZARI & FIGLI - SOCIETÀ PER AZIONI ARZIGNANO
A termini di legge è rigorosamente vietato riprodurre o comunicare a terzi il contenuto della presente tabella.

Pump Test Data

Initial Pump Evaluation

Project No.: OCHID-04-10 **Description:** Intake PSI is estimated at point of connection

Pump Station No.: Main Lift **Pump No.:** 5 **Water Source:** Canal **Parallel**

Motor Nameplate

Motor Make:	None		
Model No:			
Serial No:			
Rated Hp:	300		
Rated Voltage:	2300		
Rated Amperage:		**Ins. Class:**	None
Full Load RPM:	880	**Code:**	None
Enclosure:	None		
Design:	None		
Frame:			
Service Factor:	1.15		

Utility Meter Nameplate

Make:	None	**Meter ID:**	35 695 918		
Type:	Digital	**Serial No.:**	X9D035695918345K		
k_h:	1.2	**PTR:**	120	**CTR:**	15

Pump Nameplate

Pump Make:	Wilson-Snyder		
Type:	Split-Case Centrifugal		
Serial No:	16BAZ		
Model No:	None	**Impeller No:**	
Impeller Dia (in):		**No. of Stages:**	0
Impeller Dia (in):		**No. of Stages:**	0
Secondary Model No:	None	**Impeller No:**	
Impeller Dia (in):		**No. of Stages:**	0
Impeller Dia (in):		**No. of Stages:**	0
Rated Flow (gpm):	9000		
Rated Head (ft):	94		
Rated RPM:	880		
Column Dia (in):	0.00		
Column Length (ft):	0.0		
Shaft Dia (in):	0.000		
Tube Dia (in):	0.000		
Thrust Factor (lbs/ft):	0.0		
Impeller Wt. (lbs):	0.0		

Field Pump Test Data

Test No.	Date	Flow Measurement Device	Flow (gpm)	Pressures Intake (PSI)	Discharge (PSI)	Delivered (PSI)	Misc. Losses (ft)	TDH (ft)	Pump RPM
5-1	10/14/201	Dye Transit-Time	9,037	-3.3	27.4	27.4	3.6	74.6	900

Test No.	Voltages 1-2	1-3	2-3	Avg.	Amperages 1	2	3	Avg.	Power Factor 1	2	3	Avg.	Utility Meter Rev.	Sec.	Motor RPM	% Load
5-1													3	114.0	884	84.5%

Test No.	Power Calculations Shaft HP	Thrust HP	Water HP	Brake HP	Pump HP	Input kW	Input HP	Utility Meter (kW)	Efficiencies Motor	Pump	Discharge	Delivered
5-1	0.00	0.00	170.2	253.6	253.6	204.6	274.2	204.6	92.5%	67.1%	62.1%	62.1%

Note: If a main valve is present, the Delivered Pressure is the pressure after the valve. If no main valve is present, the Delivered Pressure will be the same as the Discharge Pressure.

Pump Test Summary Data

Project No.: OCHID-04-10

Pump Station	Pump No.	Condition	Test No.	Include	Rated Hp	Flow (gpm)	Intake (PSI)	Discharge (PSI)	Delivery (PSI)	TDH (FT)	Electric Hp	Pump Eff.	Overall Eff.
Main Lift	1	Existing	1-1		500	17,431	-3.5	27.1	27.1	73.3	414.9	79.6%	76.6%
Main Lift	1	Existing	1-2	X	500	19,500	-3.5	27.1	27.1	73.9	414.9	89.5%	86.2%
Main Lift	2	Existing	2-1		500	16,633	-3.7	28.1	28.1	75.8	412.5	79.2%	76.2%
Main Lift	2	Existing	2-2	X	500	18,600	-3.7	28.1	28.1	76.4	412.5	88.9%	85.6%
Main Lift	3	Existing	3-1		250	9,460	-3.5	28.1	28.1	77.0	199.8	95.2%	91.7%
Main Lift	4	Existing	4-1		250	8,117	-3.3	28.1	28.1	75.5	195.1	82.0%	79.1%
Main Lift	4	Existing	4-2	X	250	7,910	-3.3	28.1	28.1	75.3	195.1	79.8%	76.9%
Main Lift	5	Existing	5-1		300	9,037	-3.3	27.4	27.4	76.1	274.2	68.2%	63.1%

Model: 9800	Size: 30X20 WSFD	60Hz	RPM: 710	Stages: 1

Job/Inq.No. : Ochoco Irrigation District

Purchaser : Retrofit (Replacement) Pumps 1 and 2

End User : 17,300 gpm @ 90.05 — Issued by :

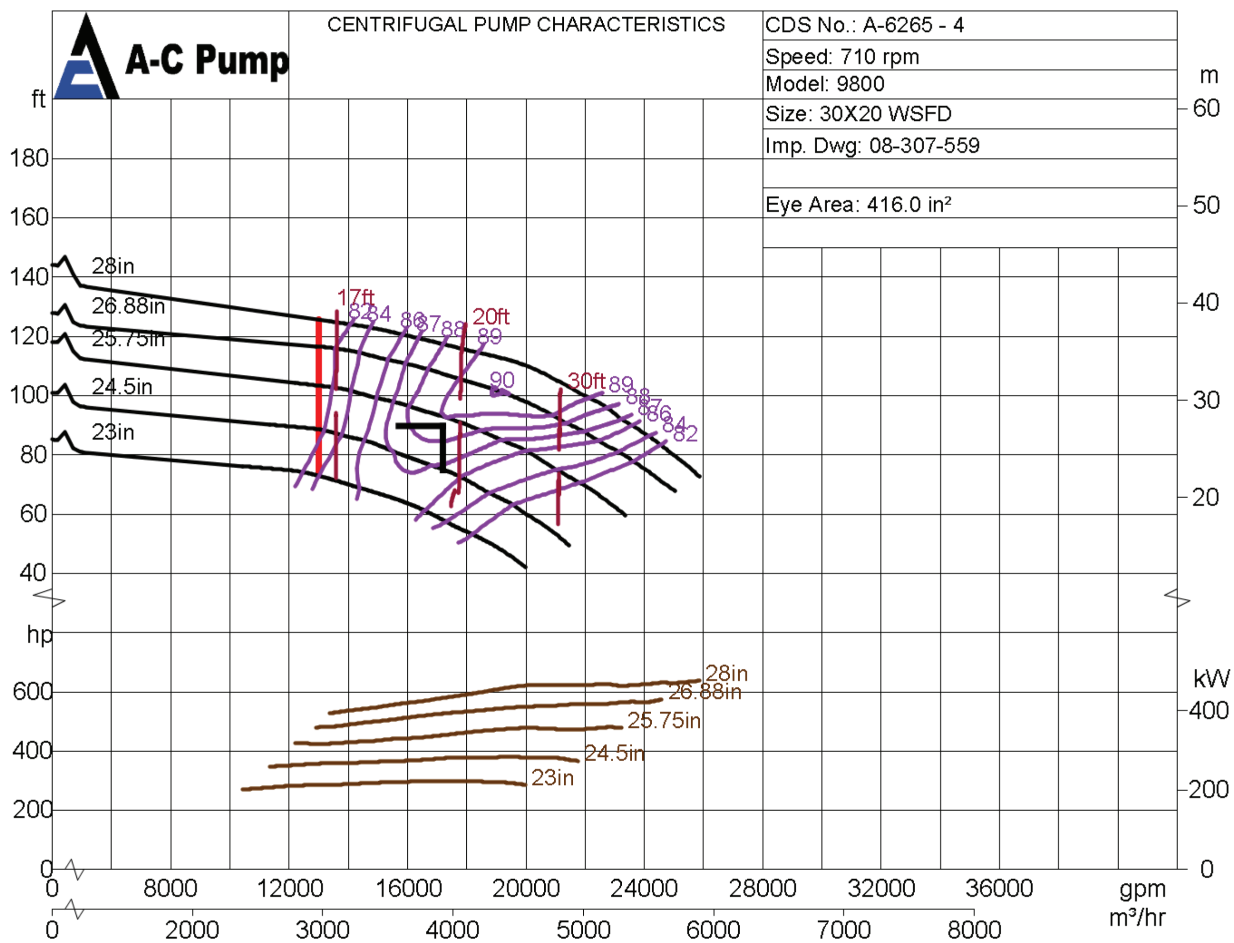
Item/Equip.No. : Replacement Pump No. 1 , and No. 2 — Quotation No. : OID - SOR BARNES BUTTE PS — Date : 06/16/2011

Service : Irrigation Water

Order No. : — Rev. : 0

Operating Conditions		Pump Performance			
Liquid:	Water	Published Efficiency:	88.5 %	Suction Specific Speed:	8,519 gpm(US) ft
Temp.:	70.0 deg F	Rated Pump Efficiency:	88.5 %	Min. Hydraulic Flow:	13,000.0 gpm
S.G./Visc.:	1.000/1.000 cp	Rated Total Power:	447.4 hp	Min. Thermal Flow:	N/A
Flow:	17,300.0 gpm	Non-Overloading Power:	470.9 hp		
TDH:	90.0 ft	Imp. Dia. First 1 Stg(s):	25.6250 in		
NPSHa:	19.7 ft	NPSHr:	19.1 ft		
Solid size:		Shut off Head:	116.1 ft		
% Susp. Solids (by wtg):		Vapor Press:			
Max. Solids Size:	2.3800 in				

Notes: 1.The Mechanical seal increased drag effect on power and efficiency is not included, unless the correction is shown in the appropriate field above. 2. Magnetic drive eddy current and viscous effect on power and efficiency is not included. 3. Elevated temperature effects on performance are not included. 4. Non Overloading power does not reflect v-belt/gear losses.



Model: 9800	Size: 24X18S WSG	60Hz	RPM: 710	Stages: 1

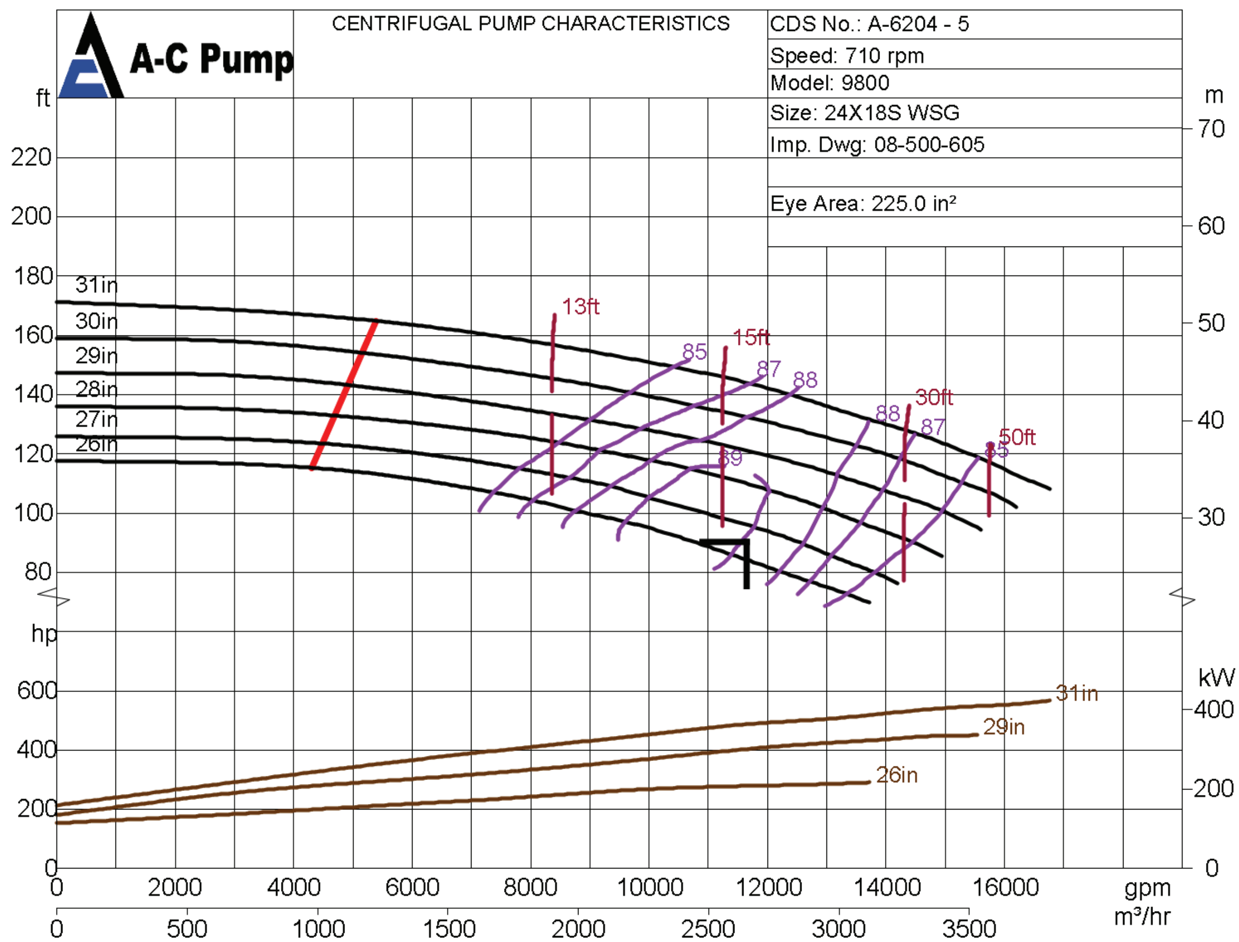
Job/Inq.No. :	Ochoco Irrigation District				
Purchaser :	Retrofit (Replacement) Pumps 3, 5 and 5				
End User :	11,700 gpm @ 90.05	Issued by :			
Item/Equip.No. :	Replacement Pump No. 3 , No. 4 and No. 5	Quotation No. :	OID - SOR BARNES BUTTE PS	Date :	06/16/2011
Service :	Irrigation Water				
Order No. :				Rev. :	0

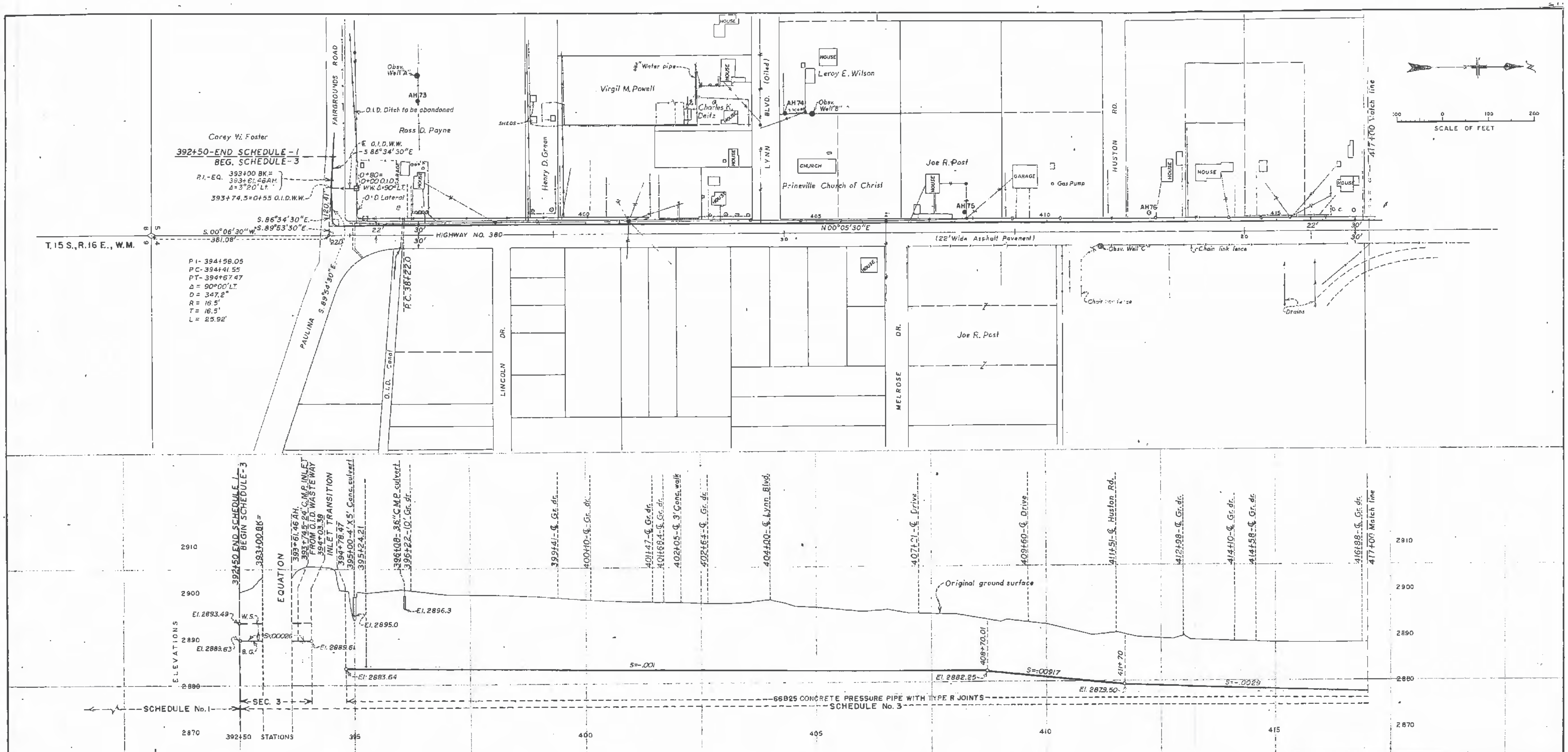
Operating Conditions		**Pump Performance**			
Liquid:	Water	Published Efficiency:	88.5 %	Suction Specific Speed:	8,484 gpm(US) ft
Temp.:	70.0 deg F	Rated Pump Efficiency:	88.5 %	Min. Hydraulic Flow:	4,442.5 gpm
S.G./Visc.:	1.000/1.000 cp	Rated Total Power:	303.7 hp	Min. Thermal Flow:	N/A
Flow:	11,700.0 gpm	Non-Overloading Power:	313.1 hp		
TDH:	90.0 ft	Imp. Dia. First 1 Stg(s):	26.6250 in		
NPSHa:	19.7 ft	NPSHr:	15.6 ft		
Solid size:		Shut off Head:	122.8 ft		
% Susp. Solids (by wtg):		Vapor Press:			
Max. Solids Size:	2.3800 in				

Notes: 1.The Mechanical seal increased drag effect on power and efficiency is not included, unless the correction is shown in the appropriate field above. 2. Magnetic drive eddy current and viscous effect on power and efficiency is not included. 3. Elevated temperature effects on performance are not included. 4. Non Overloading power does not reflect v-belt/gear losses.

CENTRIFUGAL PUMP CHARACTERISTICS

CDS No.: A-6204 - 5	
Speed: 710 rpm	
Model: 9800	
Size: 24X18S WSG	
Imp. Dwg: 08-500-605	
Eye Area: 225.0 in²	





NOTES

Stations and elevations shown on plan and profile refer to invert, unless otherwise shown.
Backfill about top of siphon as directed, 3.5' Min. unless otherwise shown.
Stations and elevations of P.I.'s are to be considered approximate only, and may be adjusted according to actual laying length of pipe.
Additional notes will be found on 113-D-175.

REFERENCE DRAWINGS

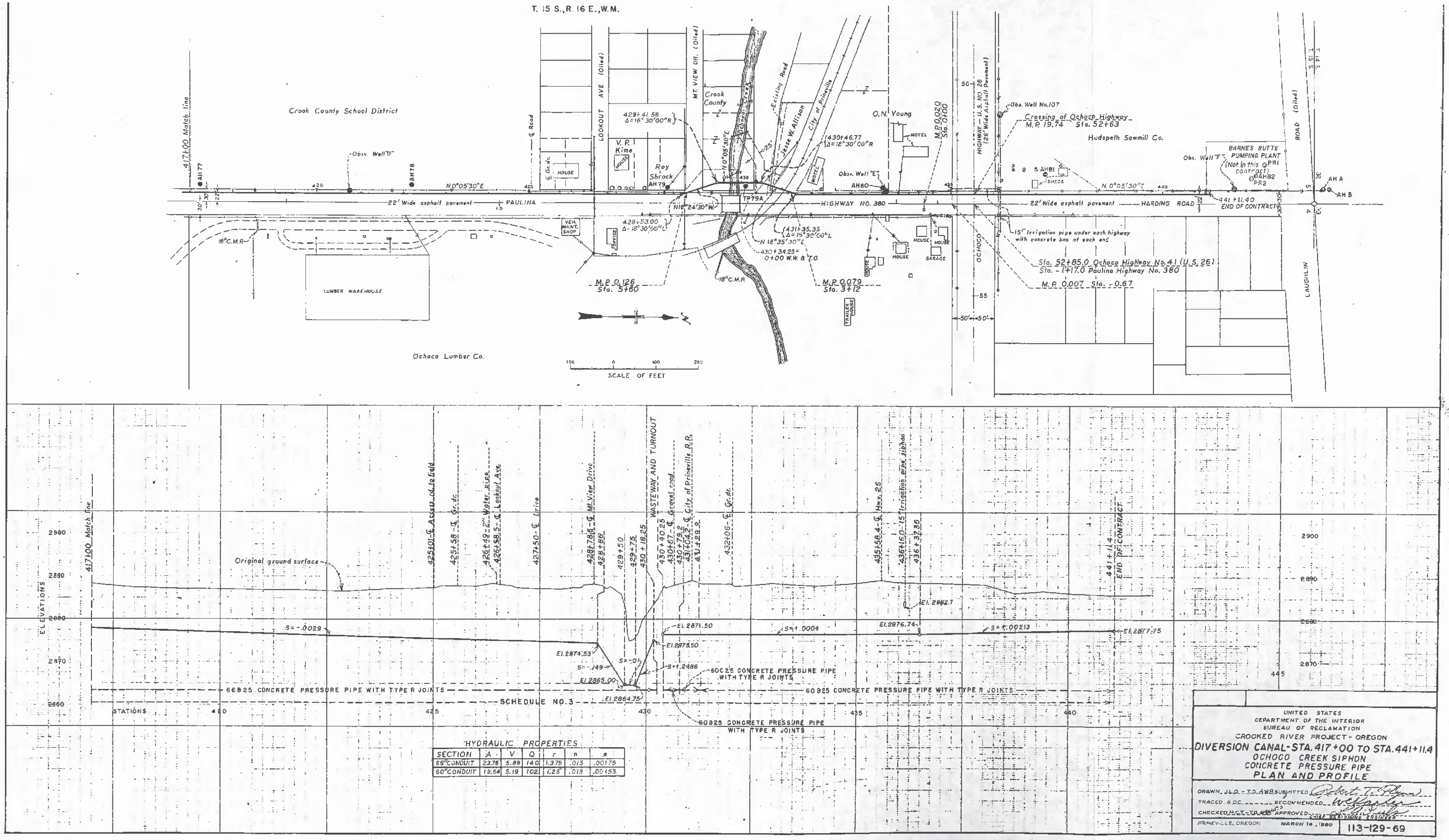
INLET TRANSITION—PLAN AND SECTIONS 113-D-175
SECTIONS AND DETAILS 113-D-176
PRECAST CONCRETE PIPE BENDS 113-D-211
WASTEWAY AND TURNOUT .... 113-D-177 & 178
OCHOCO CREEK SIPHON—SECTIONS AND DETAILS 113-D-209
LOGS OF EXPLORATION 113-129-80

HYDRAULIC PROPERTIES

SECTION	A	V	Q	r	n	s
CANAL	68.6	2.04	140	2.84	.0225	.00026
66" CONDUIT	23.76	5.89	140	1.375	.013	.00175

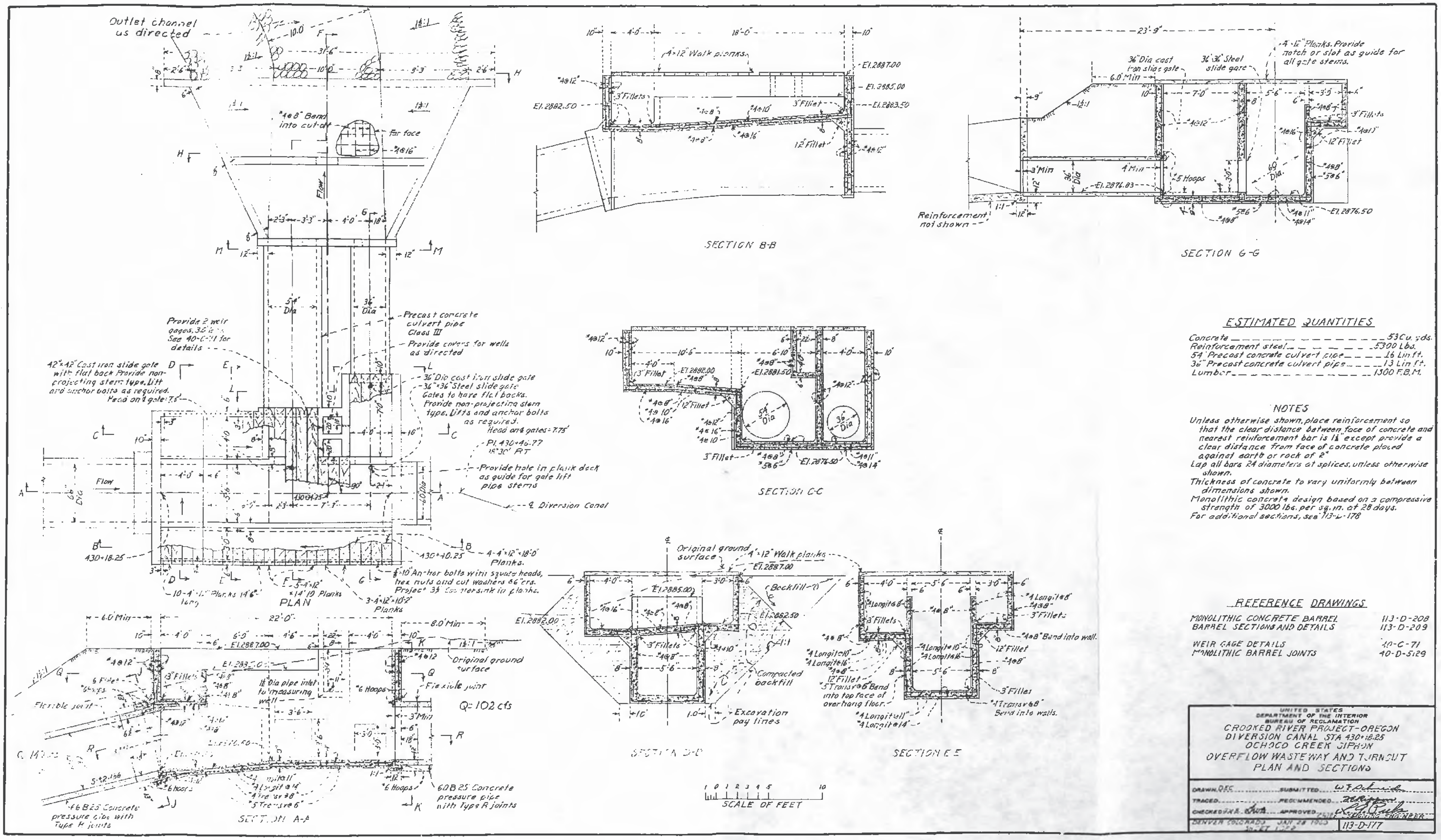
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CROOKED RIVER PROJECT—OREGON
DIVERSION CANAL-STA. 392+50 TO STA. 417+00
INLET CHANNEL AND OCHOCO CREEK SIPHON
CONCRETE PRESSURE PIPE
PLAN AND PROFILE

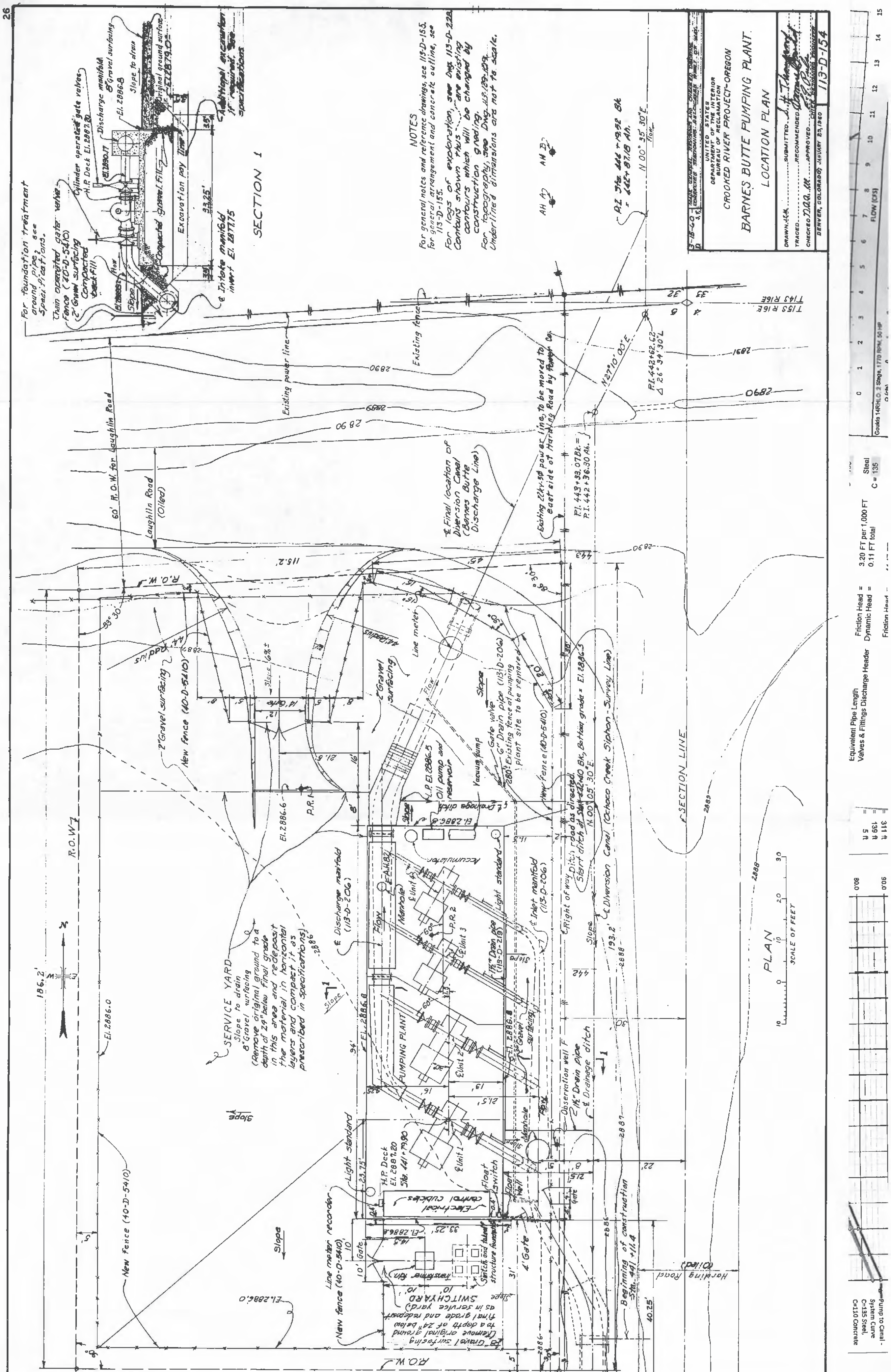
DRAWN T.D. & W.B. SUBMITTED Robert T. Harris
TRACED A.O.E. RECOMMENDED W.McKannel
CHECKED J.L.G. T.D. APPROVED L.J. Buls
PRINEVILLE, OREGON MARCH 14, 1960 113-129-68



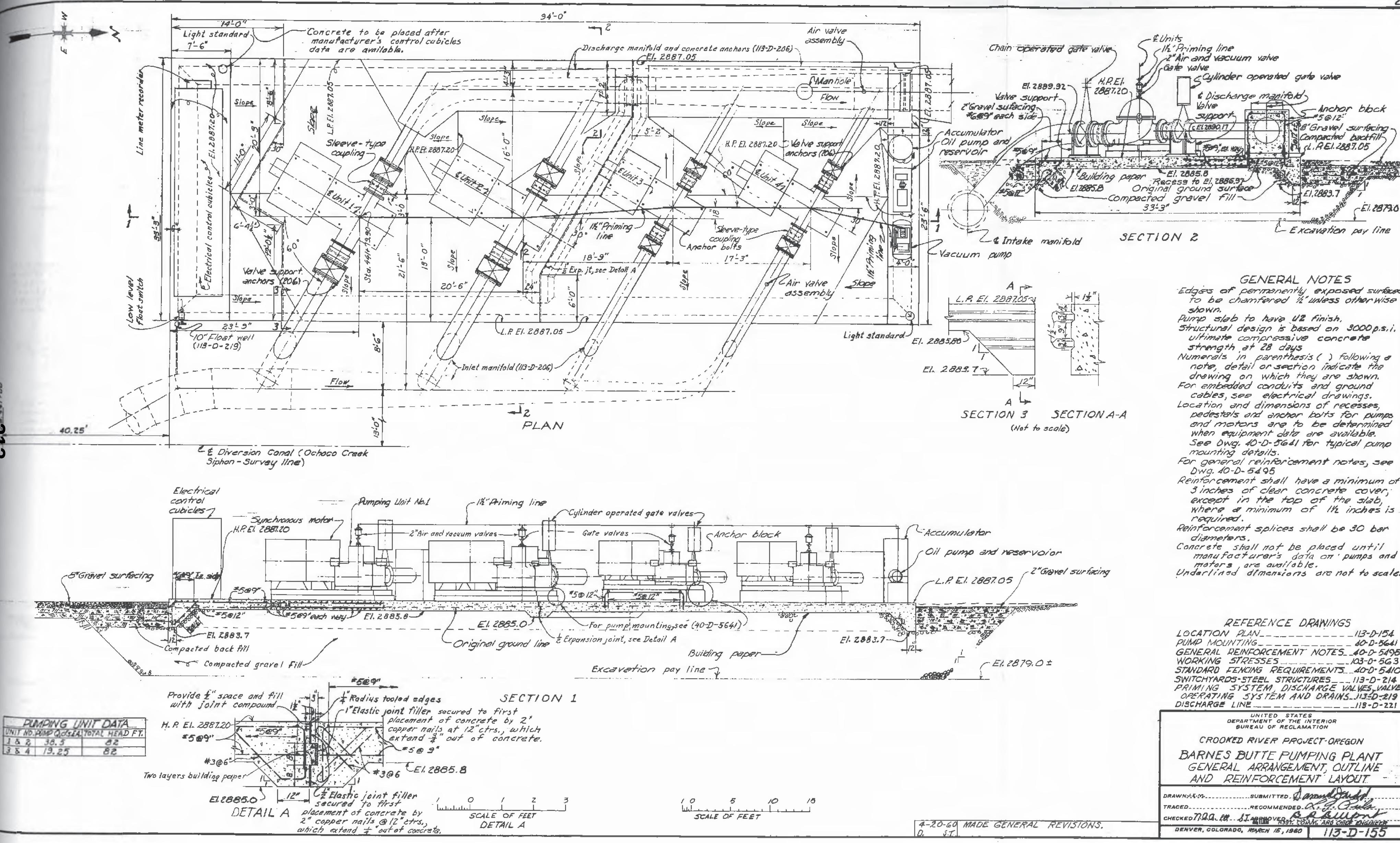
HYDRAULIC PROPERTIES

SECTION	A	V	Q	r	n	s
66" CONDUIT	23.76	5.89	140	1.375	.013	.00175
60" CONDUIT	19.64	5.19	102	1.25	.013	.00153

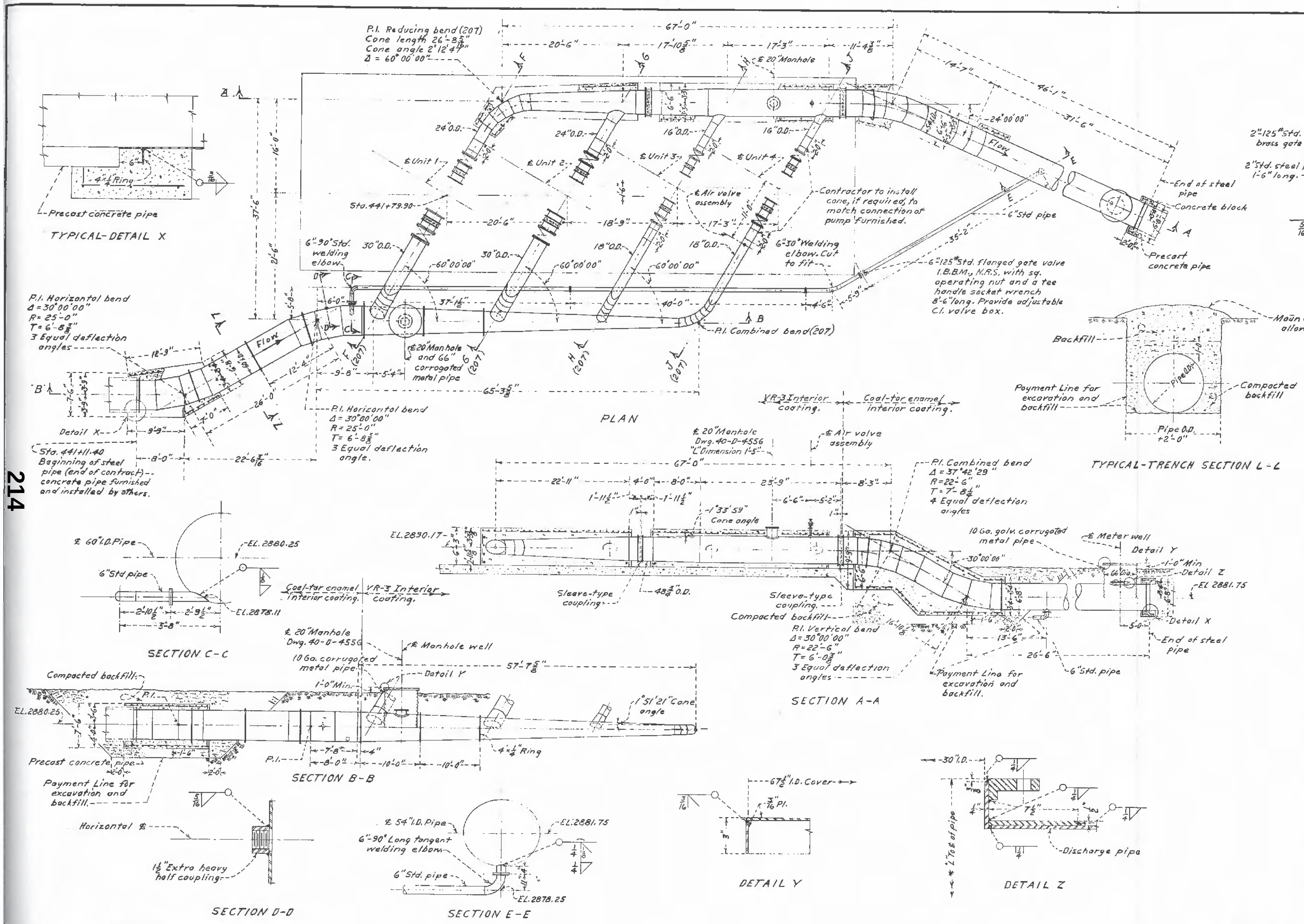

SECTION B-B
SECTION G-G
SECTION C-C
SECTION D-D
SECTION E-E
SECTION A-A
PLAN
Outlet channel as directed
Q=102 cfs
SCALE OF FEET
ESTIMATED QUANTITIES
Concrete — 53 Cu. yds.
Reinforcement steel — 5300 Lbs.
54" Precast concrete culvert pipe — 16 Lin. ft.
36" Precast concrete culvert pipe — 13 Lin. ft.
Lumber — 1300 F.B.M.
NOTES
Unless otherwise shown, place reinforcement so that the clear distance between face of concrete and nearest reinforcement bar is 1½" except provide a clear distance from face of concrete placed against earth or rock of 2".
Lap all bars 24 diameters at splices, unless otherwise shown.
Thickness of concrete to vary uniformly between dimensions shown.
Monolithic concrete design based on a compressive strength of 3000 lbs. per sq. in. at 28 days.
For additional sections, see 113-D-178
REFERENCE DRAWINGS
MONOLITHIC CONCRETE BARREL 113-D-208
BARREL SECTIONS AND DETAILS 113-D-209
WEIR GAGE DETAILS 40-C-71
MONOLITHIC BARREL JOINTS 40-D-5129
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CROOKED RIVER PROJECT-OREGON
DIVERSION CANAL STA. 430+18.25
OCHOCO CREEK SIPHON
OVERFLOW WASTEWAY AND TURNOUT
PLAN AND SECTIONS
DENVER, COLORADO
113-D-177


26
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CROOKED RIVER PROJECT-OREGON
BARNES BUTTE PUMPING PLANT
LOCATION PLAN
DENVER, COLORADO, JANUARY 25, 1960
113-D-154
NOTES
For general notes and reference drawings, see 113-D-153.
For general arrangement and concrete outline, see 113-D-155.
Underlined dimensions are not to scale.
SECTION 1
PLAN
SCALE OF FEET
SERVICE YARD
SWITCHYARD
PUMPING PLANT
Laughlin Road (Oiled)
Existing power line
Existing fence
New fence (40-D-5410)
R.O.W.
SECTION LINE
Diversion Canal (Ochoco Creek Siphon - Survey Line)
Equivalent Pipe Length
Valves & Fittings Discharge Header
Friction Head =
Dynamic Head =
3.20 FT per 1,000 FT
0.11 FT total
Steel
C = 135
FLOW (CFS)

27



PLAN
SECTION 1
SECTION 2
SECTION 3
SECTION A-A
(Not to scale)
DETAIL A
SCALE OF FEET DETAIL A
SCALE OF FEET
GENERAL NOTES
Edges of permanently exposed surfaces to be chamfered ½" unless otherwise shown.
Pump slab to have U2 finish.
Structural design is based on 3000 p.s.i. ultimate compressive concrete strength at 28 days.
Numerals in parenthesis ( ) following a note, detail or section indicate the drawing on which they are shown.
For embedded conduits and ground cables, see electrical drawings.
Location and dimensions of recesses, pedestals and anchor bolts for pumps and motors are to be determined when equipment data are available. See Dwg. 40-D-5641 for typical pump mounting details.
For general reinforcement notes, see Dwg. 40-D-5495
Reinforcement shall have a minimum of 3 inches of clear concrete cover, except in the top of the slab, where a minimum of 1½ inches is required.
Reinforcement splices shall be 30 bar diameters.
Concrete shall not be placed until manufacturer's data on pumps and motors are available.
Underlined dimensions are not to scale.
REFERENCE DRAWINGS
LOCATION PLAN 113-D-154
PUMP MOUNTING 40-D-5641
GENERAL REINFORCEMENT NOTES 40-D-5495
WORKING STRESSES 103-D-563
STANDARD FENCING REQUIREMENTS 40-D-5410
SWITCHYARDS-STEEL STRUCTURES 113-D-214
PRIMING SYSTEM, DISCHARGE VALVES, VALVE OPERATING SYSTEM AND DRAINS 113-D-219
DISCHARGE LINE 113-D-221
UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION
CROOKED RIVER PROJECT-OREGON
BARNES BUTTE PUMPING PLANT
GENERAL ARRANGEMENT, OUTLINE AND REINFORCEMENT LAYOUT
DENVER, COLORADO, MARCH 15, 1960
113-D-155
4-20-60 MADE GENERAL REVISIONS.
PUMPING UNIT DATA
UNIT NO. | PUMP Q cfs EA. | TOTAL HEAD FT.
1 & 2 | 38.5 | 82
3 & 4 | 19.25 | 82
Diversion Canal (Ochoco Creek Siphon - Survey line)



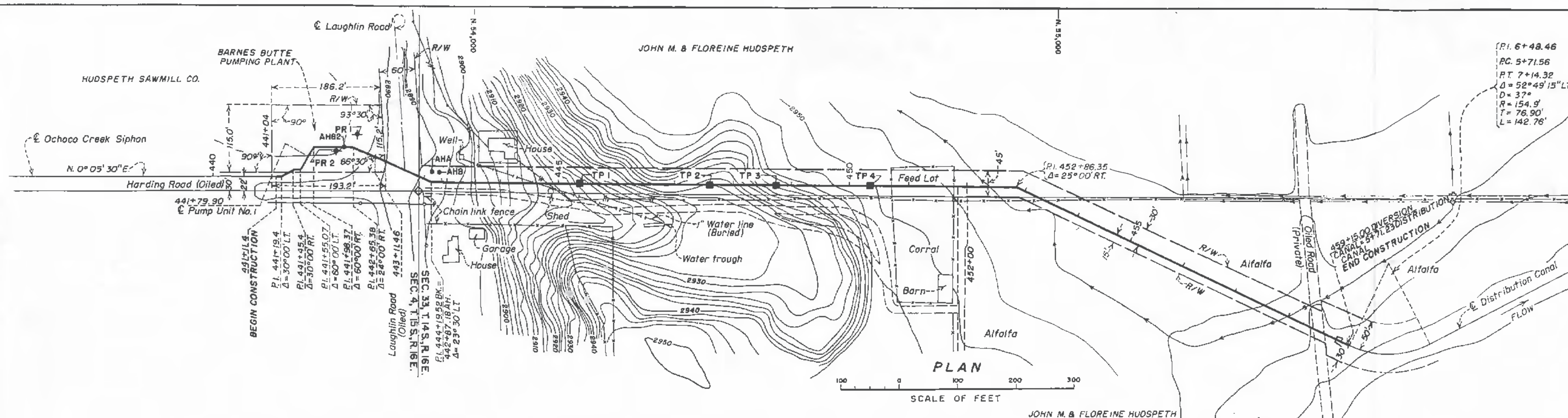
NOTES

All flanges to be AWWA Class D
Pipe shall be $\frac{1}{4}$" minimum wall thickness unless otherwise shown.
Reinforcement in anchors shall be #6 bars equally spaced on 12" maximum centers on all faces.
Reinforcement shall be placed so that the centers of the bars in the outer layer will be 3" from the face of the concrete. Bars shall be lapped 24 bar diameters at all splices. Bends in bars shall be made over 5" diameter pin.
* Contractor to determine dimension "L" to suit Line Meter furnished.
Underlined dimensions adjoining pump may be varied to suit pump requirement.
Hydrostatic test = 70 psi for discharge manifold, and 25 psi for intake manifold.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CROOKED RIVER PROJECT-OREGON

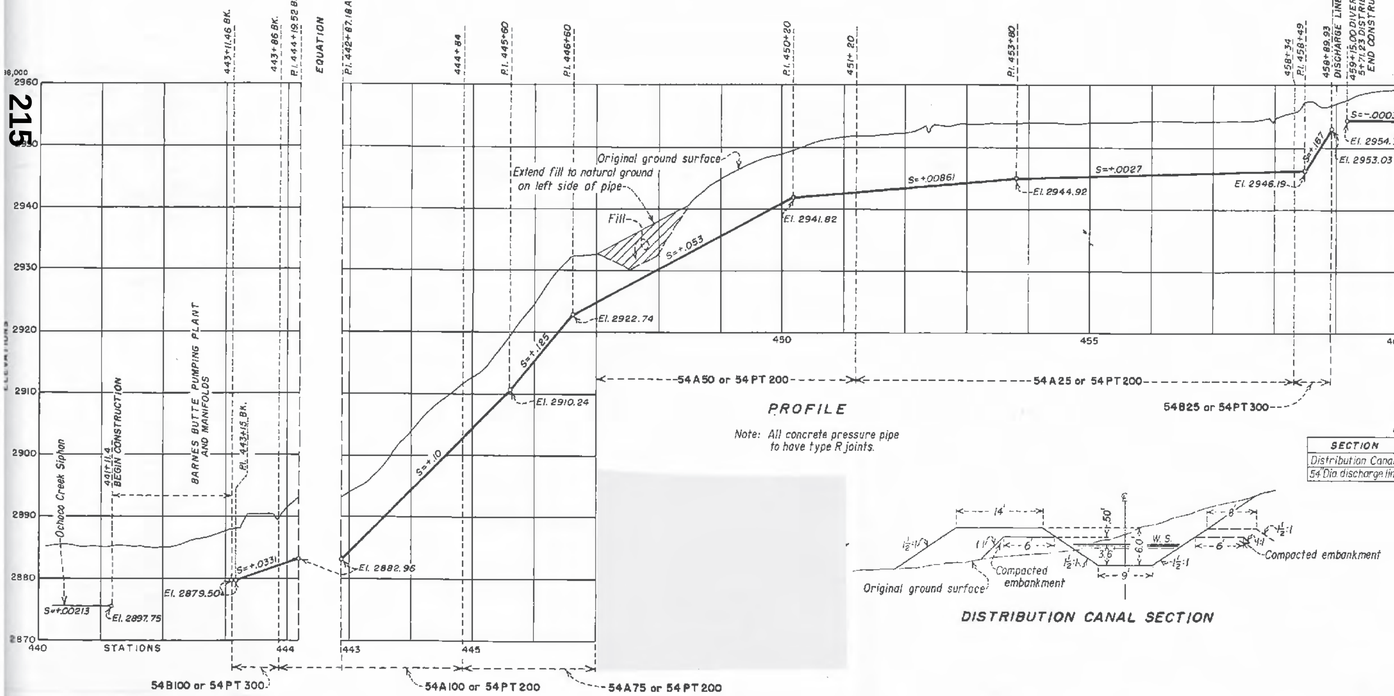
BARNES BUTTE PUMPING PLANT
STEEL INTAKE AND DISCHARGE MANIFOLDS
PLAN AND SECTIONS

DRAWN A.B. SUBMITTED J.J. Walker
TRACED RECOMMENDED F. Weidinger
CHECKED C.E.W. APPROVED H.S. [illegible] CHIEF MECHANICAL BRANCH
DENVER, COLORADO MARCH 31, 1960 113-D-206



ESTIMATED QUANTITIES

CONCRETE PRESSURE PIPE		PRETENSIONED CONCRETE PIPE	
Concrete	8 Cu. yds.		8 Cu. yds.
Reinforcement steel	700 Lbs.		700 Lbs.
54B25 Pipe	56 Lin. ft.	54PT200	1582 Lin. ft.
54A25 Pipe	714 Lin. ft.	54PT300	131 Lin. ft.
54A50 Pipe	420 Lin. ft.		
54A75 Pipe	216 Lin. ft.		
54A100 Pipe	230 Lin. ft.		
54B100 Pipe	75 Lin. ft.		



NOTES

Stations and elevations on profile refer to invert unless otherwise shown.
Stationing of vertical P.I.'s to be considered approximate only and may be adjusted according to actual laying length of pipe.
Backfill above top of pipe as directed, 3'-0" min.

REFERENCE DRAWINGS

BARNES BUTTE PUMPING PLANT	113-D-205
PUMP DISCHARGE LINE TRANSITION	113-D-222
BENDS FOR PRESSURE PIPE AND CONCRETE CYLINDER PIPE (PRETENSIONED)	113-D-226
SECTIONS FOR DISCHARGE LINES	113-D-225
GEOLOGIC LOGS OF EXPLORATION	113-D-228
GEOLOGIC MAPS	113-D-244

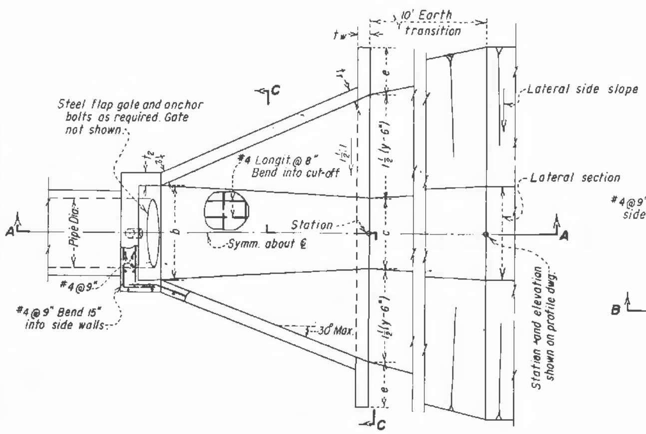
HYDRAULIC PROPERTIES

SECTION	A	V	Q	r	n	s	Cs
Distribution Canal	51.84	1.97	102	2.36	.025	.00035	
54" Dia. discharge line	15.90	6.41	102			.00205	.370

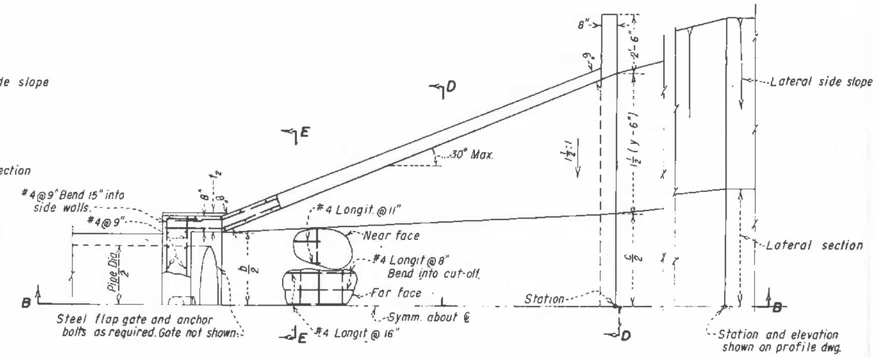
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CROOKED RIVER PROJECT—OREGON

BARNES BUTTE PUMPING PLANT
DISCHARGE LINE

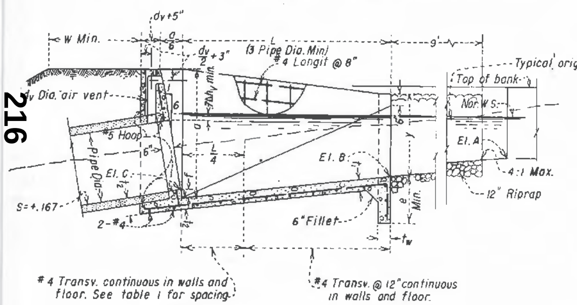
DRAWN A.O.C.-A.W.B. SUBMITTED
TRACED B.D.B. RECOMMENDED
CHECKED APPROVED CHIEF DESIGNING ENGINEER
DENVER, COLORADO, MARCH 4, 1960 113-D-221



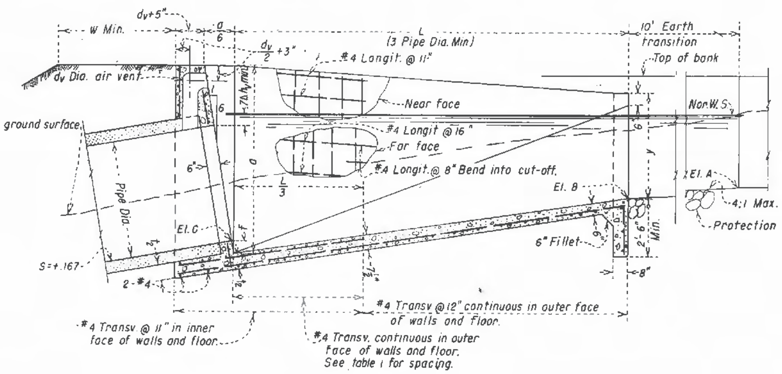
PLAN OF TYPICAL PUMP DISCHARGE LINE TRANSITION 15" TO 54" DIA.



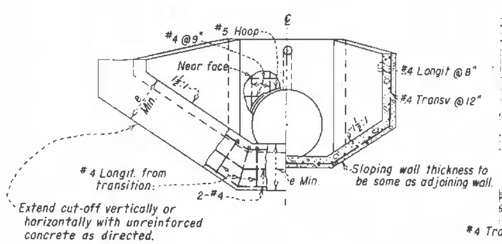
HALF PLAN OF PUMP DISCHARGE LINE TRANSITION 60" TO 78" DIA.



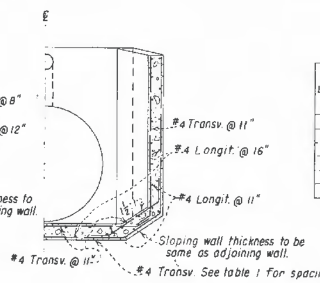
SECTION A-A



SECTION B-B



SECTION C-C
(SECTION D-D SIMILAR)



SECTION E-E

TABLE 1

DIA.	a	b	t_1	t_2	e	t_w	f	d_v	TRANSV. REINF.
15"	4'-0"	24"	5"	5"	24"	6"	3"	4"	#4 @ 12"
18"	4'-3"	2'-3"	5"	5"	24"	6"	3"	4"	#4 @ 12"
21"	4'-6"	2'-6"	5"	5"	24"	6"	3"	4"	#4 @ 12"
24"	4'-9"	2'-9"	5"	5"	24"	6"	3"	4"	#4 @ 12"
30"	5'-3"	3'-4"	5"	5"	24"	6"	3"	5"	#4 @ 12"
36"	5'-9"	4'-0"	6"	6"	2'-6"	8"	3"	6"	#4 @ 12"
42"	6'-3"	4'-6"	6"	6"	2'-6"	8"	3"	7"	#4 @ 12"
48"	7'-0"	5'-0"	6"	6"	2'-6"	8"	4"	8"	#4 @ 10"
54"	7'-6"	5'-6"	6"	7"	2'-6"	8"	5"	9"	#4 @ 8"
60"	8'-9"	6'-2"	6"	8"	–	–	5"	9"	#4 @ 7½"
66"	9'-3"	6'-6"	6"	8"	–	–	5"	10"	#4 @ 6"
72"	9'-9"	7'-0"	6"	9"	–	–	6"	11"	#4 @ 6"
78"	10'-3"	7'-8"	6"	9"	–	–	6"	12"	#4 @ 5"

When transverse bar spacing is 6" or less, end alternate bars at half wall height.

NOTES

Unless otherwise shown, place reinforcement so that the clear distance from face of concrete and nearest reinforcement bar is 1½", except provide a clear distance from face of concrete placed against earth or rock of 2". Lap all bars 24 diameters at splices, unless otherwise shown.

Monolithic concrete design based on a compressive strength of 3 000 lbs. per sq. inch at 28 days.

TABLE OF LOCATIONS AND ELEVATIONS

LATERAL	STATION	Q (C.F.S.)	DIMENSIONS: DIA.	DIMENSIONS: L	DIMENSIONS: y	DIMENSIONS: c	ELEVATIONS: A	ELEVATIONS: B	ELEVATIONS: C	EST. QUANTITIES: CONCRETE (CU. YDS.)	EST. QUANTITIES: REINF. STEEL (LBS.)	EST. QUANTITIES: FLAP GATE DIA.	REMARKS
Discharge Line	459+05	102	54	15'-0"	5'-4"	7'-0"	2954.32	2953.59	2953.03	10	900	54"	

REFERENCE DRAWING

DISCHARGE LINE 113-D-221

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CROOKED RIVER PROJECT-OREGON
BARNES BUTTE PUMPING PLANT

DISCHARGE LINE OUTLET

DRAWN A.W.B. SUBMITTED W.T. [signature]
TRACED J.A.H. RECOMMENDED [signature]
CHECKED [initials] APPROVED [signature] CHIEF DESIGNING ENGINEER
DENVER, COLORADO, MARCH 14, 1950 | 113-D-222

BARNES BUTTE PUMPING PLANT RECONSTRUCTION - EVALUATION SUMMARY

The Barnes Butte pump site is at the foot of Barnes Butte, about 0.75 miles east of the city limits of Prineville. The Barnes Butte facility was originally designed for 115.5 cubic feet per second (CFS) at 82 feet total dynamic head (TDH). The original installation circa 1961 was comprised of (4) horizontal split case pumps with synchronous motors totaling 1,500 HP. A fifth 300 HP, horizontal split case pump was added to the pumping plant a later date. The current facility consisting of the five pumping units totaling 1,800 horsepower is designed to lift approximately 135 CFS at 86 feet TDH from the end of the Crooked River diversion canal to the head of the distribution canal. The discharge main consists of approximately 1,600 feet of 54-inch I.D. concrete pipe.

Original Design

Pump Unit	Description	HP	Rated Capacity	Rated Head	Pump Eff. @ Rated Capacity	Pipe Size	Discharge Pipe Vel.	Discharge Main Vel.
No. 1	Horizontal Split Case	500	17,300 GPM	82 FT	84 %	24 IN	12.3 FPS	
No. 2	Horizontal Split Case	500	17,300 GPM	82 FT	84 %	24 IN	12.3 FPS	
No. 3	Horizontal Split Case	250	8,640 GPM	82 FT	80 %	16 IN	13.8 FPS	
No. 4	Horizontal Split Case	250	8,640 GPM	82 FT	80 %	16 IN	13.8 FPS	
Total		1,500	51,880 GPM	82 FT		54 IN		7.3 FPS

Current Condition (Ref. Initial Pump Evaluation BPA, 2010)

Pump Unit	Description	HP	Test Capacity	Test Head	Pump Eff. @ Test Capacity	Pipe Size	Discharge Pipe Vel.	Discharge Main Vel.
No. 1	Horizontal Split Case	500	17,431 GPM *	73 FT *	80 % *	24 IN	12.4 FPS	
No. 2	Horizontal Split Case	500	16,633 GPM *	76 FT *	79 %	24 IN	11.8 FPS	
No. 3	Horizontal Split Case	250	9,460 GPM	77 FT	80 % **	16 IN	15.1 FPS	
No. 4	Horizontal Split Case	250	7,910 GPM *	75 FT *	80 % **	16 IN	12.6 FPS	
No. 5	Horizontal Split Case	300	9,037 GPM	76 FT	68 %	16 IN	14.4 FPS	
Total		1,800	60,471 GPM			54 IN		8.5 FPS

* Minimum value of (2) test data points, ref. Initial Pump Evaluation, BPA, 2010

** Measured pump efficiency at the test capacity was greater than the factory curve. Factory curve data for efficiency at rated capacity used in evaluating pumping plant efficiency.

Alternate Equipment (Replace existing pump station with (5) vertical turbines at current location)

Pump Unit	Description	HP	Rated Capacity	Rated Head	Pump Eff. @ Rated Capacity	Pipe Size	Discharge Pipe Vel.	Discharge Main Vel.
No. 1	Vertical Turbine	450	16,000 GPM	89 FT	85.6 %	30 IN	7.3 FPS	
No. 2	Vertical Turbine	450	16,000 GPM	89 FT	85.6 %	30 IN	7.3 FPS	
No. 3	Vertical Turbine	450	16,000 GPM	89 FT	85.6 %	30 IN	7.3 FPS	
No. 4	Vertical Turbine	450	16,000 GPM	89 FT	85.6 %	30 IN	7.3 FPS	
No. 5	Vertical Turbine	150	5,600 GPM	89 FT	86.1 %	18 IN	7.1 FPS	
Total		1,950	69,600 GPM	89 FT		54 IN		9.8 FPS

Narrative

Evaluation of the Barnes Butte Reconstruction examines potential energy efficiency improvements gained by reconstructing the existing Barnes Butte Pumping Plant at the current pump station location. The new pumping plant would utilize (5) new vertical turbine pumps. New pumps would be installed in a newly construction wet well configuration. A concept layout and elevation view of the pump station wet well is included in the supplemental materials attached. The new wet well would be constructed adjacent to the existing pump station footprint with pump discharge connected to the existing discharge main. Pump discharge piping and valves would be sized to reduce velocity and friction losses.

Electrical systems would be rebuilt from service entrance through motor starters. New synchronous motors would be installed with the new pumps.

With five new pumps available to meet irrigation season demand variations, integration of variable speed drive equipment into alternate pump equipment would not appear to provide significant energy savings.

The capacity of the reconstructed pump station is anticipated to be approximately 155 CFS at 89 feet TDH.

Wire to water energy analysis is based on the projected capacity of the Barnes Butte Pumping Plant reconstructed adjacent to the existing station using new vertical turbine pumps in a new wet well. The Barnes Butte Pumping Plant reconstructed with new vertical turbine pumps is projected to provide a seasonal average flow of 55,620 gpm (123.9 CFS) at 83.3 feet TDH. The existing Barnes Butte Pumping plant in its current condition is projected to yield 123.9 CFS at 84.0 feet TDH.

Action Recommended for Further Evaluation: **Reconstruct Pumping Plant on new footprint, vertical turbine pumps, connect to existing discharge main**

New No. 1 pump, Vertical Turbine Pump

New No. 2 pump, Vertical Turbine Pump

New No. 3 pump, Vertical Turbine Pump

New No. 4 pump, Vertical Turbine Pump

New No. 5 pump, Vertical Turbine Pump

Replace pump discharge piping and valves

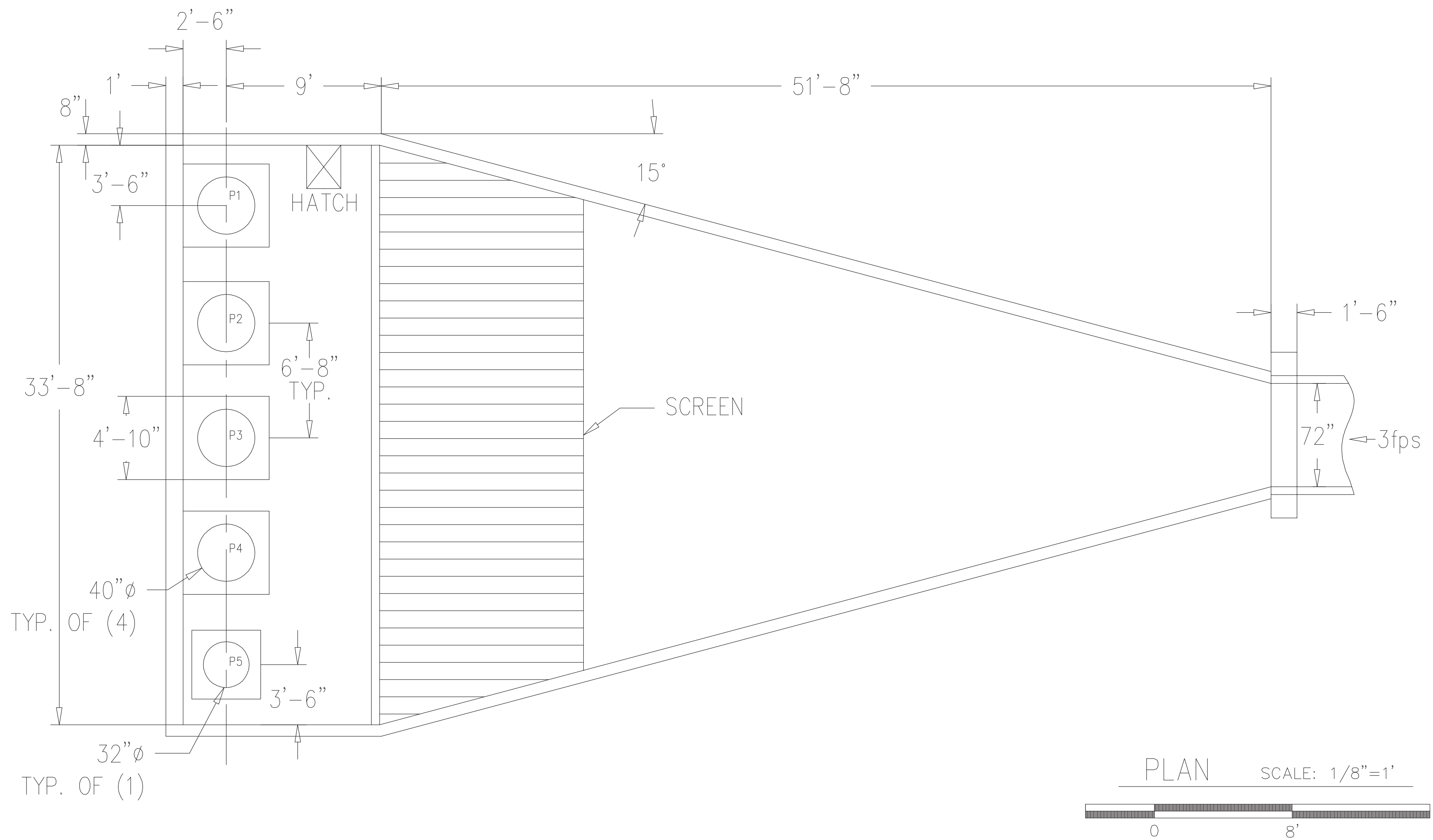
Replace electrical service entrance and motor starters

Annual Energy Savings Estimate = 642,950 KW

Initial Cost Estimate = $4,261,000

BARNES BUTTE REMODEL USING 5 VERTICAL TURBINE PUMPS

4 PUMPS @ 35.65 cfs AND 1 PUMP @ 12.40 cfs



OCHOCO IRRIGATION DIST.

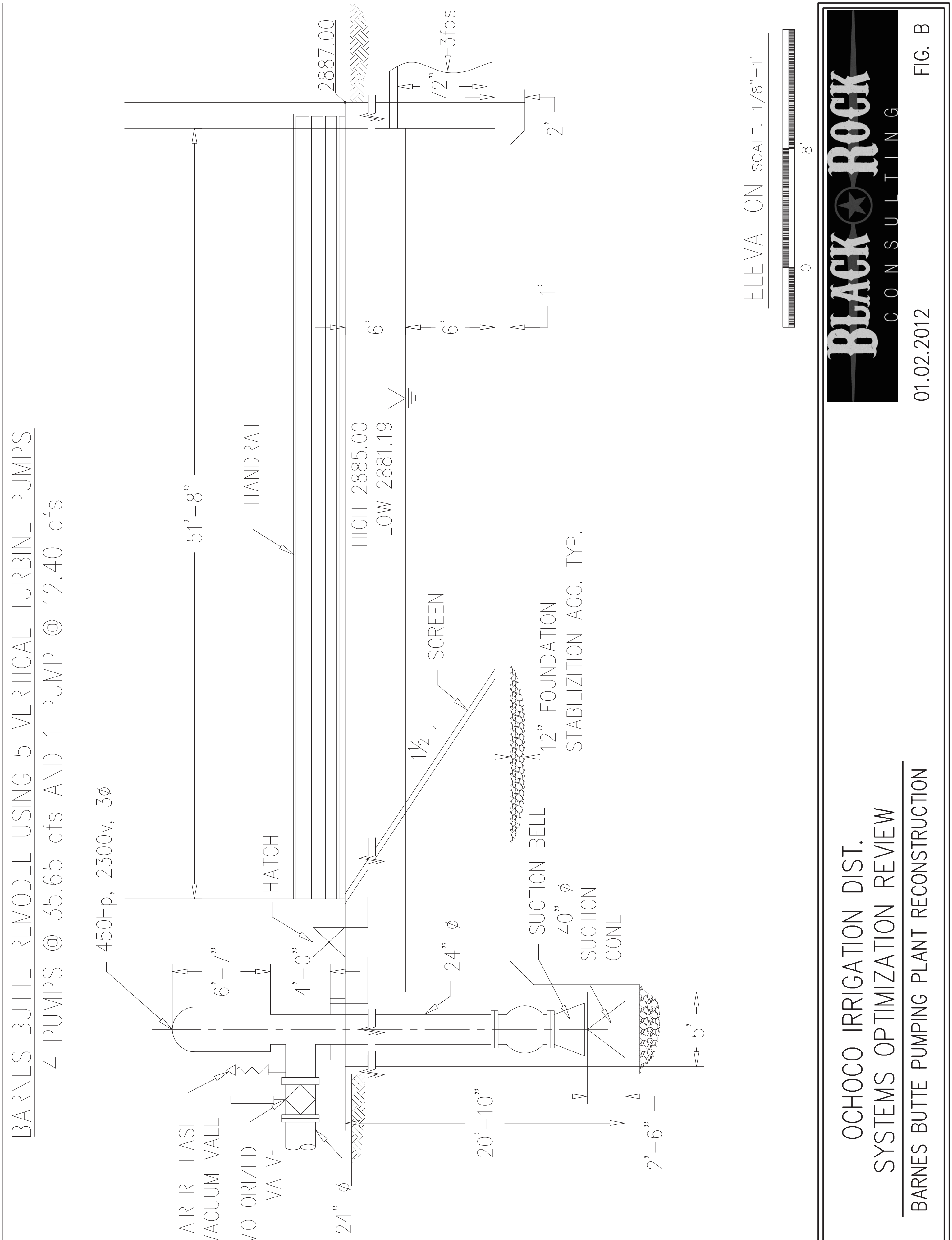
SYSTEMS OPTIMIZATION REVIEW

BARNES BUTTE PUMPING PLANT RECONSTRUCTION

BLACK ROCK CONSULTING

01.02.2012

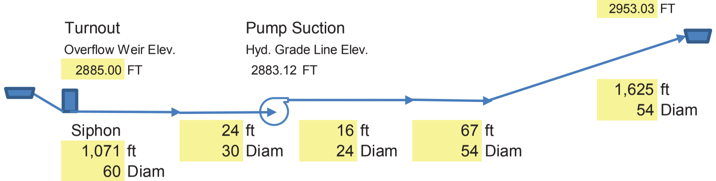
FIG. A



BARNES BUTTE REMODEL USING 5 VERTICAL TURBINE PUMPS
4 PUMPS @ 35.65 cfs AND 1 PUMP @ 12.40 cfs
450Hp, 2300v, 3ø
51'-8"
HANDRAIL
HATCH
6'-7"
4'-0"
24" ø
SCREEN
1½
1
HIGH 2885.00
LOW 2881.19
2887.00
72"
3fps
6'
6'
1'
2'
12" FOUNDATION
STABILIZITION AGG. TYP.
SUCTION BELL
40" ø
SUCTION
CONE
5'
AIR RELEASE
VACUUM VALE
MOTORIZED
VALVE
24" ø
20'-10"
2'-6"
ELEVATION SCALE: 1/8"=1'
0
8'
BLACK ROCK
CONSULTING
OCHOCO IRRIGATION DIST.
SYSTEMS OPTIMIZATION REVIEW
BARNES BUTTE PUMPING PLANT RECONSTRUCTION
01.02.2012
FIG. B

Pump to Canal Head Loss Calculations
Barnes Butte Pumping Plant Reconstruction (New Vert. Turbine PS @ existing PS location)

17,300	GPM	Split Case Horizontal Pump No. 1	
17,300	GPM	Split Case Horizontal Pump No. 2	
8,640	GPM	Split Case Horizontal Pump No. 3	Static Head = 68.03 FT
8,640	GPM	Split Case Horizontal Pump No. 4	
	GPM	Split Case Horizontal Pump No. 5	
51,880	GPM	Total = 115.6 cfs	



Diam. (Discharge Pipe) = 54 in
Total Discharge Pipe Length = 1,732 ft
Equiv. Pipe Length Valves & Fittings Pump Discharge = 91 ft
Equiv. Pipe Length Valves & Fittings Discharge Header = 241 ft

60" Siphon Pipe	Friction Head =	1.76 FT per 1,000 FT	Concrete
(Vel. = 5.9 fps)	Dynamic Head =	1.88 FT total	C = 120
30" Inlet Pipe	Friction Head =	5.05 FT per 1,000 FT	Steel
(Vel. = 7.9 fps)	Dynamic Head =	0.12 FT total	C = 140
24" Discharge Piping	Friction Head =	14.96 FT per 1,000 FT	Steel
(Vel. = 12.3 fps)	Dynamic Head =	0.24 FT total	C = 140
54" Header	Friction Head =	2.21 FT per 1,000 FT	Steel
(Vel. = 7.3 fps)	Dynamic Head =	0.15 FT total	C = 140
54" Discharge	Friction Head =	2.94 FT per 1,000 FT	Concrete
(Vel. = 7.3 fps)	Dynamic Head =	4.77 FT total	C = 120
Equivalent Pipe Length	Friction Head =	14.96 FT per 1,000 FT	Steel
Valves & Fittings Pump Discharge	Dynamic Head =	1.36 FT total	C = 140
Equivalent Pipe Length	Friction Head =	2.21 FT per 1,000 FT	Steel
Valves & Fittings Discharge Header	Dynamic Head =	0.53 FT total	C = 140
	Friction Head =	7.17 FT =	3.10 psi
	Water Depth in Discharge Canal =	4.07 FT =	1.76 psi
	Total Dynamic Head =	81.16 FT =	35.13 psi

Equivalent Pipe Length Totals:

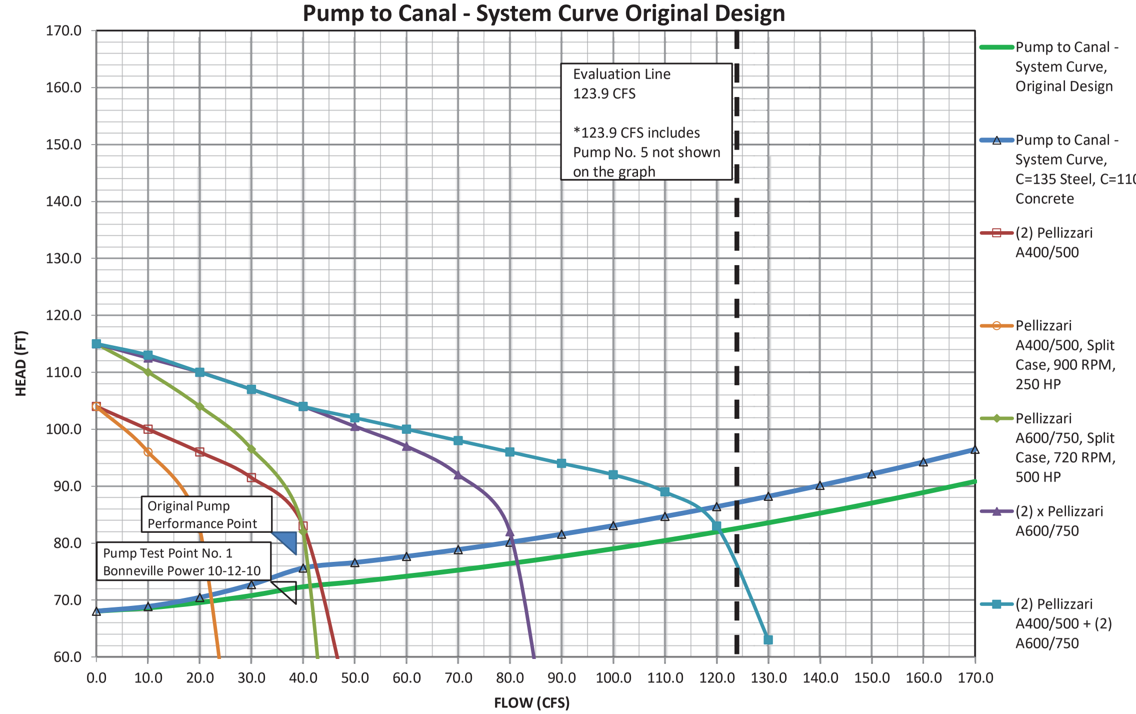
Item	24" Equiv. Length	No. of Units	Total Equiv. Length
60" to 30" square edged inlet	85 ft	1 ea	85 ft
30" pump isolation (gate) valve	3 ft	1 ea	3 ft
24" pump control (gate) valve	3 ft	1 ea	3 ft
30-inch 30 degree bend	20 ft	0 ea	0 ft
		Subtotal	91 ft

Item	54" Equiv. Length	No. of Units	Total Equiv. Length
24"x54" tee branch flow	40 ft	1 ea	40 ft
54" flow meter	1 ft	1 ea	1 ft
54"x24" tee in-line flow	30 ft	4 ea	120 ft
54"x60" expander	5 ft	1 ea	5 ft
54" 45 bend	20 ft	2 ea	40 ft
54" 11.25 bend	10 ft	2 ea	20 ft
54" flap gate	15 ft	1 ea	15 ft
		Subtotal	241 ft

Barnes Butte Pumping Plant Reconstruction
Pump to Canal - System Curve, Original Design

Q (gpm)	0	4,488	8,976	13,464	17,952	22,440	26,928	31,416	35,904	40,392	44,880	49,368	53,856	58,344	62,832	67,320	71,808	76,296
Q (cfs)	0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0	170.0
Hf	0.0	0.6	1.5	2.7	4.3	5.2	6.1	7.2	8.4	9.6	11.0	12.4	13.9	15.5	17.2	19.0	20.9	22.8
TDH (ft)	68.0	68.6	69.5	70.8	72.3	73.2	74.2	75.2	76.4	77.7	79.0	80.4	82.0	83.6	85.3	87.0	88.9	90.8
Vel. Disch. (fps)	0.0	0.6	1.3	1.9	2.5	3.1	3.8	4.4	5.0	5.7	6.3	6.9	7.5	8.2	8.8	9.4	10.1	10.7

Barnes Butte Pumping Plant Reconstruction
Pump to Canal - System Curve Original Design



Pellizzari A400/500, Split Case, 900 RPM, 250 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	104	96	83	10														

(2) Pellizzari A400/500

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	104	100	96	92	83	47	10											

Pellizzari A600/750, Split Case, 720 RPM, 500 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	115	110	104	97	82	-20												

(2) x Pellizzari A600/750

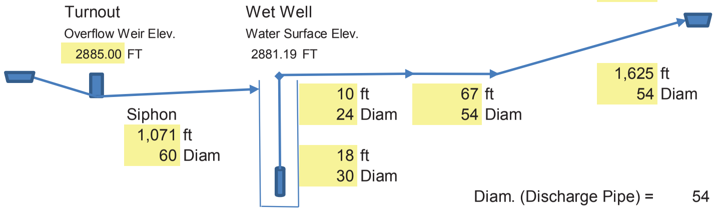
Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	115	113	110	107	104	101	97	92	82	29	-20							

(2) Pellizzari A400/500 + (2) A600/750

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	115	113	110	107	104	102	100	98	96	94	92	89	83	63				

Pump to Canal Head Loss Calculations
Barnes Butte Pumping Plant Reconstruction (New Vert. Turbine PS @ existing PS location)

16,000	GPM	Vertical Turbine Pump No. 1		
16,000	GPM	Vertical Turbine Pump No. 2		
16,000	GPM	Vertical Turbine Pump No. 3	Static Head =	68.03 FT
16,000	GPM	Vertical Turbine Pump No. 4		
5,600	GPM	Vertical Turbine Pump No. 5		
69,600	GPM	Total = 155.1 cfs		



Diam. (Discharge Pipe) =	54 in
Total Discharge Pipe Length =	1,720 ft
Equiv. Pipe Length Valves & Fittings Pump Discharge =	274 ft
Equiv. Pipe Length Valves & Fittings Discharge Header =	251 ft

60" Siphon Pipe	Friction Head =	3.56 FT per 1,000 FT	Concrete
(Vel. = 7.9 fps)	Dynamic Head =	3.81 FT total	C = 110
30" Column Pipe	Friction Head =	4.68 FT per 1,000 FT	Steel
(Vel. = 7.3 fps)	Dynamic Head =	0.08 FT total	C = 135
24" Discharge Piping	Friction Head =	13.85 FT per 1,000 FT	Steel
(Vel. = 11.3 fps)	Dynamic Head =	0.14 FT total	C = 135
54" Header	Friction Head =	4.07 FT per 1,000 FT	Steel
(Vel. = 9.8 fps)	Dynamic Head =	0.27 FT total	C = 135
54" Discharge	Friction Head =	5.94 FT per 1,000 FT	Concrete
(Vel. = 9.8 fps)	Dynamic Head =	9.65 FT total	C = 110
Equivalent Pipe Length Valves & Fittings Pump Discharge	Friction Head =	13.85 FT per 1,000 FT	Steel
	Dynamic Head =	3.80 FT total	C = 135
Equivalent Pipe Length Valves & Fittings Discharge Header	Friction Head =	4.07 FT per 1,000 FT	Steel
	Dynamic Head =	1.02 FT total	C = 135
	Friction Head =	14.96 FT =	6.48 psi
	Water Depth in Discharge Canal =	5.47 FT =	2.37 psi
	Total Dynamic Head =	92.26 FT =	39.94 psi

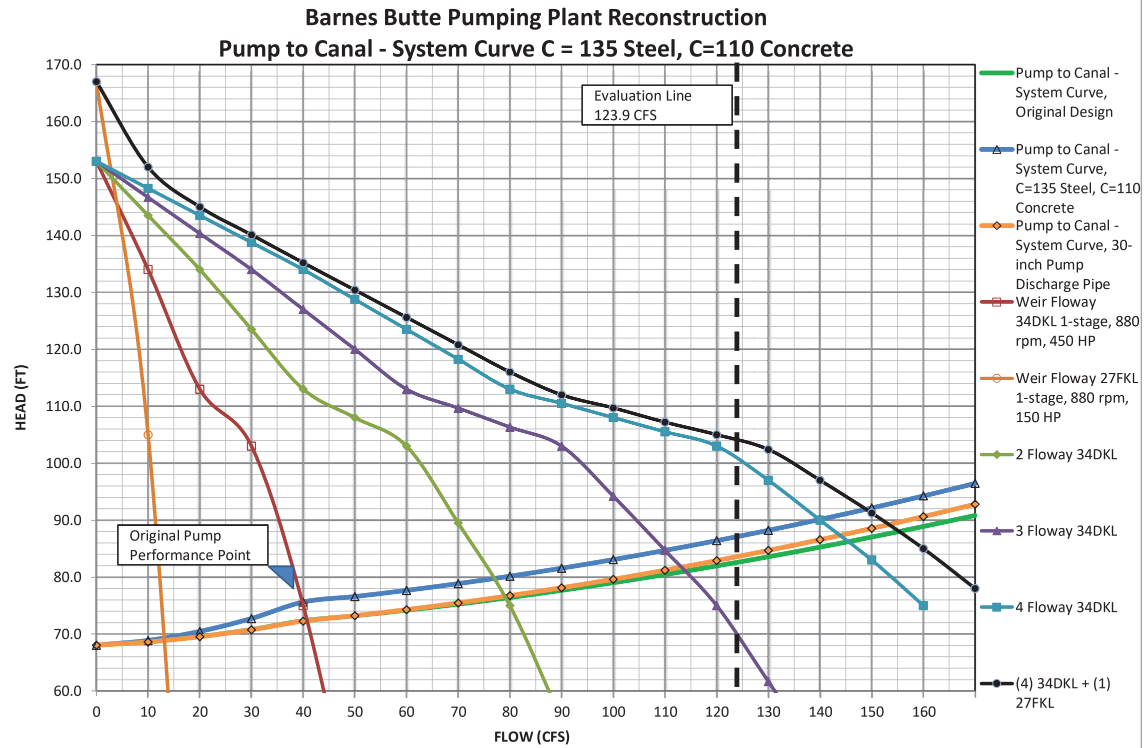
Equivalent Pipe Length Totals:

Item	24" Equiv. Length	No. of Units	Total Equiv. Length
24" pump discharge head	250 ft	1 ea	250 ft
24" pump control (gate) valve	3 ft	1 ea	3 ft
24" 45 bend	20 ft	1 ea	20 ft
24" flow meter	1 ft	1 ea	1 ft
		Subtotal	274 ft

Item	54" Equiv. Length	No. of Units	Total Equiv. Length
24"x54" tee branch flow	40 ft	1 ea	40 ft
54" flow meter	1 ft	1 ea	1 ft
24"x30" tee in-line flow	30 ft	4 ea	120 ft
54"x60" expander	5 ft	1 ea	5 ft
54" 45 bend	25 ft	2 ea	50 ft
54" 11.25 bend	10 ft	2 ea	20 ft
54" flap gate	15 ft	1 ea	15 ft
		Subtotal	251 ft

Barnes Butte Pumping Plant Reconstruction
Pump to Canal - System Curve, C=135 Steel, C=110 Concrete

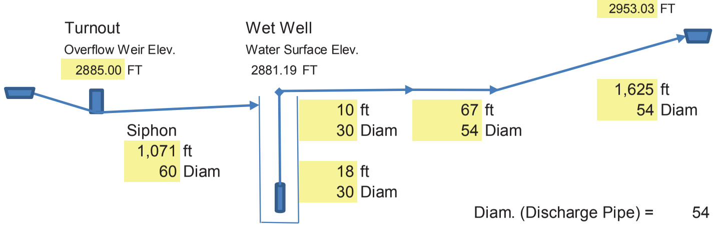
Q (gpm)	0	4,488	8,976	13,464	17,952	22,440	26,928	31,416	35,904	40,392	44,880	49,368	53,856	58,344	62,832	67,320	71,808	76,296
Q (cfs)	0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0	170.0
Hf	0.0	0.8	2.4	4.7	7.6	8.6	9.6	10.8	12.1	13.5	15.0	16.7	18.4	20.2	22.1	24.1	26.2	28.4
TDH (ft)	68.0	68.9	70.4	72.7	75.6	76.6	77.7	78.9	80.2	81.6	83.1	84.7	86.4	88.2	90.1	92.2	94.3	96.5
Vel. Disch. (fps)	0.0	0.6	1.3	1.9	2.5	3.1	3.8	4.4	5.0	5.7	6.3	6.9	7.5	8.2	8.8	9.4	10.1	10.7



Weir Floway 27FKL 1-stage, 880 rpm, 150 HP																		
Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	167	105	-25															
Weir Floway 34DKL 1-stage, 880 rpm, 450 HP																		
Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	153	134	113	103	75	35												
2 Floway 34DKL																		
Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	153	144	134	124	113	108	103	90	75	55	35							
3 Floway 34DKL																		
Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	153	147	140	134	127	120	113	110	106	103	94	85	75	62	48	35		
4 Floway 34DKL																		
Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	153	148	144	139	134	129	124	118	113	111	108	106	103	97	90	83	75	
(4) 34DKL + (1) 27FKL																		
Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	167	152	145	140	135	130	126	121	116	112	110	107	105	102	97	91	85	78

Pump to Canal Head Loss Calculations
Barnes Butte Pumping Plant Reconstruction (New Vert. Turbine PS @ existing PS location)

16,000	GPM	Vertical Turbine Pump No. 1	
16,000	GPM	Vertical Turbine Pump No. 2	
16,000	GPM	Vertical Turbine Pump No. 3	Static Head = 68.03 FT
16,000	GPM	Vertical Turbine Pump No. 4	
5,600	GPM	Vertical Turbine Pump No. 5	
69,600	GPM	Total = 155.1 cfs	



Diam. (Discharge Pipe) =	54 in
Total Discharge Pipe Length =	1,720 ft
Equiv. Pipe Length Valves & Fittings Pump Discharge =	254 ft
Equiv. Pipe Length Valves & Fittings Discharge Header =	181 ft

60" Siphon Pipe	Friction Head =	3.56 FT per 1,000 FT	Concrete
(Vel. = 7.9 fps)	Dynamic Head =	3.81 FT total	C = 110
30" Column Pipe	Friction Head =	4.68 FT per 1,000 FT	Steel
(Vel. = 7.3 fps)	Dynamic Head =	0.08 FT total	C = 135
30" Discharge Piping	Friction Head =	4.68 FT per 1,000 FT	Steel
(Vel. = 7.3 fps)	Dynamic Head =	0.05 FT total	C = 135
54" Header	Friction Head =	4.07 FT per 1,000 FT	Steel
(Vel. = 9.8 fps)	Dynamic Head =	0.27 FT total	C = 135
54" Discharge	Friction Head =	5.94 FT per 1,000 FT	Concrete
(Vel. = 9.8 fps)	Dynamic Head =	9.65 FT total	C = 110
Equivalent Pipe Length	Friction Head =	4.68 FT per 1,000 FT	Steel
Valves & Fittings Pump Discharge	Dynamic Head =	1.19 FT total	C = 135
Equivalent Pipe Length	Friction Head =	4.07 FT per 1,000 FT	Steel
Valves & Fittings Discharge Header	Dynamic Head =	0.74 FT total	C = 135
	Friction Head =	11.97 FT =	5.18 psi
	Water Depth in Discharge Canal =	5.47 FT =	2.37 psi
	Total Dynamic Head =	89.28 FT =	38.65 psi

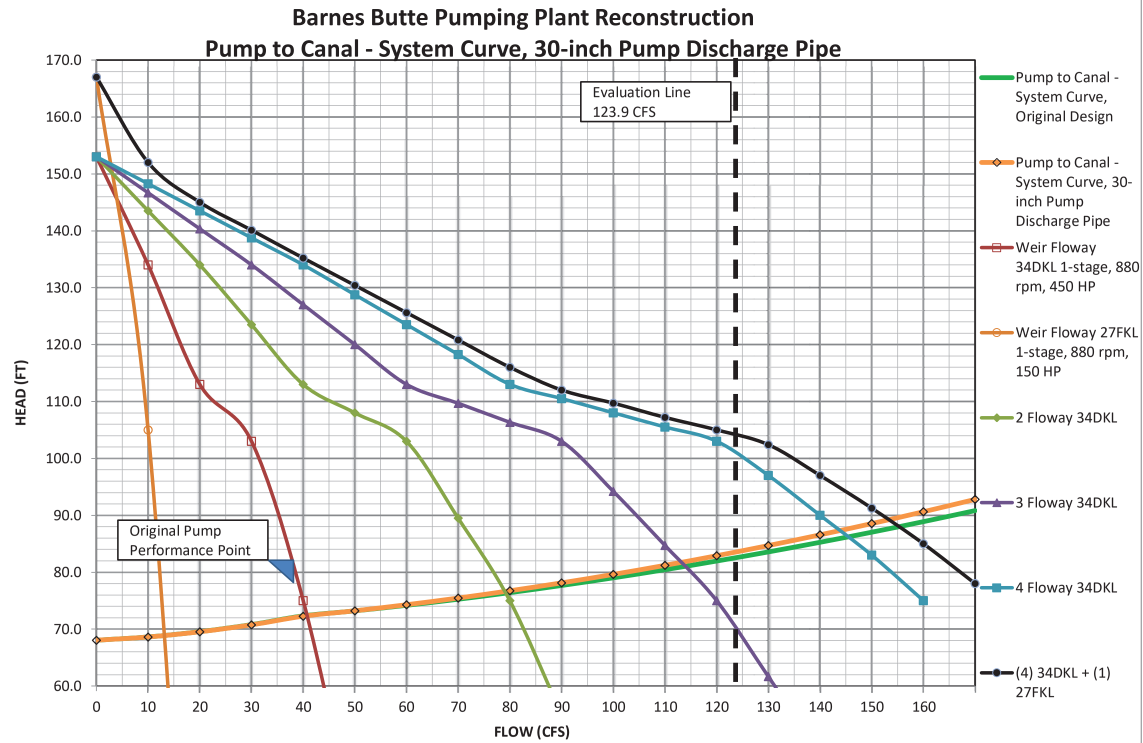
Equivalent Pipe Length Totals:

Item	30" Equiv. Length	No. of Units	Total Equiv. Length
30" pump discharge head	225 ft	1 ea	225 ft
30" pump control (gate) valve	3 ft	1 ea	3 ft
30" 45 bend	25 ft	1 ea	25 ft
30" flow meter	1 ft	1 ea	1 ft
		Subtotal	254 ft

Item	54" Equiv. Length	No. of Units	Total Equiv. Length
30"x54" tee branch flow	50 ft	1 ea	50 ft
54" flow meter	1 ft	1 ea	1 ft
54"x30" tee in-line flow	10 ft	4 ea	40 ft
54"x60" expander	5 ft	1 ea	5 ft
54" 45 bend	25 ft	2 ea	50 ft
54" 11.25 bend	10 ft	2 ea	20 ft
54" flap gate	15 ft	1 ea	15 ft
		Subtotal	181 ft

Barnes Butte Pumping Plant Reconstruction
Pump to Canal - System Curve, 30-inch Pump Discharge Pipe

Q (gpm)	0	4,488	8,976	13,464	17,952	22,440	26,928	31,416	35,904	40,392	44,880	49,368	53,856	58,344	62,832	67,320	71,808	76,296
Q (cfs)	0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0	170.0
Hf	0.0	0.6	1.5	2.7	4.2	5.2	6.2	7.4	8.7	10.1	11.6	13.2	14.9	16.7	18.5	20.5	22.6	24.8
TDH (ft)	68.0	68.6	69.5	70.7	72.3	73.2	74.3	75.4	76.7	78.1	79.6	81.2	82.9	84.7	86.6	88.5	90.6	92.8
Vel. Disch. (fps)	0.0	0.6	1.3	1.9	2.5	3.1	3.8	4.4	5.0	5.7	6.3	6.9	7.5	8.2	8.8	9.4	10.1	10.7



Weir Floway 27FKL 1-stage, 880 rpm, 150 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	167	105	-25															

Weir Floway 34DKL 1-stage, 880 rpm, 450 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	153	134	113	103	75	35												

2 Floway 34DKL

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	153	144	134	124	113	108	103	90	75	55	35							

3 Floway 34DKL

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	153	147	140	134	127	120	113	110	106	103	94	85	75	62	48	35		

4 Floway 34DKL

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	153	148	144	139	134	129	124	118	113	111	108	106	103	97	90	83	75	

(4) 34DKL + (1) 27FKL

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	167	152	145	140	135	130	126	121	116	112	110	107	105	102	97	91	85	78

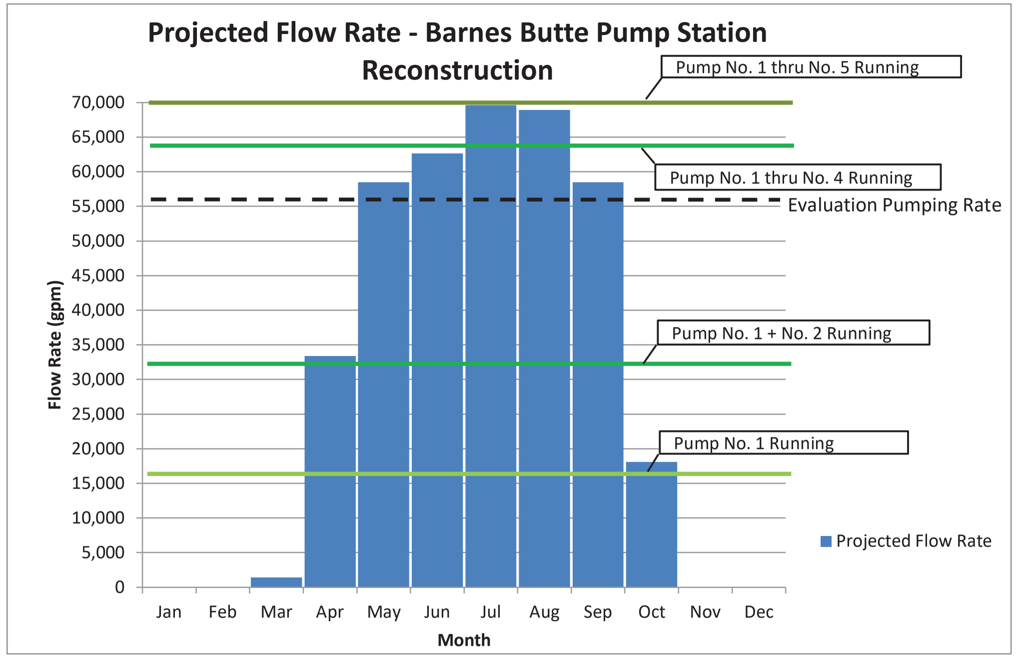
Pump to Canal Head Loss Calculations
Barnes Butte Pumping Plant Reconstruction (New Vert. Turbine PS @ existing PS location)

16,000	GPM	Vertical Turbine Pump No. 1		
16,000	GPM	Vertical Turbine Pump No. 2		
16,000	GPM	Vertical Turbine Pump No. 3		
16,000	GPM	Vertical Turbine Pump No. 4		
5,600	GPM	Vertical Turbine Pump No. 5		
69,600	GPM	Total	=	155.1 cfs

Proposed PS Design Flow Rate = 69,600 gpm

Month	% of Max Flow Rate	Projected Flow Rate
Jan	0%	0
Feb	0%	0
Mar	2%	1,392
Apr	48%	33,408
May	84%	58,464
Jun	90%	62,640
Jul	100%	69,600
Aug	99%	68,904
Sep	84%	58,464
Oct	26%	18,096
Nov	0%	0
Dec	0%	0

Evaluation Pumping Rate = 55,620 gpm
123.9 cfs



Notes: Barnes Butte PS when reconstructed with (5) new Vertical Turbine Pumps. VFD operation would not provide significant benefit toward reducing energy use and optimizing water delivery to crop requirement. New pumps can be selected at flow rates that promotes their combined use to reasonably match projected seasonal demand requirements.

Ochoco Irrigation District

Barnes Butte PS Reconstruction (Construction of new facilities adjacent to existing pump station)

Budget Level - Projection of Probable Construction Cost

Item No.	Spec Division	Description	Measurement	Units	Unit Cost	Total Cost
1	1000	Mobilization	LS	1	$120,000.00	$120,000.00
2	1000	Erosion Control	LS	1	$5,000.00	$5,000.00
3	1000	Watering / Dust Control	LS	1	$5,000.00	$5,000.00
4	1000	Construction Staking	LS	1	$2,500.00	$2,500.00
5	1000	Project Management and Coordination	LS	1	$5,000.00	$5,000.00
6	1000	Construction Progress Documentation	LS	1	$5,000.00	$5,000.00
7	1000	Submittal Procedures	LS	1	$5,000.00	$5,000.00
8	1000	Quality Requirements	LS	1	$5,000.00	$5,000.00
9	1000	Selective Demolition	LS	1	$24,000.00	$24,000.00
10	1000	Project Record Documents	LS	1	$5,000.00	$5,000.00
11	1000	Operations and Maintenance Data	LS	1	$5,000.00	$5,000.00
12	1000	General Commissioning Requirements	LS	1	$18,000.00	$18,000.00
13	2000	Erosion Control Silt Fence	LF	1,000	$2.40	$2,400.00
14	2000	Perimeter Fence, 8 ft coated wire chain link	LF	1,000	$18.00	$18,000.00
15	2000	Fence Gate	LS	1	$2,500.00	$2,500.00
16	2000	Dewatering	LS	1	$15,000.00	$15,000.00
17	2000	Bulk Excavation	CY	1,145	$7.00	$8,015.00
18	2000	Hauling	CY	1,145	$12.00	$13,740.00
19	2000	Trench Excavation, 8-12 ft depth trench box	CY	2,700	$7.00	$18,900.00
20	2000	Structural Backfill	CY	270	$38.00	$10,260.00
21	2000	Trench Backfilling	CY	2,700	$3.10	$8,370.00
22	2000	Aggregate Base	CY	250	$38.00	$9,500.00
23	2000	Surfacing Rock	CY	200	$38.00	$7,600.00
24	2000	Access Manhole	EA	2	$6,000.00	$12,000.00
25	2000	Restoration Seeding	AC	1	$1,500.00	$1,500.00
26	3000	Cast-in-Place Concrete	CY	160	$550.00	$88,000.00
27	3000	Misc Cast-in-Place Concrete (thrust and pads)	LS	1	$27,500.00	$27,500.00
28	6000	Handrail	LS	1	$6,000.00	$6,000.00
29	6000	Hatches	LS	1	$5,000.00	$5,000.00
30	6000	Trash Rack	LS	1	$50,000.00	$50,000.00
31	9000	High Performance Coating Systems	LS	1	$15,000.00	$15,000.00
32	11000	Line Shaft Turbine Pump and Motor, 500 HP	EA	4	$210,100.00	$840,400.00
33	11000	Line Shaft Turbine Pump and Motor, 150 HP	EA	1	$103,200.00	$103,200.00
34	15000	30-inch Discharge Pipe, Fittings, & Accessories	EA	4	$25,000.00	$100,000.00
35	15000	30-inch Electric Motor Actuated Butterfly Valves	EA	4	$21,500.00	$86,000.00
36	15000	18-inch Discharge Pipe, Fittings, & Accessories	EA	1	$15,000.00	$15,000.00
37	15000	18-inch Electric Motor Actuated Butterfly Valves	EA	1	$13,750.00	$13,750.00
38	15000	60-inch Steel Discharge Piping	LF	200	$250.00	$50,000.00
39	15000	72-inch Reinf. Conc. Inlet Piping	LF	500	$250.00	$125,000.00
40	15000	Hydraulic Slide Gate	EA	1	$10,000.00	$10,000.00
41	16000	Power and Distribution	LS	1	$70,170.00	$70,170.00
42	16000	Grounding Systems	LS	1	$20,340.00	$20,340.00
43	16000	Conduit and Conductors	LS	1	$58,200.00	$58,200.00
44	16000	Motor Controls	LS	1	$306,570.00	$306,570.00
45	17000	Instrumentation and Control	LS	1	$75,000.00	$75,000.00
		Construction Subtotal				$2,397,415.00
		Contractors Overhead and Profit	10%	1	$239,741.50	$239,741.50
		Contractors Bonds and Insurance	2%	1	$52,743.13	$52,743.13
		Construction Contingency	30%	1	$719,224.50	$719,224.50
		Construction Total				$3,409,124.13
		Engineering, Administration	25%	1	$852,281.03	
		Total				**$4,261,405.16**

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Wire to Water Energy Calculator

Ochoco Irrigation District - SOR

Barnes Butte Pumping Plant - Pump Station Reconstruction

Source: PumpTech Inc.

2425 SE Ochoco Street

Portland, OR 97222

503-659-6230

OPERATIONAL AND EQUIPMENT DATA

	Replacement Pumps		Existing Pumps	
	No. 1 - Floway 27FKL, 2 Stage, 880 RPM, 150 HP		No. 1 - Pellizzari A600/750, Split Case, 720 RPM, 500 HP *	
	No. 2 - Floway 34DKL, 1 Stage, 880 RPM, 450 HP		No. 2 - Pellizzari A600/750, Split Case, 720 RPM, 500 HP *	
	No. 3 - Floway 34DKL, 1 Stage, 880 RPM, 450 HP		No. 3 - Pellizzari A400/500, Split Case, 880 RPM, 250 HP *	
	No. 4 - Floway 34DKL, 1 Stage, 880 RPM, 450 HP		No. 4 - Pellizzari A400/500, Split Case, 880 RPM, 250 HP *	
	No. 5 - Floway 34DKL, 1 Stage, 880 RPM, 450 HP		No. 5 - Wilson Snyder 16BAZ, Split Case, 880 RPM, 300 HP	
Pump Operation - Hours / Day	24		24	
Pump Operation - Days / Year	198		198	
Pump Flow - GPM (Evaluation Pump Rate)	55,620		55,620	
Pump Flow - CFS	123.9		123.9	
Total Annual Volume - Acre feet	48,670		48,670	
Pump Head - Feet	83.3	*	84.0	
Ave. Pump Efficiency - %	86%		77.1%	**
Ave. Motor Efficiency - %	96.3%		95.5%	***
Energy Cost in $/kWH	$0.035		$0.035	

* Estimated Pumping head assumes pump discharge piping, and valves are 30-inch. Estimated motor efficiency assumes synchronous motors.

* Pump Make and model per original construction submittals, 1963

** Pump efficiency assumed to be similar to efficiency of original equipment as supplied. Initial Pump Evaluation test data indicates pump efficiency for tested units greater than construction submittal efficiency curves.

*** Source: Initial Pump Evaluation test data.

RESULTS

	Replacement Pumps	Existing Pumps
BHP At Design Point	1,368.4	1,530.2
Wire to Water Efficiency - %	82%	74%
KW per Year	5,037,368	5,680,317
Annual Energy Cost	$176,307.87	$198,811.10
KW Per 1,000 Gallons Pumped	0.318	0.358
Cost Per 1,000 Gallons Pumped	$0.011	$0.013
kWh per Acre Foot Pumped	103	117
Cost Per Acre Foot Pumped	$3.62	$4.08

PAYBACK

Annual Savings - kW	642,950
Annual Savings - $$	$22,503.23
Annual Savings - %	11.32%
Cost of Replacement Pumps *	$4,261,000.00
Cost of Existing Pumps	$0.00
Payback - Years	189.4

* Estimated cost assumes new pump station with (5) vertical turbine pumps, discharge piping, and valves are 30-inch

Pump Test Data

Initial Pump Evaluation

Project No.: OCHID-04-10 **Description:** Discharge 2.61 ft above Intake pressure gauge

Pump Station No.: Main Lift **Pump No.:** 1 **Water Source:** Canal **Parallel**

Motor Nameplate

Motor Make:	Pellizzari		
Model No:	APS7000/10		
Serial No:			
Rated Hp:	500		
Rated Voltage:	2300		
Rated Amperage:	100	**Ins. Class:**	None
Full Load RPM:	720	**Code:**	None
Enclosure:	None		
Design:	None		
Frame:			
Service Factor:	1.15		

Utility Meter Nameplate

Make: None **Meter ID:** 35 695 918

Type: Digital **Serial No.:** X9D035695918345K

k_h: 1.2 **PTR:** 120 **CTR:** 15

Pump Nameplate

Pump Make:	Pellizzari		
Type:	Split-Case Centrifugal		
Serial No:	275183		
Model No:	A600/750	**Impeller No:**	
Impeller Dia (in):	19.250	**No. of Stages:**	1
Impeller Dia (in):		**No. of Stages:**	0
Secondary Model No:	None	**Impeller No:**	
Impeller Dia (in):		**No. of Stages:**	0
Impeller Dia (in):		**No. of Stages:**	0
Rated Flow (gpm):	17300		
Rated Head (ft):	82		
Rated RPM:	720		
Column Dia (in):	0.00		
Column Length (ft):	0.0		
Shaft Dia (in):	0.000		
Tube Dia (in):	0.000		
Thrust Factor (lbs/ft):	0.0		
Impeller Wt. (lbs):	0.0		

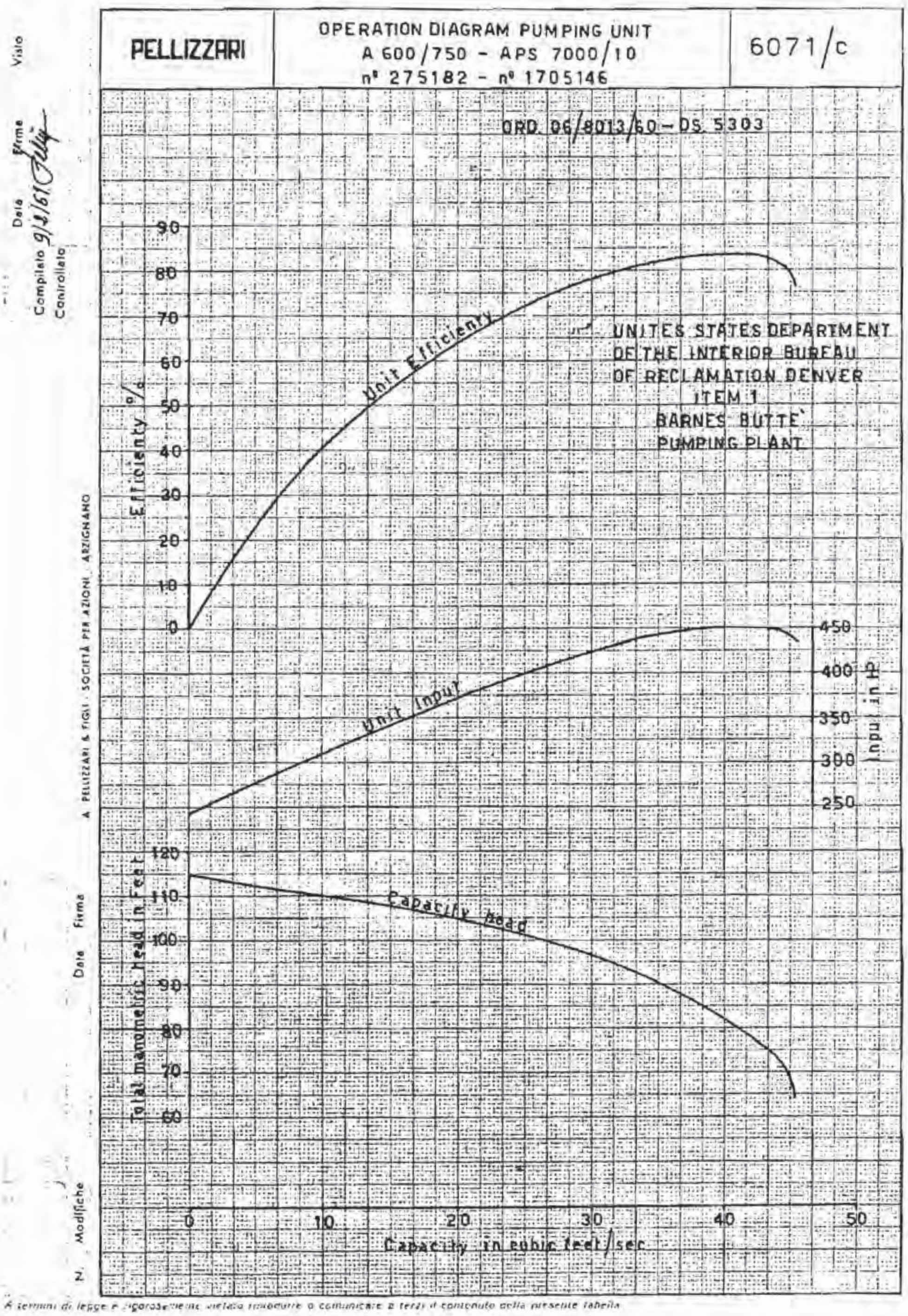
Field Pump Test Data

Test No.	Date	Flow Measurement Device	Flow (gpm)	Pressures Intake (PSI)	Discharge (PSI)	Delivered (PSI)	Misc. Losses (ft)	TDH (ft)	Pump RPM
1-1	10/14/201	Transit Time	17,431	-3.5	27.1	27.1	1.5	72.2	
1-2	10/14/201	Transit Time	19,500	-3.5	27.1	27.1	1.9	72.6	

Test No.	Voltages 1-2	1-3	2-3	Avg.	Amperages 1	2	3	Avg.	Power Factor 1	2	3	Avg.	Utility Meter Rev.	Sec.	Motor RPM	% Load
1-1	2300.0	2300.0	2300.0	2300.0	64.5	62.0	66.0	64.2	100.0%			100.0%	5	125.6	720	79.9%
1-2	2300.0	2300.0	2300.0	2300.0	64.5	62.0	66.0	64.2	100.0%			100.0%	5	125.6	720	79.9%

Test No.	Power Calculations Shaft HP	Thrust HP	Water HP	Brake HP	Pump HP	Input kW	Input HP	Utility Meter (kW)	Efficiencies Motor	Pump	Discharge	Delivered
1-1	0.00	0.00	317.8	399.5	399.5	309.6	414.9	309.6	96.3%	79.6%	76.6%	76.6%
1-2	0.00	0.00	357.5	399.5	399.5	309.6	414.9	309.6	96.3%	89.5%	86.2%	86.2%

Note: If a main valve is present, the Delivered Pressure is the pressure after the valve. If no main valve is present, the Delivered Pressure will be the same as the Discharge Pressure.


