Micro-Hydroelectric Feasibility Study

Final Report – March 2009

Prepared for the

Northern Wasco County PUD
and the
City of the Dalles

Prepared and Submitted by:

GDS Associates, Inc.
Engineers and Consultants

In partnership with

TETRA TECH

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ACKNOWLEDGEMENTS and NOTICE

This report was prepared for the Northern Wasco County PUD and the City of the Dalles by GDS Associates, Inc. with substantial data collection and analysis assistance provided by Tetra Tech, Inc. (collectively, the GDS Team). The GDS Team would like to acknowledge the many helpful data sources and the technical input provided by Paul Titus (NWASCO PUD) and Dave Anderson (City of the Dalles).

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Scott M. Albert, Principal & Northeast Region Manager
GDS Associates, Inc., March 2009

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Executive Summary

This study evaluates the potential for generating electricity using the excess head available in a proposed seven-mile long water transmission pipeline that would connect the Wicks Water Treatment Plant to the Garrison Street Reservoir Site in the City of the Dalles, Oregon.

Specifically, GDS Associates, Inc., in partnership with Tetra Tech, Inc. (collectively the GDS Team) was tasked with providing a feasibility for developing a micro-hydroelectric (micro-hydro) project on the City's potable water transmission line and integrating the power output into the NWASCO PUD's electrical distribution system.

Background Information

A water surface elevation difference (static head) of about 420 feet exists between the storage reservoir at the Wicks plant and the reservoir at the Garrison Street site. Two existing 60-year old pipelines connect the Wicks plant to the City. The diameter of one pipeline, the High Line, is 14 inches while the other, the Mill Creek Line, is 12 inches. The City's 2005 Water Master Plan indicates that neither of the existing pipelines can withstand high pressures and that they are currently operated in a reduced pressure "open-channel" mode. The Master Plan recommends replacing the two pipelines with a single new 24-inch diameter ductile iron pipeline designed for the maximum pressures to which it would be subjected. The new pipeline is proposed to be located parallel to the existing Mill Creek pipeline within public road right-of-way.

This micro-hydro feasibility study consists of six sections as follows:

1. Potential locations based on capabilities of the proposed potable water transmission line.
2. Minimum size of a tract of land for a Micro-Hydro Generating Project.
3. Timeframe for completion of a Micro-Hydro Generating Project.
4. Hazards or complications that could arise with the City's potable water supply, especially the public's perception of using treated water.
5. Regulatory Issues.
6. Technical and economic feasibility of the proposed project.

Summary of Findings