PELLIZZARI
OPERATION DIAGRAM PUMPING UNIT
A 600/750 - APS 7000/10
nº 275182 - nº 1705146
6071/c
ORD. 06/8013/60 - DS 5303
Unit Efficiency
UNITES STATES DEPARTMENT
OF THE INTERIOR BUREAU
OF RECLAMATION DENVER
ITEM 1
BARNES BUTTE
PUMPING PLANT
Efficiency %
Unit Input
Capacity head
Total manometric head in Feet
Capacity in cubic feet/sec
A. PELLIZZARI & FIGLI - SOCIETÀ PER AZIONI - ARZIGNANO
Compilato
Controllato
Data
Firme
Visto
9/3/61
Modifiche

Pump Test Data

Initial Pump Evaluation

Project No.: OCHID-04-10 **Description:** Use Test 2-2

Pump Station No.: Main Lift **Pump No.:** 2 **Water Source:** Canal **Parallel**

Motor Nameplate

Motor Make: Pellizzari
Model No: APS7000/10
Serial No:
Rated Hp: 500
Rated Voltage: 2300
Rated Amperage: 100 **Ins. Class:** None
Full Load RPM: 720 **Code:** None
Enclosure: None
Design: None
Frame:
Service Factor: 1.15

Utility Meter Nameplate

Make: None **Meter ID:** 35 695 918
Type: Digital **Serial No.:** X9D035695918345K
k_h: 1.2 **PTR:** 120 **CTR:** 15

Pump Nameplate

Pump Make: Pellizzari
Type: Split-Case Centrifugal
Serial No: 275182
Model No: A600/750 **Impeller No:**
Impeller Dia (in): 19.250 **No. of Stages:** 1
Impeller Dia (in): **No. of Stages:** 0
Secondary Model No: None **Impeller No:**
Impeller Dia (in): **No. of Stages:** 0
Impeller Dia (in): **No. of Stages:** 0
Rated Flow (gpm): 17300
Rated Head (ft): 82
Rated RPM: 720
Column Dia (in): 0.00
Column Length (ft): 0.0
Shaft Dia (in): 0.000
Tube Dia (in): 0.000
Thrust Factor (lbs/ft): 0.0
Impeller Wt. (lbs): 0.0

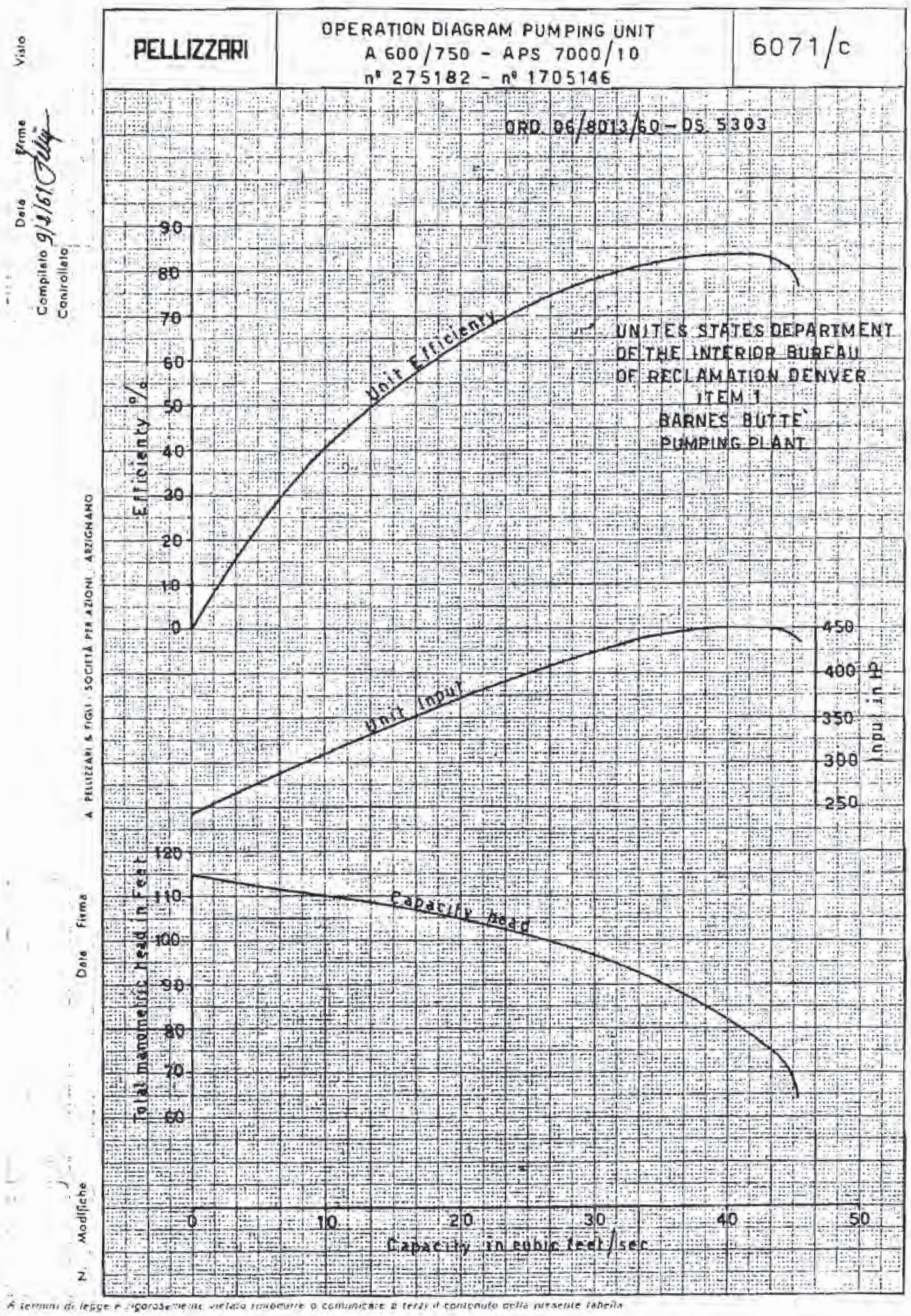
Field Pump Test Data

Test No.	Date	Flow Measurement Device	Flow (gpm)	Pressures Intake (PSI)	Pressures Discharge (PSI)	Pressures Delivered (PSI)	Misc. Losses (ft)	TDH (ft)	Pump RPM
2-1	10/14/201	Transit Time	16,633	-3.7	28.1	28.1	1.4	74.9	720
2-2	10/14/201	Dye Transit-Time	18,600	-3.7	28.1	28.1	1.7	75.2	720

Test No.	Voltages 1-2	1-3	2-3	Avg.	Amperages 1	2	3	Avg.	Power Factor 1	2	3	Avg.	Utility Meter Rev.	Sec.	Motor RPM	% Load
2-1	2300.0	2300.0	2300.0	2300.0	65.0		65.0	65.0	100.0%			100.0%	5	126.3	900	79.4%
2-2	2300.0	2300.0	2300.0	2300.0	65.0		65.0	65.0	100.0%			100.0%	5	126.3		79.4%

Test No.	Power Calculations Shaft HP	Thrust HP	Water HP	Brake HP	Pump HP	Input kW	Input HP	Utility Meter (kW)	Efficiencies Motor	Pump	Discharge	Delivered
2-1	0.00	0.00	314.6	397.2	397.2	307.8	412.5	307.8	96.3%	79.2%	76.2%	76.2%
2-2	0.00	0.00	353.2	397.2	397.2	307.8	412.5	307.8	96.3%	88.9%	85.6%	85.6%

Note: If a main valve is present, the Delivered Pressure is the pressure after the valve. If no main valve is present, the Delivered Pressure will be the same as the Discharge Pressure.


PELLIZZARI
OPERATION DIAGRAM PUMPING UNIT
A 600/750 - APS 7000/10
n° 275182 - n° 1705146
6071/c
ORD. 06/8013/60 - DS 5303
UNITES STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION DENVER
ITEM 1
BARNES BUTTE PUMPING PLANT
Unit Efficienty
Efficienty %
Unit Input
Unit Input
Capacity head
Total manometric head in Feet
Capacity in cubic feet/sec
0
10
20
30
40
50
60
70
80
90
100
110
120
250
300
350
400
450
Compilato 9/3/61
Controllato
Data
Firma
Visto
Modifiche
A. PELLIZZARI & FIGLI - SOCIETÀ PER AZIONI - ARZIGNANO
A termini di legge è rigorosamente vietato riprodurre o comunicare a terzi il contenuto della presente tabella

Pump Test Data

Initial Pump Evaluation

Project No.: OCHID-04-10 **Description:**

Pump Station No.: Main Lift **Pump No.:** 3 **Water Source:** Canal

Motor Nameplate

Motor Make:	Pellizzari		
Model No:	APS3000/8		
Serial No:			
Rated Hp:	250		
Rated Voltage:	2300		
Rated Amperage:	50	**Ins. Class:**	None
Full Load RPM:	900	**Code:**	None
Enclosure:	None		
Design:	None		
Frame:			
Service Factor:	1.15		

Utility Meter Nameplate

Make:	None			**Meter ID:**	35 695 918
Type:	Digital			**Serial No.:**	X9D035695918345K
k_h:	1.2	**PTR:**	120	**CTR:**	15

Pump Nameplate

Pump Make:	Pellizzari		
Type:	Split-Case Centrifugal		
Serial No:	275184		
Model No:	A400/500	**Impeller No:**	
Impeller Dia (in):		**No. of Stages:**	1
Impeller Dia (in):		**No. of Stages:**	0
Secondary Model No:	None	**Impeller No:**	
Impeller Dia (in):		**No. of Stages:**	0
Impeller Dia (in):		**No. of Stages:**	0
Rated Flow (gpm):	8640		
Rated Head (ft):	82		
Rated RPM:	900		
Column Dia (in):	0.00		
Column Length (ft):	0.0		
Shaft Dia (in):	0.000		
Tube Dia (in):	0.000		
Thrust Factor (lbs/ft):	0.0		
Impeller Wt. (lbs):	0.0		

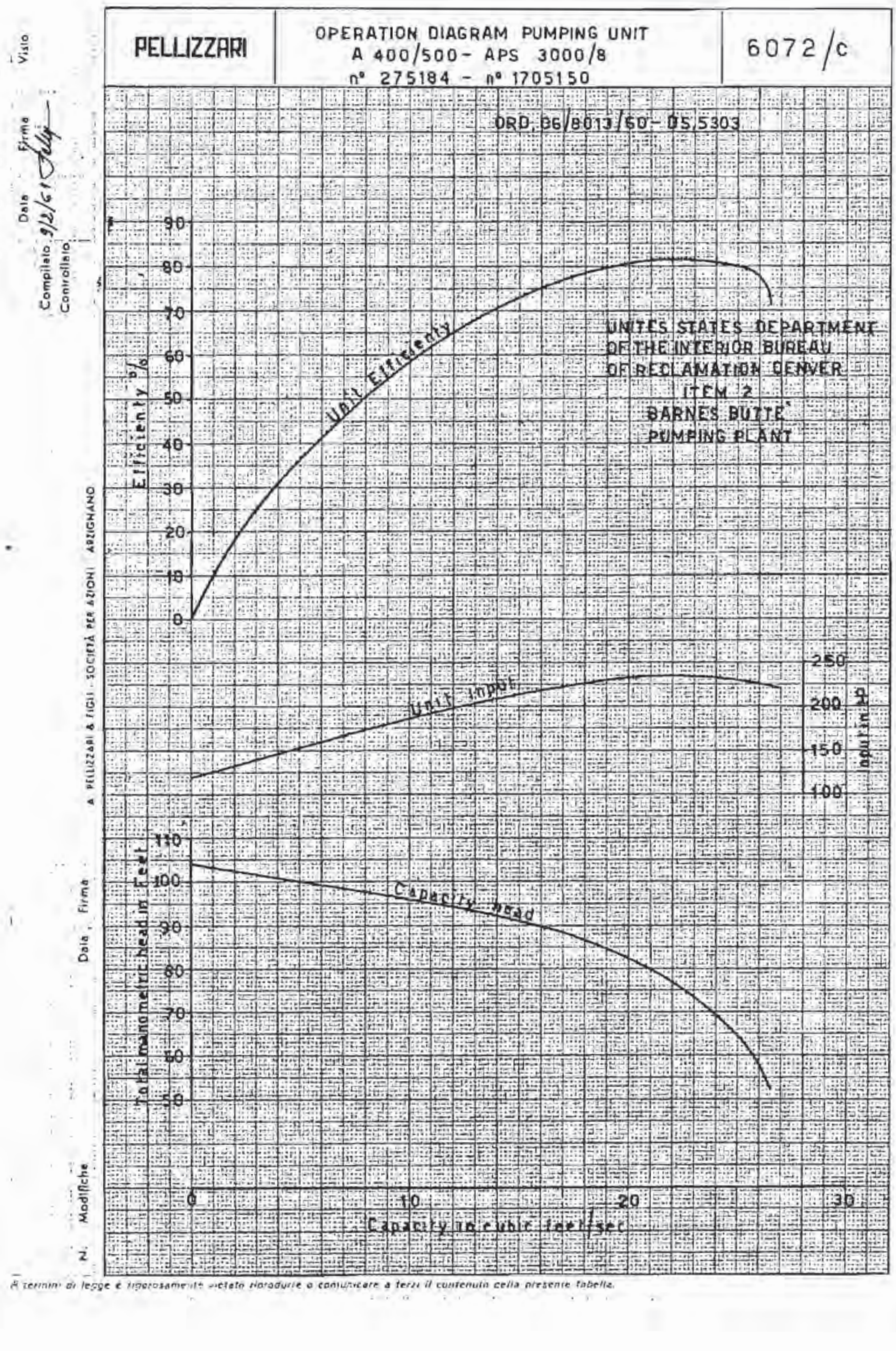
Field Pump Test Data

Test No.	Date	Flow Measurement Device	Flow (gpm)	Pressures Intake (PSI)	Pressures Discharge (PSI)	Pressures Delivered (PSI)	Misc. Losses (ft)	TDH (ft)	Pump RPM
3-1	10/14/201	Transit Time	9,460	-3.5	28.1	28.1	2.4	75.4	900

Test No.	Voltages 1-2	1-3	2-3	Avg.	Amperages 1	2	3	Avg.	Power Factor 1	2	3	Avg.	Utility Meter Rev.	Sec.	Motor RPM	% Load
3-1	2300.0	2300.0	2300.0	2300.0	19.5	20.1	19.2	19.6	100.0%			100.0%	2	104.3	900	76.9%

Test No.	Power Calculations Shaft HP	Thrust HP	Water HP	Brake HP	Pump HP	Input kW	Input HP	Utility Meter (kW)	Efficiencies Motor	Pump	Discharge	Delivered
3-1	0.00	0.00	180.1	192.4	192.4	149.1	199.8	149.1	96.3%	95.2%	91.7%	91.7%

Note: If a main valve is present, the Delivered Pressure is the pressure after the valve. If no main valve is present, the Delivered Pressure will be the same as the Discharge Pressure.


PELLIZZARI
OPERATION DIAGRAM PUMPING UNIT
A 400/500 - APS 3000/8
n° 275184 - n° 1705150
6072/c
ORD. 06/8013/60 - D5.5303
UNITES STATES DEPARTMENT
OF THE INTERIOR BUREAU
OF RECLAMATION DENVER
ITEM 2
BARNES BUTTE
PUMPING PLANT
Unit Efficiency
Efficiency %
Unit input
input in hp
Capacity head
Total manometric head in Feet
Capacity in cubic feet/sec
Visto
Firme
Data
Compilato 9/2/61
Controllato
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Modifiche
N.

Pump Test Data

Initial Pump Evaluation

Project No.: OCHID-04-10 **Description:** Use Test 4-2

Pump Station No.: Main Lift **Pump No.:** 4 **Water Source:** Canal **Parallel**

Motor Nameplate

Motor Make:	Pellizzari		
Model No:	APS3000/8		
Serial No:			
Rated Hp:	250		
Rated Voltage:	2300		
Rated Amperage:	50	**Ins. Class:**	None
Full Load RPM:	900	**Code:**	None
Enclosure:	None		
Design:	None		
Frame:			
Service Factor:	1.15		

Utility Meter Nameplate

Make: None **Meter ID:** 35 695 918

Type: Digital **Serial No.:** X9D035695918345K

k_h**:** 1.2 **PTR:** 120 **CTR:** 15

Pump Nameplate

Pump Make:	Pellizzari		
Type:	Split-Case Centrifugal		
Serial No:	275185		
Model No:	A400/500	**Impeller No:**	
Impeller Dia (in):		**No. of Stages:**	1
Impeller Dia (in):		**No. of Stages:**	0
Secondary Model No:	None	**Impeller No:**	
Impeller Dia (in):		**No. of Stages:**	0
Impeller Dia (in):		**No. of Stages:**	0
Rated Flow (gpm):	8640		
Rated Head (ft):	82		
Rated RPM:	900		
Column Dia (in):	0.00		
Column Length (ft):	0.0		
Shaft Dia (in):	0.000		
Tube Dia (in):	0.000		
Thrust Factor (lbs/ft):	0.0		
Impeller Wt. (lbs):	0.0		

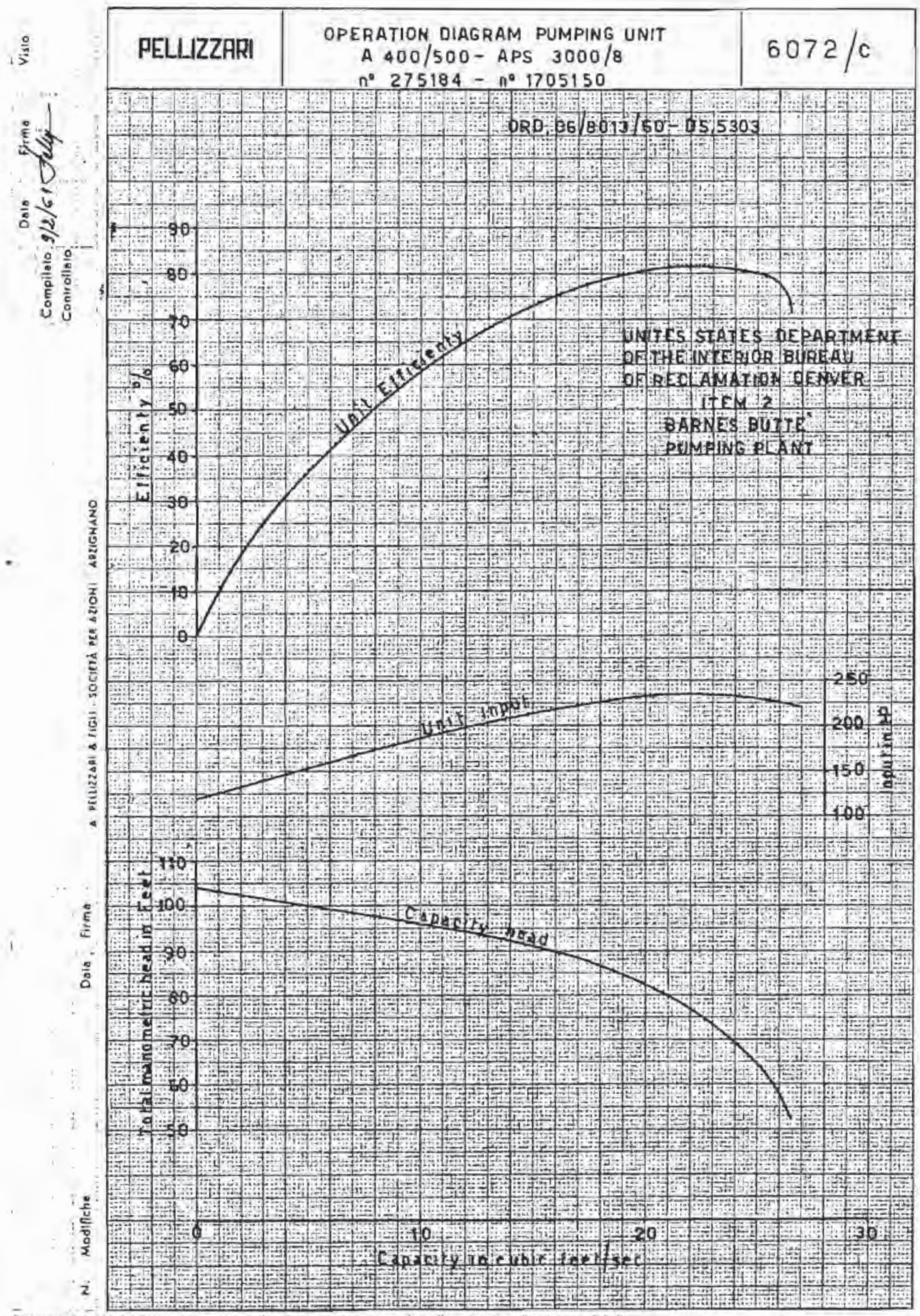
Field Pump Test Data

Test No.	Date	Flow Measurement Device	Flow (gpm)	Pressures Intake (PSI)	Pressures Discharge (PSI)	Pressures Delivered (PSI)	Misc. Losses (ft)	TDH (ft)	Pump RPM
4-1	10/14/201	Transit Time	8,117	-3.3	28.1	28.1	1.7	74.3	900
4-2	10/14/201	Dye Transit-Time	7,910	-3.3	28.1	28.1	1.6	74.2	

Test No.	Voltages 1-2	1-3	2-3	Avg.	Amperages 1	2	3	Avg.	Power Factor 1	2	3	Avg.	Utility Meter Rev.	Sec.	Motor RPM	% Load
4-1	2300.0	2300.0	2300.0	2300.0	19.0		18.0	18.5	100.0%			100.0%	2	106.8	900	75.2%
4-2	2400.0	2400.0	2400.0	2400.0	19.0		18.0	18.5	100.0%			100.0%	2	106.8	900	75.2%

Test No.	Power Calculations Shaft HP	Thrust HP	Water HP	Brake HP	Pump HP	Input kW	Input HP	Utility Meter (kW)	Efficiencies Motor	Pump	Discharge	Delivered
4-1	0.00	0.00	152.3	188.1	188.1	145.6	195.1	145.6	96.4%	82.0%	79.1%	79.1%
4-2	0.00	0.00	148.2	188.1	188.1	145.6	195.1	145.6	96.4%	79.8%	76.9%	76.9%

Note: If a main valve is present, the Delivered Pressure is the pressure after the valve. If no main valve is present, the Delivered Pressure will be the same as the Discharge Pressure.



PELLIZZARI
OPERATION DIAGRAM PUMPING UNIT
A 400/500- APS 3000/8
n° 275184 - n° 1705150
6072/c
ORD. 06/8013/60- 05.5303
UNITES STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION DENVER
ITEM 2
BARNES BUTTE PUMPING PLANT
Unit Efficiency
Efficiency %
Unit input
Capacity head
Total manometric head in Feet
Capacity in cubic feet/sec
Visto
Firma
Data
Compilato 9/2/61
Controllato
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Modifiche
N.

Pump Test Data

Initial Pump Evaluation

Project No.: OCHID-04-10 **Description:** Intake PSI is estimated at point of connection

Pump Station No.: Main Lift **Pump No.:** 5 **Water Source:** Canal **Parallel**

Motor Nameplate

Motor Make:	None		
Model No:			
Serial No:			
Rated Hp:	300		
Rated Voltage:	2300		
Rated Amperage:		**Ins. Class:**	None
Full Load RPM:	880	**Code:**	None
Enclosure:	None		
Design:	None		
Frame:			
Service Factor:	1.15		

Utility Meter Nameplate

Make:	None	**Meter ID:**	35 695 918		
Type:	Digital	**Serial No.:**	X9D035695918345K		
k_h:	1.2	**PTR:**	120	**CTR:**	15

Pump Nameplate

Pump Make:	Wilson-Snyder		
Type:	Split-Case Centrifugal		
Serial No:	16BAZ		
Model No:	None	**Impeller No:**	
Impeller Dia (in):		**No. of Stages:**	0
Impeller Dia (in):		**No. of Stages:**	0
Secondary Model No:	None	**Impeller No:**	
Impeller Dia (in):		**No. of Stages:**	0
Impeller Dia (in):		**No. of Stages:**	0
Rated Flow (gpm):	9000		
Rated Head (ft):	94		
Rated RPM:	880		
Column Dia (in):	0.00		
Column Length (ft):	0.0		
Shaft Dia (in):	0.000		
Tube Dia (in):	0.000		
Thrust Factor (lbs/ft):	0.0		
Impeller Wt. (lbs):	0.0		

Field Pump Test Data

Test No.	Date	Flow Measurement Device	Flow (gpm)	Pressures Intake (PSI)	Pressures Discharge (PSI)	Pressures Delivered (PSI)	Misc. Losses (ft)	TDH (ft)	Pump RPM
5-1	10/14/201	Dye Transit-Time	9,037	-3.3	27.4	27.4	3.6	74.6	900

Test No.	Voltages 1-2	Voltages 1-3	Voltages 2-3	Voltages Avg.	Amperages 1	Amperages 2	Amperages 3	Amperages Avg.	Power Factor 1	Power Factor 2	Power Factor 3	Power Factor Avg.	Utility Meter Rev.	Utility Meter Sec.	Motor RPM	Motor % Load
5-1													3	114.0	884	84.5%

Test No.	Shaft HP	Thrust HP	Water HP	Brake HP	Pump HP	Input kW	Input HP	Utility Meter (kW)	Efficiencies Motor	Efficiencies Pump	Efficiencies Discharge	Efficiencies Delivered
5-1	0.00	0.00	170.2	253.6	253.6	204.6	274.2	204.6	92.5%	67.1%	62.1%	62.1%

Note: If a main valve is present, the Delivered Pressure is the pressure after the valve. If no main valve is present, the Delivered Pressure will be the same as the Discharge Pressure.

Pump Test Summary Data

Project No.: OCHID-04-10

Pump Station	Pump No.	Condition	Test No.	Include	Rated Hp	Flow (gpm)	Intake (PSI)	Discharge (PSI)	Delivery (PSI)	TDH (FT)	Electric Hp	Pump Eff.	Overall Eff.
Main Lift	1	Existing	1-1		500	17,431	-3.5	27.1	27.1	73.3	414.9	79.6%	76.6%
Main Lift	1	Existing	1-2	X	500	19,500	-3.5	27.1	27.1	73.9	414.9	89.5%	86.2%
Main Lift	2	Existing	2-1		500	16,633	-3.7	28.1	28.1	75.8	412.5	79.2%	76.2%
Main Lift	2	Existing	2-2	X	500	18,600	-3.7	28.1	28.1	76.4	412.5	88.9%	85.6%
Main Lift	3	Existing	3-1		250	9,460	-3.5	28.1	28.1	77.0	199.8	95.2%	91.7%
Main Lift	4	Existing	4-1		250	8,117	-3.3	28.1	28.1	75.5	195.1	82.0%	79.1%
Main Lift	4	Existing	4-2	X	250	7,910	-3.3	28.1	28.1	75.3	195.1	79.8%	76.9%
Main Lift	5	Existing	5-1		300	9,037	-3.3	27.4	27.4	76.1	274.2	68.2%	63.1%

Pump Performance Datasheet

Customer	:	Quote number	:
Customer reference	:	Size	: 34DKL
Item number	: Barnes Butte PS - 4 Vert Turbines @ 35.65 cfs	Stages	: 1
Service	: Irrigation Water	Based on curve number	: 34DKL 880
Quantity	: 1	Date last saved	: 31 May 2011 1:38 PM

Operating Conditions

Flow, rated	: 16,000.0 USgpm
Differential head / pressure, rated (requested)	: 89.28 ft
Differential head / pressure, rated (actual)	: 89.52 ft
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: 46.28 ft
Frequency	: 60 Hz

Performance

Speed, rated	: 880 rpm
Impeller diameter, rated	: 21.91 in
Impeller diameter, maximum	: 23.62 in
Impeller diameter, minimum	: 20.62 in
Efficiency (bowl / pump)	: 85.57 / 80.62 %
NPSH required / margin required	: 29.93 / 5.00 ft
nq (imp. eye flow) / S (imp. eye flow)	: 68 / 162 Metric units
MCSF	: 3,632.2 USgpm
Head, maximum, rated diameter	: 148.5 ft
Head rise to shutoff	: 66.38 %
Flow, best eff. point (BEP)	: 15,913.0 USgpm
Flow ratio (rated / BEP)	: 100.55 %
Diameter ratio (rated / max)	: 92.72 %
Head ratio (rated dia / max dia)	: 81.67 %
Cq/Ch/Ce [ANSI/HI 9.6.7-2004]	: 1.00 / 1.00 / 1.00
Selection status	: Acceptable

Liquid

Liquid type	: --Other
Additional liquid description	: Raw Water
Solids diameter, max	: 1.50 in
Solids concentration, by volume	: 0.00 %
Temperature, max	: 68.00 deg F
Fluid density, rated / max	: 1.000 / 1.000 SG
Viscosity, rated	: 1.00 cP
Vapor pressure, rated	: 0.00 psi.a

Material

Material selected	: Cast Iron/Bronze

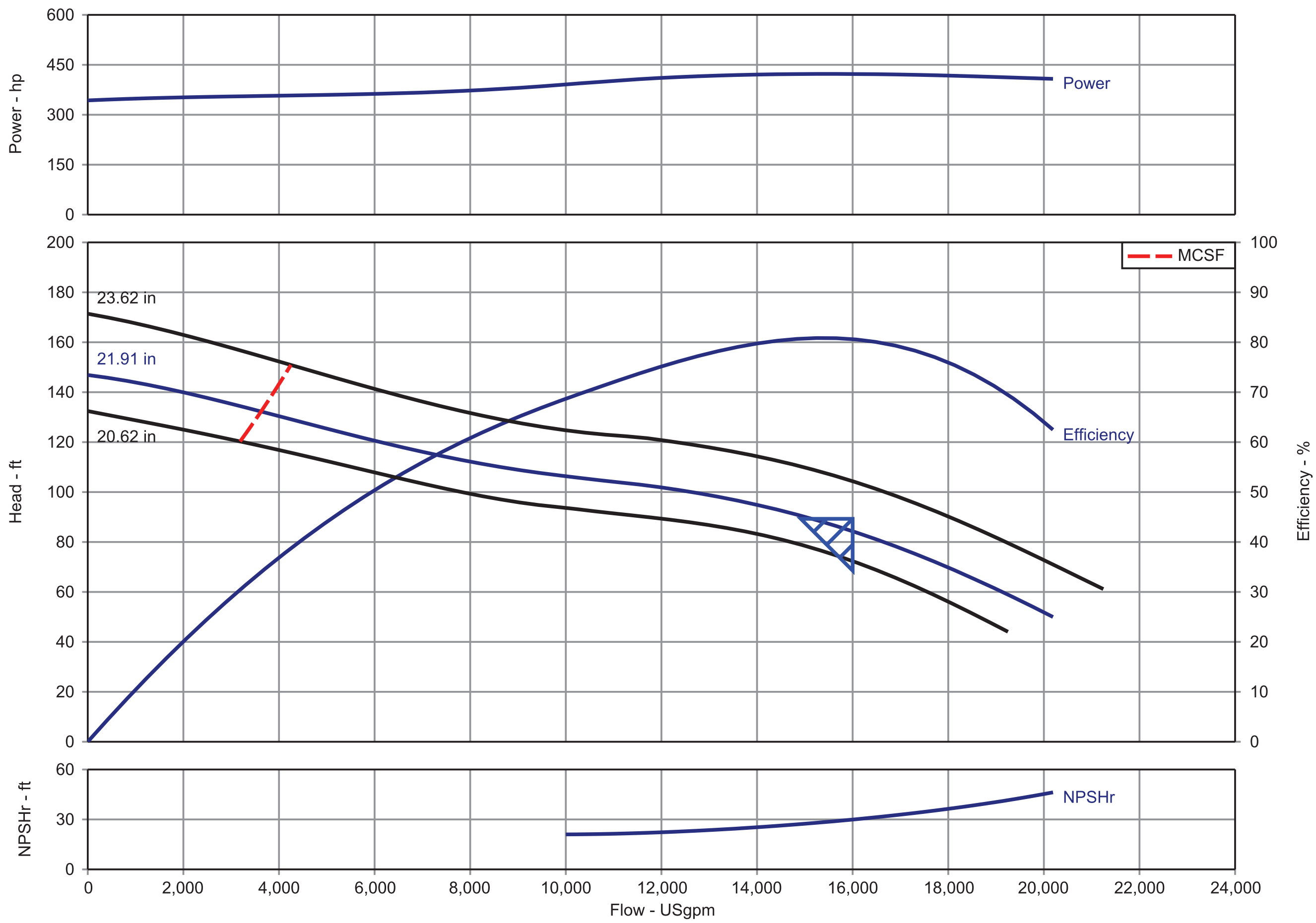
Pressure Data

Maximum working pressure	: 64.31 psi.g
Maximum allowable working pressure	: 260.0 psi.g
Maximum allowable suction pressure	: N/A
Hydrostatic test pressure	: N/A

Driver & Power Data

Driver sizing specification	: Rated power
Margin over specification	: 0.00 %
Service factor	: 1.00
Power, hydraulic	: 361 hp
Power (bowl / pump)	: 422 / 422 hp
Power, maximum, rated diameter	: 423 hp
Minimum recommended motor rating	: 450 hp / 336 kW

Pump performance. Adjusted for construction, viscosity, static lift to discharge nozzle centerline, friction and power losses of lineshaft and thrust bearings.
The duty point represents the head at the bowl.



Pump Performance Datasheet

Customer	:	Quote number	:
Customer reference	:	Size	: 27FKL
Item number	: Barnes Butte PS - 4 Vert Turbines @ 35.65 cfs	Stages	: 2
Service	: Irrigation Water	Based on curve number	: 27FKL 880
Quantity	: 1	Date last saved	: 31 May 2011 1:44 PM

Operating Conditions

Flow, rated	: 5,600.0 USgpm
Differential head / pressure, rated (requested)	: 89.28 ft
Differential head / pressure, rated (actual)	: 89.75 ft
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: 46.28 ft
Frequency	: 60 Hz

Performance

Speed, rated	: 880 rpm
Impeller diameter, rated	: 15.88 in
Impeller diameter, maximum	: 16.87 in
Impeller diameter, minimum	: 14.88 in
Efficiency (bowl / pump)	: 86.01 / 82.12 %
NPSH required / margin required	: 15.32 / 5.00 ft
nq (imp. eye flow) / S (imp. eye flow)	: 68 / 165 Metric units
MCSF	: 1,332.5 USgpm
Head, maximum, rated diameter	: 166.7 ft
Head rise to shutoff	: 86.75 %
Flow, best eff. point (BEP)	: 5,549.0 USgpm
Flow ratio (rated / BEP)	: 100.92 %
Diameter ratio (rated / max)	: 94.07 %
Head ratio (rated dia / max dia)	: 82.93 %
Cq/Ch/Ce [ANSI/HI 9.6.7-2004]	: 1.00 / 1.00 / 1.00
Selection status	: Acceptable

Liquid

Liquid type	: --Other
Additional liquid description	: Raw Water
Solids diameter, max	: 1.50 in
Solids concentration, by volume	: 0.00 %
Temperature, max	: 68.00 deg F
Fluid density, rated / max	: 1.000 / 1.000 SG
Viscosity, rated	: 1.00 cP
Vapor pressure, rated	: 0.00 psi.a

Material

Material selected	: Cast Iron/Bronze

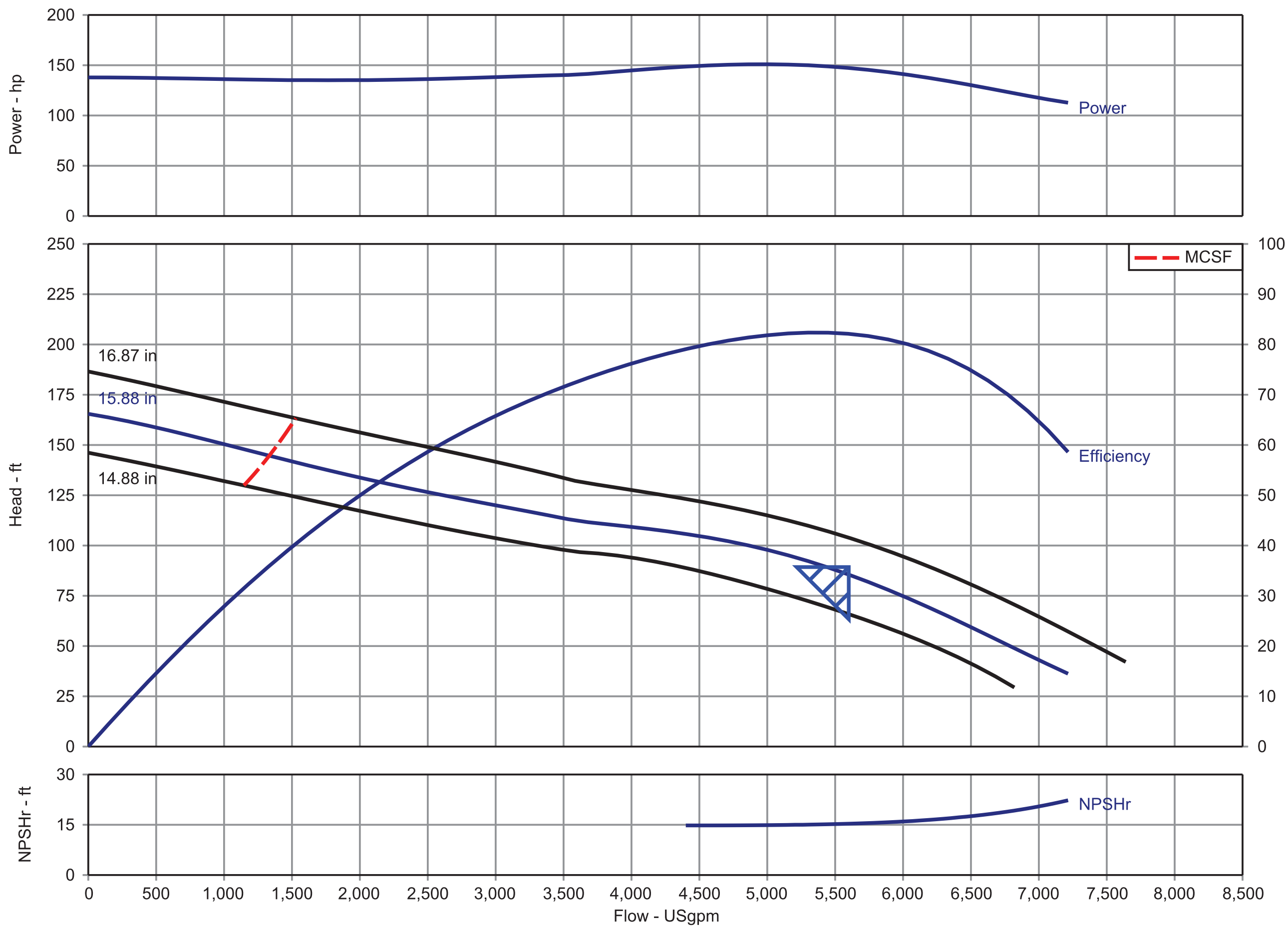
Pressure Data

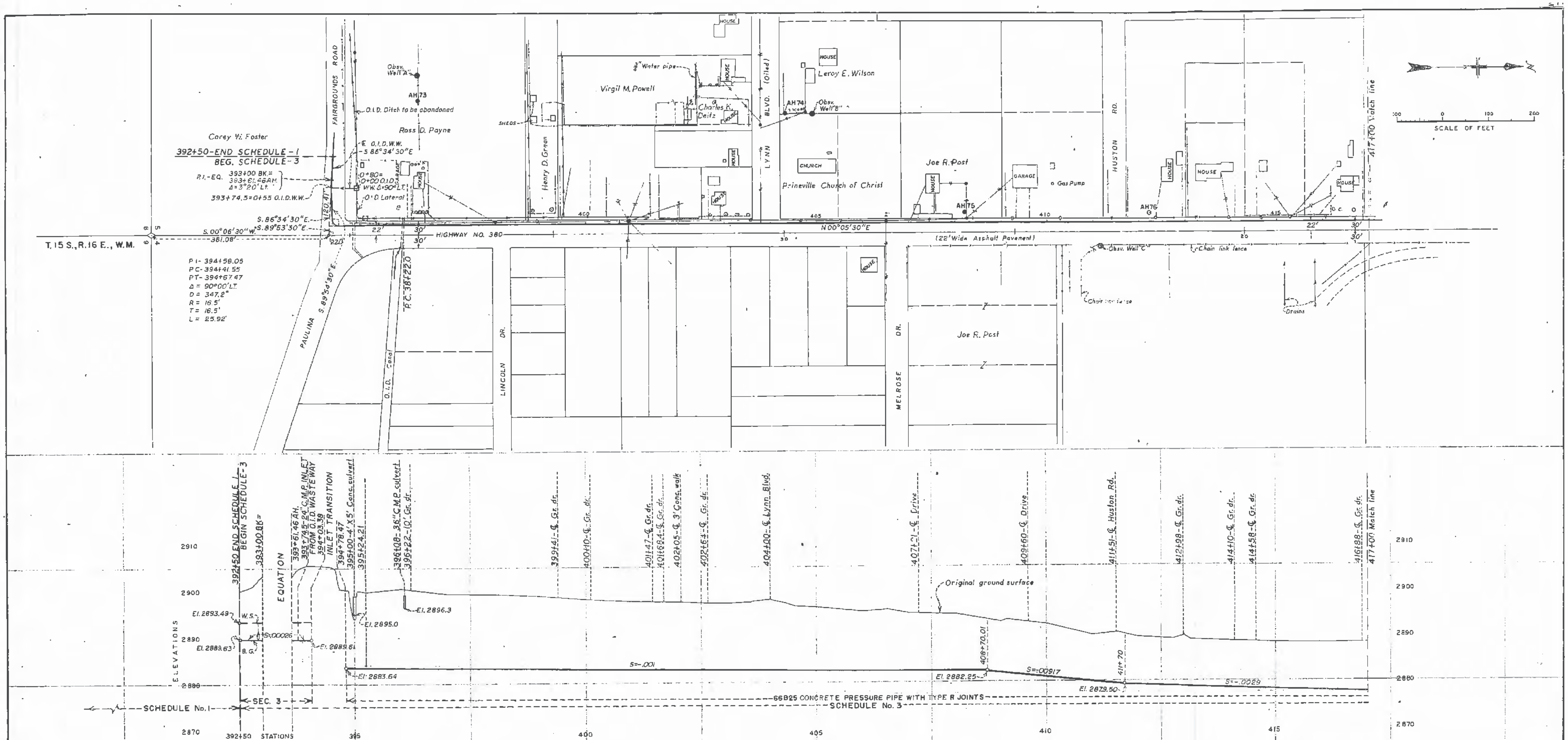
Maximum working pressure	: 72.18 psi.g
Maximum allowable working pressure	: 309.0 psi.g
Maximum allowable suction pressure	: N/A
Hydrostatic test pressure	: N/A

Driver & Power Data

Driver sizing specification	: Rated power
Margin over specification	: 0.00 %
Service factor	: 1.00
Power, hydraulic	: 126 hp
Power (bowl / pump)	: 147 / 147 hp
Power, maximum, rated diameter	: 151 hp
Minimum recommended motor rating	: 150 hp / 112 kW

Pump performance. Adjusted for construction, viscosity, static lift to discharge nozzle centerline, friction and power losses of lineshaft and thrust bearings.
The duty point represents the head at the bowl.





NOTES

Stations and elevations shown on plan and profile refer to invert, unless otherwise shown.
Backfill about top of siphon as directed, 3.5' Min. unless otherwise shown.
Stations and elevations of P.I.'s are to be considered approximate only, and may be adjusted according to actual laying length of pipe.
Additional notes will be found on 113-D-175.

REFERENCE DRAWINGS

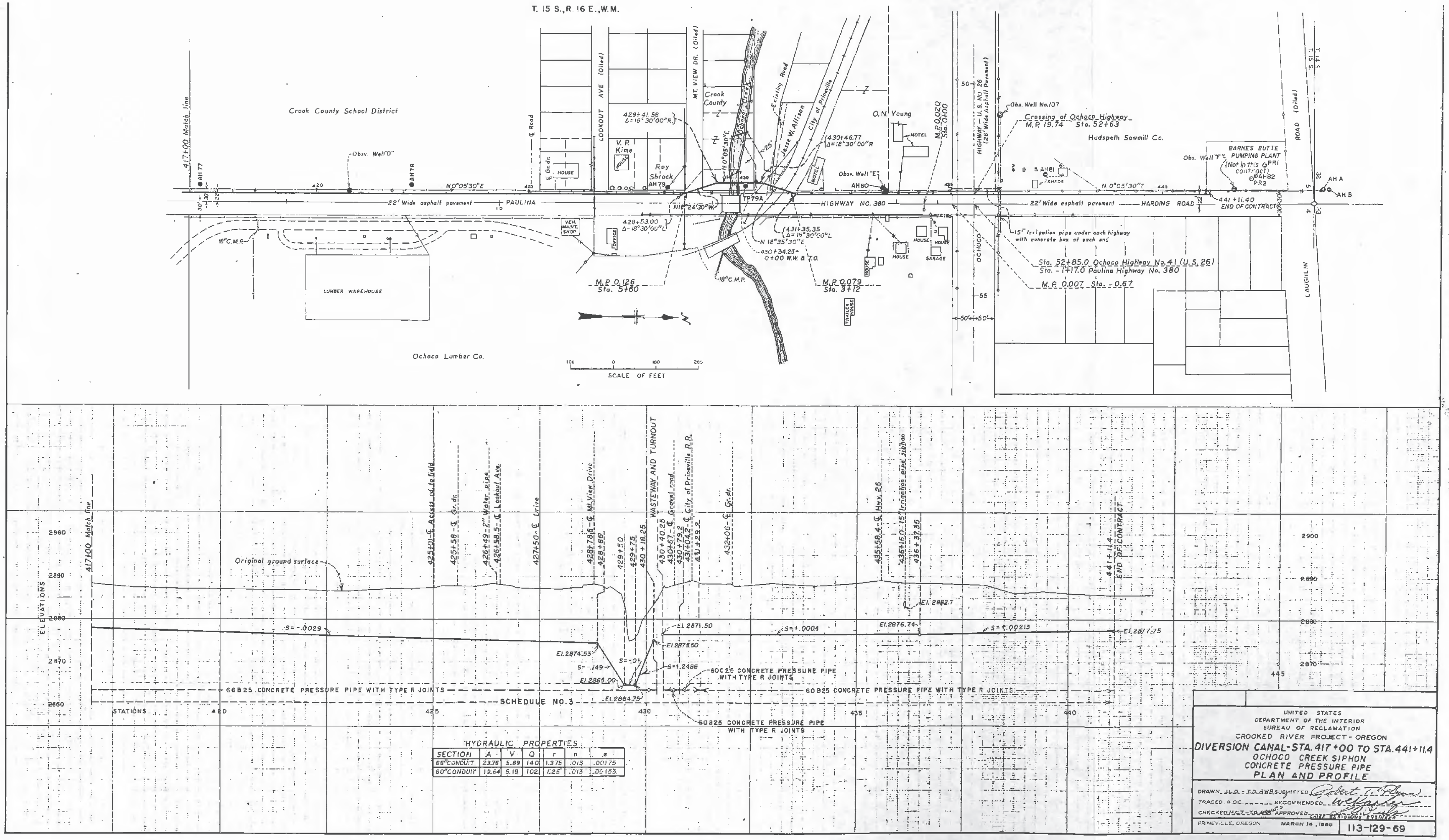
INLET TRANSITION—PLAN AND SECTIONS 113-D-175
SECTIONS AND DETAILS 113-D-176
PRECAST CONCRETE PIPE BENDS 113-D-211
WASTEWAY AND TURNOUT .... 113-D-177 & 178
OCHOCO CREEK SIPHON—SECTIONS AND DETAILS 113-D-209
LOGS OF EXPLORATION 113-129-80

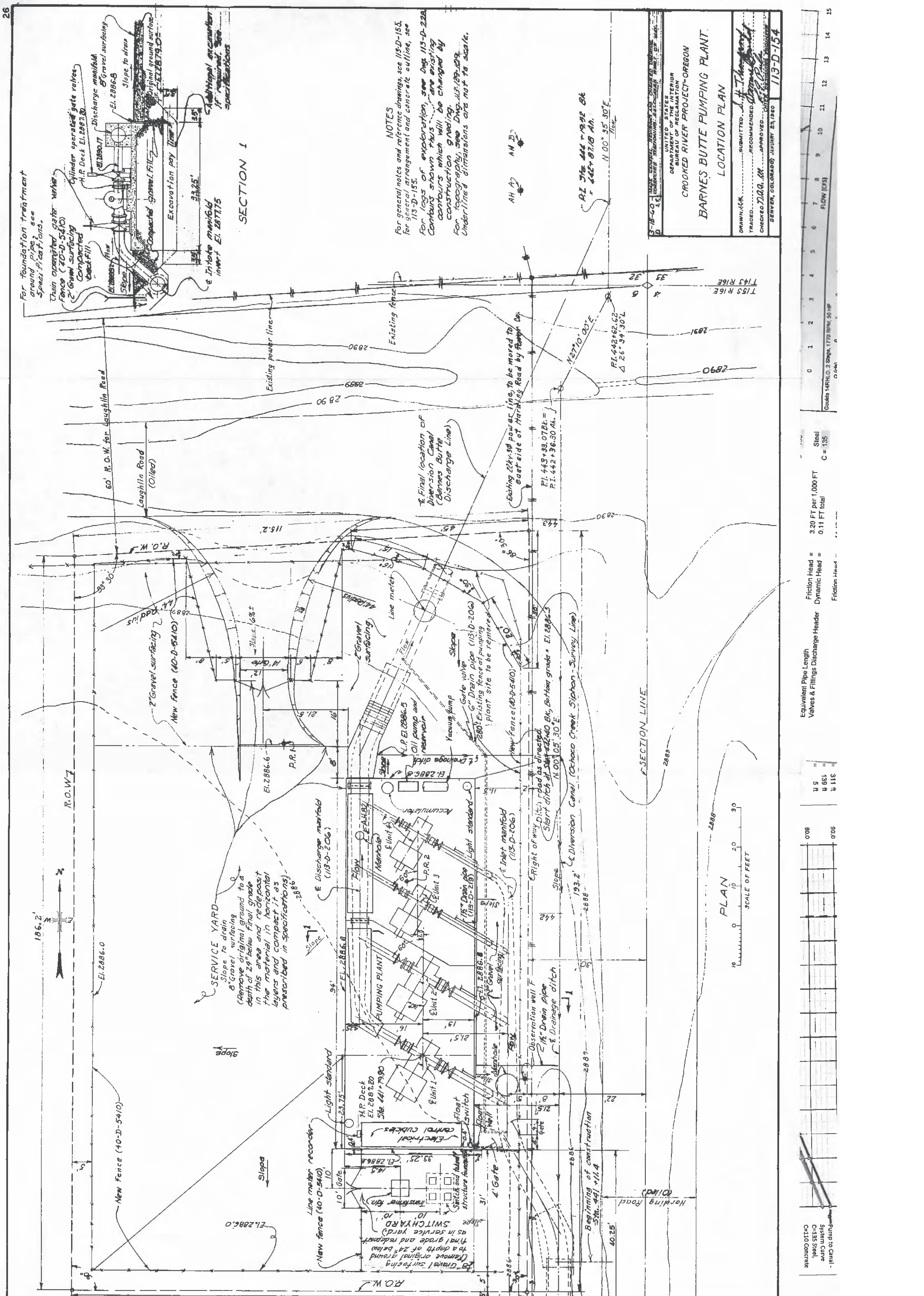
HYDRAULIC PROPERTIES

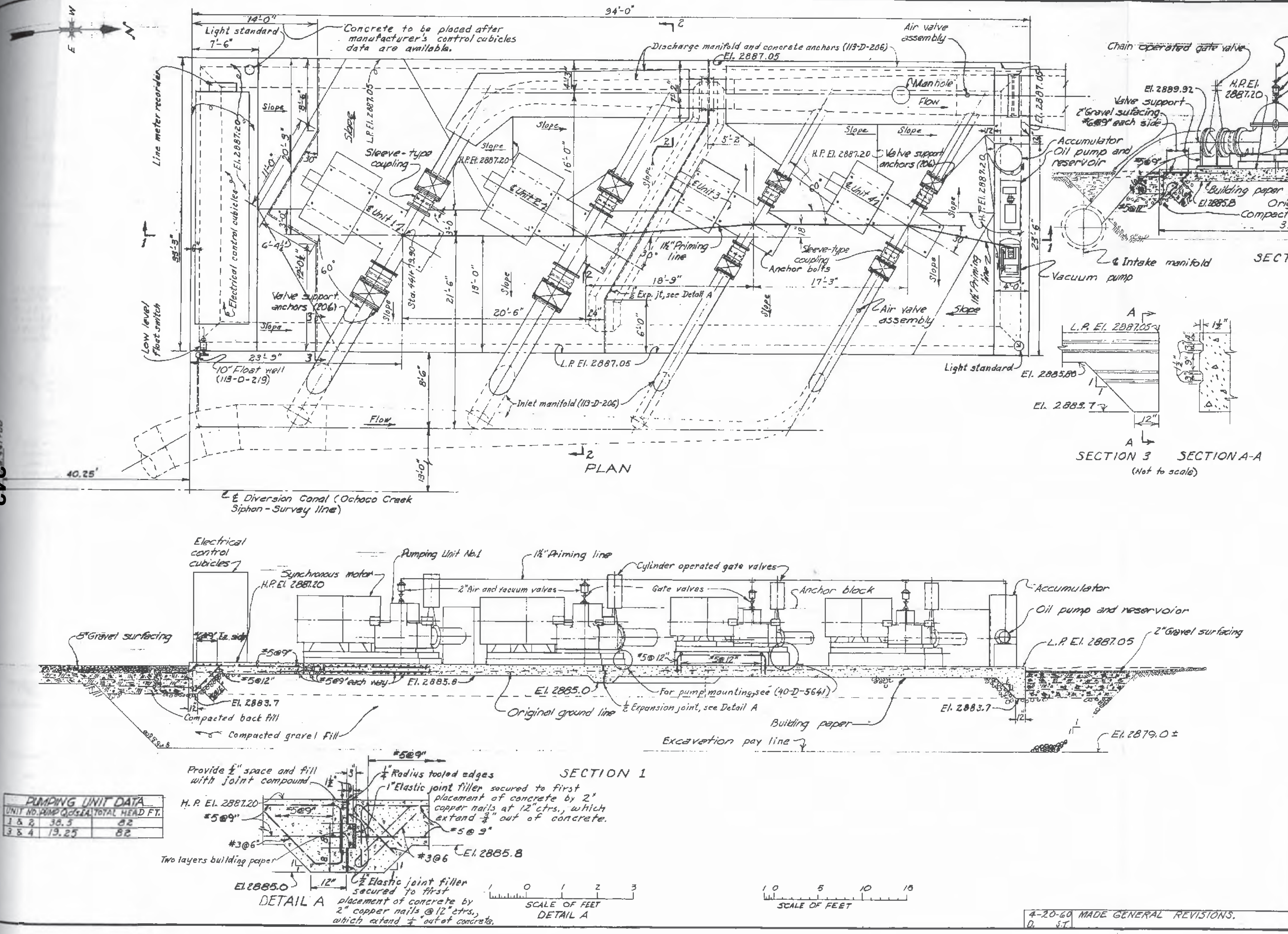
SECTION	A	V	Q	r	n	s
CANAL	68.6	2.04	140	2.84	.0225	.00026
66" CONDUIT	23.76	5.89	140	1.375	.013	.00175

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CROOKED RIVER PROJECT - OREGON
DIVERSION CANAL - STA. 392+50 TO STA. 417+00
INLET CHANNEL AND OCHOCO CREEK SIPHON
CONCRETE PRESSURE PIPE
PLAN AND PROFILE

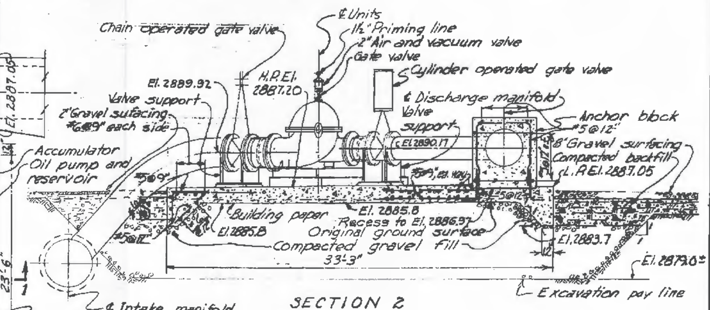
DRAWN T.D. & W.B. SUBMITTED Robert T. [signature]
TRACED A.O.F. RECOMMENDED [signature]
CHECKED J.L.O. T.D.W. APPROVED [signature]
PRINEVILLE, OREGON MARCH 14, 1960 113-129-68


T. 15 S., R. 16 E., W.M.
Crook County School District
Ochoco Lumber Co.
Hudspeth Sawmill Co.
LUMBER WAREHOUSE
PAULINA
HIGHWAY NO. 380
HARDING ROAD
22' Wide asphalt pavement
LOOKOUT AVE (Oiled)
MT. VIEW DR. (Oiled)
LAUGHLIN ROAD (Oiled)
OCHOCO HIGHWAY — U.S. NO. 26 (26' Wide Asphalt Pavement)
Crossing of Ochoco Highway M.P. 19.74 Sta. 52+63
Sta. 52+85.0 Ochoco Highway No. 41 (U.S. 26)
Sta. -1+17.0 Paulina Highway No. 380
M.P. 0.007 Sta. -0.67
M.P. 0.126 Sta. 5+60
M.P. 0.079 Sta. 3+12
M.P. 0.020 Sta. 0+00
BARNES BUTTE PUMPING PLANT (Not in this contract)
441+11.40 END OF CONTRACT
15" Irrigation pipe under each highway with concrete box at each end
SCALE OF FEET
417+00 Match line
Original ground surface
WASTEWAY AND TURNOUT
66B25 CONCRETE PRESSURE PIPE WITH TYPE R JOINTS
60C25 CONCRETE PRESSURE PIPE WITH TYPE R JOINTS
60B25 CONCRETE PRESSURE PIPE WITH TYPE R JOINTS
SCHEDULE NO. 3
STATIONS
ELEVATIONS
HYDRAULIC PROPERTIES
SECTION | A | V | Q | r | n | s
66" CONDUIT | 23.76 | 5.89 | 140 | 1.375 | .013 | .00175
60" CONDUIT | 19.64 | 5.19 | 102 | 1.25 | .013 | .00153
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CROOKED RIVER PROJECT - OREGON
DIVERSION CANAL-STA. 417+00 TO STA. 441+11.4
OCHOCO CREEK SIPHON
CONCRETE PRESSURE PIPE
PLAN AND PROFILE
PRINEVILLE, OREGON
MARCH 14, 1960
113-129-69


26
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CROOKED RIVER PROJECT-OREGON
BARNES BUTTE PUMPING PLANT
LOCATION PLAN
DENVER, COLORADO, JANUARY 25, 1960
113-D-154
SECTION 1
PLAN
SCALE OF FEET
NOTES
For general notes and reference drawings, see 113-D-153.
Underlined dimensions are not to scale.
SERVICE YARD
SWITCHYARD
PUMPING PLANT
SECTION LINE
Laughlin Road (Oiled)
60' R.O.W. for Laughlin Road
Existing power line
Existing fence
New fence (40-D-5410)
Harding Road (Oiled)
Diversion Canal (Ochoco Creek Siphon - Survey Line)



PUMPING UNIT DATA		
UNIT NO.	PUMP Q.c.f.s. EA.	TOTAL HEAD FT.
1 & 2	38.5	82
3 & 4	19.25	82



GENERAL NOTES

Edges of permanently exposed surfaces to be chamfered ¾" unless otherwise shown.
Pump slab to have U2 finish.
Structural design is based on 3000 p.s.i. ultimate compressive concrete strength at 28 days.
Numerals in parenthesis ( ) following a note, detail or section indicate the drawing on which they are shown.
For embedded conduits and ground cables, see electrical drawings.
Location and dimensions of recesses, pedestals and anchor bolts for pumps and motors are to be determined when equipment data are available. See Dwg. 40-D-5641 for typical pump mounting details.
For general reinforcement notes, see Dwg. 40-D-5495
Reinforcement shall have a minimum of 3 inches of clear concrete cover, except in the top of the slab, where a minimum of 1½ inches is required.
Reinforcement splices shall be 30 bar diameters.
Concrete shall not be placed until manufacturer's data on pumps and motors are available.
Underlined dimensions are not to scale.

REFERENCE DRAWINGS

LOCATION PLAN	113-D-154
PUMP MOUNTING	40-D-5641
GENERAL REINFORCEMENT NOTES	40-D-5495
WORKING STRESSES	103-D-563
STANDARD FENCING REQUIREMENTS	40-D-5410
SWITCHYARDS-STEEL STRUCTURES	113-D-214
PRIMING SYSTEM, DISCHARGE VALVES, VALVE OPERATING SYSTEM AND DRAINS	113-D-219
DISCHARGE LINE	113-D-221

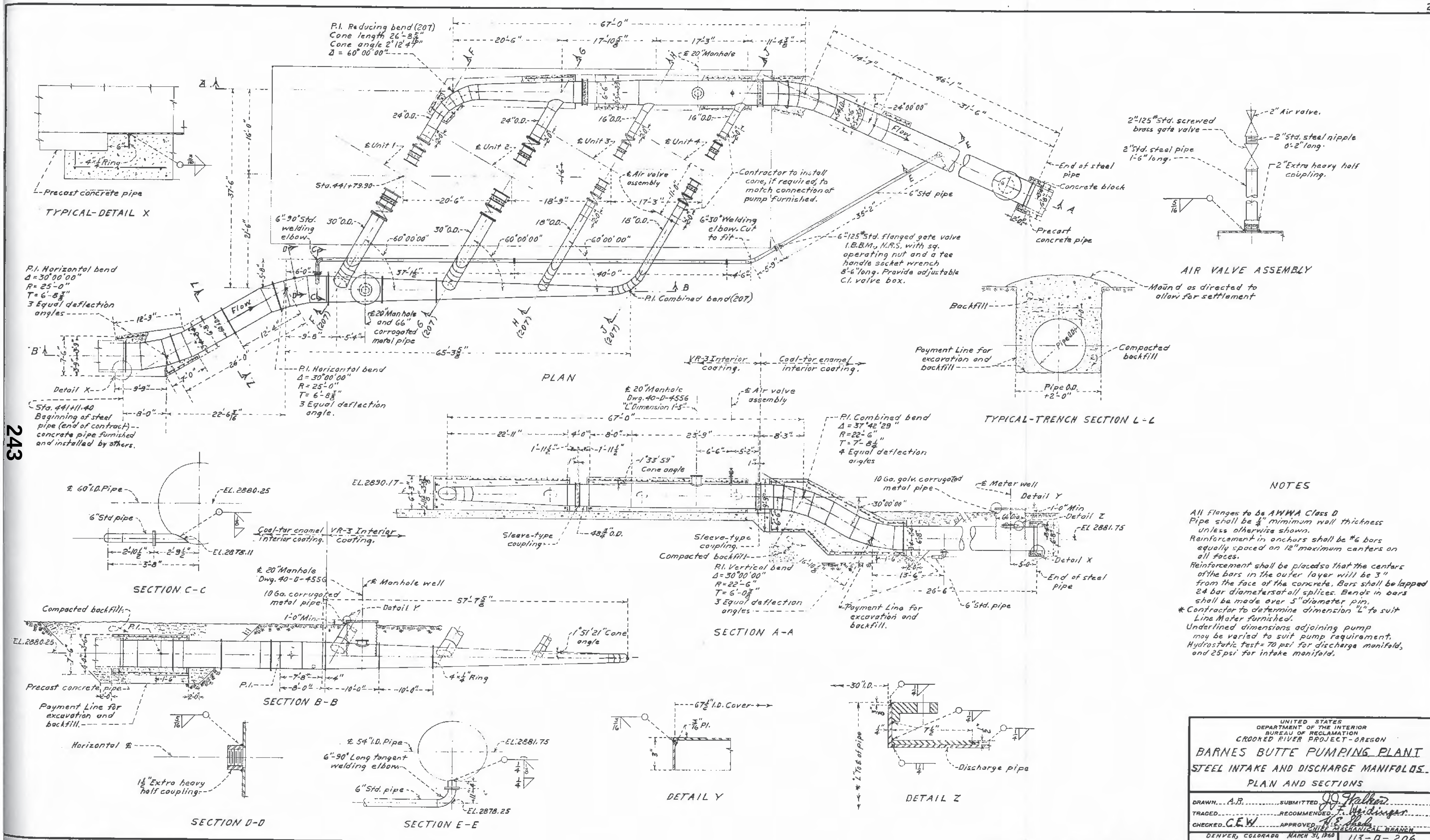
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

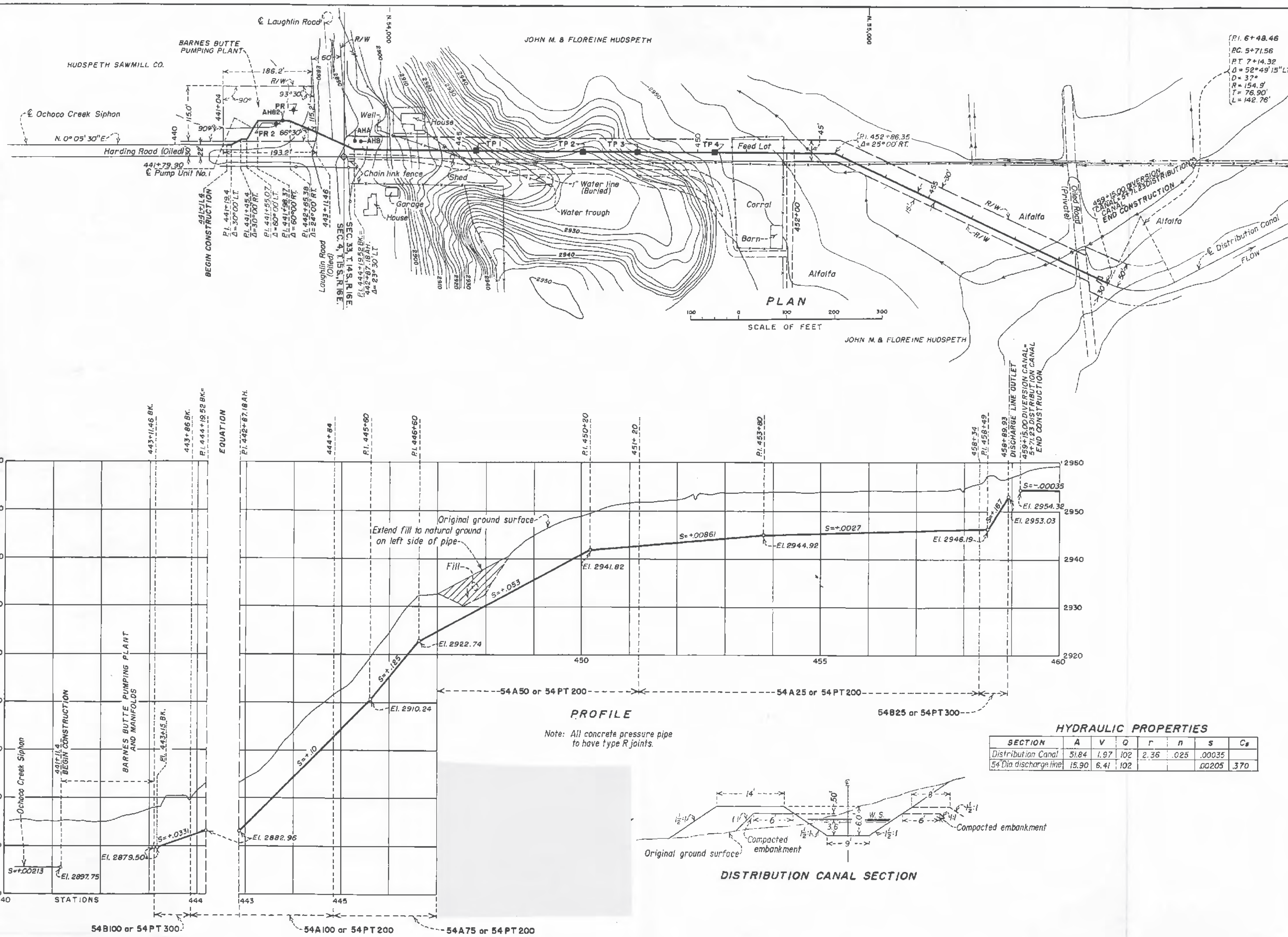
CROOKED RIVER PROJECT-OREGON

BARNES BUTTE PUMPING PLANT
GENERAL ARRANGEMENT, OUTLINE
AND REINFORCEMENT LAYOUT

DRAWN J.E.M. ... SUBMITTED ...
TRACED ... RECOMMENDED ...
CHECKED ... APPROVED ... ASST. COMMR. AND CHIEF ENGINEER

DENVER, COLORADO, MARCH 15, 1960 | 113-D-155


28
PLAN
SECTION A-A
SECTION B-B
SECTION C-C
SECTION D-D
SECTION E-E
TYPICAL-DETAIL X
DETAIL Y
DETAIL Z
TYPICAL-TRENCH SECTION L-L
AIR VALVE ASSEMBLY
NOTES
All flanges to be AWWA Class D
Pipe shall be 1/4" minimum wall thickness unless otherwise shown.
Reinforcement in anchors shall be #6 bars equally spaced on 12" maximum centers on all faces.
Reinforcement shall be placed so that the centers of the bars in the outer layer will be 3" from the face of the concrete. Bars shall be lapped 24 bar diameters at all splices. Bends in bars shall be made over 5" diameter pin.
* Contractor to determine dimension "L" to suit Line Meter furnished.
Underlined dimensions adjoining pump may be varied to suit pump requirement.
Hydrostatic test = 70 psi for discharge manifold, and 25 psi for intake manifold.
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CROOKED RIVER PROJECT-OREGON
BARNES BUTTE PUMPING PLANT
STEEL INTAKE AND DISCHARGE MANIFOLDS
PLAN AND SECTIONS
DRAWN A.B. SUBMITTED
TRACED RECOMMENDED
CHECKED C.E.W. APPROVED
CHIEF MECHANICAL BRANCH
DENVER, COLORADO MARCH 31, 1960
113-D-206



ESTIMATED QUANTITIES

CONCRETE PRESSURE PIPE		PRETENSIONED CONCRETE PIPE	
Concrete	8 Cu. yds.		8 Cu. yds.
Reinforcement steel	700 Lbs.		700 Lbs.
54B25 Pipe	56 Lin. ft.	54PT200	1582 Lin. ft.
54A25 Pipe	714 Lin. ft.	54PT300	131 Lin. ft.
54A50 Pipe	420 Lin. ft.		
54A75 Pipe	216 Lin. ft.		
54A100 Pipe	230 Lin. ft.		
54B100 Pipe	75 Lin. ft.		

NOTES

Stations and elevations on profile refer to invert unless otherwise shown.
Stationing of vertical P.I.'s to be considered approximate only and may be adjusted according to actual laying length of pipe.
Backfill above top of pipe as directed, 3'-0" min.

REFERENCE DRAWINGS

- BARNES BUTTE PUMPING PLANT — 113-D-205
- PUMP DISCHARGE LINE TRANSITION — 113-D-222
- BENDS FOR PRESSURE PIPE AND CONCRETE CYLINDER PIPE (PRETENSIONED) — 113-D-226
- SECTIONS FOR DISCHARGE LINES — 113-D-225
- GEOLOGIC LOGS OF EXPLORATION — 113-D-228
- GEOLOGIC MAPS — 113-D-244

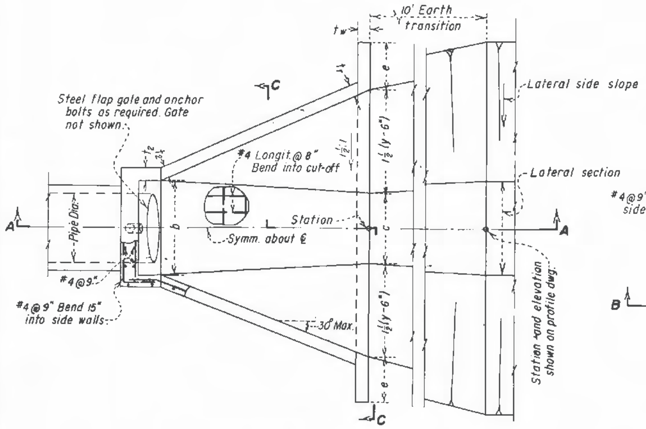
HYDRAULIC PROPERTIES

SECTION	A	V	Q	r	n	s	Cs
Distribution Canal	51.84	1.97	102	2.36	.025	.00035	
54" Dia. discharge line	15.90	6.41	102			.00205	.370

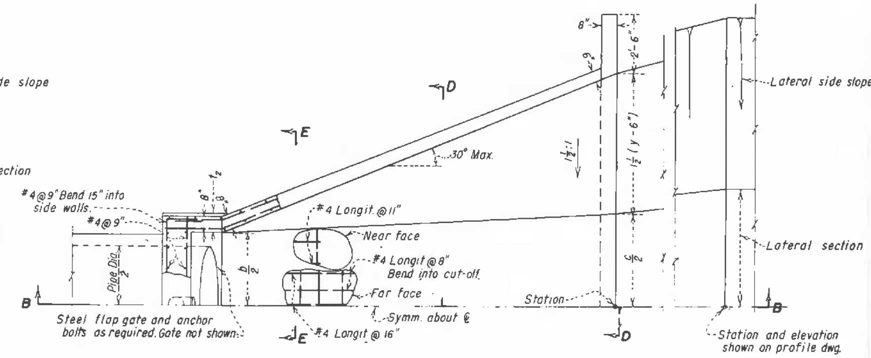
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CROOKED RIVER PROJECT–OREGON

BARNES BUTTE PUMPING PLANT
DISCHARGE LINE

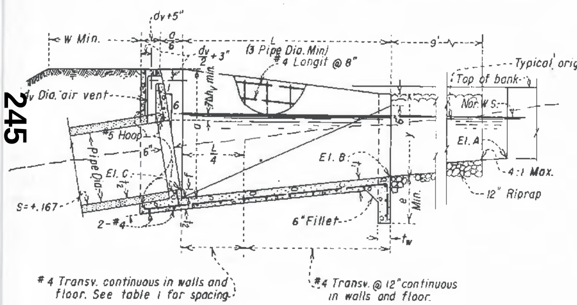
DRAWN A.O.C.-A.W.B. SUBMITTED W. E. Schmide
TRACED B.D.S. RECOMMENDED
CHECKED APPROVED CHIEF DESIGNING ENGINEER
DENVER, COLORADO, MARCH 4, 1960 113-D-221



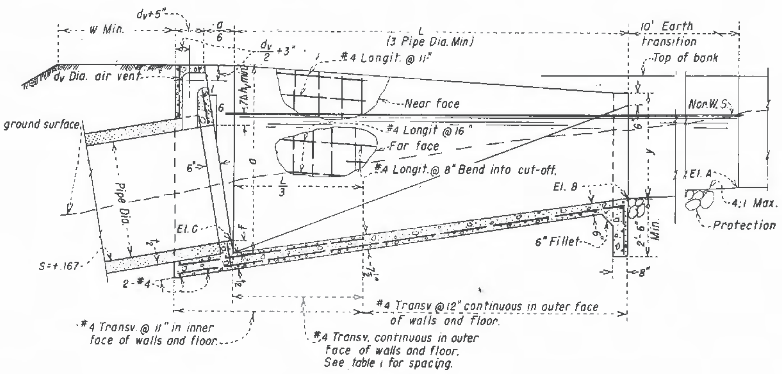
PLAN OF TYPICAL PUMP DISCHARGE LINE TRANSITION 15" TO 54" DIA.



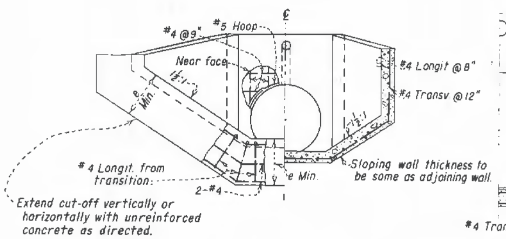
HALF PLAN OF PUMP DISCHARGE LINE TRANSITION 60" TO 78" DIA.



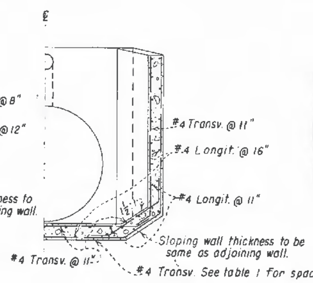
SECTION A – A



SECTION B – B



SECTION C – C
(SECTION D-D SIMILAR)



SECTION E – E

TABLE 1

DIA.	a	b	t_1	t_2	e	t_w	f	d_v	TRANSV. REINF.
15"	4'-0"	24"	5"	5"	24"	6"	3"	4"	#4@12"
18"	4'-3"	2'-3"	5"	5"	24"	6"	3"	4"	#4@12"
21"	4'-6"	2'-6"	5"	5"	24"	6"	3"	4"	#4@12"
24"	4'-9"	2'-9"	5"	5"	24"	6"	3"	4"	#4@12"
30"	5'-3"	3'-4"	5"	5"	24"	6"	3"	5"	#4@12"
36"	5'-9"	4'-0"	6"	6"	2'-6"	8"	3"	6"	#4@12"
42"	6'-3"	4'-6"	6"	6"	2'-6"	8"	3"	7"	#4@12"
48"	7'-0"	5'-0"	6"	6"	2'-6"	8"	4"	8"	#4@10"
54"	7'-6"	5'-6"	6"	7"	2'-6"	8"	5"	9"	#4@8"
60"	8'-9"	6'-2"	6"	8"	-	-	5"	9"	#4@7½"
66"	9'-3"	6'-6"	6"	8"	-	-	5"	10"	#4@6"
72"	9'-9"	7'-0"	6"	9"	-	-	6"	11"	#4@6"
78"	10'-3"	7'-8"	6"	9"	-	-	6"	12"	#4@5"

When transverse bar spacing is 6" or less, end alternate bars at half wall height.

NOTES

Unless otherwise shown, [illegible] reinforcement so that the clear distance from face of concrete and nearest reinforcement bar is 1½", except provide a clear distance from face of concrete placed against earth or rock of 2".

Lap all bars 24 diameters at splices, unless otherwise shown.

Monolithic concrete design based on a compressive strength of 3 000 lbs. per sq. inch at 28 days.

TABLE OF LOCATIONS AND ELEVATIONS

LATERAL	STATION	Q (C.F.S.)	DIMENSIONS				ELEVATIONS			EST. QUANTITIES			REMARKS
			DIA.	L	y	c	A	B	C	CONCRETE (CU. YDS.)	REINF. STEEL (LBS.)	FLAP GATE DIA.	
Discharge Line	459+05	102	54	15'-0"	5'-4"	7'-0"	2954.32	2953.59	2953.03	10	900	54"	

REFERENCE DRAWING

DISCHARGE LINE 113-D-221

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CROOKED RIVER PROJECT – OREGON
BARNES BUTTE PUMPING PLANT

DISCHARGE LINE OUTLET

DRAWN A.W.B. SUBMITTED W T Schneider
TRACED J.A.H. RECOMMENDED [illegible]
CHECKED [illegible] APPROVED [illegible] CHIEF DESIGNING ENGINEER
DENVER, COLORADO, MARCH 14, 1950 | 113-D-222

BARNES BUTTE PUMPING PLANT NEW SITE ON CROOKED RIVER

ALT 4: 72-INCH STEEL - EVALUATION SUMMARY

The current Barnes Butte pump site is at the foot of Barnes Butte, about 0.75 miles east of the Prineville city limits. The Barnes Butte facility was originally designed for 115.5 cubic feet per second (CFS) at 82 feet total dynamic head (TDH). The original installation circa 1961 was comprised of (4) horizontal split case pumps with synchronous motors totaling 1,500 HP. A fifth 300 HP, horizontal split case pump was added at a later date. The current facility consisting of five pumping units totaling 1,800 horsepower lifts approximately 135 CFS at 86 feet TDH from the end of the Crooked River diversion canal to the head of the distribution canal. The discharge main consists of approximately 1,600 feet of 54-inch I.D. concrete pipe.

Original Design

Pump Unit	Description	HP	Rated Capacity	Rated Head	Pump Eff. @ Rated Capacity	Pipe Size	Discharge Pipe Vel.	Discharge Main Vel.
No. 1	Horizontal Split Case	500	17,300 GPM	82 FT	84 %	24 IN	12.3 FPS	
No. 2	Horizontal Split Case	500	17,300 GPM	82 FT	84 %	24 IN	12.3 FPS	
No. 3	Horizontal Split Case	250	8,640 GPM	82 FT	80 %	16 IN	13.8 FPS	
No. 4	Horizontal Split Case	250	8,640 GPM	82 FT	80 %	16 IN	13.8 FPS	
Total		1,500	51,880 GPM	82 FT		54 IN		7.3 FPS

Current Condition (Ref. Initial Pump Evaluation BPA, 2010)

Pump Unit	Description	HP	Test Capacity	Test Head	Pump Eff. @ Test Capacity	Pipe Size	Discharge Pipe Vel.	Discharge Main Vel.
No. 1	Horizontal Split Case	500	17,431 GPM *	73 FT *	80 % *	24 IN	12.4 FPS	
No. 2	Horizontal Split Case	500	16,633 GPM *	76 FT *	79 %	24 IN	11.8 FPS	
No. 3	Horizontal Split Case	250	9,460 GPM	77 FT	80 % **	16 IN	15.1 FPS	
No. 4	Horizontal Split Case	250	7,910 GPM *	75 FT *	80 % **	16 IN	12.6 FPS	
No. 5	Horizontal Split Case	300	9,037 GPM	76 FT	68 %	16 IN	14.4 FPS	
Total		1,800	60,471 GPM			54 IN		8.5 FPS

* Minimum value of (2) test data points, ref. Initial Pump Evaluation, BPA, 2010

** Measured pump efficiency at the test capacity was greater than the factory curve. Factory curve data for efficiency at rated capacity used in evaluating pumping plant efficiency.

Alternate Equipment (Replace existing pump station with (5) vertical turbines at new location on Crooked River and installation of a new 72-inch Steel discharge main)

Pump Unit	Description	HP	Rated Capacity	Rated Head	Pump Eff. @ Rated Capacity	Pipe Size	Discharge Pipe Vel.	Discharge Main Vel.
No. 1	Vertical Turbine	500	15,300 GPM	113 FT	87.2 %	24 IN	10.9 FPS	
No. 2	Vertical Turbine	500	15,300 GPM	113 FT	87.2 %	24 IN	10.9 FPS	
No. 3	Vertical Turbine	500	15,300 GPM	113 FT	87.2 %	24 IN	10.9 FPS	
No. 4	Vertical Turbine	500	15,300 GPM	113 FT	87.2 %	24 IN	10.9 FPS	
No. 5	Vertical Turbine	500	15,300 GPM	113 FT	87.2 %	24 IN	10.9 FPS	
Total		2,500	76,500 GPM	113 FT		63 IN		6.0 FPS

Narrative

Initial evaluation of alternatives for a new Barnes Butte Pumping Plant on the Crooked River examined four potential options related to the size and diameter of the discharge main. Alternative 1 proposed 63-inch HDPE for new discharge main piping, slip lining the existing Barnes Butte inlet pipe with 54-inch HDPE, and using the existing 54-inch concrete discharge pipe to the outlet at the distribution canal. Alternative 1 was dismissed due to velocity, head loss, and energy requirements incurred in the 54-inch pipe sections. Alternative 2 proposed 63-inch HDPE for the new discharge pipe, replacing the existing Barnes Butte inlet pipe alignment with 63-inch HDPE, and using the existing 54-inch concrete discharge pipe to the outlet at the distribution canal. Alternative 2 was dismissed due to velocity, head loss, and energy requirements incurred by 54-inch pipe. Alternative 3 (Alt 3) is evaluated in a separate section. Alt 3 proposes new 63-inch HDPE discharge pipe including full replacement of existing pipe on the existing Barnes Butte inlet and discharge alignment. Alternative 4 (Alt 4) discussed here proposes using 72-inch steel pipe for the entire length of the discharge main from the new pump station location to the outlet at the distribution canal. The existing Barnes Butte inlet pipe alignment and existing 54-inch concrete discharge pipe to the outlet at the distribution canal would be replaced with the new 72-inch steel pipe.

Evaluation of the Barnes Butte New Site on the Crooked River - Alt 4 examines potential energy efficiency gained by constructing a new Barnes Butte Pumping Plant at a new pump station location on the Crooked River near the southwest corner of the Crook County Fairgrounds property. The new pumping plant would be served by a newly constructed diversion, fish screen, and approximately 1,200 feet of 96-inch pump station inlet pipe. The new pumping plant would utilize (5) new vertical turbine pumps. New pumps would be installed in a newly constructed wet well configuration. The wet well configuration is similar to the concept design shown in the Barnes Butte Reconstruction evaluation section. The new pumping plant would be connected to a new discharge main consisting of approximately 3,762 feet of nominal 72-inch steel pipe following an alignment east until intersecting the alignment of the existing inlet pipe serving the existing Barnes Butte Pumping Plant. The existing inlet pipe would be replaced with approximately 4,829 feet of nominal 72-inch steel pipe continuing north to the alignment of the existing Barnes Butte Pumping Plant discharge main. The existing Barnes Butte Pumping Plant discharge main would be replaced with approximately 1,603 feet of nominal 72-inch steel pipe to the current outlet location on the Barnes Butte discharge canal.

New electrical service would be extended from power lines on Fairgrounds Road. New electrical systems including transformer, service entrance, motor starters, controls, and telemetry would be constructed at the new pump station location. New synchronous motors would be installed with the new pumps.

With five new pumps available to meet irrigation season demand variations, integration of variable speed drive equipment into alternate pump equipment would not appear to provide significant energy savings.

The capacity of the reconstructed pump station is anticipated to be approximately 170 CFS at 113 feet TDH.

Wire to water energy analysis is based on the projected capacity of the new Barnes Butte Pumping Plant constructed with new vertical turbine pumps connected to a 72-inch steel discharge main. The Barnes Butte Pumping Plant constructed at a new Crooked River location with new vertical turbine pumps is projected to provide a seasonal average flow of 61,134 gpm (136.2 CFS) at 106.6 feet TDH. The existing Barnes Butte Pumping plant in its current condition is projected to yield 136.2 CFS at 86.2 feet TDH.

Action Recommended for Further Evaluation: **Construct new pumping plant at new location on Crooked River, vertical turbine pumps, 72-inch steel discharge main**

New No. 1 Pump, Vertical Turbine Pump

New No. 2 Pump, Vertical Turbine Pump

New No. 3 Pump, Vertical Turbine Pump

New No. 4 Pump, Vertical Turbine Pump

New No. 5 Pump, Vertical Turbine Pump

New pump discharge piping and valves

New electrical service entrance and motor starters

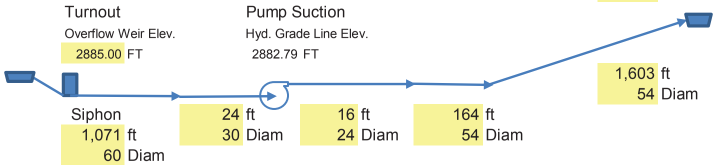
New 72-inch steel discharge main

Annual Energy Savings Estimate = - 458,365 kW-hr

Initial Cost Estimate = $20,634,000

Pump to Canal Head Loss Calculations
Barnes Butte Pumping Plant New Site (New Vert. Turbine PS on Crooked River)

17,300 GPM	Horizontal Split Case Pump No. 1	
17,300 GPM	Horizontal Split Case Pump No. 2	
8,640 GPM	Horizontal Split Case Pump No. 3	Static Head = 68.03 FT
8,640 GPM	Horizontal Split Case Pump No. 4	
GPM	Horizontal Split Case Pump No. 5	
51,880 GPM	Total = 115.6 cfs	



Diam. (Discharge Pipe) = 54 in
Total Discharge Pipe Length = 1,807 ft
Equiv. Pipe Length Valves & Fittings Pump Discharge = 91 ft
Equiv. Pipe Length Valves & Fittings Discharge Header = 241 ft

60" Siphon Pipe	Friction Head =	2.07 FT per 1,000 FT	Concrete
(Vel. = 5.9 fps)	Dynamic Head =	2.21 FT total	C = 110
30" Inlet Pipe	Friction Head =	5.40 FT per 1,000 FT	Steel
(Vel. = 7.9 fps)	Dynamic Head =	0.13 FT total	C = 135
24" Discharge Piping	Friction Head =	16.00 FT per 1,000 FT	Steel
(Vel. = 12.3 fps)	Dynamic Head =	0.26 FT total	C = 135
54" Header	Friction Head =	2.36 FT per 1,000 FT	Steel
(Vel. = 7.3 fps)	Dynamic Head =	0.39 FT total	C = 135
54" Discharge	Friction Head =	3.45 FT per 1,000 FT	Concrete
(Vel. = 7.3 fps)	Dynamic Head =	5.53 FT total	C = 110
Equivalent Pipe Length	Friction Head =	16.00 FT per 1,000 FT	Steel
Valves & Fittings Pump Discharge	Dynamic Head =	1.46 FT total	C = 135
Equivalent Pipe Length	Friction Head =	2.36 FT per 1,000 FT	Steel
Valves & Fittings Discharge Header	Dynamic Head =	0.57 FT total	C = 135
	Friction Head =	8.33 FT =	3.60 psi
	Water Depth in Discharge Canal =	4.07 FT =	1.76 psi
	Total Dynamic Head =	82.64 FT =	35.78 psi

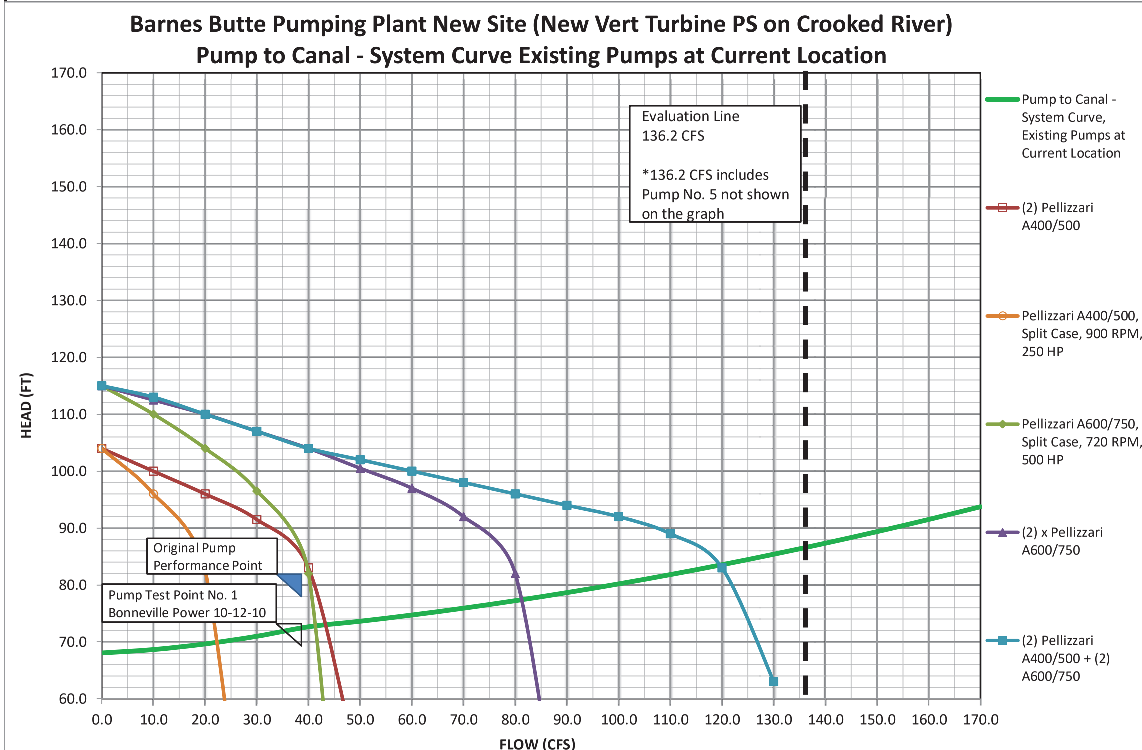
Equivalent Pipe Length Totals:

Item	24" Equiv. Length	No. of Units	Total Equiv. Length
60" to 30" square edged inlet	85 ft	1 ea	85 ft
30" pump isolation (gate) valve	3 ft	1 ea	3 ft
24" pump control (gate) valve	3 ft	1 ea	3 ft
30-inch 30 degree bend	20 ft	0 ea	0 ft
		Subtotal	91 ft

Item	54" Equiv. Length	No. of Units	Total Equiv. Length
24"x54" tee branch flow	40 ft	1 ea	40 ft
54" flow meter	1 ft	1 ea	1 ft
54"x24" tee in-line flow	30 ft	4 ea	120 ft
54"x60" expander	5 ft	1 ea	5 ft
54" 45 bend	20 ft	2 ea	40 ft
54" 11.25 bend	10 ft	2 ea	20 ft
54" flap gate	15 ft	1 ea	15 ft
		Subtotal	241 ft

Barnes Butte Pumping Plant New Site (New Vertical Turbine PS on Crooked River)
Pump to Canal - System Curve, Existing Pumps at Current Location

Q (gpm)	0	4,488	8,976	13,464	17,952	22,440	26,928	31,416	35,904	40,392	44,880	49,368	53,856	58,344	62,832	67,320	71,808	76,296
Q (cfs)	0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0	170.0
Hf	0.0	0.6	1.6	2.9	4.6	5.6	6.7	7.9	9.2	10.6	12.1	13.8	15.5	17.4	19.3	21.3	23.5	25.7
TDH (ft)	68.0	68.6	69.6	71.0	72.6	73.6	74.7	75.9	77.2	78.6	80.2	81.8	83.6	85.4	87.3	89.4	91.5	93.7
Vel. Disch. (fps)	0.0	0.6	1.3	1.9	2.5	3.1	3.8	4.4	5.0	5.7	6.3	6.9	7.5	8.2	8.8	9.4	10.1	10.7



Pellizzari A400/500, Split Case, 900 RPM, 250 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	104	96	83	10														

(2) Pellizzari A400/500

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	104	100	96	92	83	47	10											

Pellizzari A600/750, Split Case, 720 RPM, 500 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	115	110	104	97	82	-20												

(2) x Pellizzari A600/750

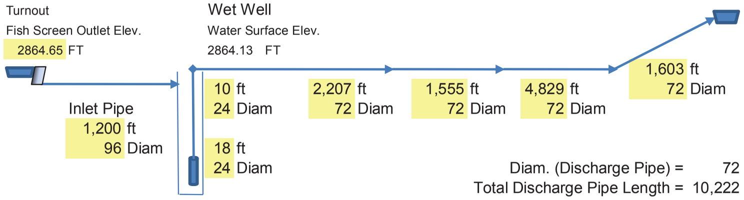
Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	115	113	110	107	104	101	97	92	82	29	-20							

(2) Pellizzari A400/500 + (2) A600/750

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302
Head (ft)	115	113	110	107	104	102	100	98	96	94	92	89	83	63				

Pump to Canal Head Loss Calculations - ALT 4 Discharge Main 6 fps max Velocity
Barnes Butte Pumping Plant New Site (new vert. turbine PS on Crooked River)

15,300 GPM	Vertical Turbine Pump No. 1	
15,300 GPM	Vertical Turbine Pump No. 2	
15,300 GPM	Vertical Turbine Pump No. 3	Static Head = 88.38 FT
15,300 GPM	Vertical Turbine Pump No. 4	
15,300 GPM	Vertical Turbine Pump No. 5	
76,500 GPM	Total = 170.4 cfs	



Diam. (Discharge Pipe) = 72 in
Total Discharge Pipe Length = 10,222 ft
Equiv. Pipe Length Valves & Fittings Pump Discharge = 370 ft
Equiv. Pipe Length Valves & Fittings Discharge Header = 1680 ft

96" Inlet Pipe	Friction Head =	0.43	FT per 1,000 FT	Concrete
(Vel. = 3.4 fps)	Dynamic Head =	0.52	FT total	C = 110
24" Column Pipe	Friction Head =	12.75	FT per 1,000 FT	Steel
(Vel. = 10.9 fps)	Dynamic Head =	0.23	FT total	C = 135
24" Pump Discharge Piping	Friction Head =	12.75	FT per 1,000 FT	Steel
(Vel. = 10.9 fps)	Dynamic Head =	0.13	FT total	C = 135
72" Steel Discharge Main	Friction Head =	1.19	FT per 1,000 FT	Steel
(Vel. = 6.0 fps)	Dynamic Head =	2.64	FT total	C = 135
72" Steel Discharge Main	Friction Head =	1.01	FT per 1,000 FT	Steel
(Vel. = 5.5 fps)	Dynamic Head =	1.57	FT total	C = 135
72" Steel Discharge Main	Friction Head =	1.01	FT per 1,000 FT	Steel
(Vel. = 5.5 fps)	Dynamic Head =	4.86	FT total	C = 135
72" Steel Discharge Main	Friction Head =	1.01	FT per 1,000 FT	Steel
(Vel. = 5.5 fps)	Dynamic Head =	1.61	FT total	C = 135
Equivalent Pipe Length Valves & Fittings Pump Discharge	Friction Head =	12.75	FT per 1,000 FT	Steel
	Dynamic Head =	4.72	FT total	C = 135
Equivalent Pipe Length Valves & Fittings Discharge Header	Friction Head =	1.19	FT per 1,000 FT	Steel
	Dynamic Head =	2.01	FT total	C = 135

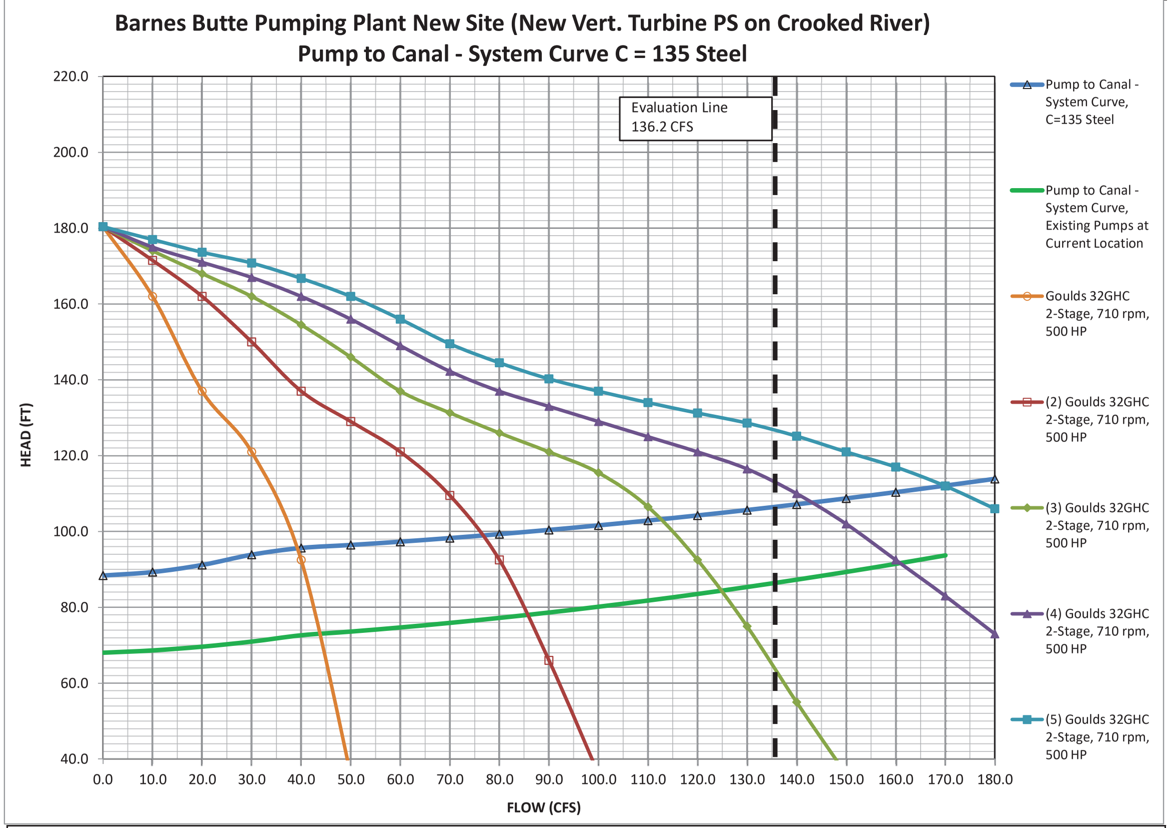
Friction Head =	17.76	FT =	7.69 psi
Water Depth in Discharge Canal =	5.48	FT =	2.37 psi
Total Dynamic Head =	112.14	FT =	48.55 psi

Equivalent Pipe Length Totals:

Item	24" Equiv. Length	No. of Units	Total Equiv. Length
24" pump discharge head	250 ft	1 ea	250 ft
24" pump control (butterfly) valve	80 ft	1 ea	80 ft
24" 45 bend	40 ft	1 ea	40 ft
		Subtotal	370 ft
Item	**72" Equiv. Length**	**No. of Units**	**Total Equiv. Length**
24"x72" tee branch flow	390 ft	1 ea	390 ft
72" flow meter	10 ft	1 ea	10 ft
24"x72" tee in-line flow	120 ft	4 ea	480 ft
72" reducer / expander	120 ft	2 ea	240 ft
72" 45 bend	120 ft	3 ea	360 ft
72" 11.25 bend	60 ft	3 ea	180 ft
72" flap gate	20 ft	1 ea	20 ft
		Subtotal	1680 ft

Barnes Butte Pumping Plant New Site
Pump to Canal - System Curve, C=135 Steel

Q (gpm)	0	4,488	8,976	13,464	17,952	22,440	26,928	31,416	35,904	40,392	44,880	49,368	53,856	58,344	62,832	67,320	71,808	76,301	80,789
Q (cfs)	0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0	170.0	180.0
Hf	0.0	0.9	2.8	5.5	7.3	8.0	8.9	9.9	10.9	12.0	13.2	14.5	15.8	17.3	18.8	20.3	22.0	23.7	25.5
TDH (ft)	88.4	89.3	91.2	93.9	95.6	96.4	97.3	98.3	99.3	100.4	101.6	102.9	104.2	105.6	107.1	108.7	110.3	112.1	113.8
Vel. Disch. (fps)	0.0	0.4	0.7	1.1	1.4	1.8	2.1	2.5	2.8	3.2	3.5	3.9	4.2	4.6	5.0	5.3	5.7	6.0	6.4



Goulds 32GHC 2-Stage, 710 rpm, 500 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302	80,790
Head (ft)	180	162	137	121	93	36													

(2) Goulds 32GHC 2-Stage, 710 rpm, 500 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302	80,790
Head (ft)	180	172	162	150	137	129	121	110	93	66	36								

(3) Goulds 32GHC 2-Stage, 710 rpm, 500 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302	80,790
Head (ft)	180	174	168	162	155	146	137	131	126	121	116	107	93	75	55	36			

(4) Goulds 32GHC 2-Stage, 710 rpm, 500 HP

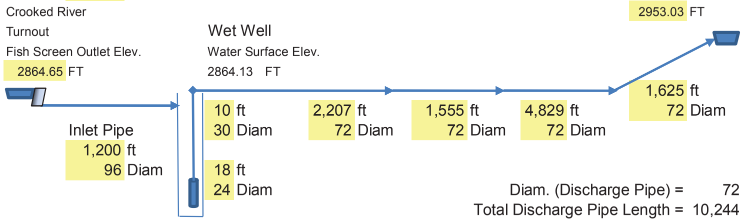
Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302	80,790
Head (ft)	180	175	171	167	162	156	149	142	137	133	129	125	121	117	110	102	93	83	73

(5) Goulds 32GHC 2-Stage, 710 rpm, 500 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302	80,790
Head (ft)	180	177	174	171	167	162	156	150	145	140	137	134	131	129	125	121	117	112	106

Pump to Canal Head Loss Calculations - ALT 4 Discharge Main 6 fps max Velocity
Barnes Butte Pumping Plant New Site (New Vert. Turbine PS on Crooked River)

15,300 GPM	Vertical Turbine Pump No. 1	
15,300 GPM	Vertical Turbine Pump No. 2	
15,300 GPM	Vertical Turbine Pump No. 3	Static Head = 88.38 FT
15,300 GPM	Vertical Turbine Pump No. 4	
15,300 GPM	Vertical Turbine Pump No. 5	
76,500 GPM	Total = 170.4 cfs	



Diam. (Discharge Pipe) = 72 in
Total Discharge Pipe Length = 10,244 ft
Equiv. Pipe Length Valves & Fittings Pump Discharge = 370 ft
Equiv. Pipe Length Valves & Fittings Discharge Header = 1680 ft

96" Inlet Pipe	Friction Head =	0.43	FT per 1,000 FT	Concrete
(Vel. = 3.4 fps)	Dynamic Head =	0.52	FT total	C = 110
24" Column Pipe	Friction Head =	12.75	FT per 1,000 FT	Steel
(Vel. = 10.9 fps)	Dynamic Head =	0.23	FT total	C = 135
30" Pump Discharge Piping	Friction Head =	4.31	FT per 1,000 FT	Steel
(Vel. = 6.9 fps)	Dynamic Head =	0.04	FT total	C = 135
72" Steel Discharge Main	Friction Head =	1.19	FT per 1,000 FT	Steel
(Vel. = 6.0 fps)	Dynamic Head =	2.64	FT total	C = 135
72" Steel Discharge Main	Friction Head =	1.01	FT per 1,000 FT	Steel
(Vel. = 5.5 fps)	Dynamic Head =	1.57	FT total	C = 135
72" Steel Discharge Main	Friction Head =	1.01	FT per 1,000 FT	Steel
(Vel. = 5.5 fps)	Dynamic Head =	4.86	FT total	C = 135
72" Steel Discharge Main	Friction Head =	1.01	FT per 1,000 FT	Steel
(Vel. = 5.5 fps)	Dynamic Head =	1.64	FT total	C = 135
Equivalent Pipe Length	Friction Head =	4.31	FT per 1,000 FT	Steel
Valves & Fittings Pump Discharge	Dynamic Head =	1.59	FT total	C = 135
Equivalent Pipe Length	Friction Head =	1.19	FT per 1,000 FT	Steel
Valves & Fittings Discharge Header	Dynamic Head =	2.01	FT total	C = 135

Friction Head =	14.58	FT =	6.31 psi
Water Depth in Discharge Canal =	5.48	FT =	2.37 psi
Total Dynamic Head =	108.95	FT =	47.17 psi

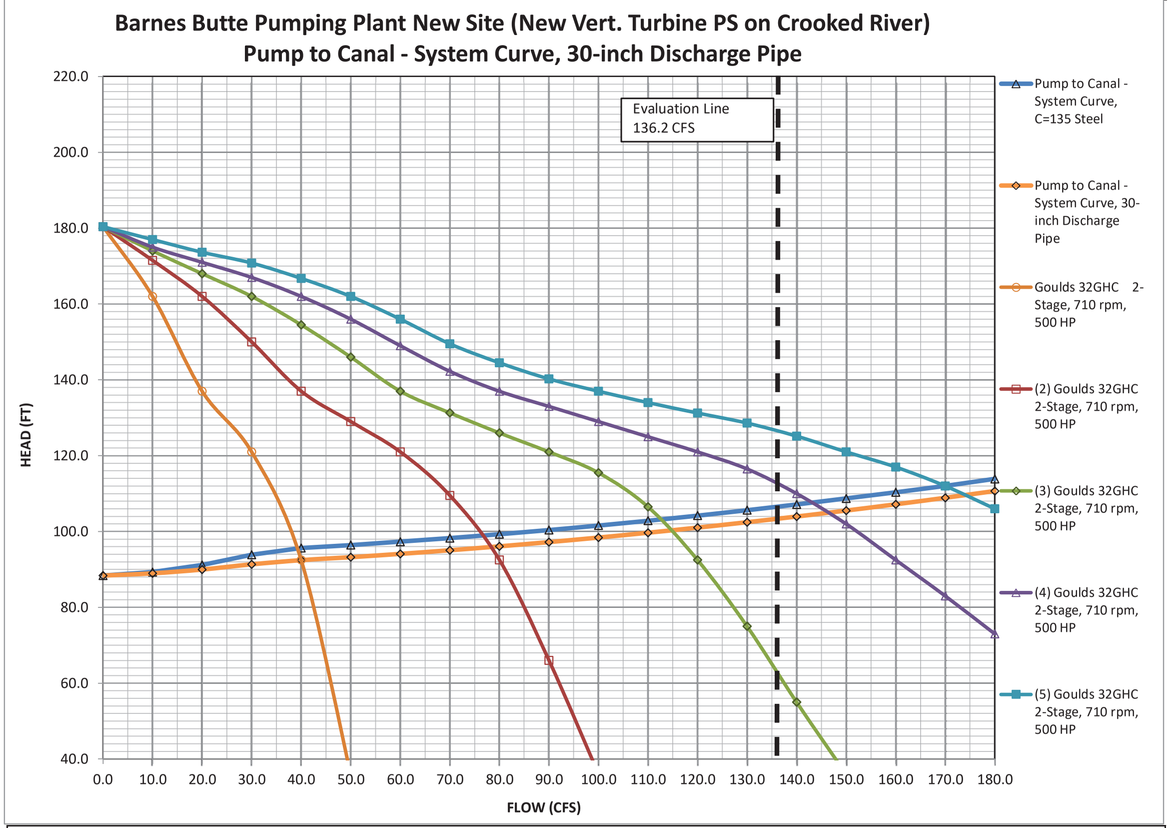
Equivalent Pipe Length Totals:

Item	24" Equiv. Length	No. of Units	Total Equiv. Length
24" pump discharge head	250 ft	1 ea	250 ft
24" pump control (butterfly) valve	80 ft	1 ea	80 ft
24" 45 bend	40 ft	1 ea	40 ft
		Subtotal	370 ft

Item	72" Equiv. Length	No. of Units	Total Equiv. Length
30"x72" tee branch flow	390 ft	1 ea	390 ft
72" flow meter	10 ft	1 ea	10 ft
30"x72" tee in-line flow	120 ft	4 ea	480 ft
72" reducer / expander	120 ft	2 ea	240 ft
72" 45 bend	120 ft	3 ea	360 ft
72" 11.25 bend	60 ft	3 ea	180 ft
72" flap gate	20 ft	1 ea	20 ft
		Subtotal	1680 ft

Barnes Butte Pumping Plant New Site (New Vert. Turbine PS on Crooked River)
Pump to Canal - System Curve, 30-inch Discharge Pipe

Q (gpm)	0	4,488	8,976	13,464	17,952	22,440	26,928	31,416	35,904	40,392	44,880	49,368	53,856	58,344	62,832	67,320	71,808	76,301	80,789
Q (cfs)	0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0	170.0	180.0
Hf	0.0	0.6	1.6	3.0	4.1	4.8	5.7	6.7	7.7	8.8	10.0	11.3	12.6	14.1	15.6	17.1	18.8	20.5	22.3
TDH (ft)	88.4	89.0	90.0	91.3	92.4	93.2	94.1	95.0	96.1	97.2	98.4	99.7	101.0	102.4	103.9	105.5	107.2	108.9	110.7
Vel. Disch. (fps)	0.0	0.4	0.7	1.1	1.4	1.8	2.1	2.5	2.8	3.2	3.5	3.9	4.2	4.6	5.0	5.3	5.7	6.0	6.4



Goulds 32GHC 2-Stage, 710 rpm, 500 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302	80,790
Head (ft)	180	162	137	121	93	36													

(2) Goulds 32GHC 2-Stage, 710 rpm, 500 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302	80,790
Head (ft)	180	172	162	150	137	129	121	110	93	66	36								

(3) Goulds 32GHC 2-Stage, 710 rpm, 500 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302	80,790
Head (ft)	180	174	168	162	155	146	137	131	126	121	116	107	93	75	55	36			

(4) Goulds 32GHC 2-Stage, 710 rpm, 500 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302	80,790
Head (ft)	180	175	171	167	162	156	149	142	137	133	129	125	121	117	110	102	93	83	73

(5) Goulds 32GHC 2-Stage, 710 rpm, 500 HP

Q (cfs)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
Q (gpm)	0	4,488	8,977	13,465	17,953	22,442	26,930	31,418	35,907	40,395	44,883	49,372	53,860	58,348	62,837	67,325	71,813	76,302	80,790
Head (ft)	180	177	174	171	167	162	156	150	145	140	137	134	131	129	125	121	117	112	106

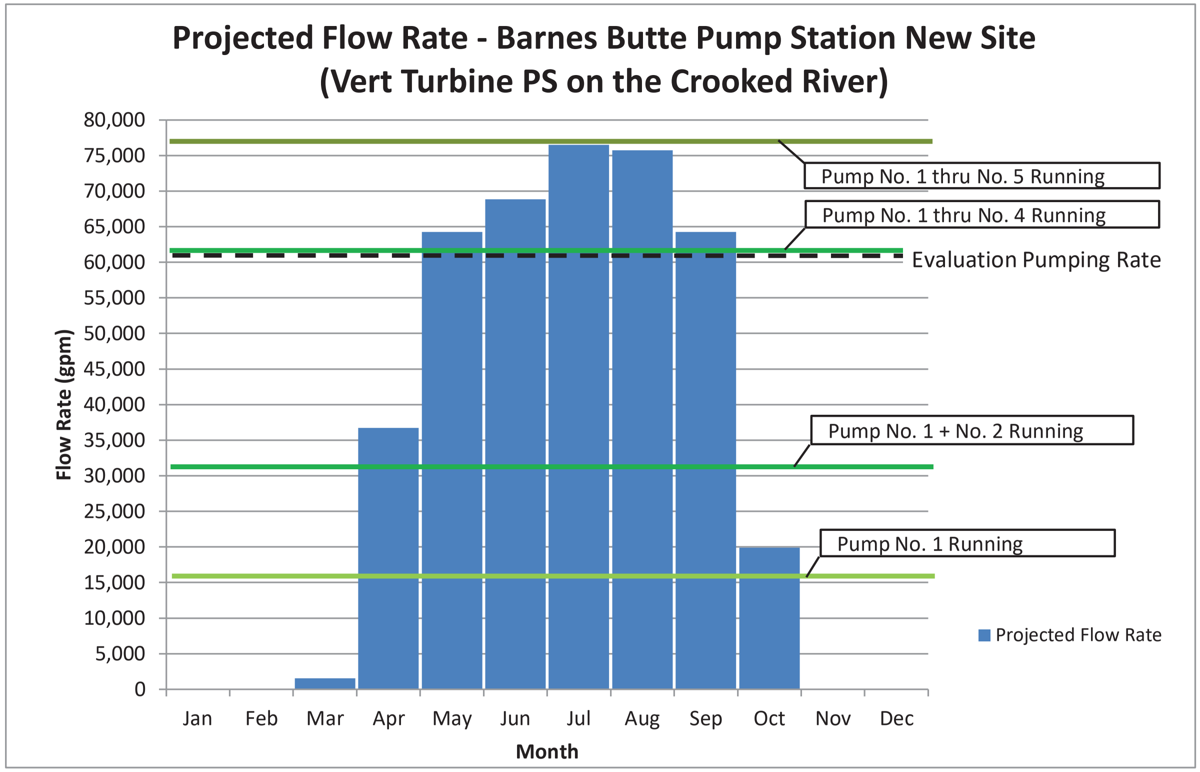
Pump to Canal Head Loss Calculations
Barnes Butte Pumping Plant New Site (New Vert. Turbine PS on the Crooked River)

15,300	GPM	Vertical Turbine Pump No. 1		
15,300	GPM	Vertical Turbine Pump No. 2		
15,300	GPM	Vertical Turbine Pump No. 3		
15,300	GPM	Vertical Turbine Pump No. 4		
15,300	GPM	Vertical Turbine Pump No. 5		
76,500	GPM	Total	=	170.4 cfs

Proposed PS Design Flow Rate = 76,500 gpm

Month	% of Max Flow Rate	Projected Flow Rate
Jan	0%	0
Feb	0%	0
Mar	2%	1,530
Apr	48%	36,720
May	84%	64,260
Jun	90%	68,850
Jul	100%	76,500
Aug	99%	75,735
Sep	84%	64,260
Oct	26%	19,890
Nov	0%	0
Dec	0%	0

Evaluation Pumping Rate = 61,134 gpm
136.2 cfs



Notes: Barnes Butte PS constructed at a new site with (5) new Vertical Turbine Pumps. VFD operation may provide benefit toward reducing energy use and optimizing water delivery to crop requirement. More detailed analysis should be conducteed to examaine selection of new pumps with flow rates that alow their combined use to reasonably match projected seasonal demand requirements.

Ochoco Irrigation District

Barnes Butte PS New Alt 4 (Construction of new facilities on Crooked River - Alt 4 Steel 72-inch)

Budget Level - Projection of Probable Construction Cost

Item No.	Spec Division	Description	Measurement	Units	Unit Cost	Total Cost
1	1000	Mobilization	LS	1	$580,000.00	$580,000.00
2	1000	Erosion Control	LS	1	$25,000.00	$25,000.00
3	1000	Watering / Dust Control	LS	1	$25,000.00	$25,000.00
4	1000	Construction Staking	LS	1	$12,500.00	$12,500.00
5	1000	Project Management and Coordination	LS	1	$25,000.00	$25,000.00
6	1000	Construction Progress Documentation	LS	1	$25,000.00	$25,000.00
7	1000	Submittal Procedures	LS	1	$25,000.00	$25,000.00
8	1000	Quality Requirements	LS	1	$25,000.00	$25,000.00
9	1000	Selective Demolition	LS	1	$100,000.00	$100,000.00
10	1000	Traffic Control	LS	1	$50,000.00	$50,000.00
11	1000	Project Record Documents	LS	1	$25,000.00	$25,000.00
12	1000	Operations and Maintenance Data	LS	1	$15,000.00	$15,000.00
13	1000	General Commissioning Requirements	LS	1	$20,000.00	$20,000.00
14	2000	Erosion Control Silt Fence	LF	3,000	$2.40	$7,200.00
15	2000	Perimeter Fence, 8 ft coated wire chain link	LF	1,000	$18.00	$18,000.00
16	2000	Fence Gate	LS	1	$2,500.00	$2,500.00
17	2000	Dewatering	LS	1	$30,000.00	$30,000.00
18	2000	Bulk Excavation	CY	1,145	$7.00	$8,015.00
19	2000	Hauling	CY	1,145	$12.00	$13,740.00
20	2000	Trench Excavation, 8-12 ft depth trench box	CY	35,150	$7.00	$246,050.00
21	2000	Structural Backfill	CY	270	$38.00	$10,260.00
22	2000	Trench Backfilling	CY	35,150	$3.10	$108,965.00
23	2000	Aggregate Base	CY	250	$38.00	$9,500.00
24	2000	Surfacing Rock	CY	200	$38.00	$7,600.00
25	2000	AC Pavement Reconstruction	SY	8000	$75.00	$600,000.00
26	2000	Access Manhole	EA	24	$7,500.00	$180,000.00
27	2000	Restoration Seeding	AC	5	$1,500.00	$7,500.00
28	3000	Cast-in-Place Concrete	CY	160	$550.00	$88,000.00
29	3000	Misc Cast-in-Place Concrete (thrust and pads)	LS	1	$27,500.00	$27,500.00
30	6000	Handrail	LS	1	$6,000.00	$6,000.00
31	6000	Hatches	LS	1	$5,000.00	$5,000.00
32	6000	Trash Rack	LS	1	$50,000.00	$50,000.00
33	9000	High Performance Coating Systems	LS	1	$15,000.00	$15,000.00
34	11000	River Diversion and Fish Screen	LS	1	$1,500,000.00	$1,500,000.00
35	11000	Air Release / Vacuum Relief Stations	EA	4	$25,000.00	$100,000.00
36	11000	Turnout Structures	EA	2	$75,000.00	$150,000.00
37	11000	Line Shaft Turbine Pump and Motor, 500 HP	EA	5	$210,000.00	$1,050,000.00
38	15000	96-inch RSC 250 Weholite Inlet Pipe	LF	1,200	$635.00	$762,000.00
39	15000	60-inch Steel Discharge Piping	LF	100	$352.00	$35,200.00
40	15000	72-inch Steel Discharge Pipe	LF	10,194	$424.00	$4,322,256.00
41	15000	24-inch Discharge Pipe, Fittings, & Accessories	EA	4	$25,000.00	$100,000.00
42	15000	24-inch Electric Motor Actuated Butterfly Valves	EA	4	$19,750.00	$79,000.00
43	15000	Hydraulic Slide Gate	EA	1	$10,000.00	$10,000.00
44	16000	Power and Distribution	LS	1	$581,970.00	$581,970.00
45	16000	Grounding Systems	LS	1	$23,760.00	$23,760.00
46	16000	Conduit and Conductors	LS	1	$67,980.00	$67,980.00
47	16000	Motor Controls	LS	1	$358,120.00	$358,120.00
48	17000	Instrumentation and Control	LS	1	$75,000.00	$75,000.00
		Construction Subtotal				$11,608,616.00
		Contractors Overhead and Profit	10%	1	$1,160,861.60	$1,160,861.60
		Contractors Bonds and Insurance	2%	1	$255,389.55	$255,389.55
		Construction Contingency	30%	1	$3,482,584.80	$3,482,584.80
		Construction Total				$16,507,451.95
		Engineering, Administration	25%	1	$4,126,862.99	
		Total				**$20,634,314.94**

Wire to Water Energy Calculator

Ochoco Irrigation District - SOR

Barnes Butte Pumping Plant - New Site at Crooked River: Alt 4 - Steel 72-inch

Source: PumpTech Inc.

2425 SE Ochoco Street

Portland, OR 97222

503-659-6230

OPERATIONAL AND EQUIPMENT DATA	Replacement Pumps		Existing Pumps	
	No. 1 - Goulds 32 GHC 2 Stage, 710 rpm, 500 HP		No. 1 - Pellizzari A600/750, Split Case, 720 RPM, 500 HP *	
	No. 3 - Goulds 32 GHC 2 Stage, 710 rpm, 500 HP		No. 2 - Pellizzari A600/750, Split Case, 720 RPM, 500 HP *	
	No. 3 - Goulds 32 GHC 2 Stage, 710 rpm, 500 HP		No. 3 - Pellizzari A400/500, Split Case, 880 RPM, 250 HP *	
	No. 4 - Goulds 32 GHC 2 Stage, 710 rpm, 500 HP		No. 4 - Pellizzari A400/500, Split Case, 880 RPM, 250 HP *	
	No. 5 - Goulds 32 GHC 2 Stage, 710 rpm, 500 HP		No. 5 - Wilson Snyder 16BAZ, Split Case, 880 RPM, 300 HP	
Pump Operation - Hours / Day	24		24	
Pump Operation - Days / Year	198		198	
Pump Flow - GPM (Evaluation Pump Rate)	61,134		61,134	
Pump Flow - CFS	136.2		136.2	
Total Annual Volume - Acre feet	53,500		53,500	
Pump Head - Feet	106.6	*	86.2	
Ave. Pump Efficiency - %	88.2%		77.1%	**
Ave. Motor Efficiency - %	96.3%		95.5%	***
Energy Cost in $/kW-hr	$0.035		$0.035	

Replacement Pumps notes: * Estimated Pumping head assumes pump discharge piping, and valves are 24-inch. Estimated motor efficiency assumes synchronous motors.

Existing Pumps notes: * Pump Make and model per original construction submittals, 1963

** Pump efficiency assumed to be similar to efficiency of original equipment as supplied. Initial Pump Evaluation test data indicates pump efficiency for tested units greater than construction submittal efficiency curves.

*** Source: Initial Pump Evaluation test data.

RESULTS

	Replacement Pumps	Existing Pumps
BHP At Design Point	1,865.0	1,726.0
Wire to Water Efficiency - %	85%	74%
kW-hr per Year	6,865,331	6,406,966
Annual Energy Cost	$240,286.58	$224,243.80
kW-hr Per 1,000 Gallons Pumped	0.394	0.368
Cost Per 1,000 Gallons Pumped	$0.014	$0.013
kW-hr per Acre Foot Pumped	128	120
Cost Per Acre Foot Pumped	$4.49	$4.19

PAYBACK

Annual Savings - kW-hr	-458,365
Annual Savings - $$	-$16,042.78
Annual Savings - %	-7.15%
Cost of Replacement Pump Sta *	$19,116,000.00
Cost of Existing Pumps	$0.00
Payback - Years	N/A

* Estimated cost assumes new pump station on Crooked River with, new intake and fish screen assembly, HDPE 96-inch inlet piping, new pumping wet well, (5) vertical turbine pumps, 24-inch pump control valves, and Steel 72-inch discharge piping

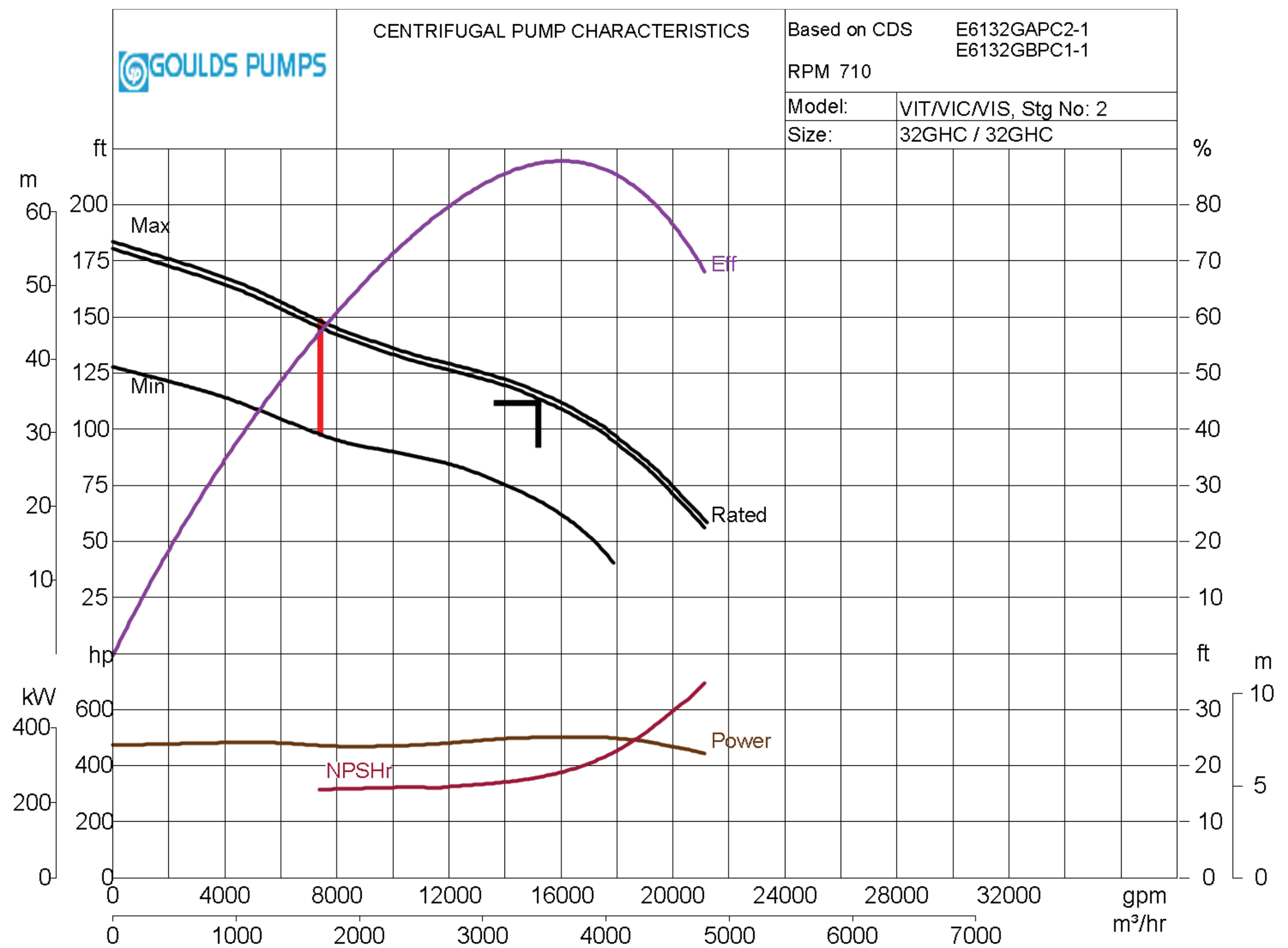
Model: VIT	Size: 32GHC	60Hz	RPM: 710	Stages: 2

Job/Inq.No. :	SOR				
Purchaser :	OID				
End User :	OID	Issued by :		Rev. :	0
Item/Equip.No. :	Barnes Butte New - Alt 4	Quotation No. :		Date :	11/21/2011
Service :	Irrigation - Raw Water				
Order No. :					

Operating Conditions / **Pump Performance**

Liquid:	Water	Published Efficiency:	86.8 %	Specific Speed 1st stg:	4,395 gpm(US) ft
Temp.:	70.0 deg F	Rated Pump Efficiency:	87.2 %	Specific Speed Adl stg:	
S.G./Visc.:	1.000/1.000 cp	Rated Total Power:	500.6 hp	Min. Hydraulic Flow:	7,395.0 gpm
Flow:	15,300.0 gpm	Non-Overloading Power:	502.3 hp	Min. Thermal Flow:	N/A
TDH:	113.0 ft	Imp. Dia. First 1 Stg(s):	20.88 in	Imp. Dia. Adl Stg(s):	20.49 in
NPSHa:	0.0 ft	NPSHr:	18.0 ft		
Solid size:	2.0000 in	Shut off Head:	180.4 ft		
% Susp. Solids (by wtg):		Vapor Press:			
Max. Solids Size:	2.1900 in				

Notes: 1. The Mechanical seal increased drag effect on power and efficiency is not included, unless the correction is shown in the appropriate field above. 2. Magnetic drive eddy current on power and efficiency is not included. 3. Elevated temperature effects on performance are not included. 4. Non Overloading power does not reflect v-belt/gear losses.



OCHOCO RELIFT 42-INCH DISCHARGE MAIN - EVALUATION SUMMARY

Ochoco Relift 42-inch Discharge Main Pumping Plant

The Ochoco Relift 42-inch Discharge Main Pumping Plant pumps a maximum of 78 cubic feet per second from the distribution canal to the Ochoco Main Canal to irrigate lands west of McKay Creek. The plant currently utilizes four pumping units fitted with a total of 1,300 horsepower in drive motors, and operates against a total dynamic head of 104 feet.

Original Design

Pump Unit	Description	HP	Rated Capacity	Rated Head	Pump Eff. @ Rated Capacity	Pipe size	Discharge Pipe Vel.	Discharge Main Vel.
No. 1	Horizontal Split Case	500	9,875 GPM	99 FT	Data Not Avail.	16 IN	15.8 FPS	
No. 2	Horizontal Split Case	500	9,875 GPM	99 FT	Data Not Avail.	16 IN	15.8 FPS	
No. 3	Horizontal Split Case	500	9,875 GPM	99 FT	Data Not Avail.	16 IN	15.8 FPS	
Total		1,500	29,625 GPM	99 FT		42 IN		6.9 FPS

Current Condition (Ref. Initial Pump Evaluation BPA, 2010)

Pump Unit	Description	HP	Test Capacity	Test Head	Pump Eff. @ Test Capacity	Pipe size	Discharge Pipe Vel.	Discharge Main Vel.
No. 1	Horizontal Split Case	350**	8,726 GPM *	91 FT *	74 % *	16 IN	13.9 FPS	
No. 2	Horizontal Split Case	350**	9,756 GPM *	92 FT *	81 % *	16 IN	15.6 FPS	
No. 3	Horizontal Split Case	350**	8,619 GPM	91 FT *	74 % *	16 IN	13.8 FPS	
No. 4	Vertical Turbine	250**	5,611 GPM *	93 FT *	65 % *	12 IN	15.9 FPS	
No. 5	Does Not Exist							
Total		1,300	32,712 GPM			42 IN		7.6 FPS

* (1) test data point, ref. Initial Pump Evaluation, BPA, 2010

** Per OID records, nameplate horsepower of existing motors

Alternate Equipment (Rebuild Existing Pumps)

Pump Unit	Description	HP	Rated Capacity	Rated Head	Pump Eff. @ Rated Capacity	Pipe size	Discharge Pipe Vel.	Discharge Main Vel.
No. 1	Horizontal Split Case	350	9,875 GPM	103 FT	88 %	18 IN	12.5 FPS	
No. 2	Horizontal Split Case	350	9,875 GPM	103 FT	88 %	18 IN	12.5 FPS	
No. 3	Horizontal Split Case	350	8,875 GPM	103 FT	88 %	18 IN	12.5 FPS	
No. 4	Vertical Turbine	200	5,400 GPM	103 FT	87 %	16 IN	8.6 FPS	
No. 5	Does Not Exist							
Total		1,250	35,025 GPM	103 FT		42 IN		8.1 FPS

Narrative

Evaluation of the Ochoco Relift 42-inch Discharge Main retrofit examines potential energy efficiency improvements gained by retrofitting the existing Ochoco Relift 42-inch Discharge Main Pumping Plant with new equipment. The pumping plant retrofit would replace existing pumps with (3) new horizontal split case pumps and (1) vertical turbine pump. New pumps would be installed at the location of existing pumping equipment. Pump discharge piping and valves would be sized to reduce velocity and friction losses.

Electrical systems would be rebuilt from service entrance through motor starters. New synchronous motors would be installed with the new pumps.

With four new pumps available to meet irrigation season demand variations, integration of variable speed drive equipment into alternate pump equipment would not appear to provide significant energy savings.

The capacity of the reconstructed pump station is anticipated to be approximately 78 CFS at 103 feet TDH.

Wire to water energy analysis is based on the projected capacity of the Ochoco Relift 42-inch Discharge Main pumping plant retrofitted with new pumps, motors, pump discharge piping, and valves. The Ochoco Relift 42-inch Discharge Main pumping plant retrofitted with new pumping equipment is projected to provide a seasonal average flow of 27,990 gpm (62.4 CFS) at 98.2 feet TDH. The existing Ochoco Relift 42-inch Discharge Main pumping plant in its current condition is projected to yield 62.4 CFS at 98.9 feet TDH.

Action Recommended for Further Evaluation: **Retrofit pumping plant, (3) horizontal split case pumps, (1) vertical turbine pump, connect to existing discharge main**

New No. 1 pump, Horizontal Split Case Pump

New No. 2 pump, Horizontal Split Case Pump

New No. 3 pump, Horizontal Split Case Pump

New No. 4 pump, Vertical Turbine Pump

Replace pump discharge piping and valves

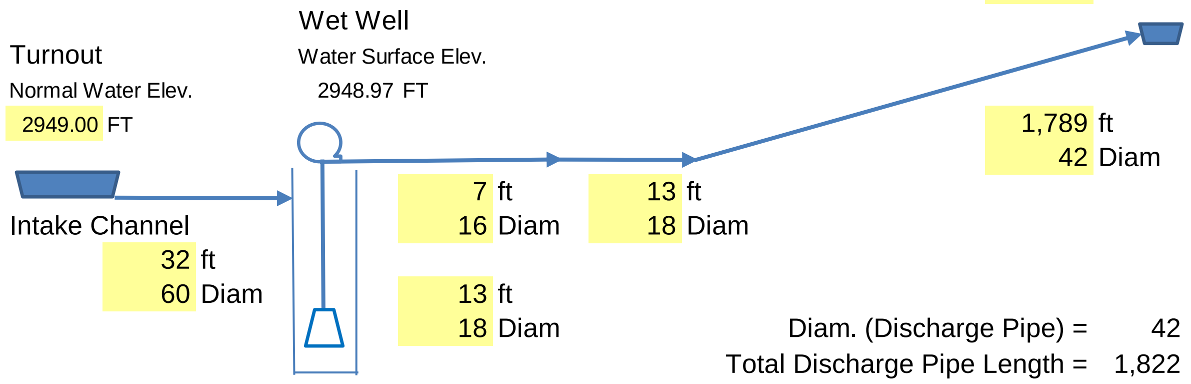
Replace electrical service entrance and motor starters

Annual Energy Savings Estimate = 464,689 kW-hr

Initial Cost Estimate = $1,932,000

Pump to Canal Head Loss Calculations
Relift Pumping Plant Retrofit, Split Case Pumps, 42-inch Discharge Line

9,875	GPM	Split Case Horizontal Pump No. 1		
9,875	GPM	Split Case Horizontal Pump No. 2		
9,875	GPM	Split Case Horizontal Pump No. 3	Static Head =	85.25 FT
5,400	GPM	Vertical Turbine Pump No. 4		
0	GPM	Does not exist		
35,025	GPM	Total = 78.0 cfs		



Diam. (Discharge Pipe) = 42 in
Total Discharge Pipe Length = 1,822 ft
Equiv. Pipe Length 16" Valves & Fittings Pump Discharge = 18 ft
Equiv. Pipe Length Fittings 42" Main Discharge Pipe = 196 ft

60" Intake Channel	Friction Head =	1.00 FT per 1,000 FT	Concrete
(Vel. = 4.0 fps)	Dynamic Head =	0.03 FT total	C = 110
18" Suction Pipe	Friction Head =	23.00 FT per 1,000 FT	Steel
(Vel. = 12.5 fps)	Dynamic Head =	0.30 FT total	C = 135
16" Pump Discharge Pipe	Friction Head =	40.79 FT per 1,000 FT	Steel
(Vel. = 15.8 fps)	Dynamic Head =	0.29 FT total	C = 135
18" Pump Discharge Pipe	Friction Head =	23.00 FT per 1,000 FT	Steel
(Vel. = 12.5 fps)	Dynamic Head =	0.30 FT total	C = 135
42" Main Discharge	Friction Head =	5.66 FT per 1,000 FT	Concrete
(Vel. = 8.1 fps)	Dynamic Head =	10.13 FT total	C = 110
Equivalent Pipe Length Valves & Fittings Pump Discharge	Friction Head =	40.79 FT per 1,000 FT	Steel
	Dynamic Head =	0.73 FT total	C = 135
Equivalent Pipe Length Valves & Fittings Main Discharge	Friction Head =	3.88 FT per 1,000 FT	Steel
	Dynamic Head =	0.76 FT total	C = 135

Friction Head = 12.50 FT = 5.41 psi

Water Depth in Discharge Canal = 6.01 FT = 2.60 psi

Total Dynamic Head = 103.80 FT = 44.93 psi

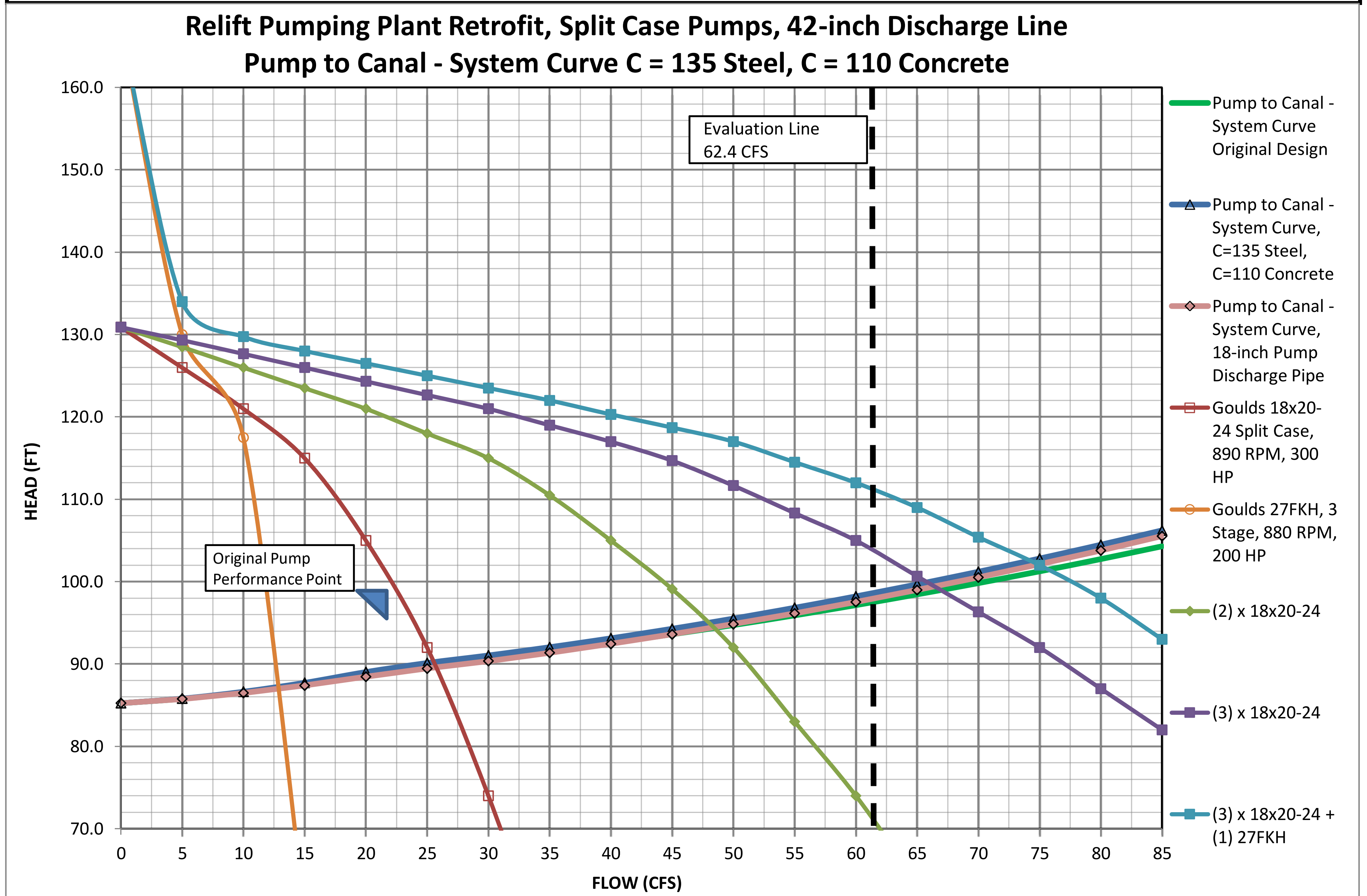
Equivalent Pipe Length Totals:

Item	16" Equiv. Length	No. of Units	Total Equiv. Length
18" bell entrance	5 ft	1 ea	5 ft
16" pump control (gate) valve	3 ft	1 ea	3 ft
16" x 18" expander	5 ft	2 ea	10 ft
		Subtotal	18 ft

Item	42" Equiv. Length	No. of Units	Total Equiv. Length
18"x42" tee branch flow	40 ft	1 ea	40 ft
42" flow meter	1 ft	1 ea	1 ft
18"x42" tee in-line flow	30 ft	2 ea	60 ft
42" 30 degree bend	30 ft	2 ea	60 ft
42" 10 degree bend	10 ft	2 ea	20 ft
42" flap gate	15 ft	1 ea	15 ft
		Subtotal	196 ft

Relift Pumping Plant Retrofit, Split Case Pumps, 42-inch Discharge Line
Pump to Canal - System Curve, C=135 Steel, C=110 Concrete

Q (gpm)	0	2,244	4,488	6,733	8,977	11,221	13,465	15,709	17,953	20,198	22,442	24,686	26,930	29,174	31,418	33,663	35,907	38,151
Q (cfs)	0.0	5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0	45.0	50.0	55.0	60.0	65.0	70.0	75.0	80.0	85.0
Hf	0.0	0.6	1.4	2.5	3.8	4.9	5.8	6.8	7.9	9.0	10.3	11.6	13.0	14.4	15.9	17.5	19.2	21.0
TDH (ft)	85.3	85.8	86.6	87.7	89.0	90.1	91.0	92.0	93.1	94.3	95.5	96.8	98.2	99.7	101.2	102.8	104.5	106.2
Vel. Disch. (fps)	0.0	0.5	1.0	1.6	2.1	2.6	3.1	3.6	4.2	4.7	5.2	5.7	6.2	6.8	7.3	7.8	8.3	8.8



Goulds 27FKH, 3 Stage, 880 RPM, 200 HP

Q (cfs)	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
Q (gpm)	0	2,244	4,488	6,732	8,977	11,221	13,465	15,709	17,953	20,197	22,442	24,686	26,930	29,174	31,418	33,662	35,907	38,151
Head (ft)	167	130	118	60														

Goulds 18x20-24 Split Case, 890 RPM, 300 HP

Q (cfs)	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
Q (gpm)	0	2,244	4,488	6,732	8,977	11,221	13,465	15,709	17,953	20,197	22,442	24,686	26,930	29,174	31,418	33,662	35,907	22
Head (ft)	131	126	121	115	105	92	74	53										

(2) x 18x20-24

Q (cfs)	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
Q (gpm)	0	2,244	4,488	6,732	8,977	11,221	13,465	15,709	17,953	20,197	22,442	24,686	26,930	29,174	31,418	33,662	35,907	38,151
Head (ft)	131	129	126	124	121	118	115	111	105	99	92	83	74	64	53			

(3) x 18x20-24

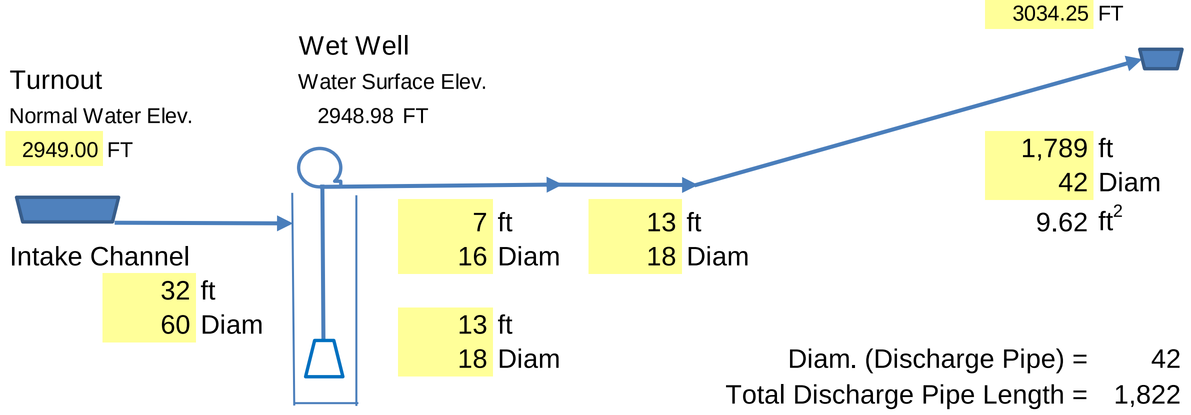
Q (cfs)	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
Q (gpm)	0	2,244	4,488	6,732	8,977	11,221	13,465	15,709	17,953	20,197	22,442	24,686	26,930	29,174	31,418	33,662	35,907	38,151
Head (ft)	131	129	128	126	124	123	121	119	117	115	112	108	105	101	96	92	87	82

(3) x 18x20-24 + (1) 27FKH

Q (cfs)	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
Q (gpm)	0	2,244	4,488	6,732	8,977	11,221	13,465	15,709	17,953	20,197	22,442	24,686	26,930	29,174	31,418	33,662	35,907	38,151
Head (ft)	167	134	130	128	127	125	124	122	120	119	117	115	112	109	105	102	98	93

Pump to Canal Head Loss Calculations
Relift Pumping Plant Retrofit, Split Case Pumps, 42-inch Discharge Line

9,875	GPM	Split Case Horizontal Pump No. 1			
9,875	GPM	Split Case Horizontal Pump No. 2			
9,875	GPM	Split Case Horizontal Pump No. 3		Static Head =	85.25 FT
0	GPM				
0	GPM				
29,625	GPM	Total =	66.0 cfs		



Diam. (Discharge Pipe) =	42 in
Total Discharge Pipe Length =	1,822 ft
Equiv. Pipe Length 16" Valves & Fittings Pump Discharge =	18 ft
Equiv. Pipe Length Fittings 42" Main Discharge Pipe =	196 ft

60" Intake Channel	Friction Head =	0.62 FT per 1,000 FT	Concrete
(Vel. = 3.4 fps)	Dynamic Head =	0.02 FT total	C = 120
18" Suction Pipe	Friction Head =	21.50 FT per 1,000 FT	Steel
(Vel. = 12.5 fps)	Dynamic Head =	0.28 FT total	C = 140
16" Pump Discharge Pipe	Friction Head =	38.13 FT per 1,000 FT	Steel
(Vel. = 15.8 fps)	Dynamic Head =	0.27 FT total	C = 140
18" Pump Discharge Pipe	Friction Head =	21.50 FT per 1,000 FT	Steel
(Vel. = 12.5 fps)	Dynamic Head =	0.28 FT total	C = 140
42" Main Discharge	Friction Head =	3.54 FT per 1,000 FT	Concrete
(Vel. = 6.9 fps)	Dynamic Head =	6.32 FT total	C = 120
Equivalent Pipe Length	Friction Head =	38.13 FT per 1,000 FT	Steel
Valves & Fittings Pump Discharge	Dynamic Head =	0.69 FT total	C = 140
Equivalent Pipe Length	Friction Head =	2.66 FT per 1,000 FT	Steel
Valves & Fittings Main Discharge	Dynamic Head =	0.52 FT total	C = 140
	Friction Head =	8.36 FT =	3.62 psi
	Water Depth in Discharge Canal =	5.08 FT =	2.20 psi
	Total Dynamic Head =	98.71 FT =	42.73 psi

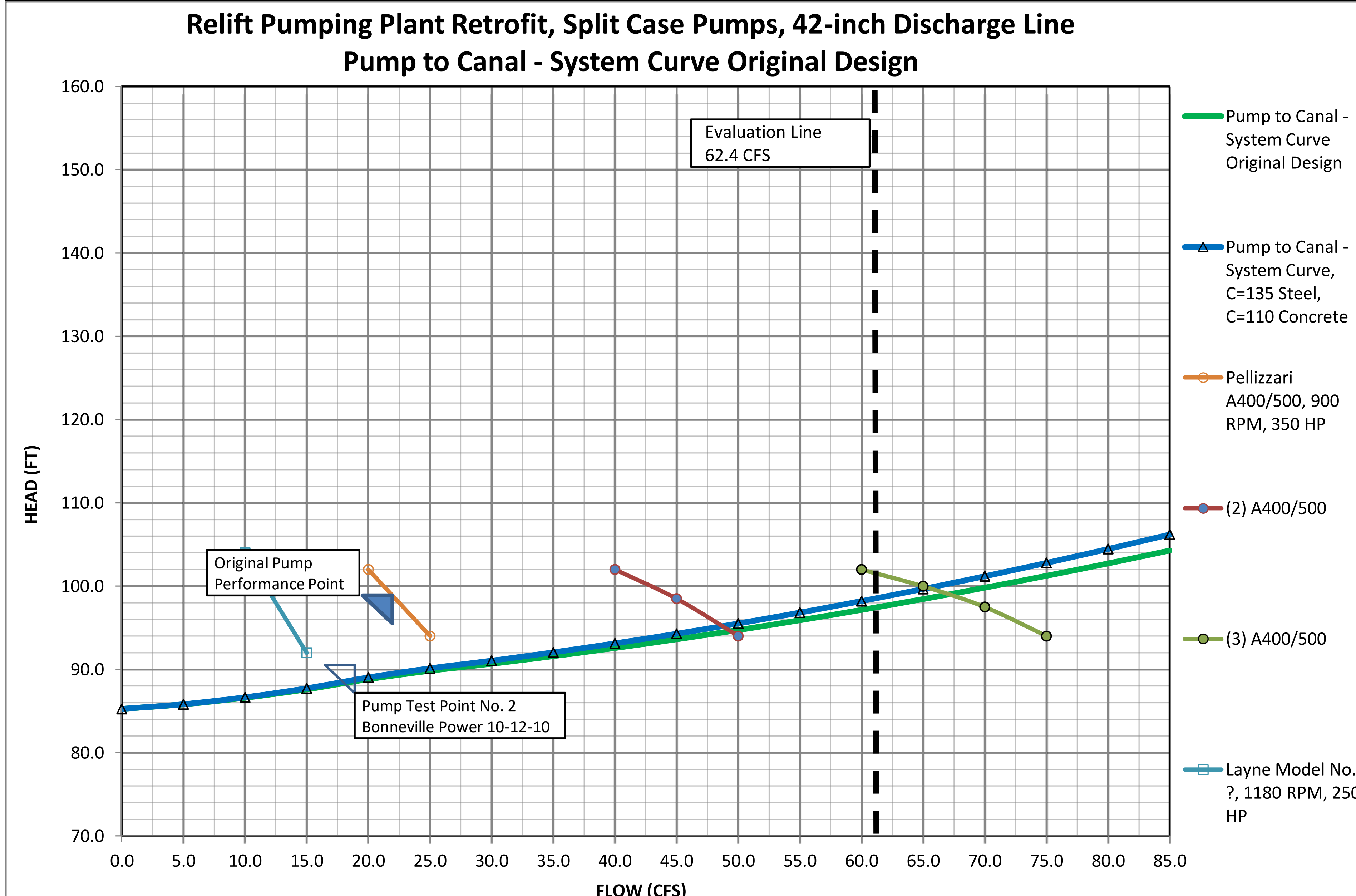
Equivalent Pipe Length Totals:

Item	16" Equiv. Length	No. of Units	Total Equiv. Length
18" bell entrance	5 ft	1 ea	5 ft
16" pump control (gate) valve	3 ft	1 ea	3 ft
16" x 18" expander	5 ft	2 ea	10 ft
		Subtotal	18 ft

Item	42" Equiv. Length	No. of Units	Total Equiv. Length
18"x42" tee branch flow	40 ft	1 ea	40 ft
42" flow meter	1 ft	1 ea	1 ft
18"x42" tee in-line flow	30 ft	2 ea	60 ft
42" 30 degree bend	30 ft	2 ea	60 ft
42" 10 degree bend	10 ft	2 ea	20 ft
42" flap gate	15 ft	1 ea	15 ft
		Subtotal	196 ft

Relift Pumping Plant Retrofit, Split Case Pumps, 42-inch Discharge Line
Pump to Canal - System Curve Original Design

Q (gpm)	0	2,244	4,488	6,733	8,977	11,221	13,465	15,709	17,953	20,198	22,442	24,686	26,930	29,174	31,418	33,663	35,907	38,151
Q (cfs)	0.0	5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0	45.0	50.0	55.0	60.0	65.0	70.0	75.0	80.0	85.0
Hf	0.0	0.5	1.3	2.3	3.6	4.6	5.4	6.3	7.3	8.4	9.5	10.6	11.9	13.2	14.6	16.0	17.5	19.0
TDH (ft)	85.3	85.8	86.6	87.6	88.8	89.8	90.7	91.6	92.6	93.6	94.7	95.9	97.1	98.4	99.8	101.2	102.7	104.3
Vel. Disch. (fps)	0.0	0.5	1.0	1.6	2.1	2.6	3.1	3.6	4.2	4.7	5.2	5.7	6.2	6.8	7.3	7.8	8.3	8.8



Pellizzari A400/500, 900 RPM, 350 HP

Q (cfs)	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
Q (gpm)	0	2,244	4,488	6,732	8,977	11,221	13,465	15,709	17,953	20,197	22,442	24,686	26,930	29,174	31,418	33,662	35,907	38,151
Head (ft)					102	94												

(2) A400/500

Q (cfs)	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
Q (gpm)	0	2,244	4,488	6,732	8,977	11,221	13,465	15,709	17,953	20,197	22,442	24,686	26,930	29,174	31,418	33,662	35,907	38,151
Head (ft)									102	99	94							

(3) A400/500

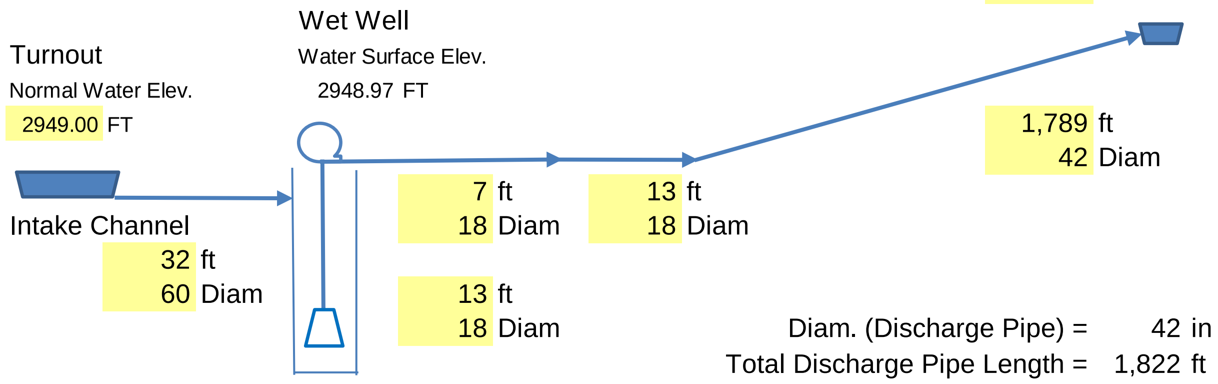
Q (cfs)	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
Q (gpm)	0	2,244	4,488	6,732	8,977	11,221	13,465	15,709	17,953	20,197	22,442	24,686	26,930	29,174	31,418	33,662	35,907	38,151
Head (ft)													102	100	98	94		

Layne Model No. ?, 1180 RPM, 250 HP

Q (cfs)	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
Q (gpm)	0	2,244	4,488	6,732	8,977	11,221	13,465	15,709	17,953	20,197	22,442	24,686	26,930	29,174	31,418	33,662	35,907	38,151
Head (ft)			104	92														

Pump to Canal Head Loss Calculations
Relift Pumping Plant Retrofit, Split Case Pumps, 42-inch Discharge Line

9,875	GPM	Split Case Horizontal Pump No. 1		
9,875	GPM	Split Case Horizontal Pump No. 2		
9,875	GPM	Split Case Horizontal Pump No. 3	Static Head =	85.25 FT
5,400	GPM	Vertical Turbine Pump No. 4		
0	GPM	Does not exist		
35,025	GPM	Total = 78.0 cfs		



Diam. (Discharge Pipe) = 42 in
Total Discharge Pipe Length = 1,822 ft
Equiv. Pipe Length 20" Valves & Fittings Pump Discharge = 8 ft
Equiv. Pipe Length Fittings 42" Main Discharge Pipe = 196 ft

60" Intake Channel	Friction Head =	1.00 FT per 1,000 FT	Concrete
(Vel. = 4.0 fps)	Dynamic Head =	0.03 FT total	C = 110
18" Suction Pipe	Friction Head =	23.00 FT per 1,000 FT	Steel
(Vel. = 12.5 fps)	Dynamic Head =	0.30 FT total	C = 135
18" Pump Discharge Pipe	Friction Head =	23.00 FT per 1,000 FT	Steel
(Vel. = 12.5 fps)	Dynamic Head =	0.16 FT total	C = 135
18" Pump Discharge Pipe	Friction Head =	23.00 FT per 1,000 FT	Steel
(Vel. = 12.5 fps)	Dynamic Head =	0.30 FT total	C = 135
42" Main Discharge	Friction Head =	5.66 FT per 1,000 FT	Concrete
(Vel. = 8.1 fps)	Dynamic Head =	10.13 FT total	C = 110
Equivalent Pipe Length	Friction Head =	23.00 FT per 1,000 FT	Steel
Valves & Fittings Pump Discharge	Dynamic Head =	0.18 FT total	C = 135
Equivalent Pipe Length	Friction Head =	3.88 FT per 1,000 FT	Steel
Valves & Fittings Main Discharge	Dynamic Head =	0.76 FT total	C = 135

Friction Head = 11.83 FT = 5.12 psi

Water Depth in Discharge Canal = 6.01 FT = 2.60 psi

Total Dynamic Head = 103.12 FT = 44.64 psi

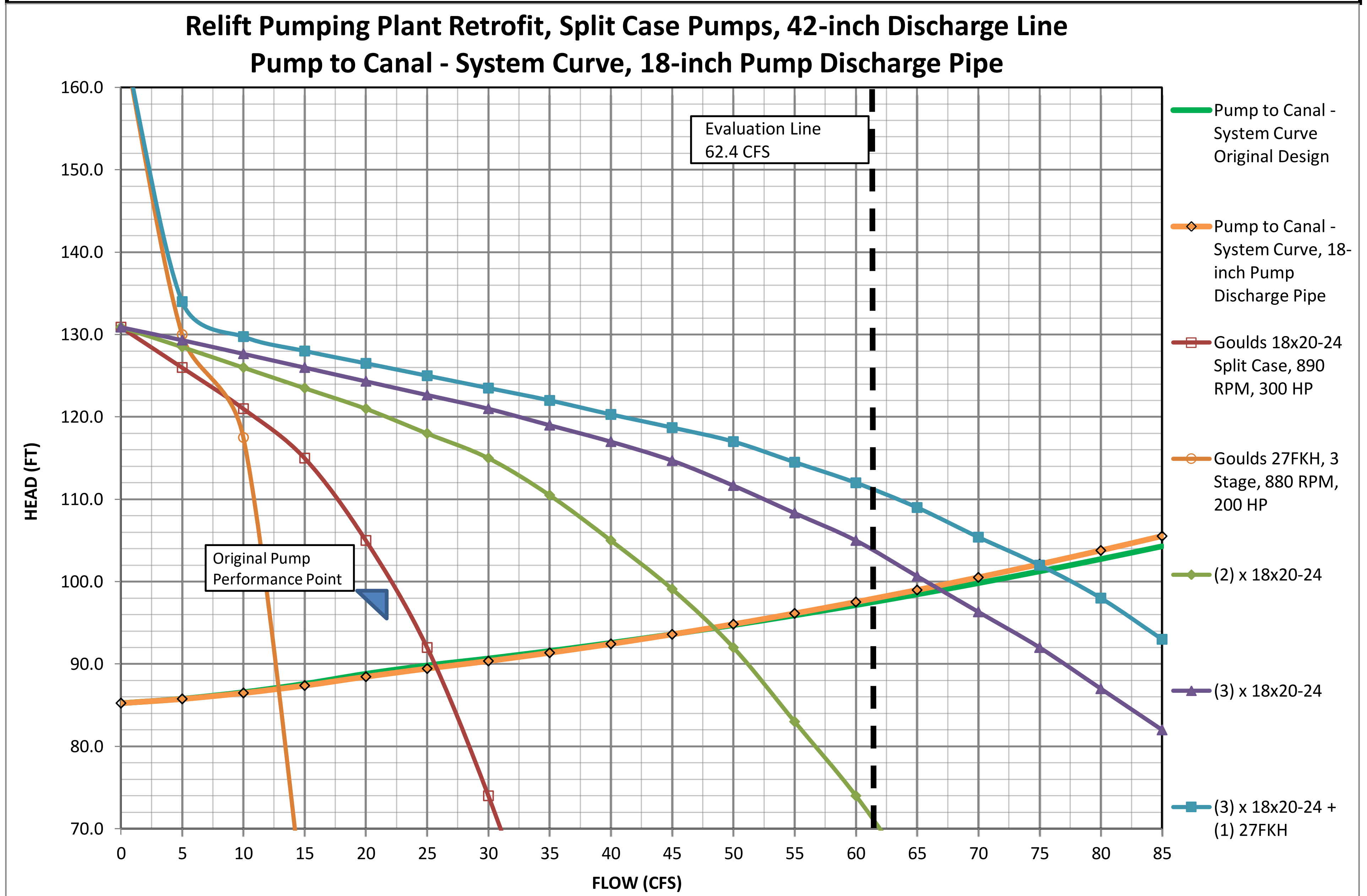
Equivalent Pipe Length Totals:

Item	16" Equiv. Length	No. of Units	Total Equiv. Length
18" bell entrance	5 ft	1 ea	5 ft
18" pump control (gate) valve	3 ft	1 ea	3 ft
		Subtotal	8 ft

Item	42" Equiv. Length	No. of Units	Total Equiv. Length
20"x42" tee branch flow	40 ft	1 ea	40 ft
42" flow meter	1 ft	1 ea	1 ft
20"x42" tee in-line flow	30 ft	2 ea	60 ft
42" 30 degree bend	30 ft	2 ea	60 ft
42" 10 degree bend	10 ft	2 ea	20 ft
42" flap gate	15 ft	1 ea	15 ft
		Subtotal	196 ft

Relift Pumping Plant Retrofit, Split Case Pumps, 42-inch Discharge Line
Pump to Canal - System Curve, 18-inch Pump Discharge Pipe

Q (gpm)	0	2,244	4,488	6,733	8,977	11,221	13,465	15,709	17,953	20,198	22,442	24,686	26,930	29,174	31,418	33,663	35,907	38,151
Q (cfs)	0.0	5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0	45.0	50.0	55.0	60.0	65.0	70.0	75.0	80.0	85.0
Hf	0.0	0.5	1.2	2.1	3.2	4.2	5.1	6.1	7.2	8.4	9.6	10.9	12.3	13.7	15.3	16.9	18.5	20.3
TDH (ft)	85.3	85.8	86.5	87.4	88.5	89.4	90.4	91.4	92.4	93.6	94.8	96.1	97.5	99.0	100.5	102.1	103.8	105.5
Vel. Disch. (fps)	0.0	0.5	1.0	1.6	2.1	2.6	3.1	3.6	4.2	4.7	5.2	5.7	6.2	6.8	7.3	7.8	8.3	8.8



Goulds 27FKH, 3 Stage, 880 RPM, 200 HP

Q (cfs)	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
Q (gpm)	0	2,244	4,488	6,732	8,977	11,221	13,465	15,709	17,953	20,197	22,442	24,686	26,930	29,174	31,418	33,662	35,907	38,151
Head (ft)	167	130	118	60														

Goulds 18x20-24 Split Case, 890 RPM, 300 HP

Q (cfs)	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
Q (gpm)	0	2,244	4,488	6,732	8,977	11,221	13,465	15,709	17,953	20,197	22,442	24,686	26,930	29,174	31,418	33,662	35,907	22
Head (ft)	131	126	121	115	105	92	74	53										

(2) x 18x20-24

Q (cfs)	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
Q (gpm)	0	2,244	4,488	6,732	8,977	11,221	13,465	15,709	17,953	20,197	22,442	24,686	26,930	29,174	31,418	33,662	35,907	38,151
Head (ft)	131	129	126	124	121	118	115	111	105	99	92	83	74	64	53			

(3) x 18x20-24

Q (cfs)	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
Q (gpm)	0	2,244	4,488	6,732	8,977	11,221	13,465	15,709	17,953	20,197	22,442	24,686	26,930	29,174	31,418	33,662	35,907	38,151
Head (ft)	131	129	128	126	124	123	121	119	117	115	112	108	105	101	96	92	87	82

(3) x 18x20-24 + (1) 27FKH

Q (cfs)	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
Q (gpm)	0	2,244	4,488	6,732	8,977	11,221	13,465	15,709	17,953	20,197	22,442	24,686	26,930	29,174	31,418	33,662	35,907	38,151
Head (ft)	167	134	130	128	127	125	124	122	120	119	117	115	112	109	105	102	98	93

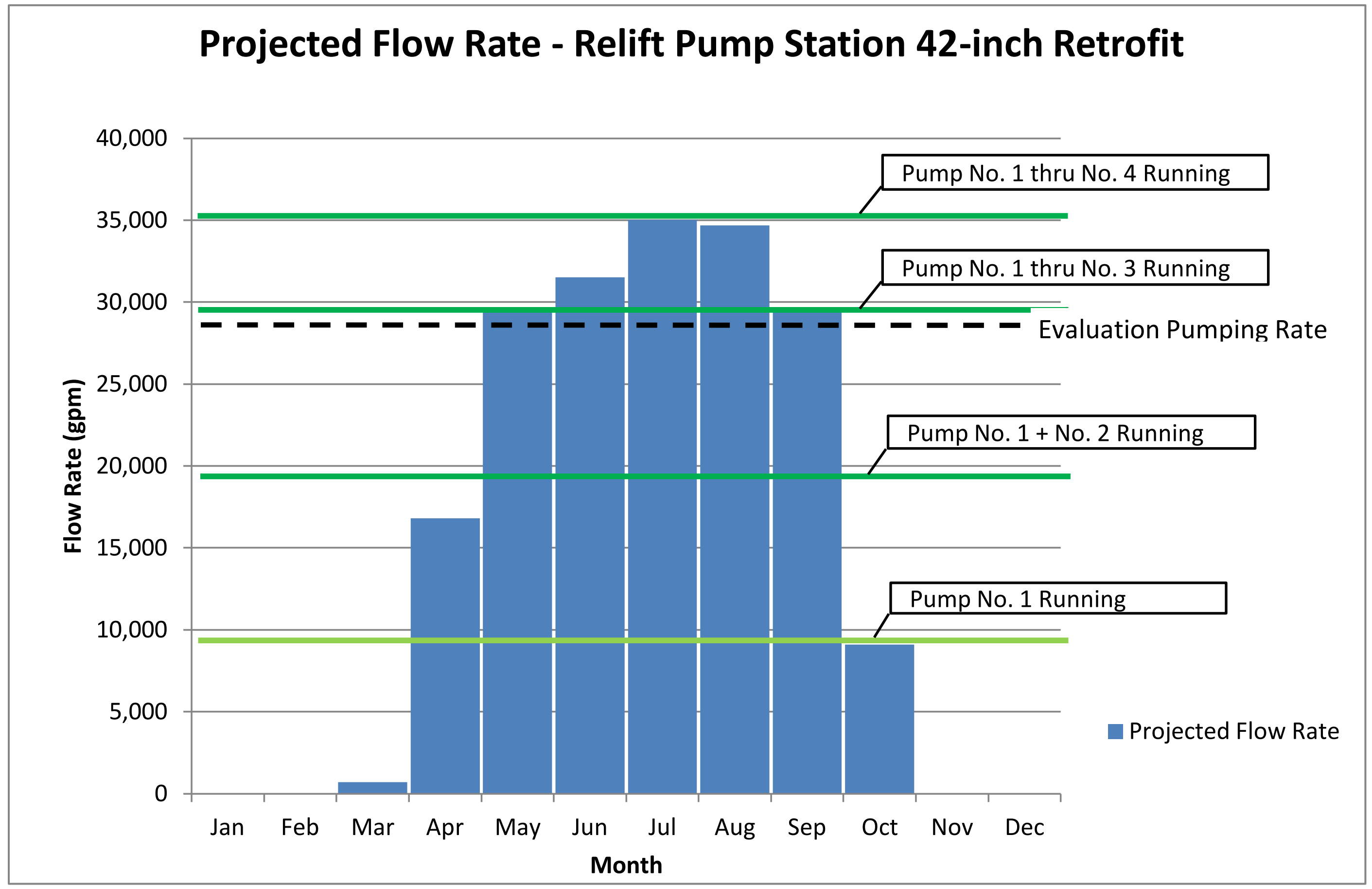
Pump to Canal Head Loss Calculations
Relift Pumping Plant Retrofit 42-inch (New Horizontal Split Case, replacement pump discharge piping and values)

9,875	GPM	Split Case Horizontal Pump No. 1		
9,875	GPM	Split Case Horizontal Pump No. 2		
9,875	GPM	Split Case Horizontal Pump No. 3		
5,400	GPM	Vertical Turbine Pump No. 4		
0	GPM	Does not exist		
35,025	GPM	Total	=	78.0 cfs

Proposed PS Design Flow Rate = 35,025 gpm

Month	% of Max Flow Rate	Projected Flow Rate
Jan	0%	0
Feb	0%	0
Mar	2%	701
Apr	48%	16,812
May	84%	29,421
Jun	90%	31,523
Jul	100%	35,025
Aug	99%	34,675
Sep	84%	29,421
Oct	26%	9,107
Nov	0%	0
Dec	0%	0

Evaluation Pumping Rate 27,990 gpm
62.4 cfs



Notes: Relift PS 42-inch Discharge Main when reconstructed with (3) new Horizontal Split Case and (1) new Vertical Turbine Pump. Considering that this pumping plant is augmented by Pump 6 (4750 gpm) and Pump 7 (3250 gpm) in a parallel 24-inch discharge main, VFD operation of pumps at this pump station would not provide significant benefit toward reducing energy use and optimizing water delivery to crop requirement. New pumps No. 1 through No. 4 can be selected at flow rates that promote their combined use to reasonably match projected seasonal demand requirements.

Ochoco Irrigation District

Relift PS 42-inch Discharge Line (Retrofit of pump equipment at existing pump station)

Budget Level - Projection of Probable Construction Cost

Item No.	Spec Division	Description	Measurement	Units	Unit Cost	Total Cost
1	1000	Mobilization	LS	1	$54,000.00	$54,000.00
2	1000	Erosion Control	LS	1	$1,000.00	$1,000.00
4	1000	Watering / Dust Control	LS	1	$2,500.00	$2,500.00
5	1000	Construction Staking	LS	1	$1,000.00	$1,000.00
6	1000	Project Management and Coordination	LS	1	$3,000.00	$3,000.00
7	1000	Construction Progress Documentation	LS	1	$3,000.00	$3,000.00
8	1000	Submittal Procedures	LS	1	$3,000.00	$3,000.00
9	1000	Quality Requirements	LS	1	$3,000.00	$3,000.00
10	1000	Selective Demolition	LS	1	$10,000.00	$10,000.00
11	1000	Project Record Documents	LS	1	$3,000.00	$3,000.00
12	1000	Operations and Maintenance Data	LS	1	$3,000.00	$3,000.00
14	1000	General Commissioning Requirements	LS	1	$12,000.00	$12,000.00
15	2000	Surfacing Rock	CY	200	$38.00	$7,600.00
16	3000	Misc Cast-in-Place Concrete (thrust and pads)	LS	1	$20,000.00	$20,000.00
17	9000	High Performance Coating Systems	LS	1	$8,000.00	$8,000.00
18	11000	Horiz. Split Case Pump and Motor, 350 HP	EA	3	$123,500.00	$370,500.00
19	11000	Line Shaft Turbine Pump and Motor, 200 HP	EA	1	$108,000.00	$108,000.00
20	15000	18-inch Handwheel Operated Butterfly Valve	EA	3	$3,625.00	$10,875.00
21	15000	18-inch Discharge Pipe, Fittings, & Accessories	EA	3	$15,000.00	$45,000.00
23	15000	18-inch Electric Motor Operated Butterfly Valve	EA	3	$13,750.00	$41,250.00
24	15000	16-inch Handwheel Operated Butterfly Valve	EA	1	$2,875.00	$2,875.00
25	15000	16-inch Surge Control Check Valve	EA	1	$9,875.00	$9,875.00
26	15000	16-inch Discharge Pipe, Fittings, & Accessories	EA	1	$12,500.00	$12,500.00
27	15000	Automatic Priming System	EA	1	$30,000.00	$30,000.00
28	16000	Power and Distribution	LS	1	$40,370.00	$40,370.00
29	16000	Grounding Systems	LS	1	$11,700.00	$11,700.00
30	16000	Conduit and Conductors	LS	1	$33,475.00	$33,475.00
31	16000	Motor Controls	LS	1	$176,350.00	$176,350.00
32	17000	Instrumentation and Control	LS	1	$60,000.00	$60,000.00
		Construction Subtotal				$1,086,870.00
		Contractors Overhead and Profit	10%	1	$108,687.00	$108,687.00
		Contractors Bonds and Insurance	2%	1	$23,911.14	$23,911.14
		Construction Contingency	30%	1	$326,061.00	$326,061.00
		Construction Total				$1,545,529.14
		Engineering, Administration	25%	1	$386,382.29	
		Total				**$1,931,911.43**

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Wire to Water Energy Calculator

Ochoco Irrigation District - SOR

Relift Pumping Plant - 42-inch Discharge Line Pump Replacment

Source: PumpTech Inc.

2425 SE Ochoco Street

Portland, OR 97222

503-659-6230

OPERATIONAL AND EQUIPMENT DATA

	Replacement Pumps		Existing Pumps	
	No. 1 - Goulds Model 3420 18x20-24, Split Case, 890 RPM, 350 HP		No. 1 - Pellizzari A400/500, Split Case, 900 RPM, 350 HP *	
	No. 1 - Goulds Model 3420 18x20-24, Split Case, 890 RPM, 350 HP		No. 2 - Pellizzari A400/500, Split Case, 900 RPM, 350 HP *	
	No. 1 - Goulds Model 3420 18x20-24, Split Case, 890 RPM, 350 HP		No. 3 - Pellizzari A400/500, Split Case, 900 RPM, 350 HP *	
	No. 4 - Floway 27FKH, 3 Stage, 880 RPM, 200 HP		No. 4 - Lane Model No. ?, Vert. Turbine, 1180 RPM, 250 HP *	
Pump Operation - Hours / Day	24		24	
Pump Operation - Days / Year	198		198	
Pump Flow - GPM (Evaluation Pump Rate)	27,990		27,990	
Pump Flow - CFS	62.4		62.4	
Total Annual Volume - Acre feet	24,490		24,490	
Pump Head - Feet	98.2	*	98.9	
Ave. Pump Efficiency - %	88.0%		76.4%	**
Ave. Motor Efficiency - %	96.3%		96.3%	**
Energy Cost in $/kWH	$0.035		$0.035	

* Estimated Pumping head assumes pump discharge piping, and valves are 18-inch. Estimated motor efficiency assumes synchronous motors.

* Pump Make and model per original construction submittals, 1963. Per OID records, motor horsepower nameplate rated as shown here.

** Source: Initial Pump Evaluation test data.

RESULTS

	Replacement Pumps	Existing Pumps
BHP At Design Point	788.7	915.0
Wire to Water Efficiency - %	85%	74%
KW per Year	2,903,525	3,368,214
Annual Energy Cost	$101,623.36	$117,887.47
KW Per 1,000 Gallons Pumped	0.364	0.422
Cost Per 1,000 Gallons Pumped	$0.013	$0.015
kWh per Acre Foot Pumped	119	138
Cost Per Acre Foot Pumped	$4.15	$4.81

PAYBACK

Annual Savings - kW	464,689
Annual Savings - $$	$16,264.12
Annual Savings - %	13.80%
Cost of Replacement Pumps *	$1,932,000.00
Cost of Existing Pumps	$0.00
Payback - Years	118.8

* Estimated cost assumes replacement of pumps and replacement of discharge piping, with pipe and valves in 18-inch size.

Pump Test Data

Initial Pump Evaluation

Project No.: OCHID-02-10 **Description:**

Pump Station No.: Relifts **Pump No.:** 1 **Water Source:** Canal

Motor Nameplate

Motor Make: Pellizzari
Model No:
Serial No:
Rated Hp: 500
Rated Voltage: 2300
Rated Amperage: 126 **Ins. Class:** None
Full Load RPM: 900 **Code:** None
Enclosure: None
Design: None
Frame:
Service Factor: 1.15

Utility Meter Nameplate

Make: None **Meter ID:** None
Type: None **Serial No.:** None
k_h: None **PTR:** None **CTR:** None

Pump Nameplate

Pump Make: Pellizzari
Type: Split-Case Centrifugal
Serial No: 275186
Model No: A400/500 **Impeller No:**
Impeller Dia (in): **No. of Stages:** 1
Impeller Dia (in): **No. of Stages:** 0
Secondary Model No: None **Impeller No:**
Impeller Dia (in): **No. of Stages:** 0
Impeller Dia (in): **No. of Stages:** 0
Rated Flow (gpm): 9875
Rated Head (ft): 99
Rated RPM: 900
Column Dia (in): 0.00
Column Length (ft): 0.0
Shaft Dia (in): 0.000
Tube Dia (in): 0.000
Thrust Factor (lbs/ft): 0.0
Impeller Wt. (lbs): 0.0

Field Pump Test Data

Test No.	Date	Flow Measurement Device	Flow (gpm)	Lift Air Line (PSI)	Lift Static Level (ft)	Lift Pumping Lift (ft)	Pressures Discharge (PSI)	Pressures Delivered (PSI)	Misc. Losses (ft)	TDH (ft)	Pump RPM
1	10/12/2010	Transit Time	8,726			8.4	34.2	34.2	3.2	90.7	900

Test No.	Voltages 1-2	Voltages 1-3	Voltages 2-3	Voltages Avg.	Amperages 1	Amperages 2	Amperages 3	Amperages Avg.	Power Factor 1	Power Factor 2	Power Factor 3	Power Factor Avg.	Utility Meter Rev.	Utility Meter Sec.	Motor RPM	Motor % Load
1	2300.0	2305.0	2310.0	2305.0	53.0	53.5	55.8	54.1	101.0%	101.0%	101.0%	101.0%				53.9%

Test No.	Power Calculations Shaft HP	Thrust HP	Water HP	Brake HP	Pump HP	Input kW	Input HP	Utility Meter (kW)	Efficiencies Motor	Pump	Discharge	Delivered
1	0.00	0.00	199.9	269.8	269.8	218.1	292.3		92.3%	74.1%	68.4%	68.4%

Note: If a main valve is present, the Delivered Pressure is the pressure after the valve. If no main valve is present, the Delivered Pressure will be the same as the Discharge Pressure.

Pump Test Data

Initial Pump Evaluation

Project No.: OCHID-02-10 **Description:**

Pump Station No.: Relifts **Pump No.:** 2 **Water Source:** Canal **Parallel**

Motor Nameplate

Motor Make: Pellizzari
Model No:
Serial No:
Rated Hp: 500
Rated Voltage: 2300
Rated Amperage: 126 **Ins. Class:** None
Full Load RPM: 900 **Code:** None
Enclosure: None
Design: None
Frame:
Service Factor: 1.15

Utility Meter Nameplate

Make: None **Meter ID:** None
Type: None **Serial No.:** None
k_h: None **PTR:** None **CTR:** None

Pump Nameplate

Pump Make: Pellizzari
Type: Split-Case Centrifugal
Serial No: 275187
Model No: A400/500 **Impeller No:**
Impeller Dia (in): **No. of Stages:** 1
Impeller Dia (in): **No. of Stages:** 0
Secondary Model No: None **Impeller No:**
Impeller Dia (in): **No. of Stages:** 0
Impeller Dia (in): **No. of Stages:** 0
Rated Flow (gpm): 9875
Rated Head (ft): 99
Rated RPM: 900
Column Dia (in): 0.00
Column Length (ft): 0.0
Shaft Dia (in): 0.000
Tube Dia (in): 0.000
Thrust Factor (lbs/ft): 0.0
Impeller Wt. (lbs): 0.0

Field Pump Test Data

Test No.	Date	Flow: Measurement Device	Flow (gpm)	Lift: Air Line (PSI)	Lift: Static Level (ft)	Lift: Pumping Lift (ft)	Pressures: Discharge (PSI)	Pressures: Delivered (PSI)	Misc. Losses (ft)	TDH (ft)	Pump RPM
1	10/13/2010	Transit Time	9,756			8.4	34.2	32.2	4.0	91.5	900

Test No.	Voltages 1-2	1-3	2-3	Avg.	Amperages 1	2	3	Avg.	Power Factor 1	2	3	Avg.	Utility Meter Rev.	Sec.	Motor RPM	% Load
1	2300.0	2305.0	2310.0	2305.0	54.8	55.8	55.9	55.5	101.0%	101.0%	101.0%	101.0%				55.5%

Test No.	Power Calculations: Shaft HP	Thrust HP	Water HP	Brake HP	Pump HP	Input kW	Input HP	Utility Meter (kW)	Efficiencies: Motor	Pump	Discharge	Delivered
1	0.00	0.00	225.4	277.6	277.6	223.7	299.8		92.6%	81.2%	75.2%	71.4%

Note: If a main valve is present, the Delivered Pressure is the pressure after the valve. If no main valve is present, the Delivered Pressure will be the same as the Discharge Pressure.

Pump Test Data

Initial Pump Evaluation

Project No.: OCHID-02-10 **Description:**

Pump Station No.: Relifts **Pump No.:** 3 **Water Source:** Canal

Motor Nameplate

Motor Make:	Pellizzari		
Model No:			
Serial No:	1705157		
Rated Hp:	500		
Rated Voltage:	2300		
Rated Amperage:	126	**Ins. Class:**	None
Full Load RPM:	900	**Code:**	None
Enclosure:	None		
Design:	None		
Frame:			
Service Factor:	1.15		

Pump Nameplate

Pump Make:	Pellizzari		
Type:	Split-Case Centrifugal		
Serial No:	275188		
Model No:	A400/500	**Impeller No:**	
Impeller Dia (in):		**No. of Stages:**	1
Impeller Dia (in):		**No. of Stages:**	0
Secondary Model No:	None	**Impeller No:**	
Impeller Dia (in):		**No. of Stages:**	0
Impeller Dia (in):		**No. of Stages:**	0
Rated Flow (gpm):	9875		
Rated Head (ft):	99		
Rated RPM:	900		
Column Dia (in):	0.00		
Column Length (ft):	0.0		
Shaft Dia (in):	0.000		
Tube Dia (in):	0.000		
Thrust Factor (lbs/ft):	0.0		
Impeller Wt. (lbs):	0.0		

Utility Meter Nameplate

Make:	None	**Meter ID:**	None		
Type:	None	**Serial No.:**	None		
k_h:	None	**PTR:**	None	**CTR:**	None

Field Pump Test Data

Test No.	Date	Flow Measurement Device	Flow (gpm)	Lift Air Line (PSI)	Lift Static Level (ft)	Lift Pumping Lift (ft)	Pressures Discharge (PSI)	Pressures Delivered (PSI)	Misc. Losses (ft)	TDH (ft)	Pump RPM
1	10/13/2010	Transit Time	8,619			8.4	34.3	34.3	3.1	90.8	900

Test No.	Voltages 1-2	Voltages 1-3	Voltages 2-3	Voltages Avg.	Amperages 1	Amperages 2	Amperages 3	Amperages Avg.	Power Factor 1	Power Factor 2	Power Factor 3	Power Factor Avg.	Utility Meter Rev.	Utility Meter Sec.	Motor RPM	Motor % Load
1	2300.0	2305.0	2310.0	2305.0	55.0	53.5	52.5	53.7	101.0%	101.0%	101.0%	101.0%			900	53.4%

Test No.	Power Calculations Shaft HP	Thrust HP	Water HP	Brake HP	Pump HP	Input kW	Input HP	Utility Meter (kW)	Efficiencies Motor	Pump	Discharge	Delivered
1	0.00	0.00	197.6	267.4	267.4	216.4	290.0		92.2%	73.9%	68.2%	68.2%

Note: If a main valve is present, the Delivered Pressure is the pressure after the valve. If no main valve is present, the Delivered Pressure will be the same as the Discharge Pressure.

Pump Test Data

Initial Pump Evaluation

Project No.: OCHID-02-10 **Description:**

Pump Station No.: Relifts **Pump No.:** 4 **Water Source:** Canal **Parallel**

Motor Nameplate

Motor Make: General Electric
Model No: 5K6326XC352A
Serial No:
Rated Hp: 300
Rated Voltage: 2300
Rated Amperage: 59 **Ins. Class:** None
Full Load RPM: 1180 **Code:** None
Enclosure: None
Design: None
Frame: 6326P24
Service Factor: 1.15

Pump Nameplate

Pump Make: Layne
Type: Vertical Turbine
Serial No: 61212
Model No: None **Impeller No:**
Impeller Dia (in): **No. of Stages:** 0
Impeller Dia (in): **No. of Stages:** 0
Secondary Model No: None **Impeller No:**
Impeller Dia (in): **No. of Stages:** 0
Impeller Dia (in): **No. of Stages:** 0
Rated Flow (gpm): 5386
Rated Head (ft): 99
Rated RPM: 1770
Column Dia (in): 0.00
Column Length (ft): 0.0
Shaft Dia (in): 0.000
Tube Dia (in): 0.000
Thrust Factor (lbs/ft): 0.0
Impeller Wt. (lbs): 0.0

Utility Meter Nameplate

Make: None **Meter ID:** None
Type: None **Serial No.:** None
k_h: None **PTR:** None **CTR:** None

Field Pump Test Data

Test No.	Date	Flow Measurement Device	Flow (gpm)	Lift Air Line (PSI)	Lift Static Level (ft)	Lift Pumping Lift (ft)	Pressures Discharge (PSI)	Pressures Delivered (PSI)	Misc. Losses (ft)	TDH (ft)	Pump RPM
1	10/13/2010	Dye	5,611			8.4	36.2	36.2	1.2	93.3	1188

Test No.	Voltages 1-2	1-3	2-3	Avg.	Amperages 1	2	3	Avg.	Power Factor 1	2	3	Avg.	Utility Meter Rev.	Sec.	Motor RPM	% Load
1	2300.0	2305.0	2310.0	2305.0	48.5	47.0	46.2	47.2				87.3%			1188	68.0%

Test No.	Power Calculations Shaft HP	Thrust HP	Water HP	Brake HP	Pump HP	Input kW	Input HP	Utility Meter (kW)	Efficiencies Motor	Pump	Discharge	Delivered
1	0.00	0.00	132.2	204.1	204.1	164.6	220.6		92.5%	64.8%	59.9%	59.9%

Note: If a main valve is present, the Delivered Pressure is the pressure after the valve. If no main valve is present, the Delivered Pressure will be the same as the Discharge Pressure.

Pump Test Data

Initial Pump Evaluation

Project No.: OCHID-02-10 **Description:** Does not exist

Pump Station No.: Relifts **Pump No.:** 5 **Water Source:** None

Motor Nameplate

Motor Make: None
Model No:
Serial No:
Rated Hp: None
Rated Voltage: None
Rated Amperage: **Ins. Class:** None
Full Load RPM: 0 **Code:** None
Enclosure: None
Design: None
Frame:
Service Factor: 0.00

Pump Nameplate

Pump Make: None
Type: None
Serial No:
Model No: None **Impeller No:**
Impeller Dia (in): **No. of Stages:** 0
Impeller Dia (in): **No. of Stages:** 0
Secondary Model No: None **Impeller No:**
Impeller Dia (in): **No. of Stages:** 0
Impeller Dia (in): **No. of Stages:** 0
Rated Flow (gpm): 0
Rated Head (ft): 0
Rated RPM: 0
Column Dia (in): 0.00
Column Length (ft): 0.0
Shaft Dia (in): 0.000
Tube Dia (in): 0.000
Thrust Factor (lbs/ft): 0.0
Impeller Wt. (lbs): 0.0

Utility Meter Nameplate

Make: None **Meter ID:** None
Type: None **Serial No.:** None
k_h: None **PTR:** None **CTR:** None

Field Pump Test Data

Test No.	Date	Flow: Measurement Device	Flow (gpm)	Lift: Air Line (PSI)	Lift: Static Level (ft)	Lift: Pumping Lift (ft)	Pressures: Discharge (PSI)	Pressures: Delivered (PSI)	Misc. Losses (ft)	TDH (ft)	Pump RPM
1	10/13/2010	None	0			0.0	0.0	0.0	0.0		

Test No.	Voltages 1-2	1-3	2-3	Avg.	Amperages 1	2	3	Avg.	Power Factor 1	2	3	Avg.	Utility Meter Rev.	Sec.	Motor RPM	% Load
1																

Test No.	Power Calculations: Shaft HP	Thrust HP	Water HP	Brake HP	Pump HP	Input kW	Input HP	Utility Meter (kW)	Efficiencies: Motor	Pump	Discharge	Delivered
1	0.00	0.00	0.0	0.0	0.0	0.0	0.0		0.0%		0.0%	0.0%

Note: If a main valve is present, the Delivered Pressure is the pressure after the valve. If no main valve is present, the Delivered Pressure will be the same as the Discharge Pressure.

Pump Test Summary Data

Project No.: OCHID-02-10

Pump Station	Pump No.	Condition	Test No.	Include	Rated Hp	Flow (gpm)	Lift (ft)	Discharge (PSI)	Delivery (PSI)	TDH (FT)	Electric Hp	Pump Eff.	Overall Eff.
Relifts	1	Existing	1		500	8,726	8.4	34.2	34.2	90.7	292.3	74.1%	68.4%
Relifts	2	Existing	1		500	9,756	8.4	34.2	32.2	91.5	299.8	81.2%	75.2%
Relifts	3	Existing	1		500	8,619	8.4	34.3	34.3	90.8	290.0	73.9%	68.2%
Relifts	4	Existing	1		300	5,611	8.4	36.2	36.2	93.3	220.6	64.8%	59.9%
Relifts	5	Existing	1		None	0	0.0	0.0	0.0	0.0	0.0	0.0%	0.0%
Relifts	6	Existing	1		125	4,094	8.4	40.0	40.0	102.9	147.4	79.2%	72.2%
Relifts	7	Existing	1		125	3,278	8.4	38.4	38.4	98.4	131.3	68.1%	62.1%

Model: 3420	Size: 18X20-24	Group: _	60Hz	RPM: 890	Stages: 1

Job/Inq.No. : Ochoco Irrigation District
Purchaser : OID - SOR Relift PS, 42-inch Discharge
End User : Replacement Pumps No. 1, 2, & 3
Issued by :
Rev. : 0
Item/Equip.No. : ITEM 001
Quotation No. :
Date : 05/31/2011
Service : Irrigation Water
Order No. :

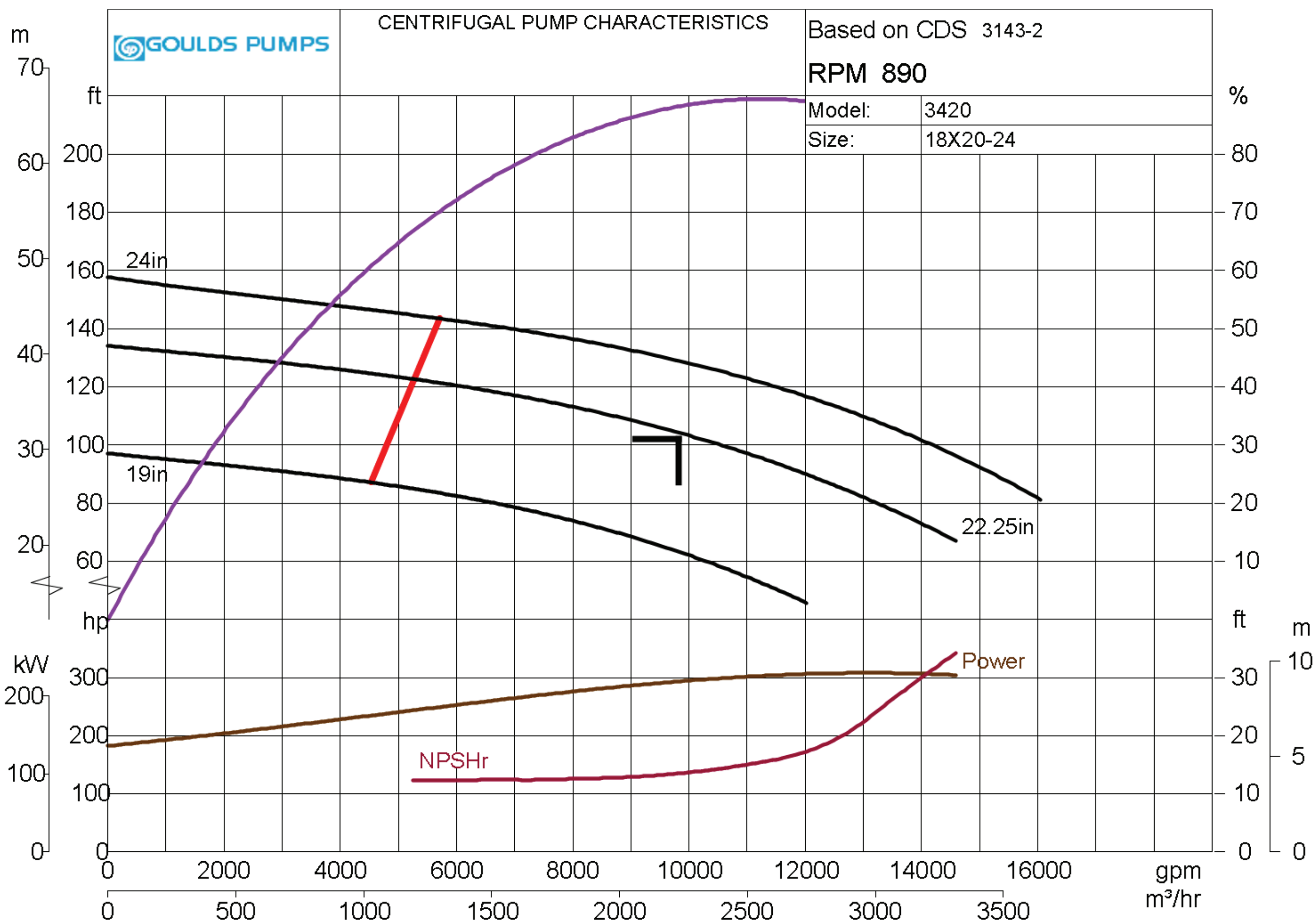
Operating Conditions

Liquid:	Raw Water
Temp.:	70.0 deg F
S.G./Visc.:	1.000/1.000 cp
Flow:	9,875.0 gpm
TDH:	103.1 ft
NPSHa:	0.0 ft
Solid size:	1.5000 in
% Susp. Solids (by wtg):	
Max. Solids Size:	0.0000 in

Pump Performance

Published Efficiency:	88.0 %	Suction Specific Speed:	8,617 gpm(US) ft
Rated Pump Efficiency:	88.0 %	Min. Hydraulic Flow:	5,297.4 gpm
Rated Total Power:	293.8 hp	Min. Thermal Flow:	N/A
Non-Overloading Power:	308.0 hp		
Imp. Dia. First 1 Stg(s):	22.2500 in		
NPSHr:	13.5 ft		
Shut off Head:	134.1 ft		
Vapor Press:	0.34 psi abs		

Notes: 1. The Mechanical seal increased drag effect on power and efficiency is not included, unless the correction is shown in the appropriate field above. 2. Magnetic drive eddy current on power and efficiency is not included. 3. Elevated temperature effects on performance are not included. 4. Non Overloading power does not reflect v-belt/gear losses.



Pump Performance Datasheet

Customer	:
Customer reference	:
Item number	: OID - SOR Relift PS 42-inch Discharge Main, Pump No. 4 Replacement
Service	: Irrigation Water
Quantity	: 1
Quote number	:
Size	: 27FKH
Stages	: 3
Based on curve number	: 27FKH 880
Date last saved	: 31 May 2011 4:54 PM

Operating Conditions

Flow, rated	: 5,400.0 USgpm
Differential head / pressure, rated (requested)	: 103.1 ft
Differential head / pressure, rated (actual)	: 103.3 ft
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: 38.95 ft
Frequency	: 60 Hz

Performance

Speed, rated	: 705 rpm
Impeller diameter, rated	: 16.03 in
Impeller diameter, maximum	: 16.87 in
Impeller diameter, minimum	: 14.88 in
Efficiency (bowl / pump)	: 87.23 / 84.23 %
NPSH required / margin required	: 12.32 / 5.00 ft
nq (imp. eye flow) / S (imp. eye flow)	: 65 / 155 Metric units
MCSF	: 1,266.9 USgpm
Head, maximum, rated diameter	: 167.3 ft
Head rise to shutoff	: 62.26 %
Flow, best eff. point (BEP)	: 5,328.3 USgpm
Flow ratio (rated / BEP)	: 101.35 %
Diameter ratio (rated / max)	: 95.00 %
Head ratio (rated dia / max dia)	: 86.24 %
Cq/Ch/Ce [ANSI/HI 9.6.7-2004]	: 1.00 / 1.00 / 1.00
Selection status	: Acceptable

Liquid

Liquid type	: Water - River or Lake, Fresh
Additional liquid description	: Raw Water
Solids diameter, max	: 1.12 in
Solids concentration, by volume	: 0.00 %
Temperature, max	: 68.00 deg F
Fluid density, rated / max	: 1.000 / 1.000 SG
Viscosity, rated	: 1.00 cP
Vapor pressure, rated	: 0.00 psi.a

Material

Material selected	: Cast Iron/Bronze

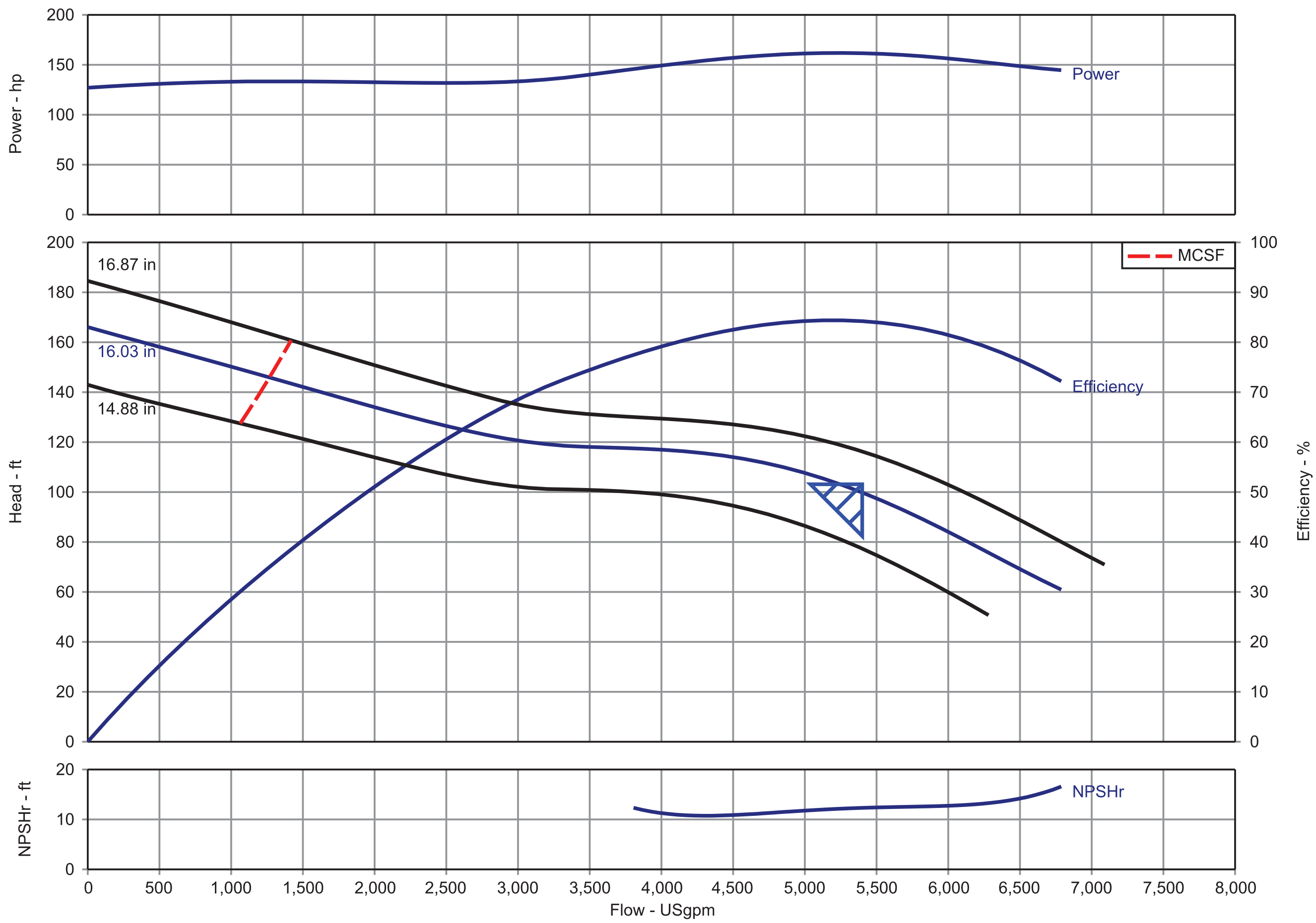
Pressure Data

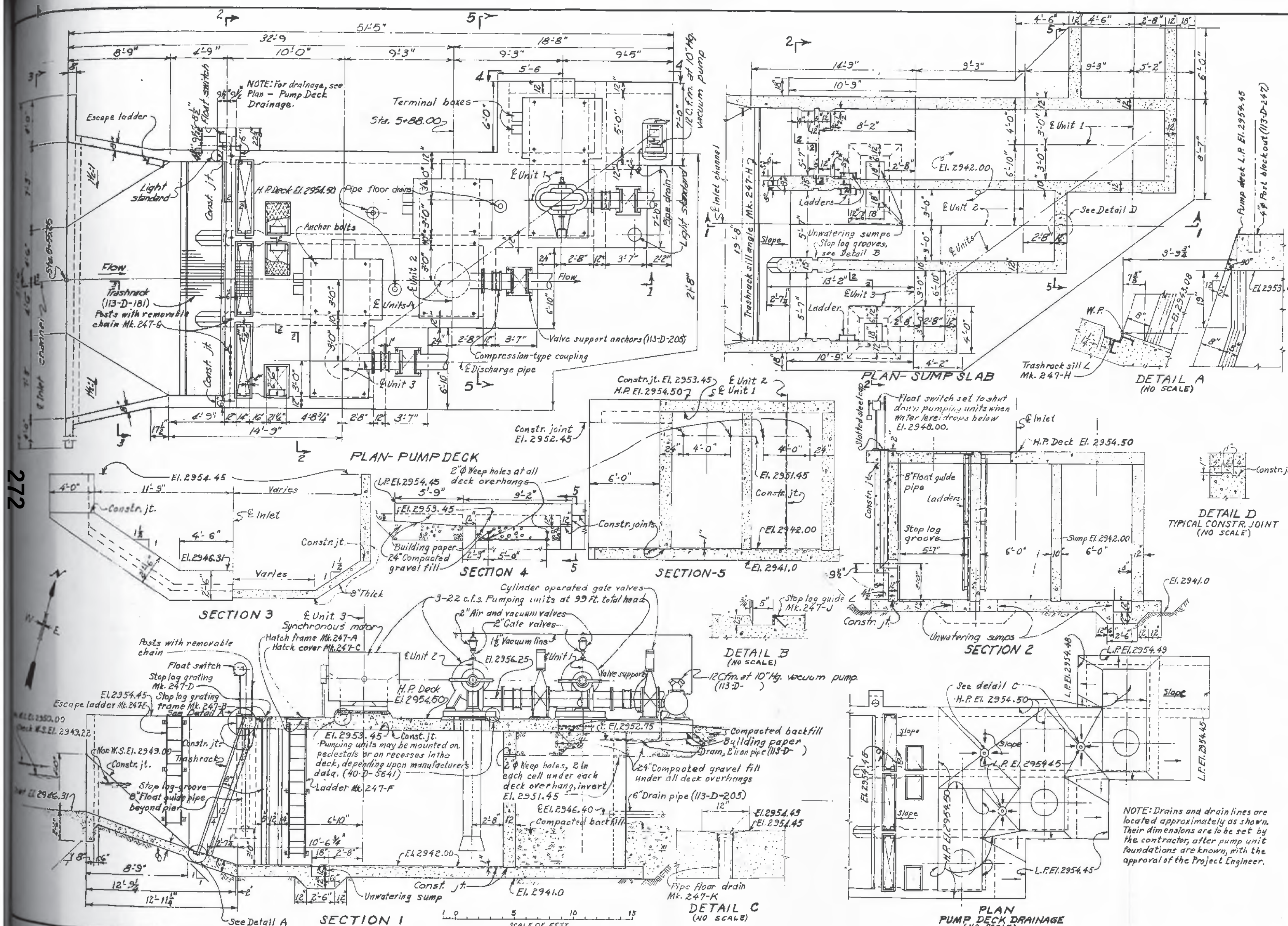
Maximum working pressure	: 72.43 psi.g
Maximum allowable working pressure	: 309.0 psi.g
Maximum allowable suction pressure	: N/A
Hydrostatic test pressure	: N/A

Driver & Power Data

Driver sizing specification	: Rated power
Margin over specification	: 0.00 %
Service factor	: 1.00
Power, hydraulic	: 141 hp
Power (bowl / pump)	: 161 / 162 hp
Power, maximum, rated diameter	: 162 hp
Minimum recommended motor rating	: 200 hp / 149 kW

Pump performance. Adjusted for construction, viscosity, static lift to discharge nozzle centerline, friction and power losses of lineshaft and thrust bearings.
The duty point represents the head at the bowl.





GENERAL NOTES

Edges of permanently exposed concrete surfaces to be chamfered ½" unless otherwise shown.
Construction joints may be added subject to the approval of the contracting officer.
For embedded conduits and ground cables, see electrical drawings.
Sump slab and pump deck to have U2 finish, except where stop logs rest on sump slabs U3 finish is required.
Backfill shall not be placed more than 3 feet above sump slab until deck slab has been in place for at least 7 days.
After placing concrete to top of walls, a delay must be made before the pump deck is placed. See specifications.
Location and dimensions of recesses, holes in deck for pumps, pedestals and anchor bolts for pumping units are to be determined when manufacturer's equipment data are available.
For general reinforcement notes, see 40-D-5495.
Reinforcement shall have a minimum of 2½ inches of clear concrete cover throughout the structure, except in the top face of the pump deck slabs, where a minimum of 1½ inches of clear concrete cover is required.
30 Bar diameter splices of reinforcement are required as follows:
- a. Vertical wall reinforcement bending into pump deck slab.
- b. Sump slab reinforcement bending into walls.
- c. All horizontal wall reinforcement.

Dowels from sump slabs to walls are to be at the same spacing as the vertical wall reinforcement.
Structural design is based on 3000 p.s.i ultimate compressive concrete strength at 28 days.
Numerals in parenthesis ( ) following a note, detail or section indicate the drawing on which they are shown.
All reinforcement shall be spaced at 12" centers unless otherwise shown.
Stop logs shall not be installed until all concrete in the pumping plant and all backfill around the plant is in place.

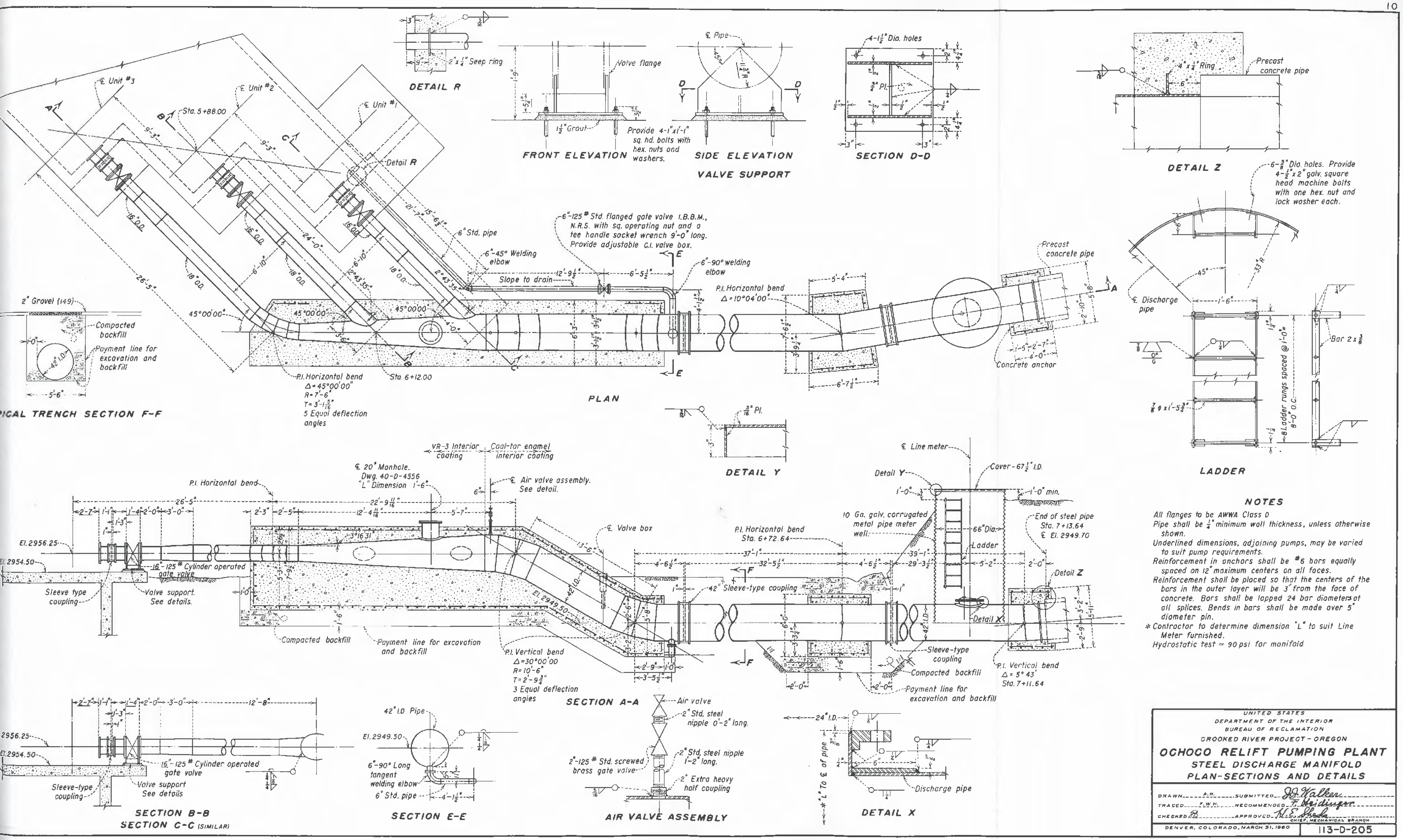
REFERENCE DRAWINGS

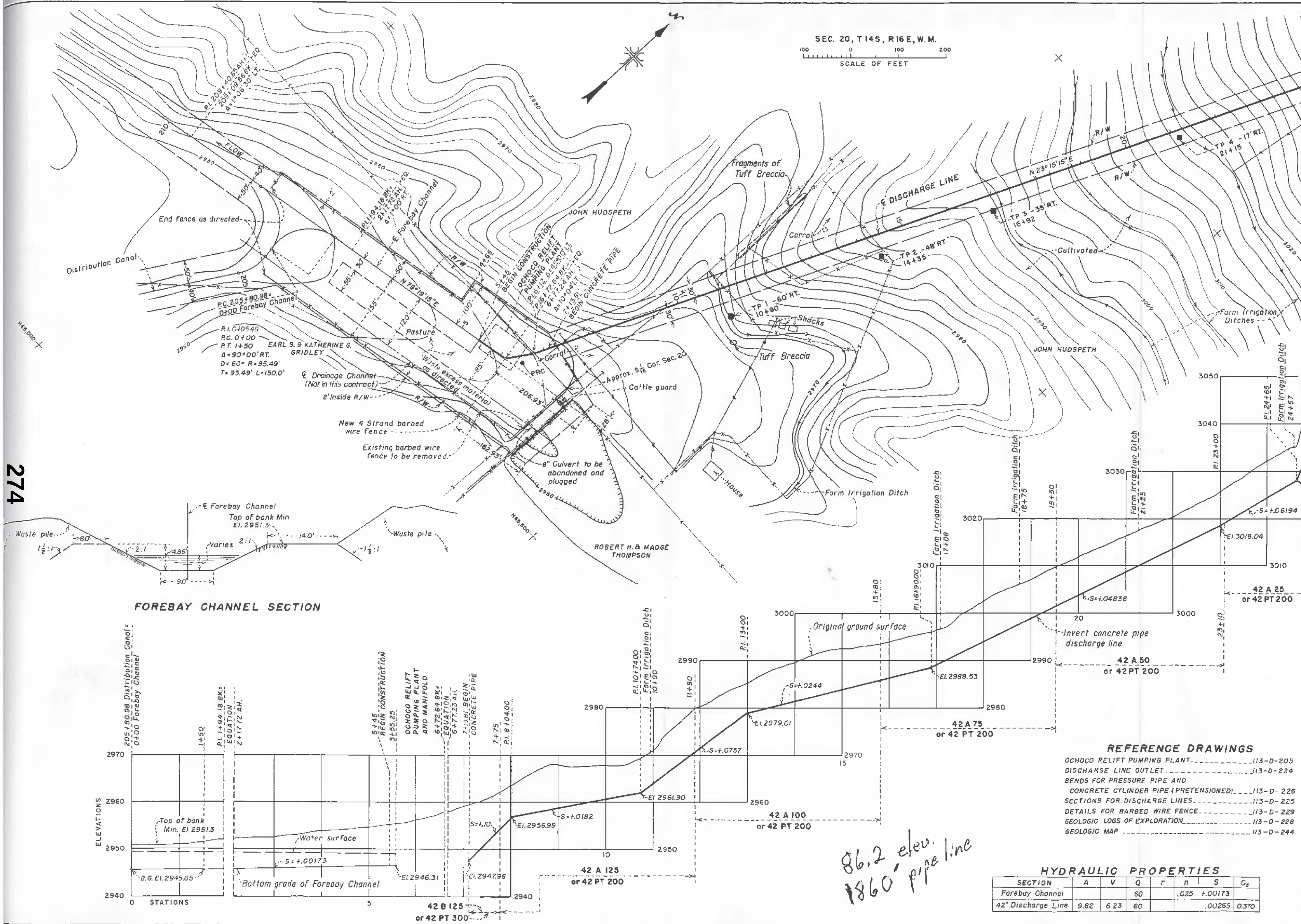
LOCATION PLAN	113-D-149
REINFORCEMENT LAYOUT	113-D-151
WORKING STRESSES	123-D-563
FENCE OVERHANG	40-D-5365
STANDARD FENCING REQUIREMENTS	40-D-5410
GENERAL REINFORCEMENT NOTES	40-D-5495
PUMP MOUNTING	40-D-5641
ELECTRICAL INSTALLATION	113-D-198
STEEL DISCHARGE MANIFOLD	113-D-205
MISCELLANEOUS STEEL	113-D-247
PRIMING SYSTEM, DISCHARGE VALVES AND VALVE OPERATING SYSTEM	113-D-220
MISCELLANEOUS FOUNDATIONS	113-D-152
TRASHRACK	113-D-181
DISCHARGE LINE	113-D-223

4-15-60 D S.T	MADE GENERAL REVISIONS AND CHECKED DWG.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CROOKED RIVER PROJECT - OREGON
OCHOCO RELIFT
PUMPING PLANT
GENERAL ARRANGEMENT AND OUTLINE

DRAWN J.E.M. SUBMITTED [illegible]
TRACED RECOMMENDED [illegible]
CHECKED [illegible] S.T. APPROVED [illegible]
ACTING ASST. COMM. AND CHIEF ENGINEER
DENVER, COLORADO, DEC. 3, 1959 113-D-150


10
DETAIL R
FRONT ELEVATION
SIDE ELEVATION
VALVE SUPPORT
SECTION D-D
DETAIL Z
LADDER
PLAN
TYPICAL TRENCH SECTION F-F
DETAIL Y
SECTION A-A
SECTION B-B
SECTION C-C (SIMILAR)
SECTION E-E
AIR VALVE ASSEMBLY
DETAIL X
6"-125# Std. flanged gate valve I.B.B.M., N.R.S. with sq. operating nut and a tee handle socket wrench 9'-0" long. Provide adjustable C.I. valve box.
P.I. Horizontal bend Δ=45°00'00" R=7'-6" T=3'-1 5/16" 5 Equal deflection angles
P.I. Vertical bend Δ=30°00'00 R=10'-6" T=2'-9 3/4" 3 Equal deflection angles
P.I. Vertical bend Δ=5°43' Sta. 7+11.64
End of steel pipe Sta. 7+13.64 ℄ El. 2949.70
NOTES
All flanges to be AWWA Class D
Pipe shall be 1/4" minimum wall thickness, unless otherwise shown.
Underlined dimensions, adjoining pumps, may be varied to suit pump requirements.
Reinforcement in anchors shall be #6 bars equally spaced on 12" maximum centers on all faces.
Reinforcement shall be placed so that the centers of the bars in the outer layer will be 3" from the face of concrete. Bars shall be lapped 24 bar diameters at all splices. Bends in bars shall be made over 5" diameter pin.
*Contractor to determine dimension "L" to suit Line Meter furnished.
Hydrostatic test = 90 psi for manifold
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CROOKED RIVER PROJECT-OREGON
OCHOCO RELIFT PUMPING PLANT
STEEL DISCHARGE MANIFOLD
PLAN-SECTIONS AND DETAILS
DENVER, COLORADO, MARCH 31, 1960
113-D-205



86.2 elev.
1860' pipe line

ESTIMATED QUANTITIES

Concrete .... 3 Cu. Yds.
Reinforcement steel .... 240 Lbs.

PRECAST CONCRETE PRESSURE PIPE

42 A 25 — 178'
42 A 50 — 360'
42 A 75 — 370'
42 A 100 — 390'
42 A 125 — 415'
42 B 125 — 64±'

PRETENSIONED CONCRETE PIPE

42 PT 200 - 1713'
42 PT 300 - 64'

NOTES

All precast concrete pressure pipe to have Type R joints.
Stations and elevations on profile refer to invert unless otherwise shown.
Stationing of vertical P.I.'s to be considered approximate only and may be adjusted according to actual laying length of pipe.
Backfill above top of pipe as directed, 3'-0 Min.

REFERENCE DRAWINGS

OCHOCO RELIFT PUMPING PLANT 113-D-205
DISCHARGE LINE OUTLET 113-D-224
BENDS FOR PRESSURE PIPE AND CONCRETE CYLINDER PIPE (PRETENSIONED) 113-D-226
SECTIONS FOR DISCHARGE LINES 113-D-225
DETAILS FOR BARBED WIRE FENCE 113-D-229
GEOLOGIC LOGS OF EXPLORATION 113-D-228
GEOLOGIC MAP 113-D-244

HYDRAULIC PROPERTIES

SECTION	A	V	Q	r	n	S	G_s
Forebay Channel			60		.025	+.00173	
42" Discharge Line	9.62	6.23	60			.00265	0.370

UNITED STATES
DEPARTMENT OF THE INTERIOR
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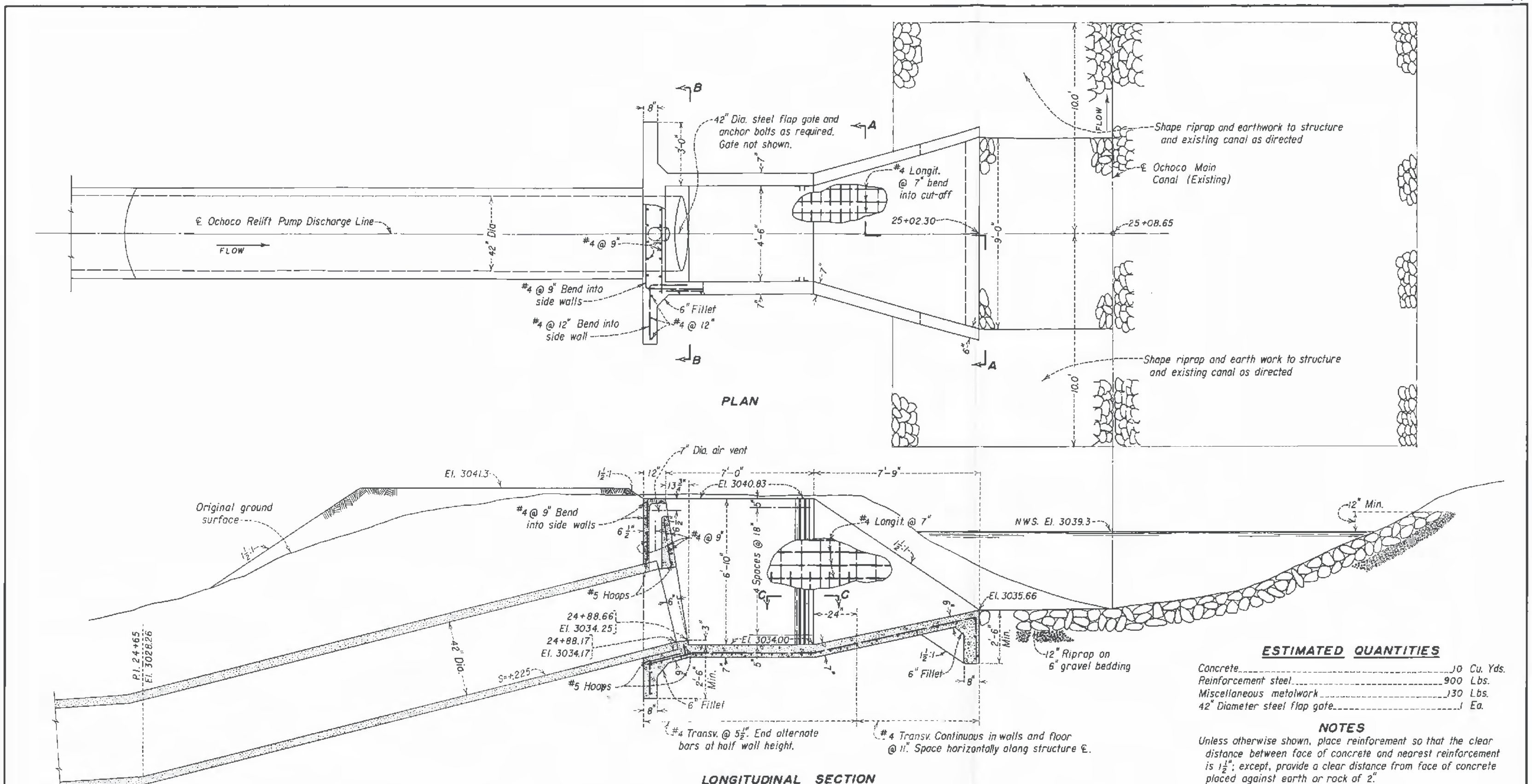
CROOKED RIVER PROJECT-OREGON

OCHOCO RELIFT PUMPING PLANT
DISCHARGE LINE

DRAWN D.E.C. SUBMITTED W. T. [signature]
TRACED D.L.G. RECOMMENDED [signature]
CHECKED Q.W.B. APPROVED [signature] CHIEF DESIGNING ENGINEER
DENVER, COLORADO, MARCH 14, 1960

113-D-223



ESTIMATED QUANTITIES

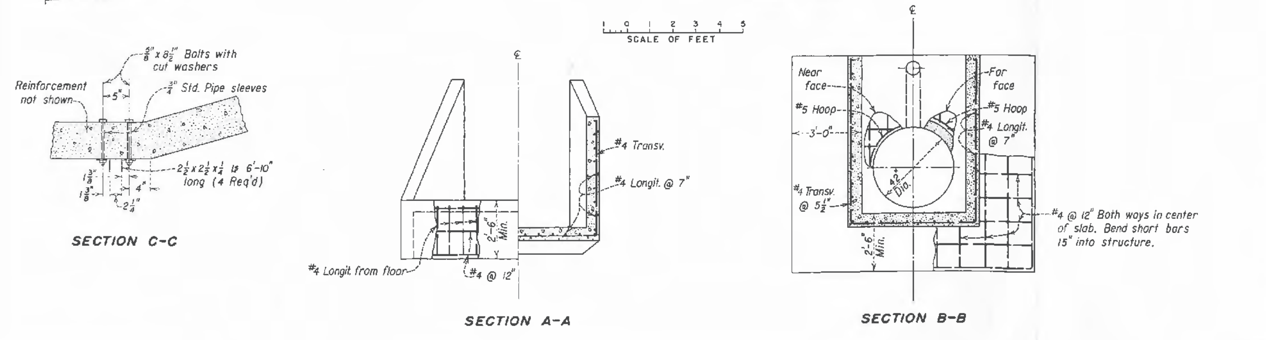
Concrete	10 Cu. Yds.
Reinforcement steel	900 Lbs.
Miscellaneous metalwork	130 Lbs.
42" Diameter steel flap gate	1 Ea.

NOTES

Unless otherwise shown, place reinforcement so that the clear distance between face of concrete and nearest reinforcement is 1½"; except, provide a clear distance from face of concrete placed against earth or rock of 2".

Lap all bars 24 diameters at splices unless otherwise shown.

Monolithic concrete design based on a compressive strength of 3000 lbs. per sq. in. at 28 days.



UNITED STATES
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CROOKED RIVER PROJECT-OREGON

OCHOCO RELIFT PUMPING PLANT
DISCHARGE LINE OUTLET

DRAWN D.E.C. SUBMITTED
TRACED T.R.H. RECOMMENDED
CHECKED A.W.B. APPROVED CHIEF DESIGNING ENGINEER
DENVER, COLORADO, MARCH 14, 1950 113-D-224

OCHOCO RELIFT 24-INCH DISCHARGE MAIN - EVALUATION SUMMARY

Ochoco Relift 24-inch Discharge Main Pumping Plant

The Ochoco Relift 24-inch Discharge Main Pumping Plant was constructed to provide additional parallel pumping capacity to the original Ochoco Relift 42-inch Main pumping plant. This parallel pumping plant is served by a 24-inch PVC discharge main running generally parallel to the discharge main of the original pumping plant. The Ochoco Relift 24-inch Discharge Main facility pumps a maximum of 17 cubic feet per second from the distribution canal to the Ochoco Main Canal to irrigate lands west of McKay Creek. The plant currently utilizes two vertical turbine pumping units, each fitted with a 125 horsepower drive motor. The pumping plant operates against a total dynamic head of 99 feet.

Original Design

Pump Unit	Description	HP	Rated Capacity	Rated Head	Pump Eff. @ Rated Capacity	Pipe size	Discharge Pipe Vel.	Discharge Main Vel.
No. 6	Vertical Turbine	125	3,900 GPM*	99 FT *	79 % *	14 IN *	8.1 FPS	
No. 7	Vertical Turbine	125	3,900 GPM*	99 FT *	79 % *	14 IN *	8.1 FPS	
Total		250	7,800 GPM	99 FT		24 IN		5.5 FPS

* Assumed pumping rate, rated head, and efficiency based on Pump No. 7 nameplate data: Layne Verti-Line 14FHH and 125 HP driver. Data from published product information sheets.

Current Condition (Ref. Initial Pump Evaluation BPA, 2010)

Pump Unit	Description	HP	Test Capacity	Test Head	Pump Eff. @ Test Capacity	Pipe size	Discharge Pipe Vel.	Discharge Main Vel.
No. 6	Vertical Turbine	125 *	4,094 GPM *	103 FT *	79 % *	14 IN	8.5 FPS	
No. 7	Vertical Turbine	125 *	3,278 GPM *	98 FT *	68 % *	14 IN	6.8 FPS	
Total		250	7,372 GPM			24 IN		5.2 FPS

* (1) test data point, ref. Initial Pump Evaluation, BPA, 2010

Alternate Equipment (Replace Existing Pump Discharge Piping and Valves)

Pump Unit	Description	HP	Rated Capacity	Rated Head	Pump Eff. @ Rated Capacity	Pipe size	Discharge Pipe Vel.	Discharge Main Vel.
No. 6	Vertical Turbine	150	4,750 GPM	99 FT	82 %	16 IN	7.6 FPS	
No. 7	Vertical Turbine	100	3,250 GPM	99 FT	83 %	14 IN	6.8 FPS	
Total		250	8,000 GPM	99 FT		24 IN		5.7 FPS

Narrative

Evaluation of the Ochoco Relift 24-inch Discharge Main pumping plant examines potential energy efficiency gained by replacing existing pumps with new equipment. The pumping plant would be retrofit with new pumps of unequal size, one operating at 150 HP and the other operating at 100 HP. Pump discharge piping and valves on the larger unit would be increased in size to reduce velocity and friction losses.

Electrical systems would be refurbished with new motor starters sized for the select pumping units. New high efficiency motors would be installed with the new pumps.

With new pumps selected to more closely match irrigation season demand variations, and with parallel operation of Ochoco Relift 42-inch Main pumping plant, integration of variable speed drive equipment would not appear to provide significant energy savings.

The capacity of the rebuilt pump station is anticipated to be approximately 17.8 CFS at 99 feet TDH.

Wire to water energy analysis is based on the projected capacity of the Ochoco Relift 24-inch Discharge Main pumping plant retrofitted with new pumps, motors, and pump discharge piping and valves. The Ochoco Relift 24-inch Discharge Main pumping plant retrofitted with new pump equipment is projected to provide a seasonal average flow of 6,393 gpm (14.2 CFS) at 96.4 feet TDH. The existing Ochoco Relift 24-inch Discharge Main pumping plant in its current condition is projected to yield 14.2 CFS at 96.5 feet TDH.

Action Recommended for Further Evaluation: **Retrofit pumping plant, (2) vertical turbine pumps, connect to existing discharge main**
New No. 6 pump, Vertical Turbine Pump
New No. 7 pump, Vertical Turbine Pump
Replace (1) set pump discharge piping and valves
Replace motor starter equipment

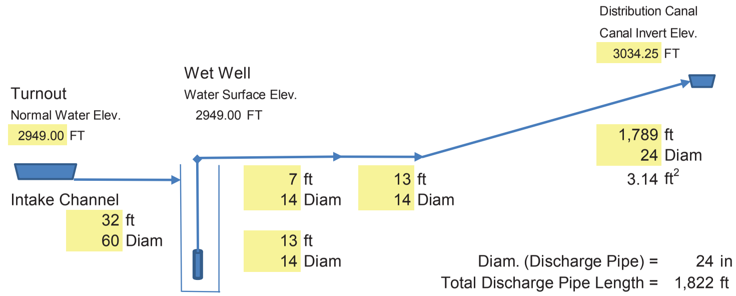
Annual Energy Savings Estimate = 106,967 kW-hr

Initial Cost Estimate = $285,000

Pump to Canal Head Loss Calculations
Relift Pumping Plant Retrofit, Vertical Turbine Pumps, 24-inch Discharge Line

3,900	GPM	Vertical Turbine Pump No. 6		
3,900	GPM	Vertical Turbine Pump No. 7		
7,800	GPM	Total	=	17.4 cfs

Static Head = 85.25 FT



Diam. (Discharge Pipe) = 24 in
Total Discharge Pipe Length = 1,822 ft
Equiv. Pipe Length 14" Valves & Fittings Pump Discharge = 223 ft
Equiv. Pipe Length Fittings 24" Main Discharge Pipe = 45 ft

60" Intake Channel	Friction Head =	0.05 FT per 1,000 FT	Concrete
(Vel. = 0.9 fps)	Dynamic Head =	0.00 FT total	C = 120
14" Column Pipe	Friction Head =	13.09 FT per 1,000 FT	Steel
(Vel. = 8.1 fps)	Dynamic Head =	0.17 FT total	C = 140
14" Pump Discharge Pipe	Friction Head =	13.09 FT per 1,000 FT	Steel
(Vel. = 8.1 fps)	Dynamic Head =	0.09 FT total	C = 140
14" Pump Discharge Pipe	Friction Head =	13.09 FT per 1,000 FT	Steel
(Vel. = 8.1 fps)	Dynamic Head =	0.17 FT total	C = 140
24" Main Discharge	Friction Head =	3.43 FT per 1,000 FT	PVC
(Vel. = 5.5 fps)	Dynamic Head =	6.13 FT total	C = 140
Equivalent Pipe Length	Friction Head =	13.09 FT per 1,000 FT	Steel
Valves & Fittings Pump Discharge	Dynamic Head =	2.92 FT total	C = 140
Equivalent Pipe Length	Friction Head =	3.43 FT per 1,000 FT	Steel
Valves & Fittings Main Discharge	Dynamic Head =	0.15 FT total	C = 140

Friction Head = 9.64 FT = 4.17 psi

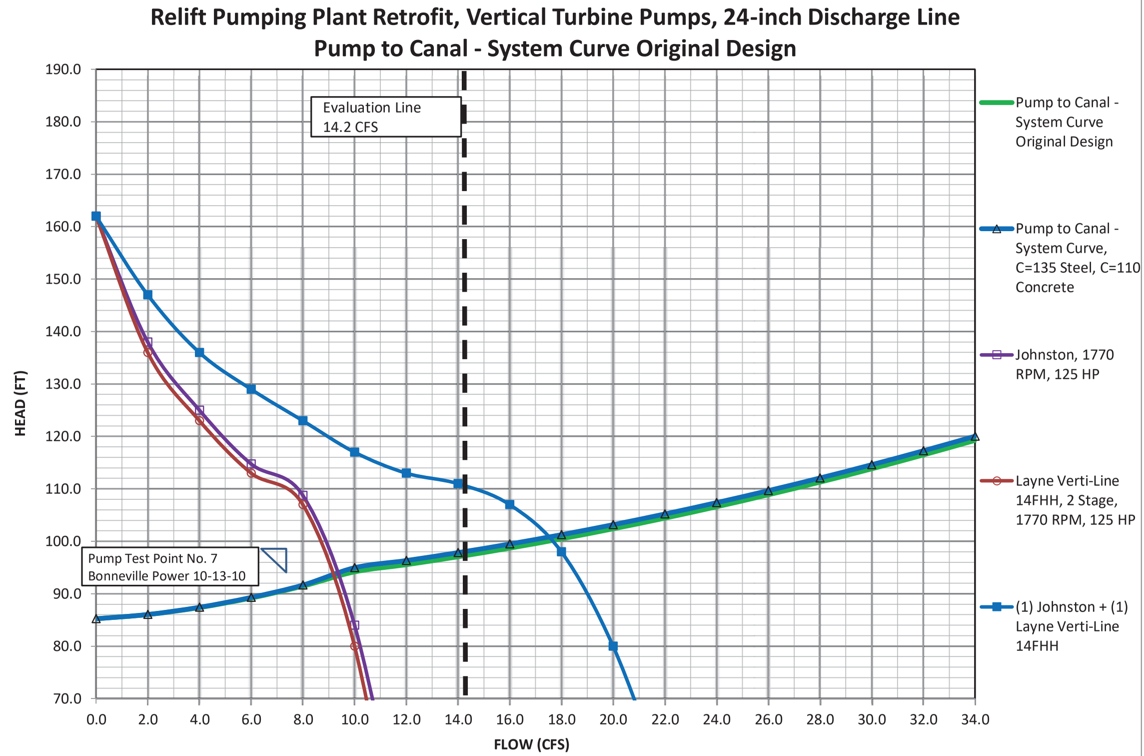
Water Depth in Discharge Canal = 4.34 FT = 1.88 psi

Total Dynamic Head = 99.23 FT = 42.96 psi

Equivalent Pipe Length Totals:			
Item	16" Equiv. Length	No. of Units	Total Equiv. Length
14" pump discharge head	90 ft	1 ea	90 ft
14" check valve	130 ft	1 ea	130 ft
14" pump control (gate) valve	3 ft	1 ea	3 ft
		Subtotal	223 ft
Item	42" Equiv. Length	No. of Units	Total Equiv. Length
14"x14"x24" tee branch flow	35 ft	1 ea	35 ft
14"x24" expander	5 ft	1 ea	5 ft
24" Flap Gate	5 ft	1 ea	5 ft
		Subtotal	45 ft

Relift Pumping Plant Retrofit, Vertical Turbine Pumps, 24-inch Discharge Line
Pump to Canal - System Curve Original Design

Q (gpm)	0	898	1,795	2,693	3,591	4,489	5,387	6,285	7,183	8,081	8,979	9,877	10,775	11,673	12,571	13,469	14,367	15,265
Q (cfs)	0.0	2.0	4.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0	22.0	24.0	26.0	28.0	30.0	32.0	34.0
Hf	0.0	0.8	2.1	3.9	6.2	8.9	10.3	11.8	13.4	15.2	17.1	19.2	21.3	23.6	26.0	28.5	31.2	34.0
TDH (ft)	85.3	86.0	87.4	89.2	91.5	94.2	95.5	97.1	98.7	100.5	102.4	104.4	106.6	108.9	111.3	113.8	116.4	119.2
Vel. Disch. (fps)	0.0	0.6	1.3	1.9	2.5	3.2	3.8	4.5	5.1	5.7	6.4	7.0	7.6	8.3	8.9	9.6	10.2	10.8



Johnston, 1770 RPM, 125 HP (approximate curve created in likeness to Layne Verti-Line 14FHH pump, 125 HP driver)

Q (cfs)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
Q (gpm)	0	898	1,795	2,693	3,591	4,488	5,386	6,284	7,181	8,079	8,977	9,874	10,772	11,670	12,567	13,465	14,363	15,260
Head (ft)	162	138	125	115	109	84	39											

Layne Verti-Line 14FHH, 2 Stage, 1770 RPM, 125 HP (approximate curve from Layne Verti-Line based on 14FHH pump and 125 HP driver)

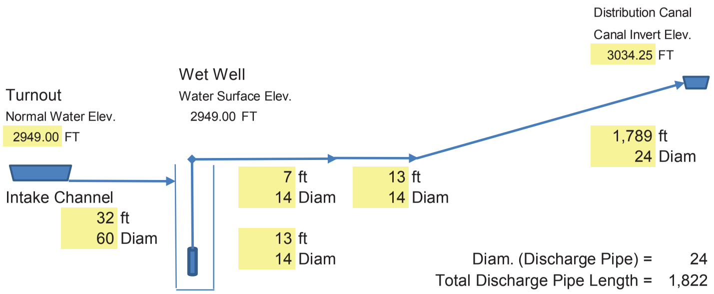
Q (cfs)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
Q (gpm)	0	898	1,795	2,693	3,591	4,488	5,386	6,284	7,181	8,079	8,977	9,874	10,772	11,670	12,567	13,465	14,363	22
Head (ft)	162	136	123	113	107	80	29											

(1) Johnston + (1) Layne Verti-Line 14FHH

Q (cfs)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
Q (gpm)	0	898	1,795	2,693	3,591	4,488	5,386	6,284	7,181	8,079	8,977	9,874	10,772	11,670	12,567	13,465	14,363	15,260
Head (ft)	162	147	136	129	123	117	113	111	107	98	80	54	29					

Pump to Canal Head Loss Calculations
Relift Pumping Plant Retrofit, Vertical Turbine Pumps, 24-inch Discharge Line

4,750	GPM	Vertical Turbine Pump No. 6		
3,250	GPM	Vertical Turbine Pump No. 7		
			Static Head =	85.25 FT
8,000	GPM	Total	=	17.8 cfs



Diam. (Discharge Pipe) = 24 in
Total Discharge Pipe Length = 1,822 ft
Equiv. Pipe Length 14" Valves & Fittings Pump Discharge = 223 ft
Equiv. Pipe Length Fittings 24" Main Discharge Pipe = 45 ft

60" Intake Channel	Friction Head =	0.07 FT per 1,000 FT	Concrete	
(Vel. = 0.9 fps)	Dynamic Head =	0.00 FT total	C =	110
14" Column Pipe	Friction Head =	20.17 FT per 1,000 FT	Steel	
(Vel. = 9.9 fps)	Dynamic Head =	0.26 FT total	C =	135
14" Pump Discharge Pipe	Friction Head =	20.17 FT per 1,000 FT	Steel	
(Vel. = 9.9 fps)	Dynamic Head =	0.14 FT total	C =	135
14" Pump Discharge Pipe	Friction Head =	20.17 FT per 1,000 FT	Steel	
(Vel. = 9.9 fps)	Dynamic Head =	0.26 FT total	C =	135
24" Main Discharge	Friction Head =	3.59 FT per 1,000 FT	PVC	
(Vel. = 5.7 fps)	Dynamic Head =	6.42 FT total	C =	140
Equivalent Pipe Length	Friction Head =	20.17 FT per 1,000 FT	Steel	
Valves & Fittings Pump Discharge	Dynamic Head =	4.50 FT total	C =	135
Equivalent Pipe Length	Friction Head =	3.84 FT per 1,000 FT	Steel	
Valves & Fittings Main Discharge	Dynamic Head =	0.17 FT total	C =	135
	Friction Head =	11.76 FT =	5.09 psi	
	Water Depth in Discharge Canal =	4.10 FT =	1.77 psi	
	Total Dynamic Head =	101.11 FT =	43.77 psi	

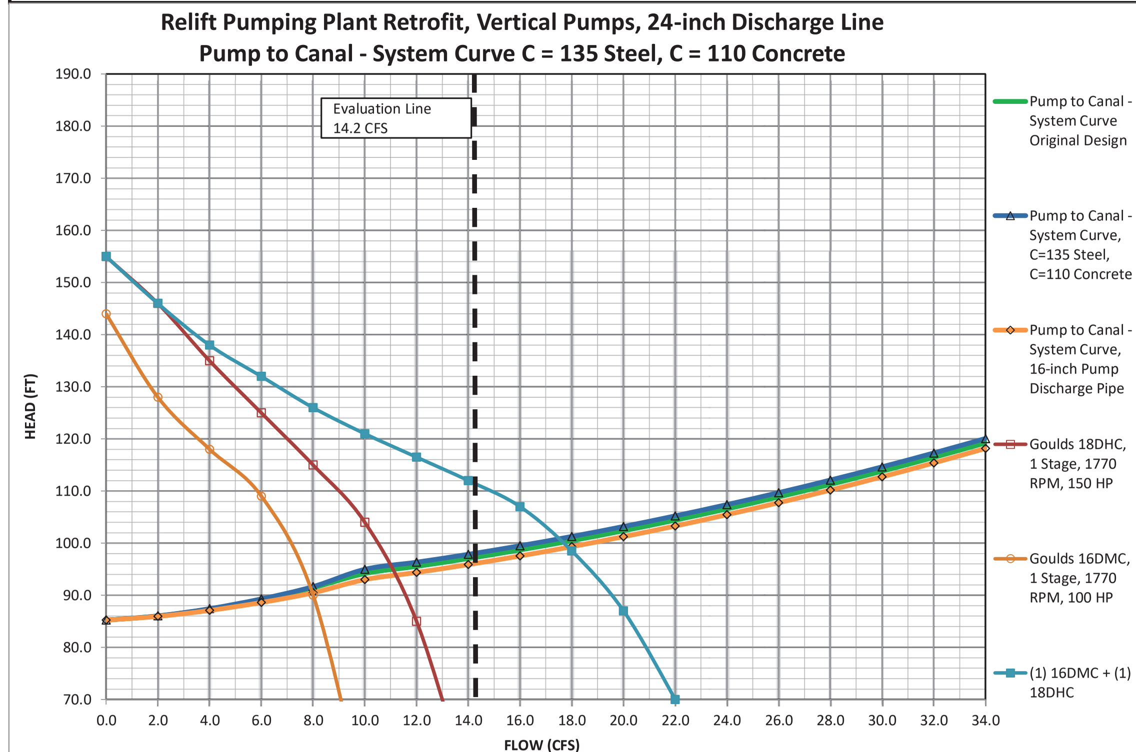
Equivalent Pipe Length Totals:

Item	16" Equiv. Length	No. of Units	Total Equiv. Length
14" pump discharge head	90 ft	1 ea	90 ft
14" check valve	130 ft	1 ea	130 ft
14" pump control (gate) valve	3 ft	1 ea	3 ft
		Subtotal	223 ft

Item	42" Equiv. Length	No. of Units	Total Equiv. Length
14"x14"x24" tee branch flow	35 ft	1 ea	35 ft
14"x24" expander	5 ft	1 ea	5 ft
24" Flap Gate	5 ft	1 ea	5 ft
		Subtotal	45 ft

Relift Pumping Plant Retrofit, Vertical Turbine Pumps, 24-inch Discharge Line
Pump to Canal - System Curve, C=135 Steel, C=110 Concrete

Q (gpm)	0	898	1,795	2,693	3,591	4,489	5,387	6,285	7,183	8,081	8,979	9,877	10,775	11,673	12,571	13,469	14,367	15,265
Q (cfs)	0.0	2.0	4.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0	22.0	24.0	26.0	28.0	30.0	32.0	34.0
Hf	0.0	0.8	2.2	4.1	6.4	9.7	11.1	12.6	14.3	16.0	17.9	20.0	22.1	24.4	26.8	29.4	32.0	34.8
TDH (ft)	85.3	86.1	87.4	89.3	91.7	95.0	96.3	97.9	99.5	101.3	103.2	105.2	107.4	109.7	112.1	114.6	117.3	120.0
Vel. Disch. (fps)	0.0	0.6	1.3	1.9	2.5	3.2	3.8	4.5	5.1	5.7	6.4	7.0	7.6	8.3	8.9	9.6	10.2	10.8



Goulds 16DMC, 1 Stage, 1770 RPM, 100 HP

Q (cfs)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
Q (gpm)	0	898	1,795	2,693	3,591	4,488	5,386	6,284	7,181	8,079	8,977	9,874	10,772	11,670	12,567	13,465	14,363	15,260
Head (ft)	144	128	118	109	90	50												

Goulds 18DHC, 1 Stage, 1770 RPM, 150 HP

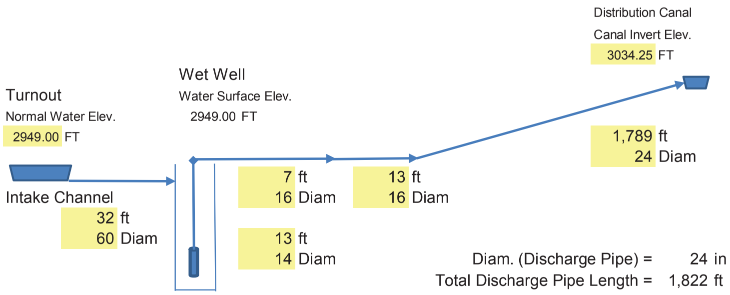
Q (cfs)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
Q (gpm)	0	898	1,795	2,693	3,591	4,488	5,386	6,284	7,181	8,079	8,977	9,874	10,772	11,670	12,567	13,465	14,363	22
Head (ft)	155	146	135	125	115	104	85	53										

(1) 16DMC + (1) 18DHC

Q (cfs)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
Q (gpm)	0	898	1,795	2,693	3,591	4,488	5,386	6,284	7,181	8,079	8,977	9,874	10,772	11,670	12,567	13,465	14,363	15,260
Head (ft)	155	146	138	132	126	121	117	112	107	99	87	70						

Pump to Canal Head Loss Calculations
Relift Pumping Plant Retrofit, Vertical Turbine Pumps, 24-inch Discharge Line

4,750	GPM	Vertical Turbine Pump No. 6			
3,250	GPM	Vertical Turbine Pump No. 7			
				Static Head =	85.25 FT
8,000	GPM	Total	=	17.8 cfs	



Diam. (Discharge Pipe) =	24 in
Total Discharge Pipe Length =	1,822 ft
Equiv. Pipe Length 16" Valves & Fittings Pump Discharge =	258 ft
Equiv. Pipe Length Fittings 24" Main Discharge Pipe =	53 ft

60" Intake Channel	Friction Head =	0.07 FT per 1,000 FT	Concrete
(Vel. = 0.9 fps)	Dynamic Head =	0.00 FT total	C = 110
14" Column Pipe	Friction Head =	20.17 FT per 1,000 FT	Steel
(Vel. = 9.9 fps)	Dynamic Head =	0.26 FT total	C = 135
16" Pump Discharge Pipe	Friction Head =	10.53 FT per 1,000 FT	Steel
(Vel. = 7.6 fps)	Dynamic Head =	0.07 FT total	C = 135
16" Pump Discharge Pipe	Friction Head =	10.53 FT per 1,000 FT	Steel
(Vel. = 7.6 fps)	Dynamic Head =	0.14 FT total	C = 135
24" Main Discharge	Friction Head =	3.59 FT per 1,000 FT	PVC
(Vel. = 5.7 fps)	Dynamic Head =	6.42 FT total	C = 140
Equivalent Pipe Length	Friction Head =	10.53 FT per 1,000 FT	Steel
Valves & Fittings Pump Discharge	Dynamic Head =	2.72 FT total	C = 135
Equivalent Pipe Length	Friction Head =	3.84 FT per 1,000 FT	Steel
Valves & Fittings Main Discharge	Dynamic Head =	0.20 FT total	C = 135
	Friction Head =	9.82 FT =	4.25 psi
	Water Depth in Discharge Canal =	4.46 FT =	1.93 psi
	Total Dynamic Head =	99.53 FT =	43.09 psi

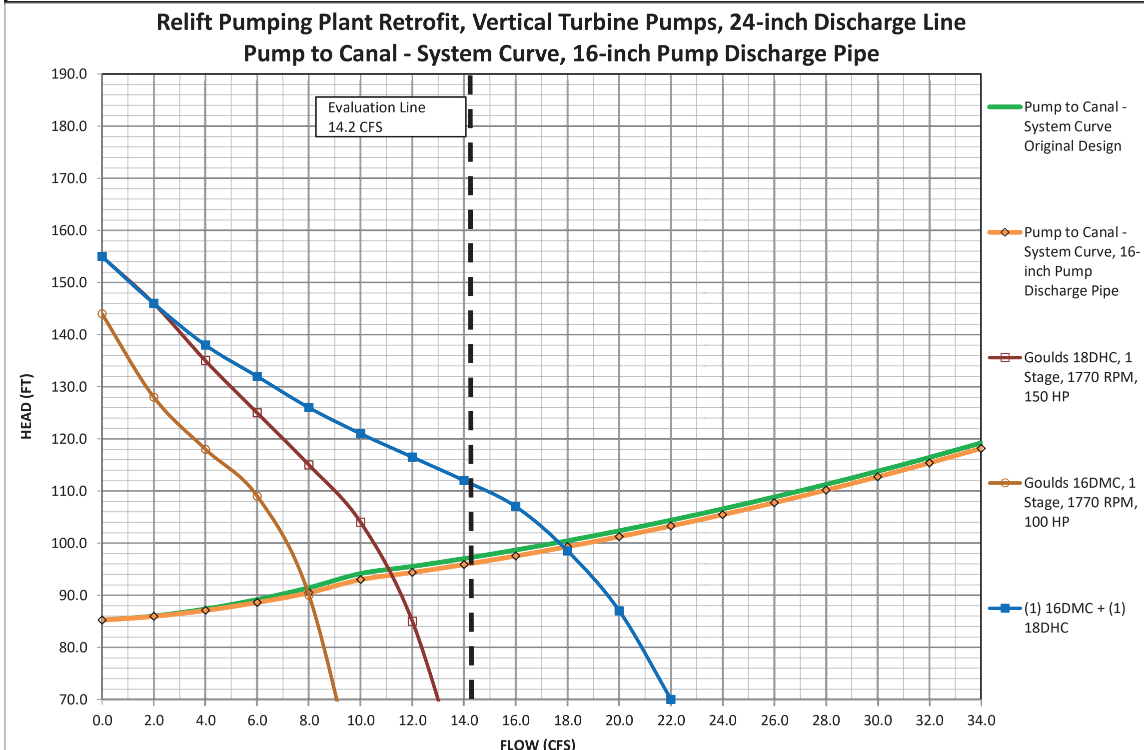
Equivalent Pipe Length Totals:

Item	16" Equiv. Length	No. of Units	Total Equiv. Length
16" pump discharge head	95 ft	1 ea	95 ft
16" check valve	160 ft	1 ea	160 ft
16" pump control (gate) valve	3 ft	1 ea	3 ft
		Subtotal	258 ft

Item	42" Equiv. Length	No. of Units	Total Equiv. Length
16"x16"x24" tee branch flow	43 ft	1 ea	43 ft
16"x24" expander	5 ft	1 ea	5 ft
24" Flap Gate	5 ft	1 ea	5 ft
		Subtotal	53 ft

Relift Pumping Plant Retrofit, Vertical Turbine Pumps, 24-inch Discharge Line
Pump to Canal - System Curve, 16-inch Pump Discharge Pipe

Q (gpm)	0	898	1,795	2,693	3,591	4,489	5,387	6,285	7,183	8,081	8,979	9,877	10,775	11,673	12,571	13,469	14,367	15,265
Q (cfs)	0.0	2.0	4.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0	22.0	24.0	26.0	28.0	30.0	32.0	34.0
Hf	0.0	0.7	1.9	3.4	5.2	7.8	9.1	10.7	12.3	14.1	16.0	18.0	20.2	22.5	24.9	27.5	30.1	32.9
TDH (ft)	85.3	86.0	87.1	88.6	90.5	93.0	94.4	95.9	97.6	99.3	101.3	103.3	105.5	107.8	110.2	112.7	115.4	118.2
Vel. Disch. (fps)	0.0	0.6	1.3	1.9	2.5	3.2	3.8	4.5	5.1	5.7	6.4	7.0	7.6	8.3	8.9	9.6	10.2	10.8



Goulds 16DMC, 1 Stage, 1770 RPM, 100 HP

Q (cfs)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
Q (gpm)	0	898	1,795	2,693	3,591	4,488	5,386	6,284	7,181	8,079	8,977	9,874	10,772	11,670	12,567	13,465	14,363	15,260
Head (ft)	144	128	118	109	90	50												

Goulds 18DHC, 1 Stage, 1770 RPM, 150 HP

Q (cfs)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
Q (gpm)	0	898	1,795	2,693	3,591	4,488	5,386	6,284	7,181	8,079	8,977	9,874	10,772	11,670	12,567	13,465	14,363	22
Head (ft)	155	146	135	125	115	104	85	53										

(1) 16DMC + (1) 18DHC

Q (cfs)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
Q (gpm)	0	898	1,795	2,693	3,591	4,488	5,386	6,284	7,181	8,079	8,977	9,874	10,772	11,670	12,567	13,465	14,363	15,260
Head (ft)	155	146	138	132	126	121	117	112	107	99	87	70						

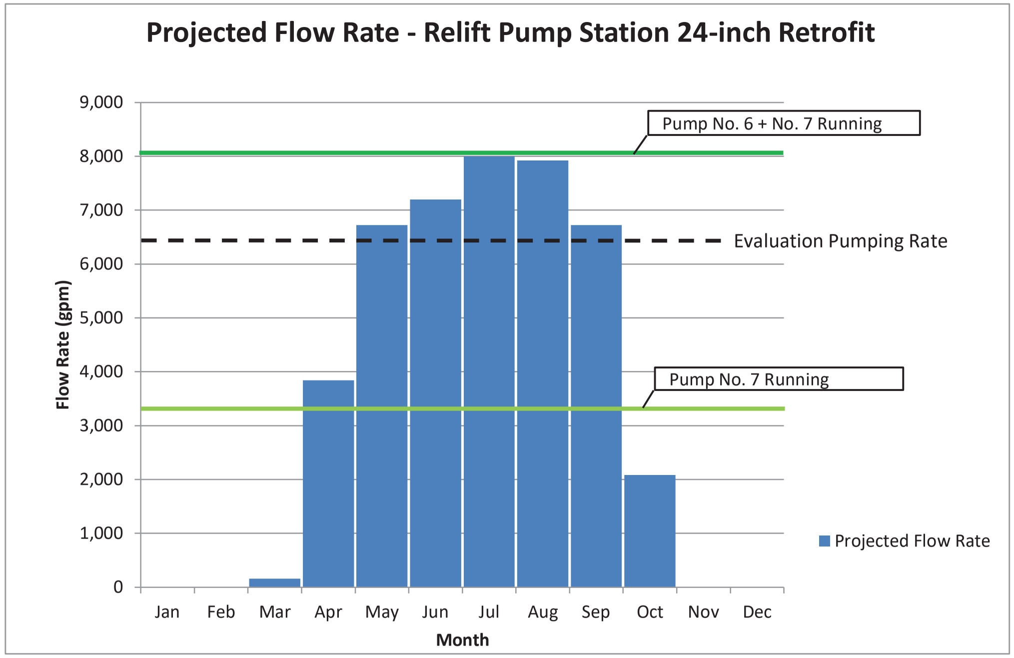
Pump to Canal Head Loss Calculations
Relift Pumping Plant Retrofit 24-inch (New Vertical Turbine Pumps, replacement pump discharge piping and valves)

4,750	GPM	Vertical Turbine Pump No. 6		
3,250	GPM	Vertical Turbine Pump No. 7		
0	GPM	Does not exist		
0	GPM	Does not exist		
0	GPM	Does not exist		
8,000	GPM	Total	=	17.8 cfs

Proposed PS Design Flow Rate = 8,000 gpm

Month	% of Max Flow Rate	Projected Flow Rate
Jan	0%	0
Feb	0%	0
Mar	2%	160
Apr	48%	3,840
May	84%	6,720
Jun	90%	7,200
Jul	100%	8,000
Aug	99%	7,920
Sep	84%	6,720
Oct	26%	2,080
Nov	0%	0
Dec	0%	0

Evaluation Pumping Rate 6,393 gpm
14.2 cfs



Notes: Relift PS 24-inch Discharge Main when reconstructed with (2) Vertical Turbine Pumps. Considering that this pumping plant is augmented by Pump 1, 2 & 3 (9,875 gpm each) and Pump 4 (5,400 gpm) in a parallel 42-inch discharge main, VFD operation of pumps at this pump station would not provide significant benefit toward reducing energy use and optimizing water delivery to crop requirement. New pumps No. 6 and No. 7 can be selected at flow rates that promote their combined use to reasonably match projected seasonal demand requirements.

Ochoco Irrigation District

Relift PS 24-inch Discharge Line (Retrofit of pump equipment at existing pump station)

Budget Level - Projection of Probable Construction Cost

Item No.	Spec Division	Description	Measurement	Units	Unit Cost	Total Cost
1	1000	Mobilization	LS	1	$8,000.00	$8,000.00
2	1000	Project Management and Coordination	LS	1	$1,200.00	$1,200.00
3	1000	Construction Progress Documentation	LS	1	$1,200.00	$1,200.00
4	1000	Submittal Procedures	LS	1	$1,200.00	$1,200.00
5	1000	Quality Requirements	LS	1	$2,500.00	$2,500.00
6	1000	Selective Demolition	LS	1	$6,000.00	$6,000.00
7	1000	Project Record Documents	LS	1	$1,200.00	$1,200.00
8	1000	Operations and Maintenance Data	LS	1	$2,500.00	$2,500.00
9	1000	General Commissioning Requirements	LS	1	$5,000.00	$5,000.00
10	2000	Surfacing Rock	CY	10	$38.00	$380.00
11	3000	Misc Cast-in-Place Concrete (thrust and pads)	LS	1	$5,000.00	$5,000.00
12	9000	High Performance Coating Systems	LS	1	$1,500.00	$1,500.00
13	11000	Line Shaft Turbine Pump and Motor, 150 HP	EA	1	$57,500.00	$57,500.00
14	11000	Line Shaft Turbine Pump and Motor, 100 HP	EA	1	$38,700.00	$38,700.00
15	15000	16-inch Handwheel Operated Butterfly Valve	EA	1	$2,875.00	$2,875.00
16	15000	16-inch Surge Control Check Valve	EA	1	$9,875.00	$9,875.00
17	15000	16-inch Discharge Pipe, Fittings, & Accessories	EA	1	$4,500.00	$4,500.00
18	16000	Power and Distribution	LS	1	$2,000.00	$2,000.00
19	16000	Grounding Systems	LS	1	$0.00	$0.00
20	16000	Motor Controls	LS	1	$9,250.00	$9,250.00
21	17000	Instrumentation and Control	LS	1	$0.00	$0.00
		Construction Subtotal				$160,380.00
		Contractors Overhead and Profit	10%	1	$16,038.00	$16,038.00
		Contractors Bonds and Insurance	2%	1	$3,528.36	$3,528.36
		Construction Contingency	30%	1	$48,114.00	$48,114.00
		Construction Total				$228,060.36
		Engineering, Administration	25%	1	$57,015.09	
		Total				**$285,075.45**

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Wire to Water Energy Calculator

Ochoco Irrigation District - SOR

Relift Pumping Plant - 24-inch Discharge Line Pump Replacment

Source: PumpTech Inc.

2425 SE Ochoco Street

Portland, OR 97222

503-659-6230

OPERATIONAL AND EQUIPMENT DATA

	Replacement Pumps	Existing Pumps	
	No. 6 - Goulds 18DHC, 1 Sage, 1170 RPM, 150 HP	No. 6 - Johnston, Vetrical Turbnine, 1770 RPM, 125 HP *	
	No. 7 - Goulds 16DMC, 1 Sage, 1170 RPM, 150 HP	No. 7 - Verti-line, Vertical Turbine, 1770 RPM, 125 HP *	
Pump Operation - Hours / Day	24	24	
Pump Operation - Days / Year	198	198	
Pump Flow - GPM (Evaluation Pump Rate)	6,393	6,393	
Pump Flow - CFS	14.2	14.2	
Total Annual Volume - Acre feet	5,590	5,590	
Pump Head - Feet	96.4	96.5	
Ave. Pump Efficiency - %	82.9%	73.7%	**
Ave. Motor Efficiency - %	93.0%	91.1%	**
Energy Cost in $/kW-hr	$0.035	$0.035	

* Estimated Pump Head assumes pump discharge piping, and valves are 16-inch large pump and 14-inch small pump.

* Pump Make and model per Bonneville Power initial pump evaluation report.

** Source: Init al Pump Evaluation test data. Average of published values.

RESULTS

	Replacement Pumps	Existing Pumps
BHP At Design Point	187.7	211.4
Wire to Water Efficiency - %	77%	67%
kW-hr per Year	715,590	822,557
Annual Energy Cost	$25,045.65	$28,789.51
kW-hr Per 1,000 Gallons Pumped	0.393	0.451
Cost Per 1,000 Gallons Pumped	$0.014	$0.016
kW-hr per Acre Foot Pumped	128	147
Cost Per Acre Foot Pumped	$4.48	$5.15

PAYBACK

Annual Savings - kW-hr	106,967
Annual Savings - $$	$3,743.86
Annual Savings - %	13.00%
Cost of Replacement Pumps *	$285,000.00
Cost of Existing Pumps	$0.00
Payback - Years	76.1

* Estimated cost assumes replacement of pumps, motors, and discharge piping and valves on one pumping unit.

Pump Test Data

Initial Pump Evaluation

Project No.: OCHID-02-10 **Description:**

Pump Station No.: Relifts **Pump No.:** 6 **Water Source:** Canal

Motor Nameplate

Motor Make:	US Motors		
Model No:			
Serial No:			
Rated Hp:	125		
Rated Voltage:	460		
Rated Amperage:	148	**Ins. Class:**	None
Full Load RPM:	1770	**Code:**	None
Enclosure:	None		
Design:	None		
Frame:	405TP		
Service Factor:	1.15		

Utility Meter Nameplate

Make: None **Meter ID:** None

Type: None **Serial No.:** None

k_h: None **PTR:** None **CTR:** None

Pump Nameplate

Pump Make:	Johnston		
Type:	Vertical Turbine		
Serial No:			
Model No:	None	**Impeller No:**	
Impeller Dia (in):		**No. of Stages:**	0
Impeller Dia (in):		**No. of Stages:**	0
Secondary Model No:	None	**Impeller No:**	
Impeller Dia (in):		**No. of Stages:**	0
Impeller Dia (in):		**No. of Stages:**	0
Rated Flow (gpm):	0		
Rated Head (ft):	0		
Rated RPM:	0		
Column Dia (in):	0.00		
Column Length (ft):	0.0		
Shaft Dia (in):	0.000		
Tube Dia (in):	0.000		
Thrust Factor (lbs/ft):	0.0		
Impeller Wt. (lbs):	0.0		

Field Pump Test Data

Test No.	Date	Flow Measurement Device	Flow (gpm)	Lift Air Line (PSI)	Lift Static Level (ft)	Lift Pumping Lift (ft)	Pressures Discharge (PSI)	Pressures Delivered (PSI)	Misc. Losses (ft)	TDH (ft)	Pump RPM
1	10/13/2010	Dye	4,094			8.4	40.0	40.0	2.1	102.9	1776

Test No.	Voltages 1-2	Voltages 1-3	Voltages 2-3	Voltages Avg.	Amperages 1	Amperages 2	Amperages 3	Amperages Avg.	Power Factor 1	Power Factor 2	Power Factor 3	Power Factor Avg.	Utility Meter Rev.	Utility Meter Sec.	Motor RPM	Motor % Load
1	479.0	479.0	478.0	478.7	153.0	153.0	153.0	153.0				86.7%				107.4%

Test No.	Shaft HP	Thrust HP	Water HP	Brake HP	Pump HP	Input kW	Input HP	Utility Meter (kW)	Efficiencies Motor	Efficiencies Pump	Efficiencies Discharge	Efficiencies Delivered
1	0.00	0.00	106.4	134.3	134.3	110.0	147.4		91.1%	79.2%	72.2%	72.2%

Note: If a main valve is present, the Delivered Pressure is the pressure after the valve. If no main valve is present, the Delivered Pressure will be the same as the Discharge Pressure.

Pump Test Data

Initial Pump Evaluation

Project No.: OCHID-02-10 **Description:**

Pump Station No.: Relifts **Pump No.:** 7 **Water Source:** Canal **Parallel**

Motor Nameplate

Motor Make: US Motors
Model No:
Serial No:
Rated Hp: 125
Rated Voltage: 460
Rated Amperage: 148 **Ins. Class:** None
Full Load RPM: 1770 **Code:** None
Enclosure: None
Design: None
Frame: 405TP
Service Factor: 1.15

Utility Meter Nameplate

Make: None **Meter ID:** None
Type: None **Serial No.:** None
k_h: None **PTR:** None **CTR:** None

Pump Nameplate

Pump Make: Verti-Line
Type: Vertical Turbine
Serial No: 378 71059
Model No: 14FHH **Impeller No:**
Impeller Dia (in): **No. of Stages:** 4
Impeller Dia (in): **No. of Stages:** 0
Secondary Model No: None **Impeller No:**
Impeller Dia (in): **No. of Stages:** 0
Impeller Dia (in): **No. of Stages:** 0
Rated Flow (gpm): 4500
Rated Head (ft): 0
Rated RPM: 1770
Column Dia (in): 0.00
Column Length (ft): 0.0
Shaft Dia (in): 0.000
Tube Dia (in): 0.000
Thrust Factor (lbs/ft): 23.2
Impeller Wt. (lbs): 26.0

Field Pump Test Data

Test No.	Date	Flow Measurement Device	Flow (gpm)	Lift Air Line (PSI)	Lift Static Level (ft)	Lift Pumping Lift (ft)	Pressures Discharge (PSI)	Pressures Delivered (PSI)	Misc. Losses (ft)	TDH (ft)	Pump RPM
1	10/13/2010	Dye	3,278			8.4	38.4	38.4	1.2	98.4	1777

Test No.	Voltages 1-2	Voltages 1-3	Voltages 2-3	Voltages Avg.	Amperages 1	Amperages 2	Amperages 3	Amperages Avg.	Power Factor 1	Power Factor 2	Power Factor 3	Power Factor Avg.	Utility Meter Rev.	Utility Meter Sec.	Motor RPM	Motor % Load
1	482.0	480.0	479.0	480.3	139.9	139.9	137.2	139.0				84.7%				95.7%

Test No.	Power Calculations Shaft HP	Thrust HP	Water HP	Brake HP	Pump HP	Input kW	Input HP	Utility Meter (kW)	Efficiencies Motor	Pump	Discharge	Delivered
1	0.00	0.00	81.5	119.7	119.7	98.0	131.3		91.2%	68.1%	62.1%	62.1%

Note: If a main valve is present, the Delivered Pressure is the pressure after the valve. If no main valve is present, the Delivered Pressure will be the same as the Discharge Pressure.

Pump Test Summary Data

Project No.: OCHID-02-10

Pump Station	Pump No.	Condition	Test No.	Include	Rated Hp	Flow (gpm)	Lift (ft)	Discharge (PSI)	Delivery (PSI)	TDH (FT)	Electric Hp	Pump Eff.	Overall Eff.
Relifts	1	Existing	1		500	8,726	8.4	34.2	34.2	90.7	292.3	74.1%	68.4%
Relifts	2	Existing	1		500	9,756	8.4	34.2	32.2	91.5	299.8	81.2%	75.2%
Relifts	3	Existing	1		500	8,619	8.4	34.3	34.3	90.8	290.0	73.9%	68.2%
Relifts	4	Existing	1		300	5,611	8.4	36.2	36.2	93.3	220.6	64.8%	59.9%
Relifts	5	Existing	1		None	0	0.0	0.0	0.0	0.0	0.0	0.0%	0.0%
Relifts	6	Existing	1		125	4,094	8.4	40.0	40.0	102.9	147.4	79.2%	72.2%
Relifts	7	Existing	1		125	3,278	8.4	38.4	38.4	98.4	131.3	68.1%	62.1%

ITT

Pump Performance Datasheet

Customer	: Ochoco Irrigation District	Quote number	:
Customer reference	: OID- SOR Relift PS 42 -inch	Item description	: 18DHC
Item number	: Pump No. 6 Replacement	Stages	: 1
Service	: Irrigation Water	Based on curve number	: 18DHC-1770
Quantity	: 1	Date last saved	: 24 Jun 2011 7:20 PM

Operating Conditions

Flow, rated	: 4,750.0 USgpm
Differential head / pressure, rated (requested)	: 99.00 ft
Differential head / pressure, rated (actual)	: 99.05 ft
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: Ample
Frequency	: 60 Hz

Performance

Speed, rated	: 1,770 rpm
Impeller diameter, rated	: 10.81 in
Impeller diameter, maximum	: 12.69 in
Impeller diameter, minimum	: 10.62 in
Efficiency (bowl / pump)	: 82.30 / - %
NPSH required / margin required	: 36.46 / 5.00 ft
Ns (imp. eye flow) / Nss (imp. eye flow)	: 3,171 / 8,475 US Units
MCSF	: 2,900.0 USgpm
Head, maximum, rated diameter	: 155.0 ft
Head rise to shutoff	: 56.55 %
Flow, best eff. point (BEP)	: 4,475.2 USgpm
Flow ratio (rated / BEP)	: 106.14 %
Diameter ratio (rated / max)	: 85.20 %
Head ratio (rated dia / max dia)	: 66.67 %
Cq/Ch/Ce [ANSI/HI 9.6.7-2004]	: 1.00 / 1.00 / 1.00
Selection status	: Acceptable

Liquid

Liquid type	: Water
Additional liquid description	: 1.125
Solids diameter, max	: 0.00 in
Solids concentration, by volume	: 0.00 %
Temperature, max	: 68.00 deg F
Fluid density, rated / max	: 1.000 / 1.000 SG
Viscosity, rated	: 1.00 cP
Vapor pressure, rated	: 0.00 psi.a

Material

Material selected	: CI Bowl (Lined) / Std. Brz Impeller

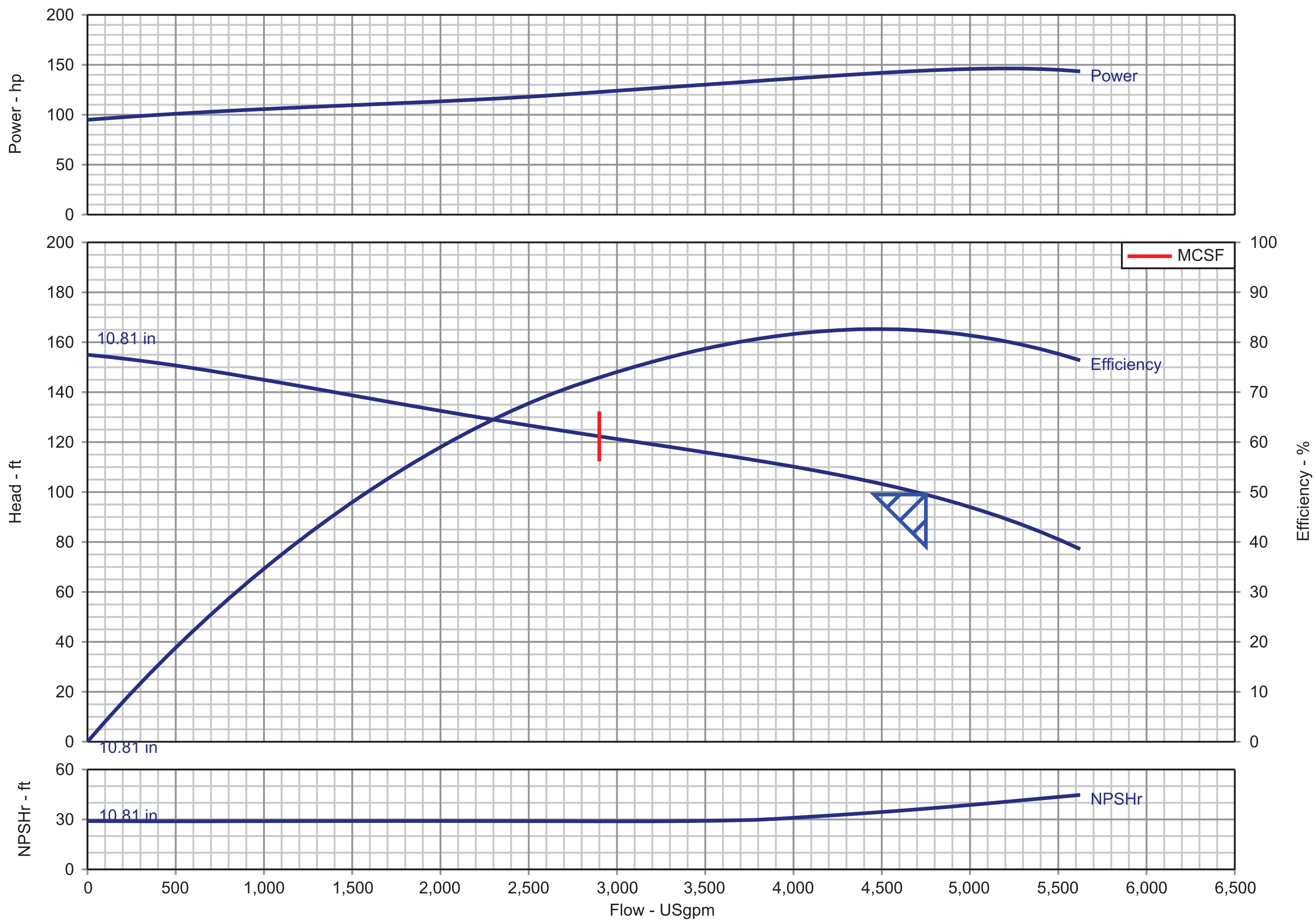
Pressure Data

Maximum working pressure	: 67.09 psi.g
Maximum allowable working pressure	: 310.0 psi.g
Maximum allowable suction pressure	: N/A
Hydrostatic test pressure	: N/A

Driver & Power Data

Driver sizing specification	: Maximum power
Margin over specification	: 0.00 %
Service factor	: 1.15
Power, hydraulic	: 119 hp
Power (bowl / pump)	: 144 / -
Power, maximum, rated diameter	: 146 hp
Minimum recommended motor rating	: 150 hp / 112 kW

Bowl performance. Adjusted for construction and viscosity.
The duty point represents the head at the bowl.



Pump Performance Datasheet

Customer	: Ochoco Irrigation District	Quote number	:
Customer reference	: OID- SOR Relift PS 42 -inch	Item description	: 16DMC
Item number	: Pump No. 6 Replacement	Stages	: 1
Service	: Irrigation Water	Based on curve number	: 16DMC-1770
Quantity	: 1	Date last saved	: 24 Jun 2011 7:21 PM

Operating Conditions

Flow, rated	: 3,250.0 USgpm
Differential head / pressure, rated (requested)	: 99.00 ft
Differential head / pressure, rated (actual)	: 100.0 ft
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: Ample
Frequency	: 60 Hz

Performance

Speed, rated	: 1,770 rpm
Impeller diameter, rated	: 10.69 in
Impeller diameter, maximum	: 11.62 in
Impeller diameter, minimum	: 9.75 in
Efficiency (bowl / pump)	: 83.57 / - %
NPSH required / margin required	: 28.13 / 5.00 ft
Ns (imp. eye flow) / Nss (imp. eye flow)	: 2,970 / 8,185 US Units
MCSF	: 1,750.0 USgpm
Head, maximum, rated diameter	: 143.8 ft
Head rise to shutoff	: 45.23 %
Flow, best eff. point (BEP)	: 3,155.9 USgpm
Flow ratio (rated / BEP)	: 102.98 %
Diameter ratio (rated / max)	: 91.98 %
Head ratio (rated dia / max dia)	: 80.06 %
Cq/Ch/Ce [ANSI/HI 9.6.7-2004]	: 1.00 / 1.00 / 1.00
Selection status	: Acceptable

Liquid

Liquid type	: Water
Additional liquid description	: 1.125
Solids diameter, max	: 0.00 in
Solids concentration, by volume	: 0.00 %
Temperature, max	: 68.00 deg F
Fluid density, rated / max	: 1.000 / 1.000 SG
Viscosity, rated	: 1.00 cP
Vapor pressure, rated	: 0.00 psi.a

Material

Material selected	: CI Bowl (Lined) / Std. Brz Impeller

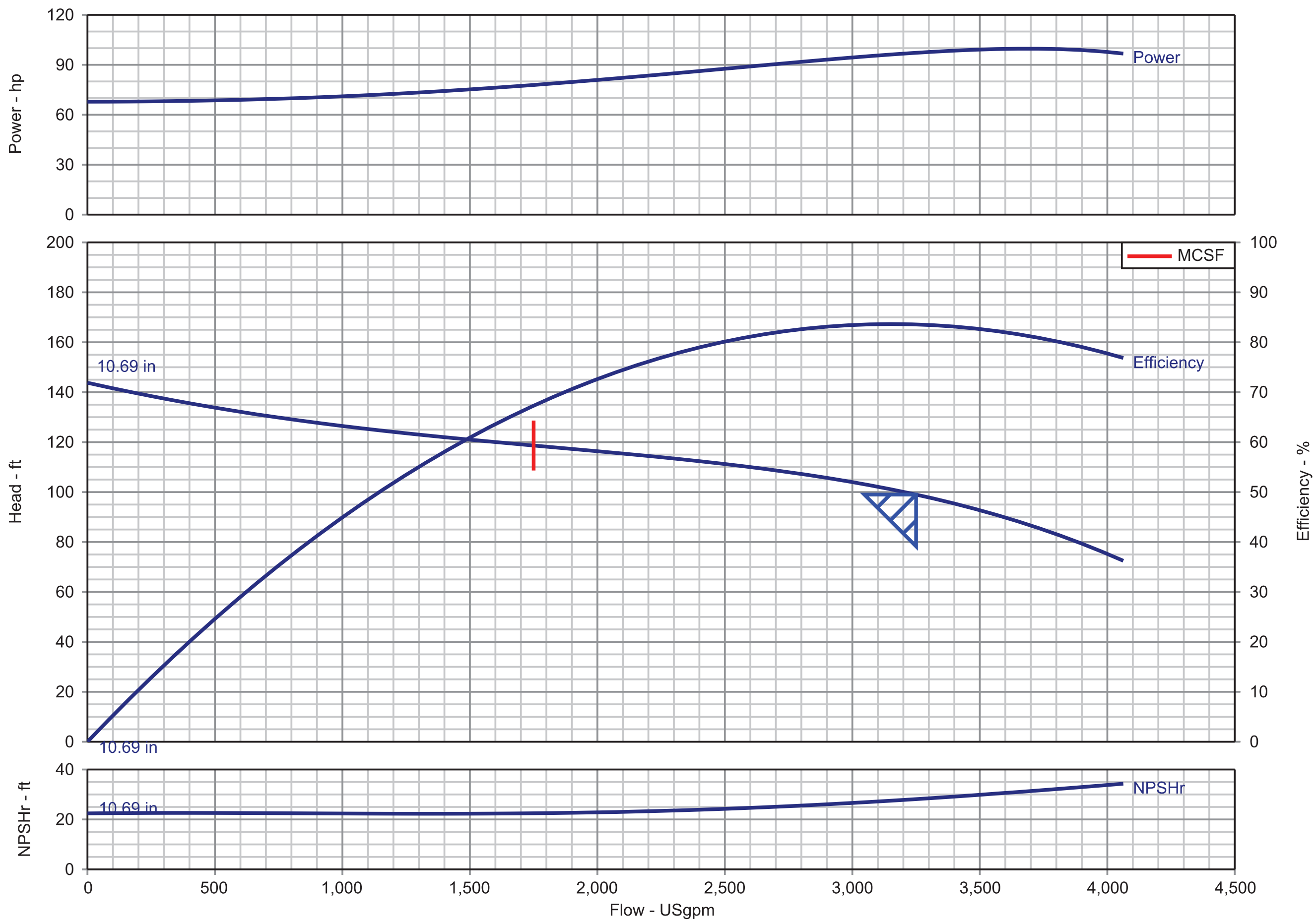
Pressure Data

Maximum working pressure	: 62.24 psi.g
Maximum allowable working pressure	: 370.0 psi.g
Maximum allowable suction pressure	: N/A
Hydrostatic test pressure	: N/A

Driver & Power Data

Driver sizing specification	: Maximum power
Margin over specification	: 0.00 %
Service factor	: 1.15
Power, hydraulic	: 81.24 hp
Power (bowl / pump)	: 97.22 / -
Power, maximum, rated diameter	: 99.69 hp
Minimum recommended motor rating	: 100 hp / 74.57 kW

Bowl performance. Adjusted for construction and viscosity.
The duty point represents the head at the bowl.



JOHNSON CREEK PUMPING PLANT - EVALUATION SUMMARY

OID infrastructure assets serving peripheral acreage were completed in the Crooked River Project Extension include six small pumping plants and associated canals, laterals, and drains. These features serve lands of six separate areas located generally east and north of the original Barnes Butte and Ochoco Relift project area. The Johnson Creek pumping plant lifts water from the Ochoco Main Canal.[1]

Since its original construction circa 1966, Johnson Creek Pumping Plant pump No. 2 was replaced with a 250 HP operating on variable speed drive.

Original Design

Pump Unit	Description	HP	Rated Capacity	Rated Head	Pump Eff. @ Rated Capacity	Pipe size	Discharge Pipe Vel.	Discharge Main Vel.
No. 1	Vertical Turbine	125	3,200 GPM	125 FT	83 %	12 IN	9.0 FPS	
No. 2	Vertical Turbine	125	3,200 GPM	125 FT	83 %	12 IN	9.0 FPS	
Total		250	6,400 GPM	125 FT		21 IN		5.9 FPS

Current Condition (Ref. Initial Pump Evaluation BPA, 2010)

Pump Unit	Description	HP	Test Capacity	Test Head	Pump Eff. @ Test Capacity	Pipe size	Discharge Pipe Vel.	Discharge Main Vel.
No. 1	Vertical Turbine	125	2,125 GPM	119 FT	54 %	12 IN	6.0 FPS	
No. 2	Vertical Turbine	250	5,183 GPM *	127 FT *	65 % *	12 IN	14.7 FPS	
Total		375	7,308 GPM			21 IN		6.8 FPS

* Average value of (2) test data points, ref. Initial Pump Evaluation, BPA, 2010

Alternate Equipment (Replace Existing Pumps)

Pump Unit	Description	HP	Rated Capacity	Rated Head	Pump Eff. @ Rated Capacity	Discharge Pipe size	Discharge Pipe Vel.	Discharge Main Vel.
No. 1	Vertical Turbine	150	3,000 GPM	126 FT	83 %	12 IN	8.5 FPS	
No. 2	Vertical Turbine	200	4,375 GPM	126 FT	86 %	16 IN	7.0 FPS	
Total		375	7,375 GPM	126 FT		21 IN		6.8 FPS

[1] US Department of the Interior, Bureau of Reclamation, Ochoco River Project, http://www.usbr.gov/projects/Project.jsp?proj_Name=Crooked River Project&pageType=ProjectPage

Narrative

Evaluation of the Johnson Creek Pumping Plant examines potential energy efficiency improvements gained by replacing existing pumps, motors, and pump discharge piping and valves. The existing Johnson Creek pumps exhibit pump efficiencies well below their published value and less than the efficiency potential of replacement units. Evaluation of potential energy savings assumes pump discharge piping and valves on Pump No. 2 (larger unit) are increased in size to reduce velocity and friction losses.

The initial cost projection for pumping plant improvements assumes existing electrical systems and motor starter equipment will be reused as is.

Evaluation of potential energy savings through the use of VFD operation suggests that continued operation of the existing VFD on the larger pump unit is beneficial to matching pump output to seasonal variations in demand.

The capacity of the rebuilt pump station is anticipated to be approximately 16.4 CFS at 126 feet TDH.

Wire to water energy analysis is based on the projected capacity of the Johnson Creek Pumping Plant retrofitted with new pumps, motors, and pump discharge piping and valves. The Johnson Creek Pumping Plant retrofitted with new pump equipment is projected to provide a seasonal average flow of 5,894 gpm (13.1 CFS) at 123.7 feet TDH. The existing Johnson Creek Pumping Plant in its current condition is projected to yield 13.1 CFS at 129.4 feet TDH.

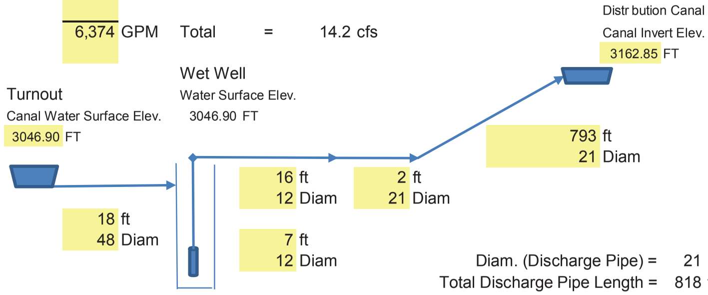
Action Recommended for Further Evaluation: **Retrofit pumping plant, (2) vertical turbine pumps, connect to existing discharge main**
New No. 1 Pump, Vertical Turbine Pump
New No. 2 Pump, Vertical Turbine Pump
Replace pump discharge piping and valves
Maintain VFD operation larger pumping unit

Annual Energy Savings Estimate = 421,466 kW-hr

Initial Cost Estimate = $291,000

Pump to Canal Head Loss Calculations
Johnson Creek Pumping Plant Retrofit

3,187 GPM	Vertical Turbine Pump No. 1	
3,187 GPM	Vertical Turbine Pump No. 2	
		Static Head = 115.95 FT
6,374 GPM	Total = 14.2 cfs	



Diam. (Discharge Pipe) =	21 in
Total Discharge Pipe Length =	818 ft
Equiv. Pipe Length Valves & Fittings Pump Discharge =	203 ft
Equiv. Pipe Length Valves & Fittings Discharge Header =	45 ft

4.4 ft x 8 ft trash rack to PS Wet Well	Friction Head =	0.11 FT per 1,000 FT	Concrete
	Dynamic Head =	0.00 FT total	C = 120
12" Column Pipe	Friction Head =	19.08 FT per 1,000 FT	Steel
(Vel. = 9.0 fps)	Dynamic Head =	0.13 FT total	C = 140
12" Discharge Piping	Friction Head =	19.08 FT per 1,000 FT	Steel
(Vel. = 9.0 fps)	Dynamic Head =	0.31 FT total	C = 140
21" Header	Friction Head =	4.52 FT per 1,000 FT	Steel
(Vel. = 5.9 fps)	Dynamic Head =	0.01 FT total	C = 140
21" Discharge	Friction Head =	4.52 FT per 1,000 FT	Steel
(Vel. = 5.9 fps)	Dynamic Head =	3.58 FT total	C = 140
Equivalent Pipe Length	Friction Head =	19.08 FT per 1,000 FT	Steel
Valves & Fittings Pump Discharge	Dynamic Head =	3.87 FT total	C = 140
Equivalent Pipe Length	Friction Head =	4.52 FT per 1,000 FT	Steel
Valves & Fittings Discharge Header	Dynamic Head =	0.20 FT total	C = 140
	Friction Head =	8.11 FT =	3.51 psi
	Water Depth in Discharge Canal =	2.13 FT =	0.92 psi
	Total Dynamic Head =	126.19 FT =	54.63 psi

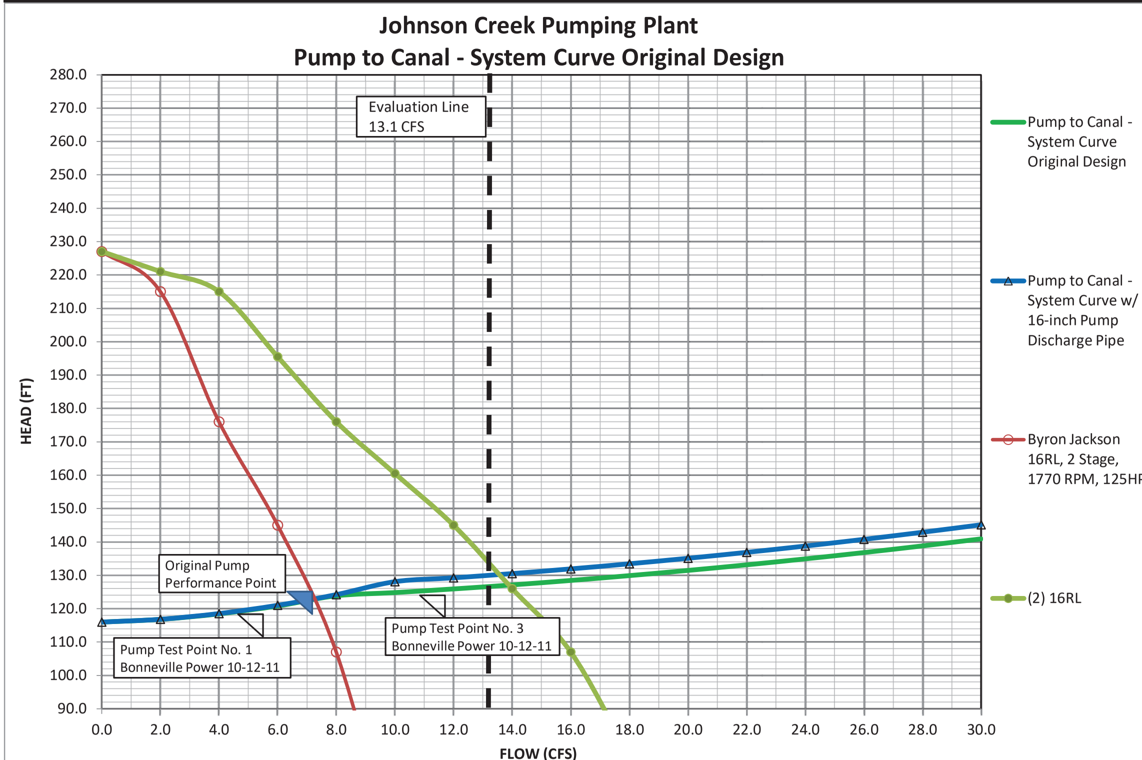
Equivalent Pipe Length Totals:

Item	12" Equiv. Length	No. of Units	Total Equiv. Length
12" pump discharge head	80 ft	1 ea	80 ft
12" check valve	120 ft	1 ea	120 ft
12" pump control (gate) valve	3 ft	1 ea	3 ft
		Subtotal	203 ft

Item	21" Equiv. Length	No. of Units	Total Equiv. Length
12"x12"x21" tee branch flow	35 ft	1 ea	35 ft
12"x21" expander	5 ft	1 ea	5 ft
21" Flap Gate	5 ft	1 ea	5 ft
		Subtotal	45 ft

Johnson Creek Pumping Plant
Pump to Canal - System Curve Original Design

Q (gpm)	0	897	1,798	2,695	3,591	4,488	5,384	6,281	7,177	8,074	8,970	9,867	10,763	11,660	12,556	13,453	14,349	15,246
Q (cfs)	0.0	2.0	4.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0	22.0	24.0	26.0	28.0	30.0	32.0	34.0
Hf	0.0	0.8	2.5	4.8	7.9	8.9	10.0	11.2	12.5	14.0	15.5	17.2	19.0	20.9	22.9	25.0	27.2	29.5
TDH (ft)	116.0	116.8	118.4	120.8	123.8	124.8	125.9	127.1	128.5	129.9	131.5	133.1	134.9	136.8	138.8	141.0	143.2	145.5
Vel. Disch. (fps)	0.0	0.8	1.7	2.5	3.3	4.2	5.0	5.8	6.6	7.5	8.3	9.1	10.0	10.8	11.6	12.5	13.3	14.1



Byron Jackson 16RL, 2 Stage, 1770 RPM, 125HP

Q (cfs)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
Q (gpm)	0	898	1,795	2,693	3,591	4,488	5,386	6,284	7,181	8,079	8,977	9,874	10,772	11,670	12,567	13,465	14,363	15,260
Head (ft)	227	215	176	145	107	45												

(2) 16RL

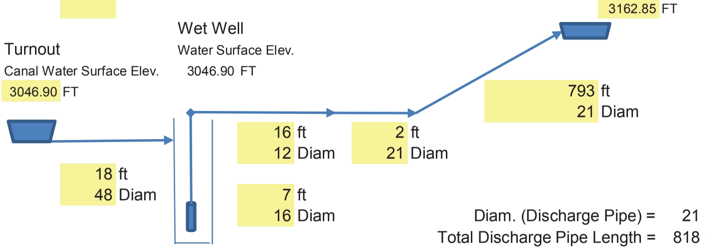
Q (cfs)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
Q (gpm)	0	898	1,795	2,693	3,591	4,488	5,386	6,284	7,181	8,079	8,977	9,874	10,772	11,670	12,567	13,465	14,363	15,260
Head (ft)	227	221	215	196	176	161	145	126	107	76	45							

NOTE: Original Pump No. 2 at the Johnson Pumping Plant has been replaced with a 250 HP unit, pump curve not immediately available.

Pump to Canal Head Loss Calculations
Johnson Creek Pumping Plant Retrofit

4,375 GPM	Vertical Turbine Pump No. 1	
3,000 GPM	Vertical Turbine Pump No. 2	
7,375 GPM	Total =	16.4 cfs

Static Head = 115.95 FT



Diam. (Discharge Pipe) = 21 in
Total Discharge Pipe Length = 818 ft
Equiv. Pipe Length Valves & Fittings Pump Discharge = 203 ft
Equiv. Pipe Length Valves & Fittings Discharge Header = 45 ft

4.4 ft x 8 ft trash rack to PS Wet Well	Friction Head =	0.17 FT per 1,000 FT	Concrete
	Dynamic Head =	0.00 FT total	C = 110
16" Column Pipe	Friction Head =	9.05 FT per 1,000 FT	Steel
(Vel. = 7.0 fps)	Dynamic Head =	0.06 FT total	C = 135
12" Discharge Piping	Friction Head =	36.67 FT per 1,000 FT	Steel
(Vel. = 12.4 fps)	Dynamic Head =	0.59 FT total	C = 135
21" Header	Friction Head =	6.33 FT per 1,000 FT	Steel
(Vel. = 6.8 fps)	Dynamic Head =	0.01 FT total	C = 135
21" Discharge	Friction Head =	6.33 FT per 1,000 FT	Steel
(Vel. = 6.8 fps)	Dynamic Head =	5.02 FT total	C = 135
Equivalent Pipe Length Valves & Fittings Pump Discharge	Friction Head =	36.67 FT per 1,000 FT	Steel
	Dynamic Head =	7.44 FT total	C = 135
Equivalent Pipe Length Valves & Fittings Discharge Header	Friction Head =	6.33 FT per 1,000 FT	Steel
	Dynamic Head =	0.28 FT total	C = 135
	Friction Head =	13.41 FT =	5.81 psi
	Water Depth in Discharge Canal =	2.46 FT =	1.07 psi
	Total Dynamic Head =	131.83 FT =	57.07 psi

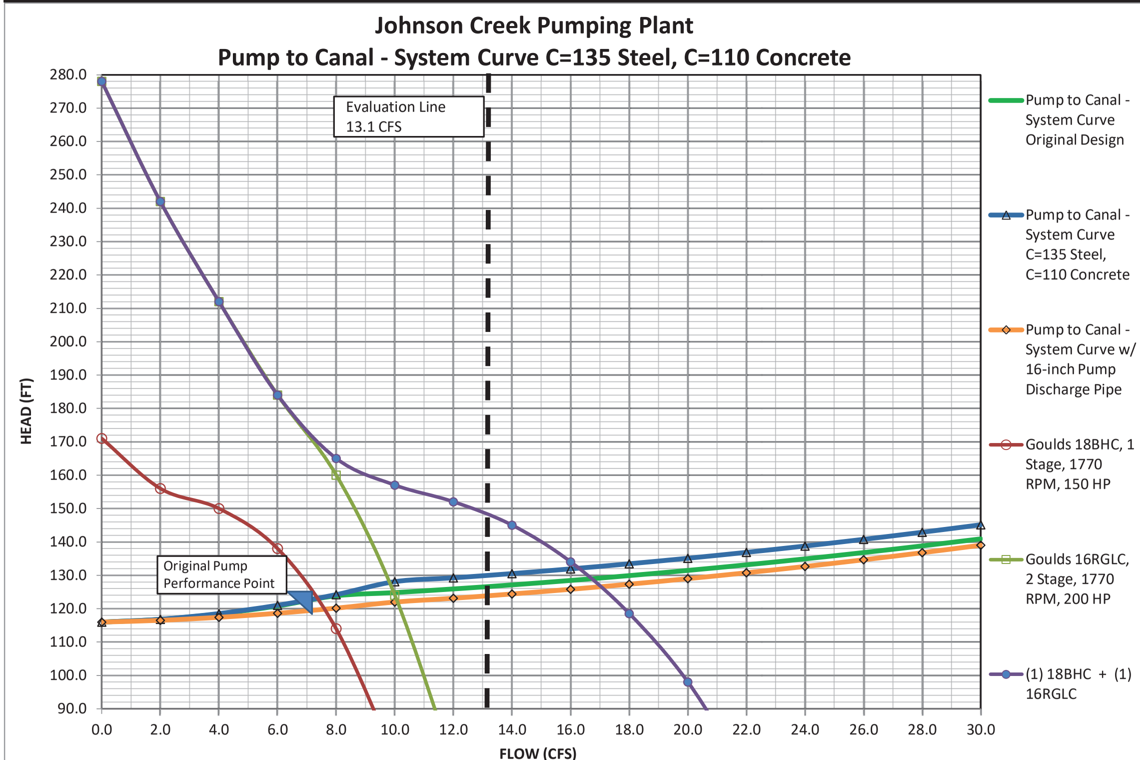
Equivalent Pipe Length Totals:

Item	12" Equiv. Length	No. of Units	Total Equiv. Length
12" pump discharge head	80 ft	1 ea	80 ft
12" check valve	120 ft	1 ea	120 ft
12" pump control (gate) valve	3 ft	1 ea	3 ft
		Subtotal	203 ft

Item	21" Equiv. Length	No. of Units	Total Equiv. Length
12"x12"x21" tee branch flow	35 ft	1 ea	35 ft
12"x21" expander	5 ft	1 ea	5 ft
21" Flap Gate	5 ft	1 ea	5 ft
		Subtotal	45 ft

Johnson Creek Pumping Plant
Pump to Canal - System Curve C=135 Steel, C=110 Concrete

Q (gpm)	0	897	1,798	2,695	3,591	4,488	5,384	6,281	7,177	8,074	8,970	9,867	10,763	11,660	12,556	13,453	14,349	15,246
Q (cfs)	0.0	2.0	4.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0	22.0	24.0	26.0	28.0	30.0	32.0	34.0
Hf	0.0	0.8	2.6	5.0	8.2	12.1	13.3	14.5	15.9	17.5	19.1	20.9	22.8	24.8	26.9	29.2	31.5	34.0
TDH (ft)	116.0	116.8	118.5	121.0	124.2	128.1	129.2	130.5	131.9	133.4	135.1	136.8	138.7	140.7	142.9	145.1	147.5	149.9
Vel. Disch. (fps)	0.0	0.8	1.7	2.5	3.3	4.2	5.0	5.8	6.6	7.5	8.3	9.1	10.0	10.8	11.6	12.5	13.3	14.1



Goulds 18BHC, 1 Stage, 1770 RPM, 150 HP

Q (cfs)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
Q (gpm)	0	898	1,795	2,693	3,591	4,488	5,386	6,284	7,181	8,079	8,977	9,874	10,772	11,670	12,567	13,465	14,363	15,260
Head (ft)	171	156	150	138	114	75												

Goulds 16RGLC, 2 Stage, 1770 RPM, 200 HP

Q (cfs)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
Q (gpm)	0	898	1,795	2,693	3,591	4,488	5,386	6,284	7,181	8,079	8,977	9,874	10,772	11,670	12,567	13,465	14,363	15,260
Head (ft)	278	242	212	184	160	124	73											

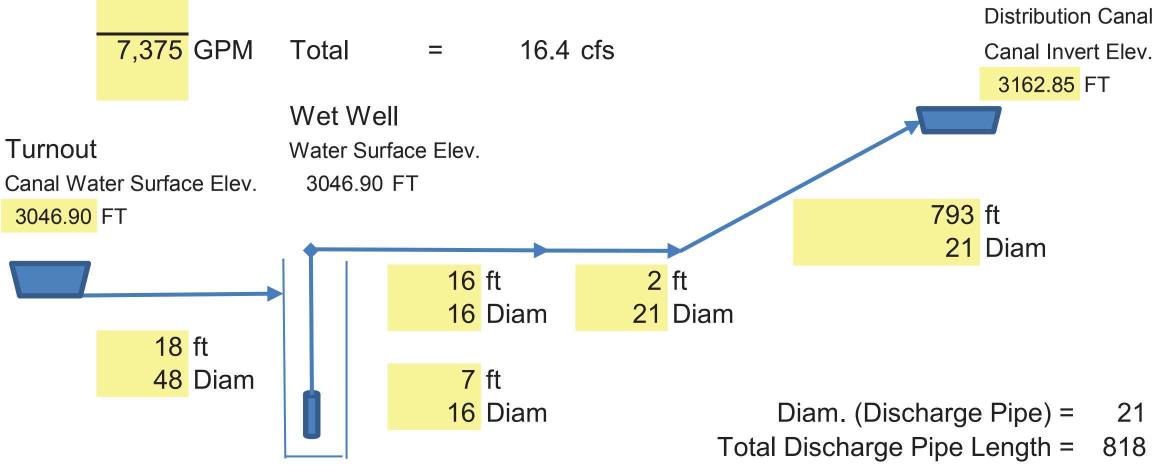
(1) 18BHC + (1) 16RGLC

Q (cfs)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
Q (gpm)	0	898	1,795	2,693	3,591	4,488	5,386	6,284	7,181	8,079	8,977	9,874	10,772	11,670	12,567	13,465	14,363	15,260
Head (ft)	278	242	212	184	165	157	152	145	134	119	98	70						

Pump to Canal Head Loss Calculations
Johnson Creek Pumping Plant Retrofit

4,375 GPM	Vertical Turbine Pump No. 1	
3,000 GPM	Vertical Turbine Pump No. 2	
7,375 GPM	Total =	16.4 cfs

Static Head = 115.95 FT

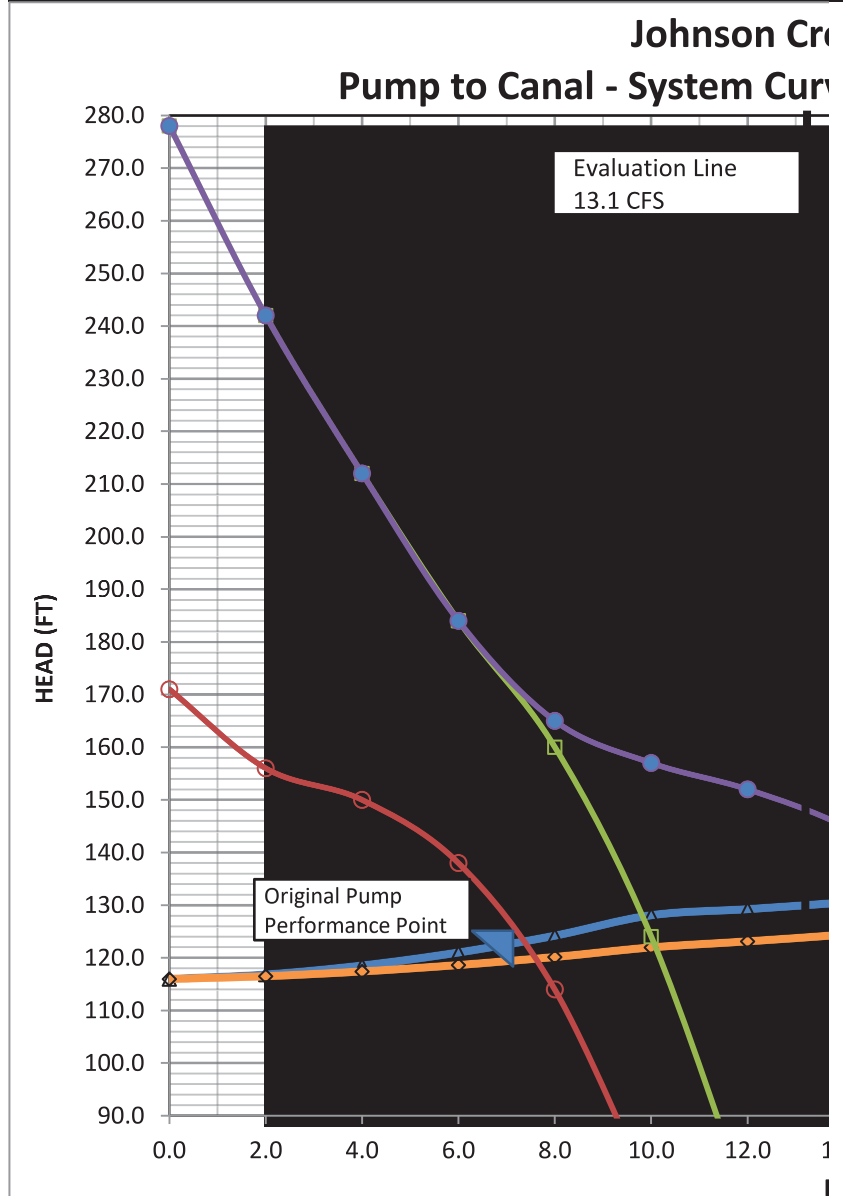


Diam. (Discharge Pipe) = 21 in
Total Discharge Pipe Length = 818 ft
Equiv. Pipe Length Valves & Fittings Pump Discharge = 228 ft
Equiv. Pipe Length Valves & Fittings Discharge Header = 45 ft

4.4 ft x 8 ft trash rack to PS Wet Well	Friction Head =	0.17 FT per 1,000 FT	Concrete
	Dynamic Head =	0.00 FT total	C = 110
16" Column Pipe	Friction Head =	9.05 FT per 1,000 FT	Steel
(Vel. = 7.0 fps)	Dynamic Head =	0.06 FT total	C = 135
16" Discharge Piping	Friction Head =	9.05 FT per 1,000 FT	Steel
(Vel. = 7.0 fps)	Dynamic Head =	0.14 FT total	C = 135
21" Header	Friction Head =	6.33 FT per 1,000 FT	Steel
(Vel. = 6.8 fps)	Dynamic Head =	0.01 FT total	C = 135
21" Discharge	Friction Head =	6.33 FT per 1,000 FT	Steel
(Vel. = 6.8 fps)	Dynamic Head =	5.02 FT total	C = 135
Equivalent Pipe Length Valves & Fittings Pump Discharge	Friction Head =	9.05 FT per 1,000 FT	Steel
	Dynamic Head =	2.06 FT total	C = 135
Equivalent Pipe Length Valves & Fittings Discharge Header	Friction Head =	6.33 FT per 1,000 FT	Steel
	Dynamic Head =	0.28 FT total	C = 135
	Friction Head =	7.59 FT =	3.29 psi

Johnson Creek Pumping Plant
Pump to Canal - System Curve w/ 16-inch Pump Discharge Pipe

Q (gpm)	0	897	1,798	2,695	3,591	4,488	5,3
Q (cfs)	0.0	2.0	4.0	6.0	8.0	10.0	12
Hf	0.0	0.5	1.4	2.7	4.2	6.0	7
TDH (ft)	116.0	116.5	117.4	118.6	120.1	122.0	123
Vel. Disch. (fps)	0.0	0.8	1.7	2.5	3.3	4.2	5



Goulds 18BHC, Single Stage, 1770 RPM, 150 HP							
Q (cfs)	0	2	4	6	8	10	
Q (gpm)	0	898	1,795	2,693	3,591	4,488	5,3

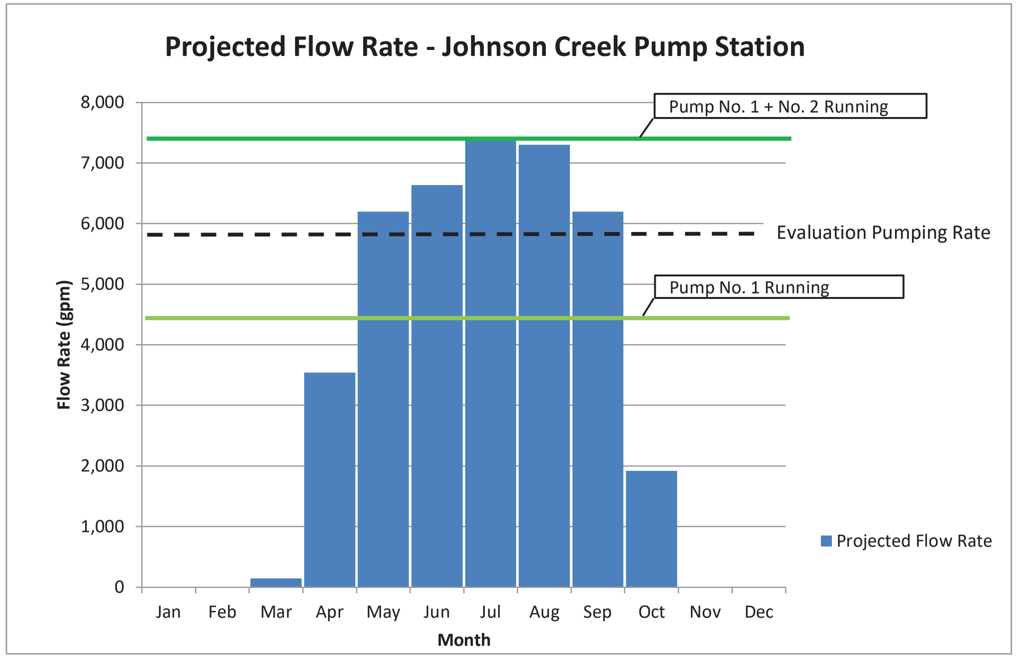
Pump to Canal Head Loss Calculations
Johnson Creek Pumping Plant Reconstruction (New vertical turbines with new pump discharge piping and valves. Retain VFD control one pump)

4,375	GPM	Vertical Turbine Pump No. 1		
3,000	GPM	Vertical Turbine Pump No. 2		
7,375	GPM	Total	=	16.4 cfs

Proposed PS Design Flow Rate = 7,375 gpm

Month	% of Max Flow Rate	Projected Flow Rate
Jan	0%	0
Feb	0%	0
Mar	2%	148
Apr	48%	3,540
May	84%	6,195
Jun	90%	6,638
Jul	100%	7,375
Aug	99%	7,301
Sep	84%	6,195
Oct	26%	1,918
Nov	0%	0
Dec	0%	0

Evaluation Pumping Rate = 5,894 gpm
13.1 cfs



Notes: Johnson Creek PS when refitted with new pumps, new pump discharge piping, and new valves. Retain currently existing VFD control on one of the pumps. VFD operation provides significant benefit toward reducing energy use and optimizing water delivery to crop requirement. Effort should be made to size replacement pumps to match seasonal demand requirements; Pump No. 1 at 48% max flow, and Pump No. 2 at 52% max flow. With Pump No. 1 fitted with VFD control, it could be modulated to a flow rate that allows its use alone or in combination with Pump No. 2 to reasonably match projected seasonal demand requirements.

Ochoco Irrigation District

Johnson Creek PS (Retrofit of pump equipment at existing pump station)

Budget Level - Projection of Probable Construction Cost

Item No.	Spec Division	Description	Measurement	Units	Unit Cost	Total Cost
1	1000	Mobilization	LS	1	$8,200.00	$8,200.00
2	1000	Project Management and Coordination	LS	1	$1,200.00	$1,200.00
3	1000	Construction Progress Documentation	LS	1	$1,200.00	$1,200.00
4	1000	Submittal Procedures	LS	1	$1,200.00	$1,200.00
5	1000	Quality Requirements	LS	1	$2,500.00	$2,500.00
6	1000	Selective Demolition	LS	1	$6,000.00	$6,000.00
7	1000	Project Record Documents	LS	1	$1,200.00	$1,200.00
8	1000	Operations and Maintenance Data	LS	1	$2,500.00	$2,500.00
9	1000	General Commissioning Requirements	LS	1	$5,000.00	$5,000.00
10	2000	Surfacing Rock	CY	10	$38.00	$380.00
11	3000	Misc Cast-in-Place Concrete (thrust and pads)	LS	1	$5,000.00	$5,000.00
12	9000	High Performance Coating Systems	LS	1	$1,500.00	$1,500.00
13	11000	Line Shaft Turbine Pump and Motor, 125 HP	EA	1	$41,000.00	$41,000.00
14	11000	Line Shaft Turbine Pump and Motor, 200 HP	EA	1	$58,500.00	$58,500.00
15	15000	16-inch Handwheel Operated Butterfly Valve	EA	1	$2,875.00	$2,875.00
16	15000	16-inch Surge Control Check Valve	EA	1	$9,875.00	$9,875.00
17	15000	16-inch Discharge Pipe, Fittings, & Accessories	EA	1	$4,500.00	$4,500.00
18	15000	12-inch Handwheel Operated Butterfly Valve	EA	1	$2,250.00	$2,250.00
19	15000	12-inch Surge Control Check Valve	EA	1	$5,250.00	$5,250.00
20	15000	12-inch Discharge Pipe, Fittings, & Accessories	EA	1	$3,500.00	$3,500.00
21	16000	Power and Distribution	LS	1	$0.00	$0.00
22	16000	Grounding Systems	LS	1	$0.00	$0.00
23	16000	Motor Controls	LS	1	$0.00	$0.00
24	17000	Instrumentation and Control	LS	1	$0.00	$0.00
		Construction Subtotal				$163,630.00
		Contractors Overhead and Profit	10%	1	$16,363.00	$16,363.00
		Contractors Bonds and Insurance	2%	1	$3,599.86	$3,599.86
		Construction Contingency	30%	1	$49,089.00	$49,089.00
		Construction Total				$232,681.86
		Engineering, Administration	25%	1	$58,170.47	
		Total				**$290,852.33**

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Wire to Water Energy Calculator

Ochoco Irrigation District - SOR

Johnson Creek Pumping Plant - Pump Replacement

Source: PumpTech Inc.

2425 SE Ochoco Street

Portland, OR 97222

503-659-6230

OPERATIONAL AND EQUIPMENT DATA	Replacement Pumps		Existing Pumps
	No. 1 - Goulds 18BHC, 1 Stage, 1770 RPM, 150 HP		No. 1 - Byron Jackson 16RLDW, 1 Stage, 1770 RPM, 125 HP *
	No. 2 - Goulds 16RGLC, 2 Stage, 1770 RPM, 200 HP		No. 2 - Byron Jackson, 1770 RPM, 250 HP **
Pump Operation - Hours / Day	24		24
Pump Operation - Days / Year	198		198
Pump Flow - GPM (Evaluation Pump Rate)	5,894		5,894
Pump Flow - CFS	13.1		13.1
Total Annual Volume - Acre feet	5,160		5,160
Pump Head - Feet	123.7	*	129.5
Ave. Pump Efficiency - %	84.5%		59.0%
Ave. Motor Efficiency - %	93.0%		92.5%
Energy Cost in $/kW-hr	$0.035		$0.035

Replacement Pumps: * Estimated pumping head assumes pump column pipe, discharge piping, and valves are changed from 12-inch to 16-inch

Existing Pumps: * Pump make and model per original construction submittals, 1963

** Pump make and model information not available at the time of evaluation

RESULTS

	Replacement Pumps	Existing Pumps
BHP At Design Point	217.9	326.7
Wire to Water Efficiency - %	79%	55%
kW-hr per Year	830,539	1,252,005
Annual Energy Cost	$29,068.88	$43,820.19
kW-hr Per 1,000 Gallons Pumped	0.494	0.745
Cost Per 1,000 Gallons Pumped	$0.017	$0.026
kW-hr per Acre Foot Pumped	161	243
Cost Per Acre Foot Pumped	$5.64	$8.50

PAYBACK

Annual Savings - kW-hr	421,466
Annual Savings - $$	$14,751.31
Annual Savings - %	33.66%
Cost of Replacement Pumps *	$291,000.00
Cost of Existing Pumps	$0.00
Payback - Years	19.7

* Estimated cost assumes pump column pipe, discharge piping, and valves are changed from 12-inch to 16-inch

Pump Test Data

Initial Pump Evaluation

Project No.: OCHID-01-10 **Description:** 125 hp North Pump

Pump Station No.: Johnson Ck **Pump No.:** 1 **Water Source:** Canal **Parallel**

Motor Nameplate

Motor Make:	General Electric		
Model No:	5K6277XH35A		
Serial No:			
Rated Hp:	125		
Rated Voltage:	440		
Rated Amperage:	158	**Ins. Class:**	None
Full Load RPM:	1770	**Code:**	None
Enclosure:	None		
Design:	None		
Frame:	B444TP20		
Service Factor:	1.15		

Pump Nameplate

Pump Make:	Byron Jackson		
Type:	Vertical Turbine		
Serial No:	661S0084		
Model No:	None	**Impeller No:**	
Impeller Dia (in):		**No. of Stages:**	0
Impeller Dia (in):		**No. of Stages:**	0
Secondary Model No:	None	**Impeller No:**	
Impeller Dia (in):		**No. of Stages:**	0
Impeller Dia (in):		**No. of Stages:**	0
Rated Flow (gpm):	0		
Rated Head (ft):	0		
Rated RPM:	0		
Column Dia (in):	0.00		
Column Length (ft):	0.0		
Shaft Dia (in):	0.000		
Tube Dia (in):	0.000		
Thrust Factor (lbs/ft):	0.0		
Impeller Wt. (lbs):	0.0		

Utility Meter Nameplate

Make: None **Meter ID:** 28697779

Type: Digital **Serial No.:**

k_h: 1.2 **PTR:** 1 **CTR:** 40

Field Pump Test Data

Test No.	Date	Flow Measurement Device	Flow (gpm)	Lift Air Line (PSI)	Lift Static Level (ft)	Lift Pumping Lift (ft)	Pressures Discharge (PSI)	Pressures Delivered (PSI)	Misc. Losses (ft)	TDH (ft)	Pump RPM
1-1	10/12/2010	Transit Time	2,125			6.1	48.7	48.7	0.5	119.1	1777

Test No.	Voltages 1-2	Voltages 1-3	Voltages 2-3	Voltages Avg.	Amperages 1	Amperages 2	Amperages 3	Amperages Avg.	Power Factor 1	Power Factor 2	Power Factor 3	Power Factor Avg.	Utility Meter Rev.	Utility Meter Sec.	Motor RPM	Motor % Load
1-1	470.0	476.0	473.0	473.0	145.0	136.0	145.0	142.0				83.4%	20	34.5	1777	94.8%

Test No.	Power Calculations Shaft HP	Thrust HP	Water HP	Brake HP	Pump HP	Input kW	Input HP	Utility Meter (kW)	Efficiencies Motor	Pump	Discharge	Delivered
1-1	0.00	0.00	63.9	118.6	118.6	97.0	130.0	100.2	91.2%	53.7%	49.0%	49.0%

Note: If a main valve is present, the Delivered Pressure is the pressure after the valve. If no main valve is present, the Delivered Pressure will be the same as the Discharge Pressure.

Pump Test Data

Initial Pump Evaluation

Project No.: OCHID-01-10 **Description:** Operated with VFD

Pump Station No.: Johnson Ck **Pump No.:** 2 **Water Source:** Canal **Parallel**

Motor Nameplate

Motor Make:	WEG Electric Motors		
Model No:			
Serial No:			
Rated Hp:	250		
Rated Voltage:	460		
Rated Amperage:	278	**Ins. Class:**	None
Full Load RPM:	1780	**Code:**	None
Enclosure:	None		
Design:	None		
Frame:	445TP WP1		
Service Factor:	1.15		

Pump Nameplate

Pump Make:	Byron Jackson		
Type:	Vertical Turbine		
Serial No:			
Model No:	None	**Impeller No:**	
Impeller Dia (in):		**No. of Stages:**	0
Impeller Dia (in):		**No. of Stages:**	0
Secondary Model No:	None	**Impeller No:**	
Impeller Dia (in):		**No. of Stages:**	0
Impeller Dia (in):		**No. of Stages:**	0
Rated Flow (gpm):	0		
Rated Head (ft):	0		
Rated RPM:	0		
Column Dia (in):	0.00		
Column Length (ft):	0.0		
Shaft Dia (in):	0.000		
Tube Dia (in):	0.000		
Thrust Factor (lbs/ft):	0.0		
Impeller Wt. (lbs):	0.0		

Utility Meter Nameplate

Make:	None	**Meter ID:**	28697779		
Type:	Digital	**Serial No.:**			
k_h:	1.2	**PTR:**	1	**CTR:**	40

Field Pump Test Data

Test No.	Date	Flow Measurement Device	Flow (gpm)	Lift Air Line (PSI)	Lift Static Level (ft)	Lift Pumping Lift (ft)	Pressures Discharge (PSI)	Pressures Delivered (PSI)	Misc. Losses (ft)	TDH (ft)	Pump RPM
2-1	10/12/2010	Transit Time	5,133			5.1	51.3	50.0	2.9	126.6	1763
2-2	10/12/2010	Transit Time	5,253			5.1	50.0	50.0	3.1	123.7	1762

Test No.	Voltages 1-2	Voltages 1-3	Voltages 2-3	Voltages Avg.	Amperages 1	Amperages 2	Amperages 3	Amperages Avg.	Power Factor 1	Power Factor 2	Power Factor 3	Power Factor Avg.	Utility Meter Rev.	Utility Meter Sec.	Motor RPM	Motor % Load
2-1	470.0	476.0	473.0	473.0	290.0	287.0	285.0	287.3				85.2%	40	34.6		100.8%
2-2													40	34.4		101.0%

Test No.	Power Calculations Shaft HP	Thrust HP	Water HP	Brake HP	Pump HP	Input kW	Input HP	Utility Meter (kW)	Efficiencies Motor	Pump	Discharge	Delivered
2-1	0.00	0.00	164.1	252.0	252.0	200.5	268.7	199.8	93.8%	65.1%	61.1%	59.6%
2-2	0.00	0.00	164.1	252.5	252.5	200.9	269.2	200.9	93.8%	65.0%	61.0%	61.0%

Note: If a main valve is present, the Delivered Pressure is the pressure after the valve. If no main valve is present, the Delivered Pressure will be the same as the Discharge Pressure.

Pump Test Summary Data

Project No.: OCHID-01-10

Pump Station	Pump No.	Condition	Test No.	Include	Rated Hp	Flow (gpm)	Lift (ft)	Discharge (PSI)	Delivery (PSI)	TDH (FT)	Electric Hp	Pump Eff.	Overall Eff.
Johnson	1	Existing	1-1	X	125	2,125	6.1	48.7	48.7	119.1	130.0	53.7%	49.0%
Johnson	2	Existing	2-1		250	5,133	5.1	51.3	50.0	126.6	268.7	65.1%	61.1%
Johnson	2	Existing	2-2		250	5,253	5.1	50.0	50.0	123.7	269.2	65.0%	61.0%

Pump Performance Datasheet

Customer	: Ochoco Irrigation District	Quote number	:
Customer reference	: OID - SOR Johnson Crk Pump Sta	Item description	: 18BHC
Item number	: Pump No. 1 Replacement	Stages	: 1
Service	: Irrigation Water	Based on curve number	: 18BHC-1770
Quantity	: 1	Date last saved	: 27 May 2011 1:08 PM

Operating Conditions

Flow, rated	: 3,000.0 USgpm
Differential head / pressure, rated (requested)	: 126.2 ft
Differential head / pressure, rated (actual)	: 127.7 ft
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: 38.45 ft
Frequency	: 60 Hz

Performance

Speed, rated	: 1,770 rpm
Impeller diameter, rated	: 11.94 in
Impeller diameter, maximum	: 12.94 in
Impeller diameter, minimum	: 10.75 in
Efficiency (bowl / pump)	: 82.96 / - %
NPSH required / margin required	: 30.46 / 5.00 ft
Ns (imp. eye flow) / Nss (imp. eye flow)	: 2,429 / 7,635 US Units
MCSF	: 1,800.0 USgpm
Head, maximum, rated diameter	: 166.2 ft
Head rise to shutoff	: 31.73 %
Flow, best eff. point (BEP)	: 3,144.3 USgpm
Flow ratio (rated / BEP)	: 95.41 %
Diameter ratio (rated / max)	: 92.25 %
Head ratio (rated dia / max dia)	: 83.74 %
Cq/Ch/Ce [ANSI/HI 9.6.7-2004]	: 1.00 / 1.00 / 1.00
Selection status	: Acceptable

Liquid

Liquid type	: Water
Additional liquid description	: Raw Water
Solids diameter, max	: 1.12 in
Solids concentration, by volume	: 0.00 %
Temperature, max	: 68.00 deg F
Fluid density, rated / max	: 1.000 / 1.000 SG
Viscosity, rated	: 1.00 cP
Vapor pressure, rated	: 0.00 psi.a

Material

Material selected	: CI Bowl (Lined) / Std. Brz Impeller

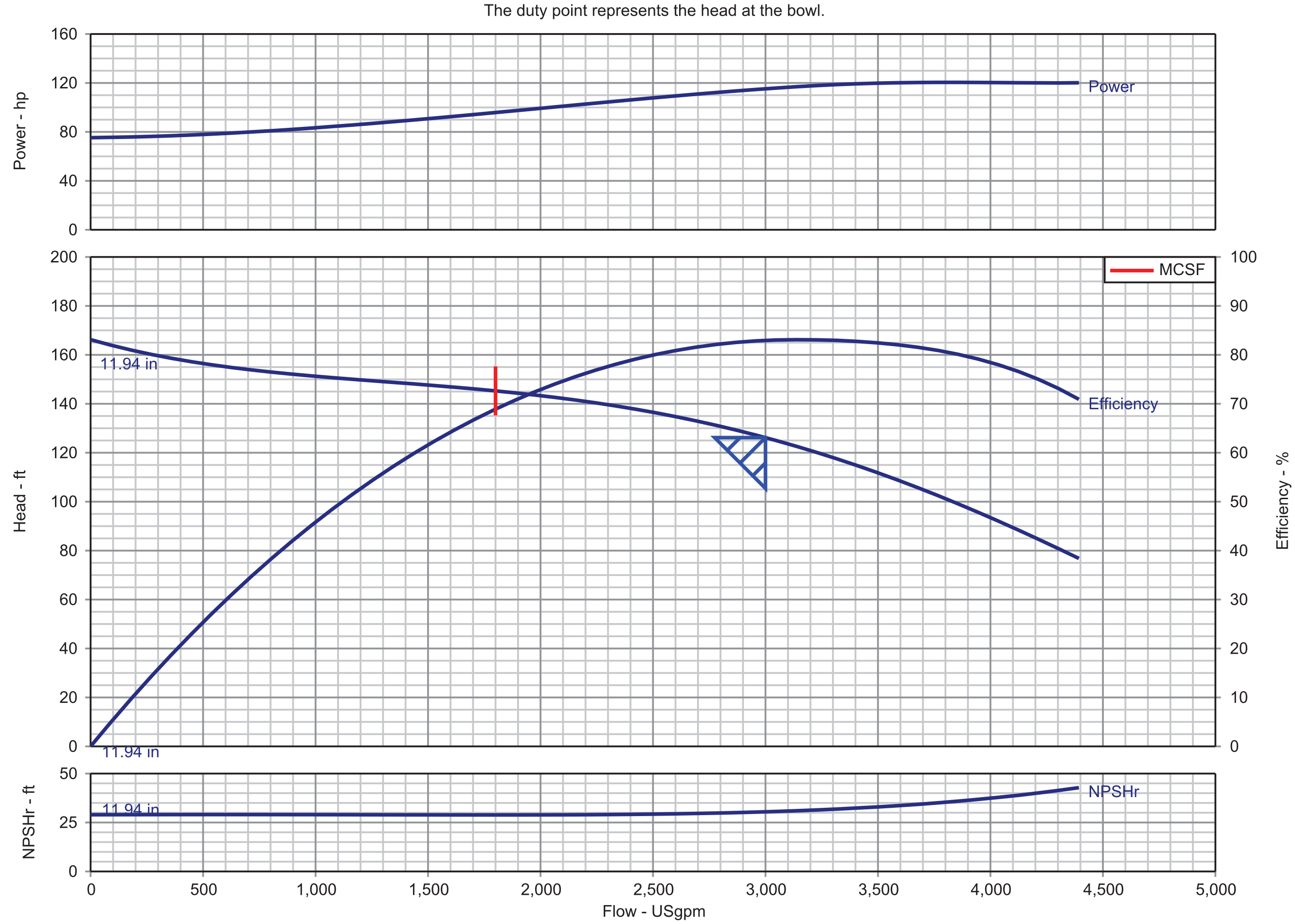
Pressure Data

Maximum working pressure	: 71.95 psi.g
Maximum allowable working pressure	: 370.0 psi.g
Maximum allowable suction pressure	: N/A
Hydrostatic test pressure	: N/A

Driver & Power Data

Driver sizing specification	: Maximum power
Margin over specification	: 0.00 %
Service factor	: 1.15
Power, hydraulic	: 95.59 hp
Power (bowl / pump)	: 115 / -
Power, maximum, rated diameter	: 120 hp
Minimum recommended motor rating	: 125 hp / 93.21 kW

Bowl performance. Adjusted for construction and viscosity.
The duty point represents the head at the bowl.



Pump Performance Datasheet

Customer	: Ochoco Irrigation District	Quote number	:
Customer reference	: OID - SOR Johnson Crk Pump Sta	Item description	: 16RGLC
Item number	: Pump No. 2 Replacement	Stages	: 2
Service	: Irrigation Water	Based on curve number	: 16RGLC-1770
Quantity	: 1	Date last saved	: 27 May 2011 1:11 PM

Operating Conditions

Flow, rated	: 4,375.0 USgpm
Differential head / pressure, rated (requested)	: 126.2 ft
Differential head / pressure, rated (actual)	: 128.8 ft
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: 38.45 ft
Frequency	: 60 Hz

Performance

Speed, rated	: 1,770 rpm
Impeller diameter, rated	: 10.13 in
Impeller diameter, maximum	: 10.45 in
Impeller diameter, minimum	: 8.93 in
Efficiency (bowl / pump)	: 85.97 / - %
NPSH required / margin required	: 28.48 / 5.00 ft
Ns (imp. eye flow) / Nss (imp. eye flow)	: 4,540 / 9,705 US Units
MCSF	: 1,400.0 USgpm
Head, maximum, rated diameter	: 271.5 ft
Head rise to shutoff	: 115.17 %
Flow, best eff. point (BEP)	: 4,155.6 USgpm
Flow ratio (rated / BEP)	: 105.28 %
Diameter ratio (rated / max)	: 96.89 %
Head ratio (rated dia / max dia)	: 88.56 %
Cq/Ch/Ce [ANSI/HI 9.6.7-2004]	: 1.00 / 1.00 / 1.00
Selection status	: Acceptable

Liquid

Liquid type	: Water
Additional liquid description	: Raw Water
Solids diameter, max	: 1.12 in
Solids concentration, by volume	: 0.00 %
Temperature, max	: 68.00 deg F
Fluid density, rated / max	: 1.000 / 1.000 SG
Viscosity, rated	: 1.00 cP
Vapor pressure, rated	: 0.00 psi.a

Material

Material selected	: CI Bowl (Lined) / Std. Brz Impeller

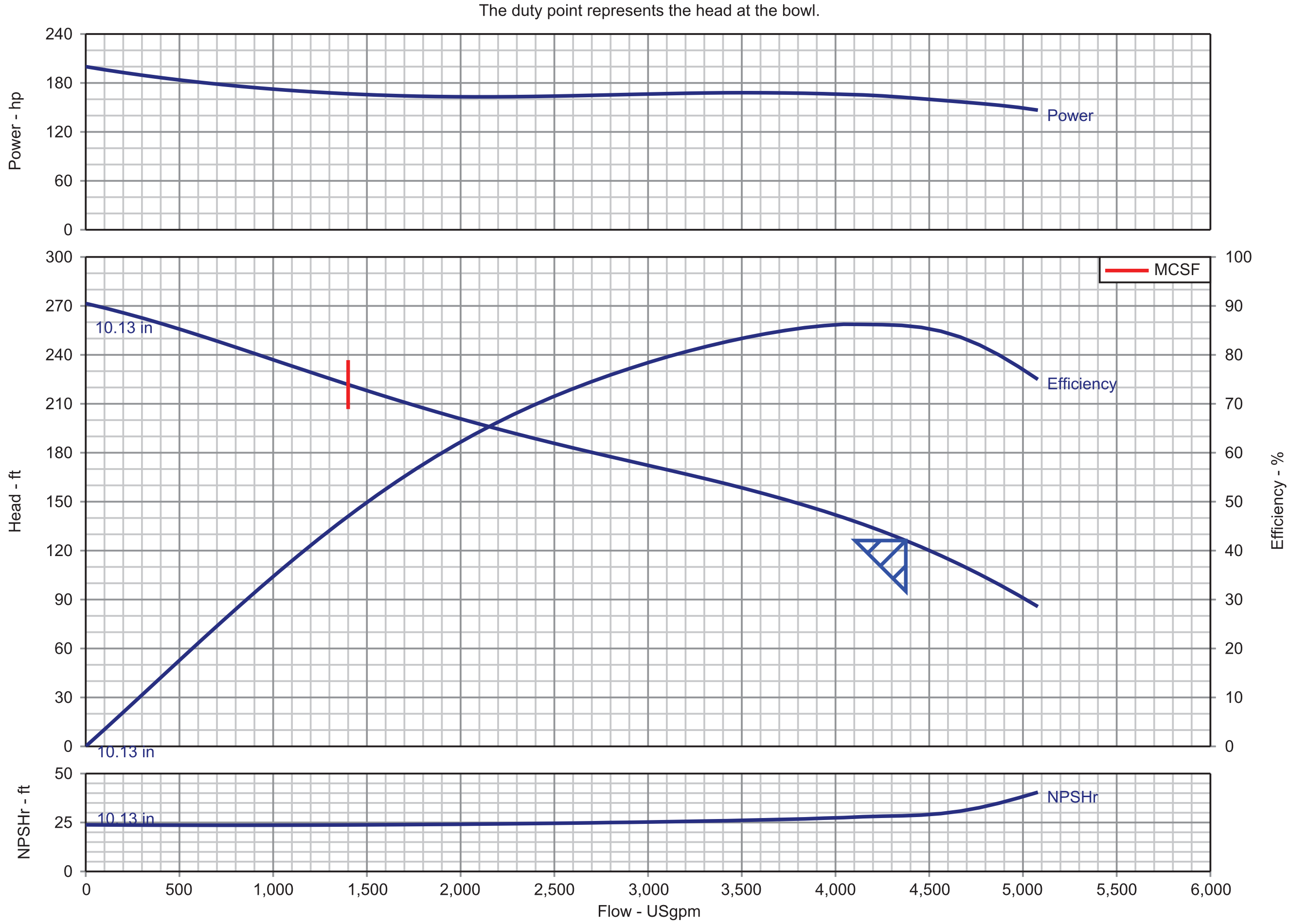
Pressure Data

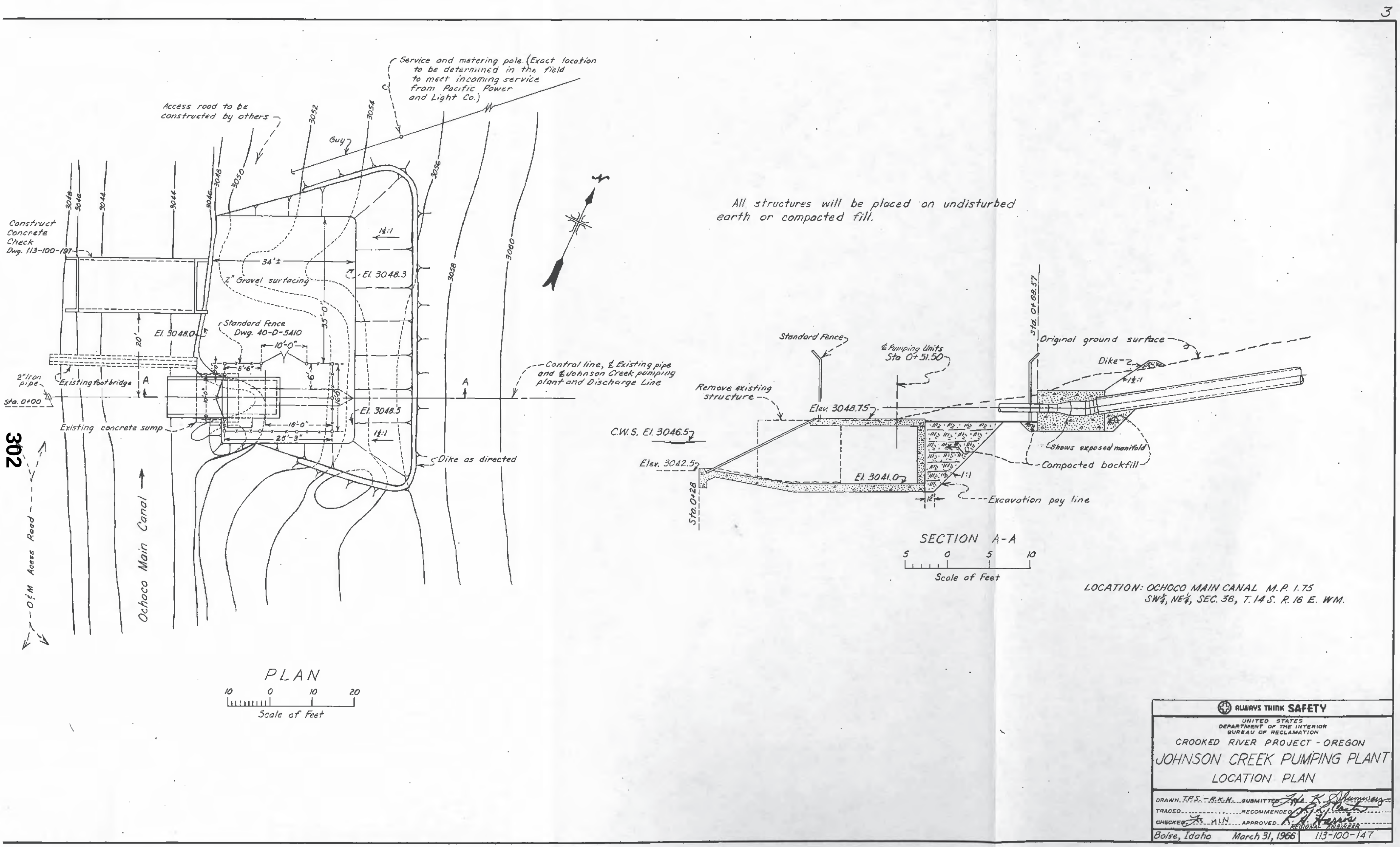
Maximum working pressure	: 117.5 psi.g
Maximum allowable working pressure	: 320.0 psi.g
Maximum allowable suction pressure	: N/A
Hydrostatic test pressure	: N/A

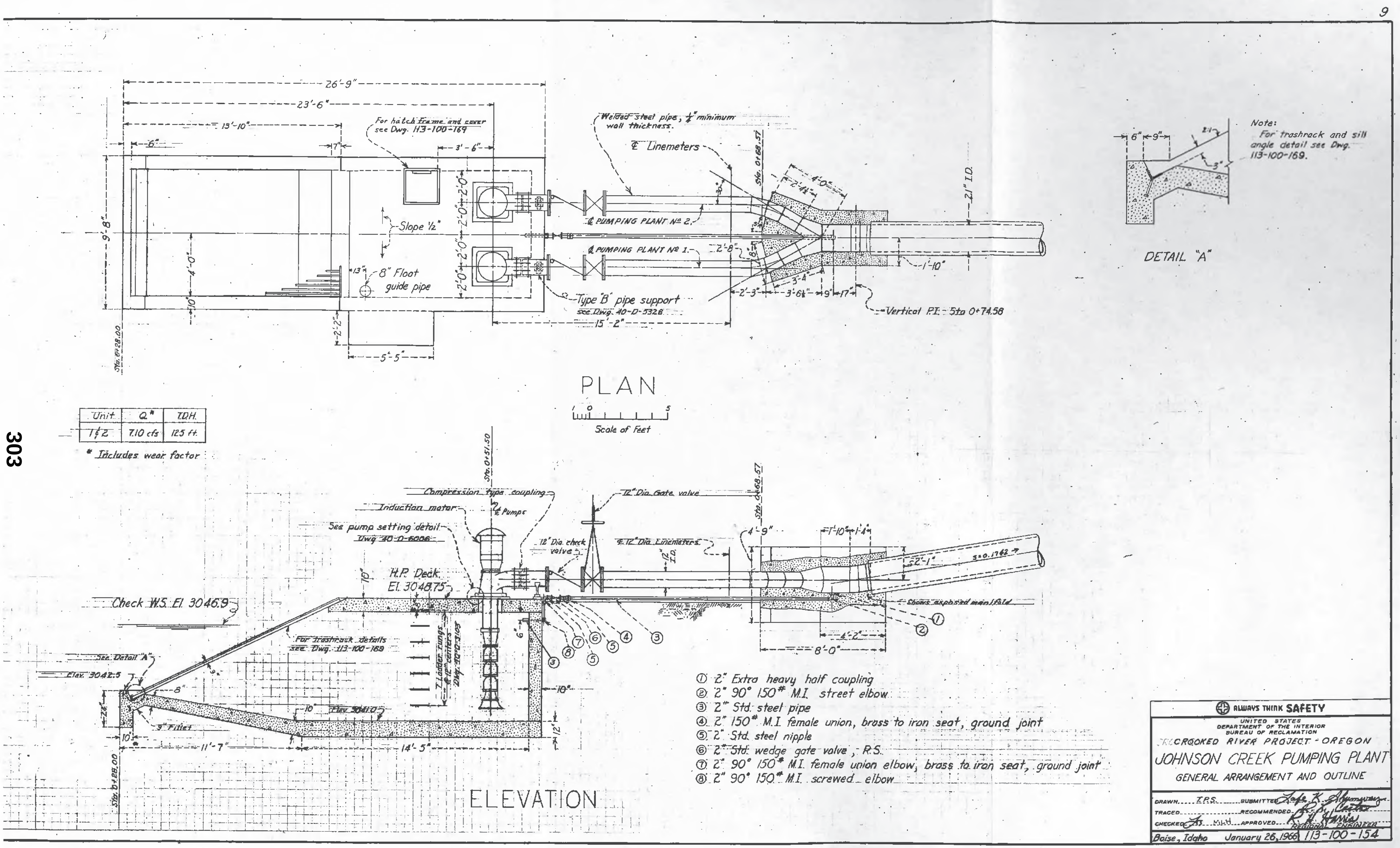
Driver & Power Data

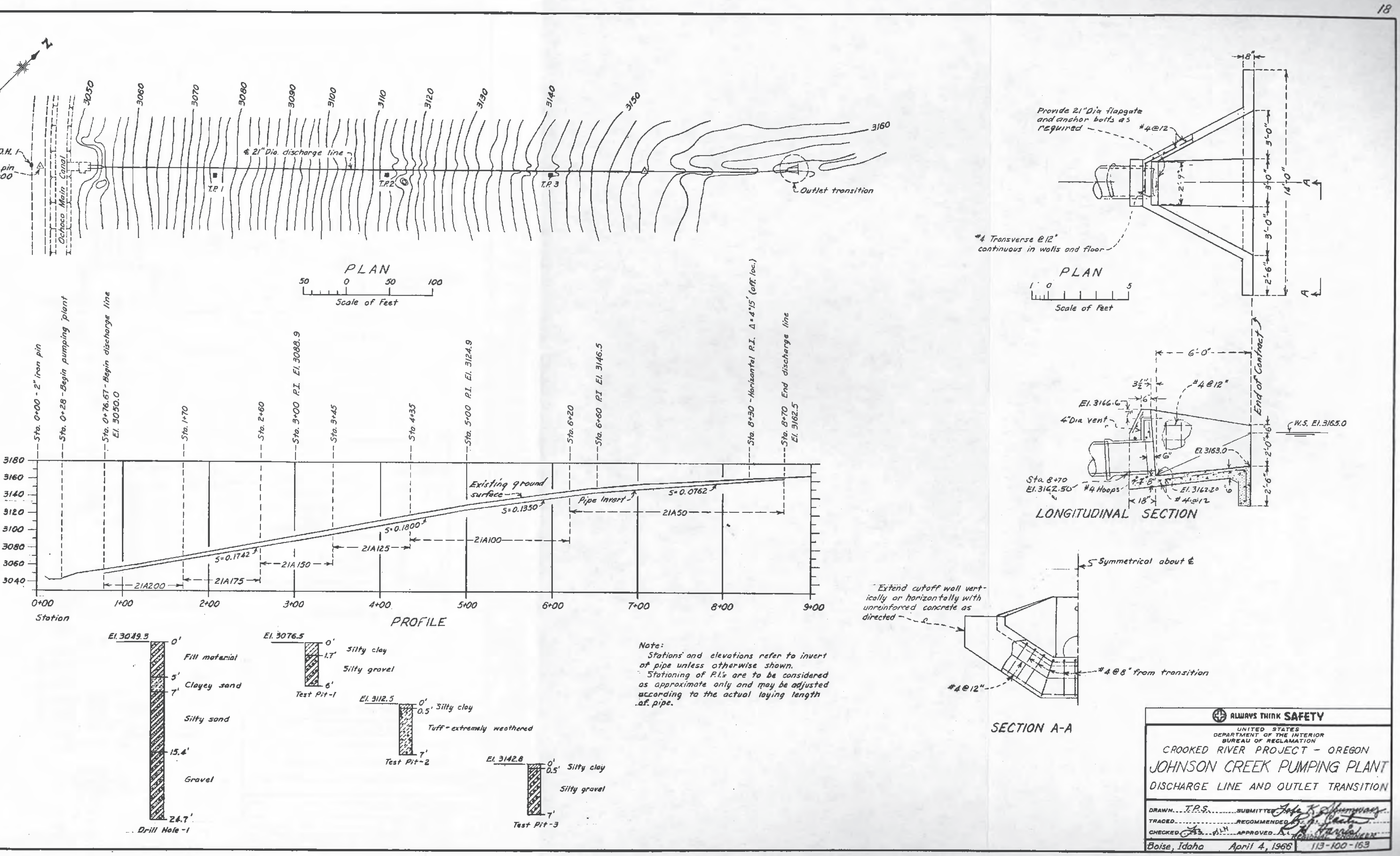
Driver sizing specification	: Maximum power
Margin over specification	: 0.00 %
Service factor	: 1.15
Power, hydraulic	: 139 hp
Power (bowl / pump)	: 162 / -
Power, maximum, rated diameter	: 200 hp
Minimum recommended motor rating	: 200 hp / 149 kW

Bowl performance. Adjusted for construction and viscosity.
The duty point represents the head at the bowl.




3
Service and metering pole. (Exact location to be determined in the field to meet incoming service from Pacific Power and Light Co.)
Access road to be constructed by others
Guy
Construct Concrete Check Dwg. 113-100-197
34'±
2" Gravel surfacing
El. 3048.3
Standard Fence Dwg. 40-D-5410
10'-0"
El. 3048.0
20'
35'-0"
16'-0"
25'-3"
El. 3048.5
2" Iron pipe
Existing footbridge
Sta. 0+00
Existing concrete sump
Control line, ℄ Existing pipe and ℄ Johnson Creek pumping plant and Discharge Line
Dike as directed
Ochoco Main Canal
O & M Acess Road
3060
3058
3056
3054
3052
3050
3048
3046
3044
PLAN
Scale of Feet
All structures will be placed on undisturbed earth or compacted fill.
Standard Fence
℄ Pumping Units Sta 0+51.50
Sta. 0+68.57
Original ground surface
Dike
Remove existing structure
Elev. 3048.75
C.W.S. El. 3046.5
Elev. 3042.5
Sta. 0+28
El. 3041.0
Shows exposed manifold
Compacted backfill
Excavation pay line
SECTION A-A
Scale of Feet
LOCATION: OCHOCO MAIN CANAL M.P. 1.75
SW¼, NE¼, SEC. 36, T. 14 S. R. 16 E. W.M.
ALWAYS THINK SAFETY
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CROOKED RIVER PROJECT - OREGON
JOHNSON CREEK PUMPING PLANT
LOCATION PLAN
DRAWN T.P.S.-R.K.H. SUBMITTED
TRACED RECOMMENDED
CHECKED M.I.N. APPROVED
REGIONAL ENGINEER
Boise, Idaho March 31, 1966 113-100-147


9
For hatch frame and cover see Dwg. 113-100-169
Welded steel pipe, 1/4" minimum wall thickness.
℄ Linemeters
℄ PUMPING PLANT Nº 2.
℄ PUMPING PLANT Nº 1.
Slope 1/2"
8" Float guide pipe
Type "B" pipe support see Dwg. 40-D-5328
21" I.D.
Vertical P.I. - Sta 0+74.58
Note: For trashrack and sill angle detail see Dwg. 113-100-169.
DETAIL "A"
PLAN
Scale of Feet
| Unit | Q* | T.D.H. |
| 1 & 2 | 7.10 cfs | 125 ft. |
* Includes wear factor
Compression type coupling
Induction motor
℄ Pumps
See pump setting detail Dwg. 40-D-6006
12" Dia. check valve
12" Dia. Gate valve
℄ 12" Dia. Linemeters
H.P. Deck El. 3048.75
Check W.S. El. 3046.9
For trashrack details see Dwg. 113-100-169
See Detail "A"
Elev. 3042.5
7 Ladder rungs @ 12" centers Dwg. 40-D-3165
Shows exposed manifold
① 2" Extra heavy half coupling
② 2" 90° 150# M.I. street elbow
③ 2" Std. steel pipe
④ 2" 150# M.I. female union, brass to iron seat, ground joint
⑤ 2" Std. steel nipple
⑥ 2" Std. wedge gate valve, R.S.
⑦ 2" 90° 150# M.I. female union elbow, brass to iron seat, ground joint
⑧ 2" 90° 150# M.I. screwed elbow
ELEVATION
ALWAYS THINK SAFETY
UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION
CROOKED RIVER PROJECT - OREGON
JOHNSON CREEK PUMPING PLANT
GENERAL ARRANGEMENT AND OUTLINE
Boise, Idaho January 26, 1966 113-100-154


18
PLAN
Scale of Feet
Ochoco Main Canal
D.H. 1
iron pin Sta. 0+00
℄ 21" Dia. discharge line
T.P. 1
T.P. 2
T.P. 3
Outlet transition
PROFILE
Elevation
Station
Sta. 0+00 - 2" iron pin
Sta. 0+28 - Begin pumping plant
Sta. 0+76.67 - Begin discharge line El. 3050.0
Sta. 1+70
Sta. 2+60
Sta. 3+00 P.I. El. 3088.9
Sta. 3+45
Sta. 4+35
Sta. 5+00 P.I. El. 3124.9
Sta. 6+20
Sta. 6+60 P.I. El. 3146.5
Sta. 8+30 - Horizontal P.I. Δ=4°15' (off. loc.)
Sta. 8+70 End discharge line El. 3162.5
Existing ground surface
Pipe Invert
S=0.1742
S=0.1800
S=0.1350
S=0.0762
21A200
21A175
21A150
21A125
21A100
21A50
El. 3049.3
Fill material
Clayey sand
Silty sand
Gravel
Drill Hole - 1
El. 3076.5
Silty clay
Silty gravel
Test Pit - 1
El. 3112.5
Silty clay
Tuff - extremely weathered
Test Pit - 2
El. 3142.8
Silty clay
Silty gravel
Test Pit - 3
Note:
Stations and elevations refer to invert of pipe unless otherwise shown.
Stationing of P.I.'s are to be considered as approximate only and may be adjusted according to the actual laying length of pipe.
Provide 21" Dia. flapgate and anchor bolts as required
#4@12
#4 Transverse @12" continuous in walls and floor
14'-0"
PLAN
Scale of Feet
End of Contract
W.S. El. 3165.0
El. 3166.6
4" Dia. vent
El. 3163.0
Sta. 8+70 El. 3162.50
#4 Hoops
El. 3162.20
#4@12
LONGITUDINAL SECTION
Symmetrical about ℄
Extend cutoff wall vertically or horizontally with unreinforced concrete as directed
#4@8" from transition
#4@12"
SECTION A-A
ALWAYS THINK SAFETY
UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION
CROOKED RIVER PROJECT - OREGON
JOHNSON CREEK PUMPING PLANT
DISCHARGE LINE AND OUTLET TRANSITION
DRAWN T.P.S.
SUBMITTED
TRACED
RECOMMENDED
CHECKED
APPROVED
Boise, Idaho
April 4, 1966
113-100-163

GRIMES FLAT PUMPING PLANT - EVALUATION SUMMARY

OID infrastructure assets serving peripheral acreage were completed in the Crooked River Project Extension include six small pumping plants and associated canals, laterals, and drains. These features serve lands of six separate areas located generally east and north of the original Barnes Butte and Ochoco Relift project area. The Grimes Flat pumping plant lifts water from the Ochoco Main Canal.[1]

Since its original construction circa 1966, the Grimes Flat Pumping Plant was augmented with the addition of a third pump with a 75 HP constant speed drive.

Original Design

Pump Unit	Description	HP	Rated Capacity	Rated Head	Pump Eff. @ Rated Capacity	Pipe size	Pump Discharge Vel.	Discharge Main Vel.
No. 1	Vertical Turbine	100	3,830 GPM	78 FT	80 %	12 IN	10.9 FPS	
No. 2	Vertical Turbine	100	3,830 GPM	78 FT	80 %	12 IN	10.9 FPS	
Total		200	7,660 GPM	78 FT		24 IN		5.4 FPS

Current Condition (Ref. Initial Pump Evaluation BPA, 2010)

Pump Unit	Description	HP	Test Capacity	Test Head	Pump Eff. @ Test Capacity	Pipe size	Pump Discharge Vel.	Discharge Main Vel.
No. 1	Vertical Turbine	100	2,176 GPM	74 FT	62 %	12 IN	6.2 FPS	
No. 2	Vertical Turbine	100	3,928 GPM	76 FT	72 %	12 IN	11.1 FPS	
No. 3	Vertical Turbine	75	850 GPM	73 FT	32 %			
Total		275	6,954 GPM			24 IN		4.9 FPS

Alternate Equipment (Replace Existing Pumps)

Pump Unit	Description	HP	Rated Capacity	Rated Head	Pump Eff. @ Rated Capacity	Pipe size	Pump Discharge Vel.	Discharge Main Vel.
No. 1	Vertical Turbine	100	3,800 GPM	80 FT	83 %	16 IN	6.1 FPS	
No. 2	Vertical Turbine	100	3,800 GPM	80 FT	86 %	16 IN	6.1 FPS	
No. 3	Vertical Turbine	60	2,250 GPM	80 FT	86 %	12 IN	6.4 FPS	
Total		260	9,850 GPM	80 FT		24 IN		7.0 FPS

[1] US Department of the Interior, Bureau of Reclamation, Ochoco River Project, http://www.usbr.gov/projects/Project.jsp?proj_Name=Crooked River Project&pageType=ProjectPage

Narrative

Evaluation of the Grimes Flat Pumping Plant examines potential energy efficiency improvements gained by replacing existing pumps, pump discharge piping, and valves. The existing Grimes Flat pumps exhibit pump efficiencies well below their published value and less than the efficiency potential of replacement units. Evaluation of potential energy savings assumes pump discharge piping and valves on Pump No. 1 and No. 3 (larger units) are increased in size to reduce velocity and friction losses.

The initial cost projection for pumping plant improvements assumes existing electrical systems and motor starter equipment will be reused as is.

Evaluation of potential energy savings through the use of VFD operation suggests that addition of a VFD driver does not provide substantial benefit for matching pump output to seasonal variations in demand.

The capacity of the Grimes Flat Pumping Plant retrofitted with new equipment is anticipated to be approximately 21.9 CFS at 80 feet TDH.

Wire to water energy analysis is based on the projected capacity of the Grimes Flat Pumping Plant retrofitted with new pumps, motors, and pump discharge pipe and valves. The retrofitted pump station is projected to operate at a seasonal average flow of 7,872 gpm (17.5 CFS) at 77.4 feet TDH. The existing pump station in its current condition is projected to yield 17.5 CFS at 82.0 feet TDH.

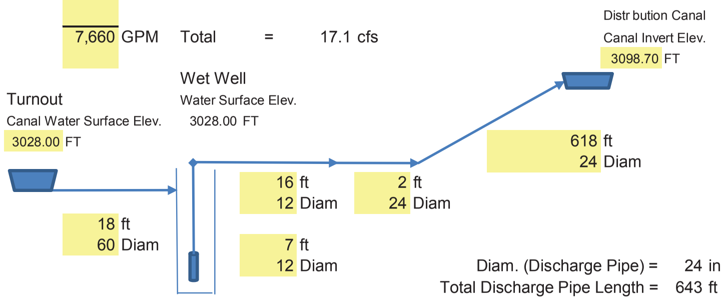
Action Recommended for Further Evaluation: **Retrofit pumping plant, (3) vertical turbine pumps, connect to existing discharge main**
New No. 1 Pump and Motor, Vertical Turbine Pump
New No. 2 Pump and Motor, Vertical Turbine Pump
New No. 3 Pump and Motor, Vertical Turbine Pump
Replace pump discharge piping and valves

Annual Energy Savings Estimate = 306,239 kW-hr

Initial Cost Estimate = $343,000

Pump to Canal Head Loss Calculations
Grimes Flat Pumping Plant Reconstruction

3,830 GPM	Vertical Turbine Pump No. 1	
3,830 GPM	Vertical Turbine Pump No. 2	
		Static Head = 70.70 FT
7,660 GPM	Total =	17.1 cfs



Diam. (Discharge Pipe) = 24 in
Total Discharge Pipe Length = 643 ft
Equiv. Pipe Length Valves & Fittings Pump Discharge = 203 ft
Equiv. Pipe Length Valves & Fittings Discharge Header = 40 ft

2.5 x 8 trash rack entrance	Friction Head =	0.05 FT per 1,000 FT	Concrete
	Dynamic Head =	0.00 FT total	C = 120
12" Column Pipe	Friction Head =	26.81 FT per 1,000 FT	Steel
(Vel. = 10.9 fps)	Dynamic Head =	0.19 FT total	C = 140
12" Discharge Piping	Friction Head =	26.81 FT per 1,000 FT	Steel
(Vel. = 10.9 fps)	Dynamic Head =	0.43 FT total	C = 140
24" Header	Friction Head =	3.31 FT per 1,000 FT	Steel
(Vel. = 5.4 fps)	Dynamic Head =	0.01 FT total	C = 140
24" Discharge	Friction Head =	4.41 FT per 1,000 FT	Concrete
(Vel. = 5.4 fps)	Dynamic Head =	2.72 FT total	C = 120
Equivalent Pipe Length Valves & Fittings Pump Discharge	Friction Head =	26.81 FT per 1,000 FT	Steel
	Dynamic Head =	5.44 FT total	C = 140
Equivalent Pipe Length Valves & Fittings Discharge Header	Friction Head =	3.31 FT per 1,000 FT	Steel
	Dynamic Head =	0.13 FT total	C = 140
	Friction Head =	8.92 FT =	3.86 psi
	Water Depth in Discharge Canal =	1.31 FT =	0.57 psi
	Total Dynamic Head =	80.94 FT =	35.04 psi

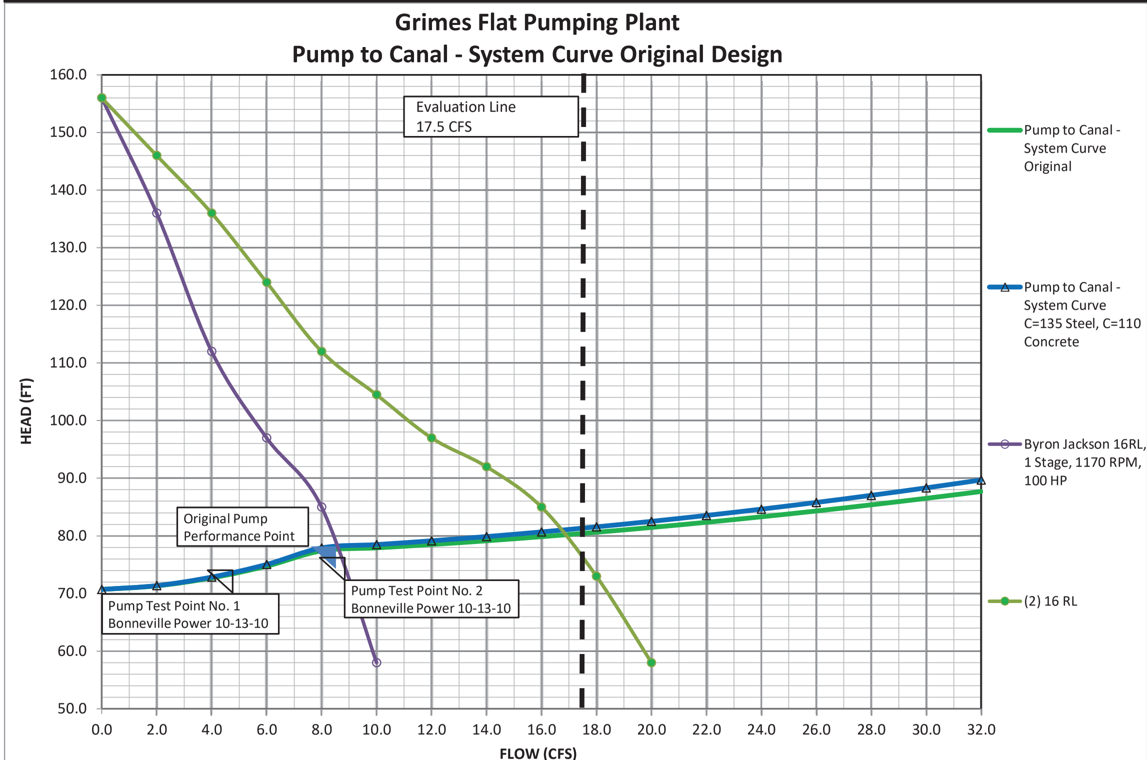
Equivalent Pipe Length Totals:

Item	12" Equiv. Length	No. of Units	Total Equiv. Length
12" pump discharge head	80 ft	1 ea	80 ft
12" check valve	120 ft	1 ea	120 ft
12" pump control (gate) valve	3 ft	1 ea	3 ft
		Subtotal	203 ft

Item	24" Equiv. Length	No. of Units	Total Equiv. Length
12"x12"x24" tee branch flow	30 ft	1 ea	30 ft
12"x24" expander	5 ft	1 ea	5 ft
24"x24" square opening	5 ft	1 ea	5 ft
		Subtotal	40 ft

Grimes Pumping Plant
Pump to Canal - System Curve Original

Q (gpm)	0	897	1,798	2,695	3,591	4,488	5,384	6,281	7,177	8,074	8,970	9,867	10,763	11,660	12,556	13,453	14,349	15,246
Q (cfs)	0.0	2.0	4.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0	22.0	24.0	26.0	28.0	30.0	32.0	34.0
Hf	0.0	0.6	2.0	4.0	6.7	7.2	7.8	8.4	9.1	9.9	10.8	11.6	12.6	13.6	14.7	15.8	17.0	18.2
TDH (ft)	70.7	71.3	72.7	74.7	77.4	77.9	78.5	79.1	79.8	80.6	81.5	82.3	83.3	84.3	85.4	86.5	87.7	88.9
Vel. Disch. (fps)	0.0	0.6	1.3	1.9	2.5	3.2	3.8	4.5	5.1	5.7	6.4	7.0	7.6	8.3	8.9	9.5	10.2	10.8



Byron Jackson 16RL, 1 Stage, 1170 RPM, 100 HP

Q (cfs)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
Q (gpm)	0	898	1,795	2,693	3,591	4,488	5,386	6,284	7,181	8,079	8,977	9,874	10,772	11,670	12,567	13,465	14,363	15,260
Head (ft)	156	136	112	97	85	58												

Byron Jackson 16RL, 1 Stage, 1170 RPM, 100 HP

Q (cfs)	0	2	4	6	8	58	12	14	16	18	20	22	24	26	28	30	32	34
Q (gpm)	0	898	1,795	2,693	3,591	26,032	5,386	6,284	7,181	8,079	8,977	9,874	10,772	11,670	12,567	13,465	14,363	15,260
Head (ft)	156	136	112	97	85	58												

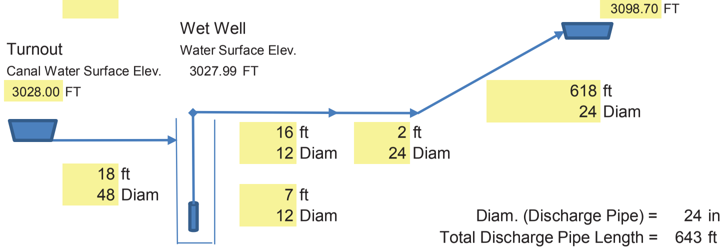
(2) 16 RL

Q (cfs)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
Q (gpm)	0	898	1,795	2,693	3,591	4,488	5,386	6,284	7,181	8,079	8,977	9,874	10,772	11,670	12,567	13,465	14,363	15,260
Head (ft)	156	146	136	124	112	105	97	92	85	73	58							

NOTE: Pump No. 3 added at a later date. Pump No. 3 curve information was not available. Pump No. 3 curve not shown.

Pump to Canal Head Loss Calculations
Grimes Flat Pumping Plant Reconstruction

3,800 GPM	Vertical Turbine Pump No. 1	
3,800 GPM	Vertical Turbine Pump No. 2	
2,250 GPM	Vertical Turbine Pump No. 3	Static Head = 70.71 FT
9,850 GPM	Total = 21.9 cfs	



Diam. (Discharge Pipe) = 24 in
Total Discharge Pipe Length = 643 ft
Equiv. Pipe Length Valves & Fittings Pump Discharge = 203 ft
Equiv. Pipe Length Valves & Fittings Discharge Header = 45 ft

2.5 x 8 trash rack entrance	Friction Head =	0.28 FT per 1,000 FT	Concrete
	Dynamic Head =	0.01 FT total	C = 110
12" Column Pipe	Friction Head =	28.26 FT per 1,000 FT	Steel
(Vel. = 10.8 fps)	Dynamic Head =	0.20 FT total	C = 135
12" Discharge Piping	Friction Head =	28.26 FT per 1,000 FT	Steel
(Vel. = 10.8 fps)	Dynamic Head =	0.45 FT total	C = 135
24" Header	Friction Head =	5.65 FT per 1,000 FT	Steel
(Vel. = 7.0 fps)	Dynamic Head =	0.01 FT total	C = 135
24" Discharge	Friction Head =	8.25 FT per 1,000 FT	Concrete
(Vel. = 7.0 fps)	Dynamic Head =	5.09 FT total	C = 110
Equivalent Pipe Length	Friction Head =	28.26 FT per 1,000 FT	Steel
Valves & Fittings Pump Discharge	Dynamic Head =	5.74 FT total	C = 135
Equivalent Pipe Length	Friction Head =	5.65 FT per 1,000 FT	Steel
Valves & Fittings Discharge Header	Dynamic Head =	0.25 FT total	C = 135
	Friction Head =	11.75 FT =	5.08 psi
	Water Depth in Discharge Canal =	1.69 FT =	0.73 psi
	Total Dynamic Head =	84.15 FT =	36.43 psi

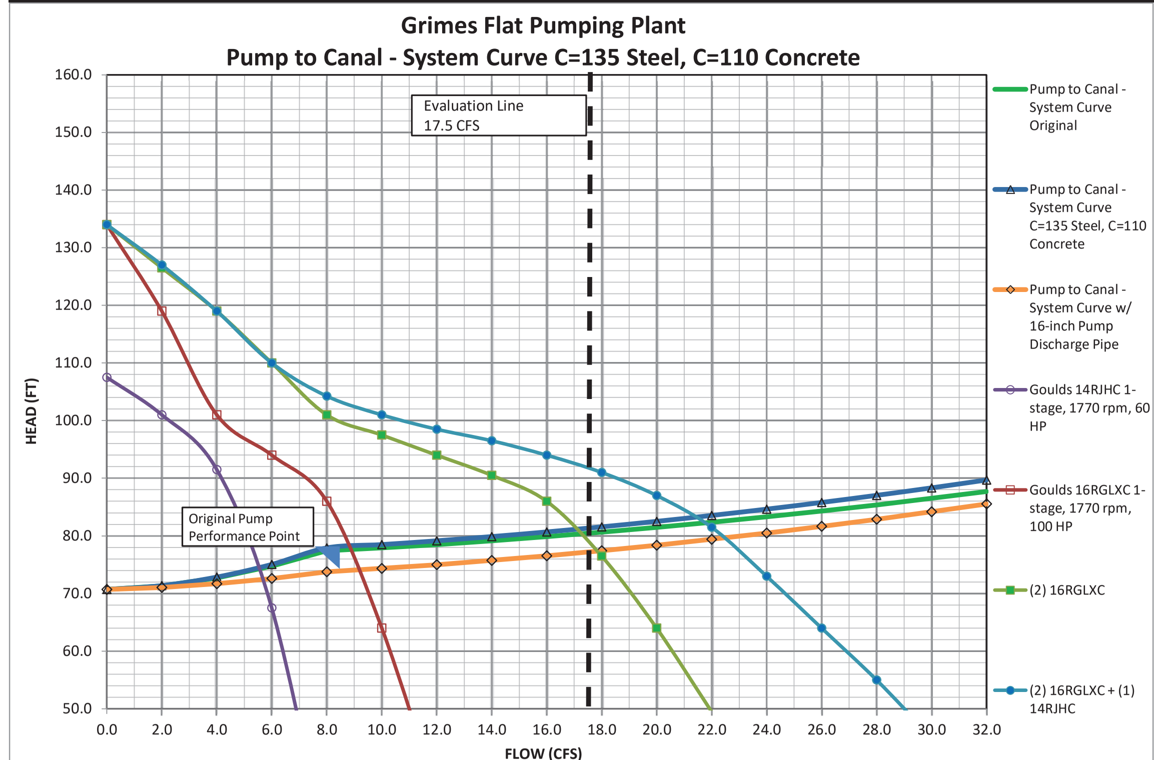
Equivalent Pipe Length Totals:

Item	12" Equiv. Length	No. of Units	Total Equiv. Length
12" pump discharge head	80 ft	1 ea	80 ft
12" check valve	120 ft	1 ea	120 ft
12" pump control (gate) valve	3 ft	1 ea	3 ft
		Subtotal	203 ft

Item	24" Equiv. Length	No. of Units	Total Equiv. Length
12"x12"x24" tee branch flow	30 ft	1 ea	30 ft
12"x24" expander	5 ft	1 ea	5 ft
24"x24" square opening	5 ft	2 ea	10 ft
		Subtotal	45 ft

Grimes Pumping Plant
Pump to Canal - System Curve C=135 Steel, C=110 Concrete

Q (gpm)	0	897	1,798	2,695	3,591	4,488	5,384	6,281	7,177	8,074	8,970	9,867	10,763	11,660	12,556	13,453	14,349	15,246
Q (cfs)	0.0	2.0	4.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0	22.0	24.0	26.0	28.0	30.0	32.0	34.0
Hf	0.0	0.7	2.1	4.3	7.2	7.8	8.4	9.2	10.0	10.8	11.8	12.8	13.9	15.1	16.3	17.6	19.0	20.4
TDH (ft)	70.7	71.4	72.8	75.0	77.9	78.5	79.1	79.9	80.7	81.6	82.5	83.5	84.6	85.8	87.0	88.3	89.7	91.1
Vel. Disch. (fps)	0.0	0.6	1.3	1.9	2.5	3.2	3.8	4.5	5.1	5.7	6.4	7.0	7.6	8.3	8.9	9.5	10.2	10.8



Goulds 14RJHC 1-stage, 1770 rpm, 60 HP

Q (cfs)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
Q (gpm)	0	898	1,795	2,693	3,591	4,488	5,386	6,284	7,181	8,079	8,977	9,874	10,772	11,670	12,567	13,465	14,363	15,260
Head (ft)	108	101	92	68	25													

Goulds 16RGLXC 1-stage, 1770 rpm, 100 HP

Q (cfs)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
Q (gpm)	0	898	1,795	2,693	3,591	4,488	5,386	6,284	7,181	8,079	8,977	9,874	10,772	11,670	12,567	13,465	14,363	15,260
Head (ft)	134	119	101	94	86	64	35											

(2) 16RGLXC

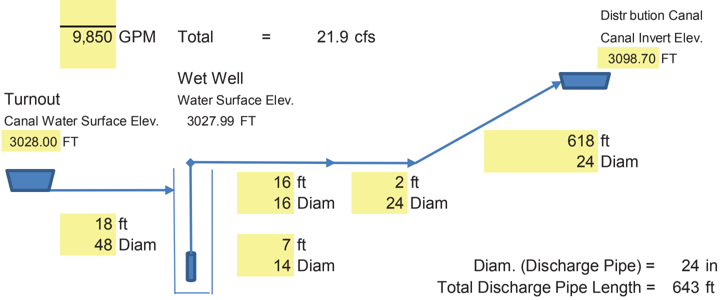
Q (cfs)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
Q (gpm)	0	898	1,795	2,693	3,591	4,488	5,386	6,284	7,181	8,079	8,977	9,874	10,772	11,670	12,567	13,465	14,363	15,260
Head (ft)	134	127	119	110	101	98	94	91	86	77	64	50	35					

(2) 16RGLXC + (1) 14RJHC

Q (cfs)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
Q (gpm)	0	898	1,795	2,693	3,591	4,488	5,386	6,284	7,181	8,079	8,977	9,874	10,772	11,670	12,567	13,465	14,363	15,260
Head (ft)	134	127	119	110	104	101	99	97	94	91	87	82	73	64	55	45	35	

Pump to Canal Head Loss Calculations
Grimes Flat Pumping Plant Reconstruction

3,800 GPM	Vertical Turbine Pump No. 1	
3,800 GPM	Vertical Turbine Pump No. 2	
2,250 GPM	Vertical Turbine Pump No. 3	Static Head = 70.71 FT
9,850 GPM	Total = 21.9 cfs	



Diam. (Discharge Pipe) =	24 in
Total Discharge Pipe Length =	643 ft
Equiv. Pipe Length Valves & Fittings Pump Discharge =	228 ft
Equiv. Pipe Length Valves & Fittings Discharge Header =	45 ft

2.5 x 8 trash rack entrance	Friction Head =	0.28 FT per 1,000 FT	Concrete
	Dynamic Head =	0.01 FT total	C = 110
14" Column Pipe	Friction Head =	13.35 FT per 1,000 FT	Steel
(Vel. = 7.9 fps)	Dynamic Head =	0.09 FT total	C = 135
16" Discharge Piping	Friction Head =	6.97 FT per 1,000 FT	Steel
(Vel. = 6.1 fps)	Dynamic Head =	0.11 FT total	C = 135
24" Header	Friction Head =	5.65 FT per 1,000 FT	Steel
(Vel. = 7.0 fps)	Dynamic Head =	0.01 FT total	C = 135
24" Discharge	Friction Head =	8.25 FT per 1,000 FT	Concrete
(Vel. = 7.0 fps)	Dynamic Head =	5.09 FT total	C = 110
Equivalent Pipe Length Valves & Fittings Pump Discharge	Friction Head =	6.97 FT per 1,000 FT	Steel
	Dynamic Head =	1.59 FT total	C = 135
Equivalent Pipe Length Valves & Fittings Discharge Header	Friction Head =	5.65 FT per 1,000 FT	Steel
	Dynamic Head =	0.25 FT total	C = 135
	Friction Head =	7.15 FT =	3.10 psi
	Water Depth in Discharge Canal =	1.69 FT =	0.73 psi
	Total Dynamic Head =	79.55 FT =	34.44 psi

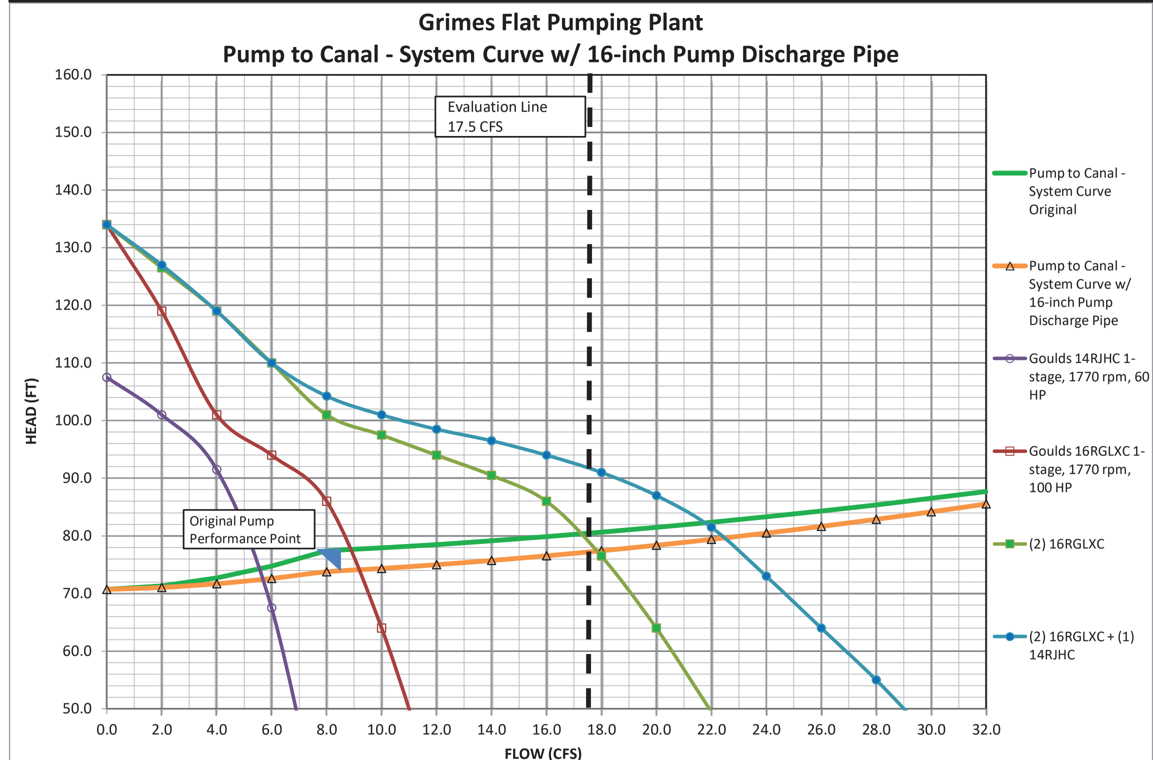
Equivalent Pipe Length Totals:

Item	16" Equiv. Length	No. of Units	Total Equiv. Length
16" pump discharge head	95 ft	1 ea	95 ft
16" check valve	130 ft	1 ea	130 ft
16" pump control (gate) valve	3 ft	1 ea	3 ft
		Subtotal	228 ft

Item	24" Equiv. Length	No. of Units	Total Equiv. Length
16"x16"x24" tee branch flow	30 ft	1 ea	30 ft
16"x24" expander	5 ft	1 ea	5 ft
16"x24" square opening	5 ft	2 ea	10 ft
		Subtotal	45 ft

Grimes Pumping Plant
Pump to Canal - System Curve w/ 16-inch Pump Discharge Pipe

Q (gpm)	0	897	1,798	2,695	3,591	4,488	5,384	6,281	7,177	8,074	8,970	9,867	10,763	11,660	12,556	13,453	14,349	15,246
Q (cfs)	0.0	2.0	4.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0	22.0	24.0	26.0	28.0	30.0	32.0	34.0
Hf	0.0	0.3	1.0	1.9	3.1	3.6	4.3	5.0	5.8	6.7	7.7	8.7	9.8	10.9	12.2	13.5	14.8	16.3
TDH (ft)	70.7	71.0	71.7	72.6	73.8	74.3	75.0	75.7	76.5	77.4	78.4	79.4	80.5	81.7	82.9	84.2	85.5	87.0
Vel. Disch. (fps)	0.0	0.6	1.3	1.9	2.5	3.2	3.8	4.5	5.1	5.7	6.4	7.0	7.6	8.3	8.9	9.5	10.2	10.8



Goulds 14RJHC 1-stage, 1770 rpm, 60 HP

Q (cfs)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
Q (gpm)	0	898	1,795	2,693	3,591	4,488	5,386	6,284	7,181	8,079	8,977	9,874	10,772	11,670	12,567	13,465	14,363	15,260
Head (ft)	108	101	92	68	25													

Goulds 16RGLXC 1-stage, 1770 rpm, 100 HP

Q (cfs)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
Q (gpm)	0	898	1,795	2,693	3,591	4,488	5,386	6,284	7,181	8,079	8,977	9,874	10,772	11,670	12,567	13,465	14,363	15,260
Head (ft)	134	119	101	94	86	64	35											

(2) 16RGLXC

Q (cfs)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
Q (gpm)	0	898	1,795	2,693	3,591	4,488	5,386	6,284	7,181	8,079	8,977	9,874	10,772	11,670	12,567	13,465	14,363	15,260
Head (ft)	134	127	119	110	101	98	94	91	86	77	64	50	35					

(2) 16RGLXC + (1) 14RJHC

Q (cfs)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
Q (gpm)	0	898	1,795	2,693	3,591	4,488	5,386	6,284	7,181	8,079	8,977	9,874	10,772	11,670	12,567	13,465	14,363	15,260
Head (ft)	134	127	119	110	104	101	99	97	94	91	87	82	73	64	55	45	35	

VFD Analysis

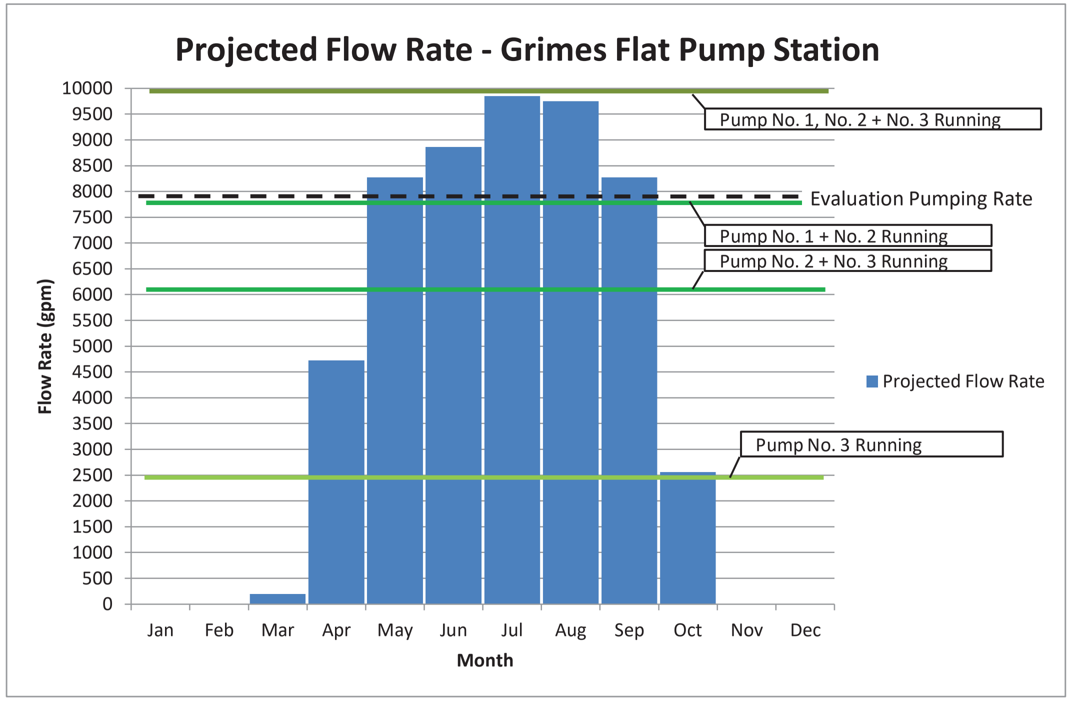
Pump to Canal Head Loss Calculations
Grimes Flat Pumping Plant Reconstruction

3,800	GPM	Vertical Turbine Pump No. 1		
3,800	GPM	Vertical Turbine Pump No. 2		
2,250	GPM	Vertical Turbine Pump No. 3		
9,850	GPM	Total	=	21.9 cfs

Proposed PS Design Flow Rate = 9,850 gpm

Month	% of Max Flow Rate	Projected Flow Rate
Jan	0%	0
Feb	0%	0
Mar	2%	197
Apr	48%	4728
May	84%	8274
Jun	90%	8865
Jul	100%	9850
Aug	99%	9751.5
Sep	84%	8274
Oct	26%	2561
Nov	0%	0
Dec	0%	0

Evaluation Pumping Rate = 7,872 gpm
17.5 cfs



Notes: Grimes PS is currently fitted with (3) Turbine Pumps and proposed improvements include replacing all (3) pumps with new equipment. VFD operation would not necessarily provide significant energy reduction toward optimizing water delivery to crop requirement. Effort should be made to size replacement pumps to match seasonal demand requirements; (1) at 50% max flow, and (1) at 35% max flow, and (1) at 15% max flow. VFD operation of one pump unit may be considered as an alternate approach.

Ochoco Irrigation District
Grimes Flat PS (Retrofit of pump equipment at existing pump station)
Budget Level - Projection of Probable Construction Cost

Item No.	Spec Division	Description	Measurement	Units	Unit Cost	Total Cost
1	1000	Mobilization	LS	1	$9,650.00	$9,650.00
2	1000	Project Management and Coordination	LS	1	$1,200.00	$1,200.00
3	1000	Construction Progress Documentation	LS	1	$1,200.00	$1,200.00
4	1000	Submittal Procedures	LS	1	$1,200.00	$1,200.00
5	1000	Quality Requirements	LS	1	$2,500.00	$2,500.00
6	1000	Selective Demolition	LS	1	$6,000.00	$6,000.00
7	1000	Project Record Documents	LS	1	$1,200.00	$1,200.00
8	1000	Operations and Maintenance Data	LS	1	$2,500.00	$2,500.00
9	1000	General Commissioning Requirements	LS	1	$5,000.00	$5,000.00
10	2000	Surfacing Rock	CY	10	$38.00	$380.00
11	3000	Misc Cast-in-Place Concrete (thrust and pads)	LS	1	$5,000.00	$5,000.00
12	9000	High Performance Coating Systems	LS	1	$1,500.00	$1,500.00
13	11000	Line Shaft Turbine Pump and Motor, 100 HP	EA	2	$39,600.00	$79,200.00
14	11000	Line Shaft Turbine Pump and Motor, 60 HP	EA	1	$30,850.00	$30,850.00
15	15000	16-inch Handwheel Operated Butterfly Valve	EA	2	$2,875.00	$5,750.00
16	15000	16-inch Surge Control Check Valve	EA	2	$9,875.00	$19,750.00
17	15000	16-inch Discharge Pipe, Fittings, & Accessories	EA	2	$4,500.00	$9,000.00
18	15000	12-inch Handwheel Operated Butterfly Valve	EA	1	$2,250.00	$2,250.00
19	15000	12-inch Surge Control Check Valve	EA	1	$5,250.00	$5,250.00
20	15000	12-inch Discharge Pipe, Fittings, & Accessories	EA	1	$3,500.00	$3,500.00
21	16000	Power and Distribution	LS	1	$0.00	$0.00
22	16000	Grounding Systems	LS	1	$0.00	$0.00
23	16000	Motor Controls	LS	1	$0.00	$0.00
24	17000	Instrumentation and Control	LS	1	$0.00	$0.00
		Construction Subtotal				$192,880.00
		Contractors Overhead and Profit	10%	1	$19,288.00	$19,288.00
		Contractors Bonds and Insurance	2%	1	$4,243.36	$4,243.36
		Construction Contingency	30%	1	$57,864.00	$57,864.00
		Construction Total				$274,275.36
		Engineering, Administration	25%	1	$68,568.84	
		Total				**$342,844.20**

Wire to Water Energy Calculator
Ochoco Irrigation District - SOR
Grimes Flat Pumping Plant - Pump Replacement

Source: PumpTech Inc.
2425 SE Ochoco Street
Portland, OR 97222
503-659-6230

OPERATIONAL AND EQUIPMENT DATA

	Replacement Pumps		Existing Pumps
	No. 1 - Goulds 16RGLXC, 1 Stage, 1770 RPM, 100 HP		No. 1 - Byron Jackson 1770 RPM, 100 HP
	No. 2 - Goulds 16RGLXC, 1 Stage, 1770 RPM, 100 HP		No. 2 - Byron Jackson, 1770 RPM, 100 HP
	No. 3 - Goulds 16RJHC, 1 Stage, 1770 RPM, 60 HP		No. 3 - ?, 1770 RPM, 75 HP *
Pump Operation - Hours / Day	24		24
Pump Operation - Days / Year	198		198
Pump Flow - GPM (Evaluation Pump Rate)	7,872		7,872
Pump Flow - CFS	17.5		17.5
Total Annual Volume - Acre feet	6,890		6,890
Pump Head - Feet	77.4	*	82.0
Ave. Pump Efficiency - %	85.5%		64.0%
Ave. Motor Efficiency - %	93.0%		91.0%
Energy Cost in $/kW-hr	$0.035		$0.035
	* Estimated pumping head assumes pump column pipe, discharge piping, and valves are changed from 12-inch to 16-inch		* Pump Make and model information not available at the time of evaluation

RESULTS

	Replacement Pumps	Existing Pumps
BHP At Design Point	180.0	254.7
Wire to Water Efficiency - %	80%	58%
kW-hr per Year	685,957	992,196
Annual Energy Cost	$24,008.50	$34,726.87
kW-hr Per 1,000 Gallons Pumped	0.306	0.442
Cost Per 1,000 Gallons Pumped	$0.011	$0.015
kW-hr per Acre Foot Pumped	100	144
Cost Per Acre Foot Pumped	$3.49	$5.04

PAYBACK

Annual Savings - kW-hr	306,239	
Annual Savings - $$	$10,718.37	
Annual Savings - %	30.86%	
Cost of Replacement Pumps	$343,000.00	*
Cost of Existing Pumps	$0.00	
Payback - Years	32.0	

* Estimated cost of replacement pumps assumes new pumps, pump column pipe, discharge piping, and valves are changed from 12-inch to 16-inch.

Pump Test Data

Initial Pump Evaluation

Project No.: OCHID-03-10 **Description:**

Pump Station No.: Grimes **Pump No.:** 1 **Water Source:** Canal **Parallel**

Motor Nameplate

Motor Make: General Electric
Model No: 5K6277XH364
Serial No:
Rated Hp: 100
Rated Voltage: 440
Rated Amperage: **Ins. Class:** None
Full Load RPM: 0 **Code:** None
Enclosure: None
Design: None
Frame: B444TP20
Service Factor: 1.15

Utility Meter Nameplate

Make: None **Meter ID:** None
Type: None **Serial No.:** None
k_h: None **PTR:** None **CTR:** None

Pump Nameplate

Pump Make: Byron Jackson
Type: Vertical Turbine
Serial No:
Model No: None **Impeller No:**
Impeller Dia (in): **No. of Stages:** 0
Impeller Dia (in): **No. of Stages:** 0
Secondary Model No: None **Impeller No:**
Impeller Dia (in): **No. of Stages:** 0
Impeller Dia (in): **No. of Stages:** 0
Rated Flow (gpm): 0
Rated Head (ft): 0
Rated RPM: 0
Column Dia (in): 0.00
Column Length (ft): 0.0
Shaft Dia (in): 0.000
Tube Dia (in): 0.000
Thrust Factor (lbs/ft): 0.0
Impeller Wt. (lbs): 0.0

Field Pump Test Data

Test No.	Date	Flow: Measurement Device	Flow (gpm)	Lift: Air Line (PSI)	Lift: Static Level (ft)	Lift: Pumping Lift (ft)	Pressures: Discharge (PSI)	Pressures: Delivered (PSI)	Misc. Losses (ft)	TDH (ft)	Pump RPM
1	10/13/2010	Transit Time	2,176			3.7	30.1	30.1	0.5	73.8	1788

Test No.	Voltages 1-2	1-3	2-3	Avg.	Amperages 1	2	3	Avg.	Power Factor 1	2	3	Avg.	Utility Meter Rev.	Sec.	Motor RPM	% Load
1	494.0	489.0	491.0	491.3	82.0	73.0	79.0	78.0				79.8%				64.6%

Test No.	Power Calculations: Shaft HP	Thrust HP	Water HP	Brake HP	Pump HP	Input kW	Input HP	Utility Meter (kW)	Efficiencies: Motor	Pump	Discharge	Delivered
1	0.00	0.00	40.6	64.6	64.6	53.0	71.0		91.0%	62.3%	56.7%	56.7%

Note: If a main valve is present, the Delivered Pressure is the pressure after the valve. If no main valve is present, the Delivered Pressure will be the same as the Discharge Pressure.

Pump Test Data

Initial Pump Evaluation

Project No.: OCHID-03-10 **Description:**

Pump Station No.: Grimes **Pump No.:** 2 **Water Source:** Canal **Parallel**

Motor Nameplate

Motor Make: General Electric
Model No:
Serial No:
Rated Hp: 100
Rated Voltage: None
Rated Amperage: **Ins. Class:** None
Full Load RPM: 1770 **Code:** None
Enclosure: None
Design: None
Frame:
Service Factor: 1.15

Utility Meter Nameplate

Make: None **Meter ID:** None
Type: None **Serial No.:** None
k_h: None **PTR:** None **CTR:** None

Pump Nameplate

Pump Make: Byron Jackson
Type: Vertical Turbine
Serial No:
Model No: None **Impeller No:**
Impeller Dia (in): **No. of Stages:** 0
Impeller Dia (in): **No. of Stages:** 0
Secondary Model No: None **Impeller No:**
Impeller Dia (in): **No. of Stages:** 0
Impeller Dia (in): **No. of Stages:** 0
Rated Flow (gpm): 0
Rated Head (ft): 0
Rated RPM: 0
Column Dia (in): 0.00
Column Length (ft): 0.0
Shaft Dia (in): 0.000
Tube Dia (in): 0.000
Thrust Factor (lbs/ft): 0.0
Impeller Wt. (lbs): 0.0

Field Pump Test Data

Test No.	Date	Flow Measurement Device	Flow (gpm)	Lift Air Line (PSI)	Lift Static Level (ft)	Lift Pumping Lift (ft)	Pressures Discharge (PSI)	Pressures Delivered (PSI)	Misc. Losses (ft)	TDH (ft)	Pump RPM
1	10/13/2010	Transit Time	3,928			3.7	30.5	30.5	1.7	75.9	1785

Test No.	Voltages 1-2	Voltages 1-3	Voltages 2-3	Voltages Avg.	Amperages 1	Amperages 2	Amperages 3	Amperages Avg.	Power Factor 1	Power Factor 2	Power Factor 3	Power Factor Avg.	Utility Meter Rev.	Utility Meter Sec.	Motor RPM	Motor % Load
1	489.0	493.0	495.0	492.3	112.7	119.0	113.0	114.9				85.7%				102.3%

Test No.	Power Calculations Shaft HP	Thrust HP	Water HP	Brake HP	Pump HP	Input kW	Input HP	Utility Meter (kW)	Efficiencies Motor	Pump	Discharge	Delivered
1	0.00	0.00	75.3	102.4	102.4	84.0	112.6		90.9%	71.9%	65.3%	65.3%

Note: If a main valve is present, the Delivered Pressure is the pressure after the valve. If no main valve is present, the Delivered Pressure will be the same as the Discharge Pressure.

Pump Test Data

Initial Pump Evaluation

Project No.: OCHID-03-10 **Description:**

Pump Station No.: Grimes **Pump No.:** 3 **Water Source:** Canal **Parallel**

Motor Nameplate

Motor Make:	General Electric		
Model No:	5K6258XH1A		
Serial No:			
Rated Hp:	75		
Rated Voltage:	230/460		
Rated Amperage:	180/90	**Ins. Class:**	None
Full Load RPM:	1775	**Code:**	None
Enclosure:	None		
Design:	None		
Frame:			
Service Factor:	1.15		

Pump Nameplate

Pump Make:	None		
Type:	Vertical Turbine		
Serial No:			
Model No:	None	**Impeller No:**	
Impeller Dia (in):		**No. of Stages:**	0
Impeller Dia (in):		**No. of Stages:**	0
Secondary Model No:	None	**Impeller No:**	
Impeller Dia (in):		**No. of Stages:**	0
Impeller Dia (in):		**No. of Stages:**	0
Rated Flow (gpm):	0		
Rated Head (ft):	0		
Rated RPM:	0		
Column Dia (in):	0.00		
Column Length (ft):	0.0		
Shaft Dia (in):	0.000		
Tube Dia (in):	0.000		
Thrust Factor (lbs/ft):	0.0		
Impeller Wt. (lbs):	0.0		

Utility Meter Nameplate

Make: None **Meter ID:** None

Type: None **Serial No.:** None

k_h: None **PTR:** None **CTR:** None

Field Pump Test Data

Test No.	Date	Flow: Measurement Device	Flow (gpm)	Lift: Air Line (PSI)	Lift: Static Level (ft)	Lift: Pumping Lift (ft)	Pressures: Discharge (PSI)	Pressures: Delivered (PSI)	Misc. Losses (ft)	TDH (ft)	Pump RPM
1	10/13/2010	Weir	850			3.7	30.0	30.0	0.4	73.4	1788

Test No.	Voltages 1-2	1-3	2-3	Avg.	Amperages 1	2	3	Avg.	Power Factor 1	2	3	Avg.	Utility Meter Rev.	Sec.	Motor RPM	% Load
1	490.0	495.0	500.0	495.0	71.0	59.3	60.4	63.6				73.5%				64.9%

Test No.	Power Calculations: Shaft HP	Thrust HP	Water HP	Brake HP	Pump HP	Input kW	Input HP	Utility Meter (kW)	Efficiencies: Motor	Pump	Discharge	Delivered
1	0.00	0.00	15.8	48.7	48.7	40.1	53.7		90.6%	32.4%	29.3%	29.3%

Note: If a main valve is present, the Delivered Pressure is the pressure after the valve. If no main valve is present, the Delivered Pressure will be the same as the Discharge Pressure.

Pump Test Summary Data

Project No.: OCHID-03-10

Pump Station	Pump No.	Condition	Test No.	Include	Rated Hp	Flow (gpm)	Lift (ft)	Discharge (PSI)	Delivery (PSI)	TDH (FT)	Electric Hp	Pump Eff.	Overall Eff.
Grimes	1	Existing	1		100	2,176	3.7	30.1	30.1	73.8	71.0	62.3%	56.7%
Grimes	2	Existing	1		100	3,928	3.7	30.5	30.5	75.9	112.6	71.9%	65.3%
Grimes	3	Existing	1		75	850	3.7	30.0	30.0	73.4	53.7	32.4%	29.3%

Pump Performance Datasheet

Customer	: Ochoco Irrigation District	Quote number	:
Customer reference	: OID - SOR Grimes Flat Pump Sta	Item description	: 16RGLXC
Item number	: Pump No. 1 & 2 Replacement	Stages	: 1
Service	: Irrigation Water	Based on curve number	: 16RGLXC-1770
Quantity	: 1	Date last saved	: 27 Jun 2011 4:02 PM

Operating Conditions

Flow, rated	: 3,800.0 USgpm
Differential head / pressure, rated (requested)	: 79.55 ft
Differential head / pressure, rated (actual)	: 80.11 ft
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: 37.45 ft
Frequency	: 60 Hz

Performance

Speed, rated	: 1,770 rpm
Impeller diameter, rated	: 9.75 in
Impeller diameter, maximum	: 10.22 in
Impeller diameter, minimum	: 8.93 in
Efficiency (bowl / pump)	: 86.10 / - %
NPSH required / margin required	: 22.01 / 5.00 ft
Ns (imp. eye flow) / Nss (imp. eye flow)	: 4,259 / 11,140 US Units
MCSF	: 2,700.0 USgpm
Head, maximum, rated diameter	: 131.7 ft
Head rise to shutoff	: 65.57 %
Flow, best eff. point (BEP)	: 4,035.2 USgpm
Flow ratio (rated / BEP)	: 94.17 %
Diameter ratio (rated / max)	: 95.40 %
Head ratio (rated dia / max dia)	: 92.01 %
Cq/Ch/Ce [ANSI/HI 9.6.7-2004]	: 1.00 / 1.00 / 1.00
Selection status	: Acceptable

Liquid

Liquid type	: Water
Additional liquid description	:
Solids diameter, max	: 1.12 in
Solids concentration, by volume	: 0.00 %
Temperature, max	: 68.00 deg F
Fluid density, rated / max	: 1.000 / 1.000 SG
Viscosity, rated	: 1.00 cP
Vapor pressure, rated	: 0.00 psi.a

Material

Material selected	: CI Bowl (Lined) / Std. Brz Impeller

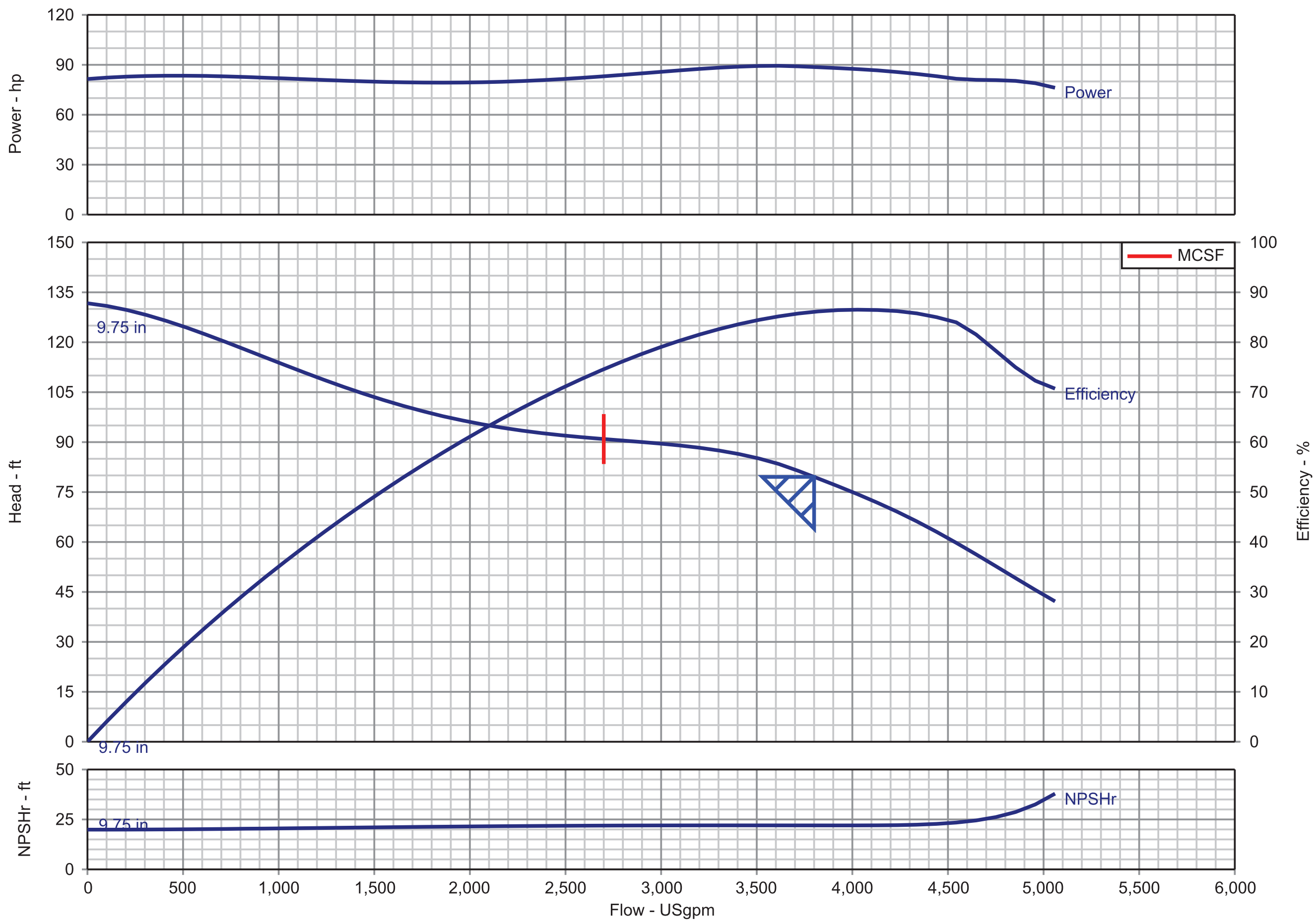
Pressure Data

Maximum working pressure	: 57.02 psi.g
Maximum allowable working pressure	: 320.0 psi.g
Maximum allowable suction pressure	: N/A
Hydrostatic test pressure	: N/A

Driver & Power Data

Driver sizing specification	: Maximum power
Margin over specification	: 0.00 %
Service factor	: 1.15
Power, hydraulic	: 76.34 hp
Power (bowl / pump)	: 88.66 / -
Power, maximum, rated diameter	: 89.42 hp
Minimum recommended motor rating	: 100 hp / 74.57 kW

Bowl performance. Adjusted for construction and viscosity.
The duty point represents the head at the bowl.



Pump Performance Datasheet

Customer	: Ochoco Irrigation District	Quote number	:
Customer reference	: OID - SOR Grimes Flat Pump Sta	Item description	: 14RJHC
Item number	: Pump No. 3 Replacement	Stages	: 1
Service	: Irrigation Water	Based on curve number	: 14RJHC-1770
Quantity	: 1	Date last saved	: 27 Jun 2011 4:06 PM

Operating Conditions

Flow, rated	: 2,250.0 USgpm
Differential head / pressure, rated (requested)	: 79.55 ft
Differential head / pressure, rated (actual)	: 79.73 ft
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: 37.45 ft
Frequency	: 60 Hz

Performance

Speed, rated	: 1,770 rpm
Impeller diameter, rated	: 9.50 in
Impeller diameter, maximum	: 9.82 in
Impeller diameter, minimum	: 7.75 in
Efficiency (bowl / pump)	: 84.92 / - %
NPSH required / margin required	: 32.01 / 5.00 ft
Ns (imp. eye flow) / Nss (imp. eye flow)	: 3,020 / 6,240 US Units
MCSF	: 1,200.0 USgpm
Head, maximum, rated diameter	: 105.1 ft
Head rise to shutoff	: 32.07 %
Flow, best eff. point (BEP)	: 2,257.2 USgpm
Flow ratio (rated / BEP)	: 99.68 %
Diameter ratio (rated / max)	: 96.74 %
Head ratio (rated dia / max dia)	: 93.26 %
Cq/Ch/Ce [ANSI/HI 9.6.7-2004]	: 1.00 / 1.00 / 1.00
Selection status	: Acceptable

Liquid

Liquid type	: Water
Additional liquid description	:
Solids diameter, max	: 1.12 in
Solids concentration, by volume	: 0.00 %
Temperature, max	: 68.00 deg F
Fluid density, rated / max	: 1.000 / 1.000 SG
Viscosity, rated	: 1.00 cP
Vapor pressure, rated	: 0.00 psi.a

Material

Material selected	: CI Bowl (Lined) / Std. Brz Impeller

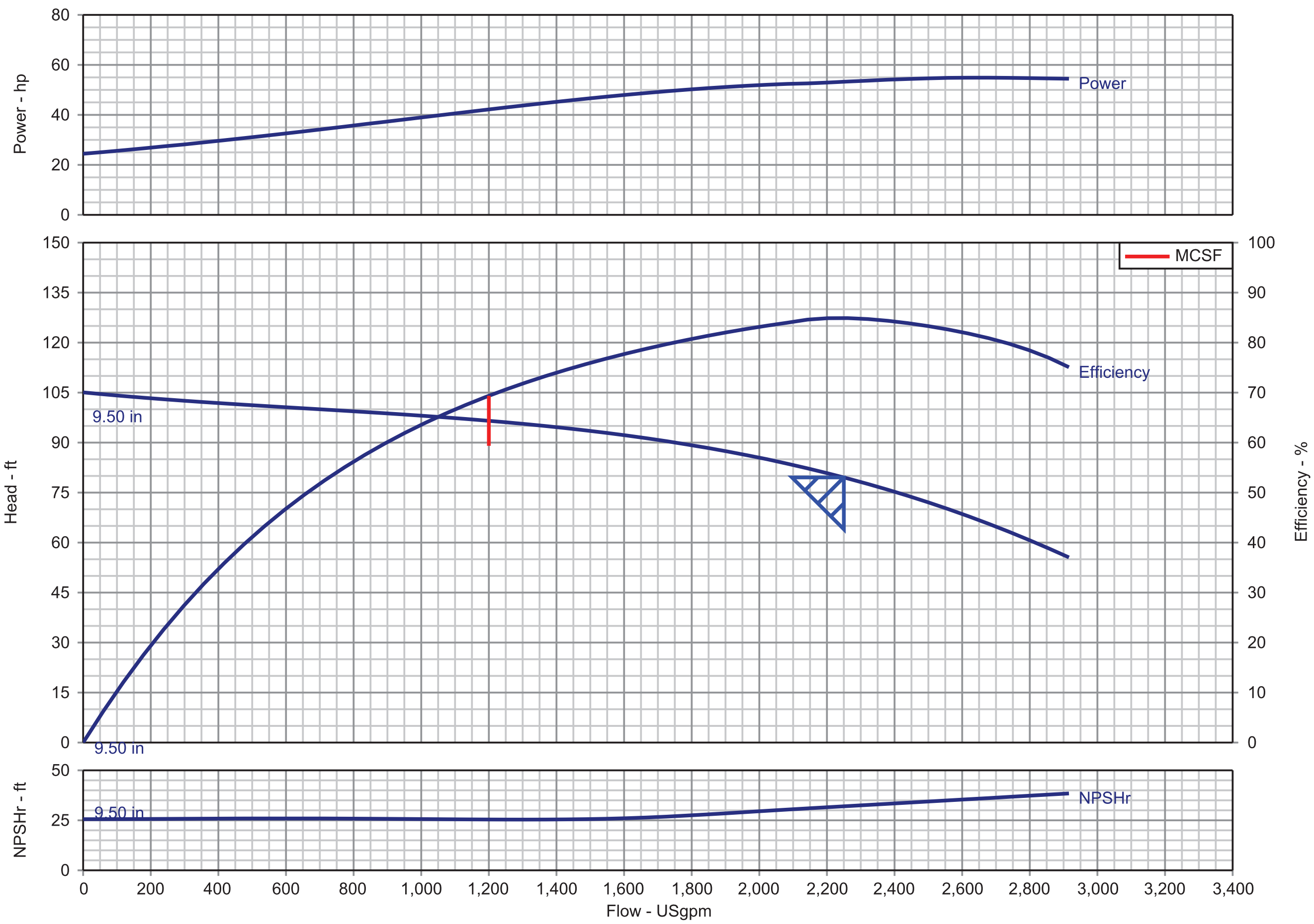
Pressure Data

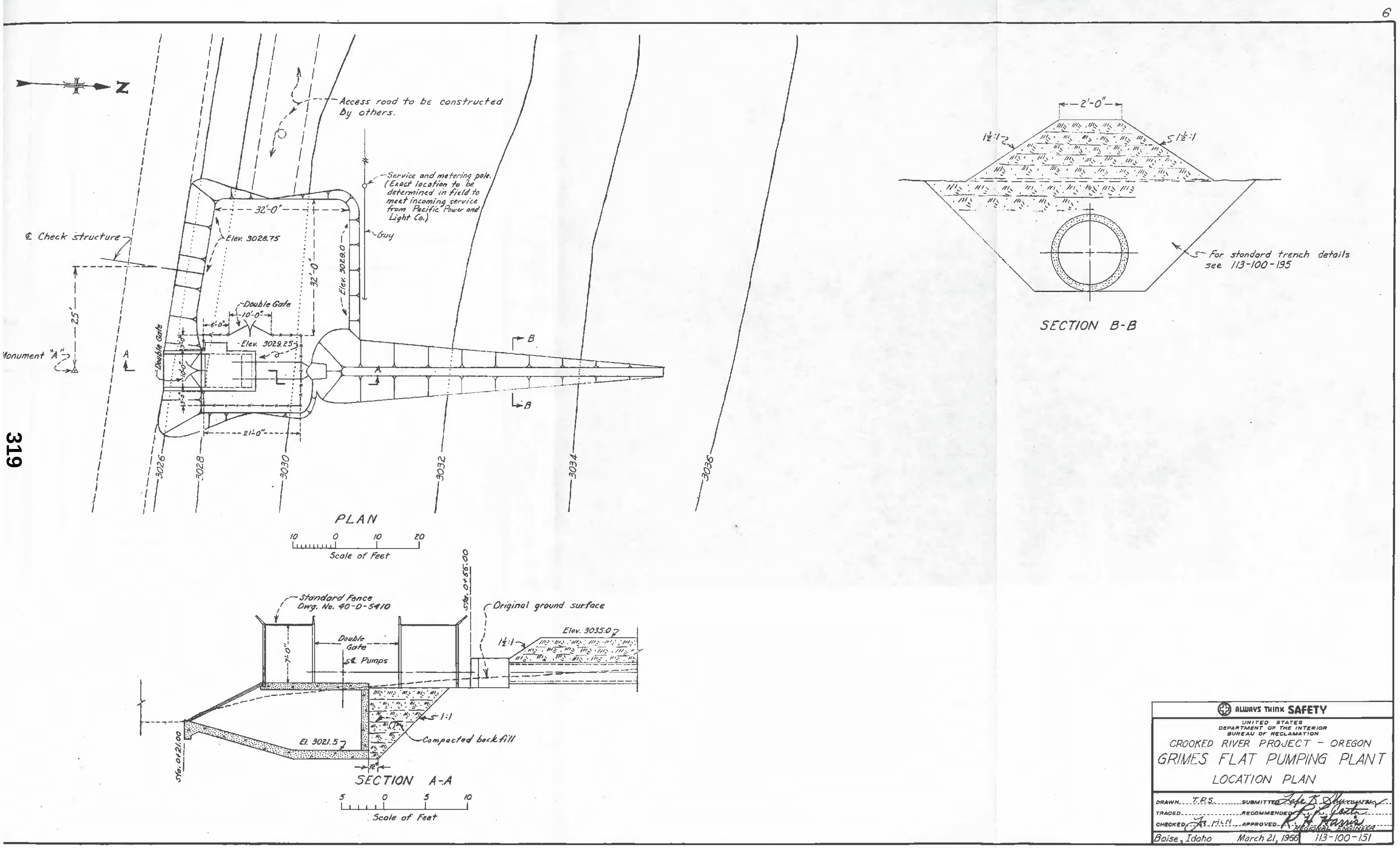
Maximum working pressure	: 45.48 psi.g
Maximum allowable working pressure	: 420.0 psi.g
Maximum allowable suction pressure	: N/A
Hydrostatic test pressure	: N/A

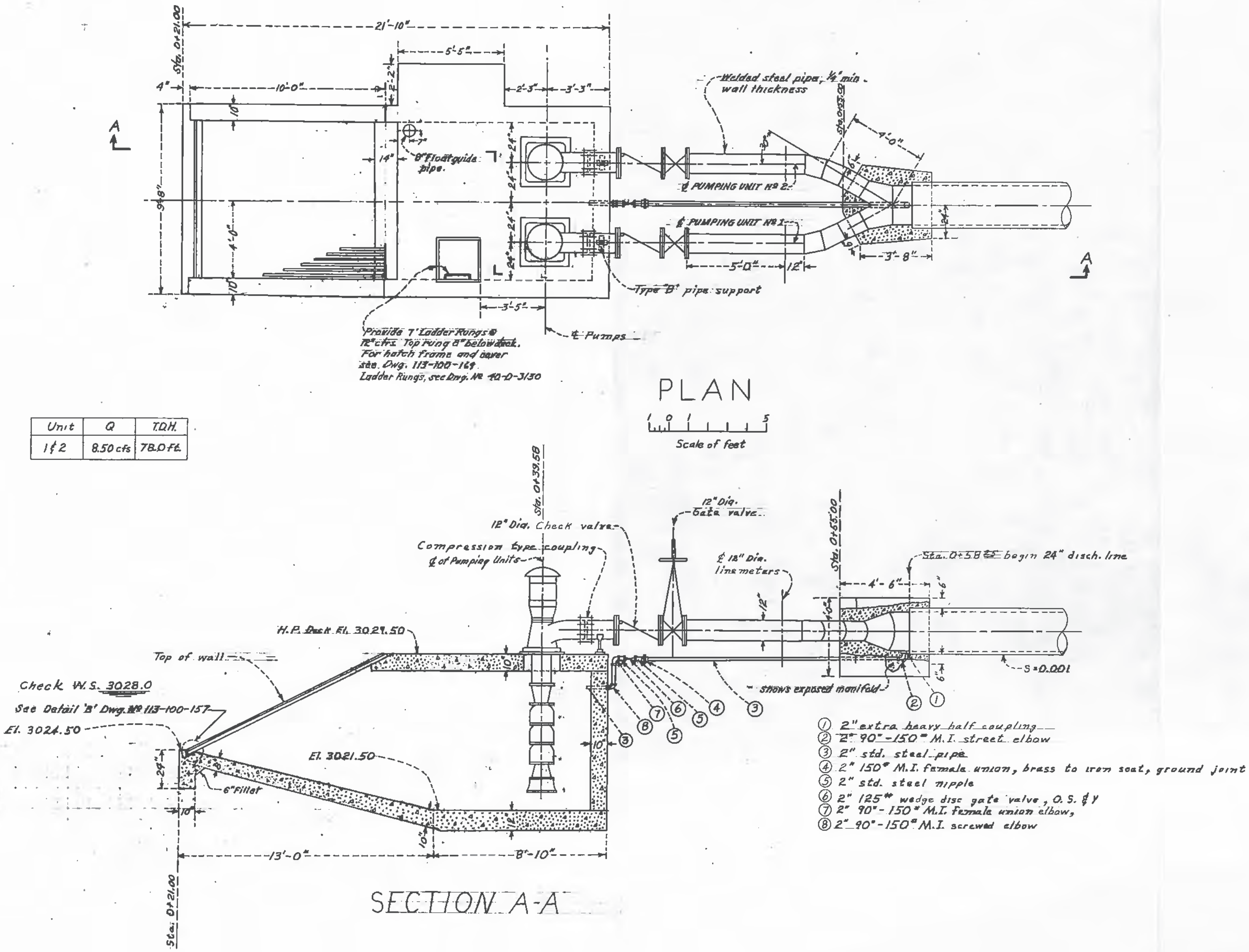
Driver & Power Data

Driver sizing specification	: Maximum power
Margin over specification	: 0.00 %
Service factor	: 1.15
Power, hydraulic	: 45.20 hp
Power (bowl / pump)	: 53.23 / -
Power, maximum, rated diameter	: 54.89 hp
Minimum recommended motor rating	: 60.00 hp / 44.74 kW

Bowl performance. Adjusted for construction and viscosity.
The duty point represents the head at the bowl.




6
Z
Access road to be constructed by others.
Service and metering pole. (Exact location to be determined in field to meet incoming service from Pacific Power and Light Co.)
Guy
℄ Check structure
Elev. 3028.75
32'-0"
32'-0"
Elev. 3029.0
Double Gate
10'-0"
6'-0"
Elev. 3029.25
Double Gate
21'-0"
25'
Monument "A"
3026
3028
3030
3032
3034
3036
PLAN
Scale of Feet
2'-0"
1½:1
1½:1
For standard trench details see 113-100-195
SECTION B-B
Standard Fence Dwg. No. 40-D-5410
Sta. 0+55.00
Original ground surface
Elev. 3035.0
Double Gate
℄ Pumps
7'-0"
1:1
Compacted backfill
El. 3021.5
Sta. 0+21.00
SECTION A-A
Scale of Feet
ALWAYS THINK SAFETY
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CROOKED RIVER PROJECT – OREGON
GRIMES FLAT PUMPING PLANT
LOCATION PLAN
DRAWN T.P.S. SUBMITTED
TRACED RECOMMENDED
CHECKED APPROVED
Boise, Idaho
March 21, 1966
113-100-151



ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

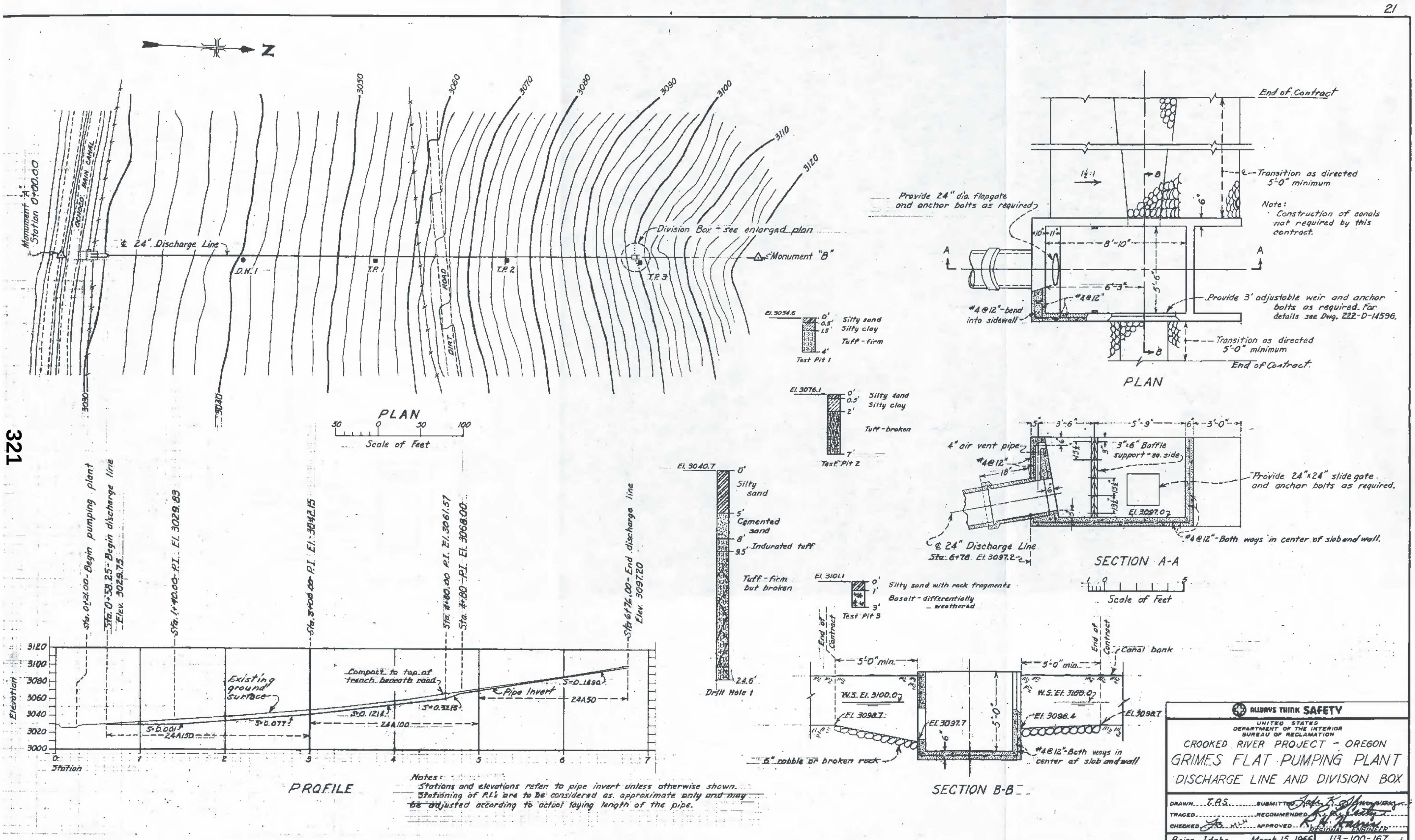
CROOKED RIVER PROJECT - OREGON

GRIMES FLAT PUMPING PLANT

GENERAL ARRANGEMENT AND OUTLINE

DRAWN M.S.A. SUBMITTED
TRACED RECOMMENDED
CHECKED MLH APPROVED

BOISE, IDAHO MAR. 16, 1966 113-100-158


21
Z
Monument "A" Station 0+00.00
OCHOCO MAIN CANAL
℄ 24" Discharge Line
D.H. 1
T.P. 1
T.P. 2
T.P. 3
ROAD
DIRT
Division Box - see enlarged plan
Monument "B"
3030
3040
3050
3060
3070
3080
3090
3100
3110
3120
PLAN
Scale of Feet
El. 3054.6
Silty sand
Silty clay
Tuff - firm
Test Pit 1
El. 3076.1
Silty sand
Silty clay
Tuff - broken
Test Pit 2
El. 3040.7
Silty sand
Cemented sand
Indurated tuff
Tuff - firm but broken
Drill Hole 1
El. 3101.1
Silty sand with rock fragments
Basalt - differentially weathered
Test Pit 3
Sta. 0+21.00 - Begin pumping plant
Sta. 0+58.25 - Begin discharge line
Elev. 3029.75
Sta. 1+40.00 - P.I. El. 3029.83
Sta. 3+08.00 - P.I. El. 3042.15
Sta. 4+80.00 P.I. El. 3061.57
Sta. 4+80 - P.I. El. 3068.00
Sta. 6+76.00 - End discharge line
Elev. 3097.20
Existing ground surface
Compact to top of trench beneath road
Pipe Invert
S=0.001
24A150
S=0.077
S=0.1214
24A100
S=0.3215
S=0.1490
24A50
Elevation
Station
PROFILE
Notes:
Stations and elevations refer to pipe invert unless otherwise shown.
Stationing of P.I.'s are to be considered as approximate only and may be adjusted according to actual laying length of the pipe.
End of Contract
Transition as directed 5'-0" minimum
Note: Construction of canals not required by this contract.
Provide 24" dia. flapgate and anchor bolts as required
Provide 3' adjustable weir and anchor bolts as required. For details see Dwg. 222-D-14596.
#4 @ 12" - bend into sidewall
Transition as directed 5'-0" minimum
End of Contract
PLAN
4" air vent pipe
3"x6" Baffle support - ea. side
Provide 24"x24" slide gate and anchor bolts as required.
El. 3097.0
#4 @ 12" - Both ways in center of slab and wall.
℄ 24" Discharge Line
Sta. 6+76 El. 3097.2
SECTION A-A
Scale of Feet
End of Contract
Canal bank
5'-0" min.
W.S. El. 3100.0
El. 3098.7
El. 3097.7
El. 3096.4
El. 3098.7
6" cobble or broken rock
#4 @ 12" - Both ways in center of slab and wall
SECTION B-B
ALWAYS THINK SAFETY
UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION
CROOKED RIVER PROJECT - OREGON
GRIMES FLAT PUMPING PLANT
DISCHARGE LINE AND DIVISION BOX
DRAWN T.R.S.
SUBMITTED
TRACED
RECOMMENDED
CHECKED
APPROVED
REGIONAL ENGINEER
Boise, Idaho
March 15, 1966
113-100-167

COMBS FLAT PUMPING PLANT - EVALUATION SUMMARY

OID infrastructure assets serving peripheral acreage were completed in the Crooked River Project Extension include six small pumping plants and associated canals, laterals, and drains. These features serve lands of six separate areas located generally east and north of the original Barnes Butte and Ochoco Relift project area. The Combs Flat pumping plant lifts water from the Crooked River Diversion Canal.[1]

Since its original construction circa 1966, Combs Flat Pumping Plant pumps No. 1 and No. 2 have been replaced with a 125 HP unit and a 100 HP unit, respectively.

Original Design

Pump Unit	Description	HP	Rated Capacity	Rated Head	Pump Eff. @ Rated Capacity	Pipe size	Discharge Pipe Vel.	Discharge Main Vel.
No. 1	Vertical Turbine	60 *	1,300 GPM*	140 FT *	78 % *	8 IN	8.3 FPS	
No. 2	Vertical Turbine	60 *	1,300 GPM*	140 FT *	78 % *	8 IN	8.3 FPS	
Total		120	2,600 GPM	140 FT		15 IN		4.7 FPS

* Data from *Earthwork, Pipelines and Structures for Six Pumping Plants, Crooked River Extension Crooked River Project, Oregon,* United States Department of the Interior Bureau of Reclamation Region 1, 1966, Para. 68, Page 90.

Current Condition

Pump Unit	Description	HP	Rated Capacity	Rated Head	Pump Eff. @ Rated Capacity	Pipe size	Discharge Pipe Vel.	Discharge Main Vel.
No. 1	Vertical Turbine	125	2,660 GPM *	154 FT *	84 % **	8 IN	17.0 FPS	
No. 2	Vertical Turbine	100	2,175 GPM *		86 % **	8 IN	13.9 FPS	
Total		225	4,835 GPM			15 IN		8.8 FPS

* Pump Nameplate data recorded at the pumping plant site 4-29-11.

** Data from pump curve and data on published product information sheets.

Alternate Equipment (Replace Existing Pump Discharge Piping and Valves)

Pump Unit	Description	HP	Rated Capacity	Rated Head	Pump Eff. @ Rated Capacity	Pipe size	Discharge Pipe Vel.	Discharge Main Vel.
No. 1	Vertical Turbine	125	2,660 GPM	147 FT	84 %	12 IN	7.5 FPS	
No. 2	Vertical Turbine	100	2,175 GPM	147 FT	86 %	12 IN	6.2 FPS	
Total		225	4,835 GPM	147 FT		15 IN		8.8 FPS

[1] US Department of the Interior, Bureau of Reclamation, Ochoco River Project, http://www.usbr.gov/projects/Project.jsp?proj_Name=Crooked River Project&pageType=ProjectPage

Narrative

The original Combs Flat pumps have subsequently been replaced with newer, larger units with published pump efficiencies greater than the original equipment. Because new pump equipment has increased output compared to original equipment, the pump discharge piping and valves appear to be undersized.

Evaluation of the Combs Flat Pumping Plant examines potential energy efficiency gained by replacing existing pump discharge piping and valves. Evaluation of potential energy savings assumes pump discharge piping and valves on both pump units are increased in size to reduce velocity and friction losses.

The initial cost projection for pumping plant improvements includes addition of a VFD drive on one pumping unit.

Evaluation of potential energy savings through the use of VFD's suggests that variable speed operation of one pump (smaller unit) would be beneficial to matching pump output to seasonal variations in demand.

The capacity of the rebuilt pump station is anticipated to be approximately 10.8 CFS at 147 feet TDH.

Wire to water energy analysis is based on the projected capacity of the Combs Flat Pumping Plant retrofitted with new pump discharge pipe and valves. The retrofitted pump station is projected to operate at a seasonal average flow of 3,864 gpm (8.6 CFS) at 144.3 feet TDH. The existing pump station in its current condition is projected to yield 8.6 CFS at 156.6 feet TDH.

Action Recommended for Further Evaluation: **Replace pump discharge piping and valves**
Add VFD unit to smaller pump motor

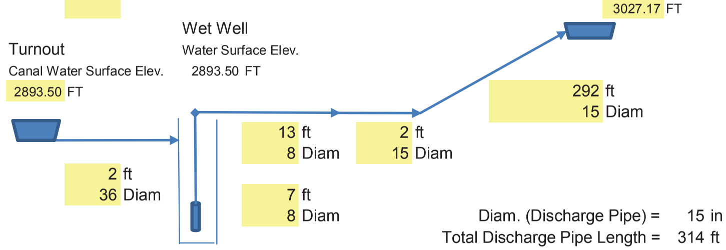
Annual Energy Savings Estimate = **53,822 kW-hr**

Initial Cost Estimate = **$115,000**

Pump to Canal Head Loss Calculations
Combs Flat Pumping Plant Retrofit

1,300	GPM	Vertical Turbine Pump No. 1		
1,300	GPM	Vertical Turbine Pump No. 2		
2,600	GPM	Total	=	5.8 cfs

Static Head = 133.67 FT



Diam. (Discharge Pipe) =	15	in
Total Discharge Pipe Length =	314	ft
Equiv. Pipe Length Valves & Fittings Pump Discharge =	134	ft
Equiv. Pipe Length Valves & Fittings Discharge Header =	30	ft

36-inch Opening to PS Wet Well	Friction Head =	0.08 FT per 1,000 FT	Concrete	
	Dynamic Head =	0.00 FT total	C =	120
8" Column Pipe	Friction Head =	26.11 FT per 1,000 FT	Steel	
(Vel. = 8.3 fps)	Dynamic Head =	0.18 FT total	C =	140
8" Discharge Piping	Friction Head =	26.11 FT per 1,000 FT	Steel	
(Vel. = 8.3 fps)	Dynamic Head =	0.34 FT total	C =	140
15" Header	Friction Head =	4.42 FT per 1,000 FT	Steel	
(Vel. = 4.7 fps)	Dynamic Head =	0.01 FT total	C =	140
15" Discharge	Friction Head =	4.42 FT per 1,000 FT	Steel	
(Vel. = 4.7 fps)	Dynamic Head =	1.29 FT total	C =	140
Equivalent Pipe Length	Friction Head =	26.11 FT per 1,000 FT	Steel	
Valves & Fittings Pump Discharge	Dynamic Head =	3.50 FT total	C =	140
Equivalent Pipe Length	Friction Head =	4.42 FT per 1,000 FT	Steel	
Valves & Fittings Discharge Header	Dynamic Head =	0.13 FT total	C =	140
	Friction Head =	5.45 FT =	2.36 psi	
	Water Depth in Discharge Canal =	2.84 FT =	1.23 psi	
	Total Dynamic Head =	141.96 FT =	61.46 psi	

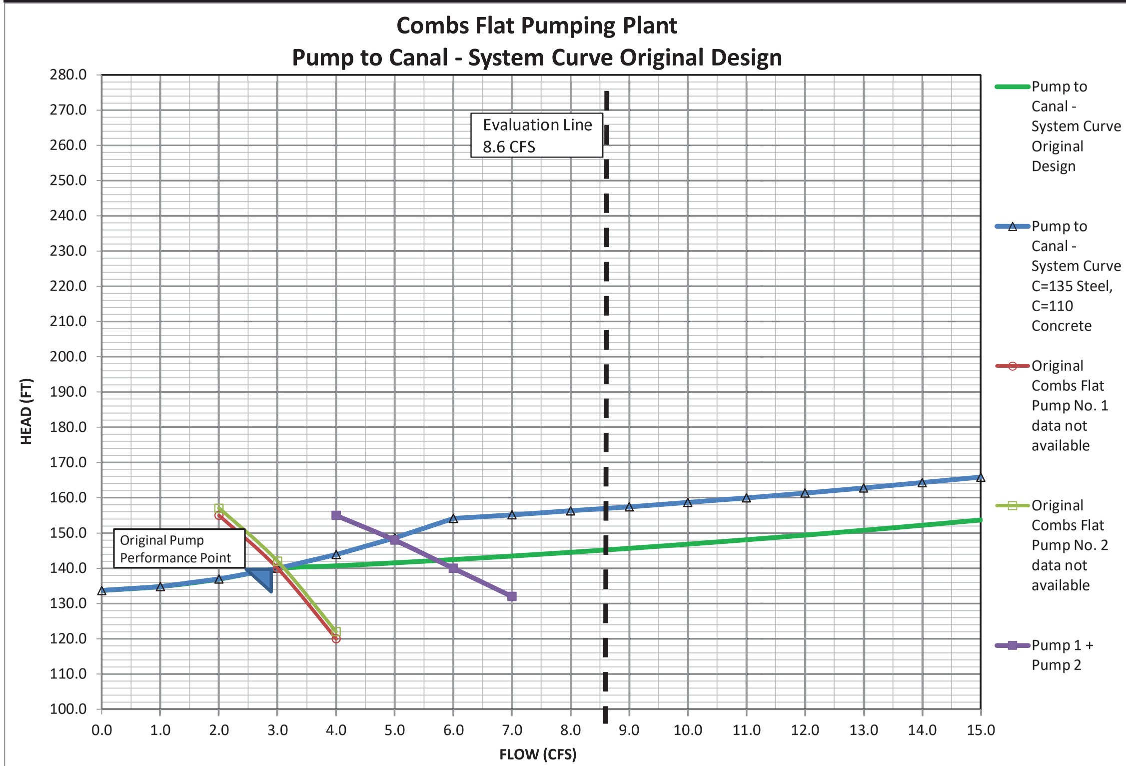
Equivalent Pipe Length Totals:

Item	8" Equiv. Length	No. of Units	Total Equiv. Length
8" pump discharge head	57 ft	1 ea	57 ft
8" check valve	74 ft	1 ea	74 ft
8" pump control (gate) valve	3 ft	1 ea	3 ft
		Subtotal	134 ft

Item	15" Equiv. Length	No. of Units	Total Equiv. Length
8"x8"x15" tee branch flow	25 ft	1 ea	25 ft
8"x15" expander	5 ft	1 ea	5 ft
		Subtotal	30 ft

Combs Flat Pumping Plant
Pump to Canal - System Curve Original Design

Q (gpm)	0	449	898	1,346	1,795	2,244	2,693	3,142	3,591	4,039	4,488	4,937	5,386	5,835	6,284	6,732	7,181	7,630
Q (cfs)	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0
Hf	0.0	1.1	3.2	6.2	7.0	7.8	8.8	9.8	10.8	11.9	13.1	14.4	15.7	17.1	18.5	20.0	21.5	23.1
TDH (ft)	133.7	134.8	136.9	139.9	140.6	141.5	142.4	143.4	144.5	145.6	146.8	148.0	149.4	150.7	152.2	153.6	155.2	156.8
Vel. Disch. (fps)	0.0	0.8	1.6	2.4	3.3	4.1	4.9	5.7	6.5	7.3	8.1	9.0	9.8	10.6	11.4	12.2	13.0	13.9



Original Combs Flat Pump No. 1 data not available

Q (cfs)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Q (gpm)	0	449	898	1,346	1,795	2,244	2,693	3,142	3,591	4,039	4,488	4,937	5,386	5,835	6,284	6,732	7,181	7,630
Head (ft)			155	140	120													

Original Combs Flat Pump No. 2 data not available

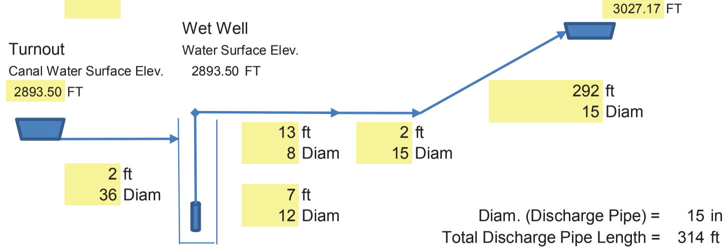
Q (cfs)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Q (gpm)	0	449	898	1,346	1,795	2,244	2,693	3,142	3,591	4,039	4,488	4,937	5,386	5,835	6,284	6,732	7,181	7,630
Head (ft)			157	142	122													

Pump 1 + Pump 2

Q (cfs)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Q (gpm)	0	449	898	1,346	1,795	2,244	2,693	3,142	3,591	4,039	4,488	4,937	5,386	5,835	6,284	6,732	7,181	7,630
Head (ft)					155	148	140	132										

Pump to Canal Head Loss Calculations
Combs Flat Pumping Plant Retrofit

2,660 GPM	Vertical Turbine Pump No. 1	
2,175 GPM	Vertical Turbine Pump No. 2	
		Static Head = 133.67 FT
4,835 GPM	Total = 10.8 cfs	



Diam. (Discharge Pipe) =	15 in
Total Discharge Pipe Length =	314 ft
Equiv. Pipe Length Valves & Fittings Pump Discharge =	134 ft
Equiv. Pipe Length Valves & Fittings Discharge Header =	30 ft

36-inch Opening to PS Wet Well	Friction Head =	0.31 FT per 1,000 FT	Concrete
	Dynamic Head =	0.00 FT total	C = 110
12" Column Pipe	Friction Head =	14.61 FT per 1,000 FT	Steel
(Vel. = 7.5 fps)	Dynamic Head =	0.10 FT total	C = 135
8" Discharge Piping	Friction Head =	105.03 FT per 1,000 FT	Steel
(Vel. = 17.0 fps)	Dynamic Head =	1.37 FT total	C = 135
15" Header	Friction Head =	14.90 FT per 1,000 FT	Steel
(Vel. = 8.8 fps)	Dynamic Head =	0.03 FT total	C = 135
15" Discharge	Friction Head =	14.90 FT per 1,000 FT	Steel
(Vel. = 8.8 fps)	Dynamic Head =	4.35 FT total	C = 135
Equivalent Pipe Length	Friction Head =	105.03 FT per 1,000 FT	Steel
Valves & Fittings Pump Discharge	Dynamic Head =	14.07 FT total	C = 135
Equivalent Pipe Length	Friction Head =	14.90 FT per 1,000 FT	Steel
Valves & Fittings Discharge Header	Dynamic Head =	0.45 FT total	C = 135
	Friction Head =	20.37 FT =	8.82 psi
	Water Depth in Discharge Canal =	5.28 FT =	2.29 psi
	Total Dynamic Head =	159.32 FT =	68.97 psi

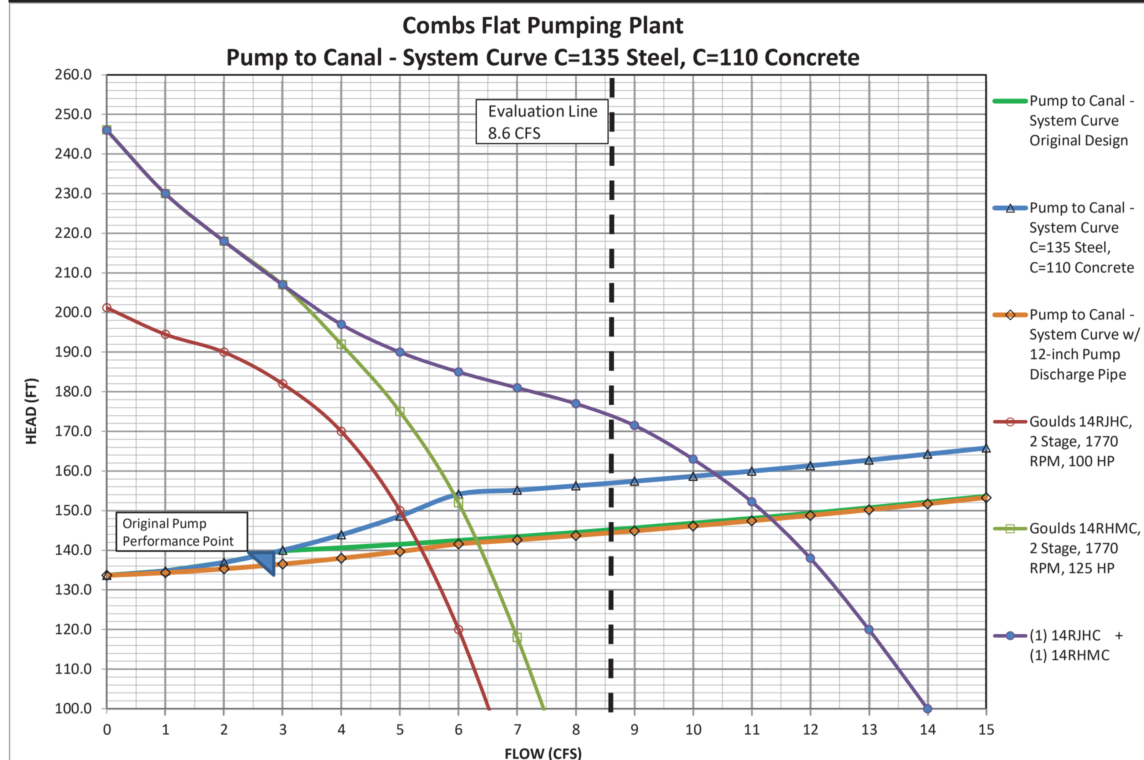
Equivalent Pipe Length Totals:

Item	8" Equiv. Length	No. of Units	Total Equiv. Length
8" pump discharge head	57 ft	1 ea	57 ft
8" check valve	74 ft	1 ea	74 ft
8" pump control (gate) valve	3 ft	1 ea	3 ft
		Subtotal	134 ft

Item	15" Equiv. Length	No. of Units	Total Equiv. Length
8"x8"x15" tee branch flow	25 ft	1 ea	25 ft
8"x15" expander	5 ft	1 ea	5 ft
		Subtotal	30 ft

Combs Flat Pumping Plant
Pump to Canal - System Curve C=135 Steel, C=110 Concrete

Q (gpm)	0	449	898	1,346	1,795	2,244	2,693	3,142	3,591	4,039	4,488	4,937	5,386	5,835	6,284	6,732	7,181	7,630
Q (cfs)	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0
Hf	0.0	1.1	3.3	6.3	10.2	15.0	20.5	21.5	22.6	23.8	25.0	26.3	27.7	29.1	30.6	32.2	33.8	35.5
TDH (ft)	133.7	134.8	136.9	140.0	143.9	148.6	154.1	155.2	156.3	157.4	158.7	160.0	161.3	162.8	164.3	165.8	167.4	169.1
Vel. Disch. (fps)	0.0	0.8	1.6	2.4	3.3	4.1	4.9	5.7	6.5	7.3	8.1	9.0	9.8	10.6	11.4	12.2	13.0	13.9



Goulds 14RJHC, 2 Stage, 1770 RPM, 100 HP

Q (cfs)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Q (gpm)	0	449	898	1,346	1,795	2,244	2,693	3,142	3,591	4,039	4,488	4,937	5,386	5,835	6,284	6,732	7,181	7,630
Head (ft)	201	195	190	182	170	150	120	80										

Goulds 14RHMC, 2 Stage, 1770 RPM, 125 HP

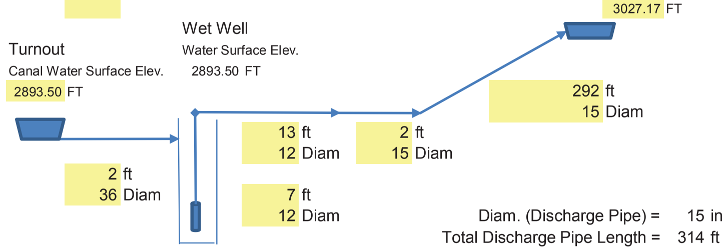
Q (cfs)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Q (gpm)	0	449	898	1,346	1,795	2,244	2,693	3,142	3,591	4,039	4,488	4,937	5,386	5,835	6,284	6,732	7,181	7,630
Head (ft)	246	230	218	207	192	175	152	118	77									

(1) 14RJHC + (1) 14RHMC

Q (cfs)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Q (gpm)	0	449	898	1,346	1,795	2,244	2,693	3,142	3,591	4,039	4,488	4,937	5,386	5,835	6,284	6,732	7,181	7,630
Head (ft)	246	230	218	207	197	190	185	181	177	172	163	152	138	120	100			

Pump to Canal Head Loss Calculations
Combs Flat Pumping Plant Retrofit

2,660 GPM	Vertical Turbine Pump No. 1	
2,175 GPM	Vertical Turbine Pump No. 2	
		Static Head = 133.67 FT
4,835 GPM	Total = 10.8 cfs	



Diam. (Discharge Pipe) =	15 in
Total Discharge Pipe Length =	314 ft
Equiv. Pipe Length Valves & Fittings Pump Discharge =	203 ft
Equiv. Pipe Length Valves & Fittings Discharge Header =	30 ft

Item				
36-inch Opening to PS Wet Well	Friction Head =	0.31 FT per 1,000 FT	Concrete
	Dynamic Head =	0.00 FT total	C = 110
12" Column Pipe	Friction Head =	14.61 FT per 1,000 FT	Steel
(Vel. = 7.5 fps)	Dynamic Head =	0.10 FT total	C = 135
12" Discharge Piping	Friction Head =	14.61 FT per 1,000 FT	Steel
(Vel. = 7.5 fps)	Dynamic Head =	0.19 FT total	C = 135
15" Header	Friction Head =	14.90 FT per 1,000 FT	Steel
(Vel. = 8.8 fps)	Dynamic Head =	0.03 FT total	C = 135
15" Discharge	Friction Head =	14.90 FT per 1,000 FT	Steel
(Vel. = 8.8 fps)	Dynamic Head =	4.35 FT total	C = 135
Equivalent Pipe Length	Friction Head =	14.61 FT per 1,000 FT	Steel
Valves & Fittings Pump Discharge	Dynamic Head =	2.97 FT total	C = 135
Equivalent Pipe Length	Friction Head =	14.90 FT per 1,000 FT	Steel
Valves & Fittings Discharge Header	Dynamic Head =	0.45 FT total	C = 135
	Friction Head =	8.08 FT =	3.50 psi
	Water Depth in Discharge Canal =	5.28 FT =	2.29 psi
	Total Dynamic Head =	147.03 FT =	63.65 psi

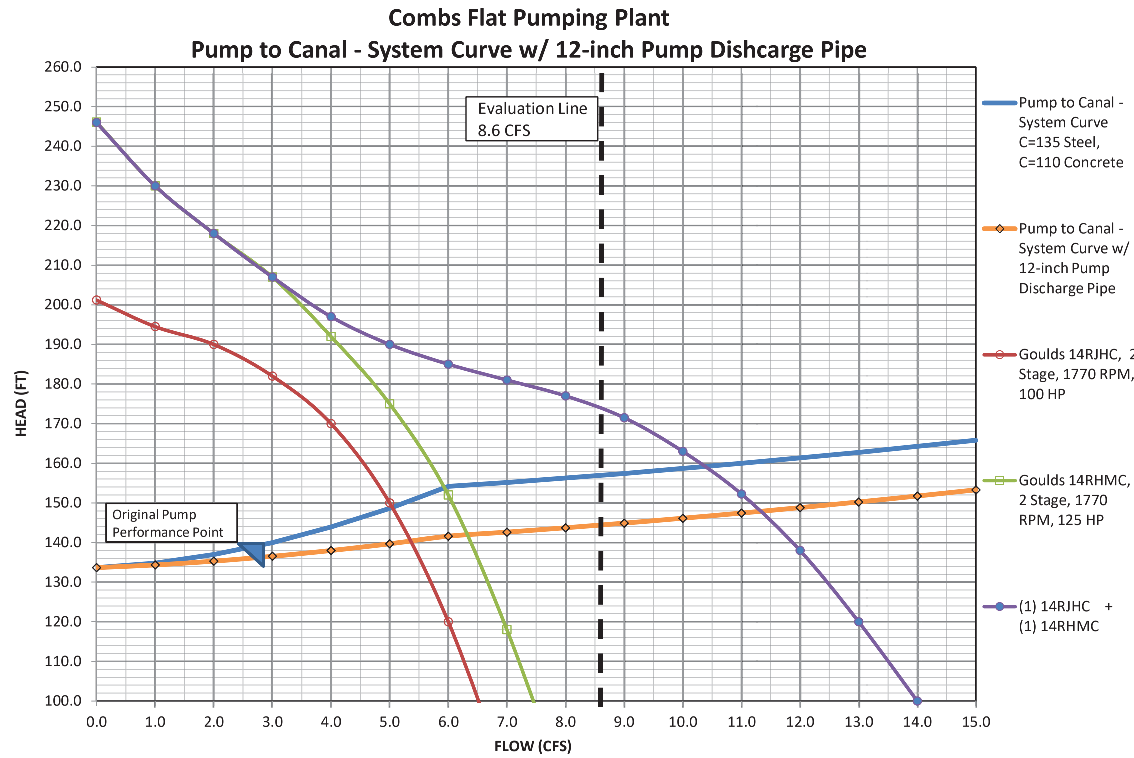
Equivalent Pipe Length Totals:

Item	12" Equiv. Length	No. of Units	Total Equiv. Length
12" pump discharge head	80 ft	1 ea	80 ft
12" check valve	120 ft	1 ea	120 ft
12" pump control (gate) valve	3 ft	1 ea	3 ft
		Subtotal	203 ft

Item	15" Equiv. Length	No. of Units	Total Equiv. Length
12"x12"x15" tee branch flow	25 ft	1 ea	25 ft
12"x15" expander	5 ft	1 ea	5 ft
		Subtotal	30 ft

Combs Flat Pumping Plant
Pump to Canal - System Curve w/ 12-inch Pump Discharge Pipe

Q (gpm)	0	449	898	1,346	1,795	2,244	2,693	3,142	3,591	4,039	4,488	4,937	5,386	5,835	6,284	6,732	7,181	7,630
Q (cfs)	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0
Hf	0.0	0.7	1.6	2.8	4.3	6.0	7.9	8.9	10.0	11.2	12.4	13.7	15.1	16.5	18.0	19.6	21.2	22.9
TDH (ft)	133.7	134.3	135.3	136.5	138.0	139.7	141.6	142.6	143.7	144.9	146.1	147.4	148.8	150.2	151.7	153.3	154.9	156.6
Vel. Disch. (fps)	0.0	0.8	1.6	2.4	3.3	4.1	4.9	5.7	6.5	7.3	8.1	9.0	9.8	10.6	11.4	12.2	13.0	13.9



Goulds 14RJHC, 2 Stage, 1770 RPM, 100 HP																		
Q (cfs)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Q (gpm)	0	449	898	1,346	1,795	2,244	2,693	3,142	3,591	4,039	4,488	4,937	5,386	5,835	6,284	6,732	7,181	7,630
Head (ft)	201	195	190	182	170	150	120	80										

Goulds 14RHMC, 2 Stage, 1770 RPM, 125 HP																		
Q (cfs)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Q (gpm)	0	449	898	1,346	1,795	2,244	2,693	3,142	3,591	4,039	4,488	4,937	5,386	5,835	6,284	6,732	7,181	7,630
Head (ft)	246	230	218	207	192	175	152	118	77									

(1) 14RJHC + (1) 14RHMC																		
Q (cfs)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Q (gpm)	0	449	898	1,346	1,795	2,244	2,693	3,142	3,591	4,039	4,488	4,937	5,386	5,835	6,284	6,732	7,181	7,630
Head (ft)	246	230	218	207	197	190	185	181	177	172	163	152	138	120	100			

Pump to Canal Head Loss Calculations
Combs Flat Pumping Plan Reconstruction (Existing vertical turbines with new pump discharge piping and valves)

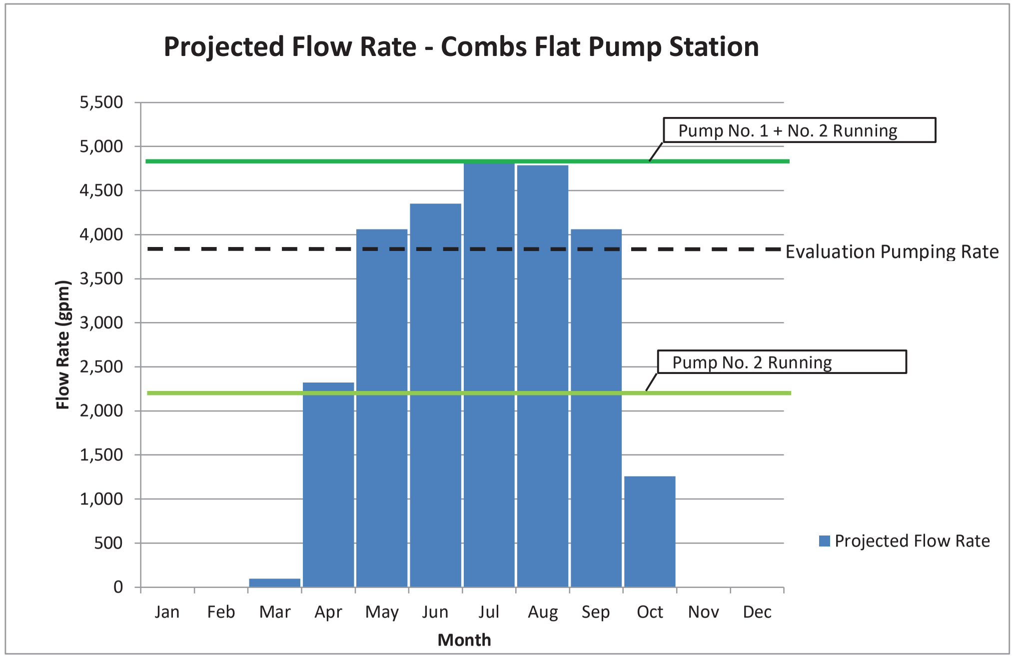
2,660 GPM Vertical Turbine Pump No. 1
2,175 GPM Vertical Turbine Pump No. 2

4,835 GPM Total = 10.8 cfs

Proposed PS Design Flow Rate = 4,835 gpm

Month	% of Max Flow Rate	Projected Flow Rate
Jan	0%	0
Feb	0%	0
Mar	2%	97
Apr	48%	2,321
May	84%	4,061
Jun	90%	4,352
Jul	100%	4,835
Aug	99%	4,787
Sep	84%	4,061
Oct	26%	1,257
Nov	0%	0
Dec	0%	0

Evaluation Pumping Rate = 3,864 gpm
8.6 cfs



Notes: Combs Flat PS when refitted with new pump discharge piping and valves. VFD operation would provide significant benefit toward reducing energy use and optimizing water delivery to crop requirement. Pump No. 2 if fitted with VFD control could be modulated to a flow rate that allows its use alone or in combination with Pump No. 1 to reasonably match projected seasonal demand requirements.

Ochoco Irrigation District
Combs Flat PS (Retrofit of pump equipment at existing pump station)
Budget Level - Projection of Probable Construction Cost

Item No.	Spec Division	Description	Measurement	Units	Unit Cost	Total Cost
1	1000	Mobilization	LS	1	$3,200.00	$3,200.00
2	1000	Project Management and Coordination	LS	1	$1,200.00	$1,200.00
3	1000	Construction Progress Documentation	LS	1	$1,200.00	$1,200.00
4	1000	Submittal Procedures	LS	1	$1,200.00	$1,200.00
5	1000	Quality Requirements	LS	1	$1,200.00	$1,200.00
6	1000	Selective Demolition	LS	1	$3,000.00	$3,000.00
7	1000	Project Record Documents	LS	1	$1,200.00	$1,200.00
8	1000	Operations and Maintenance Data	LS	1	$1,200.00	$1,200.00
9	1000	General Commissioning Requirements	LS	1	$2,500.00	$2,500.00
10	2000	Surfacing Rock	CY	10	$38.00	$380.00
11	3000	Misc Cast-in-Place Concrete (thrust and pads)	LS	1	$5,000.00	$5,000.00
12	9000	High Performance Coating Systems	LS	1	$1,500.00	$1,500.00
13	11000	Line Shaft Turbine Pump and Motor, 150 HP	EA	0	$39,250.00	$0.00
14	11000	Line Shaft Turbine Pump and Motor, 125 HP	EA	0	$35,750.00	$0.00
15	15000	12-inch Handweel Operated Butterfly Valve	EA	2	$2,250.00	$4,500.00
16	15000	12-inch Surgebuster Check Valve	EA	2	$5,250.00	$10,500.00
17	15000	12-inch Discharge Pipe, Fittings, & Accessories	EA	2	$3,500.00	$7,000.00
18	16000	Power and Distribution	LS	1	$0.00	$0.00
19	16000	Grounding Systems	LS	1	$0.00	$0.00
20	16000	Motor Controls	LS	1	$20,000.00	$20,000.00
21	17000	Instrumentation and Control	LS	1	$0.00	$0.00
		Construction Subtotal				$64,780.00
		Contractors Overhead and Profit	10%	1	$6,478.00	$6,478.00
		Contractors Bonds and Insurance	2%	1	$1,425.16	$1,425.16
		Construction Contingency	30%	1	$19,434.00	$19,434.00
		Construction Total				$92,117.16
		Engineering, Administration	25%	1	$23,029.29	
		Total				**$115,146.45**

c:\Projects\B\BRCI-0002\0600 INFO\Combs Flat Budget Construction Cost Estimate 3-3-12

Wire to Water Energy Calculator

Ochoco Irrigation District - SOR

Combs Flat Pumping Plant - Pump Discharge Pipe Replacement

Source: PumpTech Inc.

2425 SE Ochoco Street

Portland, OR 97222

503-659-6230

OPERATIONAL AND EQUIPMENT DATA

	Replacement Pump Discharge Piping		Existing Pump Discharge Piping	
	No. 1 - Goulds 14RJHC, 1 Stage, 1770 RPM, 125 HP		No. 1 - Goulds 14RJHC, 1 Stage, 1770 RPM, 125 HP *	
	No. 2 - Goulds 14RHMC, 2 Stage, 1770 RPM, 125 HP		No. 2 - Goulds 14RHMC, 2 Stage, 1770 RPM, 125 HP *	
Pump Operation - Hours / Day	24		24	
Pump Operation - Days / Year	198		198	
Pump Flow - GPM (Evaluation Pump Rate)	3,864		3,864	
Pump Flow - CFS	8.6		8.6	
Total Annual Volume - Acre feet	3,380		3,380	
Pump Head - Feet	144.3	*	156.6	
Ave. Pump Efficiency - %	85.0%		85.0%	
Ave. Motor Efficiency - %	93.0%		93.0%	**
Energy Cost in $/kW-hr	$0.035		$0.035	

* Estimated pumping head assumes pump column pipe, discharge piping, and valves are changed from 8-inch to 12-inch.

* Pump make and model information as recorded on the pump discharge head.

** Efficiency of existing motors assumed to be 93% as indicated on the existing 125HP motor name plate.

RESULTS

	Replacement Pump Discharge Piping	Existing Pump Discharge Piping
BHP At Design Point	165.6	179.8
Wire to Water Efficiency - %	79%	79%
kW-hr per Year	631,425	685,247
Annual Energy Cost	$22,099.87	$23,983.64
kW-hr Per 1,000 Gallons Pumped	0.573	0.622
Cost Per 1,000 Gallons Pumped	$0.020	$0.022
kW-hr per Acre Foot Pumped	187	203
Cost Per Acre Foot Pumped	$6.54	$7.09

PAYBACK

Annual Savings - kW-hr	53,822	
Annual Savings - $$	$1,883.77	
Annual Savings - %	7.85%	
Cost of Replacement Piping	$115,000.00	*
Cost of Existing Piping	$0.00	
Payback - Years	61.0	

* Estimated cost assumes pump column pipe, discharge piping, and valves are changed from 8-inch to 12-inch plus the cost of adding a VFD for one pump driver.

Pump Performance Datasheet

Customer	: Ochoco Irrigation District
Customer reference	: OID - SOR Combs Flat Pump Sta
Item number	: Pump No. 1 Replacement
Service	: Irrigation water
Quantity	: 1
Quote number	:
Item description	: 14RJHC
Stages	: 2
Based on curve number	: 14RJHC-1770
Date last saved	: 26 May 2011 1:25 PM

Operating Conditions

Flow, rated	: 2,175.0 USgpm
Differential head / pressure, rated (requested)	: 154.0 ft
Differential head / pressure, rated (actual)	: 155.8 ft
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: 37.45 ft
Frequency	: 60 Hz

Performance

Speed, rated	: 1,770 rpm
Impeller diameter, rated	: 9.25 in
Impeller diameter, maximum	: 9.82 in
Impeller diameter, minimum	: 7.75 in
Efficiency (bowl / pump)	: 85.51 / - %
NPSH required / margin required	: 31.29 / 5.00 ft
Ns (imp. eye flow) / Nss (imp. eye flow)	: 3,020 / 6,240 US Units
MCSF	: 1,200.0 USgpm
Head, maximum, rated diameter	: 201.2 ft
Head rise to shutoff	: 30.64 %
Flow, best eff. point (BEP)	: 2,223.0 USgpm
Flow ratio (rated / BEP)	: 97.84 %
Diameter ratio (rated / max)	: 94.20 %
Head ratio (rated dia / max dia)	: 87.42 %
Cq/Ch/Ce [ANSI/HI 9.6.7-2004]	: 1.00 / 1.00 / 1.00
Selection status	: Acceptable

Liquid

Liquid type	: Water
Additional liquid description	: Raw Water
Solids diameter, max	: 1.12 in
Solids concentration, by volume	: 0.00 %
Temperature, max	: 68.00 deg F
Fluid density, rated / max	: 1.000 / 1.000 SG
Viscosity, rated	: 1.00 cP
Vapor pressure, rated	: 0.00 psi.a

Material

Material selected	: CI Bowl (Lined) / Std. Brz Impeller

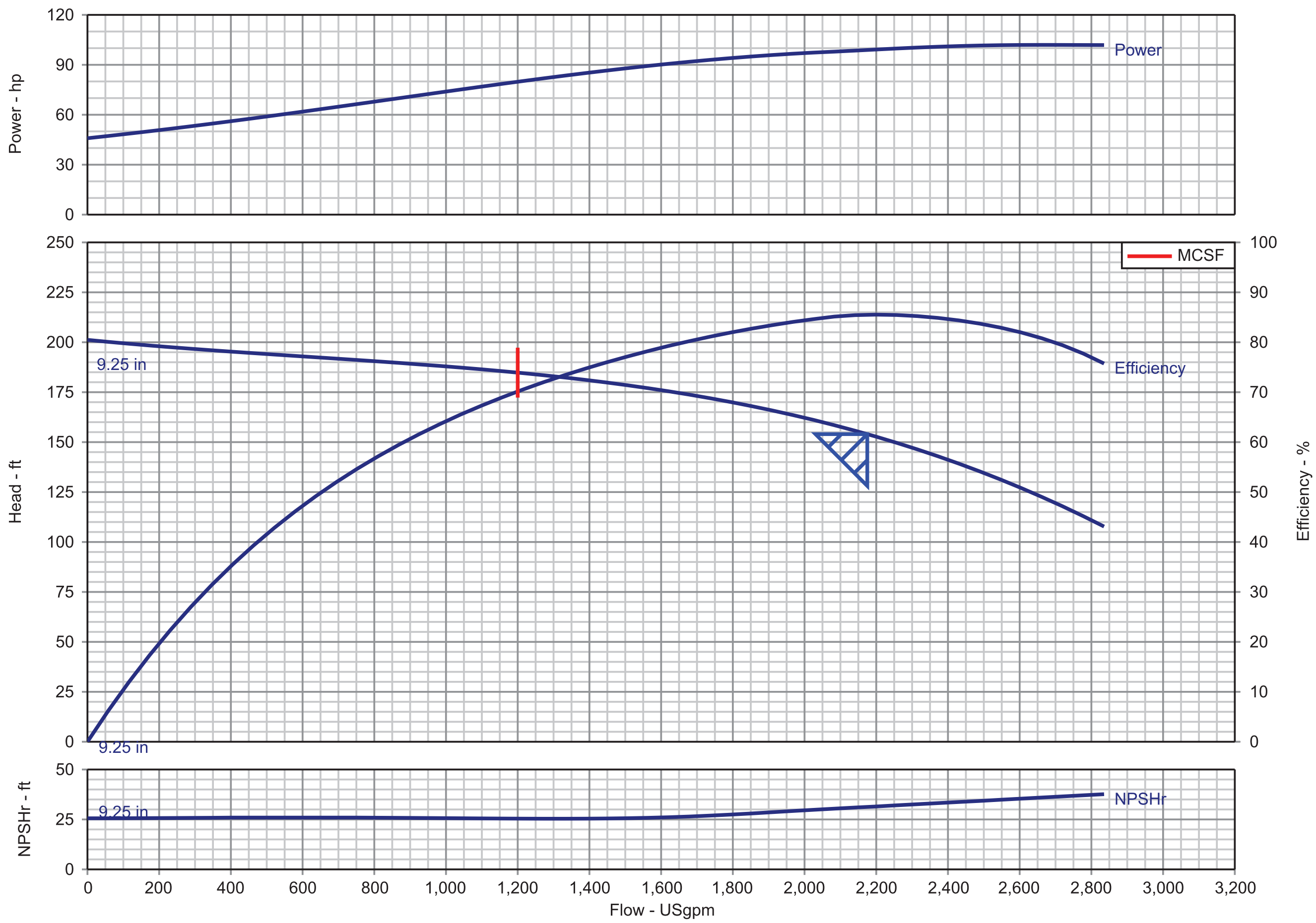
Pressure Data

Maximum working pressure	: 87.09 psi.g
Maximum allowable working pressure	: 420.0 psi.g
Maximum allowable suction pressure	: N/A
Hydrostatic test pressure	: N/A

Driver & Power Data

Driver sizing specification	: Maximum power
Margin over specification	: 0.00 %
Service factor	: 1.15
Power, hydraulic	: 84.58 hp
Power (bowl / pump)	: 98.92 / -
Power, maximum, rated diameter	: 102 hp
Minimum recommended motor rating	: 125 hp / 93.21 kW

Bowl performance. Adjusted for construction and viscosity.
The duty point represents the head at the bowl.



Pump Performance Datasheet

Customer	: Ochoco Irrigation District	Quote number	:
Customer reference	: OID - SOR Combs Flat Pump Sta	Item description	: 14RHMC
Item number	: Pump No. 2 Replacement	Stages	: 2
Service	: Irrigation water	Based on curve number	: 14RHMC-1770
Quantity	: 1	Date last saved	: 26 May 2011 1:29 PM

Operating Conditions

Flow, rated	: 2,660.0 USgpm
Differential head / pressure, rated (requested)	: 153.8 ft
Differential head / pressure, rated (actual)	: 153.8 ft
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: 37.45 ft
Frequency	: 60 Hz

Performance

Speed, rated	: 1,770 rpm
Impeller diameter, rated	: 9.88 in
Impeller diameter, maximum	: 9.88 in
Impeller diameter, minimum	: 8.00 in
Efficiency (bowl / pump)	: 84.38 / - %
NPSH required / margin required	: 28.09 / 5.00 ft
Ns (imp. eye flow) / Nss (imp. eye flow)	: 3,394 / 7,580 US Units
MCSF	: 1,200.0 USgpm
Head, maximum, rated diameter	: 246.8 ft
Head rise to shutoff	: 60.49 %
Flow, best eff. point (BEP)	: 2,602.0 USgpm
Flow ratio (rated / BEP)	: 102.23 %
Diameter ratio (rated / max)	: 100.00 %
Head ratio (rated dia / max dia)	: 100.00 %
Cq/Ch/Ce [ANSI/HI 9.6.7-2004]	: 1.00 / 1.00 / 1.00
Selection status	: Acceptable

Liquid

Liquid type	: Water
Additional liquid description	: Raw Water
Solids diameter, max	: 1.12 in
Solids concentration, by volume	: 0.00 %
Temperature, max	: 68.00 deg F
Fluid density, rated / max	: 1.000 / 1.000 SG
Viscosity, rated	: 1.00 cP
Vapor pressure, rated	: 0.00 psi.a

Material

Material selected	: CI Bowl (Lined) / Std. Brz Impeller

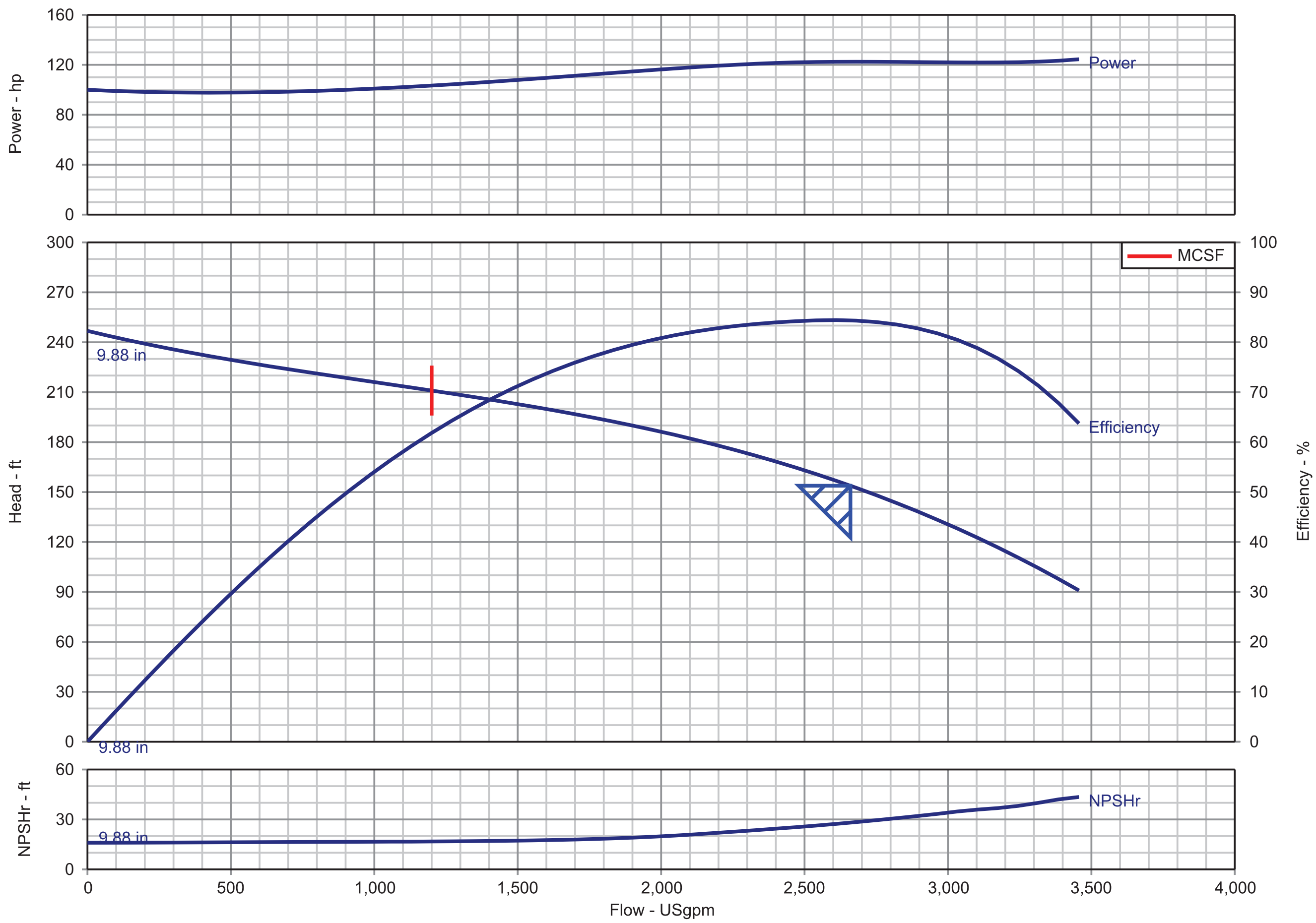
Pressure Data

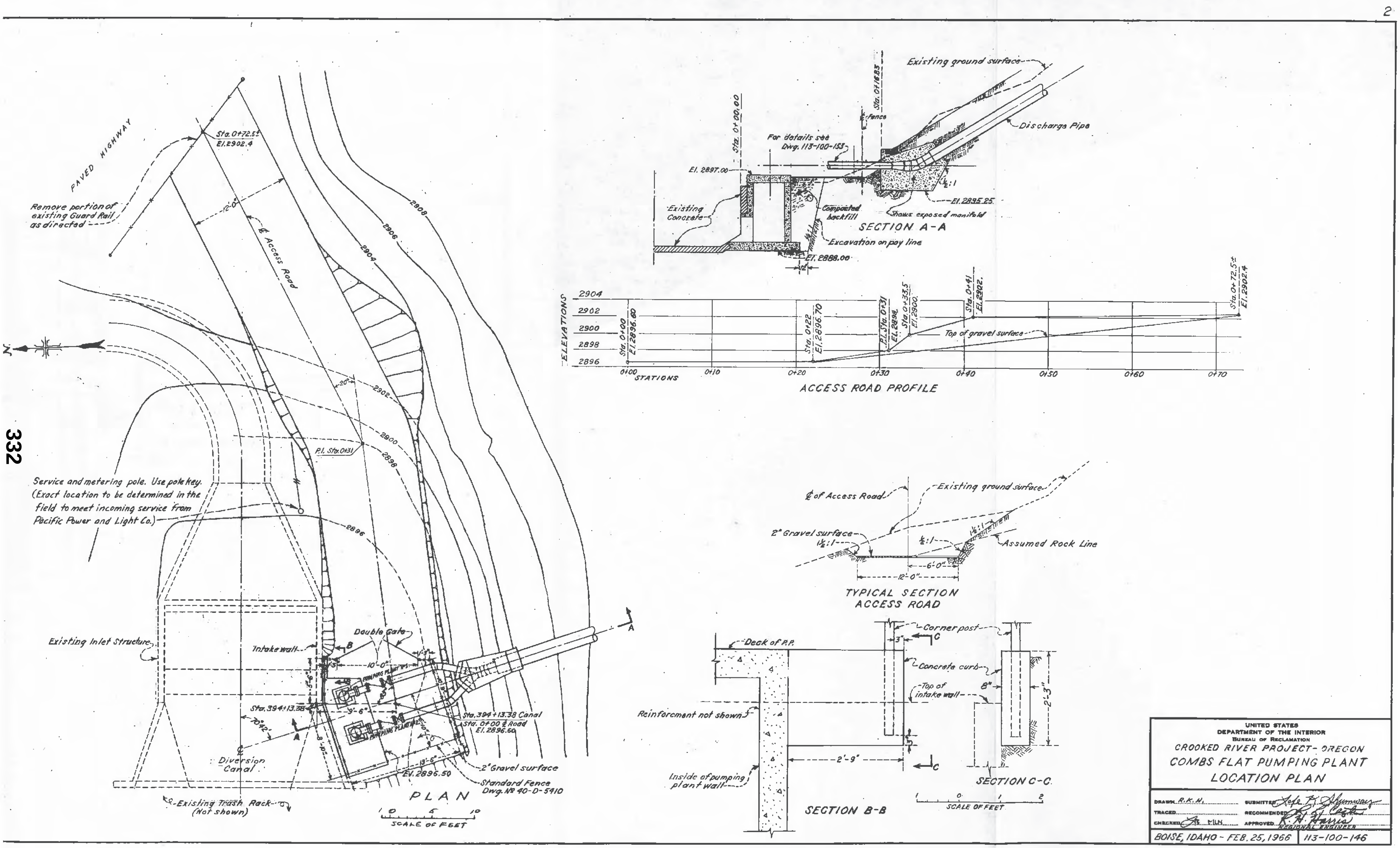
Maximum working pressure	: 106.9 psi.g
Maximum allowable working pressure	: 330.0 psi.g
Maximum allowable suction pressure	: N/A
Hydrostatic test pressure	: N/A

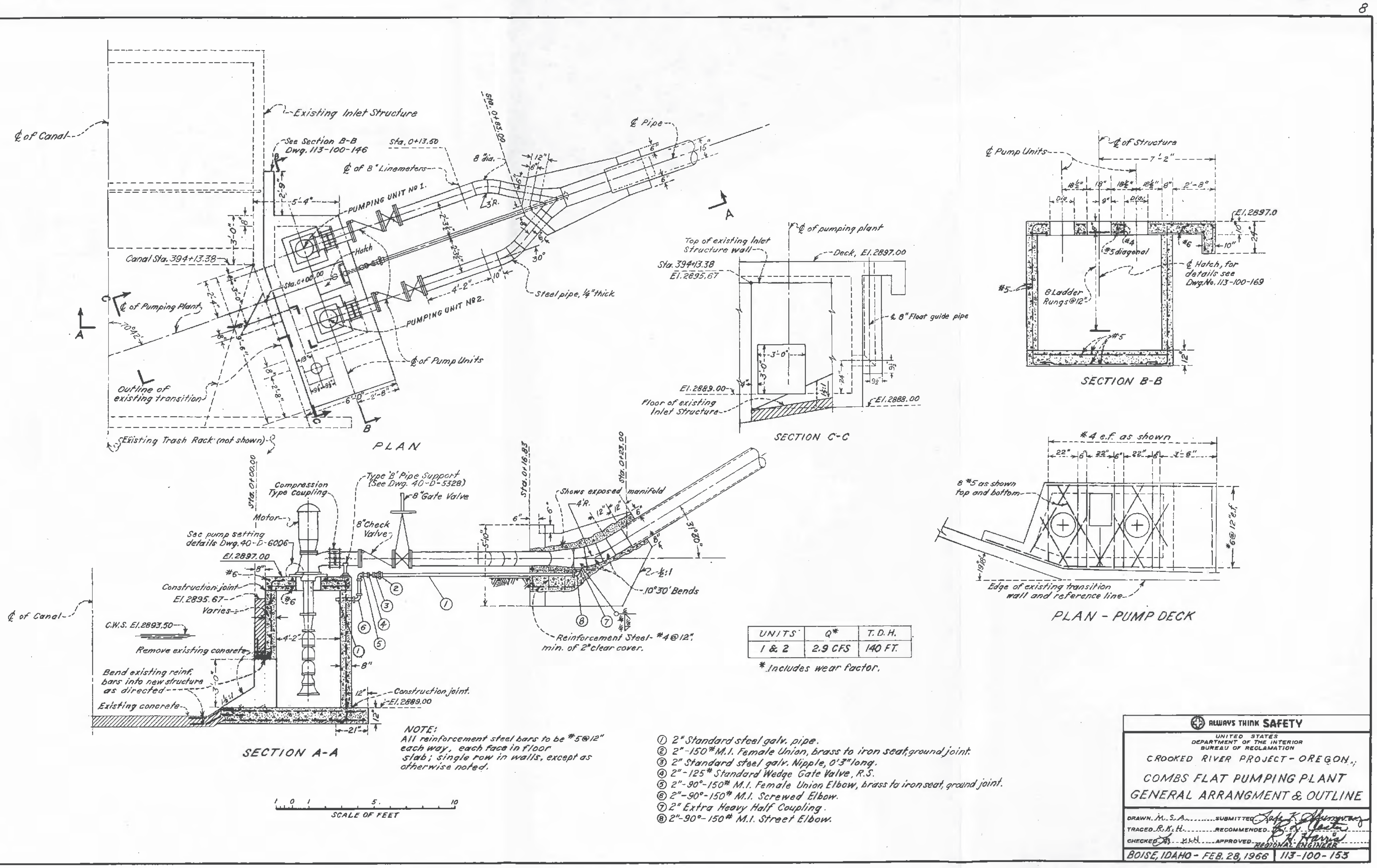
Driver & Power Data

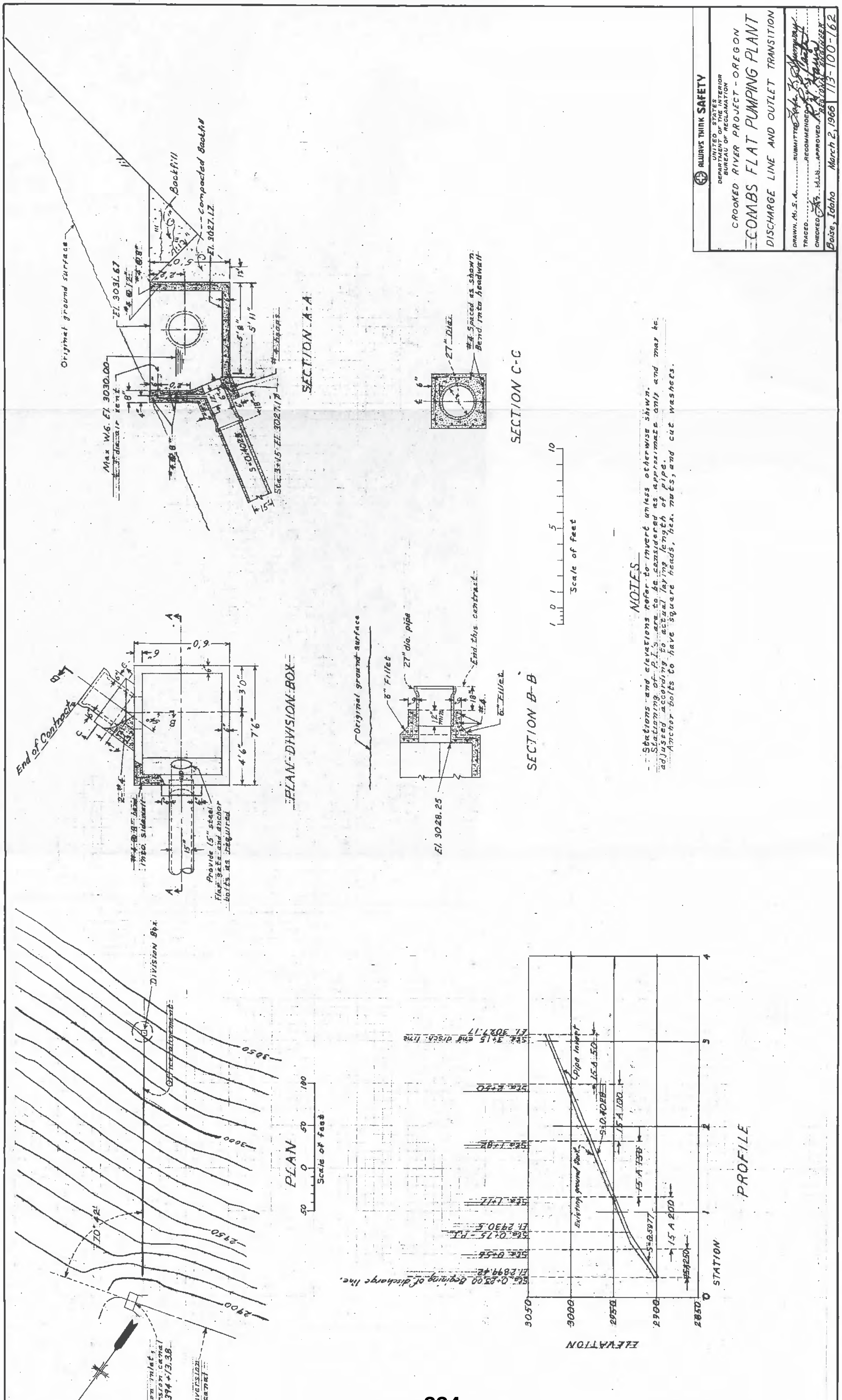
Driver sizing specification	: Maximum power
Margin over specification	: 0.00 %
Service factor	: 1.15
Power, hydraulic	: 103 hp
Power (bowl / pump)	: 122 / -
Power, maximum, rated diameter	: 124 hp
Minimum recommended motor rating	: 125 hp / 93.21 kW

Bowl performance. Adjusted for construction and viscosity.
The duty point represents the head at the bowl.




2
PAVED HIGHWAY
Remove portion of existing Guard Rail as directed
Sta. 0+72.5±
El. 2902.4
12'-0"
℄ Access Road
2908
2906
2904
2902
2900
2898
2896
20'
P.I. Sta. 0+31
Service and metering pole. Use pole key. (Exact location to be determined in the field to meet incoming service from Pacific Power and Light Co.)
Existing Inlet Structure
Intake wall
Double Gate
10'-0"
Sta. 394+13.38
Sta. 394+13.38 Canal
Sta. 0+00 ℄ Road
El. 2896.60
El. 2896.50
2" Gravel surface
Standard Fence Dwg. № 40-D-5410
℄ Diversion Canal
℄ Existing Trash Rack (Not shown)
PLAN
SCALE OF FEET
Existing ground surface
Discharge Pipe
Sta. 0+18.83
Sta. 0+00.00
For details see Dwg. 113-100-153
El. 2897.00
Existing Concrete
Compacted backfill
El. 2895.25
Shows exposed manifold
SECTION A-A
Excavation on pay line
El. 2888.00
ELEVATIONS
STATIONS
Sta. 0+00
El. 2896.60
Sta. 0+22
El. 2896.70
P.I. Sta. 0+31
El. 2898
Sta. 0+33.5
El. 2900
Sta. 0+41
El. 2902
Sta. 0+72.5±
El. 2902.4
Top of gravel surface
ACCESS ROAD PROFILE
℄ of Access Road
Existing ground surface
2" Gravel surface
Assumed Rock Line
6'-0"
12'-0"
TYPICAL SECTION ACCESS ROAD
Deck of P.P.
Corner post
Concrete curb
Top of intake wall
Reinforcement not shown
Inside of pumping plant wall
2'-9"
SECTION B-B
8"
2'-3"
SECTION C-C
SCALE OF FEET
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CROOKED RIVER PROJECT - OREGON
COMBS FLAT PUMPING PLANT
LOCATION PLAN
DRAWN R.K.H.
TRACED
CHECKED
SUBMITTED
RECOMMENDED
APPROVED
REGIONAL ENGINEER
BOISE, IDAHO - FEB. 25, 1966
113-100-146


8
PLAN
SECTION A-A
SECTION B-B
SECTION C-C
PLAN - PUMP DECK
Existing Inlet Structure
PUMPING UNIT No 1.
PUMPING UNIT No 2.
Steel pipe, 1/4" thick
Outline of existing transition
Existing Trash Rack (not shown)
Canal Sta. 394+13.38
Compression Type Coupling
Motor
Type 'B' Pipe Support (See Dwg. 40-D-5328)
8" Gate Valve
8" Check Valve
See pump setting details Dwg. 40-D-6006
C.W.S. El. 2893.50
Remove existing concrete
Bend existing reinf. bars into new structure as directed
Existing concrete
Construction joint
Reinforcement Steel- #4@12". min. of 2" clear cover.
Shows exposed manifold
10°30' Bends
Top of existing Inlet Structure wall
Deck, El. 2897.00
8" Float guide pipe
Floor of existing Inlet Structure
8 Ladder Rungs@12"
Hatch, for details see Dwg. No. 113-100-169
8 #5 as shown top and bottom
Edge of existing transition wall and reference line
#4 e.f. as shown
UNITS | Q* | T.D.H.
1 & 2 | 2.9 CFS | 140 FT.
* Includes wear factor.
NOTE: All reinforcement steel bars to be #5@12" each way, each face in floor slab; single row in walls, except as otherwise noted.
① 2" Standard steel galv. pipe.
② 2"-150# M.I. Female Union, brass to iron seat, ground joint.
③ 2" Standard steel galv. Nipple, 0'3" long.
④ 2"-125# Standard Wedge Gate Valve, R.S.
⑤ 2"-90°-150# M.I. Female Union Elbow, brass to iron seat, ground joint.
⑥ 2"-90°-150# M.I. Screwed Elbow.
⑦ 2" Extra Heavy Half Coupling.
⑧ 2"-90°-150# M.I. Street Elbow.
SCALE OF FEET
ALWAYS THINK SAFETY
UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION
CROOKED RIVER PROJECT - OREGON
COMBS FLAT PUMPING PLANT
GENERAL ARRANGMENT & OUTLINE
DRAWN M.S.A. SUBMITTED
TRACED R.K.H. RECOMMENDED
CHECKED APPROVED REGIONAL ENGINEER
BOISE, IDAHO - FEB. 28, 1966
113-100-153


17
ALWAYS THINK SAFETY
UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION
CROOKED RIVER PROJECT - OREGON
COMBS FLAT PUMPING PLANT
DISCHARGE LINE AND OUTLET TRANSITION
Boise, Idaho March 2, 1966 113-100-162
SECTION A-A
SECTION B-B
SECTION C-C
PLAN-DIVISION BOX
End of Contract
PLAN
Scale of feet
PROFILE
STATION
ELEVATION
Original ground surface
Division Box
Max W.S. El. 3030.00
El. 3031.67
El. 3027.17
El. 3028.25
27" Dia.
27" dia. pipe
End this contract
Provide 15" steel flap gate and anchor bolts as required
Compacted Backfill
Backfill
NOTES
- Stations and elevations refer to invert unless otherwise shown.
- Stationing of P.I.'s are to be considered as approximate only and may be adjusted according to actual laying length of pipe.
- Anchor bolts to have square heads, hex. nuts, and cut washers.

MCKAY PUMPING PLANT - EVALUATION SUMMARY

OID infrastructure assets serving peripheral acreage were completed in the Crooked River Project Extension include six small pumping plants and associated canals, laterals, and drains. These features serve lands of six separate areas located generally east and north of the original Barnes Butte and Ochoco Relift project area. The McKay pumping plant lifts water from the Ochoco Main Canal.[1]

Since its original construction circa 1966, McKay Pumping Plant Pump No. 1 has been replaced with a 25 HP unit.

Original Design

Pump Unit	Description	HP	Rated Capacity	Rated Head	Pump Eff. @ Rated Capacity	Pipe size	Discharge Pipe Vel.	Discharge Main Vel.
No. 1	Vertical Turbine	25	1,350 GPM	49 FT	77 % *	8 IN	8.6 FPS	
Total		25	1,350 GPM	49 FT		12 IN		3.8 FPS

Current Condition

Pump Unit	Description	HP	Assumed Capacity	Head	Pump Eff. @ Test Capacity	Pipe size	Discharge Pipe Vel.	Discharge Main Vel.
No. 1	Vertical Turbine	25	1,350 GPM *	49 FT		8 IN	8.6 FPS	
Total		25	1,350 GPM			12 IN		3.8 FPS

* Assumed pump capacity, pump curve for existing unit not available.

** Pump Efficiency data from pump curve (similar pump) published product information sheets.

Alternate Equipment (Replace Existing Pump Discharge Piping and Valves)

Pump Unit	Description	HP	Rated Capacity	Rated Head	Pump Eff. @ Rated Capacity	Discharge Pipe size	Discharge Pipe Vel.	Discharge Main Vel.
No. 1	Vertical Turbine	25	1,350 GPM	46 FT	78 %	10 IN	5.5 FPS	
Total		25	1,350 GPM	46 FT		12 IN		3.8 FPS

[1] US Department of the Interior, Bureau of Reclamation, Ochoco River Project, http://www.usbr.gov/projects/Project.jsp?proj_Name=Crooked River Project&pageType=ProjectPage

Narrative

The original McKay pump installed circa 1966 has subsequently been replaced with a newer equal sized unit. New pump equipment is assumed to have similar output compared to original equipment.

Evaluation of the McKay Pumping Plant examines potential energy efficiency gained by replacing existing pump discharge piping and valves at the existing. Evaluation of potential energy savings assumes pump discharge piping and valves are increased in size to reduce velocity and friction losses.

Evaluation of potential energy savings through the use of VFD's suggests that variable speed operation of the one pump could be beneficial to matching pump output to seasonal variations in demand. However, the expected energy savings is not expected to pay back the initial investment. The initial cost projection for pumping plant improvements does not includes addition of a VFD drive.

The capacity of the rebuilt pump station is anticipated to be approximately 3.0 CFS at 46.5 feet TDH.

Wire to water energy analysis is based on the projected capacity of the McKay Pumping Plant retrofitted with new pump discharge pipe and valves. The retrofitted pump station is projected to operate at a seasonal average flow of 1,079 gpm (2.4 CFS) at 44.8 feet TDH. The existing pump station in its current condition is projected to yield 2.4 CFS at 46.9 feet TDH.

Action Recommended for Further Evaluation: Replace pump discharge piping and valves

Annual Energy Savings Estimate = 2,782 kW-hr

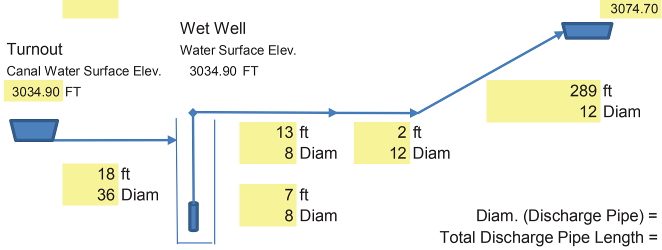
Initial Cost Estimate = $27,900

Pump to Canal Head Loss Calculations
McKay Pumping Plant Retrofit

1,350 GPM Vertical Turbine Pump No. 1

Static Head = 39.80 FT

1,350 GPM Total = 3.0 cfs



Diam. (Discharge Pipe) =	12 in
Total Discharge Pipe Length =	311 ft
Equiv. Pipe Length Valves & Fittings Pump Discharge =	134 ft
Equiv. Pipe Length Valves & Fittings Discharge Header =	5 ft

36-inch Opening to PS Wet Well	Friction Head =	0.02 FT per 1,000 FT	Concrete
	Dynamic Head =	0.00 FT total	C = 120
8" Column Pipe	Friction Head =	28.00 FT per 1,000 FT	Steel
(Vel. = 8.6 fps)	Dynamic Head =	0.20 FT total	C = 140
8" Discharge Piping	Friction Head =	28.00 FT per 1,000 FT	Steel
(Vel. = 8.6 fps)	Dynamic Head =	0.36 FT total	C = 140
12" Header	Friction Head =	3.89 FT per 1,000 FT	Steel
(Vel. = 3.8 fps)	Dynamic Head =	0.01 FT total	C = 140
12" Discharge	Friction Head =	3.43 FT per 1,000 FT	Asb Cem
(Vel. = 3.8 fps)	Dynamic Head =	0.99 FT total	C = 150
Equivalent Pipe Length Valves & Fittings Pump Discharge	Friction Head =	28.00 FT per 1,000 FT	Steel
	Dynamic Head =	3.75 FT total	C = 140
Equivalent Pipe Length Valves & Fittings Discharge Header	Friction Head =	3.89 FT per 1,000 FT	Steel
	Dynamic Head =	0.02 FT total	C = 140
	Friction Head =	5.33 FT =	2.31 psi
	Water Depth in Discharge Canal =	4.00 FT =	1.73 psi
	Total Dynamic Head =	49.13 FT =	21.27 psi

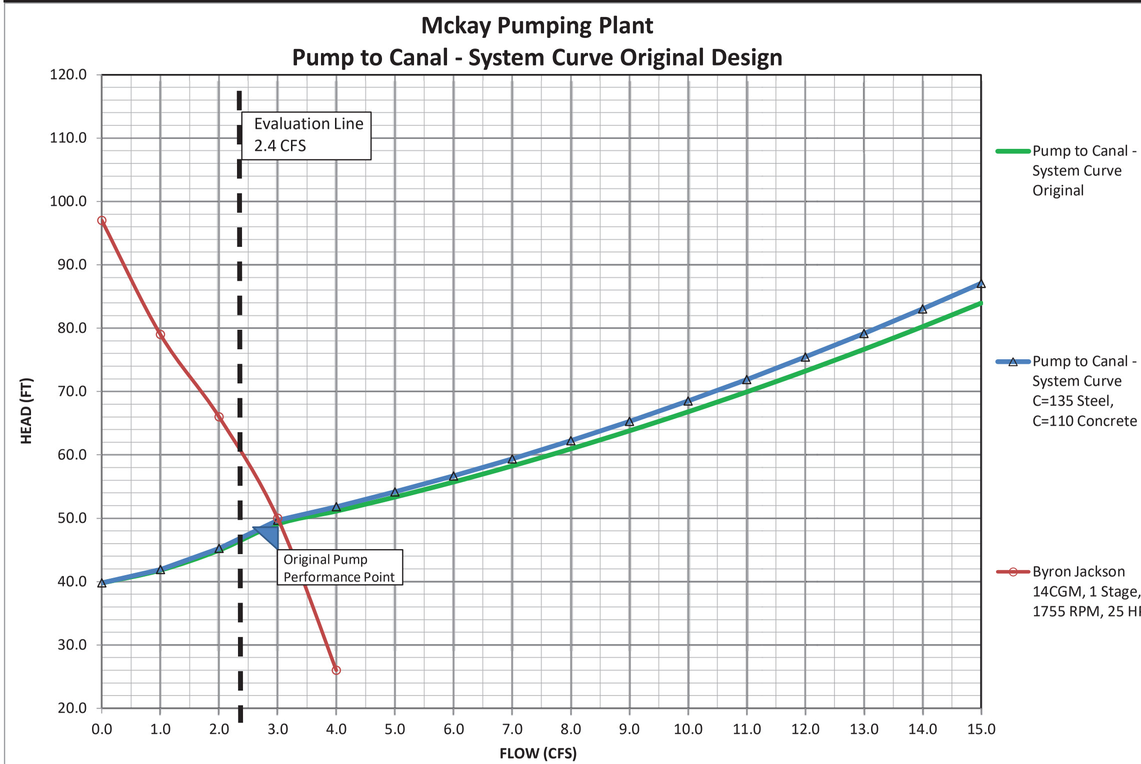
Equivalent Pipe Length Totals:

Item	8" Equiv. Length	No. of Units	Total Equiv. Length
8" pump discharge head	57 ft	1 ea	57 ft
8" check valve	74 ft	1 ea	74 ft
8" pump control (gate) valve	3 ft	1 ea	3 ft
		Subtotal	134 ft

Item	12" Equiv. Length	No. of Units	Total Equiv. Length
8"x8"x12" tee branch flow	25 ft	0 ea	0 ft
8"x12" expander	5 ft	1 ea	5 ft
		Subtotal	5 ft

McKay Pumping Plant
Pump to Canal - System Curve Original

Q (gpm)	0	449	898	1,346	1,795	2,244	2,693	3,142	3,591	4,039	4,488	4,937	5,386	5,835	6,284	6,732	7,181	7,630
Q (cfs)	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0
Hf	0.0	2.0	5.2	9.3	11.3	13.5	15.9	18.5	21.2	24.0	27.0	30.1	33.4	36.9	40.4	44.1	48.0	52.0
TDH (ft)	39.8	41.8	45.0	49.1	51.1	53.3	55.7	58.3	61.0	63.8	66.8	69.9	73.2	76.7	80.2	83.9	87.8	91.8
Vel. Disch. (fps)	0.0	1.3	2.5	3.8	5.1	6.4	7.6	8.9	10.2	11.5	12.7	14.0	15.3	16.6	17.8	19.1	20.4	21.6



Byron Jackson 14CGM, 1 Stage, 1755 RPM, 25 HP

Q (cfs)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Q (gpm)	0	449	898	1,346	1,795	2,244	2,693	3,142	3,591	4,039	4,488	4,937	5,386	5,835	6,284	6,732	7,181	7,630
Head (ft)	97	79	66	50	26													

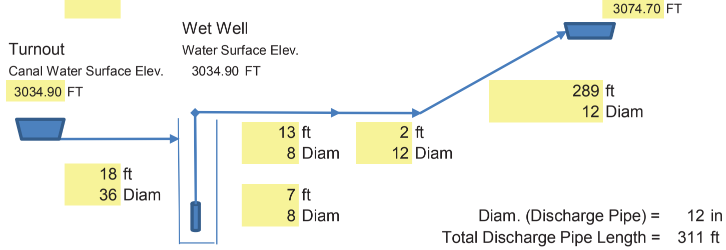
NOTE: Original Pump Byron Jackson 14CGM, 1 Sstage, 1755 RPM, 25 HP has been replaced with a Worthington 12HH-165-F, 1 Stage pump.
Worthington pump curve data not immediately available

Pump to Canal Head Loss Calculations
Mckay Pumping Plant Retrofit

1,350 GPM Vertical Turbine Pump No. 1

Static Head = 39.80 FT

1,350 GPM Total = 3.0 cfs



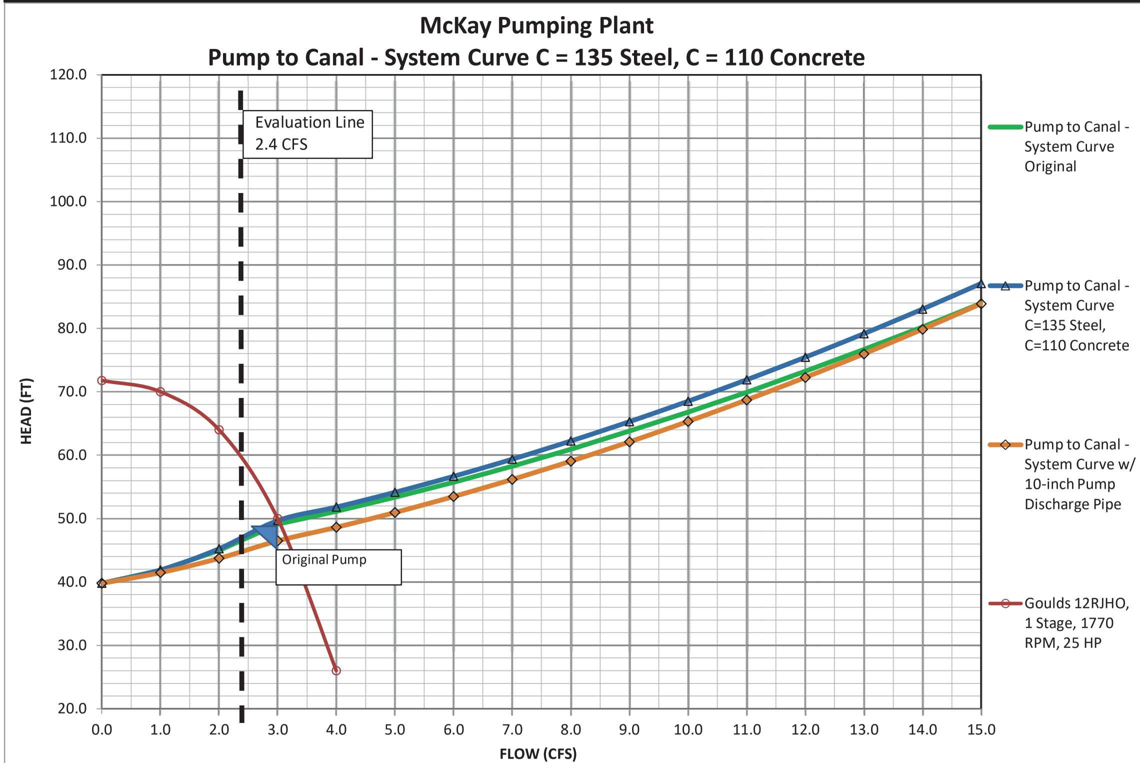
Diam. (Discharge Pipe) = 12 in
Total Discharge Pipe Length = 311 ft
Equiv. Pipe Length Valves & Fittings Pump Discharge = 139 ft
Equiv. Pipe Length Valves & Fittings Discharge Header = 5 ft

36-inch Opening to PS Wet Well	Friction Head =	0.03 FT per 1,000 FT	Concrete
	Dynamic Head =	0.00 FT total	C = 110
8" Column Pipe	Friction Head =	29.95 FT per 1,000 FT	Steel
(Vel. = 8.6 fps)	Dynamic Head =	0.21 FT total	C = 135
8" Discharge Piping	Friction Head =	29.95 FT per 1,000 FT	Steel
(Vel. = 8.6 fps)	Dynamic Head =	0.39 FT total	C = 135
12" Header	Friction Head =	4.17 FT per 1,000 FT	Steel
(Vel. = 3.8 fps)	Dynamic Head =	0.01 FT total	C = 135
12" Discharge	Friction Head =	3.89 FT per 1,000 FT	Asb Cem
(Vel. = 3.8 fps)	Dynamic Head =	1.13 FT total	C = 140
Equivalent Pipe Length Valves & Fittings Pump Discharge	Friction Head =	29.95 FT per 1,000 FT	Steel
	Dynamic Head =	4.16 FT total	C = 135
Equivalent Pipe Length Valves & Fittings Discharge Header	Friction Head =	4.17 FT per 1,000 FT	Steel
	Dynamic Head =	0.02 FT total	C = 135
	Friction Head =	5.92 FT =	2.56 psi
	Water Depth in Discharge Canal =	4.00 FT =	1.73 psi
	Total Dynamic Head =	49.72 FT =	21.52 psi

Equivalent Pipe Length Totals:			
Item	8" Equiv. Length	No. of Units	Total Equiv. Length
8" pump discharge head	57 ft	1 ea	57 ft
8" check valve	74 ft	1 ea	74 ft
8" pump control (gate) valve	3 ft	1 ea	3 ft
8" 30 bend	5 ft	1 ea	5 ft
		Subtotal	139 ft
Item	12" Equiv. Length	No. of Units	Total Equiv. Length
8"x8"x12" tee branch flow	25 ft	0 ea	0 ft
8"x12" expander	5 ft	1 ea	5 ft
		Subtotal	5 ft

McKay Pumping Plant
Pump to Canal - System Curve C=135 Steel, C=110 Concrete

Q (gpm)	0	449	898	1,346	1,795	2,244	2,693	3,142	3,591	4,039	4,488	4,937	5,386	5,835	6,284	6,732	7,181	7,630
Q (cfs)	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0
Hf	0.0	2.1	5.4	9.9	12.0	14.3	16.9	19.6	22.4	25.5	28.7	32.1	35.6	39.4	43.2	47.3	51.5	55.8
TDH (ft)	39.8	41.9	45.2	49.7	51.8	54.1	56.7	59.4	62.2	65.3	68.5	71.9	75.4	79.2	83.0	87.1	91.3	95.6
Vel. Disch. (fps)	0.0	1.3	2.5	3.8	5.1	6.4	7.6	8.9	10.2	11.5	12.7	14.0	15.3	16.6	17.8	19.1	20.4	21.6



Goulds 12RJHO, 1 Stage, 1770 RPM, 25 HP																		
Q (cfs)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Q (gpm)	0	449	898	1,346	1,795	2,244	2,693	3,142	3,591	4,039	4,488	4,937	5,386	5,835	6,284	6,732	7,181	7,630
Head (ft)	72	70	64	50	26													

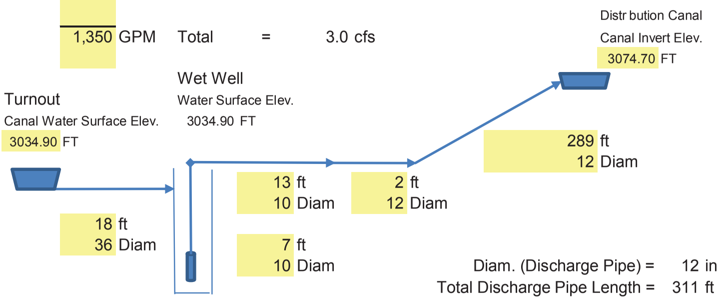
NOTE: Original Pump Byron Jackson 14CGM, 1 Sstage, 1755 RPM, 25 HP has been replaced with a Worthington 12HH-165-F, 1 Stage pump. Worthington pu
data not immediately available. Gould 12 RJHO, 1 Stage, 1770 RPM, 25 HP pump curve provided for evalaution of discharge pipe changes.

Pump to Canal Head Loss Calculations
McKay Pumping Plant Retrofit

1,350 GPM Vertical Turbine Pump No. 1

Static Head = 39.80 FT

1,350 GPM Total = 3.0 cfs



Diam. (Discharge Pipe) =	12 in
Total Discharge Pipe Length =	311 ft
Equiv. Pipe Length Valves & Fittings Pump Discharge =	134 ft
Equiv. Pipe Length Valves & Fittings Discharge Header =	5 ft

36-inch Opening to PS Wet Well	Friction Head =	0.03 FT per 1,000 FT	Concrete
	Dynamic Head =	0.00 FT total	C = 110
10" Column Pipe	Friction Head =	10.11 FT per 1,000 FT	Steel
(Vel. = 5.5 fps)	Dynamic Head =	0.07 FT total	C = 135
10" Discharge Piping	Friction Head =	10.11 FT per 1,000 FT	Steel
(Vel. = 5.5 fps)	Dynamic Head =	0.13 FT total	C = 135
12" Header	Friction Head =	4.17 FT per 1,000 FT	Steel
(Vel. = 3.8 fps)	Dynamic Head =	0.01 FT total	C = 135
12" Discharge	Friction Head =	3.89 FT per 1,000 FT	Asb Cem
(Vel. = 3.8 fps)	Dynamic Head =	1.13 FT total	C = 140
Equivalent Pipe Length	Friction Head =	10.11 FT per 1,000 FT	Steel
Valves & Fittings Pump Discharge	Dynamic Head =	1.36 FT total	C = 135
Equivalent Pipe Length	Friction Head =	4.17 FT per 1,000 FT	Steel
Valves & Fittings Discharge Header	Dynamic Head =	0.02 FT total	C = 135
	Friction Head =	2.71 FT =	1.17 psi
	Water Depth in Discharge Canal =	4.00 FT =	1.73 psi
	Total Dynamic Head =	46.51 FT =	20.14 psi

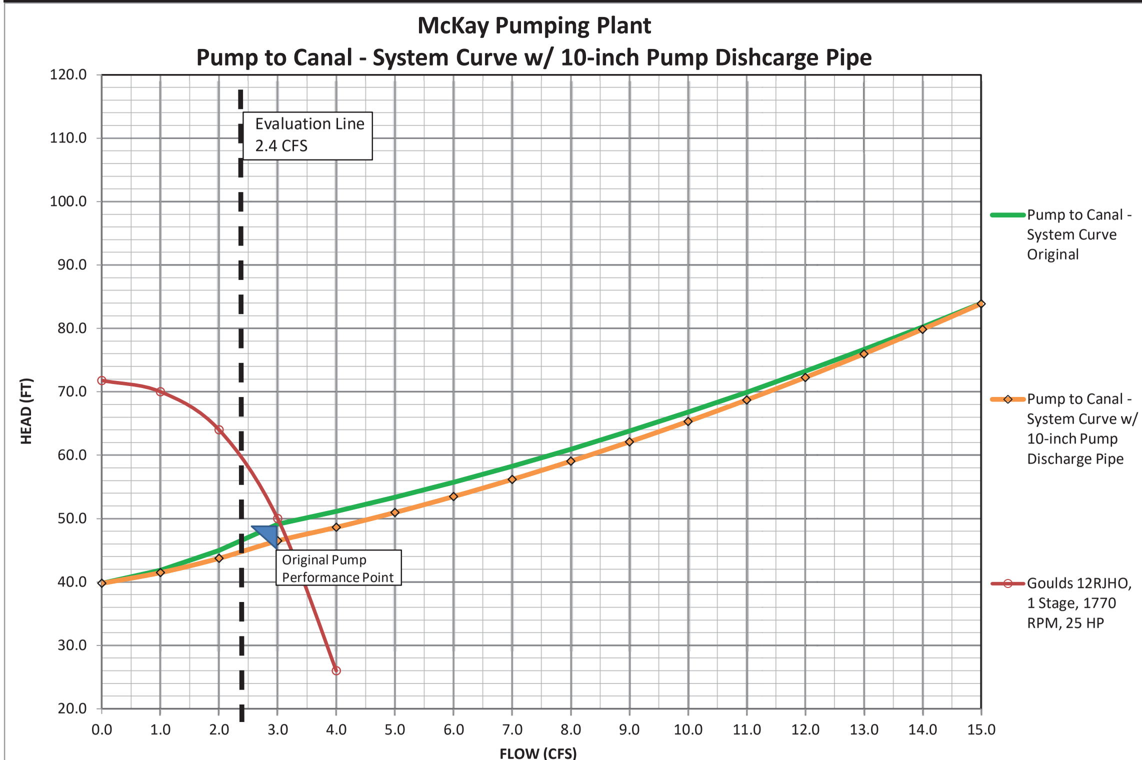
Equivalent Pipe Length Totals:

Item	8" Equiv. Length	No. of Units	Total Equiv. Length
8" pump discharge head	57 ft	1 ea	57 ft
8" check valve	74 ft	1 ea	74 ft
8" pump control (gate) valve	3 ft	1 ea	3 ft
		Subtotal	134 ft

Item	12" Equiv. Length	No. of Units	Total Equiv. Length
8"x8"x12" tee branch flow	25 ft	0 ea	0 ft
8"x12" expander	5 ft	1 ea	5 ft
		Subtotal	5 ft

McKay Pumping Plant
Pump to Canal - System Curve w/ 10-inch Pump Discharge Pipe

Q (gpm)	0	449	898	1,346	1,795	2,244	2,693	3,142	3,591	4,039	4,488	4,937	5,386	5,835	6,284	6,732	7,181	7,630
Q (cfs)	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0
Hf	0.0	1.7	3.9	6.7	8.8	11.2	13.7	16.4	19.2	22.3	25.5	28.9	32.4	36.2	40.0	44.1	48.3	52.6
TDH (ft)	39.8	41.5	43.7	46.5	48.6	51.0	53.5	56.2	59.0	62.1	65.3	68.7	72.2	76.0	79.8	83.9	88.1	92.4
Vel. Disch. (fps)	0.0	1.3	2.5	3.8	5.1	6.4	7.6	8.9	10.2	11.5	12.7	14.0	15.3	16.6	17.8	19.1	20.4	21.6



Goulds 12RJHO, 1 Stage, 1770 RPM, 25 HP

Q (cfs)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Q (gpm)	0	449	898	1,346	1,795	2,244	2,693	3,142	3,591	4,039	4,488	4,937	5,386	5,835	6,284	6,732	7,181	7,630
Head (ft)	72	70	64	50	26													

Pump to Canal Head Loss Calculations
McKay Pumping Plant Reconstruction (Existing vertical turbine with new pump discharge piping and valves)

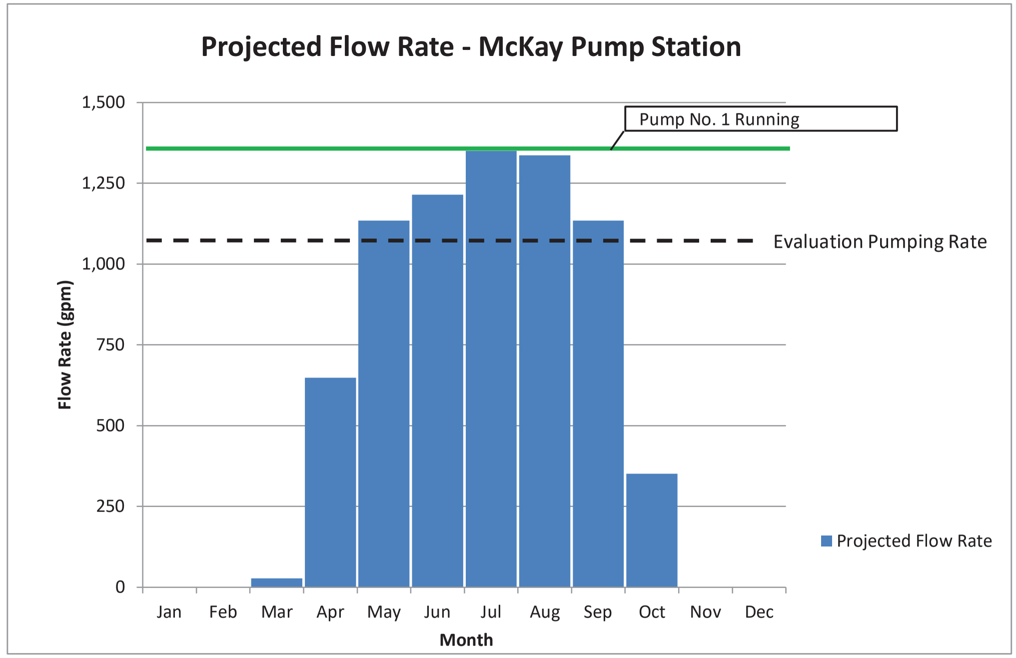
1,350 GPM Vertical Turbine Pump No. 1

1,350 GPM Total = 3.0 cfs

Proposed PS Design Flow Rate = 1,350 gpm

Month	% of Max Flow Rate	Projected Flow Rate
Jan	0%	0
Feb	0%	0
Mar	2%	27
Apr	48%	648
May	84%	1,134
Jun	90%	1,215
Jul	100%	1,350
Aug	99%	1,337
Sep	84%	1,134
Oct	26%	351
Nov	0%	0
Dec	0%	0

Evaluation Pumping Rate = 1,079 gpm
2.4 cfs



Notes: Mckay PS when refitted with new pump discharge piping and new valves. VFD operation could provide benefit toward reducing energy use and optimizing water delivery to crop requirement. With Pump No. 1 fitted with VFD control, it could be modulated to a flow rate that allows its use to reasonably match projected seasonal demand requirements.

Ochoco Irrigation District

McKay PS (Replace existing pump discharge piping)

Budget Level - Projection of Probable Construction Cost

Item No.	Spec Division	Description	Measurement	Units	Unit Cost	Total Cost
1	1000	Mobilization	LS	1	$800.00	$800.00
2	1000	Project Management and Coordination	LS	1	$500.00	$500.00
3	1000	Submittal Procedures	LS	1	$500.00	$500.00
4	1000	Selective Demolition	LS	1	$750.00	$750.00
5	1000	Project Record Documents	LS	1	$500.00	$500.00
6	1000	Operations and Maintenance Data	LS	1	$500.00	$500.00
7	1000	General Commissioning Requirements	LS	1	$500.00	$500.00
8	2000	Surfacing Rock	CY	10	$38.00	$380.00
9	9000	High Performance Coating Systems	LS	1	$750.00	$750.00
10	15000	10-inch Handwheel Operated Butterfly Valve	EA	1	$2,250.00	$2,250.00
11	15000	10-inch Surge Control Check Valve	EA	1	$5,250.00	$5,250.00
12	15000	10-inch Discharge Pipe, Fittings, & Accessories	EA	1	$3,000.00	$3,000.00
13	16000	Power and Distribution	LS	0	$0.00	$0.00
14	16000	Grounding Systems	LS	0	$0.00	$0.00
15	16000	Motor Controls	LS	0	$0.00	$0.00
16	17000	Instrumentation and Control	LS	0	$0.00	$0.00
		Construction Subtotal				$15,680.00
		Contractors Overhead and Profit	10%	1	$1,568.00	$1,568.00
		Contractors Bonds and Insurance	2%	1	$344.96	$344.96
		Construction Contingency	30%	1	$4,704.00	$4,704.00
		Construction Total				$22,296.96
		Engineering, Administration	25%	1	$5,574.24	
		Total				**$27,871.20**

Wire to Water Energy Calculator

Ochoco Irrigation District - SOR

McKay Pumping Plant - Pump Discharge Piping Replacement

Source: PumpTech Inc.

2425 SE Ochoco Street

Portland, OR 97222

503-659-6230

OPERATIONAL AND EQUIPMENT DATA

	Replacement Pump Discharge Piping		Existing Pump Discharge Piping	
	No. 1 - Goulds 14RJHO, 1 Stage, 1770 RPM, 25 HP *		No. 1 - Worthington 12HH-165-F, 1 Stage, 1770 RPM, 25 HP *	
Pump Operation - Hours / Day	24		24	
Pump Operation - Days / Year	198		198	
Pump Flow - GPM (Evaluation Pump Rate)	1,079		1,079	
Pump Flow - CFS	2.4		2.4	
Total Annual Volume - Acre feet	940		940	
Pump Head - Feet	44.8	**	46.9	
Ave. Pump Efficiency - %	78.4%		78.4%	**
Ave. Motor Efficiency - %	93.0%		93.0%	**
Energy Cost in $/kW-hr	$0.035		$0.035	

Replacement Pump Discharge Piping notes:

* Pump Make and Model used to establish pump efficiency

** Estimated Pumping head assumes discharge piping, and valves are changed from 8-inch to 10-inch.

Existing Pump Discharge Piping notes:

* Pump Make and model information as recorded on the pump discharge head.

** Pump and motor efficiency unknown. Assumed to be similar to that of new equipment. Existing equipment is like new.

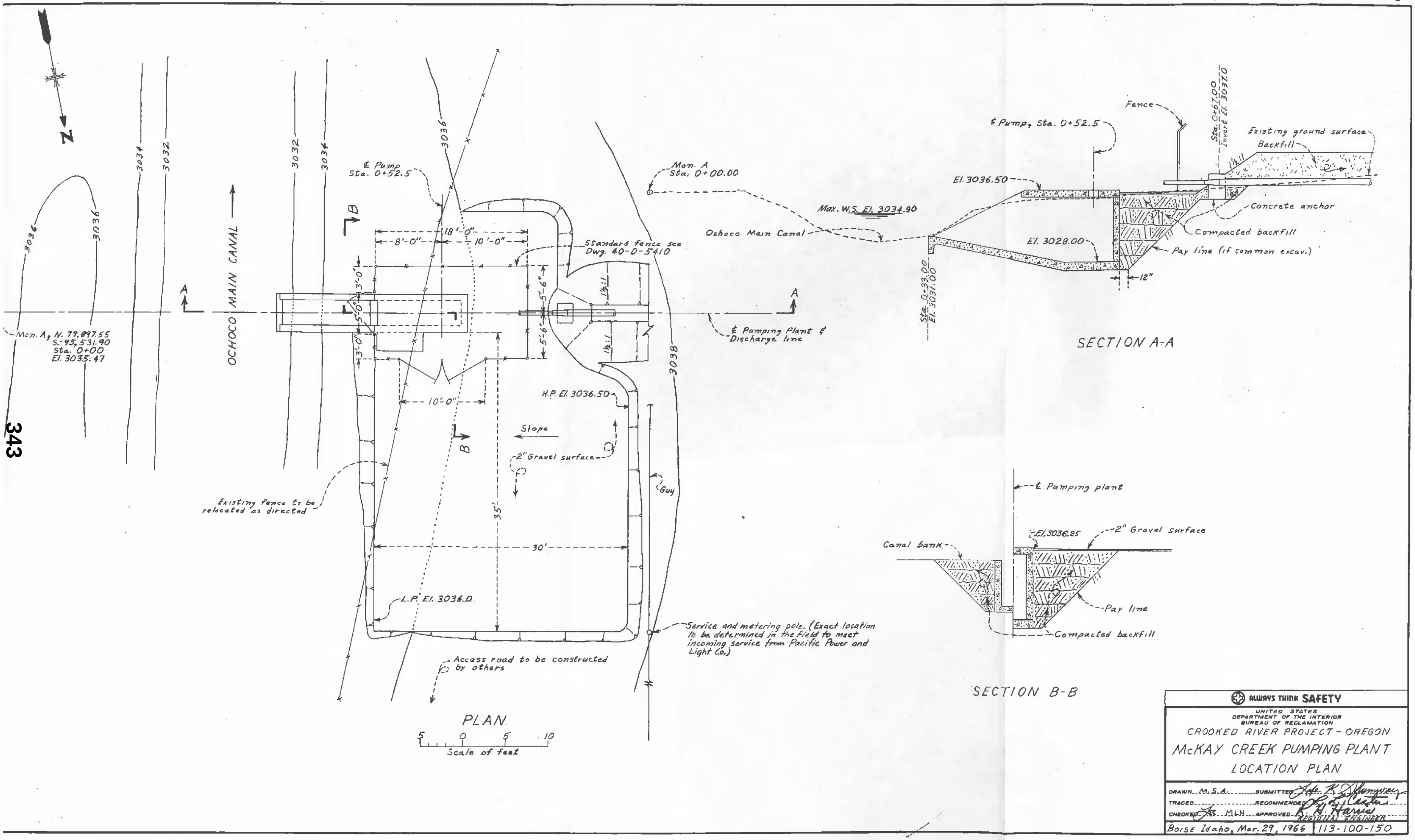
RESULTS

	Replacement Pump Discharge Piping	Existing Pump Discharge Piping
BHP At Design Point	15.6	16.3
Wire to Water Efficiency - %	73%	73%
kW-hr per Year	0	62,132
Annual Energy Cost	$0.00	$2,174.62
kW-hr Per 1,000 Gallons Pumped	0.000	0.202
Cost Per 1,000 Gallons Pumped	$0.000	$0.007
kW-hr per Acre Foot Pumped	0	66
Cost Per Acre Foot Pumped	$0.00	$2.30

PAYBACK

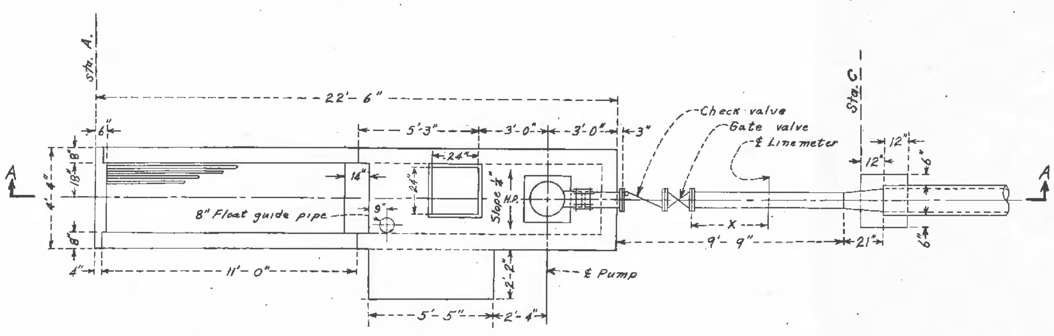
Annual Savings - kW-hr	62,132
Annual Savings - $$	$2,174.62
Annual Savings - %	100.00%
Cost of Replacement Piping	$27,900.00
Cost of Existing Piping	$0.00
Payback - Years	12.8

*** Estimated cost assumes discharge piping, and valves are changed from 8-inch to 10-inch.



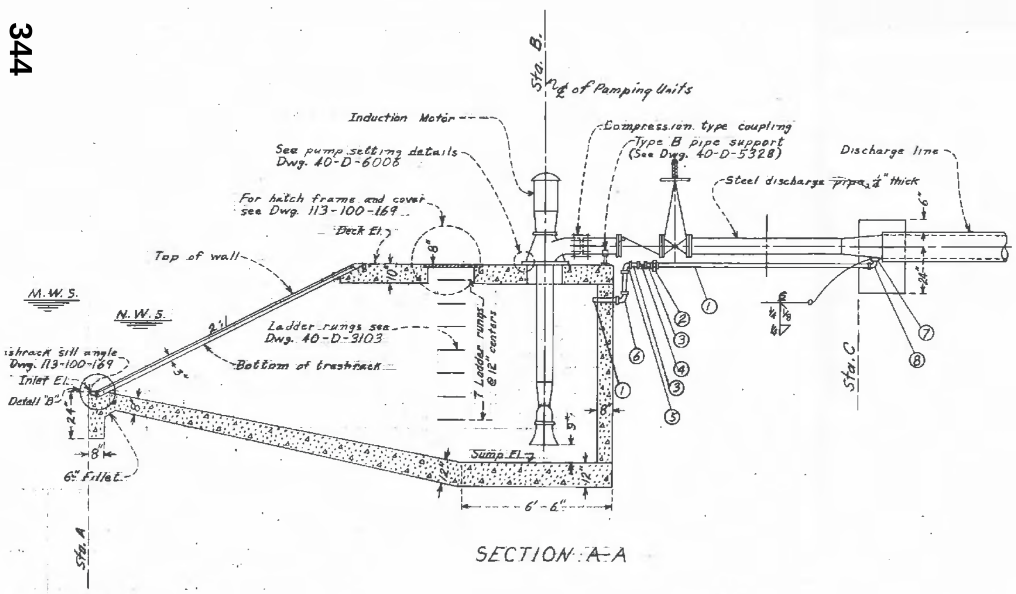
N
OCHOCO MAIN CANAL
3036
3034
3032
Mon. A, N. 79,897.55 S. 95,531.90 Sta. 0+00 El. 3035.47
℄ Pump Sta. 0+52.5
18'-0"
8'-0"
10'-0"
3'-0"
5'-0"
5'-6"
Standard fence see Dwg. 40-D-5410
1½:1
3038
Mon. A Sta. 0+00.00
Max. W.S. El. 3034.90
Ochoco Main Canal
℄ Pumping Plant & Discharge line
H.P. El. 3036.50
Slope
2" Gravel surface
Guy
35'
30'
L.P. El. 3036.0
Existing fence to be relocated as directed
Service and metering pole. (Exact location to be determined in the field to meet incoming service from Pacific Power and Light Co.)
Access road to be constructed by others
PLAN
5 0 5 10
Scale of feet
℄ Pump, Sta. 0+52.5
Fence
Sta. 0+67.00 Invert El. 3037.0
Existing ground surface
Backfill
El. 3036.50
Concrete anchor
Compacted backfill
El. 3028.00
Pay line (if common excav.)
12"
Sta. 0+33.00 El. 3031.00
SECTION A-A
℄ Pumping plant
El. 3036.25
2" Gravel surface
Canal bank
Pay line
Compacted backfill
SECTION B-B
ALWAYS THINK SAFETY
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CROOKED RIVER PROJECT - OREGON
McKAY CREEK PUMPING PLANT
LOCATION PLAN
DRAWN M.S.A. SUBMITTED
TRACED RECOMMENDED
CHECKED M.L.N. APPROVED
REGIONAL ENGINEER
Boise Idaho, Mar. 29, 1966
113-100-150

11

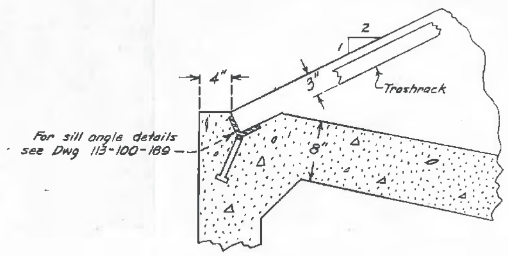


PLAN

Scale of feet



SECTION A-A



DETAIL "B"

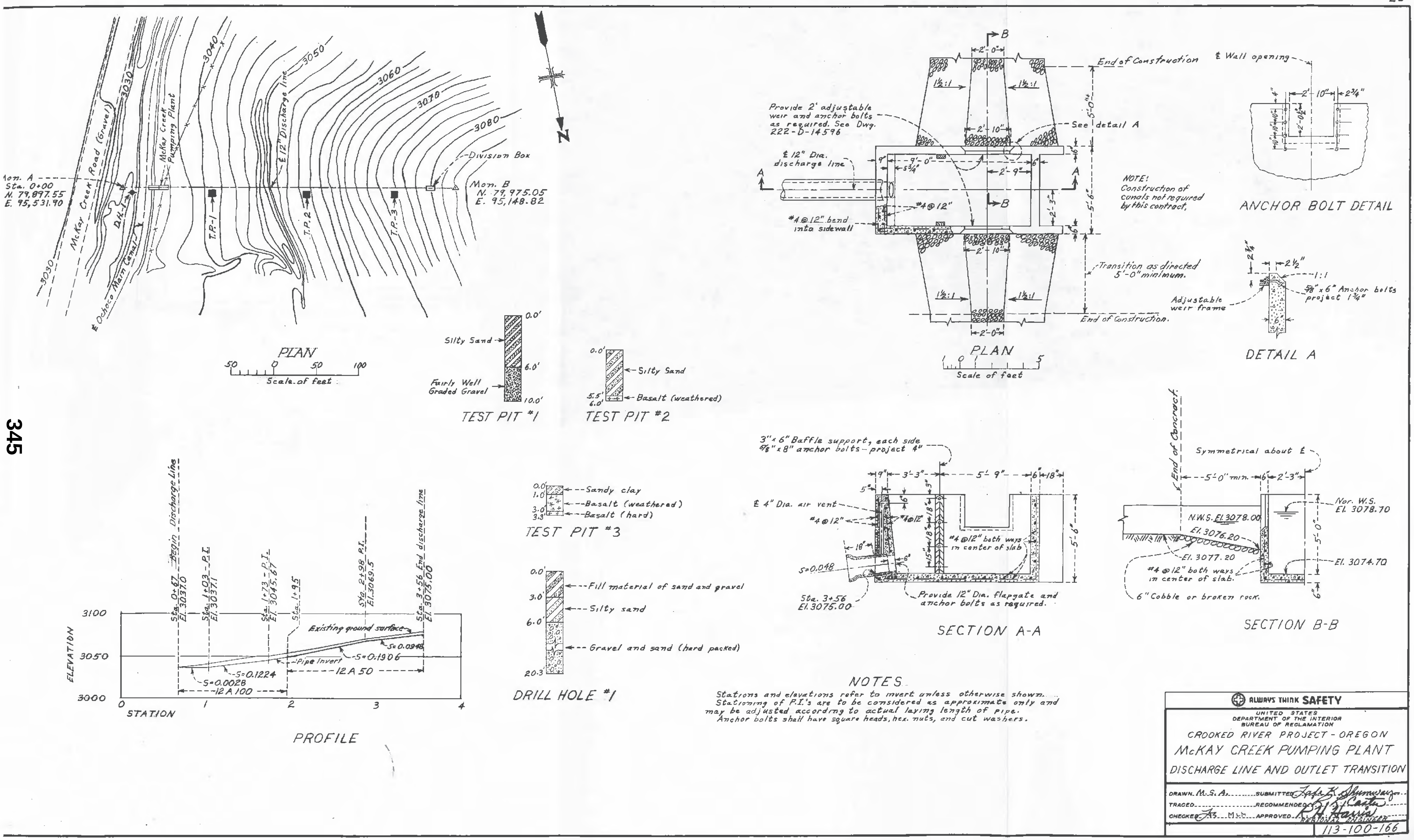
	McKAY CREEK Pumping Plant	HUDSPETH Pumping Plant
Q cfs	3.0	2.0
G.P.M.	1350	900
T.D.H. feet	49'	59'
Steel Manifold I.D.	8"+12"	6"+10"
Discharge line I.D.	12"	10"
Deck El. (H.P.)	3036.50	3037.50
Inlet El.	3031.00	3032.00
Sump El.	3028.00	3029.00
Normal W.S. El.	3034.10	3034.90
Max. W.S. El.	3034.90	—
Dimension X.	5'-0"	4'-0"
Station A	0+33.00	0+28.00
Station B	0+52.50	0+47.50
Station C	0+66.00	0+61.00

① 2" Standard steel galv. pipe
② 2"-150# M.I. Female Union, brass to iron seat, ground joint.
③ 2" Standard steel galv. Nipple, 0'-3" long.
④ 2"-125# Standard Wedge Gate Valve, R.S.
⑤ 2"-90°-150# M.I. Female Union Elbow, brass to iron seat, ground joint.
⑥ 2"-90°-150# M.I. Screwed Elbow.
⑦ 2" Extra Heavy Half Coupling.
⑧ 2"-90°-150# M.I. Street Elbow.

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CROOKED RIVER PROJECT - OREGON
McKAY CREEK AND HUDSPETH PUMPING PLANTS
GENERAL ARRANGEMENT AND OUTLINE

DRAWN M.S.A. SUBMITTED [signature]
TRACED RECOMMENDED [signature]
CHECKED [signature] APPROVED R.H. Harris, REGIONAL ENGINEER
BOISE, IDAHO - MAR. 28, 1966 | 113-100-157


Mon. A
Sta. 0+00
N. 79,897.55
E. 95,531.90
McKay Creek Road (Gravel)
℄ Ochoco Main Canal
D.H.-1
McKay Creek Pumping Plant
T.P.-1
℄ 12" Discharge line
T.P.2
T.P.-3
Division Box
Mon. B
N. 79,975.05
E. 95,148.82
3030
3040
3050
3060
3070
3080
N
PLAN
Scale of feet
Silty Sand
Fairly Well Graded Gravel
TEST PIT #1
Silty Sand
Basalt (weathered)
TEST PIT #2
Sandy clay
Basalt (weathered)
Basalt (hard)
TEST PIT #3
Fill material of sand and gravel
Silty sand
Gravel and sand (hard packed)
DRILL HOLE #1
Sta. 0+67 Begin Discharge Line
El. 3037.0
Sta. 1+03 - P.I.
El. 3037.1
Sta. 1+73 - P.I.
El. 3045.67
Sta. 1+95
Sta. 2+98 P.I.
El. 3069.5
Sta. 3+56 End discharge line
El. 3075.00
Existing ground surface
Pipe Invert
S=0.0028
S=0.1224
S=0.1906
S=0.0948
12 A 100
12 A 50
ELEVATION
STATION
PROFILE
Provide 2' adjustable weir and anchor bolts as required. See Dwg. 222-D-14596
℄ 12" Dia. discharge line
#4 @ 12" bend into sidewall
#4 @ 12"
See detail A
End of Construction
NOTE: Construction of canals not required by this contract.
Transition as directed 5'-0" minimum.
PLAN
Scale of feet
℄ Wall opening
ANCHOR BOLT DETAIL
Adjustable weir frame
5/8" x 6" Anchor bolts project 1¾"
DETAIL A
3" x 6" Baffle support, each side 5/8" x 8" anchor bolts - project 4"
℄ 4" Dia. air vent
#4 @ 12" both ways in center of slab
S=0.048
Sta. 3+56
El. 3075.00
Provide 12" Dia. flapgate and anchor bolts as required.
SECTION A-A
End of Concrete
Symmetrical about ℄
Nor. W.S. El. 3078.70
N.W.S. El. 3078.00
El. 3076.20
El. 3077.20
El. 3074.70
#4 @ 12" both ways in center of slab.
6" Cobble or broken rock.
SECTION B-B
NOTES
Stations and elevations refer to invert unless otherwise shown.
Stationing of P.I.'s are to be considered as approximate only and may be adjusted according to actual laying length of pipe.
Anchor bolts shall have square heads, hex. nuts, and cut washers.
ALWAYS THINK SAFETY
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CROOKED RIVER PROJECT - OREGON
McKAY CREEK PUMPING PLANT
DISCHARGE LINE AND OUTLET TRANSITION
DRAWN M.S.A.
SUBMITTED
TRACED
RECOMMENDED
CHECKED
APPROVED
113-100-166

Pump Performance Datasheet

Customer	: Ochoco Irrigation District	Quote number	:
Customer reference	: OID - SOR McKay Pump Sta	Item description	: 12RJHO
Item number	: Replacement Pump No. 1	Stages	: 1
Service	: Irrigation Water	Based on curve number	: 12RJHO-1760
Quantity	: 1	Date last saved	: 27 May 2011 7:51 PM

Operating Conditions

Flow, rated	: 1,350.0 USgpm
Differential head / pressure, rated (requested)	: 50.00 ft
Differential head / pressure, rated (actual)	: 50.01 ft
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: 38.95 ft
Frequency	: 60 Hz

Performance

Speed, rated	: 1,760 rpm
Impeller diameter, rated	: 7.94 in
Impeller diameter, maximum	: 8.00 in
Impeller diameter, minimum	: 6.25 in
Efficiency (bowl / pump)	: 82.69 / - %
NPSH required / margin required	: 21.87 / 5.00 ft
Ns (imp. eye flow) / Nss (imp. eye flow)	: 2,838 / 7,065 US Units
MCSF	: 600.0 USgpm
Head, maximum, rated diameter	: 71.77 ft
Head rise to shutoff	: 43.44 %
Flow, best eff. point (BEP)	: 1,146.4 USgpm
Flow ratio (rated / BEP)	: 117.76 %
Diameter ratio (rated / max)	: 99.22 %
Head ratio (rated dia / max dia)	: 98.85 %
Cq/Ch/Ce [ANSI/HI 9.6.7-2004]	: 1.00 / 1.00 / 1.00
Selection status	: Acceptable

Liquid

Liquid type	: Water
Additional liquid description	: Raw Water
Solids diameter, max	: 1.12 in
Solids concentration, by volume	: 0.00 %
Temperature, max	: 68.00 deg F
Fluid density, rated / max	: 1.000 / 1.000 SG
Viscosity, rated	: 1.00 cP
Vapor pressure, rated	: 0.00 psi.a

Material

Material selected	: CI Bowl (Lined) / Std. Brz Impeller

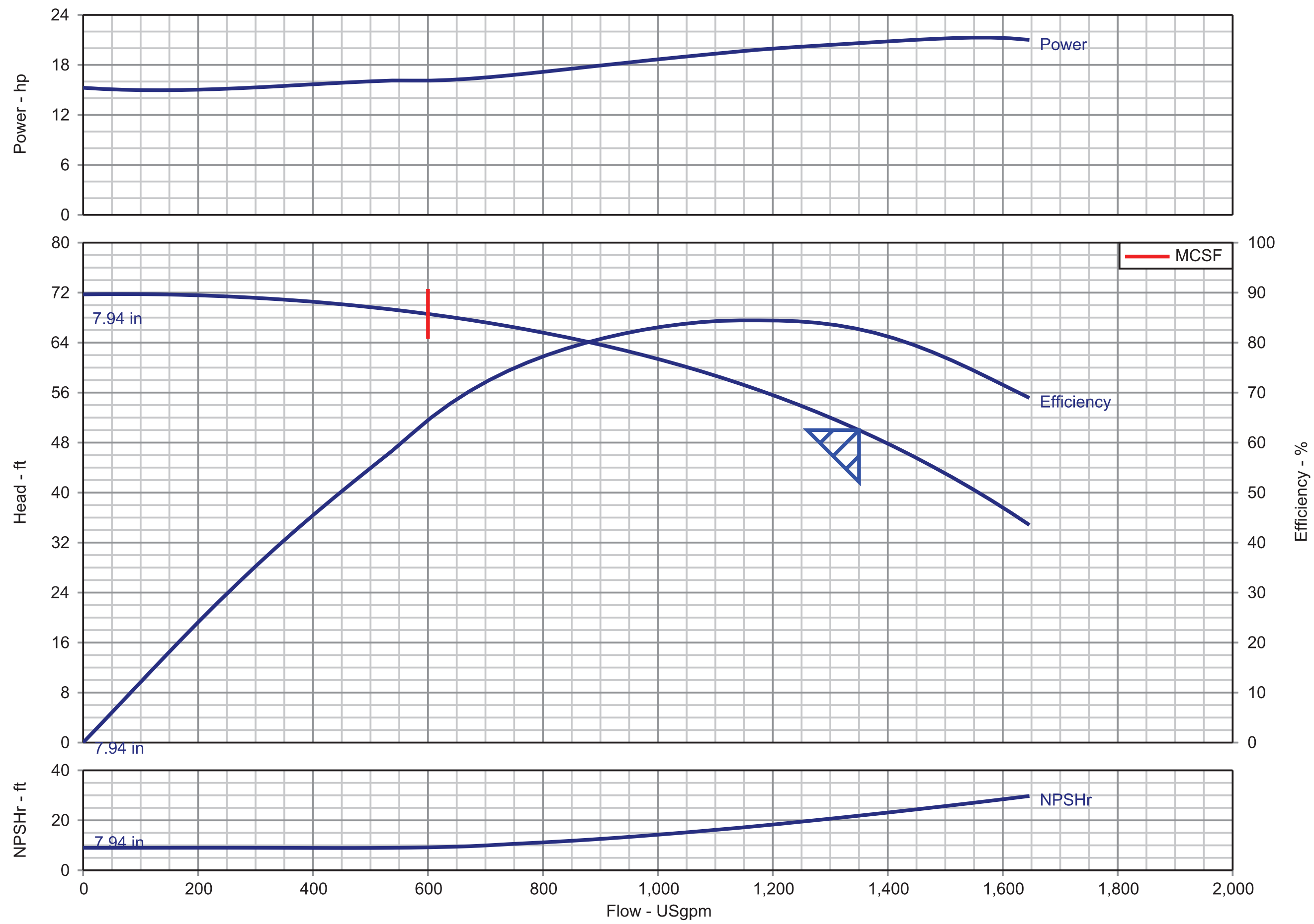
Pressure Data

Maximum working pressure	: 31.07 psi.g
Maximum allowable working pressure	: 430.0 psi.g
Maximum allowable suction pressure	: N/A
Hydrostatic test pressure	: N/A

Driver & Power Data

Driver sizing specification	: Maximum power
Margin over specification	: 0.00 %
Service factor	: 1.15
Power, hydraulic	: 17.04 hp
Power (bowl / pump)	: 20.61 / -
Power, maximum, rated diameter	: 21.28 hp
Minimum recommended motor rating	: 25.00 hp / 18.64 kW

Bowl performance. Adjusted for construction and viscosity.
The duty point represents the head at the bowl.



TUNNEL PUMPING PLANT - EVALUATION SUMMARY

OID infrastructure assets serving peripheral acreage were completed in the Crooked River Project Extension include six small pumping plants and associated canals, laterals, and drains. These features serve lands of six separate areas located generally east and north of the original Barnes Butte and Ochoco Relift project area. The Tunnel pumping plant lifts water from the Ochoco Main Canal.[1]

Since its original construction circa 1966, the Tunnel Pumping Plant and discharge main have been relocated approximately 1/2 mile north of the original site. Field reconnaissance of the reconstructed Tunnel Pumping Plant was conducted 4-29-11 to evaluate current conditions. The discharge main, formerly 488 feet of 18-inch steel pipe, was measured in its new location to be 2,262 feet of 12-inch steel pipe. Reconnaissance level survey of the static lift of the new pumping plant measured 81.4 feet, approximately 1 foot less than the static lift shown on original construction documents. In its current location and configuration only Pump No. 1 and associated discharge piping and starter panel are present.

Original Design

Pump Unit	Description	HP	Rated Capacity	Rated Head	Pump Eff. @ Rated Capacity	Pipe size	Pump Discharge Vel.	Discharge Main Vel.
No. 1	Vertical Turbine	60	1,700 GPM	92 FT	80 % *	8 IN	10.9 FPS	
No. 2	Vertical Turbine	60	1,700 GPM	92 FT	80 % *	8 IN	10.9 FPS	
Total		120	3,400 GPM	92 FT		18 IN		4.3 FPS

* Source: Certified factory curve and product data documents from original construction.

Current Condition

Pump Unit	Description	HP	Capacity	Head	Pump Eff. @ Capacity	Pipe size	Pump Discharge Vel.	Discharge Main Vel.
No. 1	Vertical Turbine	75	1,480 GPM *	100 FT *	65 % **	8 IN	9.4 FPS	
Total		75	1,480 GPM *	100 FT *		12 IN		3.9 FPS

* Assumed pump capacity and head from System Curve C=135 steel, C= 110 Concrete.

** Pump Efficiency assumed equal to measured efficiency of similar equipment at the Johnson Creek Pumping Plant.

Alternate Equipment (Replace Existing Pump, Discharge Piping and Valves)

Pump Unit	Description	HP	Rated Capacity	Rated Head	Pump Eff. @ Rated Capacity	Pipe size	Pump Discharge Vel.	Discharge Main Vel.
No. 1	Vertical Turbine	60	1,700 GPM	101 FT	84 %	10 IN	6.9 FPS	
Total		60	1,700 GPM	101 FT		12 IN		4.8 FPS

[1] US Department of the Interior, Bureau of Reclamation, Ochoco River Project, http://www.usbr.gov/projects/Project.jsp?proj_Name=Crooked River Project&pageType=ProjectPage

Narrative

The original Tunnel pumping plant and discharge main installed circa 1966 were subsequently relocated approximately 1/2 mile north. The relocation work included installation of only Pump No. 1, there is no Pump No. 2 in the current configuration. Based on field reconnaissance 4-29-11and identification of a serial number on the current pumping unit, the pump equipment is assumed to be the original Tunnel Pump No. 1 fitted with a new 75 HP motor.

Evaluation of the Tunnel pumping plant included examination of potential energy efficiency improvements gained by replacing the existing Pump No.1, and replacing existing pump discharge piping and valves. The existing Pump No. 1 is assumed to have 65% efficiency at the design point flow rate of 1,700 gpm (similar efficiency as similar equipment of the same vintage in the OID system). Alternate pumping equipment has a published pump efficiency of 84% at the design point flow rate.

Evaluation of potential energy savings assumes pump discharge piping and valves are increased in size to reduce velocity and friction losses. Existing 8-inch pump discharge piping and valves operate at a velocity of 10.9 fps at 1,700 gpm projected flow rate for alternate equipment. Alternate 10-inch pump discharge piping and valves would operate at 6.9 fps at 1,700 gpm projected flow rate.

Evaluation of potential energy savings through the use of VFD's suggests that variable speed operation of the one pump would be beneficial to matching pump output to seasonal variations in demand. However, the expected energy savings is not expected to pay back the initial investment. The initial cost projection for pumping plant improvements does not includes addition of a VFD drive.

The capacity of the rebuilt pump station is anticipated to be approximately 1,700 gpm (3.8 CFS) at 101.3 feet TDH.

Wire to water energy analysis is based on the projected capacity of the Tunnel Pumping Plant retrofitted with a new pump, new motor, and new pump discharge pipe and valves. The retrofitted pump station is projected to operate at a seasonal average flow of 1,350 gpm (3.0 CFS) at 94.9 feet TDH. The existing pump station in its current condition is projected to yield 3.0 CFS at 97.6 feet TDH.

Action Recommended for Further Evaluation: **New No. 1 Pump and Motor, Vertical Turbine Pump**
Replace pump discharge piping and valves

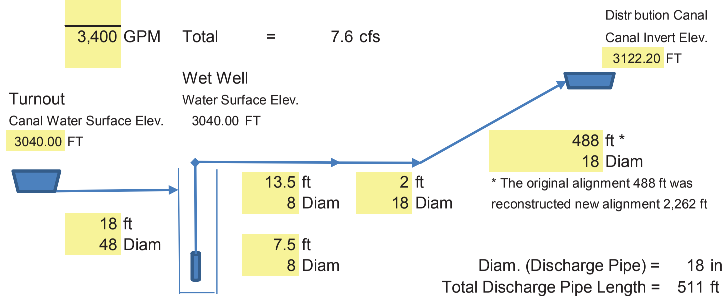
Annual Energy Savings Estimate = **52,977 kW-hr**

Initial Cost Estimate = **$107,000**

Pump to Canal Head Loss Calculations
Tunnel Pumping Plant Retrofit

1,700 GPM	Vertical Turbine Pump No. 1	
1,700 GPM	Vertical Turbine Pump No. 2	
3,400 GPM	Total =	7.6 cfs

Static Head = 82.20 FT



Diam. (Discharge Pipe) =	18 in
Total Discharge Pipe Length =	511 ft
Equiv. Pipe Length Valves & Fittings Pump Discharge =	134 ft
Equiv. Pipe Length Valves & Fittings Discharge Header =	35 ft

3.75 ft x 6 ft trash rack to PS Wet Well	Friction Head =	0.03 FT per 1,000 FT	Concrete
	Dynamic Head =	0.00 FT total	C = 120
8" Column Pipe	Friction Head =	42.89 FT per 1,000 FT	Steel
(Vel. = 10.9 fps)	Dynamic Head =	0.32 FT total	C = 140
8" Discharge Piping	Friction Head =	42.89 FT per 1,000 FT	Steel
(Vel. = 10.9 fps)	Dynamic Head =	0.58 FT total	C = 140
18" Header	Friction Head =	2.99 FT per 1,000 FT	Steel
(Vel. = 4.3 fps)	Dynamic Head =	0.01 FT total	C = 140
18" Discharge	Friction Head =	2.99 FT per 1,000 FT	Steel
(Vel. = 4.3 fps)	Dynamic Head =	1.46 FT total	C = 140
Equivalent Pipe Length	Friction Head =	42.89 FT per 1,000 FT	Steel
Valves & Fittings Pump Discharge	Dynamic Head =	5.75 FT total	C = 140
Equivalent Pipe Length	Friction Head =	2.99 FT per 1,000 FT	Steel
Valves & Fittings Discharge Header	Dynamic Head =	0.10 FT total	C = 140
	Friction Head =	8.22 FT =	3.56 psi
	Water Depth in Discharge Canal =	4.55 FT =	1.97 psi
	Total Dynamic Head =	94.96 FT =	41.11 psi

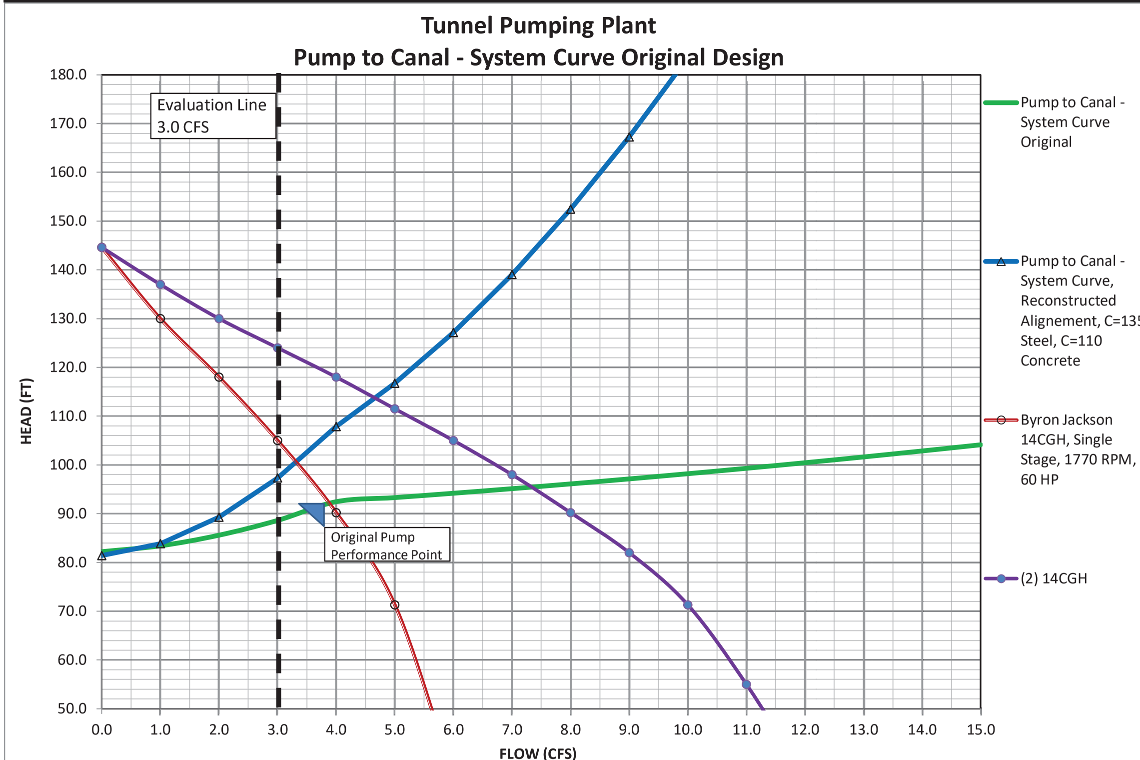
Equivalent Pipe Length Totals:

Item	8" Equiv. Length	No. of Units	Total Equiv. Length
8" pump discharge head	57 ft	1 ea	57 ft
8" check valve	74 ft	1 ea	74 ft
8" pump control (gate) valve	3 ft	1 ea	3 ft
		Subtotal	134 ft

Item	18" Equiv. Length	No. of Units	Total Equiv. Length
8"x8"x18" tee branch flow	25 ft	1 ea	25 ft
8"x18" expander	5 ft	1 ea	5 ft
18" Flap Gate	5 ft	1 ea	5 ft
		Subtotal	35 ft

Tunnel Pumping Plant
Pump to Canal - System Curve Original

Q (gpm)	0	449	898	1,346	1,795	2,244	2,693	3,142	3,590	4,039	4,488	4,937	5,386	5,834	6,283	6,732	7,181	7,630
Q (cfs)	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0
Hf	0.0	1.2	3.4	6.4	10.2	11.1	12.0	12.9	13.9	14.9	16.0	17.1	18.2	19.4	20.6	21.9	23.2	24.6
TDH (ft)	82.2	83.4	85.6	88.6	92.4	93.3	94.2	95.1	96.1	97.1	98.2	99.3	100.4	101.6	102.8	104.1	105.4	106.8
Vel. Disch. (fps)	0.0	0.6	1.1	1.7	2.3	2.8	3.4	4.0	4.5	5.1	5.7	6.2	6.8	7.4	7.9	8.5	9.1	9.6



Byron Jackson 14CGH, Single Stage, 1770 RPM, 60 HP

Q (cfs)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Q (gpm)	0	449	898	1,346	1,795	2,244	2,693	3,142	3,591	4,039	4,488	4,937	5,386	5,835	6,284	6,732	7,181	7,630
Head (ft)	145	130	118	105	90	71	36											

(2) 14CGH

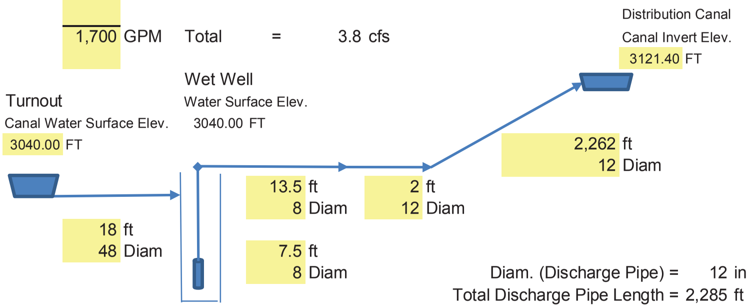
Q (cfs)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Q (gpm)	0	449	898	1,346	1,795	2,244	2,693	3,142	3,591	4,039	4,488	4,937	5,386	5,835	6,284	6,732	7,181	7,630
Head (ft)	145	137	130	124	118	112	105	98	90	82	71	55	36					

Pump to Canal Head Loss Calculations
Tunnel Pumping Plant Retrofit

1,700 GPM Vertical Turbine Pump No. 1

Static Head = 81.40 FT

1,700 GPM Total = 3.8 cfs



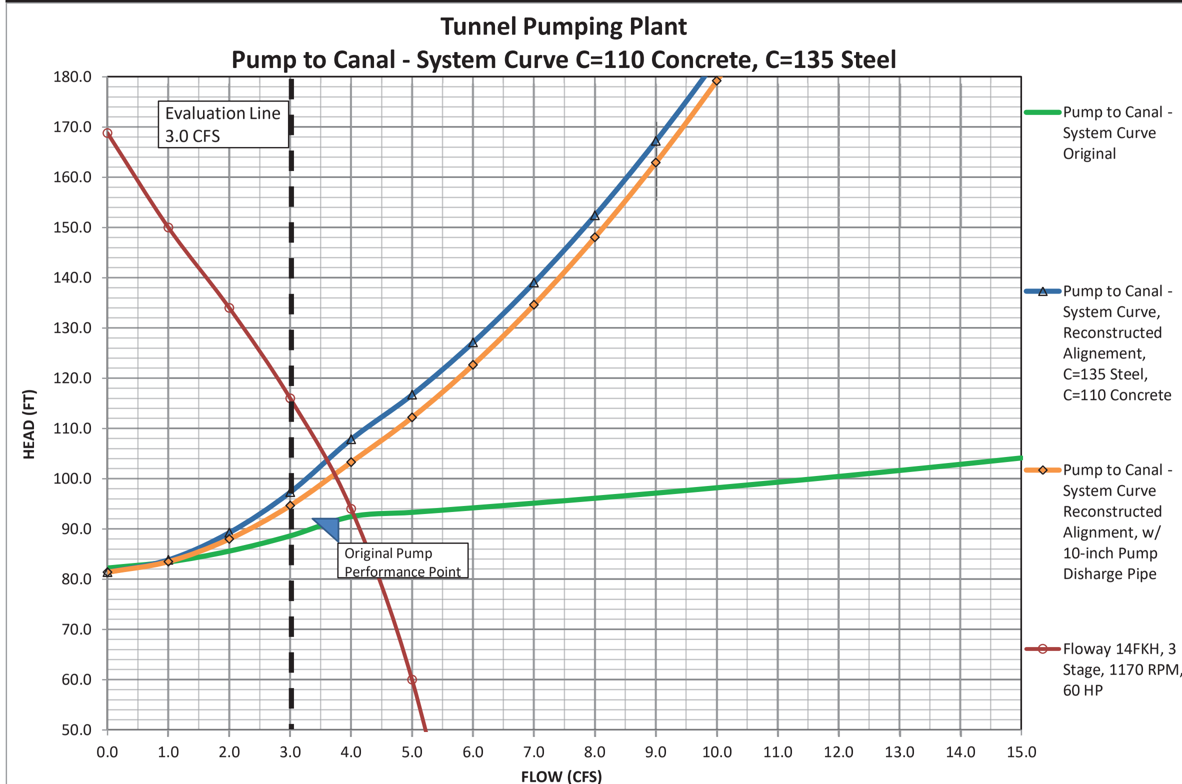
Diam. (Discharge Pipe) = 12 in
Total Discharge Pipe Length = 2,285 ft
Equiv. Pipe Length Valves & Fittings Pump Discharge = 134 ft
Equiv. Pipe Length Valves & Fittings Discharge Header = 30 ft

3.75 ft x 6 ft trash rack to PS Wet Well	Friction Head =	0.01 FT per 1,000 FT		Concrete
	Dynamic Head =	0.00 FT total		C = 110
8" Column Pipe	Friction Head =	45.88 FT per 1,000 FT		Steel
(Vel. = 10.9 fps)	Dynamic Head =	0.34 FT total		C = 135
8" Discharge Piping	Friction Head =	45.88 FT per 1,000 FT		Steel
(Vel. = 10.9 fps)	Dynamic Head =	0.62 FT total		C = 135
12" Header	Friction Head =	6.38 FT per 1,000 FT		Steel
(Vel. = 4.8 fps)	Dynamic Head =	0.01 FT total		C = 135
12" Discharge	Friction Head =	6.38 FT per 1,000 FT		Steel
(Vel. = 4.8 fps)	Dynamic Head =	14.43 FT total		C = 135
Equivalent Pipe Length	Friction Head =	45.88 FT per 1,000 FT		Steel
Valves & Fittings Pump Discharge	Dynamic Head =	6.15 FT total		C = 135
Equivalent Pipe Length	Friction Head =	6.38 FT per 1,000 FT		Steel
Valves & Fittings Discharge Header	Dynamic Head =	0.19 FT total		C = 135
	Friction Head =	21.75 FT =	9.41 psi	
	Water Depth in Discharge Canal =	2.27 FT =	0.98 psi	
	Total Dynamic Head =	105.42 FT =	45.64 psi	

Equivalent Pipe Length Totals:			
Item	8" Equiv. Length	No. of Units	Total Equiv. Length
8" pump discharge head	57 ft	1 ea	57 ft
8" check valve	74 ft	1 ea	74 ft
8" pump control (gate) valve	3 ft	1 ea	3 ft
		Subtotal	134 ft
Item	12" Equiv. Length	No. of Units	Total Equiv. Length
8"x8"x12" tee branch flow	25 ft	1 ea	25 ft
12" Flap Gate	5 ft	1 ea	5 ft
		Subtotal	30 ft

Tunnel Pumping Plant
Pump to Canal - System Curve, Reconstructed Alignement, C=135 Steel, C=110 Concrete

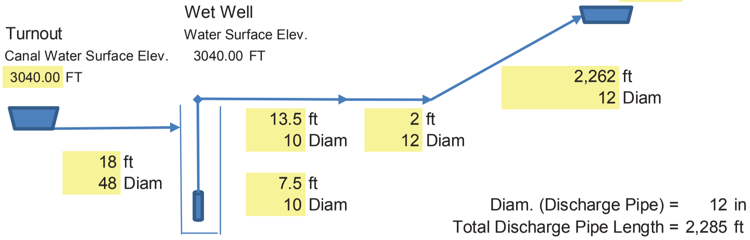
Q (gpm)	0	449	898	1,347	1,795	2,244	2,693	3,142	3,591	4,039	4,488	4,937	5,386	5,835	6,283	6,732	7,181	7,630
Q (cfs)	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0
Hf	0.0	2.5	7.9	15.9	26.5	35.3	45.7	57.7	71.0	85.8	102.1	119.7	138.6	159.0	180.6	203.6	227.9	253.4
TDH (ft)	81.4	83.9	89.3	97.3	107.9	116.7	127.1	139.1	152.4	167.2	183.5	201.1	220.0	240.4	262.0	285.0	309.3	334.8
Vel. Disch. (fps)	0.0	1.3	2.5	3.8	5.1	6.4	7.6	8.9	10.2	11.5	12.7	14.0	15.3	16.6	17.8	19.1	20.4	21.6



Floway 14FKH, 3 Stage, 1170 RPM, 60 HP																		
Q (cfs)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Q (gpm)	0	449	898	1,346	1,795	2,244	2,693	3,142	3,591	4,039	4,488	4,937	5,386	5,835	6,284	6,732	7,181	7,630
Head (ft)	169	150	134	116	94	60	10											

Pump to Canal Head Loss Calculations
Tunnel Pumping Plant Retrofit

1,700 GPM	Vertical Turbine Pump No. 1	
		Static Head = 81.40 FT
1,700 GPM	Total = 3.8 cfs	



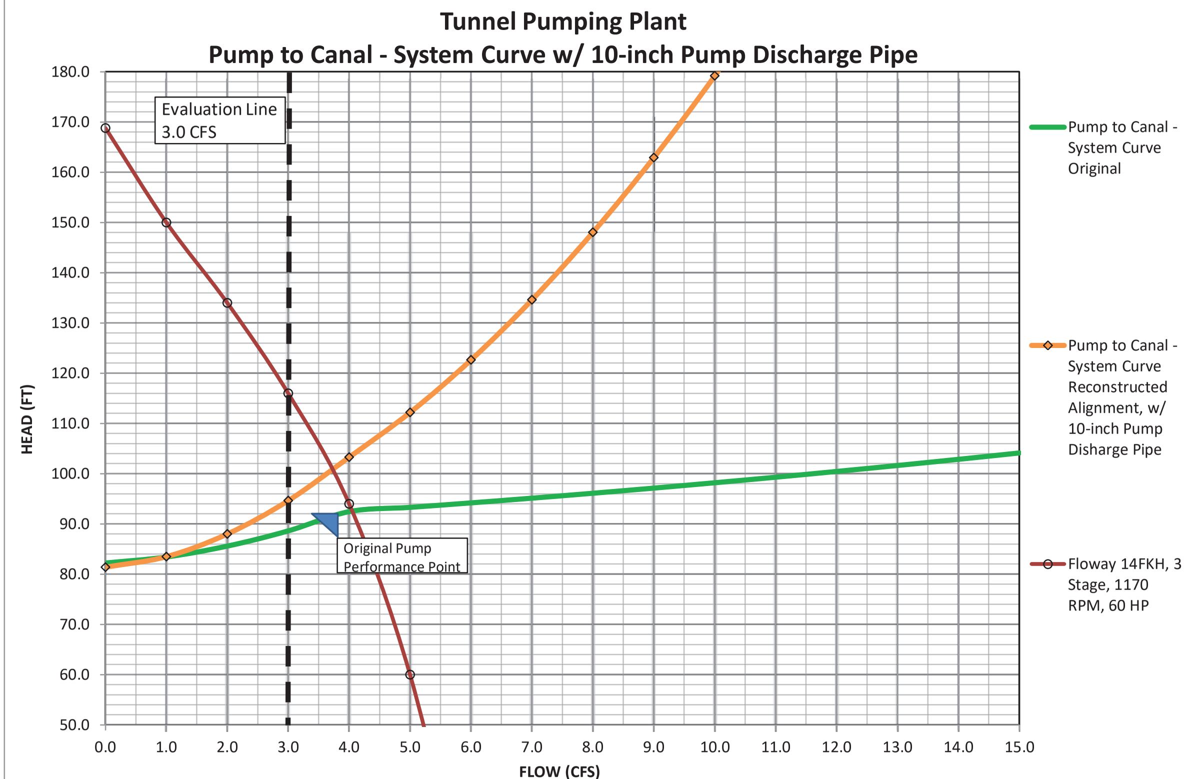
Diam. (Discharge Pipe) = 12 in
Total Discharge Pipe Length = 2,285 ft
Equiv. Pipe Length Valves & Fittings Pump Discharge = 168 ft
Equiv. Pipe Length Valves & Fittings Discharge Header = 40 ft

3.75 ft x 6 ft trash rack to PS Wet Well	Friction Head =	0.01 FT per 1,000 FT	Concrete
	Dynamic Head =	0.00 FT total	C = 110
10" Column Pipe	Friction Head =	15.49 FT per 1,000 FT	Steel
(Vel. = 6.9 fps)	Dynamic Head =	0.12 FT total	C = 135
10" Discharge Piping	Friction Head =	15.49 FT per 1,000 FT	Steel
(Vel. = 6.9 fps)	Dynamic Head =	0.21 FT total	C = 135
12" Header	Friction Head =	6.38 FT per 1,000 FT	Steel
(Vel. = 4.8 fps)	Dynamic Head =	0.01 FT total	C = 135
12" Discharge	Friction Head =	6.38 FT per 1,000 FT	Steel
(Vel. = 4.8 fps)	Dynamic Head =	14.43 FT total	C = 135
Equivalent Pipe Length	Friction Head =	15.49 FT per 1,000 FT	Steel
Valves & Fittings Pump Discharge	Dynamic Head =	2.60 FT total	C = 135
Equivalent Pipe Length	Friction Head =	6.38 FT per 1,000 FT	Steel
Valves & Fittings Discharge Header	Dynamic Head =	0.26 FT total	C = 135
	Friction Head =	17.63 FT =	7.63 psi
	Water Depth in Discharge Canal =	2.27 FT =	0.98 psi
	Total Dynamic Head =	101.30 FT =	43.85 psi

Equivalent Pipe Length Totals:			
Item	10" Equiv. Length	No. of Units	Total Equiv. Length
10" pump discharge head	70 ft	1 ea	70 ft
10" check valve	95 ft	1 ea	95 ft
10" pump control (butterfly) valve	3 ft	1 ea	3 ft
		Subtotal	168 ft
Item	12" Equiv. Length	No. of Units	Total Equiv. Length
12"x12"x12" tee branch flow	35 ft	1 ea	35 ft
12" Flap Gate	5 ft	1 ea	5 ft
		Subtotal	40 ft

Tunnel Pumping Plant
Pump to Canal - System Curve Reconstructed Alignment, w/ 10-inch Pump Discharge Pipe

Q (gpm)	0	449	898	1,346	1,795	2,244	2,693	3,142	3,590	4,039	4,488	4,937	5,386	5,834	6,283	6,732	7,181	7,630
Q (cfs)	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0
Hf	0.0	2.1	6.6	13.3	21.9	30.8	41.3	53.2	66.7	81.5	97.8	115.5	134.5	155.0	176.7	199.8	224.2	249.8
TDH (ft)	81.4	83.5	88.0	94.7	103.3	112.2	122.7	134.6	148.1	162.9	179.2	196.9	215.9	236.4	258.1	281.2	305.6	331.2
Vel. Disch. (fps)	0.0	1.3	2.5	3.8	5.1	6.4	7.6	8.9	10.2	11.5	12.7	14.0	15.3	16.6	17.8	19.1	20.4	21.6



Floway 14FKH, 3 Stage, 1170 RPM, 60 HP																		
Q (cfs)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Q (gpm)	0	449	898	1,346	1,795	2,244	2,693	3,142	3,591	4,039	4,488	4,937	5,386	5,835	6,284	6,732	7,181	7,630
Head (ft)	169	150	134	116	94	60	10											

VFD Analysis

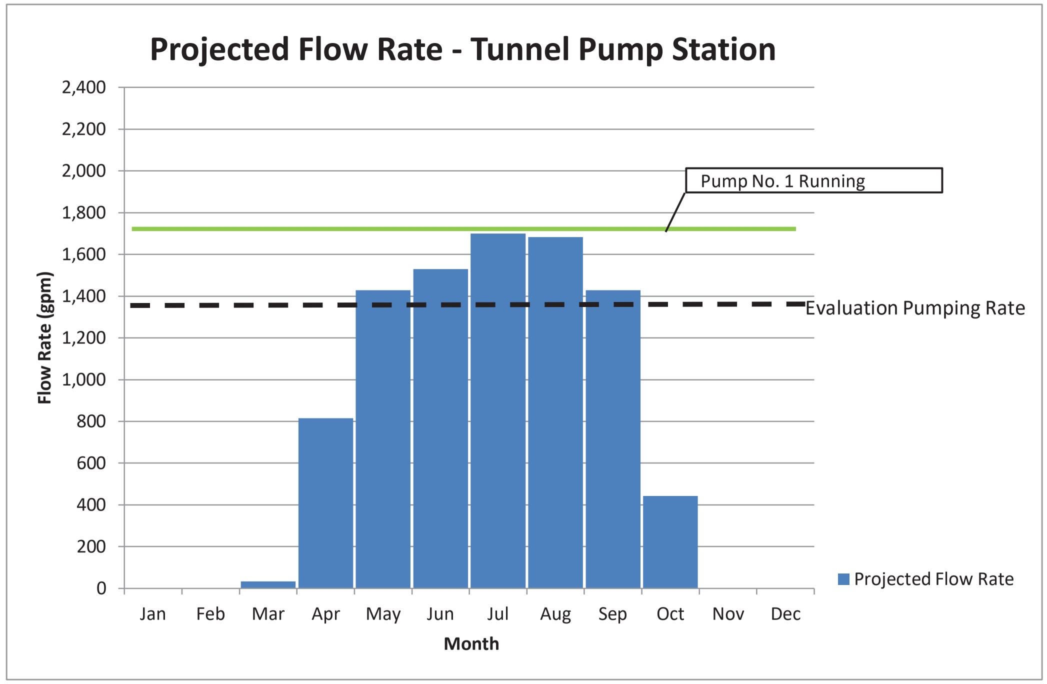
Pump to Canal Head Loss Calculations
Tunnel Pumping Plant Retrofit

1,700	GPM	Vertical Turbine Pump No. 1		
1,700	GPM	Total	=	3.8 cfs

Proposed PS Design Flow Rate = 1,700 gpm

Month	% of Max Flow Rate	Projected Flow Rate
Jan	0%	0
Feb	0%	0
Mar	2%	34
Apr	48%	816
May	84%	1,428
Jun	90%	1,530
Jul	100%	1,700
Aug	99%	1,683
Sep	84%	1,428
Oct	26%	442
Nov	0%	0
Dec	0%	0

Evaluation Pumping Rate = 1,359 gpm
3.0 cfs



Notes: Tunnel PS is currently fitted with (1) Turbine Pump. To optimize water delivery to crop requirement and reduce energy use, VFD operation of Pump No. 1 would provide benefit.

Ochoco Irrigation District

Tunnel PS (Retrofit of pump equipment at existing pump station)

Budget Level - Projection of Probable Construction Cost

Item No.	Spec Division	Description	Measurement	Units	Unit Cost	Total Cost
1	1000	Mobilization	LS	1	$3,000.00	$3,000.00
2	1000	Project Management and Coordination	LS	1	$1,200.00	$1,200.00
3	1000	Construction Progress Documentation	LS	1	$1,200.00	$1,200.00
4	1000	Submittal Procedures	LS	1	$1,200.00	$1,200.00
5	1000	Quality Requirements	LS	1	$1,200.00	$1,200.00
6	1000	Selective Demolition	LS	1	$2,500.00	$2,500.00
7	1000	Project Record Documents	LS	1	$1,200.00	$1,200.00
8	1000	Operations and Maintenance Data	LS	1	$1,200.00	$1,200.00
9	1000	General Commissioning Requirements	LS	1	$2,500.00	$2,500.00
10	2000	Surfacing Rock	CY	10	$38.00	$380.00
11	3000	Misc Cast-in-Place Concrete (thrust and pads)	LS	1	$1,000.00	$1,000.00
12	9000	High Performance Coating Systems	LS	1	$750.00	$750.00
13	11000	Line Shaft Turbine Pump and Motor, 60 HP	EA	1	$31,800.00	$31,800.00
14	15000	10-inch Handwheel Operated Butterfly Valve	EA	1	$2,250.00	$2,250.00
15	15000	10-inch Surge Control Check Valve	EA	1	$5,250.00	$5,250.00
16	15000	10-inch Discharge Pipe, Fittings, & Accessories	EA	1	$3,500.00	$3,500.00
17	16000	Power and Distribution	LS	0	$0.00	$0.00
18	16000	Grounding Systems	LS	0	$0.00	$0.00
19	16000	Motor Controls	LS	0	$0.00	$0.00
20	17000	Instrumentation and Control	LS	0	$0.00	$0.00
		Construction Subtotal				$60,130.00
		Contractors Overhead and Profit	10%	1	$6,013.00	$6,013.00
		Contractors Bonds and Insurance	2%	1	$1,322.86	$1,322.86
		Construction Contingency	30%	1	$18,039.00	$18,039.00
		Construction Total				$85,504.86
		Engineering, Administration	25%	1	$21,376.22	
		Total				**$106,881.08**

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Wire to Water Energy Calculator

Ochoco Irrigation District - SOR

Tunnel Pumping Plant - Pump Replacement

Source: PumpTech Inc.
2425 SE Ochoco Street
Portland, OR 97222
503-659-6230

OPERATIONAL AND EQUIPMENT DATA

	Replacement Pumps		Existing Pumps	
	No. 1 - Floway 14FKH, 3 Stage, 1170 RPM, 60 HP		No. 1 -Byron Jackson 14CGH, 1 Stage, 1770 RPM, 75 HP *	
	No. 2 - None		No. 2 - None **	
Pump Operation - Hours / Day	24		24	
Pump Operation - Days / Year	197		197	
Pump Flow - GPM (Eval. Pump Rate)	1,359		1,359	
Pump Flow - CFS	3.0		3.0	
Total Annual Volume - Acre feet	1,180		1,180	
Pump Head - Feet	94.9	**	97.6	
Ave. Pump Efficiency - %	84%		65%	***
Ave. Motor Efficiency - %	93.0%		91.0%	****
Energy Cost in $/kW-hr	$0.035		$0.035	

Replacement Pumps notes:

* Cost Estimate assumes that only Pump No. 1 will be replaced. Pump No. 2 - None.

** Estimated pumping head assumes pump column pipe, discharge piping, and valves are changed from 8-inch to 12-inch.

Existing Pumps notes:

* Pump make and model information as recorded on the pump discharge head.

** Pump No. 2 not installed at the time of evaluation.

*** Pump efficiency unknown. Estimated to be similar to equipment at Johnson Creek and Grimes Flat pump stations.

**** Motor efficiency unknown. Estimated to be similar to equipment at Johnson Creek and Grimes Flat pump stations.

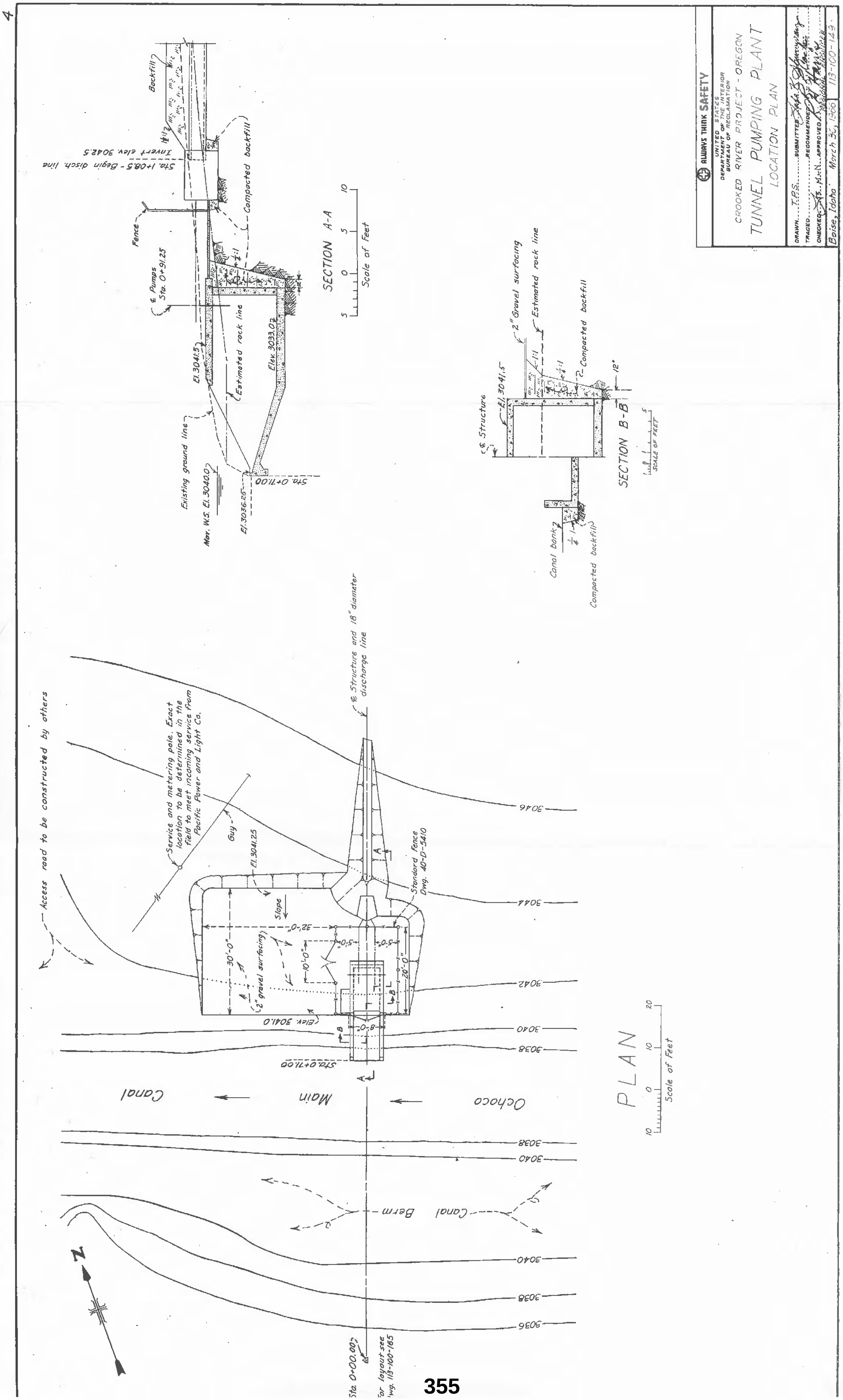
RESULTS

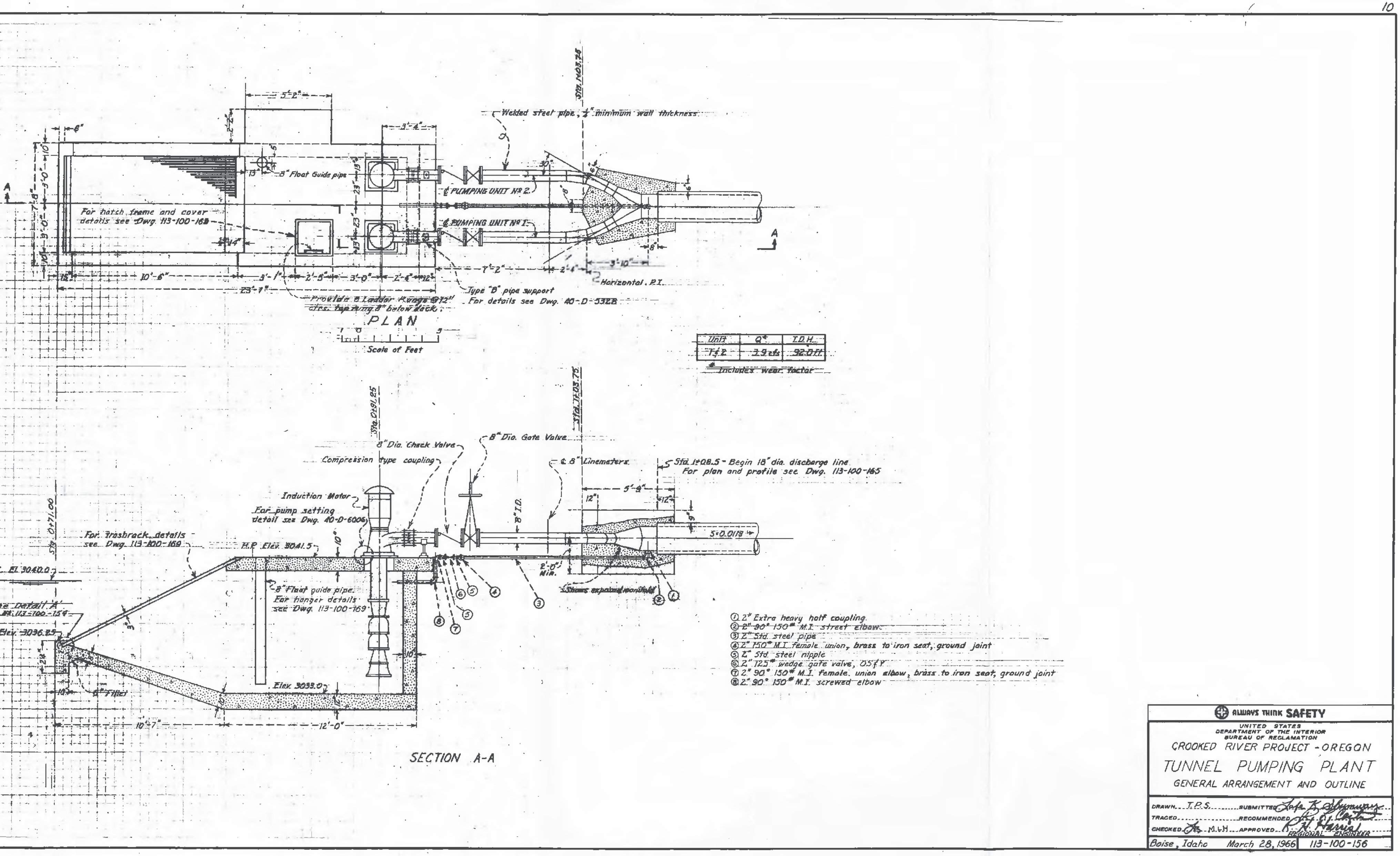
	Replacement Pumps	Existing Pumps
BHP At Design Point	38.8	51.5
Wire to Water Efficiency - %	78%	59%
kW-hr per Year	146,997	199,706
Annual Energy Cost	$5,144.88	$6,989.71
kW-hr Per 1,000 Gallons Pumped	0.381	0.518
Cost Per 1,000 Gallons Pumped	$0.013	$0.018
kW-hr per Acre Foot Pumped	124	169
Cost Per Acre Foot Pumped	$4.35	$5.91

PAYBACK

Annual Savings - kW-hr	52,709
Annual Savings - $$	$1,844.83
Annual Savings - %	26.39%
Cost of Replacement Pump	$107,000.00
Cost of Existing Pump	$0.00
Payback - Years	58.0

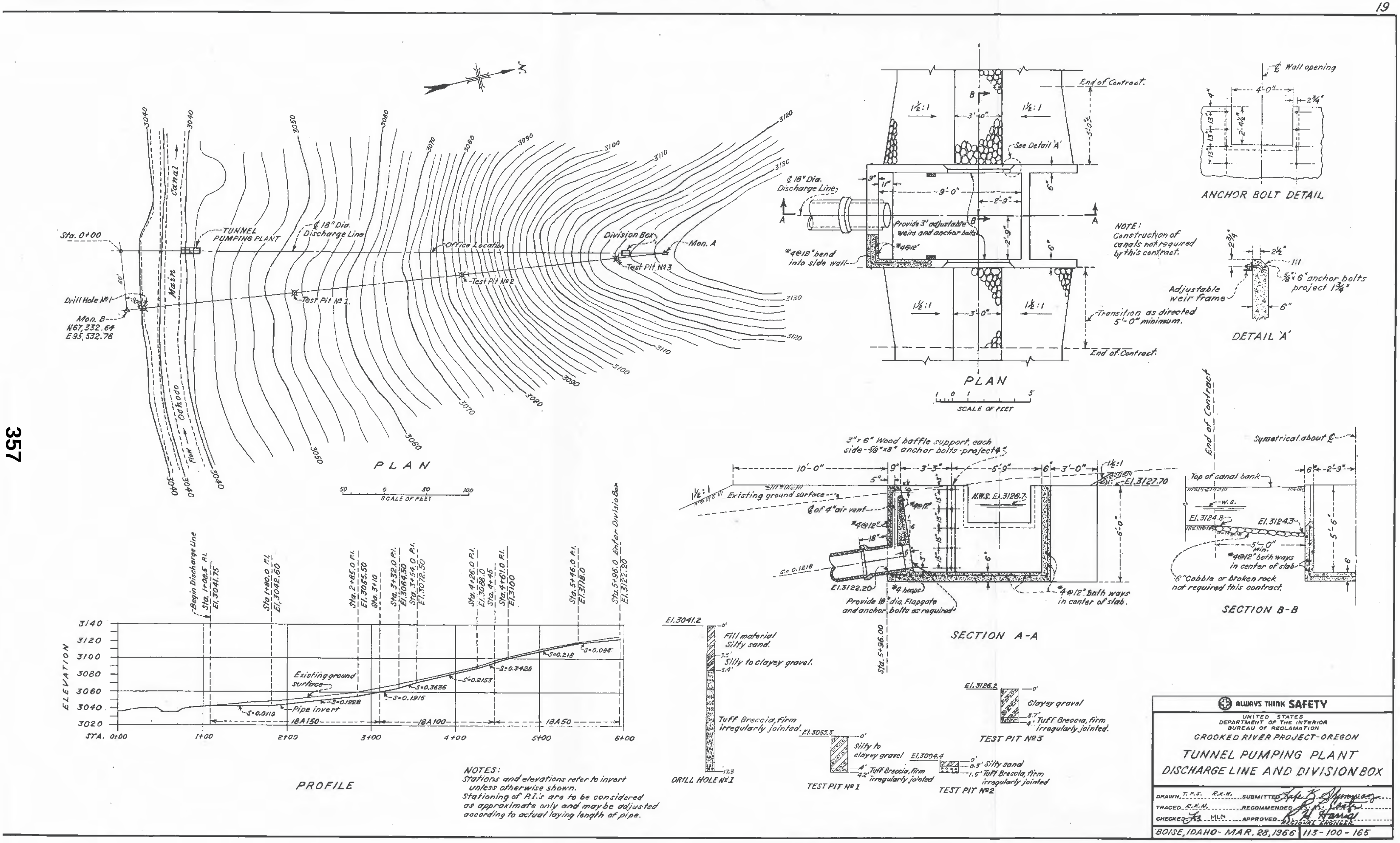
*** Estimated cost assumes one pump replacement, pump column pipe, discharge piping, and valves are changed from 8-inch to 12-inch.


ALWAYS THINK SAFETY
UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION
CROOKED RIVER PROJECT - OREGON
TUNNEL PUMPING PLANT
LOCATION PLAN
Boise, Idaho
113-100-143
SECTION A-A
Scale of Feet
SECTION B-B
PLAN
Scale of Feet
Access road to be constructed by others
Service and metering pole. Exact location to be determined in the field to meet incoming service from Pacific Power and Light Co.
Guy
℄ Structure and 18" diameter discharge line
Standard Fence Dwg. 40-D-5410
El. 3041.25
Slope
2" gravel surfacing
Elev. 3041.0
Sta. 0+71.00
Ochoco
Main
Canal
Canal Berm
Sta. 0+00.00
For layout see Dwg. 113-100-165
Sta. 1+08.5 - Begin disch. line
Invert elev. 3042.5
Backfill
Compacted backfill
Fence
℄ Pumps Sta. 0+91.25
El. 3041.5
Estimated rock line
Elev. 3033.02
Existing ground line
Max. W.S. El. 3040.0
El. 3036.25
Sta. 0+71.00
℄ Structure
El. 3041.5
2" Gravel surfacing
Estimated rock line
Compacted backfill
Canal bank
Compacted backfill



Unit	Q*	T.D.H.
1 & 2	2.9 cfs	92.0 ft

* Includes wear factor


PLAN
SCALE OF FEET
Sta. 0+00
Drill Hole No1
Mon. B
N67,332.64
E95,532.76
TUNNEL PUMPING PLANT
℄ 18" Dia. Discharge Line
Office Location
Test Pit No 1
Test Pit No 2
Test Pit No3
Division Box
Mon. A
Main Canal
Ochoco
Flow
PROFILE
ELEVATION
STA.
Begin Discharge Line
Sta. 1+08.5 P.I.
El. 3041.75
Sta 1+80.0 P.I.
El. 3042.60
Sta. 2+85.0 P.I.
El. 3055.50
Sta. 3+10
Sta. 3+32.0 P.I.
El. 3064.50
Sta. 3+54.0 P.I.
El. 3072.50
Sta. 4+26.0 P.I.
El. 3088.0
Sta. 4+45
Sta. 4+61.0 P.I.
El. 3100
Sta. 5+46.0 P.I.
El. 3118.0
Sta. 5+96.0 Enter Division Box
El. 3122.20
Existing ground surface
Pipe invert
18A150
18A100
18A50
NOTES:
Stations and elevations refer to invert unless otherwise shown.
Stationing of P.I.'s are to be considered as approximate only and may be adjusted according to actual laying length of pipe.
End of Contract.
See Detail 'A'
℄ 18" Dia. Discharge Line
Provide 3' adjustable weirs and anchor bolts
#4@12" bend into side wall
NOTE: Construction of canals not required by this contract.
Transition as directed 5'-0" minimum.
ANCHOR BOLT DETAIL
℄ Wall opening
DETAIL 'A'
Adjustable weir frame
5/8" x 6" anchor bolts project 1 3/4"
3" x 6" Wood baffle support, each side - 5/8" x 8" anchor bolts project 4"
Existing ground surface
℄ of 4" air vent
N.W.S. El. 3126.7
El. 3127.70
El. 3122.20
#4 hoops
Provide 18" dia. Flapgate and anchor bolts as required
#4@12" both ways in center of slab.
Sta. 5+96.00
SECTION A-A
Symmetrical about ℄
Top of canal bank
W.S.
El. 3124.8
El. 3124.3
#4@12" both ways in center of slab
6" Cobble or broken rock not required this contract.
SECTION B-B
El. 3041.2
Fill material Silty sand.
Silty to clayey gravel.
Tuff Breccia, firm irregularly jointed.
DRILL HOLE No 1
El. 3053.3
Silty to clayey gravel
Tuff Breccia, firm irregularly jointed
TEST PIT No 1
El. 3084.4
Silty sand
Tuff Breccia, firm irregularly jointed
TEST PIT No2
El. 3126.2
Clayey gravel
Tuff Breccia, firm irregularly jointed.
TEST PIT No3
ALWAYS THINK SAFETY
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CROOKED RIVER PROJECT-OREGON
TUNNEL PUMPING PLANT
DISCHARGE LINE AND DIVISION BOX
DRAWN
TRACED
CHECKED
SUBMITTED
RECOMMENDED
APPROVED
REGIONAL ENGINEER
BOISE, IDAHO - MAR. 28, 1966
113-100-165

DELIVERABLES – TAB 6

Cost/Benefit Analysis of Hydro Facility on Ochoco Dam

EXPIRES: 31 DECEMBER, 2011

May 2011

Ochoco Irrigation District

Ochoco Canal Hydropower Feasibility Study

BLACK ROCK
CONSULTING
Kevin L. Crew, P.E.
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TABLE OF CONTENTS

EXECUTIVE SUMMARY

This Feasibility Study for Hydroelectric Power Generation at the Ochoco Main Canal Site was authorized by OID in January, 2011. The Study will be funded in part by the United States Bureau of Reclamation System Optimization Review (SOR) grant and in part by the District.

Based on 2007-2010 flow data gathered from the District/USBR Hydromet site, feasibility-level head-loss estimates and associated net-heads were developed for Francis-type turbine unit and Natel Energy Machine alternatives. Such heads ranged from approximately 34-FT to 68-FT over the 2007-2010 period of record.

PacifiCorp is the local power interconnect utility, and it is anticipated that the interconnect pole will be located adjacent to Highway 26 approximately 460-FT from the proposed powerhouse site. Current Schedule 37 blended rates were used to estimate power revenue from the project turbine and machine alternatives.

The site is considered medium-head and therefore Francis and Natel Energy options were explored. Chinese Francis and Natel appeared to be the most cost –effective alternatives for the site and each were compared against the other based upon potential revenue generation as well as potential project cost. The Natel Energy SLH-50 will pass up to approximately 150 CFS at a modulated constant 23-FT of net head, whereas the Francis turbine will pass up to approximately 160 CFS. For limited periods, it will be necessary to bypass additional flows that exceed the 160 CFS. The cost of site installation is expected to be lower for the Natel technology as the machine may be placed anywhere along the hydraulic column whereas the Francis turbine must be located deeper at the tailrace area, increasing its comparative design and installation cost.

Funding programs were discussed along with potential funders known in the basin. Feasibility-level cost estimates were prepared for both hydroelectric power types. For the Francis, the estimate with a 500 kW Chinese Turbine/Generator was $2,008,600 and for the 233 kW Natel Energy Machine was $1,621,620.

Expected revenue estimates were developed for the two alternatives and compared to the costs in a benefit-cost analysis. No options resulted in a positive benefit/cost ratio greater than 1.0, therefore indicating an unviable project given the assumptions.

It was noted that the project is very sensitive to potential funding programs such as the re-authorization of the Oregon Business Energy Tax Credit and out of state REC programs; therefore these should be watched carefully.

The apparent best project would be a Chinese Francis turbine with a benefit/cost ratio of 0.87 (given that grant funding and ETO funding were obtained).

BACKGROUND

The intent of this Feasibility Report is to evaluate and present the technical, financial, and permitting feasibility of a potential hydroelectric power generation site on the Ochoco Irrigation District's (OID) Ochoco Main Canal at its headworks in Prineville, Oregon.

The potential hydro site is generally located as indicated in Figure 1.

Black Rock Consulting (BRC) of Bend, Oregon was authorized by OID in January, 2011 to commence work on this Study that will be funded in part by the United States Bureau of Reclamation's the System Optimization Review Grant and in part by OID itself.

The primary objectives of this Feasibility Study and associated data development were as follows:

1) Review any available historical project information provided by OID.
2) Establish project limits based upon canal and future piping project specifics (elevation differential, existing houses or structures in vicinity, location of existing utility facilities, etc.).
3) Review and interpret feasibility-level gross head information for the proposed hydro site given Ochoco Reservoir telemetry data and as-built information for the Ochoco Canal headworks.
4) Develop an aerial site plan (from existing aerial sources) for the site.
5) Research and verify probable annual average flow rates (minimum/average/peak) at the site. Data to be gathered from OID SCADA and the USBR Hydromet systems.
6) Develop turbine/machine water supply strategies depending upon the technology evaluated and estimate potential head losses associated with these strategies.
7) Evaluate project head-loss for the site and develop probable elevation head range at the turbine or machine for the site.
8) Size a feasibility level turbine or machine and generator for the site. Explore alternative procurements both internationally and low head machine technology.
9) Request equipment cost estimates from reputable manufacturers.
10) Develop a feasibility level cost estimate for the site.
11) Develop feasibility level energy production estimates for the site.
12) Develop revenue expectations given estimated rates.
13) Develop a benefit/cost comparison for the site.
14) Prepare a feasibility report compiling the above information and providing recommendations for the site.

GENERAL PROJECT LOCATION

The proposed project site is located within the easterly extent of the OID boundary, approximately 6-miles east of Main Street in Prineville along Highway 26. The site is located near the OID Ochoco Reservoir immediately downstream of the Ochoco Dam exitworks and immediately upstream of the Oregon Water Resources Department's canal flow measurement telemetry station. The Ochoco canal supplies the District with over 130 CFS of irrigation water during the peak season and also is designed to return flows to Ochoco Creek at its headworks. With the exception of proposed power pole alignments, the proposed project falls completely within the fee title land ownership of OID. The site is located adjacent to the existing Ochoco Reservoir discharge structure and gate-house at approximate latitude/Longitude N44°17'55.62" W120°43'36.01".

As may be seen in Figures 1, the site is located on OID property, well insulated from development other than the District's own ditch rider residence located on the same parcel.

HISTORICAL INFORMATION AND DATA REVIEW

The Ochoco Irrigation District was established in 1917 and is a quasi-municipal corporation of the state of Oregon.

The District's system consists of three main canals: the Ochoco Main Canal, which runs east to west on the high side of the District, the Crooked River Distribution Canal which runs through the middle of the District, and Rye-Grass Canal which runs through the lower portion of the District. The District provides water to approximately 20,000 acres of farmland in and around the Prineville area.

The District owns, operates and maintains the Ochoco Dam and Reservoir. The reservoir provides 44,000 acre-feet of storage and feeds the Ochoco Main Canal. In addition the District is under contract to operate and maintain the Bowman Dam on Prineville Reservoir. This reservoir provides 150,000 acre-feet of storage, feeds the Crooked River and the Crooked River Diversion Canal as well.

Over the last 10 years, the Ochoco Irrigation District has implemented programs to modernize many of its facilities including conservation projects involving lining and piping of portions of its system, implementation of compliant automated fish screening facilities at its Crooked River Diversion, implementation of SCADA/Telemetry flow-measurement systems, installation of public and employee safety devices, and maintenance and upgrades of its existing facilities, including Bowman Dam. Additionally, the District has invested in efforts to upgrade its mapping and GIS capabilities. Most recently, the District has participated in a basin-wide effort to develop a comprehensive Habitat Conservation Plan and has commenced system efficiency evaluations through its System Optimization Review study of which this study is a component. The

District continues to make such improvements and remain involved as a partner in the community and to perpetuate its mission of irrigation supply to its patrons.

The historic flow measurement data gathered to develop flow rate estimates for hydroelectric power generation was from USBR Hydromet telemetry data sites downloaded from the worldwide web. Ochoco Reservoir discharges were found by combining the data from the OCHOQJ (Ochoco Main Canal) and OCHOQD (Ochoco Creek) gauges. As these telemetry sites reside immediately adjacent to the proposed project, no adjustment was necessary for canal losses and consequently the data is considered very good for estimating purposes. Data from 2007 through 2010 was downloaded for use in estimating flow rates for the site.

SUMMARY FEASIBILITY PROJECT DETAILS

The project is located as indicated above and as shown in Figure 1. The Ochoco Irrigation District diverts water into the Ochoco Main Canal generally during its irrigation season between the first week in April and the second week in October of each year depending upon the weather and other factors addressed annually by its Board of Directors. Additionally, it passes some water at other periods and at various flow rates that are immediately returned to Ochoco Creek just downstream of the Ochoco Reservoir. Details of 2007, 2008, 2009 and 2010 flow rates available at the hydroelectric power generation site are included later in this study.

The site for the project was selected based upon the existence of District facilities at the District's Ochoco Reservoir. Although details for such facilities will not be provided herein, the facilities are capable of providing pressurized water from the reservoir at the head-end of the Ochoco Main Canal. This pressurized water, in conjunction with the flows passed annually provides the basis for power production at the site. The site is also located within approximately 460-FT of the interconnect utility and such close proximity would affect lower interconnection costs (see Figure 2).

Several technologies were evaluated for application at the site including Kaplan, Francis, and Natel Machine technologies. Additionally, international versus domestic suppliers were evaluated. The most competitive technologies evaluated for the site were Chinese Francis and American Natel Energy options.

When evaluating the Francis turbine alternative, it was assumed that a conventional arrangement including a horizontal turbine and generator arrangement, an inlet control valve, a bypass valve, valve controls, a small powerhouse building, connection to existing facilities, utility interconnect poles and conductor, a transformer, draft tube, and minor discharge pool modifications were included.

When evaluating the Natel Energy machine, the head limitation of the machine required that energy head modulation be included, therefore it was assumed that a valve such as a Ross or sleeve multi-orifice type valve would be included to accomplish head regulation. Details for such modulation would require full development in design and alternate methods may be used to accomplish similar results. Other aspects as identified for the Francis turbine technology were also included for the Natel option.

Geotechnical evaluations were not within the scope of this study therefore no information is available to ascertain excavation issues. Rock is present at the site; therefore it is assumed that excavations will be into large cobble for installation of mechanical and structural features in the relatively small project footprint. During final design it is recommended that a geotechnical investigation be performed to develop final design criteria for the powerhouse building and to insure the integrity of the subsurface material for placement of a plant at that location.

Location Map

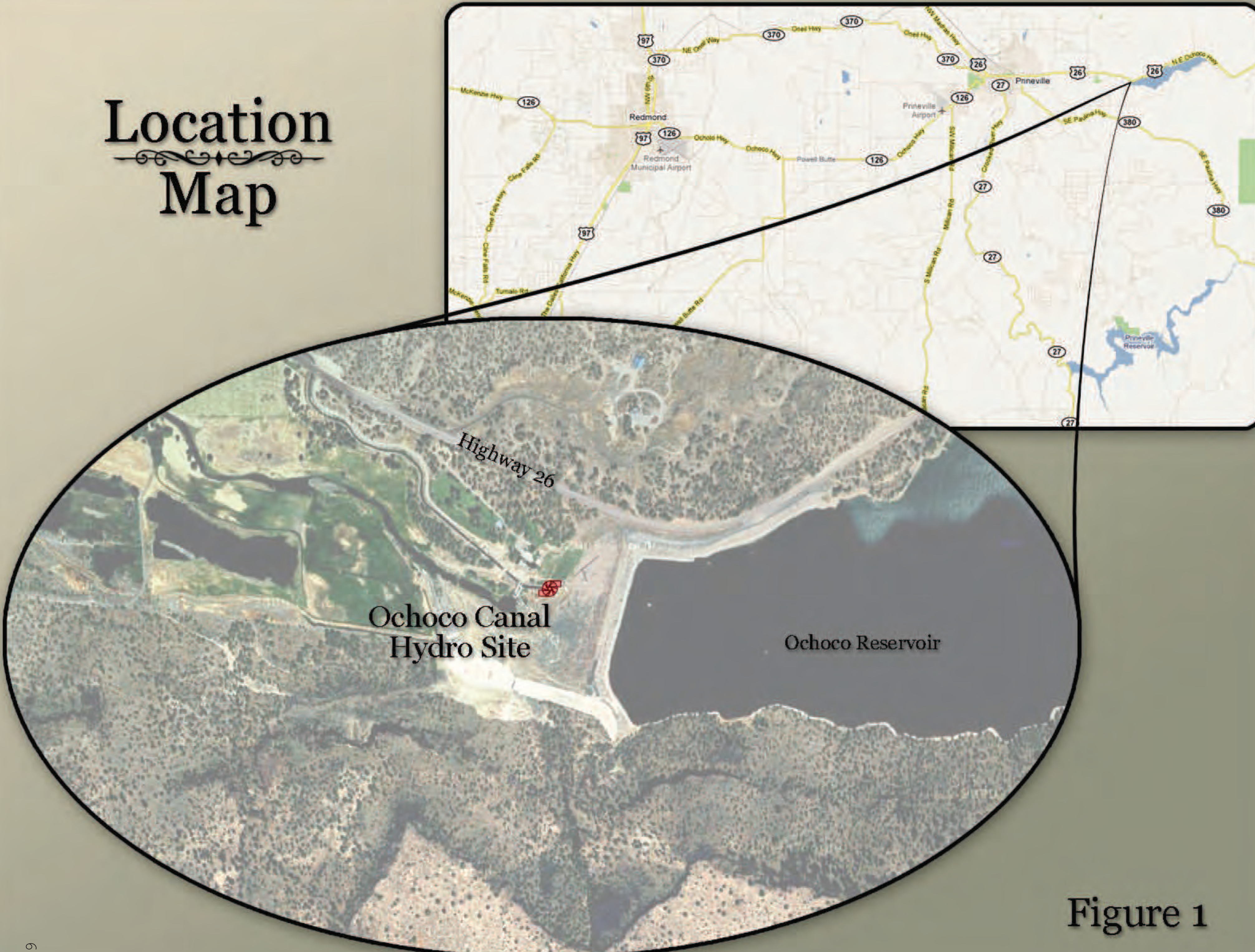

Figure 1

Site Map

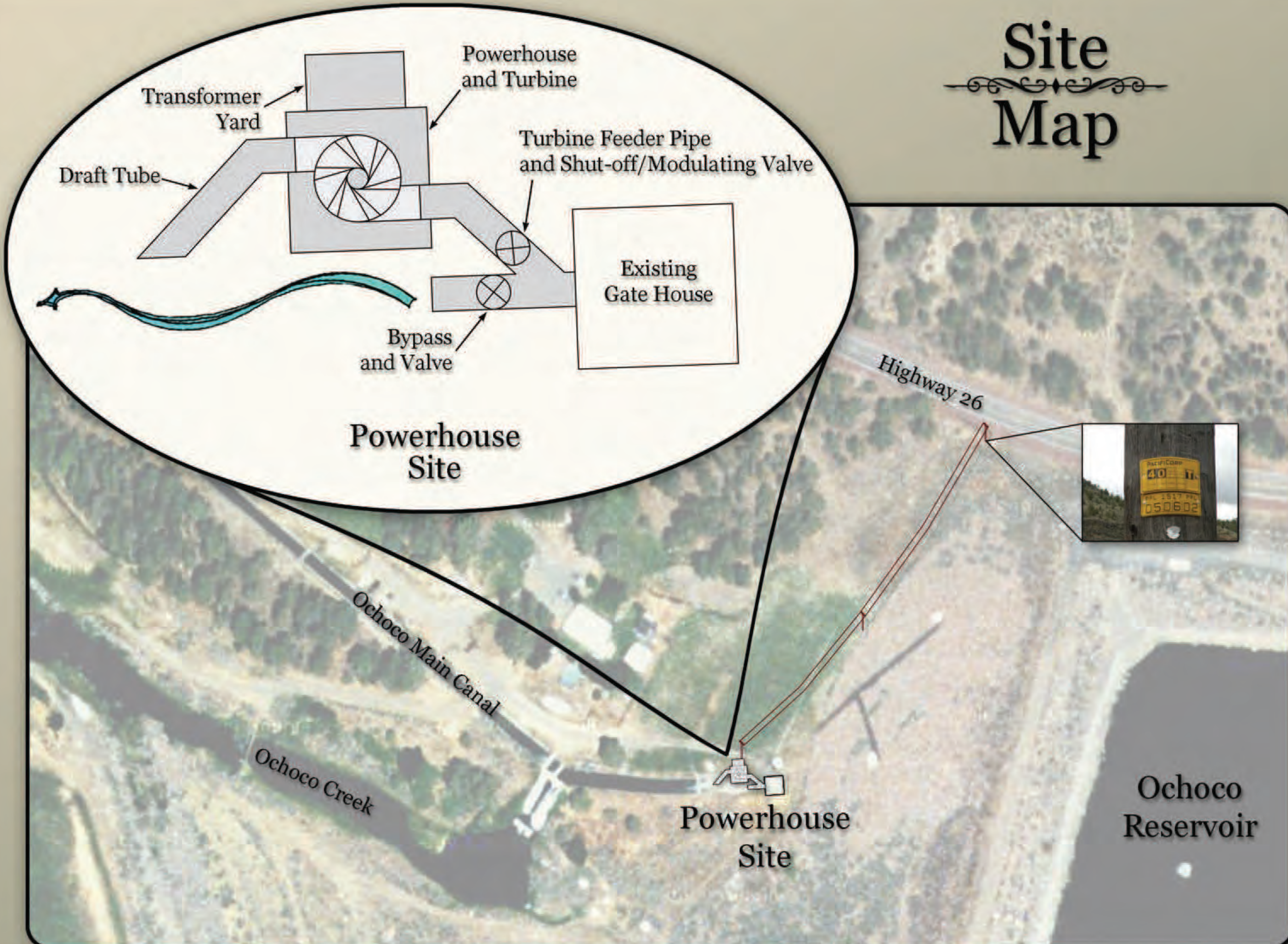

Figure 2

PROBABLE GROSS HEAD

Available head at the site is based upon the water surface elevation in the Ochoco Reservoir and therefore fluctuates based upon annual demands, filling and withdrawal cycles, etc. Water surface elevation above mean sea level is monitored by telemetry that is uplinked to the USBR Hydromet system under gauge code OCH. Water surface elevation in the reservoir fluctuated between elevation 3098 and 3130 in the period from 2007-2010. This gross elevation estimate should be confirmed during design as elevations vary given final tail water and intake designs.

HISTORICAL FLOW DATA

The historic flow measurement data gathered to develop flow rate estimates for hydroelectric power generation was from USBR Hydromet telemetry data sites downloaded from the worldwide web. Ochoco Reservoir discharges were found by combining the data from the OCHOQJ (Ochoco Main Canal) and OCHOQD (Ochoco Creek) gauges. As these telemetry sites reside immediately adjacent to the proposed project, no adjustment was necessary for canal losses and consequently the data is considered very good for estimating purposes. Data from 2007 through 2010 was downloaded for use in estimating flow rates for the site. This data has been included below for each year from 2007 through 2010.

2007 ESTIMATED FLOW RATES AT OCHOCO CANAL

	2007											
	January	February	March	April	May	June	July	August	September	October	November	December
1st	61.0	9.6	10.1	21.8	132.2	113.5	137.1	84.1	61.7	40.3	6.1	6.7
2nd	48.1	9.6	10.1	17.6	131.2	108.4	145.9	89.0	61.8	35.9	6.1	6.7
3rd	62.1	9.6	10.1	54.3	123.1	99.1	141.8	95.8	61.1	33.6	6.1	6.6
4th	117.2	9.6	10.1	24.4	117.2	97.5	137.2	100.2	56.8	32.3	6.1	6.5
5th	140.3	9.6	10.1	37.7	117.2	84.8	136.2	99.6	48.5	29.3	6.4	6.4
6th	140.3	9.6	10.1	54.7	116.5	74.6	141.3	98.1	45.6	27.7	6.4	6.4
7th	140.1	9.6	10.1	61.1	106.5	68.0	140.9	98.1	45.9	27.6	6.4	6.4
8th	140.4	9.6	10.1	73.8	103.1	65.1	140.4	95.4	46.1	27.5	6.4	6.4
9th	141.6	9.6	11.2	73.9	106.6	62.7	138.1	88.8	46.4	27.5	6.4	6.7
10th	129.7	9.6	15.4	74.4	115.8	57.7	136.2	89.0	46.6	27.4	6.7	6.9
11th	121.5	9.6	15.7	74.5	120.7	55.5	132.4	89.0	46.8	27.3	6.7	6.4
12th	117.0	9.6	20.7	79.8	120.5	56.9	127.2	89.3	46.8	26.5	6.7	6.1
13th	116.1	9.6	23.8	87.9	121.0	57.7	127.7	95.0	47.1	24.2	6.7	6.1
14th	116.1	9.6	23.9	96.7	127.6	65.1	127.9	97.0	47.6	23.1	6.7	6.1
15th	117.6	9.6	24.1	111.6	128.8	74.7	128.2	103.9	48.0	11.4	6.7	6.1
16th	80.2	9.6	32.5	111.9	131.7	74.6	124.2	103.9	48.3	5.8	6.7	6.1
17th	51.4	9.6	51.5	112.7	143.4	72.9	120.4	104.0	48.6	5.8	6.7	6.1
18th	37.3	9.7	63.9	113.0	148.3	72.4	120.5	104.3	47.5	5.6	6.7	6.1
19th	37.2	9.8	95.0	111.5	148.2	79.2	109.5	104.1	47.2	5.6	6.7	6.1
20th	37.4	9.6	110.1	96.5	147.6	96.3	89.2	97.5	47.0	5.6	6.7	6.2
21st	36.9	9.6	109.0	90.0	143.9	100.5	73.5	84.5	47.3	5.5	6.7	6.1
22nd	37.3	9.8	110.1	88.5	132.1	99.8	77.7	75.0	47.6	5.3	6.7	6.1
23rd	37.4	10.0	111.5	88.9	130.3	99.2	79.4	65.1	47.9	5.2	6.7	6.1
24th	34.7	9.9	110.9	89.4	138.5	102.6	79.0	61.1	52.9	5.2	6.7	6.1
25th	22.3	10.1	110.2	94.5	136.8	109.2	93.4	68.8	48.9	5.3	6.7	6.1
26th	15.7	10.1	101.0	101.8	126.8	107.6	102.5	68.8	46.8	5.8	6.7	6.1
27th	14.4	10.1	95.0	114.3	125.4	107.8	81.5	68.6	47.0	6.1	6.7	6.1
28th	14.4	10.0	82.2	127.4	126.8	112.8	72.4	69.1	45.0	6.1	6.7	6.1
29th	11.8		53.3	132.5	121.9	126.9	72.6	73.7	43.7	5.8	6.7	6.1
30th	9.6		27.2	132.4	118.0	134.7	73.3	75.8	43.7	5.9	6.7	6.1
31st	9.6		21.8		112.9		73.9	66.5		6.0		6.1

2007 FLOW DATA RANGE

2007	Operation Days	Minimum Volume (cfs)	Average Volume (cfs)	Peak Volume (cfs)
January	31	9.58	70.87	141.61
February	28	9.56	9.70	10.05
March	31	10.05	48.39	111.51
April	30	17.57	84.97	132.45
May	31	103.06	126.46	148.26
June	30	55.54	87.91	134.66
July	31	72.36	112.30	145.89
August	31	61.14	87.20	104.28
September	30	43.71	48.87	61.77
October	31	5.19	16.52	40.33
November	30	6.09	6.53	6.70
December	31	6.09	6.26	6.92
Average			69.15	

2008 ESTIMATED FLOW RATES AT OCHOCO CANAL

2008	January	February	March	April	May	June	July	August	September	October	November	December
1st	6.1	6.1	6.1	37.1	83.2	249.1	134.1	91.2	73.6	59.8	4.3	3.1
2nd	6.1	6.1	6.1	37.1	72.7	211.0	131.6	81.5	71.1	59.4	4.2	3.1
3rd	6.1	6.1	6.1	37.2	71.8	187.0	130.2	79.2	71.6	52.0	4.1	3.1
4th	6.1	6.1	6.1	37.2	72.8	157.1	132.2	84.1	72.3	50.1	3.9	3.1
5th	6.2	6.1	6.1	37.2	79.9	131.0	130.7	93.2	72.1	51.1	3.9	3.1
6th	6.1	6.1	6.1	37.2	81.7	126.9	130.8	102.1	71.1	49.3	3.9	3.1
7th	6.1	6.1	6.1	37.5	76.1	120.9	128.7	94.5	73.7	46.7	3.7	3.1
8th	6.1	6.1	6.1	37.5	85.4	115.7	134.6	91.8	68.3	46.0	3.5	3.1
9th	6.1	6.1	6.3	37.7	92.5	93.5	133.9	92.0	62.8	46.1	3.7	3.1
10th	6.2	6.1	6.2	44.1	87.3	68.9	139.1	91.8	58.1	46.3	3.7	3.1
11th	6.3	6.1	6.1	59.0	84.4	68.5	145.0	92.5	54.9	46.5	3.5	3.1
12th	6.3	6.1	6.2	57.0	84.1	67.9	148.6	98.1	55.5	24.7	3.5	3.1
13th	6.2	6.1	6.4	73.5	83.8	67.6	138.8	100.6	56.3	8.1	3.5	3.1
14th	6.3	6.1	6.4	103.4	80.4	68.4	147.5	106.6	57.0	5.3	3.5	3.1
15th	6.4	6.1	6.4	115.0	79.4	69.0	153.5	109.3	57.4	5.3	3.3	3.1
16th	6.3	6.1	6.4	100.0	89.8	69.5	142.2	109.4	58.1	5.3	3.1	3.3
17th	6.1	6.1	6.5	85.1	100.7	70.2	133.9	106.5	59.2	5.1	3.1	3.3
18th	6.1	6.1	6.6	80.9	104.8	70.4	127.3	99.0	59.0	5.1	3.1	3.2
19th	6.1	6.1	6.7	82.4	115.9	91.6	120.0	97.6	58.7	5.1	3.1	3.1
20th	6.1	6.2	6.7	72.5	117.2	105.4	106.2	91.0	59.1	4.6	3.1	3.1
21st	6.1	6.3	6.7	67.0	116.2	104.0	100.1	81.2	59.6	4.7	3.1	3.1
22nd	6.1	6.4	6.7	67.1	107.3	98.9	95.3	76.1	59.8	4.6	3.1	3.1
23rd	6.1	6.4	6.7	72.3	88.2	99.8	82.2	76.8	59.5	4.6	3.1	3.1
24th	6.1	6.4	6.8	90.6	84.0	108.4	79.6	77.2	59.5	4.6	3.1	3.1
25th	6.1	6.4	6.9	98.3	128.7	120.0	72.6	78.2	59.5	4.6	3.1	3.1
26th	6.2	6.4	7.0	100.2	129.0	127.0	71.2	79.1	59.7	4.6	3.2	3.1
27th	6.4	6.4	7.0	105.4	115.4	124.8	71.8	78.8	60.0	4.6	3.1	3.1
28th	6.4	6.1	7.0	101.2	154.4	127.7	71.0	79.0	60.1	4.6	3.1	3.1
29th	6.3	5.8	7.0	96.8	382.5	132.8	96.3	79.4	60.2	4.6	3.1	3.1
30th	6.1		35.9	94.7	369.4	132.4	109.9	79.7	60.1	4.5	3.1	3.1
31st	6.1		35.9		306.8		110.5	79.9		4.5		3.1

2008 FLOW DATA RANGE

2008	Operation Days	Minimum Volume (cfs)	Average Volume (cfs)	Peak Volume (cfs)
January	31	6.09	6.16	6.37
February	28	5.83	6.15	6.37
March	31	6.05	8.34	35.90
April	30	37.10	70.07	114.98
May	31	71.78	120.19	382.48
June	30	67.60	112.83	249.13
July	31	71.03	117.72	153.47
August	31	76.07	89.59	109.41
September	30	54.93	62.26	73.66
October	31	4.49	21.68	59.81
November	30	3.07	3.41	4.33
December	31	3.06	3.09	3.26
Average			67.65	

2009 ESTIMATED FLOW RATES AT OCHOCO CANAL

	2009											
	January	February	March	April	May	June	July	August	September	October	November	December
1st	3.1	3.5	3.3	26.7	21.2	137.7	114.7	111.3	73.8	43.6	3.9	2.9
2nd	3.1	3.5	3.3	26.7	21.0	114.6	120.2	115.5	73.9	42.3	3.9	2.8
3rd	3.1	3.5	3.3	26.7	20.9	93.1	125.8	108.2	78.9	38.7	3.9	2.7
4th	3.1	3.6	3.3	26.9	20.8	73.5	138.3	104.6	76.2	38.5	3.9	2.7
5th	3.1	3.7	3.3	27.0	18.0	53.5	143.8	105.7	72.8	37.0	3.9	2.7
6th	3.5	3.7	3.3	27.1	15.3	41.7	143.3	100.2	72.8	33.8	4.0	2.6
7th	3.7	3.7	3.3	27.5	13.7	32.5	141.3	97.2	69.6	28.7	4.0	2.5
8th	3.5	3.7	3.3	27.8	13.6	33.5	140.2	96.6	64.6	27.0	3.9	2.5
9th	3.4	3.7	3.3	28.0	13.6	38.3	140.4	97.3	58.5	25.4	3.9	2.5
10th	3.4	3.7	3.3	28.2	14.3	38.2	147.0	90.3	55.4	24.4	3.9	2.7
11th	3.5	3.7	3.3	28.5	20.0	38.0	150.4	87.7	57.2	24.0	3.9	2.7
12th	3.5	3.7	3.4	31.2	19.4	29.6	150.4	88.0	57.8	23.9	3.9	2.7
13th	3.5	3.6	3.4	33.3	31.4	26.3	150.0	89.4	58.0	7.6	3.8	2.7
14th	3.5	3.5	3.5	35.2	44.0	26.8	152.4	86.9	57.9	4.7	3.7	2.7
15th	3.5	3.4	3.5	29.8	50.9	29.7	151.8	87.8	56.1	4.3	3.7	2.6
16th	3.5	3.5	3.5	35.0	53.9	32.4	158.2	87.8	54.3	4.3	3.7	2.5
17th	3.5	3.5	3.5	35.5	65.6	37.7	161.6	85.0	51.1	4.3	3.6	2.5
18th	3.3	3.5	3.5	36.1	82.3	40.0	161.8	80.4	49.3	4.3	3.6	2.4
19th	3.3	3.4	3.4	36.4	105.9	44.5	161.8	83.4	49.5	4.3	3.5	2.2
20th	3.3	3.4	3.4	36.6	120.3	39.0	156.6	85.6	49.6	4.2	3.5	2.2
21st	3.3	3.5	3.5	36.8	122.2	38.8	153.6	89.0	49.4	4.1	3.6	2.2
22nd	3.3	3.5	3.5	39.7	122.4	38.6	140.6	91.3	49.4	4.1	3.5	2.2
23rd	3.5	3.5	3.5	55.6	122.5	37.5	126.6	93.9	46.1	4.1	3.5	2.2
24th	3.5	3.5	3.5	56.0	124.8	37.6	122.4	97.9	44.1	4.1	3.2	2.2
25th	3.5	3.5	3.5	53.0	126.6	49.6	123.0	96.3	47.4	4.1	3.1	2.2
26th	3.5	3.5	3.5	51.7	128.9	53.7	123.0	97.8	47.6	3.6	3.1	2.2
27th	3.5	3.3	3.5	46.7	138.5	68.6	109.0	95.1	47.5	3.7	3.0	2.2
28th	3.5	3.3	3.5	34.8	144.0	75.2	91.2	93.9	45.4	4.0	2.9	2.2
29th	3.5		3.5	24.2	145.0	84.0	84.7	91.3	43.8	3.9	2.9	2.2
30th	3.5		45.2	21.5	145.5	108.1	106.1	84.2	43.4	3.9	2.9	2.2
31st	3.5		35.1		145.8		107.3	75.4		3.9		2.2

2009 FLOW DATA RANGE

2009	Operation Days	Minimum Volume (cfs)	Average Volume (cfs)	Peak Volume (cfs)
January	31	3.07	3.37	3.66
February	28	3.26	3.51	3.67
March	31	3.26	5.75	45.15
April	30	21.53	34.34	56.03
May	31	13.55	72.00	145.80
June	30	26.27	53.07	137.70
July	31	84.69	135.41	161.83
August	31	75.41	93.38	115.46
September	30	43.44	56.71	78.90
October	31	3.63	15.12	43.55
November	30	2.88	3.57	3.96
December	31	2.19	2.46	2.88
Average			52.14	

2010 ESTIMATED FLOW RATES AT OCHOCO CANAL

	2010											
	January	February	March	April	May	June	July	August	September	October	November	December
1st	2.2	2.4	2.7	3.3	33.7	74.4	93.5	95.6	79.1	35.9	5.3	4.3
2nd	2.2	2.4	2.7	3.3	33.8	80.6	98.7	89.6	78.6	35.8	5.3	4.2
3rd	2.2	2.4	2.7	3.3	34.6	151.6	98.7	80.7	74.4	35.9	5.1	4.1
4th	2.2	2.4	2.8	3.2	36.0	297.4	107.0	71.1	72.9	36.0	5.0	4.1
5th	2.2	2.4	2.8	3.3	43.6	366.2	120.8	69.2	73.3	33.0	4.6	4.2
6th	2.2	2.4	2.8	3.3	45.7	338.8	120.8	81.2	73.5	31.4	4.6	4.1
7th	2.2	2.5	2.9	3.3	45.9	250.2	136.9	84.9	73.6	31.3	4.6	4.1
8th	2.2	2.5	2.9	3.3	47.2	217.9	158.5	88.8	75.0	31.3	4.6	4.1
9th	2.2	2.5	2.9	3.3	48.8	187.0	173.1	91.9	76.4	31.3	4.6	4.1
10th	2.2	2.5	2.9	3.3	49.6	149.8	179.9	101.2	76.3	31.0	4.6	4.1
11th	2.2	2.5	3.0	3.4	68.6	141.2	178.1	106.7	76.0	27.1	4.6	4.1
12th	2.2	2.5	3.0	3.4	75.8	140.5	163.3	96.0	76.4	25.1	4.6	4.1
13th	2.2	2.5	3.0	3.4	80.1	139.0	172.2	90.9	76.8	10.7	4.6	4.1
14th	2.2	2.5	3.1	3.5	93.1	113.2	171.7	79.7	77.0	6.1	4.6	4.1
15th	2.2	2.5	3.2	3.5	99.8	89.0	167.8	78.5	77.1	6.1	4.6	4.1
16th	2.3	2.6	3.1	3.5	101.2	88.9	167.4	87.1	73.7	5.9	4.6	4.1
17th	2.3	2.6	3.2	3.5	112.4	88.1	167.4	95.2	68.4	5.9	4.6	4.1
18th	2.4	2.7	3.2	3.6	176.2	88.3	166.8	94.6	62.7	5.6	4.6	4.1
19th	2.3	2.7	3.2	3.7	153.0	90.0	157.6	97.0	60.8	5.6	4.6	4.1
20th	2.3	2.7	3.2	3.7	144.6	89.7	140.9	100.4	58.6	5.6	4.6	4.1
21st	2.3	2.7	3.3	3.7	125.9	87.2	146.6	99.8	51.3	5.7	4.6	4.1
22nd	2.4	2.6	3.2	3.8	98.1	85.9	154.1	99.8	44.3	5.8	4.6	4.1
23rd	2.4	2.5	3.3	3.8	87.9	79.4	154.0	98.9	37.7	5.8	4.3	6.8
24th	2.4	2.5	3.3	3.9	87.4	70.9	154.5	98.6	34.9	5.8	4.3	10.7
25th	2.4	2.5	3.3	4.0	80.3	78.9	153.6	98.6	35.1	5.8	4.3	12.3
26th	2.4	2.5	3.2	50.1	73.4	86.9	144.3	98.2	35.2	5.8	4.3	12.6
27th	2.4	2.5	3.3	38.8	76.0	77.7	134.0	98.6	35.2	5.6	4.3	12.6
28th	2.4	2.5	3.3	35.5	77.1	74.5	124.0	91.7	35.2	5.6	4.3	16.4
29th	2.4		3.3	35.1	76.5	82.1	110.2	79.8	36.2	5.4	4.3	33.9
30th	2.4		3.3	34.7	75.7	85.4	97.7	76.1	36.1	5.3	4.3	56.7
31st	2.4		3.2		75.0		94.8	77.2		5.3		60.7

2010 FLOW DATA RANGE

2010	Operation Days	Minimum Volume (cfs)	Average Volume (cfs)	Peak Volume (cfs)
January	31	2.20	2.27	2.36
February	28	2.36	2.53	2.70
March	31	2.70	3.06	3.27
April	30	3.24	9.37	50.12
May	31	33.65	79.25	176.17
June	30	70.88	133.02	366.20
July	31	93.51	142.22	179.89
August	31	69.16	90.25	106.70
September	30	34.94	61.39	79.10
October	31	5.30	16.07	35.98
November	30	4.29	4.58	5.33
December	31	4.10	10.11	60.70
Average			59.68	

PERMITTING/UTILITY INTERCONNECT

Expected permitting for the project will include applying for and obtaining:

1) Federal Energy Regulatory Commission (FERC) exemption. This site appears eligible for a FERC exemption. It may qualify for a conduit exemption but more likely the "5 MW or Less" exemption at an existing dam facility. The District controls the real property at the site and that is another key qualifying criteria,
2) Crook County building permit and zoning clearance for the powerhouse,
3) Oregon Water Resources Department issued water right for use of the canal water for hydropower production,
4) US ACOE permitting or maintenance exemption,
5) If Federal funding is involved in the project, the National Environmental Policy Act (NEPA) process must be followed for environmental clearance related to the project,
6) Potentially, a USBR clearance for the project.

Depending upon the funding sources involved in the project, other necessary processing may include Oregon Department of Energy bond/loan application, ODOE Business Energy Tax Credit application, Treasury Grant In-Lieu or Production Tax Credit application, US DOE Grant application, and/or Energy Trust grant application. Local traditional funders also include the Oregon Watershed Enhancement Board, Deschutes River Conservancy, and the Crooked River Watershed Council.

Interconnection with a utility requires an agreement for power purchase as well as an agreement for interconnection. The power purchase agreement will provide guidance on the term and rate for power purchase. The interconnection agreement will provide the technical terms and costs for the interconnection from the proposed plant into the utility grid.

In the case of this project, the nearest power lines to the site are owned by PacifiCorp (see Figure 2). The nearest PacifiCorp pole to the site has tag number 1517-050602. For the purposes of this feasibility study, we have assumed that the interconnect will occur at this pole, located adjacent to Highway 26 approximately 460 feet from the proposed powerhouse and that the poles will be placed within the District's property between the powerhouse and the utility. It appears that this interconnect point would be to 12kV lines and our project would step-up to this voltage. The final interconnection details will be a result of facility studies required by the utility and developed through design interaction during the project design process.

There are no known reasons at the time of this study that a power purchase agreement and an interconnect agreement may not be obtained. PacifiCorp has standard PUC requirements and associated agreements that it will follow in the process of developing the PPA and Interconnection agreements. For the purposes of this study, the current PacifiCorp Schedule 37 rates have been used to estimate project revenue. It should be noted that the Schedule 37 rates are subject to change and have been routinely changed every few years. Such rate changes can dramatically affect project viability.

PENSTOCK and NET HEAD DEVELOPMENT

For the purposes of this feasibility level evaluation, the flow rates provided above from irrigation years 2007-2010 were used to develop head losses and net head estimates at the plant site.

TRADITIONAL FRANCIS-TYPE TURBINE: Specifics for the existing dam outlet civil works are not included herein. The Ochoco Main Canal headworks has an approximate water surface elevation of 3053.5 at high water level. Based upon the existing dam outlet civil works and range of discharge flows up to 175 CFS, an average head-loss adjustment of 8.5-FT was applied between the reservoir and the draft tube return to channel. This adjustment includes an estimated 5-FT of losses through the turbine and draft tube that must be carefully evaluated and adjusted during design and is critical to project viability. For the period from 2007-2010, the feasibility-level net heads ranged from 34-FT to 68-FT.

NATEL ENERGY TURBINE: Natel Energy has developed a series of hydroelectric machines that are "stepped" in size based upon the intake cross sectional area and machine size. The SLH-50 is a machine that is sized for an intake of 1/2 Square Meter. Its current maximum safe head is approximately 23-FT, net and this was assumed for the purposes of this evaluation. Although reservoir head would fluctuate, a modulating valve would be used to adjust incoming head to maintain a total of 23-FT of net head across the machine.

TURBINE and GENERATOR

We investigated several alternatives for project equipment including hydroelectric-machines, Kaplan-type turbine systems, Francis turbine systems and international manufacturers. After evaluating project cost sensitivity, the most feasible options were foreign Francis turbines and domestic Natel Energy technologies. Domestic Francis turbines may also be competitive in time, but at the time of this feasibility study, domestic Francis turbines were approximately 3-times more costly than their Chinese counterparts. The Chinese are currently manufacturing nearly ½ of all turbines delivered in the world and certain manufacturers there have been in operation for over 50 years therefore reducing risk. However, the decision to purchase Chinese equipment must be carefully considered by the project owner given operation and maintenance responsiveness timeframes, replacement part availability, and other constraints based upon manufacturer proximity.

We provided the manufacturers with feasibility pricing level flow range and gross head (net to the intake side of the turbine or machine) operating parameters for each site. Chinese Francis and Natel Energy options were compared and the following basic information was provided by the manufacturers:

CHINESE FRANCIS TURBINE AND GENERATOR:

Design Parameters: Head = 60 ft, Flow = 140 cfs (range 40 CFS-160 CFS), Capacity = 500 kW, Francis turbine. Turbine/generator combined efficiency = 0.73 – 0.83. Turbine and generator cost = $250,000

The cost for the turbine and generator package includes:

- Horizontal Francis Turbine
- 500 kW Generator
- Excitation
- Governor
- Spare parts and special tools

Turbine equipment materials used are defined in accordance with the applicable standards. The selected equipment have been manufactured and tested for more than 50 years with continuous improvements and modification. We believe that the proposed equipment satisfies the requirements of the project with high quality and reliability.

Turbine equipment materials used are defined in accordance with the applicable USA standards.

NATEL ENERGY:

- Installed Capacity = 233 kW
- Estimated Machine/Draft/Valve loss <0.5m at 150 CFS
- 23-FT Net Head
- Capacity to 150 CFS at 23-FT Net Head
- SLH-50: Throat Area = 1/2 SQ Meter
- 25-FT head rating = **$234,375 Turbine/Generator/Control Package**
- Approx. 81% wire to water efficiency at 125 CFS, Approx. 77% wire to water efficiency at 150 CFS

The Francis style turbine can operate through the range of flow rates and can therefore generate a greater quantity of power over the period of system operation. Civil works necessary to properly set a Francis system, however, require significant excavation and concrete work. The Natel Energy machine may be set at any point in the penstock water column therefore the civil works necessary to support it may be minimized, however it is limited in that it can not pass more than 150 CFS for this site. As may be seen from the manufacturer information provided, the initial basic turbine and generator package costs are similar.

ENERGY/REVENUE PRODUCTION ESTIMATE

Given the flow rates estimated above and given the estimated turbine/generator and machine/generator efficiencies provided by the manufacturers above, the feasibility-level estimated power production would be:

2007 ESTIMATED POWER PRODUCTION (kWh)		
MONTH	CHINESE FRANCIS	NATEL ENERGY
January	144,777	66,657
February	0	0
March	121,296	43,572
April	254,785	88,071
May	393,857	142,806
June	244,795	94,068
July	287,754	126,813
August	191,401	96,848
September	37,061	19,926
October	0	0
November	0	0
December	0	0
	1,675,726	**678,762**

2008 ESTIMATED POWER PRODUCTION (kWh)		
MONTH	CHINESE FRANCIS	NATEL ENERGY
January	0	0
February	0	0
March	0	0
April	159,991	62,296
May	318,913	113,544
June	325,879	114,409
July	342,148	132,266
August	228,310	101,162
September	136,894	63,679
October	22,207	10,967
November	0	0
December	0	0
	1,534,343	**598,322**

2009 ESTIMATED POWER PRODUCTION (kWh)		
MONTH	CHINESE FRANCIS	NATEL ENERGY
January	0	0
February	0	0
March	0	0
April	18,780	7,372
May	177,717	70,447
June	80,277	32,804
July	333,630	152,906
August	196,380	105,265
September	80,456	47,120
October	0	0
November	0	0
December	0	0
	887,241	**415,915**

2010 ESTIMATED POWER PRODUCTION (kWh)		
MONTH	CHINESE FRANCIS	NATEL ENERGY
January	0	0
February	0	0
March	0	0
April	0	0
May	221,371	77,254
June	335,747	117,769
July	425,753	160,597
August	236,960	101,910
September	115,992	52,087
October	0	0
November	0	0
December	9,536	4,003
	1,345,358	**513,619**

AVERAGE POWER PRODUCTION 2008-2010 (kWh)		
YEAR	**CHINESE FRANCIS**	**NATEL ENERGY**
2007	1,675,726	678,762
2008	1,534,343	598,322
2009	887,241	415,915
2010	1,345,358	513,619
AVERAGE	**1,360,667**	**551,654**

The “blended Peak/Off-Peak” Pacificorp Schedule 37 was used to estimate revenue for the project. Based upon these rates, the annual revenue over the feasibility-level estimate period of 17 years (through the end of the Schedule 37 period) would be:

ESTIMATED REVENUE - AVERAGE PRODUCTION 2007-2010					
YEAR	ON PEAK	OFF PEAK	BLENDED ESTIMATE	CHINESE FRANCIS	NATEL ENERGY
2012	5.87¢	4.36¢	5.20¢	$70,769	$28,692
2013	6.14¢	4.50¢	5.41¢	$73,659	$29,864
2014	7.96¢	6.10¢	7.14¢	$97,097	$39,366
2015	8.16¢	6.27¢	7.32¢	$99,638	$40,396
2016	8.39¢	6.46¢	7.54¢	$102,526	$41,567
2017	8.60¢	6.65¢	7.74¢	$105,263	$42,677
2018	8.87¢	6.87¢	7.98¢	$108,636	$44,044
2019	8.76¢	6.74¢	7.87¢	$107,018	$43,388
2020	8.85¢	6.79¢	7.94¢	$108,002	$43,787
2021	9.33¢	7.23¢	8.40¢	$114,292	$46,337
2022	9.84¢	7.70¢	8.89¢	$120,990	$49,053
2023	9.33¢	7.15¢	8.36¢	$113,810	$46,142
2024	9.03¢	6.81¢	8.05¢	$109,487	$44,389
2025	9.47¢	7.22¢	8.47¢	$115,293	$46,743
2026	9.65¢	7.36¢	8.64¢	$117,501	$47,638
2027	9.68¢	7.35¢	8.65¢	$117,668	$47,706
2028	10.04¢	7.67¢	8.99¢	$122,325	$49,594

FEASIBILITY LEVEL COST ESTIMATE FOR PROJECT

The following cost estimates provides feasibility level cost estimating for the proposed project site given the two technology types compared. An estimate was prepared for alternative turbine procurement internationally and machine domestically such that benefit versus cost may be determined for each. It should be noted that the installation costs may vary significantly from those shown below depending upon the level of self-performance by the District, actual negotiated interconnect costs, final project design, geotechnical investigation results, and permitting.

FEASIBILITY LEVEL COST ESTIMATE CHINESE FRANCIS TURBINE				
ITEM	**QTY**	**UNITS**	**COST/UNIT**	**SUBTOTAL**
Turb./Gen/Controls	1	LS	$350,000	$350,000
Install system	1	LS	$200,000	$200,000
Building	700	SF	$350	$245,000
Civil Works	1	LS	$500,000	$500,000
Permits/Processing	1	LS	$100,000	$100,000
Electrical Service	1	LS	$15,000	$15,000
Electrical Interconnect	1	LS	$250,000	$250,000
Contingency	10%			$166,000
Design/Legal/C.M.	10%			$182,600
			TOTAL	**$2,008,600**

FEASIBILITY LEVEL COST ESTIMATE NATEL ENERGY SLH-50				
ITEM	**QTY**	**UNITS**	**COST/UNIT**	**SUBTOTAL**
Natel SLH-50/Gen/Switchgear	1	LS	$350,000	$350,000
Install system	1	LS	$75,000	$75,000
Building	500	SF	$250	$125,000
Civil Works	1	LS	$450,000	$450,000
Permits/Processing	1	LS	$100,000	$100,000
Electrical Service	1	LS	$15,000	$15,000
Electrical Interconnect	1	LS	$250,000	$250,000
Contingency	10%			$136,500
Design/Legal/C.M.	8%			$120,120
			TOTAL	**$1,621,620**

FINANCING and/or GRANT OPTIONS

The Oregon Department of Energy administers the Business Energy Tax Credit Program. For a municipal organization such as OID, the program has traditionally followed a pass-through process to allow the District to pass on credits to a private entity with an Oregon tax burden. To facilitate this process, an incentive is credited to the private business utilizing the tax credits. This net grant opportunity to the District is approximately 33% of the project cost. At the time of preparation of this study, the BETC program access was limited. However, it is anticipated that the program may be perpetuated in some form therefore has been included as a program to pursue if available at such time as the project may move forward.

The Energy Trust of Oregon provides incentive funds for hydropower projects that are marginally viable or non-viable in the absence of such incentive funds. The Energy Trust evaluates projects on a case by case basis and based upon the proposed production and marginality of the project makes a determination at what level, if any, they will participate financially.

A US Department of Energy competitive grant program has been issued with an application deadline closing in late spring, 2011. This program is geared toward new innovative technologies and/or USBR Districts therefore the OID may qualify for this grant, especially for the Natel technology.

For private project ownership, the US Treasury Department has several programs including the “in-lieu” grant that provides 30% of allowable project costs. This program generally expires in December, 2011 and a minimum of 5% of the project must be in-place by that deadline. For the purposes of evaluation, this program was applied as an option to the Francis turbine technology cost estimate.

Green Tag renewable energy credits (RECs) may be generated by the project. These credits may be sold in Oregon and potentially outside the state as well. Credit values vary and may be investigated at the time of project financing development. For the purposes of this evaluation, no value for RECs was applied however it is conceivable that the value for RECs may become a significant revenue factor in the coming years.

Although water conservation may not be a key element on the project, alternative energy production is a priority of the State and Nation. The United States Bureau of Reclamation, Oregon Watershed Enhancement Board, and Natural Resources Conservation Service may be approached regarding the long term benefits of the project and on-going grants available.

Financing options for the project include private commercial financing, Federal Renewable Energy Bonds, or Oregon Department of Energy SELP loan. Private rates likely range from 6% to 8% APR. Renewable Energy Bonds are low cost but require the District to issue the bonds under its name on behalf of the project and the associated bond issuance carries costs. The ODOE SELP program is currently lending at approximately 7% for a 15-year term. For the purposes of this evaluation, we assumed a term of 20-years and 7% interest for project dept amortization.

SIMPLE PAYBACK/BENEFIT vs. COST OF THE PROJECT

The following table provides a simple cost benefit analysis for the project given the two technologies evaluated and a 17 year average revenue projection based upon the current Schedule 37 rate structure. For the Francis technology, potential Treasury Grant dollars and Energy Trust of Oregon participation were also evaluated and for the Natel technology, ETO and US DOE grant potential were additionally evaluated.

BENEFIT/COST RATIO	CHINESE FRANCIS TURBINE	NATEL ENERGY MACHINE
Project Cost Without Financial Assistance	$2,008,600	$1,621,620
Ammortization Given 20 Year Term and 7% Int.	$186,864	$150,324
Average Annual Revenue over 17 Years	$106,116	$43,123
Benefit/Cost Ratio	**0.57**	**0.29**
With DOE Grant 50%	NA	$0
With Treasury Grant 30%	$2,008,600	NA
Possible ETO Participation	$100,000	$100,000
Net Project Debt.	$1,908,600	$1,521,620
Ammortization Given 20 Year Term and 7% Int.	$121,500	$66,120
Benefit/Cost Ratio	0.87	0.65

Generally speaking, a benefit/cost ratio of 1.0 or greater indicates a project that is immediately viable. The table above indicates that given the assumptions indicated and even with the application of available programs, neither technology is financially viable over the debt repayment period of 20-years.

Given up-front funding of the project with no carry of debt, the simple payback period for the project ranges from about 12 years for the Chinese Francis with Treasury Grant and ETO funding to just over 16 years for the Natel Energy Machine with DOE and ETO funding.

Although the project is not considered viable given the evaluation performed, the project is very sensitive to new energy programs and/or the increase in renewable energy credit values. For example, given the Treasury Grant program combined with Oregon BETC program proceeds, the project would be viable. Or if RECs may be sold for $0.03/kWh at some point in time (that may be conceivable given programs outside of Oregon), then the project would likely be viable.

Given the assumptions applied, above, however, the apparent best project would be a Chinese Francis turbine with emphasis on pursuit of funding to the greatest extent practicable. Given grant and ETO funding assumptions indicated above, the benefits lag the costs by a factor of 0.87 to 1.0.

DELIVERABLES – TAB 7

OID Water Conservation and Management Plan

Ochoco Irrigation District

Water Management
And
Conservation Plan

November, 2012

OAR Chapter 690, Division 86

Prepared by:

Water Management and Conservation Plan

OCHOCO IRRIGATION DISTRICT
PRINEVILLE, OREGON

Executive Summary

The Ochoco Irrigation District (OID) is submitting this Water Management and Conservation Plan (WMCP) in accordance with OAR Chapter 690 Division 86. This plan is divided into six sections that cover the OID Water Management and Conservation Plan. The order of the first five sections within the plan follows the rule requirements in OAR 690 Division 86. Section Six of the plan also provides a brief history of the district and description of the climate and soils.

The purpose of this WMCP is to update the plan as required by the final order from the Water Resources Department approving the first OID WMCP.

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Section 1 Water Supplier Description - OAR 690-086-0240		
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SECTION 1: SYSTEM DESCRIPTION
OAR 690-086-0240

LOCATION

Ochoco Irrigation District is located in Central Oregon, in Crook County. The irrigated lands are situated in a valley extending from Ochoco Dam, 5.5 miles east of the City of Prineville to a point on Crooked River 12 miles west of Prineville. The lands are enclosed by foothills and lava escarpments on the north and south. The land slopes south and west from Ochoco Dam. Elevations in this document are in feet above sea level. The outlet works at Ochoco Dam is at an elevation of 3050 feet. Typically, canals flow on a grade of 1 foot fall per 1,000 foot of length. Elevation of irrigated lands within the District is 2800 to 3120 feet above sea level.

SECTION 1.1: Water Rights - OAR 690-086-0240(1)

The irrigation season is approximately April 1 to October 15. All users in the District share water rights on all irrigated lands. Water rights provided to Ochoco ID are specifically stated on the certificates as follows:

Certificate 82246

Permit	5426
Source	Ochoco, McKay, Dry, Lytle and Johnson Creeks, and all waste and return water flowing in all unnamed waterways, and Ochoco Reservoir
Priority	March 13, 1916, from McKay Creek, and August 10, 1917, from all other sources named herein
Use	Primary irrigation of 16614.3 acres and industrial use of 160.2 acres/equivalent
Rate	209.7 cfs
Duty	4 ac-ft/acre
Legal Season	Feb. - Dec.
Actual Season	April - Oct.
Remarks	This is the primary right for most of the District.

Certificate 82247

Permit	25991
Source	Crooked River and Prineville Reservoir
Priority	April 8, 1914
Use	Primary irrigation of 3087.3 acres and supplemental irrigation of 12011.9 acres
Rate	190 cfs
Duty	4 ac-ft/acre
Legal Season	Feb. - Dec.
Actual Season	April - Oct.
Remarks	This is the supplemental right for most of the District.

Certificate 82248

Permit	49824
Source	Ochoco Creek and Reservoir
Priority	September 2, 1986
Use	Industrial use for the equivalent of 200 irrigated acres
Rate	2.75 cfs
Duty	4 ac-ft/acre
Legal Season	Year round
Actual Season	Year round
Remarks	This right makes use of 600 ac-ft of the water stored in Ochoco Reservoir.

Certificate 82249

Permit	N/A
Source	Crooked River, Ochoco Creek and Springs, and McKay Creek
Priority	Varies from 1869 to1916
Use	Supplemental irrigation of 4601.87 acres
Rate	59.93 cfs
Duty	4 ac-ft/acre
Legal Season	Year round
Actual Season	Year round
Remarks	This certificate combined many prior rights with varying priority dates into one supplemental certificate.

Certificate 55973

Permit	R-528
Source	Ochoco Creek
Priority	April 8, 1914
Use	Storage of 46,400 ac-ft for irrigation and 600 ac-ft for industrial use
Rate	N/A
Duty	N/A
Legal Season	Year round
Actual Season	Year round
Remarks	The reservoir lands and this water right are owned by OID.

Certificate 57612

Permit	R-2223
Source	Crooked River
Priority	April 8, 1914
Use	Storage of 155,000 ac-ft for irrigation
Rate	N/A
Duty	N/A
Legal Season	Year round
Actual Season	Year round

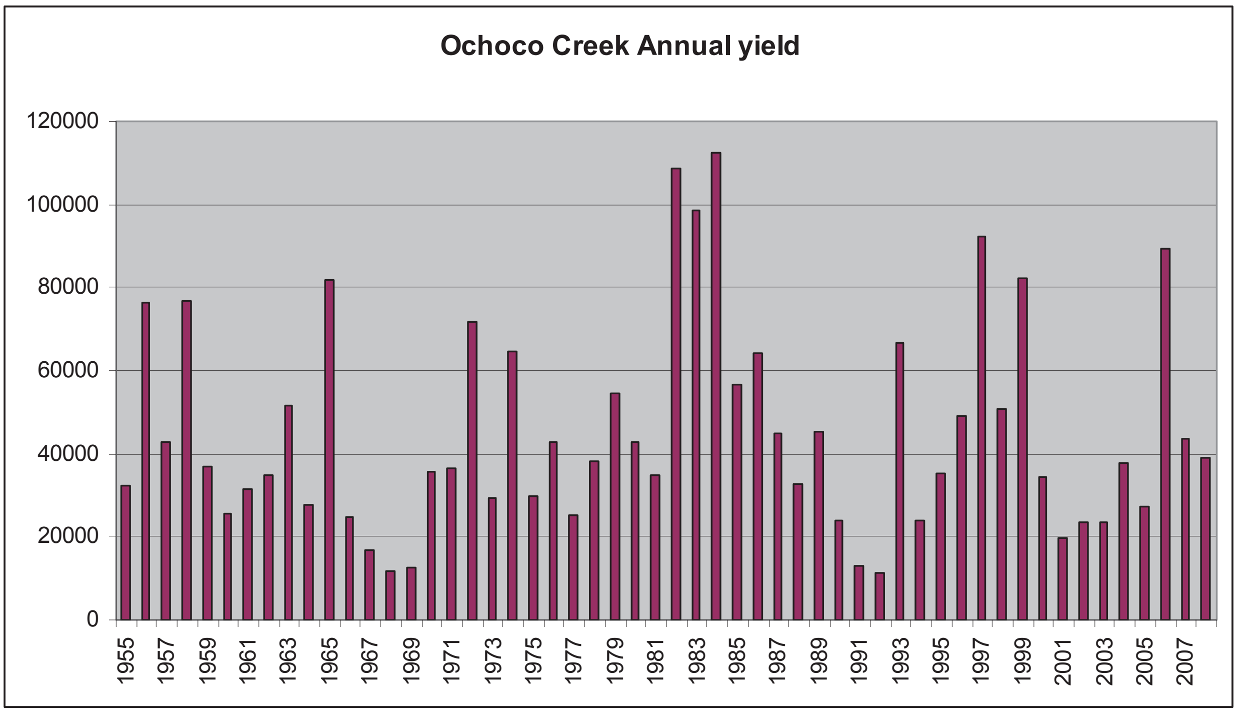
Remarks The reservoir lands and water right are owned by the United States. OID operates the reservoir under contract with USBR. OID has contracted for 57,899 ac-ft of the storage space. The right to storage for the United States is secondary to the OID natural flow right.

SECTION 1.2: Sources of Water; Storage and Regulation Facilities; and Summary of Transfer, Rotation, Exchange, or Intergovernmental Agreements - OAR 690-086-0240(2)

The primary sources of water are Ochoco Creek, Ochoco Reservoir, Crooked River, and Prineville Reservoir. However, OID holds water rights on Johnson Creek, Dry Creek, McKay Creek, Lytle Creek and unnamed sources. If water is available in the spring, it is diverted from these sources. These rights are not enough to fully supply the district needs, but augment the flow from the two main reservoirs. In addition to the OID canal system, segments of Crooked River, Ochoco Creek, Johnson Creek, Dry Creek, McKay Creek, and Lytle Creek are used as conveyances for district irrigation water.

It is important to know the hydrology of the District's water sources in order to understand the operating limitations of water management.

Ochoco Creek: The average annual yield of the watershed is 45,000 acre feet (a.f.), but the variation is very large, from a low of 11,000 a.f. to a high of 112,000 a.f. A graph of the annual yield demonstrates this variation:



The elevation of the Ochoco Main Canal is high enough to reach most of the district by gravity, making it the "least cost" source of water, though the variability of the supply makes it least reliable. The elevation of the Crooked River Distribution Canal is such that water must be pumped into it from the Barnes Butte Pump Plant. From the outlet of the pumps, water then flows by gravity. It is the most reliable source. Experience and necessity has shown the District that cost is less important than reliability. To preserve reliability, the District uses Crooked River water to supplement the Ochoco supply whenever possible. Since about one-third of the District can only be reached with Ochoco water, about 16,000 a.f. of Ochoco water must be dedicated to that portion of the District.

The average annual yield of Crooked River is 250,000 a.f., with a high of 643,000 a.f. and a low of 34,000 a.f. Its variability is also very large.

OID has two principal sources of stored water, Ochoco Reservoir, formed by Ochoco Dam constructed on Ochoco Creek, and Prineville Reservoir, created by Bowman Dam constructed on Crooked River.

Storage Facilities

Ochoco Dam	Owned by OID
Capacity	44,330
Crest Elevation	3143
Dam height	152 ft
Crest Length	1350 ft
Use	Irrigation, flood control, Industrial
Construction Date	1918-20

Bowman Dam	Owned by US Dept. of Interior
Capacity	150,216 ac-ft
Crest Elevation	3264.0 ft
Crest height	245 ft
Crest Length	800 ft
Use	Irrigation, flood control (10 cfs minimum release)
Construction Date	1958-61

Ochoco Dam and Reservoir

Ochoco Dam is a hydraulic-fill structure on Ochoco Creek about 6 miles east of Prineville. It was built by the District in 1918-1920, Ochoco Dam was rehabilitated by BOR in 1949 and the reservoir capacity was increased at that time. The dam provides flood control of Ochoco Creek in addition to storing water for irrigation. In 1989, the dam was deemed unsafe due to excessive leakage from the north abutment and storage was limited to 25,000 ac-ft. The dam was repaired in the mid 1990s under the BOR Safety of Dams Program. Presently Ochoco Dam has a storage capacity of 44,330 ac-ft with 16,500 ac-ft required for flood control from November 15 through February 1 each year. 600 ac-ft is for industrial use. Title to Ochoco Reservoir remains with OID.

Bowman Dam and Prineville Reservoir

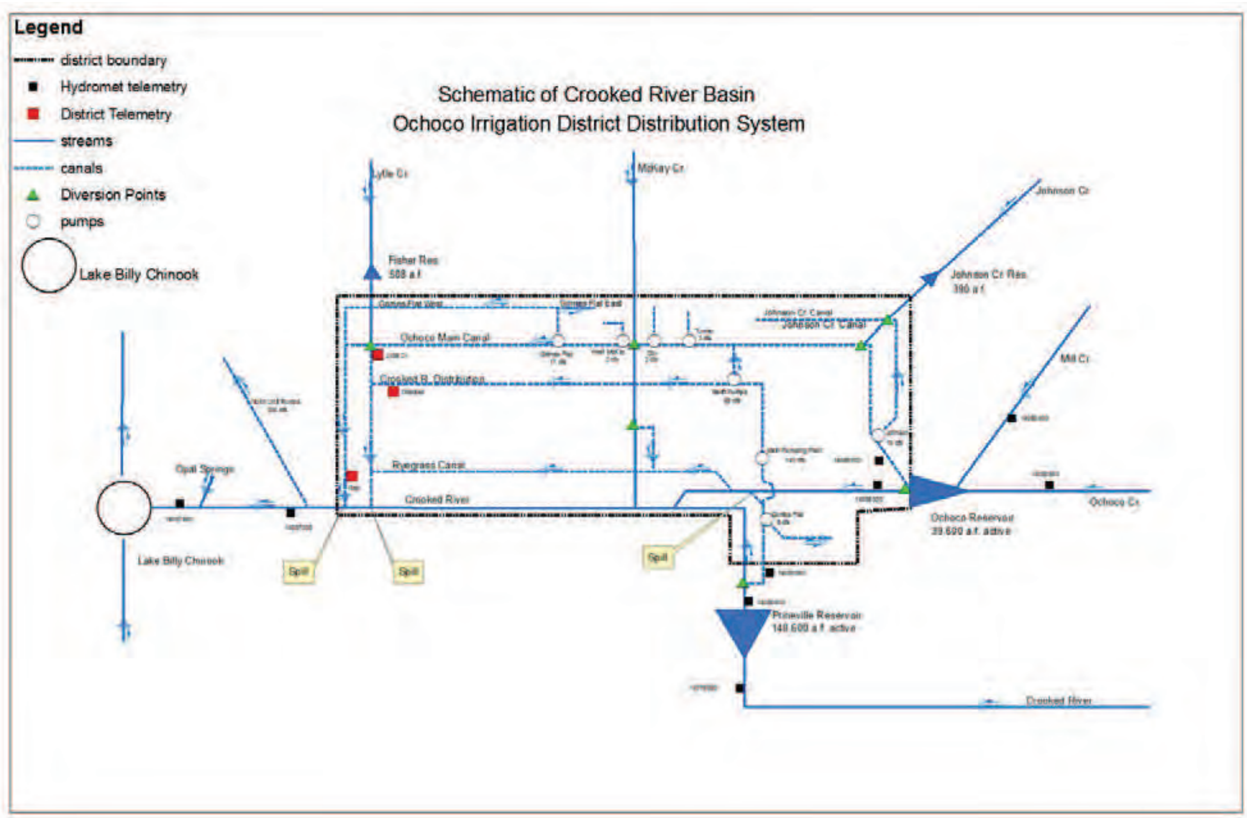
Bowman Dam is an earthen-filled structure built by the Bureau of Reclamation on the Crooked River about 20 miles upstream from Prineville. OID contracted with the Bureau of Reclamation (BOR) for the irrigation use of percentages of the storage space in Prineville Reservoir in contracts executed in 1958, 1966, and 1968, pursuant to the Crooked River Project Act and the Crooked River Project Extension Act. The total percentage of storage space contracted for was originally equivalent to 59,600 ac-ft, however this was reduced to 57,899 ac-ft as a result of a BOR 1998 reservoir sedimentation survey.

The total capacity of Prineville Reservoir at closure was 154,690 ac-ft (active storage 152,800 ac-ft). A BOR reservoir sedimentation survey completed in 1998 estimated the total capacity at 150,216 ac-ft (active storage 148,633 ac-ft). 60,000 ac-ft of vacant space is required from November 15 through February 15 each year for flood control. After February 15, water can be stored following the fill rule curve in accordance with forecasted inflow. The fill rule-curve was developed by the BOR and the US Army Corps of Engineers. The title to the dam and reservoir is with the BOR

District Water Delivery Contracts, Agreements, and Interconnections

OID operates and maintains Bowman Dam and Prineville Reservoir under contracts with the BOR. OID releases irrigation water into the Crooked River for 15 contractors who are outside of the OID boundaries and have contracted with Reclamation for the irrigation use of Prineville Reservoir storage space. The largest non-OID contractor is the Peoples Irrigation Company. Peoples has a contract with BOR for the use of a percentage of storage space in Prineville Reservoir that is equivalent to 3,497 ac-ft, with stored water released into the Crooked River.

SECTION 1.3: Schematic of the Irrigation System - OAR 690-086-0240(3)



As shown in the schematic above, the major diversion structures include the following:

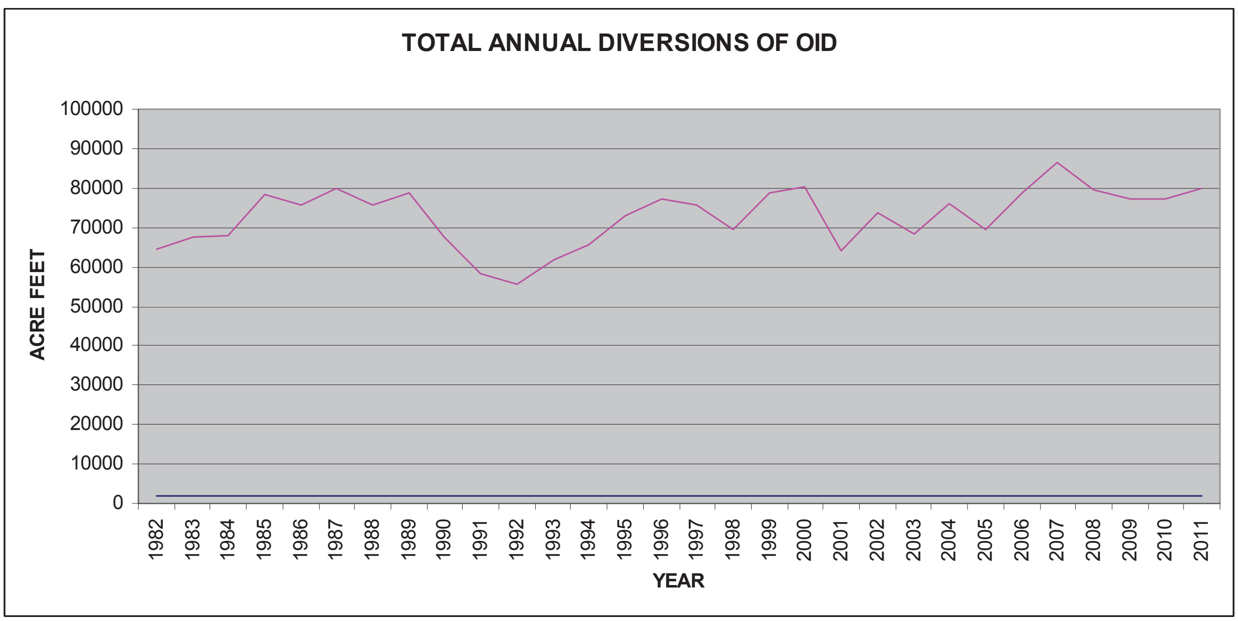
- Downstream of Prineville Reservoir, from Crooked River at the Diversion Dam, into the Crooked River Diversion Canal.
- From the outlet facilities of Ochoco Reservoir, into the Ochoco Main Canal and Ochoco Creek.
- From Ochoco Creek downstream from Ochoco Dam, into the Rye Grass Canal.
- Other points of diversion are where the main canal crosses Johnson, McKay, Lytle and Dry Creeks.

SECTION 1.4: Current Water Use and Return Flows - OAR 069-086-0240(4)

Year	Diversion Name	Gauge Number	Time of Use	Total Annual Diversion (ac-ft)
2011	Ochoco Creek	14085300	Year Round	1200
	Ochoco Main Canal	14085200	Seasonal	31700
	Crooked Diversion Canal	14080590	Seasonal	47771
2010	Ochoco Creek	14085300	Year Round	1200
	Ochoco Main Canal	14085200	Seasonal	23900
	Crooked Diversion Canal	14080590	Seasonal	52005
2009	Ochoco Creek	14085300	Year Round	1200
	Ochoco Main Canal	14085200	Seasonal	21595
	Crooked Diversion Canal	14080590	Seasonal	54573
2008	Ochoco Creek	14085300	Year Round	1200
	Ochoco Main Canal	14085200	Seasonal	28240
	Crooked Diversion Canal	14080590	Seasonal	51086
2007	Ochoco Creek	14085300	Year Round	1200
	Ochoco Main Canal	14085200	Seasonal	28075
	Crooked Diversion Canal	14080590	Seasonal	55791
2006	Ochoco Creek	14085300	Year Round	1200
	Ochoco Main Canal	14085200	Seasonal	26580
	Crooked Diversion Canal	14080590	Seasonal	47700
2005	Ochoco Creek	14085300	Year Round	1200
	Ochoco Main Canal	14085200	Seasonal	18125
	Crooked Diversion Canal	14080590	Seasonal	50340
2004	Ochoco Creek	14085300	Year Round	1200
	Ochoco Main Canal	14085200	Seasonal	25350
	Crooked Diversion Canal	14080590	Seasonal	51030
2003	Ochoco Creek	14085300	Year Round	1200
	Ochoco Main Canal	14085200	Seasonal	18322
	Crooked Diversion Canal	14080590	Seasonal	49300
2002	Ochoco Creek	14085300	Year Round	1200
	Ochoco Main Canal	14085200	Seasonal	17675
	Crooked Diversion Canal	14080590	Seasonal	55690
2001	Ochoco Creek	14085300	Year Round	1200
	Ochoco Main Canal	14085200	Seasonal	21210
	Crooked Diversion Canal	14080590	Seasonal	50812

RESERVOIR STORAGE AND USAGE

Year	Reservoir Name	Contents April 1	Maximum Contents	Contents Oct. 31	Total Storage Released
2011	Ochoco Reservoir	37070	40450	26550	13900
	Prineville Reservoir	125900	148633	93940	54693
2010	Ochoco Reservoir	28840	43730	25340	18390
	Prineville Reservoir	138400	148633	92000	56633
2009	Ochoco Reservoir	29150	36740	17570	19170
	Prineville Reservoir	121200	148633	88940	59693
2008	Ochoco Reservoir	31806	43870	22993	20877
	Prineville Reservoir	116900	148633	88820	59573
2007	Ochoco Reservoir	41878	43930	18504	25426
	Prineville Reservoir	145029	148633	76480	72153
2006	Ochoco Reservoir	34270	43470	23502	19968
	Prineville Reservoir	120344	148633	88140	60493
2005	Ochoco Reservoir	30054	42100	22745	19355
	Prineville Reservoir	131021	148633	89980	58653
2004	Ochoco Reservoir	41051	44330	27002	17328
	Prineville Reservoir	144631	148633	91770	56853
2003	Ochoco Reservoir	23654	33580	14097	19483
	Prineville Reservoir	123168	144500	78970	65530
2002	Ochoco Reservoir	20654	29800	10866	18394
	Prineville Reservoir	104200	138500	67510	70990



District Return Flows

The district calculated or measured return flows with standard USGS measurement procedures in flumes, weirs or with fixed flow measurement devices. The Gap return flow data for example is gathered with a fixed flow measurement device and telemetry (please refer to the district schematic).

Average Return Flows in Acre-Feet by Location 2007 to 2011

Month	Reynolds Dam	Lytle Creek	Ochoco Creek	Gap	Totals
April	448	891	466	136	1941
May	687	1359	1032	345	3423
June	456	1316	1371	262	3405
July	277	818	915	263	2273
August	222	1240	989	290	2741
Sept	430	1480	1102	317	3329
Oct	189	661	546	105	1501
Totals	2709	7765	6421	1718	18,613

SECTION 1.5: Classification of User Accounts - OAR 690-086-0240(5)

User accounts are described in the following table. This summary is based on district records for 2010.

User Classification	Amount in acres or acres-equivalent	Number of Accounts
Irrigation	19,701.6 acres	860
Manufacturing & Industrial	360.2 acre equivalent	14

SECTION 1.6: Types of Irrigation Systems - OAR 690-086-0240(6)

The percentages of irrigated cropland associated with these irrigation methods and systems in OID are estimated at:

Type of Irrigation System	Percent of Irrigated Acreage
Flood, furrow, corrugation, border, etc	18.8
Hand-Wheel and solid set sprinklers	55.2
Center Pivot	26

SECTION 1.7: Crops Commonly Grown, Average and Peak Use - OAR 690-086-0240(7)

For the ease of estimating gross irrigation water requirements, information on types of irrigation systems, crops commonly grown, and the estimated average and peak consumptive use of the crops are combined into this section on irrigation water requirements for the district.

Commonly Grown Crops

The district maintains a data base containing ownership and assessment (fees charged) for each acre served by the district. The District historically, collects crop data on lands over 25 acres. Many patrons change crop type in their fields annually. Annual crop reports are prepared and submitted to BOR. Most crops grown in the district are included in the analysis; however some were grouped together to determine crop ET (evapotranspiration or consumptive use) and IR (irrigation requirement). Major crops represent nearly 70 % of the total irrigated crops in OID, i.e. grain, alfalfa hay, grass hay, and pasture. There are a total of 860 patrons with many combinations of crops and specific fields. Therefore, many crops are changed annually. Specific crops by field by account are not reasonable to display (i.e. garlic, carrot seed etc. are typically grown in a new field each year). Mint may be rotated every few years depending on disease. Many of the fields on the small farms remain long term in pasture, grass hay and alfalfa hay.

The general mix of crops within the district is shown in the following table. The acreages for 2010 were chosen to represent an average distribution of crops in the district. Urban area represents small farms or users in the district of less than 25 acres, also including turf on county, city, schools, cemetery, etc. for which there are water rights.

Crop	Acres	Percent of Total Area
Grain	1783	9.1
Alfalfa hay	4614	23.4
Grass Hay	5771	29.3
Pasture grass	2189	11.1
Mint	197	1.0
Carrot Seed	205	1.0
Garlic seed	218	1.1
Other Crops/Seed	306	1.6
Under 25 Acres	3431	17.4
Fallow	987	5.0
TOTAL	**19,701**	**100.0**

Estimates of Crop Consumptive Use

OID operates water deliveries on what is known as a “Demand System”. Each spring OID management and board of directors review reservoir contents, weather forecast, current conditions, and stream flow forecast. After reviewing all of these elements, water allocations are set. Typically on average water years an allotment of 3 acre feet per acre is used. The patron is then responsible to manage their allotted amount of water. The demand system allows the patron to call in the day before they need water turned on or off. In the case of subdivisions or groups, specific dates for irrigating are set. OID patrons are encouraged to work with the local OSU extension service in determining crop needs. The district promotes such extension programs such as Living on a Few Acres. OSU Extension Bulletin 8530 and AgriMet on-line data from the Madras and Powell Butte station are also available. Bulletin 8530 does not provide data for mint, garlic and other seed crops, or urban water use (lawns), which together account for about one quarter of the total acreage. It was therefore necessary to determine ET and IR using AgriMet data from the Madras station. Data collected from the AgriMet weather station located at the OSU Experiment Station at Powell Butte is transmitted to the GOES satellite system and downloaded at the regional BOR office in Boise, ID, where the raw data is converted to crop ET using a modified Penman equation. Crop ET information for most crops in the Prineville area are available on the BOR web site, as the AWARDS program. The information below is an Example of the information available to district patrons.

The 2006 season was chosen for analysis of crop water requirements because it was the fifth ranked year out of 19 years, implying that the ET for alfalfa that year was greater than or equal to approximately 80% of the seasons. AgriMet estimates of ET during 2007 for the various crops were downloaded from the *Crop Water Use Information/Historical Crop ET* web page. Corresponding monthly rainfall data for 2007 were downloaded from the *AgriMet Weather Data/Historical Archive Data Access web page*. The monthly irrigation requirements, calculated as the difference between ET and precipitation, are shown in the table below. The seasonal ET demand is typically offset by about 3 inches from the carryover of winter storage in the soil that can be utilized by the crop during the following season.

Net Irrigation requirements (2006) (inches)										
	Acres	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Season**
Grains	449	0.0	0.0	1.8	6.3	9.7	0.6	0.0	0.0	18.4
Alfalfa Hay	4244	0.0	2.5	4.5	5.4	9.0	7.5	5.2	0.8	34.8
Other hay	5949	0.0	2.5	4.5	5.4	9.0	7.5	5.2	0.8	34.8
Grass Pasture	2718	0.0	2.0	3.4	4.0	7.2	5.9	3.8	0.4	26.6
Mint	675	0.0	0.0	0.9	4.3	9.8	7.8	0.0	0.0	22.8
Garbanzo beans	87	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Garlic seed	344	0.0	1.1	2.6	6.0	10.6	4.3	0.0	0.0	24.7
Other seed	45	0.0	0.0	0.5	2.9	5.1	1.1	0.0	0.0	9.6
Urban	2794	0.0	2.5	4.2	5.0	8.5	7.0	4.5	0.7	32.3

The maximum crop ET and IR typically occurs in July when the temperature is the highest, crop growth (foliage) and soil surface evaporation is the greatest and precipitation is the least.

The following net irrigation requirements, expressed as irrigation depths in inches, was converted to ac-ft by multiplying the above monthly ET values by the acreages shown in the first column. The results are shown in the following table. During 2006 the district net irrigation requirement peaked in July at 14,824 ac-ft. The annual total consumptive use in 2006 was 48,549 ac-ft. However the annual total would be offset by 3.0 inches carryover soil moisture from winter and spring precipitation, equivalent to 5040 ac-ft of antecedent moisture, which brings the resulting annual gross demand down to 43,509 ac-ft.

Net Irrigation requirements (2006) Monthly (ac-ft)								
	Apr	May	Jun	Jul	Aug	Sep	Oct	Season
Grains	0	67	236	363	21	0	0	687
Alfalfa hay	866	1602	1906	3194	2642	1825	269	12304
Other hay	1215	2246	2672	4477	3703	2558	377	17247
Grass Pasture	451	772	915	1626	1339	852	79	6034
Mint	0	49	240	552	440	0	0	1281
Garbanzo beans	0	0	0	0	0	0	0	0
Garlic seed	32	75	171	304	123	0	0	707
Other seed	0	2	11	19	4	0	0	36
Urban	584	971	1160	1972	1621	1048	170	7525
Monthly totals	3149	5784	7310	12507	9893	6282	895	
Antecedent moisture								4326
							Annual total	41494

Gross irrigation requirements at the farm level

Dividing net irrigation requirements by application efficiency gives the gross water requirement at the field level. District average application efficiency was based on the irrigation systems used. Two principal methods of irrigation water application exist in OID, that being surface (flood) or sprinkler. Of surface irrigation method, flood systems are most prevalent. Common crops irrigated by flood systems include mostly pasture with some hay. Common sprinkler systems include: hand lines, solid sets, and center pivots. Common crops irrigated by sprinkler systems include hay, grain, pasture, mint, garlic seed, carrot seed, etc.

Specific on-farm evaluations to determine actual application efficiencies are not available at this time, district wide estimates are provided based on observations by district personnel and published industry values.

- Surface Irrigated lands - Seasonal irrigation efficiency of 55 % is used as the district wide seasonal on-farm efficiency for all of the surface irrigated lands (23.5% of irrigated land). It is estimated that 25% goes to deep percolation (DP), and 20 % goes to runoff (RO).

- Sprinkler Irrigated Lands - An overall application efficiency of 75 % is used as the district wide seasonal on-farm efficiency for all sprinkler irrigated lands (76.5% of irrigated land). It is estimated 70 % is used to meet crop IR, 10 % goes to evaporation and 20 % goes to deep percolation. Of the sprinkler irrigated lands in the district, nearly 100 % are pressurized by pumping at the point of delivery (practically all using electric motors).

- District Wide Weighted Average - Based on average delivery needs and weighted crop IR (and accounting for 3.0 inches of carry-over soil moisture), the weighted average (for both surface and sprinkler irrigated lands) for the seasonal overall district wide on-farm efficiency then becomes 70%.

The weighted average represents an ‘attainable’ efficiency. However, there will be inevitable losses to deep percolation due to occasional over irrigation and longer set times than needed, inadequate pattern distribution uniformity due to worn nozzles or inadequate operating pressure, wind drift losses, direct evaporation from plant and soil surface surfaces, joint leaks etc. Consequently the above attainable efficiency is unlikely to be achieved as a district average. On the other hand, with the many center pivot systems now in use and the diligent operation and water management of many irrigators, it is felt the value is a reasonable goal.

Gross water demand for full irrigation in 8 out of 10 years in OID was calculated using the estimated attainable efficiency of 70% and the peak and annual net water requirements listed earlier (12,507 ac-ft in July and 41,494 ac-ft for the year). Peak delivery rates (averaged for the peak month of July) were calculated by dividing the monthly demand by the number of day in the month (31), then dividing again by 1.9835 to convert acre feet per day to cfs. Summarizing the results:

- Peak monthly demand (July): 17,867 ac-ft
- The peak delivery rate during July: 291 cfs
- Annual total demand: 59,277 ac-ft

SECTION 1.8: Operation & Maintenance - OAR 690-086-0240(8)

Operation

The governing body is a Board of Directors comprised of three directors elected at large by direct vote of district landowners. Each Director serves 3 years. The Board of Directors set the policy for the district. They meet monthly, and more often as necessary. The annual budget (prepared by the manager and staff), non-budgeted construction, inclusion and exclusion of irrigation land, etc. must be approved by the Directors. The Directors select a Secretary/Manager who has full charge of all departments of the district for the day-to-day operations. The district has 8 full time employees who are primarily responsible for the operation of the district. The district has a full time manager who is responsible to the board of directors and oversees all of the operations of the district and is the secretary to the board. The administrative staff is comprised of an assistant manager, office manager and an office assistant. Their function is billing, taking water orders, customer service, completing government forms and reports, grant writing, planning, and other administrative duties required by the manager.

The field operation of the district is divided into two sections (divisions). The first is Irrigation operations which occurs during the water delivery season and the second being construction, general maintenance and repair which occurs in the off season. The field operation section has three ditch riders who control the distribution of water to the various water users. The ditch riders are also dam tenders (operators). Their duties include releasing water from the dams, setting diversions, screen cleaning, adjusting pumps, and monitoring canal operation. The three “ditch riders” provide control of deliveries for 6,000 – 7,000 acres each. They keep daily records of delivery at each diversion and turnout, which is then totaled weekly. There is a maintenance foreman and a maintenance technician; they are responsible for repair and maintenance during the irrigation season and maintenance and construction during the non Irrigation season. There are also several part time employees that allow the district to operate continuously during the irrigation season.

Ditch riders and maintenance personnel keep track of problems that do not need immediate attention and are evaluated and prioritized at the end of the irrigation season for repair.

Off-Season Construction, Maintenance and Repair

Most maintenance is preformed on the distribution system during non-irrigation season, i.e. fall, winter and early spring months. Any new construction must be done between when the irrigation season ends, typically mid October to the end of March. Maintenance consists of removing excess vegetation and moss, and removal of accumulated sediment from canals, repair or replacement of water control structures, maintenance & repair on diversion structures, repair of canal lining, new construction, and installation of new flow measuring devices. Maintenance and repair on pumps and electrical motors and their related controls is preformed at this time also. Maintenance must also be performed on the telemetry facilities the district owns and operates.

Inspections

The district performs inspections for safety and to prevent down time during the irrigation season. Key inspections include:

- BOR and OID provide yearly inspections of Ochoco and Bowman Dams (for structural integrity and maintenance items). Dam tenders provide weekly and monthly inspections. The control gates on the outlets of Ochoco and Prineville Reservoirs have regular inspections to assure adequate operation. BOR provides inspections of all facilities in the district on a regular schedule, including diversions, pump facilities, canals and canal structures. Recommendations are made and repairs are completed as necessary.

- OID has a large number of pumps and electrical controls that are critical to the district operation. The district contracts to have all pumps and electrical switch gear inspected and serviced before the beginning of the irrigation season. The pumps are also inspected during the irrigation season for excessive heat and vibration.

Distribution System

Ochoco Irrigation District is a Demand Delivery System, whereby the patron orders water turned “on” or “off” as they determine their need. The water order is to be placed the day prior to delivery. In the case of subdivisions or groups, specific watering dates are set in advance. Discharge gates at Ochoco Dam may be regulated several times daily during irrigation season as demand dictates. Crooked River water from Prineville Reservoir is regulated with gates at Bowman Dam and gates at the Crooked River Headwork’s (Diversion Canal). The conveyance and distribution system consists of many miles of open Main canals, open and closed laterals and drains. The Main canals are known as; Crooked River Diversion Canal, Crooked River Distribution Canal, Ochoco Main Canal, and Rye Grass canal. Laterals consist of open earthen canals or ditches; some are concrete lined, gravity pipes and tightline pipe.

There are approximately 50 miles of open delivery Main canals. A section 1.75 miles long, referred to as the Ochoco Feed Canal, beginning at Ochoco Dam is concrete lined, with another approximately 5.5 miles clay or bentonite lined.

The Districts Main Canals are at several different elevations with the most upper canal starting at elevation 3120 feet. The distribution system consists of 24 miles of open laterals, 36 miles of pipelines and concrete-lined laterals. There are also 16 miles of drains of which 12 miles are piped.

Where Main Canals cross McKay Creek, siphons have been constructed to pass canal flows beneath the stream bed. This allows for natural stream flows to be passed unobstructed during flood flows. Fish passage is also a benefit of these structures. Water can be diverted as well as spilled at these structures. Where other creek crossings or diversions occur, different types of fish friendly structures have been constructed. There are also many bridges and culverts where the canals and laterals are crossed by state, county and private roads.

There are five tributaries of the Crooked River within the bounds of the district. None of the tributaries have year long natural flow within the district. Irrigation water is delivered into the tributaries at various points as the district uses all five as part of their conveyance system, and for operational spills. Four of the tributaries totally dry up after the end of the irrigation season when irrigation delivery water is shut off. Ochoco Creek has flow after the close of the season due to seepage from Ochoco Dam. This flow may be supplemented with releases from Ochoco Reservoir for fish and wildlife purposes and to maintain stream riparian growth.

Functional Operation

Releases from Ochoco Reservoir are diverted into the Ochoco Main Canal and Ochoco Creek. Water travels down the canal where some is removed at the Johnson Creek pumping plant to supply water to the Johnson Creek Canal. Water continues down Ochoco Main Canal to the intersection with Johnson Creek. When there is water available, Johnson Creek water is diverted into the Ochoco Main Canal. Water continues down Ochoco Main Canal until it reaches the point where the Ochoco Relift Pumps lift water from the Crooked River Distribution Canal to the Ochoco Main Canal. At this point Ochoco Reservoir water and Crooked River water can be co-mingled. Water continues down the canal with pumping plants to divert water into the Tunnel Canal and Cox Pipeline. The canal then passes under McKay Creek via a siphon (Known as “Jones”). Water can be diverted from McKay Creek when water is available or spilled into McKay Creek as needed. A little further down the Main Canal water is diverted by pump into the West McKay Canal. As water continues down the Ochoco Main Canal, the Grimes Flat Pumping Plant diverts water into the Grimes Flat East and West Canal (aka Lytle Creek East and West). Water continues down the Canal to the intersection with Lytle Creek, water can be diverted if water is available or spilled into Lytle Creek as needed. At Lytle Creek the District operates a telemetry station to monitor flow which is used to help determine the release from Ochoco Reservoir and the Relift pumps. Grimes Flat West Canal returns spill into the Ochoco Main Canal, west of this point. The Ochoco Main Canal continues through the Gap and spills into the Crooked River. There is also District telemetry at this point.

Water is diverted into Ochoco Creek at the Ochoco Dam Headworks. After the diversion, Ochoco Creek flows in a westerly direction with several district and patron delivery points along its path to the Crooked River. The Rye Grass Canal is one of the main re-diversions. This re-diversion is complete with fish screening and passage. Rye Grass Canal also continues in a westerly direction and crosses McKay Creek via siphon (Known as “Pine Products”) and eventually joins with Lytle Creek, which in turn flows to the Crooked River.

Prineville Reservoir releases flow via Bowman Dam down the Crooked River to the Crooked River Headworks. The releases from the reservoir are measured by gauging station 140.80.500

and the water that is diverted is measured by gauging station 140.80.540. The District's water is diverted into the Crooked River Diversion Canal (Up to 190 cfs). As the water travels down the canal some water is diverted by pump for the Combs Flat Canal. Also, it is at this point the open Diversion Canal enters a pipeline and travels north, crossing Ochoco Creek via an aqueduct and continues to the Barnes Butte pumping plant where the water is lifted to the Crooked River Distribution Canal. A portion of water is spilled into to Ochoco Creek at this aqueduct to keep a positive force on the pumps. The Barnes Butte Pumping Plant is capable of pumping up to 140 cfs. The Crooked River Distribution Canal continues on a north westerly track to the Ochoco Relift Pump Plant. Up to 98 cfs can be lifted to the Ochoco Main Canal at this point. The Canal continues on from the Relifts, and then crosses McKay Creek via siphon (Known as "Reynolds"). Water can be spilled at this point. The Canal continues in its westerly direction until it joins Lytle Creek. There is a telemetry station on the canal prior to it joining Lytle. There are 4 small District pump stations along the Distribution Canal that deliver water to patrons.

Pump Plants

OID relays heavily on pumps to move water to canals and pipe lines in the district. A summary of the main pump plants is listed below.

Name	Number of Units	Capacity (cfs)	Dynamic Head (ft)	Total Horsepower
Barnes Butte (Main)	5	140	82	1,800
Ochoco Relift	6	98	99	1,550
Combs flat	2	8	140	225
Cox	1	2	59	25
Johnson Creek	2	14	125	375
Tunnel	1	3	92	75
Mckay Creek	1	3	49	25
Grimes Flat	3	21	78	260
Owens	1	1	28	2
Houston	2	4	4	3
Stahancyk No. 2	2	4	4	3

Operation and Maintenance Concerns

Aquatic weeds and moss become a big problem in the Main Canals and Laterals during mid and late summer as water temperature increases. Moss and water weeds drastically reduce canal capacity and cause clogging of screens, trash racks and inlets to pumps. Maintenance time and materials cost to the district to control moss in the canals is a major concern. Moss must be controlled and/or removed, as it can cause canal overflow if left unchecked. Both mechanical and chemical control methods are used. All chemical applications are in strict accordance with the manufactures label and EPA requirements.

SECTION 2: WATER CONSERVATION ELEMENT

OAR 690-086-0250

SECTION 2.1: Progress Report on Previous Measures – OAR 690-086-0250(1)

The following table provides a list of water management or conservation projects that have been completed since the last WMCP was filed. One major item to note about this progress report is that OID and the local community experienced a devastating flood in the late spring of 1998. 3” to 7” of rain fell in a three day period, causing Ochoco Reservoir to spill and Ochoco Creek to flood. Other local tributaries were overwhelmed by the rain event as well. Most of the District’s check board diversions in Ochoco and McKay Creek were damaged or destroyed. As a result many of the projects identified in the previous WMCP were put on hold and are being re-evaluated. However the good news is that projects still went forward that benefited the District, community, and environment. Some of the biggest benefits were the installation of fish friendly devices on OID’s stream diversions. These included the removal of 11 check board diversion dams and installation of fish friendly diversion structures on Ochoco and McKay Creeks. Other notable projects were constructed as well.

Diversion Projects	Description
Jones Dam	Installed siphon, automated fish screen and ladder.
Reynolds Dam	Installed siphon and automated regulating gate.
Battles Dam	Abandoned Dam, Installed pipeline from main canal.
Pine Products Dam	Installed siphon.
Smith Dam	Installed inverted weir and pump boxes.
Rye Grass Dam	Installed inverted weir and piping.
Slaughter House Dam	Abandoned dam, Install infiltration gallery, install piping.
Schnoor Dam	Abandoned dam, install infiltration gallery, install piping.
Breese Dam	Installed inverted weir, 2 pumps, and pump boxes.
Cook Dam	Installed inverted weir, piping, delivery boxes.
Red Granary Dam	Built new automated dam complete with fish ladder and screen.

Open Canals and Laterals Converted to Pipe

Piping Projects	Description
Lanius Pipeline	Installed pipe resulting in large water savings and pressure to patron pumps. eliminating flood irrigation on this lateral.
301 Pipeline	Concrete changed to PCV, tight lined.
Breese Pipeline	Piped open lateral, added delivery boxes .
Battles Pipeline	Install Piping off Main Distribution Canal, Replacing Battles Dam on Mckay Creek.
Various Pipeline Replacements, Lateral Piping, Relocations	Concrete to PVC, New Installations, Tightlining Patron Pumps for efficiency.

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Telemetry

Location	Description
The Gap Telemetry	Real time flow measurement, sent directly to OID.
Lytle Creek Telemetry	Real time flow measurement, sent directly to OID.
Crooked River Telemetry-End of Crooked River Canal	Real time flow measurement, sent directly to OID.
Relift Alarm System	Alarm alerts OID Office of system failure.
Main Plant Alarm System	Alarm alerts OID Office of system failure.

Canal Check Dams

Location	Description
Ochoco Main Canal #3	Construct new check dam in Ochoco Main Canal

Pumps

Location	Description
Johnson Creek Pumping Plant	Installed variable frequency drive, pump and motor

SECTION 2.2: District's Water Measurement Program - OAR 690-086-0250(2)

OID has a comprehensive flow measurement system. Diversion flow measurement and annual reporting to OWRD and BOR meet OAR 690 Division 85 requirements. All on-farm delivery points are also measured. Major flow measurement points are included on the district schematic. Location of these sites and the continuous recording devices used meets OAR 690 Division 85 requirements. The district has many other flow measurement sites at key locations within the district that are used for day-to-day operation and management purposes.

Reservoirs and Major Diversions

All Major tributaries into Prineville Reservoir and Ochoco Reservoir are gauged. Also Reservoir volumes and out flows are gauged as well. These gauges are operated and maintained by OWRD and BOR.

Stream flow is measured into Ochoco Reservoir on Mill Creek and Ochoco Creek and into the Prineville Reservoir on Crooked River. The elevation of the water in the reservoirs is measured and the capacity can be computed.

Output from Prineville Reservoir is measured below Bowman Dam on the Crooked River. The flow into Crooked River Diversion Canal is measured in the canal downstream of the headworks.

Total Releases from the Ochoco Reservoir can be measured by summing the measurement of flow on Ochoco Creek and Ochoco Main Canal. These diversion flow measurements and annual reporting to WRD and BOR meet OAR 690, Division 85 requirements.

When available, water can be diverted from Johnson Creek, Dry Creek, McKay Creek and Lytle Creek. These diversions typically flow into the Ochoco Main Canal; however the District has a legal right to divert McKay Creek water into the Crooked River Distribution Canal as well as Rye Grass Canal.

Ochoco Main and Crooked River Diversion Canal are equipped with continuous recording data loggers and data is transmitted by telemetry facilities. The telemetry is transmitted through the BOR Hydromet System. OWRD Deschutes River Basin Watermaster monitors the same system as well as the information being recorded at each station. Where the schematic shows diversion sites, spills or diversion into canals or laterals, these spots can also be measured. In addition there are many manual measure points throughout the entire distribution system.

OWRD Flow Measurement Sites within the Crooked River Basin

Location	Gage Number	Data Date
Crooked River near Post	14079800	1961 – 1968, 1993 - present
Prineville Reservoir	14080400	1961 - present
Crooked River below Bowman Dam	14080500	1961 - present
Crooked River Diversion Canal	14080590	1981 - present
Crooked River below OID	14087300	1967 - 2004
Mill Creek above Ochoco Dam	14083400	2000 - present
Ochoco Reservoir	14085100	1953 - present
Ochoco Main (Feed) Canal	14085200	1953 - present
Ochoco Creek below Ochoco Dam	14085300	1953 - present
Ochoco Creek above Ochoco Dam	14082550	2000 - present

Conveyance and Distribution Canals and Return Flows

The OID has automated gauging stations at critical points throughout the district. The readings from these gauging stations are available real time at the district office and to the ditch riders by cell phone. The district also has manual gauging stations throughout the district. These stations are located where water is diverted into lesser canals or laterals. Measurement is generally by weir. Canal diversions and return flows are both measure manually and by telemetry.

District Operated Measuring Sites

Location	Description	System Type
The Gap	Ochoco Main canal return flows	Telemetry
Lytle Creek	Return flows end of Lytle Creek	Manual
Crooked River Distribution Canal	C.R. Distribution canal return flow into Lytle Creek	Telemetry
McKay Creek Siphon/Ochoco Main canal	Main canal flow measurement	Manual
McKay Creek Siphon/Distribution canal	Distribution canal flow measurement	Manual
Main Canal and Tunnel Lateral	Diversion to Tunnel Canal	Manual
Main Canal Johnson Creek	Diversion to Johnson Creek lateral	Manual

Location	Description	System Type
Main Canal and Cox	Diversion to Cox Canal	Manual
Main Canal and West McKay	Diversion to West McKay Creek Canal	Manual
Main Canal and Grimes Flat	Diversion to Grimes Flat Canal	Manual
Diversion Canal at Relift Pump	Output of Relift Pump	Manual
Diversion Canal at Main Plant	Output of Main Plant	Manual
Ochoco Creek Rye Grass Canal	Diversion to Rye Grass Canal	Manual
Crooked River Diversion Canal to Ochoco Creek	Spill to Ochoco Creek	Manual

Delivery for Farm Use

The ditch rider adjusts the user's delivery outlet gate to meet the amount ordered. 90% of all deliveries are measured or estimated with standard devices. These include weirs, standard type flow meters, and manufacturers' standard operating curve for center pivots, counting sprinkler heads, or calculating pump discharge knowing power usage. Totalizing flow meters may be required to be installed by a user when a free flowing sharp crested weir cannot be used, i.e. delivery to areas upslope of the canal. The amount of water delivered to the users is recorded by the ditch rider each day. At the end of the week the ditch rider's daily water reports are turned into the office. A tabulation of the weekly usage for each irrigator is recorded and the amount subtracted from their seasonal allocation, thus determining the amount of water remaining for their use.

SECTION 2.3: Other Conservation Measures Currently Implemented - OAR 690-086-0250(3)

OID has a number of conservation measures that were identified and some have been implemented under the previous WMCP. Currently the District is working on a "System Optimization Review" (SOR) funded in partnership with BOR. The purpose of the SOR is to look at several targeted areas of water and power conservation and efficiencies within the District. The following are some of the items in review; pump power and pump efficiency, pump plant relocation, potential for hydro project on outlet of Ochoco Dam, wetlands on tail end of delivery system, pump back facility, GIS, system seepage loss evaluation, and piping of main canals and several laterals.

The District in the last two years has relocated two patron deliveries (Radabaugh and Winebarger Projects) from smaller canals where reliability was uncertain, to main canals where efficiencies greatly improved. The realized water savings were in that previously shorting patron pumps caused unintentional spill (pump shut off) and loss of otherwise deliverable water. These projects where funded in partnership with BOR field services conservation program.

The District also recently completed a water management and conservation project (Peterson Project) to recapture water otherwise spilled into a drain and now making it available for delivery in the Distribution Canal.

SECTION 2.4: District Goals for Improving Water Conservation and Management - OAR 690-086-0250(4)

It is recognized the pursuit of all of the following goals may be expensive and time consuming; however the district will pursue what they can physically and financially. The cumulative effect of all of these goals would be to improve district operations, water accountability, increase water conservation, and improve watershed enhancement in Ochoco Creek, McKay Creek, Crooked River, and adjoining tributaries.

Overall goals include:

- Provide Irrigation water delivery to District patrons in a safe and efficient manner.
- Keeping within the Districts authority.
- Maintain Irrigation acreage base and water rights for District patrons.
- Improve system water losses by improving water management. Installing additional Telemetry sites in strategic areas. Maintaining existing measurements.
- Implement new and maintain current GIS technology to improve data collection and retrieval that will improve and reduce costs of district operations.
- Continue to improve distribution system through piping of appropriate canals and laterals. Thereby addressing seepage losses and return flows.
- Support education to patrons on water delivery, crop scheduling, and stewardship. Also inform them of known on farm conservation opportunities and cost share programs.
- Aggressively pursue affordable water and power conservation measures that benefit the overall District operations.
- Improving stream habitat and watershed heath.

These following actions will be taken to fulfill these goals:

Immediate - Less than one year

- Continue work to improve district maps and records. This includes water rights maps and data, GIS.
- Investigate and implement methods of keeping current paper records on computer spread sheets.
- Complete SOR report.
- Install Multi Purpose Fish Screen on Ochoco Main Canal Diversion.
- Complete updated Water Management and Conservation Plan
- Continue temporary instream leasing program with Deschutes River Conservancy.

Short Term - 1-2 years

- Investigate and install additional telemetry that will improve water management.
- Continue to improve distribution system, based on District priority, by piping or tightlining smaller open laterals and ditches.
- Continue temporary instream leasing program with Deschutes River Conservancy.

Long Term - 2 – 10 years

- Continue to improve distribution system, based on District priority. Piping and tightlining laterals.
- Continue to improve water management through installation of additional telemetry stations with in the District.
- Investigate tail end pump back system on Rye Grass Canal.
- Investigate Pump and Motor replacements or upgrades based on SOR report and need.
- Continue temporary instream leasing program with Deschutes River Conservancy.

SECTION 2.5: Improving Water Use Efficiency - OAR 690-086-0250(5)

Based on previous BOR studies (April 1997 "Upper Deschutes River Basin Water Conservation Study") on canal losses and seepage, OID has identified that the greatest opportunities to increase water use and efficiency is through reduction in operational spills and return flows. The following tables provide a list of potential projects and cost estimates as provided by OID. Cost estimates include, labor, equipment, materials, and contingency. Most likely these estimates are high, as pipe size reduction has not been fully evaluated. The previous plan called for lining many of these projects. Today, after evaluating past efforts and testing of various liners within the district, the district has come to the conclusion that piping would be the preferred alternative. While lining has it advantages as to cost and controlling seepage, maintenance and control of spills are major concerns to the district. The projects listed below only have a feasibility level of review, and would need a much greater depth of analysis and cost benefits. As with most projects, cost is a major concern. The district looks at cost and evaluates if there is even a chance of funding, before fully evaluating water savings. Because of contractual restraints and federal regulations (Reservoir Authorization), the district is unable to participate in conserved water projects that dedicate a portion of water savings instream. Needless to say, this makes partner funding less likely, as there is no incentive to do so. Currently the district is pursuing legal avenues to change this situation.

COST ESTIMATES FOR OPEN CANAL AND LATERAL PIPING

LATERAL PIPING RECONAISSANCE

Lateral/Canal	Length ft.	Pipe Size	Project Cost
J - Lateral	5,745	24”	$ 548,263
311 - Lateral	2,284	16”	$ 118,270
321 - Lateral	4,201	12”	$ 178,835
375 - Lateral	3,642	18”	$ 214,188
381 - Lateral	7,122	14”	$ 408,167
389 - Lateral	2,380	14”	$ 116,243
407 - Lateral	4,922	12”	$ 203,387
Grimes Flat West Canal (aka Lytle Creek)	32,734	36”	$ 6,222,200
Grimes Flat East Canal (aka Lytle Creek)	9,576	24”	$ 931,375

OCHOCO MAIN CANAL PIPING RECONAISSANCE

Ochoco Irrigation District System Optimization Review#

OCTOBER, 2012

Construction Item	Total Length	Diameter (O.D. Inches)	Material	Estimated Cost/LF	Estimated Total Cost
1. Pipe	19000	90	HDPE Profile	925	17,575,000
2. Pipe	48012	96	HDPE Profile	1000	48,012,000
3. Pipe	9954	90	HDPE Profile	925	9,207,450
4. Pipe	17330	78	HDPE Profile	790	13,690,700
5. Pipe	9690	54	HDPE DR32.5	300	2,907,000
6. Pipe	7014	48	HDPE DR32.5	270	1,893,780
7. Pipe	6000	42	HDPE DR32.5	230	1,380,000
8. Pipe	3379	22	HDPE DR32.5	120	405,480
9. Pipe	8941	22	HDPE DR21	150	1,341,150
10. Turnouts					500,000
11. Crossings and Major Connections					250,000
				SUBTOTAL	**97,162,560**
Contractor OH/Profit	10%				9,716,256
Contractor Bonds and Insurance	2%				1,943,251
Construction Contingency	30%				29,148,768
				SUBTOTAL	**137,970,835**
Engineering, Administration	15%				20,695,625
				GRAND TOTAL	**158,666,460**

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C. R. DISTRIBUTION CANAL PIPING RECONNAISSANCE

Ochoco Irrigation District
System #

Optimization Review#

OCTOBER, 2012

Construction Item		Total Length	Diameter (O.D. Inches)	Material	Estimated Cost/LF	Estimated Total Cost
1. Pipe		8500	90	HDPE Profile	925	7,862,500
2. Pipe		13943	60	HDPE Profile	675	9,411,525
3. Pipe		10675	54	HDPE DR32.5	300	3,202,500
4. Pipe		10618	48	HDPE DR32.5	270	2,866,860
5. Pipe		9519	42	HDPE DR32.5	230	2,189,370
6. Pipe		2392	36	HDPE DR32.5	200	478,400
7. Pipe		4945	28	HDPE DR32.5	150	741,750
8. Pipe		2752	12	HDPE DR32.5	60	165,120
9. Turnouts						150,000
10. Crossings and Major Connections						75,000
					SUBTOTAL	**27,143,025**
Contractor OH/Profit		10%				2,714,303
Contractor Bonds and Insurance		2%				542,861
Construction Contingency		30%				8,142,908
					SUBTOTAL	**38,543,096**
Engineering, Administration		15%				5,781,464
					GRAND TOTAL	**44,324,560**

One of the goals of the recent “System Optimization Review” was to look at the potential for piping the entire Ochoco Main canal and Crooked River Distribution Canal. As can be seen in the tables above these endeavors are cost prohibitive at this time. This analysis did not cover full delivery of pressurized water, which may result in reduced pipe sizing. However with that said, the reality of constructing such large projects in the near future is highly improbable. The current best conservation opportunities are to pipe laterals as funding allows, install telemetry to help manage flows, and work with irrigators to improve on farm efficiencies.

SECTION 2.6: Evaluation of Water Conservation Projects - OAR 690-086-0250(6)

OID evaluates each potential conservation project with the following set of guidelines;

- Financial - Is the project financially feasible? Is there cost share or funding opportunities?
- Benefits - Does the project better the overall good of the District? Project outcome.
- Practicable - Can it be physically constructed? Are resources available?
- Environmentally - What are the environmental benefits, impacts and requirements?

Promotion of energy audits

OID supports energy audits for water users. At this time there is not a formal energy audit program offered by Pacific Power and Light. These programs are administered through the Energy Trust of Oregon and BPA. The Energy Trust of Oregon has an ongoing program available. The Energy Trust of Oregon provides incentives throughout its service territory for cost-effective agricultural measures through the Production Efficiency Program. BPA offers similar programs, such as sprinkler replacement packages, gaskets, variable frequency drives (VFD’s) and nozzle exchange. A description of these programs and the contact information will be supplied in the OID office or in the district’s annual newsletter.

Conversion to metered, piped or pressured deliveries parcels one acre or less

There are 166 patrons with 1 acre or less. Half of these users are within subdivisions and delivered water at one delivery point. OID will further evaluate the option of metered, piped or pressurized deliveries of parcels of one acre or less. The district has already implemented grouped deliveries to most subdivisions or groups. These deliveries are monitored for quantity at this time; many of them are piped and or pressurized from the point of delivery. Currently when land is subdivided, the district secures a water delivery agreement. This insures a primary and secondary contact, single point delivery, and maintenance responsibilities.

Piping or lining earthen canals

Through the last WCMP and the 1997 BOR study, OID has identified and implemented lining and piping laterals. As stated above due to the flood of 1998, priorities were and have changed since the last WCMP. Section 2.1 describes many projects completed to date. The district is very pro-active in pursuing piping of canals and laterals. With the recent SOR close to completion and the information contained in the 1997 BOR water conservation study, the district will update cost estimates and pursue projects that are feasible and reasonable, as funding is available.

Modifying distribution facilities and district policies to increase the flexibility of water deliveries

OID has already implemented modification to distribution facilities as described elsewhere in this WMCP. District policies have also been modified to increase flexibility and efficiency of water deliveries. For example, the district has consolidated the delivery of subdivision water to a single point and will continue to do so with new subdivisions in the future.

Provision of on farm irrigation scheduling assistance

The district monitors patron water use. The amount of water delivered to the users is recorded by the ditch rider each day. At the end of the week the ditch rider's daily water reports are turned into the office. A tabulation of the weekly usage for each irrigator is recorded, and the amount subtracted from their seasonal allocation, thus determining the amount of water remaining for their use. In addition to monitoring patron water use, the district will cooperate with OSU extension on an on-going basis to promote on farm irrigation scheduling through the district's newsletter and will make appropriate publications available at the district office, such as Crook County Extension's program: Living on a Few Acres.

Construction of re-regulating reservoirs

OID has constructed and evaluated the potential for constructing re-regulating reservoirs in past studies. At that time the district found the costs of the projects too high compared to water savings benefits.

Adoption of rate structures that support and encourage water conservation

The district rate structure is based on a cost per acre of delivered water. The district will continue to review their O & M costs, rate structures and revenues as part of the annual budget process.

Any other conservation measures identified by the water supplier that would improve water use efficiency

The district may explore a program with the Energy Trust on the opportunity to exchange old worn irrigation nozzles for new replacement nozzles free of charge. Worn nozzles may cause an irrigation system to deliver more water than necessary and consequently use more energy.

SECTION 2.7: Schedule for Implementation of the Projects - OAR 690-086-0250(7)

Information and outreach program

The district strives to stay current on new or up and coming technologies. The district learns of such new technologies through attending seminars, various organizational annual meetings (such as OWRC), BOR reports, local extension office etc. Information is gathered and shared with district patrons through a newsletter and or annual meeting.

Other conservation measures identified as feasible and appropriate

The district will evaluate on an annual basis the feasibility of participation in the programs listed in section 2.6.

SECTION 2.8: Program for Evaluations of Projects - OAR 690-086-0250(8)

Capitol improvement projects are likely to be done with cooperative funding partnerships from state and or federal agency programs. At the time of project funding the method of evaluation will be consistent with the funding agency's criteria.

SECTION 3: WATER ALLOCATION AND CURTAILMENT ELEMENT

OAR 690-086-0260

SECTION 3.1: Frequency and Magnitude of Past Supply Deficiencies - OAR 690-086-0260(1)

The drought of 2001 was the most recent water supply deficiency. Others occurred in 1991, 1992 and 1994. In the early 1990s, single patron deliveries to subdivisions were discontinued. During these low water conditions, the district grouped the delivery of water to subdivisions. The practice of grouping these deliveries proved to be a cost effective conservation program that also eliminated distribution workload for non-drought circumstances and has been continued.

Past experience has shown that if the reservoirs do not have 50 % of capacity by the beginning of the irrigation season there is a high potential for supply deficiency during the irrigation season.

SECTION 3.2: Criteria for Implementation of Water Allocation/Curtailment Element - OAR 690-086-0260(2)

The three primary criteria that OID will use for triggering actions under its curtailment plan are:

1. Drought which would result in less than 50% of the reservoir capacity, particularly in Ochoco Reservoir.

2. Catastrophic damage to the reservoirs or main canals flood or seismic events.

3. Spills from truck or rail that would include chemicals that would damage crops.

SECTION 3.3: Procedure for Allocating Water During Shortages - OAR 690-086-0260(3)

The fundamental tool used by the District is the allocation per acre set by the Board. The initial allocation is set at the start of the irrigation season, and all patrons are notified with the number of acre feet in their account. In good water years this is typically set at three acre feet per acre, with up to one additional acre foot allocated in mid-summer if supplies allow. During drought the allocation is set within the limits of what is available. In 1992 the allocation was 0.7 acre feet per acre. This allocation system forces all uses to share equally.

The following priorities are applied by OID when allocating water during shortages:

1. Share in shortage equally if possible.

2. Work with patrons to group irrigators to make the most of each run on laterals.

The District uses the following procedures when allocating water:

Drought: Rotations may be based on patron cropping. The district will consult with OSU Extension Services and local farmers to see if storage/available supply can be prioritized for critical stages of crop need.

Catastrophic Damage: The district manager is authorized to contact media to alert patrons of possible supply or safety issues.

Media Contacts (as listed in the Oregon Blue Book):

KLTW-FM (95.1), Soft Adult Contemporary;
KWLZ-FM (96.5), Classic Rock
854 NE 4th, Bend 97701; 541-383-3825; Fax: 541-383-3403

KRCO-AM (690), Classic Country
PO Box 690, Prineville 97754; 541-447-6770; Fax: 541-383-3403

KRDM-AM (1240), Spanish
1514 SW Highland Ave., Suite A, Redmond 97756; 541-548-7621; Fax: 541-504-8145

Central Oregonian
558 N Main St., Prineville 97754; 541-447-6205

SECTION 4: WATER SUPPLY ELEMENT

OAR 690-086-0270

SECTION 4.1: Long Range Water Demand Projections - OAR 690-086-0270(1)

OID will continue to investigate various sources of accurate information on events that effect crop water use or water supply. With respect to population changes and water demand, Central Oregon in general is one of the fastest growing portions of the state (source Oregon Economic and Community Development Department). Since 1990, Crook County has grown in population from approximately 14,000 to 24,000 people. The City of Prineville has grown from approximately 5,400 to nearly 10,000. However, the urban influence and conversion of agricultural lands to urban uses near Prineville is not expected to be as strong as that experienced by districts nearer to Bend and Redmond. Developments such as the new Department of Corrections facility near Madras may influence other economic development and result in urban expansion into the district. OID continues to monitor these trends but does not anticipate needing significant additional water supplies. As a result of urbanization in the Prineville area, the district is working to preserve agricultural lands by transferring water rights from lands as they are developed to other lands. In conjunction with these transfers, the district will explore alternatives for modification of the district boundary.

SECTION 4.2: Projected Water Needs and Size and Reliability of Water Rights Permits and Contracts - OAR 690-086-0270(2)

OID anticipates that agricultural demand for water will remain relatively constant during the next 20 years. Urbanization may result in modest changes in water demands. However, the effect of these changes on the district's available water supply is not expected to be significant and can be accommodated within the district's water rights.

SECTION 4.3: Potential Water Sources - OAR 690-086-0270(3)

The district will investigate other sources of water. Water stored by the BOR in Prineville Reservoir provides a potential source of additional water if new water requirements are larger than anticipated. However at this time the district's infrastructure cannot adequately distribute more water from that source.

The district is monitoring water demands and will work with the landowners to improve water use efficiency if water demands increase as a result of land divisions. In addition, the district will evaluate whether infrastructure improvements are needed to improve the efficiency of deliveries or to convey additional supplies.

SECTION 4.4: Comparison of Potential Water Sources - OAR 690-086-0270(4)

No evaluation of additional sources of water has been done at this time. There is still approximately 50% of the federal storage in Prineville Reservoir available for contracts. Any new uses of ground water in the upper Deschutes Basin would need to be mitigated to protect flows in the Deschutes River Scenic Waterway.

SECTION 4.5: Evaluation of the Effects of Long Range Water Needs - OAR 690-086-0270(5)

Regional options for meeting future water needs

OID has not investigated options outside of either the Ochoco Watershed or the Crooked River Watershed. Within the ten-year planning period of this WMCP, it is expected that water service contracts with the BOR will meet current and future needs.

Urbanization and other land use trends

Urbanization of lands within the district is an issue, but so far not a major problem. However the District is working with the County and City on issues to make sure that all deliveries can be maintained. The District attempts to insure that delivery easements are recorded for each new partition or plat.

Local government related plans and ordinances

Other land use trends that may affect the district are large farms being split up into smaller units. These units still may be of a significant size (100 plus acres). This equates into more physical water deliveries. This potentially results in higher overhead for the district. In some instances, a subdivision of land within the District may require a water delivery agreement.

SECTION 5: ADDITIONAL REQUIREMENTS

OAR 690-086-0225

SECTION 5.1: List of Affected Governments, Copy of Comments - OAR 690-086-0225(5)

At least 30 days prior to submitting a draft plan to OWRD, each agricultural water supplier must make the draft plan available for review by each affected local government.

Consistent with these rules, OID provided the draft plan to Crook County and the City of Prineville for review 30 days prior to submitting a draft plan to OWRD. As a courtesy, the district also included North Unit Irrigation District, Confederated tribes of Warm Springs and the local office of the BOR.

SECTION 5.2: Submittal of Updated Plan, Implementation Schedule - OAR 690-086-0225(6)

The primary implementation activities identified in this WMCP involve capital improvement projects which can take significant time to implement given funding constraints and construction timelines. With respect to available current supplies, the district can generally meet existing needs and does not anticipate significant impacts from urbanization over the next ten years. For these reasons, OID proposes to update the WMCP in ten years. An updated plan will be submitted to WRD by December 31, 2022.

SECTION 6: BACKGROUND INFORMATION

History of District

As early as 1905, plans were made to irrigate the Ochoco Valley; however because of difficulty in obtaining financing, the proposed project did not materialize until 1916 when OID was organized. Several cooperative studies on proposed reservoirs sites and reports prepared by US Reclamation Service and the State of Oregon, were developed during the period of 1914 – 1916. The test pits in the foundations of the proposed sites were excavated using pick and shovel. Feasibility was established and construction by either the US Reclamation Service or State of Oregon was recommended. The lands comprising the project were used as a nucleus for the formation of the OID under the laws of the State of Oregon. At the time authorization and construction by the BOR was considered remote.

Immediately after World War I, as a part of the Veterans Farm Settlement Program by the State of Oregon, authorization was granted to construct Ochoco Dam on Ochoco Creek 5.5 miles east of the City of Prineville. The dam was constructed during the period from 1918 to 1921 using private capital. Permit No. R-528 was issued by the State of Oregon to allow the construction of Ochoco Dam and storage of the waters in Ochoco Reservoir for irrigation purposes. Twenty two thousand (22,000) acres were to be irrigated by the water stored behind Ochoco Dam.

In 1929 and 1930, the OID was near bankruptcy. The farmers could not pay their water assessment due to crop losses as a result of water shortages and low crop and livestock prices. The water shortages were due to inadequate runoff, excessive leakage around the north end of dam, excessive canal seepage and breaks in the canals. 1930 was one of the driest years on record resulting in extremely low runoff into Ochoco Reservoir, with farm delivery of 0.15 ac-ft/acre. The dry years, along with financial difficulties experienced by the growers, forced the District to be re-organized in 1935. With re-organization, total acres to be irrigated were reduced to 8,500.

To increase the reliability of the district's water supply and the amount of land that could be irrigated, authorization was sought for the construction of the Prineville Dam on the Crooked River. The Crooked River Project was authorized by the 84th Congress on August 6, 1956, and construction of Prineville Dam began in November, 1958, and was dedicated as Prineville Dam and Reservoir on October 20, 1962. Water rights for the Crooked River Project were assigned by the State of Oregon from a State Engineer's withdrawal of 1914. The reservoir had an original storage capacity of 155,000 ac-ft. OID purchased 52,600 ac-ft of storage space for irrigation. An additional 7,000 ac-ft of storage was purchased from the uncommitted storage space provided for under the original authorization Act bringing the total storage space to 59,600 ac-ft. The construction of Prineville Dam on Crooked River made it possible for the District to increase the irrigated acreage from 8,500 acres to the original intent.

The District now has a total of 20,061.8 irrigated acres and stores 600 ac-ft for industrial use. There are a total of 860 water users within OID with 571 users with acreage of 25 acres and less. Also, there are 166 users with acreage of 1.0 acre and less. Approximately 2/3 of these are in small parcel subdivisions and 1/3 are scattered throughout the District. Approximately half of the small parcel subdivisions are delivered water at one point. Water is distributed both in pipelines and open ditch.

Climate

Climate in the Ochoco Valley is influenced by Pacific Ocean air masses moving eastward over the Cascade Range located 50 miles to the west. Precipitation, which is mainly derived from the easterly movement of low pressure systems originating in the North Pacific in winter is accordingly low, thus a dry, semi-arid type of climate results.

Climate in the area is characterized by low annual precipitation, moderate to high temperatures, and a reasonably good growing season. Two weather stations provide data. One near Prineville at the radio station (official US Weather Service station), and one at the OSU Experiment Station ("Grimed" weather station location) located about 5 miles west of Prineville in the Powell Butte area.

Average annual precipitation is about 9 inches, with only about 1.1 inches falling during the months of June, July and August. Fall rains typically begin in October, with snow during November, December, January and February in varied amounts. Rains again occur in March, April and May. Thunderstorms occurring during the summer months are often accompanied by heavy rains and lightning. However, these storms are infrequent, brief, and with typically narrow storm paths, thus preventing any significant amounts of overall soil moisture. Many times the lightning is unaccompanied by rain. July temperature averages 66° F with an average annual growing season of 105 +/- days. Normal maximum daily temperatures in July and August are typically +/- 90° F, with a few days exceeding 100° F. However, it is not uncommon to experience frost in May and September.

Soils

Soils are generally light colored loam or sandy loam containing small quantities of gravel or pebbles. They are low in organic matter content, slightly alkaline and slightly calcareous. Drainage is, for the most part, satisfactory, except for small areas adjacent to Crooked River. Substrata are usually partially consolidated gravelly materials. Most of the soils are of good quality, suitable for all climatically adapted crops.

Soils have been mapped by NRCS (formerly SCS) and Oregon State University (OSU), with a published report and maps available in NRCS office in Redmond, or online at the NRCS website.

DELIVERABLES – TAB 8

Cost/Benefit Analysis of Wetlands Installation at Lytle Creek/Rye-Grass Tail Area

Ochoco Irrigation District - Surface flow Wetland for Treatment of Canal Tailwater Evaluation Summary

1.0 GENERAL

In response to a scope element of the System Optimization Review undertaken by Ochoco Irrigation District (OID) this section examines the use of a constructed wetland system to reduce sediment and nutrient load in irrigation tailwater discharged to the Crooked River. The analysis focuses on a specific tailwater source; Rye Grass Canal, and a specific treatment area and location identified by OID.

Two different assessment models were used to evaluate the proposed constructed wetland treatment system. The first model, an empirical assessment of nutrient reduction developed by treatment wetland specialists, was used to correlate available treatment wetland area (square feet) to flow rate (cubic feet per second). This empirical model was used to quantify nutrient removal (lbs per year) for further consideration in over-all benefit versus cost.

The second model, developed by the U.S. Soil Conservation Service, uses prescriptive equations to correlate treatment wetland area (square feet) to a corresponding area (acres) of the agricultural drainage basin. This model does not quantify anticipated nutrient reduction, but was used in this evaluation to relate available treatment wetland area to the area of agricultural land that can be served.

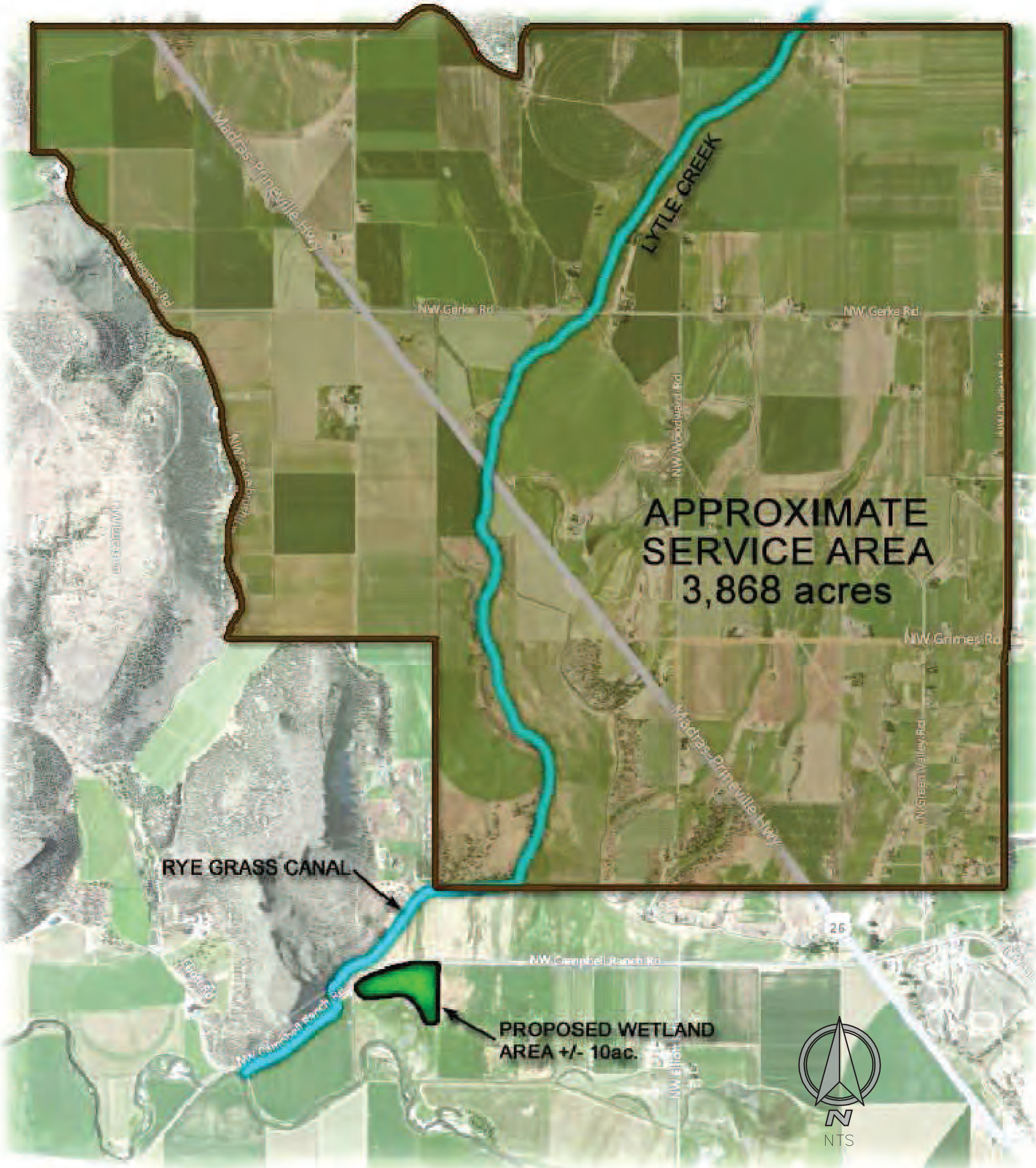
1.1. EXISTING TAILWATER AND TREATMENT AREA SUMMARY

The exhibit on the following page is a proximity map of the Rye Grass Canal / Lytle Creek area located along the western edge of the Ochoco Irrigation District. As an area size reference, the land bordered by the Rye Grass Road on the North, non-irrigated land on the west, NW Campbell Road on the South, and Puckett Road on the East is approximately 3,800 acres in size. The formal extent and size of the drainage basin for Lytle Creek and the Rye Grass Canal was not specifically defined as part of this study.

The Rye Grass Canal generally conveys surface water run-off within the drainage basin to the Crooked River. During non-irrigation season, the Rye Grass Canal conveys Lytle Creek flow, the flow of unnamed springs, and surface run-off from agricultural lands and natural areas in the drainage basin. During the irrigation season, the Rye Grass Canal conveys the combined flow of Lytle Creek, springs, surface run-off and tailwater from the Ochoco Canal.

The Ochoco Irrigation District does not maintain flow data specific to the Rye Grass Canal at the location of the proposed treatment wetland area. The range of flow is generally believed to vary from 10 to 20 cubic feet per second (cfs).

The Ochoco Irrigation District identified a parcel of land between the Rye Grass Canal and the Crooked River as a potential site for constructed wetlands to treat tailwater flow in the Rye Grass Canal. The subject wetland site is generally comprised of about 15 acres of upland area and 15 acres of existing natural wetland. The property is currently owned by a private party and consists of untilled upland area and wetland bordered by railroad tack, the Crooked River, and agricultural land in production.



OCHOCO IRRIGATION DIST.
SYSTEMS OPTIMIZATION REVIEW

RYE GRASS CANAL / LYTLE CREEK AREA

BLACK ROCK CONSULTING

01.02.2012

FIG. A

1.2. EVALUATION PROCEDURE

The objective of the treatment wetland evaluation process was to examine the proposed site for potential development as a treatment system, and to quantify an estimate of the sediment / nutrient load reduction that might be achieved. The evaluation work consisted of;

a) Field reconnaissance of the Rye Grass Canal and proposed treatment area
b) Research and examination of available records;
   - Land ownership
   - Real-time or historic flow rate in Rye Grass Canal and Lytle Creek
c) Review of web-based data;
   - Soil Survey
   - National Wetland Inventory
   - Federal Insurance Rate Map, and other floodplain delineations
d) Investigating available water quality data for the Rye Grass Canal, Lytle Creek, and Crooked River
e) Selecting wetland treatment type and assessment model
g) Developing concept layouts of wetland systems
f) Evaluating wetland performance
h) Evaluating treatment efficacy
i) Developing an opinion of probable construction cost for a treatment wetland system

2.0 BACKGROUND DATA

2.1. FIELD RECONAISANCE DEMONSTRATION AREA

Field reconnaissance of the Rye Grass Canal and proposed treatment wetland site consisted of;

a) General examination of the proposed treatment wetland site on 1-26-11.

2.2. RECORDS RESEARCH AND REVIEW - PROPERTY OWNERSHIP AND STREAM FLOW

A web-based search for reasonably available land ownership and stream flow records was conducted.

a) Crook County Tax Assessors Maps - Confirmed the subject property is owned by a private party. The proposed treatment wetland site was identified as a portion of Tax Lot 101 of Section 21, T. 14S, R. 15E of Willamette Meridian, Crook County, Oregon.

b) Real-time and historic flow records for Lytle Creek or the Rye Grass Canal - Research of web-based sources failed to identify flow rate records for the Rye Grass Canal or Lytle Creek.

2.3. DATA RESEARCH AND REVIEW - SOILS, WETLAND, AND FLOODPLAIN

A web-based search for reasonably available data on soil characteristics, wetland delineation, and flood plan delineation was conducted.

a) Soil Survey data available through the U.S. Department of Agriculture (USDA) / National Resource Conservation Service (NRCS) - A downloaded map and soils report indicates silt, loam, and sands in the 0" - 60" profile of three soil types in the general location of the proposed treatment wetland. These soils are generally classified as poorly drained and appear to be free of characteristics that would outright inhibit development of a constructed wetland on the subject site. A copy of the web-based Soil Resource Report for the site is attached at the end of this section.

b) National Wetland Inventory data available through the U.S. Fish and Wildlife Service (USFWS) - A web-based mapping tool output indicates the south end of the proposed treatment wetland site is characterized by freshwater emergent wetland and riverine ecology. No formal wetland reconnaissance or delineation was conducted as part of this evaluation. A copy of the web-based National Wetlands Inventory map for the site is attached at the end of this section.

c) Federal Insurance Rate Map (FIRM) available through the Federal Emergency Management Agency (FEMA), and floodplain data available through Crook County GIS services - Web-based mapping tools indicate the south end of the proposed treatment wetland site is base floodplain (FEMA - ZONE A: Base floodplain, no base flood elevation has been determined). A copy of the FIRM map and Crook County resource map for the site are attached at the end of this section.

2.4. WATER QUALITY DATA COLLECTION AND REVEIW

Water quality data for Rye Grass Canal / Lytle Creek was collected from web-based data sources including the U.S. Environmental Protection Agency, STORET data base 1974 - 2000, and the Oregon Department of Environmental Quality, LASAR data base 2005 - 2006. The data was used to establish winter cold water temperature, summer warm water temperature, and the influent concentration for constituents analyzed in subsequent wetland evaluations.

Table 1 - Water Quality Data Summary Rye Grass Canal (Lytle Creek) and Crooked River

Parameter	Rye Grass Canal (Lytle Creek)			Crooked River		
	Max	Min	Ave	Max	Min	Ave
Dissolved Oxygen (DO), mg/l	-	-	9.0*	11.8	8.1	10.1
Biochemical Oxygen Demand (BOD), mg/l	-	-	-	2.6	1.0	1.7
Temperature, ^{o}C	20.5	1.0	9.9	21.3	3.4	13.6
Total Suspended Solids, mg/l	91.0	2.0	31.5	28.0	4.0	10.6
Total Phosphorus, mg/l	-	-	-	0.170	0.100	0.127
Phosphate Phosphorus as P, mg/l	0.300	0.103	0.185	-	-	-
Orthophosphate Phosphorus as P, mg/l	0.229	0.076	0.144	0.131	0.060	0.082
Total Kjeldahl Nitrogen, mg/l	1.04	0.25	0.55	0.60	0.40	0.44
Ammonia as NH3, mg/l	0.07	<0.02	0.03	0.10	<0.02	0.04
Fecal Coliform, #/100ml	1,180	8	363	45	40	42.5

Sources: U.S. Environmental Protection Agency, STORET data base 1974 - 2000
Oregon Department of Environmental Quality, LASAR data base 2005 - 2006
* Only one data point in the sample set
\- No data found in data search

2.5. SELECTION OF WETLAND TREATMENT TYPE AND MODELING TOOLS

2.5.1. Alternative 1 - Constructed Surface Flow Wetland and Nutrient Decay Model

Available land area on the proposed treatment site is generally comprised of 15 acres of mildly sloping upland soil with presumed shallow groundwater, and 15 acres of existing wetland habitat within the floodplain of the Crooked River. A surface flow constructed wetland on approximately 10 acres of upland ground was selected for evaluation based on the following basic considerations;

1. Constructed facilities are sited outside of jurisdictional wetlands and floodplain areas
2. Constructed facilities are to have a low initial cost
3. Constructed facilities are to have a low maintenance requirement
4. Constructed facilities should be compatible with surrounding land use and natural systems
5. Constructed facilities should enhance the habitat features of adjacent natural systems

2.5.2. ALTERNATIVE 1 - CONCEPT LAYOUT

The exhibit on the following page shows a conceptual layout of a 10 acre surface flow wetland generally sited on the upland portion of the proposed treatment site. The layout includes 0.6 acres of sedimentation trench, and 10 acres of free water surface (surface flow) constructed wetland. The existing natural wetland area is immediately south of the proposed treatment wetland. Outflow from the treatment wetland would be discharged directly into the natural wetland system and on to the Crooked River.

The concept layout also includes a diversion structure on the Rye Grass Canal, a conveyance pipeline between the Rye Grass Canal and the treatment wetland, and a casing under the railroad embankment. The diversion structure provides a means to control flow from the Rye Grass Canal to the treatment wetland or down the canal in the case of excess flow. The diversion structure also allows the treatment wetland to be flow isolated from the Rye Grass Canal if need be.


BLACK ROCK
CONSULTING
RYE GRASS
CANAL
0.6 ACRES
SEDIMENTATION
TRENCH
10 ACRES
FREE WATER
SURFACE WETLAND
CROOKED
RIVER
N
SCALE:
1"=600'
0
600
LEGEND
INLET
OUTLET
PIPE
TRENCH
PROPOSED
WETLAND
ALTERNATIVE NO. 1
OID-SOR
CONCEPT LAYOUT - RYE GRASS WETLAND
WETLAND HYDRAULIC RETENTION TIME=HRT=2.5 DAYS
DESIGN FLOW=2.0 cfs
BASED ON FREE WATER SURFACE WETLAND
CONSTRUCTED FOR TREATMENT OF WATER QUALITY

2.6. ALTERNATIVE 1 - SURFACE FLOW WETLAND WATER QUALITY MODEL

Water quality modeling for reduction of solids and nutrients was conducted using empirical formula from relevant technical literature. [1] The analysis considered nitrification of ammonia, denitrification (nitrogen removal), reduction of Biochemical Oxygen Demand (BOD), reduction of Total Suspended Solids (TSS), and reduction of phosphorous. Warm water summer conditions and cold water winter conditions were examined. The analysis also looked at hydraulic considerations such as maximum length, and length to width ratio. A wetland water depth of 1.5 feet was assumed in all cases. Based on water temperature data proximal to the study area, a summer warm water temperature value of 20.5 degrees C (68.90 degrees F) and a winter cold water value of 1.0 degree C (33.8 degrees F) were used in all calculations.

a) Nitrification of Ammonia - Microbial processes in the wetland system transform ammonia (as a portion of Total Kjeldahl Nitrogen - TKN) into nitrogen compounds, primarily nitrite and nitrate. The empirical equation used in the evaluation is modeled after first order exponential decay. Variables include flow, temperature, inlet concentration, wetland cell depth, and wetland section porosity as a measure of plant density. An inlet concentration of 0.55 mg/l used in the model is an average value of data taken from available water quality records. At water temperatures less than 10 degrees C, nitrification is strongly temperature dependent and ceases at 0 degrees C.
b) Dentrification (nitrogen removal) - Microbial reduction of nitrate in the wetland system. The empirical equation used in the evaluation is modeled after first order exponential decay. Variables include flow, temperature, inlet concentration, wetland cell depth, and wetland section porosity as a measure of plant density.
c) Reduction of Biochemical Oxygen Demand (BOD) - Reduction of settleable, colloidal, and dissolved organic compounds by sedimentation and microbial activity in the wetland system. The empirical equation used in the evaluation is modeled after first order exponential decay. Variables include flow, temperature, inlet concentration, wetland cell depth, and wetland section porosity as a measure of plant density. An inlet concentration of 2.00 mg/l is an assumed value similar to the average value for Crooked River water quality data proximal to the study area.
d) Reduction of Total Suspended Solids (TSS) - Reduction of suspended solids in the wetland system by way of physical and chemical processes. The empirical equation used in the evaluation model is a linear reduction based on hydraulic loading rate in the wetland system. Variables include flow, inlet concentration, and length / width / depth of the wetland. An inlet concentration of 31.5 mg/l used in the model is taken from water quality data as the average value of available data points.
e) Reduction of Phosphorous - Reduction of total phosphorous by physical, chemical, and biological processes. The empirical equation used in the evaluation is modeled after first order exponential decay. Variables include flow, inlet concentration, wetland cell depth, and wetland section porosity as a measure of plant density. An inlet concentration of 0.23 mg/l used in the model is taken from water quality data as the maximum value from available data points for orthophosphate.

The calculations used in evaluation of wetland performance are attached to the end of this section. The calculations are based on performance of a 10-acre surface flow wetland system using the background data and assumptions stated in the description of the water quality model.

[1] Reed S.C., Crites R. W., Middlebrook E. J., *Natural Systems for Waste Management and Treatment, 2nd Edition*, 1995.

2.7. ALTERNATIVE 2 - NUTRIENT AND SEDIMENT CONTROL SYSTEM BY U.S. SOIL CONSERVATION SERVICE

To address sediment and nutrient constituents in non-point run-off from agricultural lands, the U.S. Soil Conservation Service (SCS) has developed a process for treatment and management using a series of natural systems such as wet meadows, wetlands, and ponds. [2, 3]

The first element in SCS treatment process consists of a sediment trench to remove settleable solids. One edge of the sediment trench is cut lower than the remaining perimeter and forms a spreader lip to allow water to run in sheet flow across the next element of the treatment process; the wet meadow. The wet meadow is a stand of emergent wetland species planted on a gentle slope. This step in the process is designed to provide reduction of suspended solids as well as nutrient reduction. The third step in the process is a surface flow wetland designed for de-nitrification and reduction of other constituents including BOD, bacteria, and phosphorous. The last step in the process is a deep pond where de-nitrification and phosphorous reduction continues.

The land area requirement for each step in the SCS process is calculated using prescriptive formula based on the size of the contributing watershed. Table 2 on the following page provides tabulated values derived from the numerical relationship. The highlighted cells on the table indicate the land area requirement for each element associated with 550 acres of contributing watershed. Approximately 15 acres is the sum total of land area required for all elements in the SCS system associated with 550 acres of contributing watershed area. As shown in the concept layout that follows, the existing natural wetlands on the proposed treatment site provide the wetland area requirement in the SCS concept system. No prediction of water treatment comes out of the SCS system sizing approach.

2.8. ALTERNATIVE 2 - CONCEPT LAYOUT

The exhibit following Table 2 shows a conceptual layout of a 7.5 acre wet meadow area and a 2.3 acre deep pond generally sited on the upland soil of the proposed treatment site. The layout includes 0.6 acres of sedimentation trench, and approximately 12 acres of natural wetland incorporated in the treatment flow path. The existing natural wetland area is immediately south of the proposed wet meadow. Outflow from the deep pond would be discharged directly to the Crooked River.

The concept layout also includes a diversion structure on the Rye Grass Canal, a conveyance pipeline between the Rye Grass Canal and the wet meadow area, and a casing under the railroad embankment. The diversion structure provides a means to control flow from the Rye Grass Canal to the wet meadow or down the canal in the case of excess flow. The diversion structure also allows the wet meadow to be flow isolated from the Rye Grass Canal if need be.

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[2] Reed S.C., Crites R. W., Middlebrook E. J., *Natural Systems for Waste Management and Treatment, 2nd Edition*, 1995. pages 265 - 268

[3] Hoag, J. C., and Sellers M. E., *Constructed Wetland System for Water Quality Improvement of Irrigation Wastewater*. Riparian/Wetland Project Information Series No. 8. December, 1994. 3 pp.

Table 2 - Wetland System Sizing According to SCS Sediment / Nutrient Control System

Alternative No. 2 - US Soil Conservation Service Nutrient / Sediment Control System

Sedimentation Trench

Area Sedimentation Trench = AST

AST = 843 + 4.54 (WA) + 0.07 $(WA)^2$ = 0.6 Acres

where WA = area of the contributing watershed (acres) = about 550 acres

WA	(acres)	50	100	150	200	250	300	350	400	450	500
AST	ft^2	1,245	1,997	3,099	4,551	6,353	8,505	11,007	13,859	17,061	20,613
AST	(acres)	0.0	0.0	0.1	0.1	0.1	0.2	0.3	0.3	0.4	0.5

WA	(acres)	550	600	650	700	750	800	850	900	950	1000
AST	ft^2	24,515	28,767	33,369	38,321	43,623	49,275	55,277	61,629	68,331	75,383
AST	(acres)	0.6	0.7	0.8	0.9	1.0	1.1	1.3	1.4	1.6	1.7

Wet Meadow

Area Wet Meadow = AWM

AWM = 8430 + 45 (WA) + 0.7 $(WA)^2$ = 5.6 Acres

where WA = area of the contributing watershed (acres) = about 550 acres

WA	(acres)	50	100	150	200	250	300	350	400	450	500
AWM	ft^2	12,430	19,930	30,930	45,430	63,430	84,930	109,930	138,430	170,430	205,930
AWM	(acres)	0.3	0.5	0.7	1.0	1.5	1.9	2.5	3.2	3.9	4.7

WA	(acres)	550	600	650	700	750	800	850	900	950	1000
AWM	ft^2	244,930	287,430	333,430	382,930	435,930	492,430	552,430	615,930	682,930	753,430
AWM	(acres)	5.6	6.6	7.7	8.8	10.0	11.3	12.7	14.1	15.7	17.3

Length Wet Meadow = LWM

LWM = 75 + WA

where WA = area of the contributing watershed (acres) = about 550 acres

WA	(acres)	50	100	150	200	250	300	350	400	450	500
Length	ft	125	175	225	275	325	375	425	475	525	575
Width	ft	99.4	113.9	137.5	165.2	195.2	226.5	258.7	291.4	324.6	358.1
				x 4	(x 4 provides the treatment area required for > 550 Acres)						

WA	(acres)	550	600	650	700	750	800	850	900	950	1000
Length	ft	625	675	725	775	825	875	925	975	1,025	1,075
Width	ft	391.9	425.8	459.9	494.1	528.4	562.8	597.2	631.7	666.3	700.9

Wetland

Area Wetland = AWL

AWL = 8430 + 45 (WA) + 0.7 $(WA)^2$ = 5.6 Acres

where WA = area of the contributing watershed (acres) = about 550 acres

WA	(acres)	50	100	150	200	250	300	350	400	450	500
AWL	ft^2	12,430	19,930	30,930	45,430	63,430	84,930	109,930	138,430	170,430	205,930
AWL	(acres)	0.3	0.5	0.7	1.0	1.5	1.9	2.5	3.2	3.9	4.7

WA	(acres)	550	600	650	700	750	800	850	900	950	1000
AWL	ft^2	244,930	287,430	333,430	382,930	435,930	492,430	552,430	615,930	682,930	753,430
AWL	(acres)	5.6	6.6	7.7	8.8	10.0	11.3	12.7	14.1	15.7	17.3

Deep Pond

Area Deep Pond = ADP

ADP = 4000 + 240 (WA) = 3.1 Acres

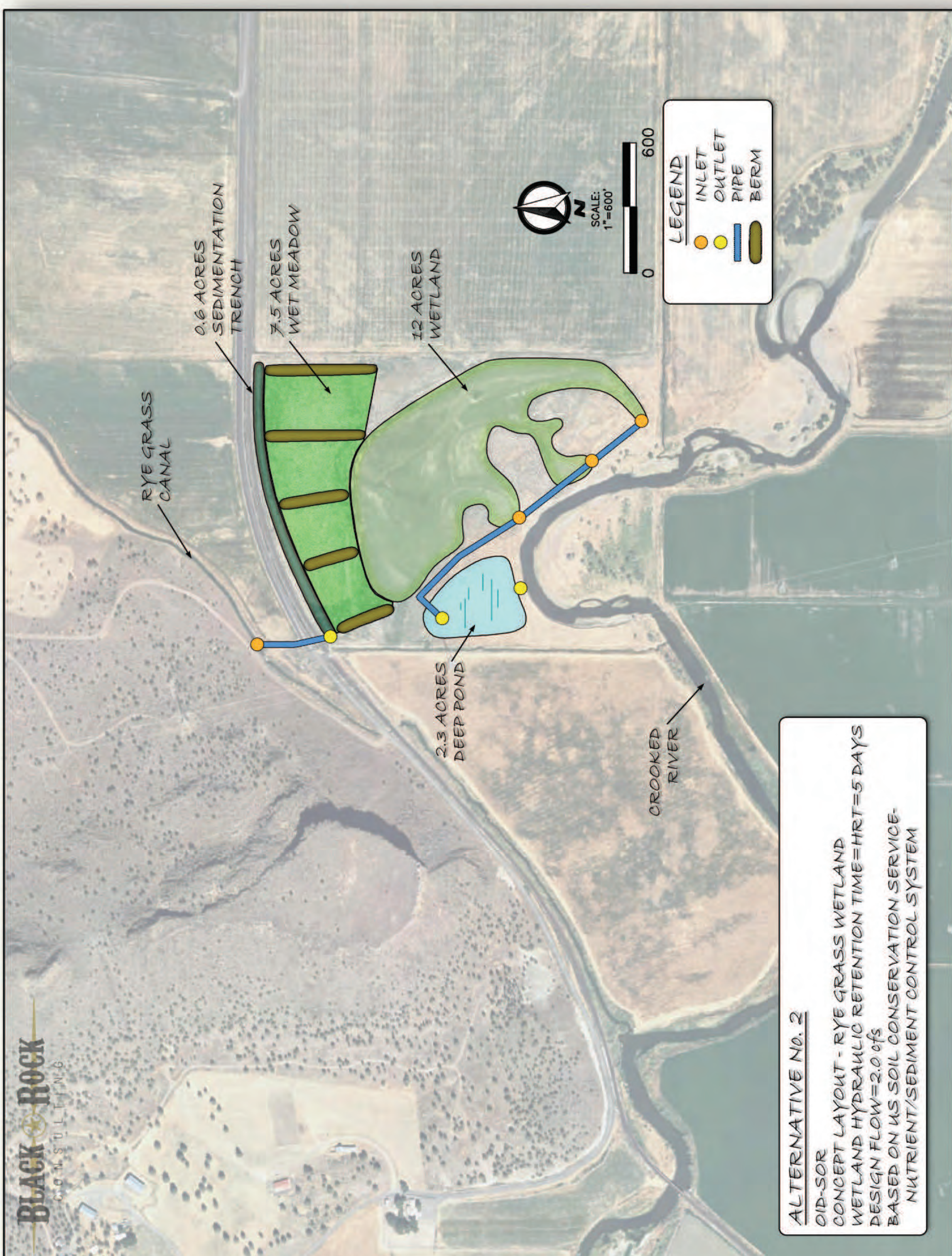
where WA = area of the contributing watershed (acres) = about 550 acres

WA	(acres)	50	100	150	200	250	300	350	400	450	500
ADP	ft^2	16,000	28,000	40,000	52,000	64,000	76,000	88,000	100,000	112,000	124,000
ADP	(acres)	0.4	0.6	0.9	1.2	1.5	1.7	2.0	2.3	2.6	2.8

WA	(acres)	550	600	650	700	750	800	850	900	950	1000
ADP	ft^2	136,000	148,000	160,000	172,000	184,000	196,000	208,000	220,000	232,000	244,000
ADP	(acres)	3.1	3.4	3.7	3.9	4.2	4.5	4.8	5.1	5.3	5.6

References:

1. Reed S. C., Crites R. W., Middlebrooks J.E. Natural Systems for Waste Management and Treatment 2nd Edition, U.S. Soil Conservation Service (SCS), Nutrient / Sediment Control System p. 265 - 268


0.6 ACRES
SEDIMENTATION
TRENCH
7.5 ACRES
WET MEADOW
12 ACRES
WETLAND
RYE GRASS
CANAL
2.3 ACRES
DEEP POND
CROOKED
RIVER
N
SCALE:
1"=600'
0
600
LEGEND
INLET
OUTLET
PIPE
BERM
BLACK ROCK
CONSULTING
ALTERNATIVE NO. 2
OID-SOR
CONCEPT LAYOUT - RYE GRASS WETLAND
WETLAND HYDRAULIC RETENTION TIME=HRT=5 DAYS
DESIGN FLOW=2.0 cfs
BASED ON US SOIL CONSERVATION SERVICE-
NUTRIENT/SEDIMENT CONTROL SYSTEM

2.8. EVALUATION OF ANNUAL TREATMENT EFFICACY

Evaluation of treatment efficacy for a surface flow constructed wetland system is presented in Table 3 and Table 4 below. The evaluation is based on empirical analysis of a 10-acre surface flow constructed wetland operated at 2 cfs on a continuous basis. Inlet concentration values for modeled constituents are taken from water quality data presented in Part 2.4 and 2.6 above. Modeled summer period constituent removal and winter period constituent removal each account for 1/2 of the annual removal total.

Table 3 - 10 Acre (2 CFS) Wetland Treatment Efficacy, Removal on an Annual Basis

Constituent	Influent (mg/L)	Effluent Winter (mg/L)	Winter removal Total (lbs)	Effluent Summer (mg/L)	Summer Removal Total (Lbs)	Annual Removal Total (Lbs)
Total Kjeldahl Nitrogen (TKN)	0.55	0.54	20	0.34	413	433
Biochemical Oxygen Demand (BOD)	2.00	1.16	1,654	0.36	3,229	4,883
Total Suspended Solids (TSS)	31.5	4.41	53,329	4.41	53,329	106,658
Phosphorous	0.23	0.18	98	0.18	98	196

Table 4 - 10 Acre (2 CFS) Wetland Treatment Efficacy, % Reduction

Constituent	Influent (mg/L)	Effluent Winter (mg/L)	Winter Average Reduction	Effluent Summer (mg/L)	Summer Average Reduction	Annual Average Reduction
Total Kjeldahl Nitrogen (TKN)	0.55	0.54	2%	0.34	38%	20%
Biochemical Oxygen Demand (BOD)	2.00	1.16	42%	0.36	82%	62%
Total Suspended Solids (TSS)	31.5	4.41	86%	4.41	86%	86%
Phosphorous	0.23	0.18	20%	0.18	20%	20%

2.9. OPINION OF PROBABLE CONSTRUCTION COSTS

An opinion of probable construction cost was developed to establish an initial cost baseline for construction of a treatment wetland as described in the ALTERNATIVE 1 - CONCEPT LAYOUT.

The opinion of probable construction cost was developed according to the general format of the 17 Division Construction Standards Institute. Division 1 cost projections include general elements of a construction contract including Mobilization, Project Management and Coordination, Submittal Procedures, Project Record Documents, Operation and Maintenance Data, and General Commissioning Requirements. Ensuing Divisions address earthwork, concrete, equipment, electrical, etc.

Construction Total cost values provided in the opinion of probable construction cost are derived from the project construction subtotal with line item multipliers added for;

- Contractor Overhead and Profit: 10%
- Contractors Bond and Insurance: 2%
- Construction Contingency: 30%

Total cost values provided in the opinion of probable construction cost were derived from the project construction total with a line item multiplier addition for;

- Engineering and Administration: 25%

A copy of the budget level projection of probable construction cost is attached to the end of this section.

3.0 CONCLUSION

3.1. SUMMARY OF RYE GRASS CANAL TAILWATER SURFACE FLOW WETLAND TREATMENT-FLOW AND NUTRIENT REDUCTION POTENTIAL

The treatment area proposed for construction of surface flow wetland system has approximately 15 acres of upland area available for development of treatment elements. The site was examined for potential construction of a surface flow wetland system similar to the natural wetland systems adjacent to it. The area was also examined for potential construction of a wet meadow treatment process in accordance with US Soil Conservation Service (SCS) nutrient and sediment control system. The proposed layout for the nutrient and sediment control system proposes to use approximately 12 acres of the existing natural wetland to provide the wetland treatment element per SCS.

Based on concept level evaluation of the Rye Grass Canal water quality, flow rate, site soils, and hydrology there appears to be no readily apparent shortcomings in the proposed treatment area other than lack of sufficient area.

In general, the 10 acres of proposed wetland treatment system provides treatment for approximately 2.0 cubic feet per second (cfs) of inlet flow. 10 acres of wetland area provides a hydraulic residence time of approximately 2.4 days at 2.0 cfs inlet. At a flow rate greater than 2.0 cfs, a 10-acre wetland system will become hydraulically overloaded. Short circuiting, under performance, and instability would be expected results if a wetland treatment system is hydraulically overloaded. With a 2.0 cfs inlet flow rate the proposed wetland treatment system is sized for approximately 10% to 20% of the estimated flow in the Rye Grass Canal under normal flow conditions. Referencing the SCS treatment system land area assessment, the proposed treatment site is sufficient to serve approximately 550 acres of contributing agricultural watershed area. The Rye Grass Canal / Lytle Creek drainage area is roughly estimated at 3,800 acres.

The proposed wetland system was modeled using empirical formula to evaluate potential reduction of sediment and nutrient load in inlet water. Concept level modeling used expected winter and summer water temperatures, and estimated inlet concentration of typical constituents. Model results indicate a 10 acre wetland operated at 2 cfs flow rate can reduce Total Suspended Solids by 85%, BOD by 60%, Total Kjeldahl Nitrogen by 20%, and Phosphorous by 20% on a annual average basis. The projected annual removal estimate measure in lbs/year is presented in Table 2 of Part 2.8 above.

3.2. CONCLUSION

At an estimated construction cost of $585,000 the proposed 10-acre treatment wetland on the proposed treatment site is suitable for addressing 10% to 20% of the estimated flow in the Rye Grass Canal and 10% to 20% of the agricultural land in the contributing watershed. The expected removal of constituents of concern may benefit water quality in the Crooked River basin. The benefit value of removing a portion of key constituents from Rye Grass Canal flow may or may not be significant enough to basin stakeholders to warrant further consideration of the proposed wetland treatment system.

United States Department of Agriculture

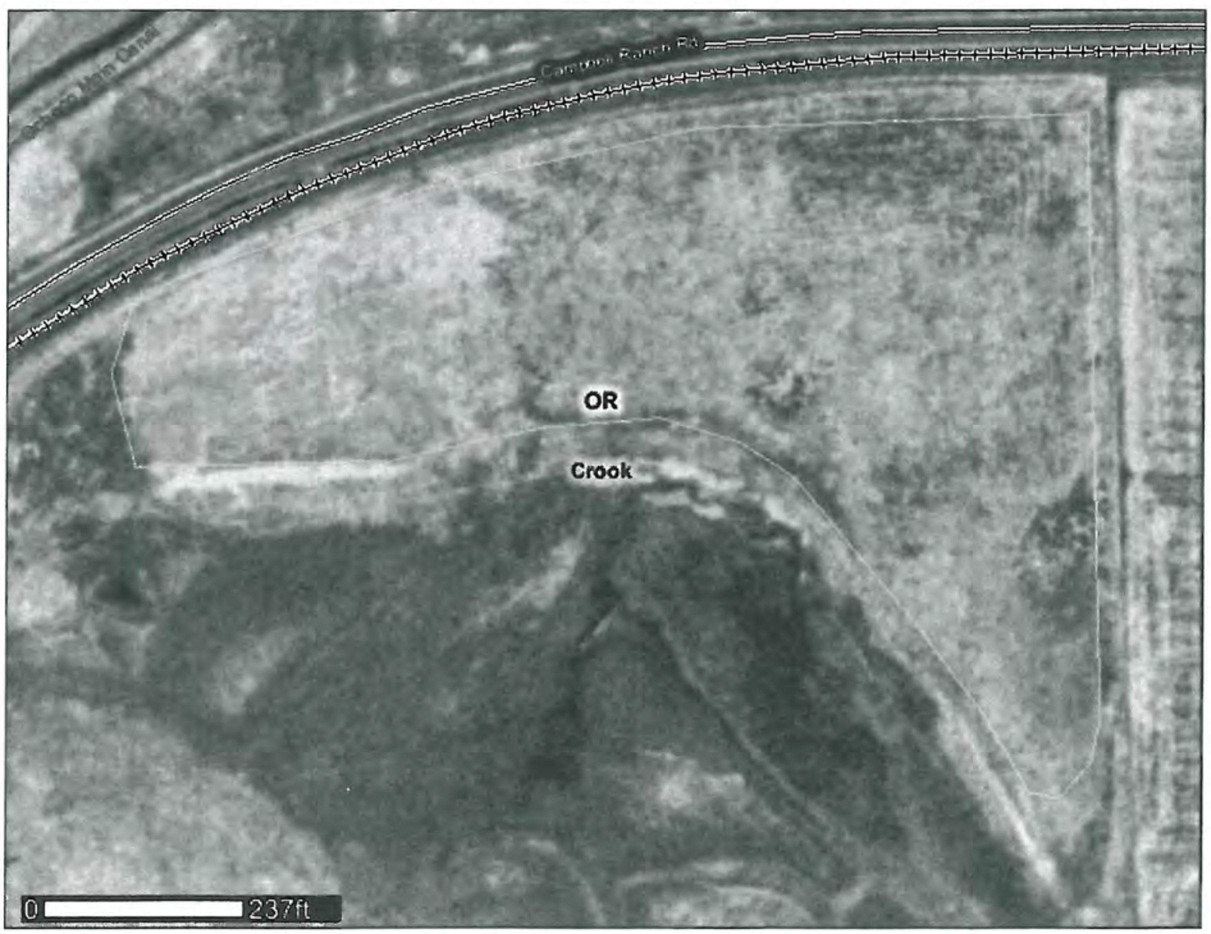
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Prineville Area, Oregon



March 11, 2011

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://soils.usda.gov/sqi/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (http://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://soils.usda.gov/contact/state_offices/).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Soil Data Mart Web site or the NRCS Web Soil Survey. The Soil Data Mart is the data storage site for the official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map—Prineville Area, Oregon
(Concept 15 Acres Wetland - Rye Grass Canal)

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Units

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other

Special Line Features
- Gully
- Short Steep Slope
- Other

Political Features
- Cities

Water Features
- Oceans
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

MAP INFORMATION

Map Scale: 1:3,260 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 10N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Prineville Area, Oregon
Survey Area Data: Version 8, Oct 21, 2010

Date(s) aerial images were photographed: 7/24/2005

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Prineville Area, Oregon (OR654)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
016	Crooked-Stearns complex, 0 to 2 percent slopes	10.3	99.1%
020	Boyce silt loam, 0 to 2 percent slopes	0.1	0.9%
Totals for Area of Interest		**10.4**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series.* Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases.* Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas.* Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Prineville Area, Oregon

016—Crooked-Stearns complex, 0 to 2 percent slopes

Map Unit Setting

Elevation: 2,700 to 3,200 feet
Mean annual precipitation: 9 to 13 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 70 to 100 days

Map Unit Composition

Crooked and similar soils: 50 percent
Stearns and similar soils: 35 percent

Description of Crooked

Setting

Landform: Terraces, depressions
Landform position (three-dimensional): Tread
Down-slope shape: Linear, concave
Across-slope shape: Concave
Parent material: Alluvium from mixed volcanic rock with influence of ash on the surface

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 5.95 in/hr)
Depth to water table: About 12 to 36 inches
Frequency of flooding: Rare
Frequency of ponding: None
Calcium carbonate, maximum content: 3 percent
Maximum salinity: Nonsaline to very slightly saline (2.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum: 30.0
Available water capacity: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): 3s
Land capability (nonirrigated): 4s
Ecological site: SODIC BOTTOM (R010XY007OR)

Typical profile

0 to 6 inches: Ashy sandy loam
6 to 25 inches: Ashy sandy loam
25 to 38 inches: Ashy sandy loam
38 to 44 inches: Silt
44 to 55 inches: Coarse sand
55 to 60 inches: Loam

Description of Stearns

Setting

Landform: Terraces
Landform position (three-dimensional): Tread

Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Alluvium from mixed volcanic rock

Properties and qualities
Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 12 to 36 inches
Frequency of flooding: Rare
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Maximum salinity: Slightly saline to moderately saline (8.0 to 16.0 mmhos/cm)
Sodium adsorption ratio, maximum: 70.0
Available water capacity: High (about 10.5 inches)

Interpretive groups
Land capability classification (irrigated): 3w
Land capability (nonirrigated): 4w
Ecological site: SODIC BOTTOM (R010XY007OR)

Typical profile
0 to 4 inches: Silt loam
4 to 9 inches: Silty clay loam
9 to 18 inches: Silty clay loam
18 to 32 inches: Loam
32 to 52 inches: Silt loam
52 to 60 inches: Fine sandy loam

020—Boyce silt loam, 0 to 2 percent slopes

Map Unit Setting
Elevation: 2,700 to 3,200 feet
Mean annual precipitation: 9 to 12 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 70 to 100 days

Map Unit Composition
Boyce and similar soils: 85 percent

Description of Boyce

Setting
Landform: Flood plains
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: 20 to 40 inches to abrupt textural change
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 6 to 12 inches
Frequency of flooding: Rare
Frequency of ponding: None
Calcium carbonate, maximum content: 3 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water capacity: Low (about 5.4 inches)

Interpretive groups

Land capability classification (irrigated): 3w
Land capability (nonirrigated): 4w
Ecological site: WET MEADOW (R010XY003OR)

Typical profile

0 to 3 inches: Silt loam
3 to 7 inches: Silty clay loam
7 to 15 inches: Clay loam
15 to 24 inches: Clay loam
24 to 31 inches: Sandy loam
31 to 60 inches: Extremely gravelly sand

References

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U.S. Fish and Wildlife Service

National Wetlands Inventory

OID - SOR

Jan 28, 2011

Wetlands

- Freshwater Emergent
- Freshwater Forested/Shrub
- Estuarine and Marine Deepwater
- Estuarine and Marine
- Freshwater Pond
- Lake
- Riverine
- Other

Riparian

- Herbaceous
- Forested/Shrub

This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.

User Remarks:

Concept 15 Acres Wetland - Rye Grass Canal

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures.** Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Oregon State Plane south zone (FIPSZONE 3602). The **horizontal datum** was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum.** For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC 3, #9202
1315 East West Highway
Silver Spring, MD 20910 3282

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713- 3242,** or visit its website at http://www.ngs.noaa.gov/.

Base map information shown on this FIRM was derived from multiple sources. Base map files were provided in digital format by Crook County GIS Department. This information was photogrammetrically compiled at a scale of 1:2000 from aerial photography dated 2003 and 2005.

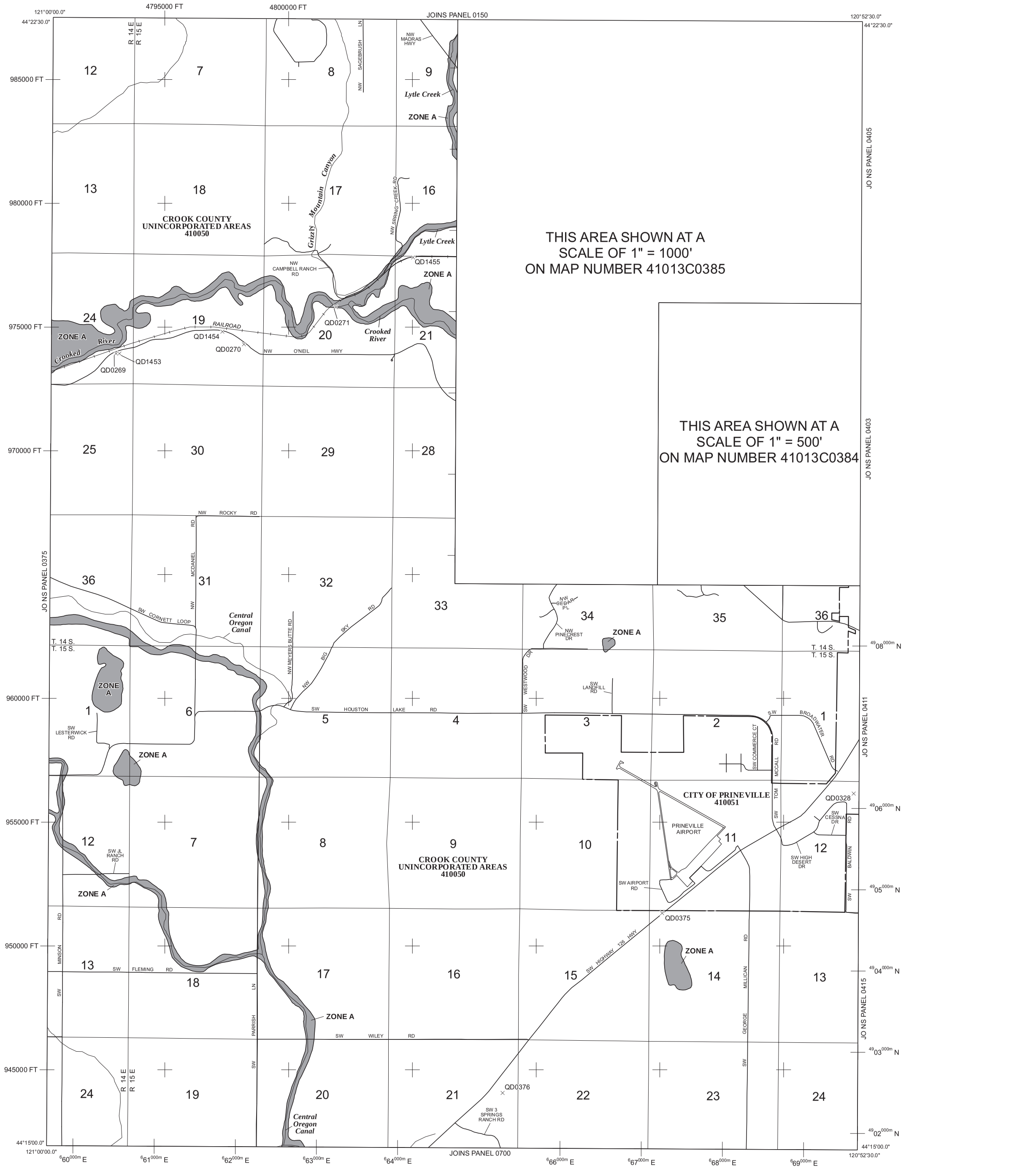
This map reflects more detailed and up to date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables *in the Flood Insurance Study report (which contains authoritative hydraulic data)* may reflect stream channel distances that differ from what is shown on this map.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1 800 358 9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, *a Flood Insurance Study report*, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1 800 358 9620 and its website at http://www.msc.fema.gov/.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1- 877- FEMA MAP** (1 877 336 2627) or visit the FEMA website at http://www.fema.gov/.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100 year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

	Floodplain boundary
	Floodway boundary
	Zone D boundary
	CBRS and OPA boundary
	Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A — A	Cross section line
23 - - - - 23	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
$^{42}75^{000m}$N	1000 meter Universal Transverse Mercator grid ticks, zone 10
6000000 FT	5000 foot grid ticks: Oregon State Plane coordinate system, south zone (FIPSZONE 3602), Lambert Conformal Conic
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
July 17, 1989
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
- to update corporate limits, to change Base Flood Elevations, to change Special Flood Hazard Areas, and to add roads and road names.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1- 800- 638- 6620.

N

MAP SCALE 1" = 2000'

1000 0 2000 4000 FEET
600 0 600 1200 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0400C

FIRM
FLOOD INSURANCE RATE MAP

CROOK COUNTY, OREGON
AND INCORPORATED AREAS

PANEL 400 OF 1825
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CROOK COUNTY	410050	0400	C
PRINEVILLE, CITY OF	410051	0400	C

PRELIMINARY
APRIL 30, 2010

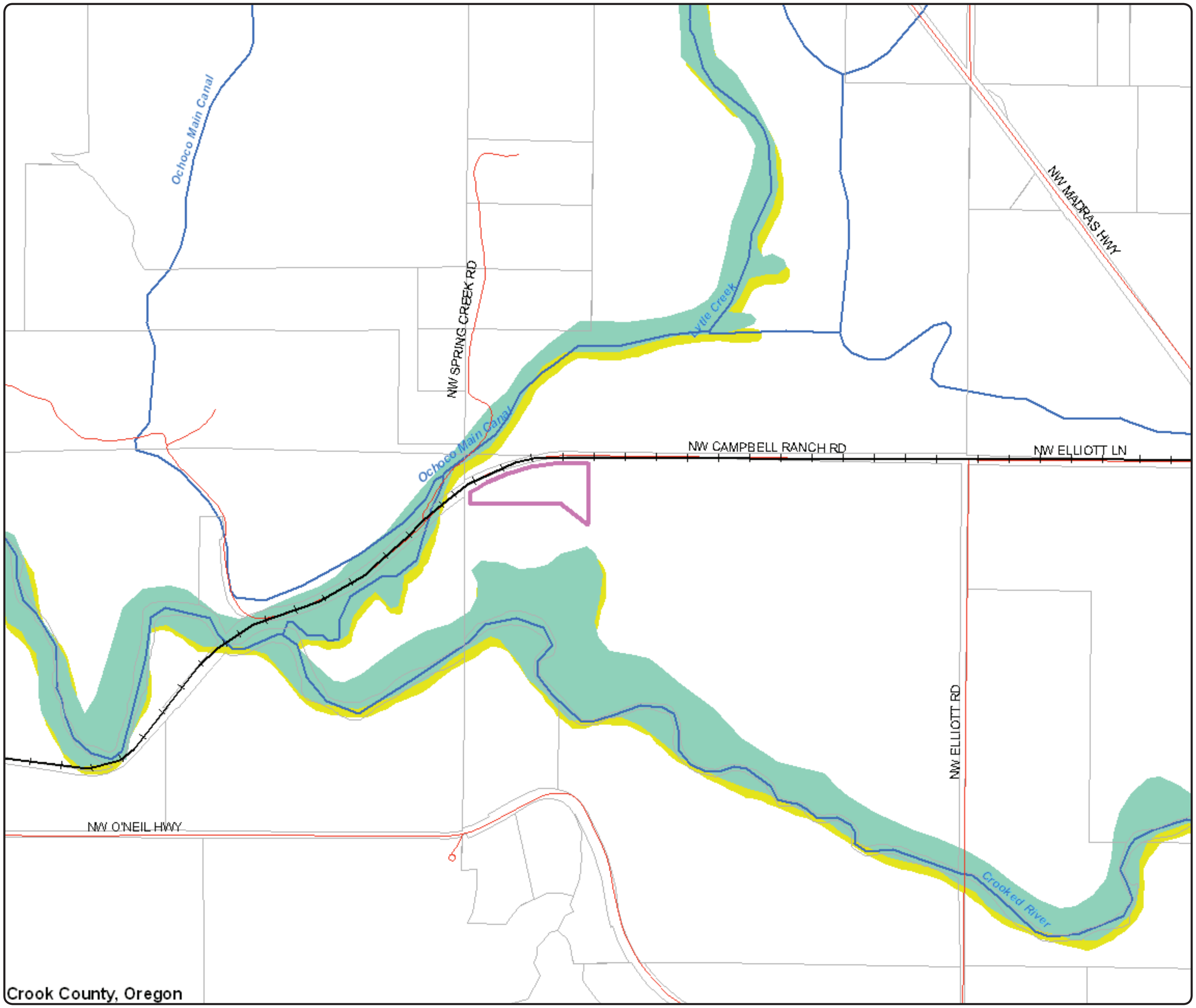
Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
41013C0400C

MAP REVISED

DEPARTMENT OF HOMELAND SECURITY

Federal Emergency Management Agency



Crook County GIS
GEOGRAPHIC INFORMATION SYSTEMS

OID - SOR

Rye Grass Wetland: 2 cfs, 10 Acres

- Railway
- Roads
- Township Range
- Parcels
- Parks
- City Limits
- Water Courses
- Lakes
- Base Floodplain
- Preliminary Base Floodplain
- Preliminary Base Floodway
- 500 Yr Floodplain
- Preliminary 500 Yr Floodplain

CROOK COUNTY MAKES NO WARRANTY OF ANY KIND, EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR ANY OTHER MATTER. THE COUNTY IS NOT RESPONSIBLE FOR POSSIBLE ERRORS, OMISSIONS, MISUSE, OR MISSINTERPRETATION. THE INFORMATION ON THIS MAP IS PREPARED FOR REFERENCE PURPOSES ONLY AND SHOULD NOT BE USED, AND IS NOT INTENDED, FOR SURVEY OR ENGINEERING PURPOSES. NO REPRESENTATION IS MADE CONCERNING THE LEGAL STATUS OF ANY APPARENT ROUTE OF ACCESS IDENTIFIED IN DIGITAL OR HARDCOPY MAPPING OF GEOSPATIAL INFORMATION OR DATA. PLEASE NOTIFY CROOK COUNTY GIS OF ANY ERRORS 541-416-3930.

Map Created By:
GIS Department
Crook County, Oregon

scale 1" = 1,562.00'
created: 3/23/2011

Client:	OID	Designer:	D. Prull
Project:	SOR	Date:	11-Mar-11
Wetland I.D.	Rye Grass: 2 cfs - 10 acres		

General Design Procedure

Free Water Surface Wetland (FWS)

1. General Design using plug flow model:

$$C_e/C_o = \exp(-K_T t)$$ (ref. 1, Equation 6.1)

Where: C_e = Effluent pollution concentration, mg/l
C_o = Influent pollution concentration, mg/l
K_T = Temperature dependent first order rate constant, d^{-1}
t = Hydraulic residence time, d

2. Average Flow Rate:

$$Q = (Q_{in} + Q_{out}) / 2$$ (ref. 1, equation 6.3)

Where: $Q_{out} = Q_{in}$ - exfiltration - evaporation + precipitation

3. Hydraulic Residence Time:

$$t = L [(W)(y)(n) / (Q)]$$ (ref. 1, equation 6.2)

Where: t = Hydraulic residence time, days
L = Length of the wetland cell, ft
W = Width of the wetland cell, ft
y = Depth of the wetland cell, ft
n = porosity through the flow section, percent as a decimal
Q = Average flow through wetland, ft^3/day

4. Area Requirement of SFW:

$$A_S = (L)(W) = (Q \ln (C_o/C_e)) / (K_T\ y\ n)$$ (ref. 1, equation 6.4)

Where: As = Area of the FWS wetland system, ft^2
L = Length of the wetland cell, ft
W = Width of the wetland cell, ft
Q = Average flow through wetland, ft^3/day
Ce = Effluent pollution concentration, mg/l
Co = Influent pollution concentration, mg/l
K_T = Temperature dependent first order rate constant, d^{-1}
y = Depth of the wetland cell, ft
n = porosity through the flow section, percent as a decimal

Procedure:
1. Assume water depth and temperature
2. Solve kinetic equations to achieve desired % removal of the contaminant
3. Determine the required wetland area.
4. Return to Step 1 until convergence on temperature is obtained using the required wetland area
5. Confirm aspect ratio of wetland cell (L:W), typically between 1:1 and 4:1
6. Confirm velocity and if O.K. stop, if not O.K. return to Step 1.

Footnote: 1. Natural Systems for Waste Management and Treatment, Reed, Crites, Middlebrook, 2nd Edition, 1995

Client:	OID		Designer:	D Prull
Project:	SOR		Date:	11-Mar-11
Wetland I.D.	Rye Grass: 2 cfs - 10 acres			

Nitrogen Removal (Part 1)

Free Water Surface Wetland (FWS) - Summer warm weather conditions

1. System Operating Data Summer:

2.00	ft^3/sec	= Q = Average Flow Summer		
172,800	ft^3/day	= Q = Average Flow Summer		
4,893	m^3/day	= Q = Average Flow Summer		
1,292,544	Gal/day	= Q = Average Flow Summer		
1.29	MGD	= Q = Average Flow Summer		
68.90	^{o}F	= T = Influent Temperature Summer ------->	=	20.5 ^{o}C
1.50	ft	= y = design depth of wetland in feet		
0.46	m	= y = design depth of wetland in meters		
0.65		= n = porosity of wetland section as a decimal fraction (typically between 0.65 and 0.75)		
0.55	mg/l	= C_o = Influent TKN Concentration		
0.32	mg/l	= C_e = Effluent Ammonia Concentration		

Nitrification

2. Temperature Dependent First Order Rate Constant:

$K_T = 0 =$	0.000	<--	at 0 ^{o}C	(ref. 1, equation 6.42)
$K_T = 0.1367(1.15)^{(T-10)} =$	0.593	<--	at 1-10 ^{o}C	(ref. 1, equation 6.42)
$K_T = 0.2187\ (1.048)^{(T-20)} =$	0.224	<--	at 10 ^{o}C +	(ref. 1, equation 6.42)

Choose K_T = 0.224

3. Required Wetland Area for Targeted Nitrification Summer:

$A_s = Q \ln (C_o/C_e) / K_T\ (y)\ (n) =$ 39,831 m^2 (ref. 1, equation 6.42)

= 428,735 ft^2 = 9.84 Acres

4. Hydraulic Residence Time:

$t = (L)(W)(y)(n) / Q =$ 2.42 days (ref. 1, equation 6.2)

Where: t = Hydraulic residence time, days
L = Length of the wetland cell, ft
W = Width of the wetland cell, ft
y = Depth of the wetland cell, ft
n = porosity through the flow section, percent as a decimal
Q = Average flow through wetland, ft3/day

5. Summer Nitrification Process Resultant Ammonia Effluent:

$C_e = (C_o) \exp ((-K_T)(t)) =$ 0.32 mg/l (ref. 1, equation 6.41)

6. Hydraulic Loading Rate: typ 0.4 - 75 cm/d

$HLR = 100\ (Q) / A_s =$ 12.28 cm/d

Where: HLR = Hydraulic Loading Rate, cm/d
Q = Average Flow, m^3/d
As = Wetland Surface Area, m^2

Footnote: 1. Natural Systems for Waste Management and Treatment, Reed, Crites, Middlebrook, 2nd Edition, 1995

Client:	OID		Designer:	D. Prull
Project:	SOR		Date:	11-Mar-11
Wetland I.D.	Rye Grass: 2cfs - 10 acres			

Nitrogen Removal (Part 1)

Free Water Surface Wetland (FWS) - Winter cold weather conditions

1. System Operating Data Winter:

2.00	ft^3/sec	= Q = Average Flow Winter	
172,800	ft^3/day	= Q = Average Flow Winter	
4,893	m^3/day	= Q = Average Flow Winter	
1,292,544	Gal/day	= Q = Average Flow Winter	
1.29	MGD	= Q = Average Flow Winter	
33.80	°F	= T = Influent temperature Winter -------> =	1.0 °C
1.50	ft	= y = design depth of wetland in feet	
0.46	m	= y = design depth of wetland in meters	
0.65		= n = porosity of wetland section as a decimal fraction (typically between 0.65 and 0.75)	
0.55	mg/l	= C_o = Influent TKN Concentration	
0.50	mg/l	= C_e = Effluent Ammonia Concentration	

Nitrification

2. Temperature Dependent First Order Rate Constant:

$K_T = 0 =$	0.000	<--	at 0 °C	(ref. 1, equation 6.42)
$K_T = 0.1367(1.15)^{(T-10)} =$	0.039	<--	at 1-10 °C	(ref. 1, equation 6.42)
$K_T = 0.2187\ (1.048)^{(T-20)} =$	0.090	<--	at 10 °C +	(ref. 1, equation 6.42)

Choose K_T = 0.039

3. Required Wetland Area for Targeted Nitrification Winter:

$A_s = Q \ln (C_o/C_e) / K_T\ (y)\ (n) =$ 40,385 m^2 (ref. 1, equation 6.42)

= 434,703 ft^2 = 9.98 Acres

4. Hydraulic Residence Time:

t = (L)(W)(y)(n) / Q = 2.45 days (ref. 1, equation 6.2)

Where: t = Hydraulic residence time, days
L = Length of the wetland cell, ft
W = Width of the wetland cell, ft
y = Depth of the wetland cell, ft
n = porosity through the flow section, percent as a decimal
Q = Average flow through wetland, ft^3/day

5. Winter Nitrification Process Resultant Ammonia Effluent:

$C_e = (C_o) \exp((-K_T)(t)) =$ 0.50 mg/l (ref. 1, equation 6.41)

6. Hydraulic Loading Rate: typ 0.4 - 75 cm/d

HLR = 100 (Q) / A_s = 12.12 cm/d

Where: HLR = Hydraulic Loading Rate, cm/d
Q = Average Flow, m^3/d
As = Wetland Surface Area, m^2

Footnote: 1. Natural Systems for Waste Management and Treatment, Reed, Crites, Middlebrook, 2nd Edition, 1995

Client:	OID	Designer:	D. Prull
Project:	SOR	Date:	11-Mar-11
Wetland I.D.	Rye Grass: 2 cfs - 10 acres		

Nitrogen Removal (Part 2)

Free Water Surface Wetland (FWS) - Summer warm weather conditions

1. System Operating Data Summer:

2.00	ft^3/sec	= Q = Average Flow Summer	
172,800	ft^3/day	= Q = Average Flow Summer	
4,893	m^3/day	= Q = Average Flow Summer	
1,292,544	Gal/day	= Q = Average Flow Summer	
1.29	MGD	= Q = Average Flow Summer	
68.90	^oF	= T = Influent Temperature Summer ------>	= 20.5 ^oC
1.50	ft	= y = design depth of wetland in feet	
0.46	m	= y = design depth of wetland in meters	
0.65		= n = porosity of wetland section as a decimal fraction (typically between 0.65 and 0.75)	
0.23	mg/l	= C_o = Influent Nitrate Concentration	
0.02	mg/l	= C_e = Effluent Nitrate Concentration	= Reduction of 91% Nitrate

De-Nitrification

2. Temperature Dependent First Order Rate Constant:

$K_T = 0 =$ 0.000 <-- at 0 ^oC (ref. 1, equation 6.48)

$K_T = 01.000\ (1.15)^{(T-20)} =$ 1.072 <-- at 1 ^oC + (ref. 1, equation 6.48)

Choose $K_T =$ 1.072

3. Required Wetland Area for Targeted De-Nitrification Summer:

$A_s = Q \ln (C_o/C_e) / K_T\ (y)\ (n) =$ 37,500 m^2 (ref. 1, equation 6.48)

= 403,645 ft^2 = 9.27 Acres

4. Hydraulic Residence Time:

t = (L)(W)(y)(n) / Q = 2.28 days (ref. 1, equation 6.2)

Where: t = Hydraulic residence time, days
L = Length of the wetland cell, ft
W = Width of the wetland cell, ft
y = Depth of the wetland cell, ft
n = porosity through the flow section, percent as a decimal
Q = Average flow through wetland, ft^3/day

5. Summer De-Nitrification Process Resultant Nitrate in Effluent:

$C_e = (C_o) \exp ((-K_T)(t)) =$ 0.02 mg/l (ref. 1, equation 6.47)

6. Hydraulic Loading Rate: typ 0.4 - 75 cm/d

HLR = 100 (Q) / A_s = 13.05 cm/d

Where: HLR = Hydraulic Loading Rate, cm/d
Q = Average Flow, m^3/d
As = Wetland Surface Area, m^2

7. Total Nitrogen (TN) in effluent in Summer:

TN = Ammonia Out Summer + Nitrate Out Summer = 0.32 mg/l NH_3 - N + 0.02 mg/l NO_3 - N = 0.34 mg/l TN

Footnote: 1. Natural Systems for Waste Management and Treatment, Reed, Crites, Middlebrook, 2nd Edition, 1995

Client:	OID	Designer:	D. Prull
Project:	SOR	Date:	11-Mar-11
Wetland I.D.	Rye Grass: 2 cfs - 10 acres		

Nitrogen Removal (Part 2)

Free Water Surface Wetland (FWS) - Winter cold weather conditions

1. System Operating Data Winter:

2.00	ft^3/sec	= Q = Average Flow Winter
172,800	ft^3/day	= Q = Average Flow Winter
4,893	m^3/day	= Q = Average Flow Winter
1,292,544	Gal/day	= Q = Average Flow Winter
1.29	MGD	= Q = Average Flow Winter
33.80	^{o}F	= T = Influent temperature -----------------> = 1.0 ^{o}C
1.50	ft	= y = design depth of wetland in feet
0.46	m	= y = design depth of wetland in meters
0.65		= n = porosity of wetland section as a decimal fraction (typically between 0.65 and 0.75)
0.05	mg/l	= C_o = Influent Nitrate Concentration
0.04	mg/l	= C_e = Effluent Nitrate Concentration = Reduction of 16% Nitrate

De-Nitrification

2. Temperature Dependent First Order Rate Constant:

$K_T = 0 =$	0.000	<--	at 0 ^{o}C	(ref. 1, equation 6.48)
$K_T = 01.000\ (1.15)^{(T-20)} =$	0.070	<--	at 1 ^{o}C +	(ref. 1, equation 6.48)

Choose K_T = 0.070

3. Required Wetland Area for Targeted De-Nitrification Winter:

$A_s = Q \ln (C_o/C_e) / K_T\ (y)\ (n) =$ 40,299 m^2 (ref. 1, equation 6.48)

= 433,777 ft^2 = 9.96 Acres

4. Hydraulic Residence Time:

t = (L)(W)(y)(n) / Q = 2.45 days (ref. 1, equation 6.2)

Where: t = Hydraulic residence time, days
L = Length of the wetland cell, ft
W = Width of the wetland cell, ft
y = Depth of the wetland cell, ft
n = porosity through the flow section, percent as a decimal
Q = Average flow through wetland, ft^3/day

5. Winter De-Nitrification Process Resultant Nitrate in Effluent:

$C_e = (C_o) \exp ((-K_T)(t)) =$ 0.04 mg/l (ref. 1, equation 6.47)

6. Hydraulic Loading Rate: typ 0.4 - 75 cm/d

$HLR = 100\ (Q) / A_s =$ 12.14 cm/d

Where: HLR = Hydraulic Loading Rate, cm/d
Q = Average Flow, m^3/d
As = Wetland Surface Area, m^2

7. Total Nitrogen (TN) in effluent in Winter:

TN = Ammonia Out Winter + Nitrate Out Winter = 0.50 mg/l NH_3 - N + 0.04 mg/l NO_3 - N = 0.54 mg/l TN

Footnote: 1. Natural Systems for Waste Management and Treatment, Reed, Crites, Middlebrook, 2nd Edition, 1995

Client:	OID	Designer:	D. Prull
Project:	SOR	Date:	11-Mar-11
Wetland I.D.	Rye Grass: 2 cfs - 10 acres		

BOD Removal

Free Water Surface Wetland (FWS) - Summer warm weather conditions

1. System Operating Data Summer:

2.00	ft^3/sec	= Q = Average Flow Summer
172,800	ft^3/day	= Q = Average Flow Summer
4,893	m^3/day	= Q = Average Flow Summer
1,292,544	Gal/day	= Q = Average Flow Summer
1.29	MGD	= Q = Average Flow Summer
68.90	^oF	= T = Influent temperature -----------------> = 20.5 ^oC
1.50	ft	= y = design depth of wetland in feet
0.46	m	= y = design depth of wetland in meters
0.65		= n = porosity of wetland section as a decimal fraction (typically between 0.65 and 0.75)
2.00	mg/l	= C_o = Influent BOD Concentration
0.36	mg/l	= C_e = Effluent BOD Concentration = Reduction of 82% BOD

2. Temperature Dependent First Order Rate Constant Summer:

$K_T = K_{20}\,(1.06)^{(T-20)} =$ 0.698

Where: $K_{20} = 0.678$

3. Required Wetland Area for Targeted BOD Removal Summer:

$A_s = Q\,(\ln C_o - \ln C_e) / K_T\,(y)\,(n) =$ 435,381 ft^2 = 9.99 Acres (ref. 1, equation 6.32)

= 40,448 m^2

4. Summer Resultant BOD Effluent:

$C_e = (C_o)\exp((-K_T)(t)) =$ 0.37 mg/l (ref. 1, equation 6.33)

5. Hydraulic Loading Rate: typ 0.4 - 75 cm/d

$HLR = 100\,(Q) / A_s =$ 12.10 cm/d

Where: HLR = Hydraulic Loading Rate, cm/d

Q = Average Flow, m^3/d

As = Wetland Surface Area, m^2

6. Check Summer BOD Removal Required Wetland Area:

$C_e = (0.192)(C_o) + (0.097)(HLR) =$ 1.56 mg/l Knight et. al (ref. 1, equation 6.37)

Where: C_e = effluent BOD, mg/l

C_o = influent BOD, mg/l

HLR = hydraulic loading rate, cm^3/cm^2-d

Footnote: 1. Natural Systems for Waste Management and Treatment, Reed, Crites, Middlebrook, 2nd Edition, 1995

Client:	OID	Designer:	D. Prull
Project:	SOR	Date:	11-Mar-11
Wetland I.D.	Rye Grass: 2 cfs - 10 acres		

BOD Removal

Free Water Surface Wetland (FWS) - Winter cold weather conditions

1. System Operating Data Winter:

2.00	ft^3/sec	= Q = Average Flow Winter
172,800	ft^3/day	= Q = Average Flow Winter
4,893	m^3/day	= Q = Average Flow Winter
1,292,544	Gal/day	= Q = Average Flow Winter
1.29	MGD	= Q = Average Flow Winter
33.80	^oF	= T = Influent Temperature Winter -----------> = 1.0 ^oC
1.50	ft	= y = Design depth of wetland in feet
0.46	m	= y = Design depth of wetland in meters
0.65		= n = Porosity of wetland section as a decimal fraction (typically between 0.65 and 0.75)
2.00	mg/l	= C_o = Influent BOD Concentration
1.16	mg/l	= C_e = Effluent BOD Concentration = Reduction of 42% BOD

2. Temperature Dependent First Order Rate Constant Winter:

$K_T = K_{20}\,(1.06)^{(T-20)} =$ 0.224

Where: $K_{20} = 0.678$

3. Required Wetland Area for Targeted BOD Removal Winter:

$A_s = Q\,(\ln C_o - \ln C_e) / K_T\,(y)\,(n) =$ 430,824 ft^2 = 9.89 Acres (ref. 1, equation 6.32)

= 40,025 m^2

4. Winter Resultant BOD Effluent:

$C_e = (C_o)\exp((-K_T)(t)) =$ 1.15 mg/l (ref. 1, equation 6.33)

4. Hydraulic Loading Rate: typ 0.4 - 75 cm/d

$HLR = 100\,(Q) / A_s =$ 12.23 cm/d

Where: HLR = Hydraulic Loading Rate, cm/d

Q = Average Flow, m^3/d

As = Wetland Surface Area, m^2

5. Check Winter BOD Removal Required Wetland Area:

$C_e = (0.192)(C_o) + (0.097)(HLR) =$ (equation not valid in cold weather)

Where: C_e = effluent BOD, mg/l

C_o = influent BOD, mg/l

HLR = hydraulic loading rate, cm^3/cm^2-d

Footnote: 1. Natural Systems for Waste Management and Treatment, Reed, Crites, Middlebrook, 2nd Edition, 1995

Client:	OID	Designer:	D. Prull
Project:	SOR	Date:	11-Mar-11
Wetland I.D.	Rye Grass: 2 cfs - 10 acres		

Total Suspended Solids (TSS) Reduction

Free Water Surface Wetland (FWS) - Average Annual Operating Conditions

1. System Operating Data Average:

2.00	ft^3/sec	= Q = Average Flow Annual	
172,800	ft^3/day	= Q = Average Flow Annual	
4,893	m^3/day	= Q = Average Flow Annual	
1,292,544	Gal/day	= Q = Average Flow Annual	
1.29	MGD	= Q = Average Flow Annual	
51.35	^oF	= T = Influent temperature ---> =	10.75 ^oC
1.50	ft	= y = design depth of wetland in feet	
0.46	m	= y = design depth of wetland in meters	
0.65		= n = porosity of wetland section as a decimal fraction (typically between 0.65 and 0.75)	
31.50	mg/l	= C_o = Influent TSS Concentration	
4.41	mg/l	= C_e = Effluent TSS Concentration	= Reduction of 86% TSS

2. Hydraulic Loading Rate: typ 0.4 - 75 cm/d

HLR = 100 (Q) / A_s = 12.28 cm/d

Where: HLR = Hydraulic Loading Rate, cm/d
Q = Average Flow, m^3/d
As = Wetland Surface Area, m^2

3. Average Annual TSS Concentration in Effluent:

$C_e = C_o\,[0.1139 + (0.00213)(HLR)]$ = 4.41 mg/l (ref. 1, equation 6.40)

Where: C_e = effluent TSS, mg/l
C_o = influent TSS, mg/l
HLR = hydraulic loading rate, cm^3/cm^2-d

Footnote: 1. Natural Systems for Waste Management and Treatment, Reed, Crites, Middlebrook, 2nd Edition, 1995

Client:	OID	Designer:	D. Prull
Project:	SOR	Date:	11-Mar-11
Wetland I.D.	Rye Grass: 2 cfs - 10 acres		

Phosphorus Reduction

Free Water Surface Wetland (FWS) - Average Annual Operating Conditions

1. System Operating Data Average:

2.00	ft^3/sec	= Q = Average Flow Annual
172,800	ft^3/day	= Q = Average Flow Annual
4,893	m^3/day	= Q = Average Flow Annual
1,292,544	Gal/day	= Q = Average Flow Annual
1.29	MGD	= Q = Average Flow Annual
51.35	^oF	= T = Influent temperature ---> = 10.75 ^oC
1.50	ft	= design depth of wetland in feet
0.46	m	= y = design depth of wetland in meters
0.65		= n = porosity of wetland section as a decimal fraction (typically between 0.65 and 0.75)
0.23	mg/l	= C_o = Influent Phosphorus Concentration
0.18	mg/l	= C_e = Effluent Phosphorus Concentration = Reduction of 20% TSS

2. Hydraulic Loading Rate: typ 0.4 - 75 cm/d

HLR = 100 (Q) / A_s = 12.20 cm/d

Where: HLR = Hydraulic Loading Rate, cm/d
Q = Average Flow, m^3/d
As = Wetland Surface Area, m^2

3. Average Annual Phosphorus Concentration in Effluent:

$C_e = C_o * \exp[-K_p/HLR]$ = 0.18 mg/l (ref. 1, equation 6.60)

Where: C_e = effluent phosphorus, mg/l
C_o = influent phosphorus, mg/l
K_p = 2.73 cm/d (6.93 in/d)
HLR = hydraulic loading rate, cm^3/cm^2-d

Footnote: 1. Natural Systems for Waste Management and Treatment, Reed, Crites, Middlebrook, 2nd Edition, 1995

Client:	OID	Designer:	D. Prull
Project:	SOR	Date:	11-Mar-11
Wetland I.D.	Rye Grass: 2cfs - 10 acres		

Hydraulic Design

Free Water Surface Wetland (FWS) - maximum flow conditions

1. System Operating Data:

2.00	ft^3/sec	= Q = Average Flow Summer
172,800	ft^3/day	= Q = Average Flow Summer
4,893	m^3/day	= Q = Average Flow Summer
1,292,544	Gal/day	= Q = Average Flow Summer
1.29	MGD	= Q = Average Flow Summer
68.90	^oF	= T = Influent Temperature Summer ----> = 20.5 ^oC
1.50	ft	= y = design depth of wetland in feet
0.46	m	= y = design depth of wetland in meters
0.65		= n = porosity of wetland section as a decimal fraction (typically between 0.65 and 0.75)

2. Maximum Length of Wetland Cell:

$L = [(A_s)(y)^{2.66}(m)^{0.50}(86{,}400) / (a)(Q)]^{0.66} =$ 1,164 ft (ref. 1, equation 6.8)

Where: L = Length of the wetland cell, ft
A_s = Wetland Surface Area, ft^2
y = Depth of the wetland cell, ft
m = Increment of depth serving as driving head, percent as a decimal. Typically 10 to 30 percent. m = 0.05
a = resistance factor, s-ft

a =	0.877	s-ft for sparse, low-standing vegetation, y > 16-inches
a =	3.549	s-ft for moderately dense vegetation, y = 12-inches
a =	14.197	s-ft for very dense vegetation and litter layer, y < 12-inches

Choose a = 3.549

Q = Average flow through wetland, ft^3/day

3. Width of Wetland Cell Based on Maximum Length:

W = AS/L = 368 ft

Where: W = Width of Wetland Cell based on Maximum Length, ft
A_s = Wetland Surface Area, ft^2
L = Length of the wetland cell, ft

4. Aspect Ratio (L:W): typ 1:1 to 4:1

Aspect Ratio = 3.2 : 1

5. Velocity Through Wetland:

v = Q/Wy = 0.004 ft/sec

Where: v = Hydraulic Loading Rate, ft/sec
Q = Average Flow, ft3/sec
W = Width of Wetland Cell based on Maximum Length, ft
y = Depth of the wetland cell, ft

6. Slope Across the Wetland Length:

s = (m)(y)/L 0.000064 ft/ft

Footnote: 1. Natural Systems for Waste Management and Treatment, Reed, Crites, Middlebrook, 2nd Edition, 1995

Ochoco Irrigation District

Rye Grass Wetland 2 cfs, 10 Acres

Budget Level - Projection of Probable Construction Cost

Item No.	Spec Division	Description	Measurement	Units	Unit Cost	Total Cost
1	1000	Mobilization	LS	1	$8,000.00	$8,000.00
2	1000	Erosion Control	LS	1	$500.00	$500.00
4	1000	Watering / Dust Control	LS	1	$1,250.00	$1,250.00
5	1000	Construction Staking	LS	1	$1,500.00	$1,500.00
6	1000	Project Management and Coordination	LS	1	$4,000.00	$4,000.00
7	1000	Construction Progress Documentation	LS	1	$2,000.00	$2,000.00
8	1000	Submittal Procedures	LS	1	$2,000.00	$2,000.00
9	1000	Quality Requirements	LS	1	$2,500.00	$2,500.00
10	1000	Selective Demolition	LS	1	$1,000.00	$1,000.00
11	1000	Project Record Documents	LS	1	$2,000.00	$2,000.00
12	1000	Operations and Maintenance Data	LS	1	$1,500.00	$1,500.00
13	1000	General Commissioning Requirements	LS	1	$1,500.00	$1,500.00
14	2000	Erosion Control Silt Fence	LF	1100	$2.40	$2,640.00
15	2000	Perimeter Fence, 3 strand wire	LF	1100	$3.00	$3,300.00
16	2000	Fence Gate	LS	1	$800.00	$800.00
17	2000	Boring and Jacking, 30-inch	LF	100	$400.00	$40,000.00
18	2000	Bulk Excavation	CY	24,200	$3.50	$84,700.00
19	2000	Hauling	CY	1,000	$12.00	$12,000.00
20	2000	Trench Excavation, 0-4 ft depth no trench box	CY	400	$7.00	$2,800.00
21	2000	Trench Backfilling	CY	400	$3.10	$1,240.00
22	2000	Aggregate Base	CY	200	$37.50	$7,500.00
23	2000	Aggregate Rip Rap	CY	60	$60.00	$3,600.00
24	2000	Manhole	EA	2	$5,000.00	$10,000.00
25	2000	Wetland Plant Stock	AC	10	$1,800.00	$18,000.00
26	2000	Wetland Planting	AC	10	$2,000.00	$20,000.00
27	2000	Restoration Seeding	AC	2	$1,500.00	$3,000.00
28	3000	Misc Cast-in-Place Concrete	LS	1	$3,000.00	$3,000.00
29	4000	None	LS	0	$0.00	$0.00
30	5000	None	LS	0	$0.00	$0.00
31	6000	None	LS	0	$0.00	$0.00
32	7000	None	LS	0	$0.00	$0.00
33	8000	None	LS	0	$0.00	$0.00
34	9000	None	LS	0	$0.00	$0.00
35	10000	None	LS	0	$0.00	$0.00
36	11000	None	LS	0	$0.00	$0.00
37	12000	None	LS	0	$0.00	$0.00
38	13000	None	LS	0	$0.00	$0.00
39	14000	None	LS	0	$0.00	$0.00
40	15000	24-inch PVC Pipe	LF	800	$105.00	$84,000.00
41	15000	Hydraulic Slide Gate	EA	2	$2,500.00	$5,000.00
42	16000	None	LS	0	$0.00	$0.00
43	17000	None	LS	0	$0.00	$0.00
		Construction Subtotal				$329,330.00
		Contractors Overhead and Profit	10%	1	$32,933.00	$32,933.00
		Contractors Bonds and Insurance	2%	1	$7,245.26	$7,245.26
		Construction Contingency	30%	1	$98,799.00	$98,799.00
		Construction Total				$468,307.26
		Engineering, Administration	25%	1	$117,076.82	
		Total				**$585,384.08**

DELIVERABLES – TAB 9

Updated GIS Mapping

I. Updated District GIS Mapping

During the course of this System Optimization Review, the Ochoco Irrigation District employed its staff and equipment resources to update and/or create new GIS mapping attributes for its existing mapping system.

One primary and necessary input to this SOR was to obtain horizontal and vertical survey grade data for the Ochoco Main Canal and Crooked River Distribution Canal. Additionally, to locate and document patron turnout points and lateral points along these major alignments. Over a period of weeks (and 30-miles of canal systems), this data was gathered by District staff using its survey grade GIS data collection system. This data was reduced by the District. Furthermore, irrigation turnout and associated acreage information was confirmed in the field by District O&M staff and provided to the District's consulting GIS personnel. Finally, the canal and turnout data was input into the District's GIS mapping system.

From this base data, GIS layers and attributes were developed to memorialize the field data into the system. Mapping and digital data files were then developed and conveyed to the SOR team for use in evaluating the Ochoco Main Canal and Crooked River Distribution Canal systems. Tables were formed from this data indicating the location and associated acreage of the various patron turnouts along the canal alignments. This, along with the elevational survey data, made it possible for proposed pipelines to be sized for these major District facilities.

DELIVERABLES – TAB 10

Conceptual Framework for Managing Conservation Savings to Improve Instream Flows in Ochoco Creek

10. Conceptual Framework for Managing Conservation Savings to Improve Instream Flows in Ochoco Creek

Overview: Water conservation activities identified in the System Optimization Review have potential to decrease district diversions from Ochoco Reservoir and Ochoco Creek. OID and the DRC have assessed the contractual constraints to protecting this water in Ochoco Creek and have designed the following strategy to achieve restoration when future conservation projects are implemented.

Framework for Restoring Conservation Savings in Ochoco Creek

Ochoco Irrigation District's assessment of its contract with the Bureau of Reclamation constrains it from participating in the State of Oregon's Allocation of Conserved Water Program. In 2012, however, OID supported Federal legislation that would amend OID's contract with Reclamation to authorize the use of water for instream purposes, including fish or wildlife purposes, in order for the district to engage in, or take advantage of, conserved water projects and temporary instream leasing as authorized by Oregon State law. (S. 3483: Crooked River Collaborative Water Security Act (Introduced 8/02/12); and H.R. 2060: Central Oregon Jobs and Water Security Act (Referred to Senate Committee (06/06/12)).

If this legislation becomes law, OID may use Oregon's Allocation of Conserved Water Statute to restore conservation savings to Ochoco Creek and other source streams, depending on where conservation projects occur. When using the statute, State law requires that 25% of the water be restored instream. Additional water would be protected instream proportionate to public investment in the conservation projects. To the extent practicable and legal, OID will target flow restoration when most needed for the reintroduction of anadromous fish. OID will work in partnership with agencies and entities such as the Deschutes River Conservancy to finance appropriate and cost-effective conserved water projects and shepherd them through the State process.

DELIVERABLES – TAB 11

MOU with the DRC Identifying Parameters for Managing Non-District Water Conserved Upstream of Ochoco Reservoir through the Reservoir

Agreement Between
Deschutes River Conservancy
And
Ochoco Irrigation District
Regarding
The Instream Water Leasing Program for the Deschutes Basin

A. Background

The Ochoco Irrigation District ("District") and the Deschutes River Conservancy ("DRC") have worked together since 2001 to promote the leasing of water rights under ORS 537.348 (2) by Landowners within the District. Since the 2002 irrigation season, the DRC has offered to pay Landowners for water leased instream. In 2003 and 2004 the DRC and District initiated a reverse auction to allocate leasing dollars. However, due to circumstances beyond either OID or DRC's control, water leased in the Crooked River is not protected additively but rather fills an existing agreement. Until this matter is resolved, the DRC will offer it's fixed per acre foot price option to Landowners in OID, as consistent with other Districts participating in the program.

Payment of leases is renewed annually pending grant funding and per the payment schedule attached as Exhibit A. The DRC also offers its Annual Water Leasing Program ("Program") to Landowners within other irrigation districts in the Deschutes Basin. The DRC and the District seek to continue and expand their cooperative effort to restore instream flows in Ochoco Creek and the Crooked River through annual water leasing. This Agreement establishes the terms of this relationship between the DRC and the District, allowing for future decisions to hold a fixed price or auction format for obtaining leases. Year-to-year specifics of the program will be agreed upon separately (with Exhibit A and, or written notification) and approved as necessary by the respective Boards of each organization.

B. Definitions

1. "Annual Water Leasing Program" or "Program" refers to all of the DRC water leases, including donated leases, for instream flows undertaken with Landowners in irrigation districts in the Deschutes Basin.

2. "Department" means the Oregon Water Resources Department.

3. "District" means the Ochoco Irrigation District.

4. "Donated Lease" means any water leased instream in a district by a Lessor who is not eligible for payment, including municipal corporations, irrigation districts, and others who are leasing to meet a wildlife mitigation or other mandatory obligation. The determination of who is eligible for payment by the DRC shall be at the sole discretion of the DRC.

5. “Instream Lease” or “Lease” means the lease agreement between the District Landowner, the District, the DRC and the Department under ORS 537.348(2) and OAR 690-77-077.

6. “Landowner” means an owner or purchaser of land situated in a district with an appurtenant water right and subject to the charges or assessments of the district or other entity holding a quit-claim for a water right; provided a “District Landowner” shall mean such a landowner within the District who is subject to the charges or assessments of the district or other entity holding a quit claim for a water right within the District.

7. “Lessee” or “Lessees” means the DRC and the Department.

8. “Lessor” or “Lessors” means the Landowner and the District.

9. “Pooled District Form” means the form of Lease developed by the Department for use by irrigation districts.

10. “Pooled Landowner Form” means the form of Lease developed by the Department for use by Landowners within and supplied by irrigation districts.

11. “Primary Water Right” means the water right designated by the Water Resources Commission as the principal water supply for the authorized use, or if no designation has been made, the water right designated by the Landowner as the principal water supply for the authorized use.

12. “Program Year” shall mean the period between November 1 and October 31, with the Program Year being designated by the calendar year in which the Program Year ends, i.e., the 2013 Program Year shall mean the period November 1, 2012 to October 31, 2013.

13. “Restoration Lease” is a lease submitted for restoration without mitigation.

C. Purpose of Agreement; Effective Date

The purpose of this Agreement is to define the respective roles and responsibilities of the DRC and the District in carrying out the Annual Water Leasing Program as it applies to Landowners supplied by the District.

D. Parties

The parties to this Agreement are: (1) the Ochoco Irrigation District, an Oregon special district organized under ORS Chapter 545 with offices at 1001 N. Deer Street, Prineville, Oregon 97754; and (2) the Deschutes River Conservancy, an Oregon not-for-profit corporation with offices at 700 N.W. Hill Street, Bend, Oregon 97701.

E. Roles and Responsibilities

The DRC agrees to:

1. Pay Lessors (except for donated leases) to lease their Primary Water Right instream based on a flat rate of compensation per acre-foot as specified in Exhibit A and contingent on the availability of grant funding.

2. Respond to District Landowner inquiries regarding the program.

3. Prepare and file the Lease Forms for all participating District Landowners with the Department, with copies to the DRC and the District. Choice of form will be in accordance with the schedule laid out in Exhibit A.

4. Cover state fees in accordance with the schedule provided in Exhibit A.

5. Provide lease applicants and existing lessors with the farm deferral information sheet and DRC weed policy sheet attached as Exhibit C.

6. Consult with District on Lease payments. Execute the Instream Leasing Payment Schedule (Exhibit B) per Section F below; following the issuance of the last District lease Final Order by the Department.

7. Pay Landowners directly (except for donated leases) to lease their Primary Water Right instream based on a flat rate of compensation per acre-foot, and up to an agreed upon total acreage limit, as depicted in Exhibit A. As funding allows, payment may be made on acreage leased beyond the limit depicted in Exhibit A. Payment will be made in August. Landowner is responsible for paying assessment by due date.

8. Prepare letters to Lessors thanking them for their participation in the Annual Leasing Program and asking them to complete the AWLP Participation Survey.

9. Send the "thank you" letters to Lessors from the DRC and the Annual Water Leasing Program Participation Survey to participating Lessors when payment checks are sent to such Lessors under subsection F.2 below.

10. Subject to limits set by the Board of Directors of the District, the DRC shall make every effort to reallocate funds available for the Annual Leasing Program from other irrigation districts to expand the acreage leased within the District if leasing demand exceeds the acreage allocation to the District under Exhibit A and leasing demand is less than expected in other districts.

11. Subject to priority rights of water users and applicable laws and regulations, monitor flows during the irrigation season and coordinate with the District and the Department to assure that the water leased is released and protected instream in accordance with the terms of the Lease.

12. Recognize the District and lease donors as 'River Stewards' in appreciation for their contribution to the success of the Program.

13. Prepare a summary of leasing activity and participation in the District for the leasing season for dissemination to interested parties.

The District agrees to:

14. Advertise the Program in the District newsletter including information about the amount of per acre payment that DRC is offering to Landowners willing to lease their water rights instream.

15. Respond to District Landowner inquiries regarding the Program and refer Landowners to the DRC to prepare lease forms.

16. Prepare maps of District Landowner acres to be leased in accordance with the Department lease application.

17. Review all lease applications from District Landowners to assure that water can be leased instream without injury to other District Landowners and otherwise address issues posed by instream leases to District operations and plans.

18. Monitor flows during the irrigation season (per the Addendum to Exhibit A) and coordinate with the Department to assure that the water leased is not being diverted and is protected instream in accordance with the terms of the Lease.

19. Review the Instream Leasing Payment Schedule (Exhibit B) per Section F and Section G below, following the issuance of the last District lease Final Order by the Department.

20. Acknowledge the cooperative effort between the District and the DRC by naming the DRC as a Lessee on all lease forms, including forms related to donated leases.

F. Payments

1. DRC Responsibilities. The DRC shall pay the Lessor directly (as specified in Section E.6 above and Exhibit A) for each acre of water rights leased instream, excluding donated leases.

    a. Instream Leasing Payment Schedule. Upon issuance of Department Final Order for the last District lease submitted for the year, the DRC shall submit the Instream Leasing Payment Schedule (Exhibit B) to the District for review and signature.

    b. Compliance Verification. Upon District verification of Lessors listed in Exhibit B and notification and verification of any weed complaints against a participating Landowner and notwithstanding Section C below, the DRC will process payment. Payment will be made to the Lessors no later than 60 days after receipt of the signed Exhibit B from the District.

    c. DRC Payment Contingency. For leases submitted to the Department after March 1, DRC will pay only the lease fee per Exhibit A. Any exception to the March 1 deadline will be subject to DRC approval and funding availability. The lease(s) may be paid in subsequent years pending availability of funds and per the payment schedule (Exhibit A). DRC payment to the Lessor for leases is contingent upon on the availability of grant funding.

d. Discontinuation of Payments. If notice is provided to the District before the Department issues a Final Order, the DRC's payments to District Landowner thereof may be discontinued, modified, or withheld at any time prior to lease execution by the Department, when in the sole and absolute discretion of the DRC, such action is necessary to comply with the requirements of law, regulations or rulings or if DRC funding is reduced.

2. District Responsibilities.

a. Instream Leasing Payment Schedule. The District will review the Instream Leasing Payment Schedule (Exhibit B) in a timely manner.

b. Compliance Verification. The District will provide the DRC with written notice of any non-compliance issues, including weed complaints against or water usage by a Lessor, with the return of the Exhibit B.

G. Schedule

The implementation schedule is as follows:

1.	Joint Determination of acreage limits	November/December
2.	District Board Presentation of Agreement	December
3.	Newsletter Notification	December/January
4.	Completion of lease forms	January - February 15th
5.	Program Monitoring	Throughout instream lease season
6.	Exhibit B submitted to District	Upon Final Order of last District lease
7.	Payment to Lessor	August
8.	Program Evaluation; Review of Agreement for next Program Year	October/November

The schedule may be modified upon mutual agreement of the parties.

H. Relationship to Department

The DRC will work with the District to file the Lease Forms with the Department on or before March 1 of the Program Year. The DRC will monitor the Department processing of the Lease Forms. The District and the DRC agree to notify one another of any requests for additional information they receive from the Department and to cooperate in responding to any comments the Department receives on the lease applications.

I. Funding

The District acknowledges that the DRC funding for lease payments under the Program is partially provided by grants. Grant funding is derived from a variety of sources including federal and state grants and private donations. The District agrees to provide to the DRC all financial and other information it needs to report to those individuals and agencies that fund the Program.

J. Weeds

DRC expects participants in the Program will continue to exercise agricultural best management practices on lands enrolled in the Program, particularly with respect to the control of noxious and/or nuisance weeds. Failure to comply with the provisions of existing laws, ordinances and regulations pertaining to weed management, including but not limited to Crook County Ordinance #139, Chapter 8.24, Crook County Code and failure to control nuisance weeds may result in the suspension of payments under this Agreement. With proper notification, in the form of written notice to the District, the DRC reserves the right to withhold, modify or discontinue payment based on lack of compliance with existing laws, ordinances, and regulations and for failure to control nuisance weeds.

K. Restoration and Mitigation Leases

Funds committed under this Agreement are intended for flow restoration purposes in accordance with OAR 690 Division 077. Water leased but not used for mitigation is considered by the Program as restoration water.

L. Public Information and Outreach

The District agrees to provide draft and final copies of any press releases, technical, educational or information materials, including but not limited to any website information, produced about the Program for review by the DRC prior to publication and to acknowledge the DRC, Pelton Fund and National Fish and Wildlife Foundation funding of the Program in any such publications or releases.

M. General Provisions

1. Termination. Either Party may terminate its participation in this Agreement after thirty (30) days prior notice to the other Party; provided, such termination as to the current Program Year shall not affect the parties' obligations as to leases that have been put in effect and/or continue beyond the end of the current Program Year. During the intervening thirty (30) days, the Parties agree to actively attempt to resolve outstanding disputes or disagreements. Each fall the parties agree to review this Agreement and, based on such review, make any mutually agreed changes to this Agreement. Unless terminated or amended, the provisions of this Agreement shall apply to any subsequent Program Years and, if amended, shall apply as amended.

2. Statutory Responsibilities. Each Party recognizes that the Parties and their representatives have statutory and other responsibilities which cannot be waived or abrogated. This Agreement does not affect such non-discretionary mandates.

3. Amendments. Amendments to this Agreement may be proposed by either Party and shall become effective upon written approval of both Parties.

4. Notice. Notice may be given (i) by certified mail to a party at the address listed herein return receipt requested, addressed to the District Manager in the case of the District and addressed to 700 NW Hill Street, NW, Bend, OR, 97701 in the case of DRC, such notice to be deemed given three (3) days after such mailing in the US Mails postage prepaid, (ii) by personal delivery to such person, which notice will be deemed delivered upon receipt or (iii) by facsimile to the attention of such person at the following facsimile numbers: for the District 541-447-3978 and for DRC 541-382-4078; provided such address or fax number for or designated person to receive notice for a party may be changed by notice given in the same manner.

5. Governing Law. This Agreement shall be governed and construed in accordance with the laws of the State of Oregon applicable to contracts executed and performed in Oregon.

6. Severability. The invalidity or unenforceability of any terms of this Agreement shall not affect the validity or enforceability of the remaining terms and provisions, which shall remain in full force and effect unless such invalidity and unenforceability substantially alters the underlying intent of the Agreement.

7. Assignment and Waiver. Neither this Agreement nor any interest herein may be assigned, in whole or in part by either party without the prior written consent of the other party hereto. The failure or delay of either party to enforce at any time any provision(s) of this Agreement shall not constitute a waiver of such right thereafter to enforce each and every provision of this Agreement.

8. Entire Agreement. This Agreement supersedes all previous negotiations, writings, commitments, or any other Agreement between the parties in respect of the subject matter hereof. This Agreement shall not be modified or amended, except by a written instrument signed by both parties.

9. Arbitration. Any dispute arising out of or in connection with this Agreement, which is not settled by mutual agreement of the Parties within sixty (60) days of notification in writing by any Party, shall be submitted to an arbitrator mutually agreed upon by the Parties. In the event the Parties cannot agree on the arbitrator, then the arbitrator shall be appointed by the Presiding Judge (Civil) of the Circuit Court of the State of Oregon for Deschutes County. The arbitrator shall be selected within thirty (30) days from the expiration of the sixty (60)-day period following notification of the dispute. The arbitration shall be conducted in Bend, Oregon unless the parties agree otherwise in writing. The applicable arbitration rules of the Arbitration Services of Portland shall apply unless the Parties agree in writing to other rules. See http://www.arbserve.com/.

Insofar as the Parties may legally do so, they agree to be bound by the decision of the arbitrator. The prevailing party in any such dispute will be entitled to recover all of its attorney fees, paralegal fees, costs, disbursements, and other expenses from the non-prevailing party including without limitation those arising before and at any trial, arbitration, bankruptcy, or other proceeding, and in any appeal.

10. Headings. The headings in this Agreement are for convenience only and shall not affect the interpretation of this Agreement.

11. No Third Party Beneficiaries. This Agreement is for the sole benefit of the Parties hereto and their successors and permitted assigns, and nothing herein, express or implied, is intended to or shall confer upon any other person or entity any legal or equitable right, benefit or remedy of any nature whatsoever under or by reason of this Agreement.

12. Execution in Counterparts. This Agreement and any amendments, waivers hereto may be executed in any number of counterparts, each of which counterparts, when so executed and delivered, shall be deemed to be an original, and all of which counterparts, taken together shall constitute one and the same instruments. Delivery of an executed signature page to this Agreement by facsimile or email transmission shall be as effective as delivery of a manually signed counterpart.

Entered into effective this __ day of ________, 2013 by

Deschutes River Conservancy	**Ochoco Irrigation District**
By:	**By:**
Program Director	**Manager**

EXHIBIT A

Schedule of Leasing Forms and Fees: Ochoco Irrigation District 2013 Leasing Program Year

Type of Lessor	Type of Lease	Payment of OID Lease Fees[2]	Mapping Costs	Payment of State Fees	Compensation from DRC[1]
I. Restoration Leases					
A. New Leases	1 year standard or pooled	Lessor	OID	DRC	Yes to Paid, No to Donated
B. Renewing Leases	1 year standard or pooled	Lessor	n/a	DRC	Yes to Paid, No to Donated
II. Mitigation Leases					
A. By Individual District Approval	1 year standard mitigation lease	Lessor	OID	DRC	Yes to Paid, No to Donated
	Industrial Water Rights Only				

Note: [1]DRC compensation is $7/acre-foot in 2013 (pursuant to Agreement deadlines)
[2]OID has set this fee at $______ for 2013
Leases less than 10 acres at OID discretion
Lessors to be pooled when possible

Leeway on fee or lessor payment deadline only with prior DRC approval (Agreement, Section F.1.c) .

Donated

Leases not eligible for payment

Lease with Public Corporation
Leases < 5 acres
Leases with verified weed complaint
Leases submitted after March 1
Renewing leases, Dist/DRC review

Entered into this_____________day of______________, 2012 by

Deschutes River Conservancy

By: Program Director

Ochoco Irrigation District

By: District Manager

Addendum to Exhibit A of the
Agreement Between
Deschutes River Conservancy
And
Ochoco Irrigation District
Regarding the Instream Water Leasing Program

A. PURPOSE:

The purpose of this addendum is to formalize the intent of Ochoco Irrigation District (OID) and the Deschutes River Conservancy (DRC) to adjust its Instream Leasing Agreement to optimize flow restoration in Ochoco Creek to support the reintroduction of anadramous fish.

To this end, this instrument contains provisions to formalize and define the roles and responsibilities required for OID and the DRC to shape its Instream Leasing Agreement to optimize ecological benefits in Ochoco Creek. This addendum will be reviewed annually and adapted as necessary based on consent of both parties.

B. PROJECT SUMMARY AND STATEMENT OF MUTUAL BENEFIT AND INTERESTS:

The DRC runs an Annual Water Leasing Program throughout the Deschutes Basin. The DRC partners with OID to instream lease approximately 2,500 acre-feet each year in Ochoco Creek. This program benefits streamflows in Ochoco Creek, while benefiting landowners by compensating them for the instream lease and providing a year of beneficial use for the water right. Leased water is currently protected in Ochoco Creek throughout the irrigation season, generally April 15th through October 15th. In practice, however, the leases have not been finalized until June due to timing issues with submittal and State processing.

Anadromous fish have been reintroduced into the lower Crooked River Basin, and Ochoco Creek provides important habitat, particularly for summer steelhead (*Oncorhynchus mykiss)* listed as threatened under the Endangered Species Act. Both OID and the DRC have an interest in improving conditions to ensure a successful anadromous reintroduction. Fish biologists have indicated that improved streamflows in April, May and June would have beneficial impact on summer steelhead during critical life stages. This addendum identifies the following changes to the Instream Leasing Agreement to optimize flow restoration during this time period:

- Monitoring of streamflows in Ochoco Creek will be improved to ensure leased water is protected instream.

- Instream leases will be shaped to maximize the flow restoration benefits from April through June.
- Timelines for lease notification and processing will be adjusted to accommodate water being protected instream by April.

C. OCHOCO IRRIGATION DISTRICT SHALL:

1. Install a new rated section in Ochoco Creek, with the downstream point being the point of lowest flow in the protected instream reach. OID partners, such as the DRC, the Crooked River Watershed Council, and the Oregon Water Resources Department will be responsible for establishing and maintaining the rating curve in the first year.
2. Monitor flows in this section as part of its routine district management to ensure that the leased flows are protected instream pursuant to the State Lease Final Order.
3. Provide the DRC with monitoring records on the 15th of each month during the instream lease period. Records will indicate the dates checked and flow observed.
4. Coordinate with the DRC to process leases earlier in the year to ensure flows are protected by April 15th (see Section G of Leasing Agreement for implementation schedule).
5. Agree to review this addendum by November 30th, 2013, with the intention of adapting as necessary to achieve goals.

D. THE DESCHUTES RIVER CONSERVANCY SHALL:

1. Process leases earlier in the year to ensure flows are protected by April 15th (see Section G of Agreement for implementation schedule).
2. Agree to review this addendum by November 30th, 2013, with the intention of adapting as necessary to achieve goals.

E. IT IS MUTUALLY UNDERSTOOD AND AGREED BY AND BETWEEN THE PARTIES THAT:

1. INFORMATION SHARING. Any information derived from the implementation of the Project or supported monitoring, evaluation, and/or restoration actions will be available for public presentation and/or publication by any of the parties or jointly by parties.

2. MODIFICATION. Modifications to this Addendum shall be made by mutual consent of the parties, by the issuance of a written modification, signed and dated by all parties, prior to any changes being performed.

3. TERMINATION. Either of the parties may terminate this Addendum in whole, or in part, at any time before the date of expiration by providing sixty (60) days written notice. Any such termination, or wholesale adjustment of roles by either DRC or OID, however, will permit the other parties to reconsider their participation in and responsibilities for supporting, funding, or implementing.

4. NON-FUND OBLIGATING DOCUMENT. This instrument is neither a fiscal nor a funds obligation document.

   Any duties or obligations imposed by this MOU are subject to the availability of funding. If such funding is not adequate to meet the terms and conditions of this MOU, the DRC and OID will not be responsible for completing tasks outlined in this MOU.

5. COMMENCEMENT/EXPIRATION DATE. This instrument is executed as of the date of last signature and is effective through October 31, 2013, at which time it will expire unless extended.

IN WITNESS WHEREOF, the parties hereto have executed this agreement as of the last written date below.

Entered into effective this __ day of ________, 2012 by

Deschutes River Conservancy	**Ochoco Irrigation District**
By:	**By:**
Program Director	**Manager**

DELIVERABLES – TAB 12

Prioritized Recommendations to Optimize Water Marketing

12. Recommendations to Optimize Water Marketing in OID

Goal: Provide recommendations to optimize OID's flexibility to market water to respond to other water demands and to meet district goals (ex. maintaining beneficial use on its full water right; maintaining its assessment base; managing urbanization; managing Endangered Species Act risks).

Overview: OID has actively participated in the DRC's Annual Water Leasing Program (AWLP) for the past ten years. Its instream leasing, however, is limited to its Ochoco Creek water rights due to the federal authorization of Prineville Reservoir. Leasing industrial water rights for temporary groundwater mitigation has just recently been piloted. The following recommendations support increased flexibility in water marketing.

Recommendations:

1. Continue to test the use of Ochoco Creek industrial water right leases for temporary mitigation (OID piloted this in 2012).
2. Seek federal authorization to instream lease water rights from Prineville Reservoir (OID is currently seeking this through introduced Federal legislation (S. 3483 and H.R. 2060).
3. Continue to market the leasing program within the district to include as many fallowed acres as possible each year without harming operations.
4. Shape the instream lease period, where opportunities exist, to maximize ecological benefit within the irrigation season. (See Deliverable 11 for more detail).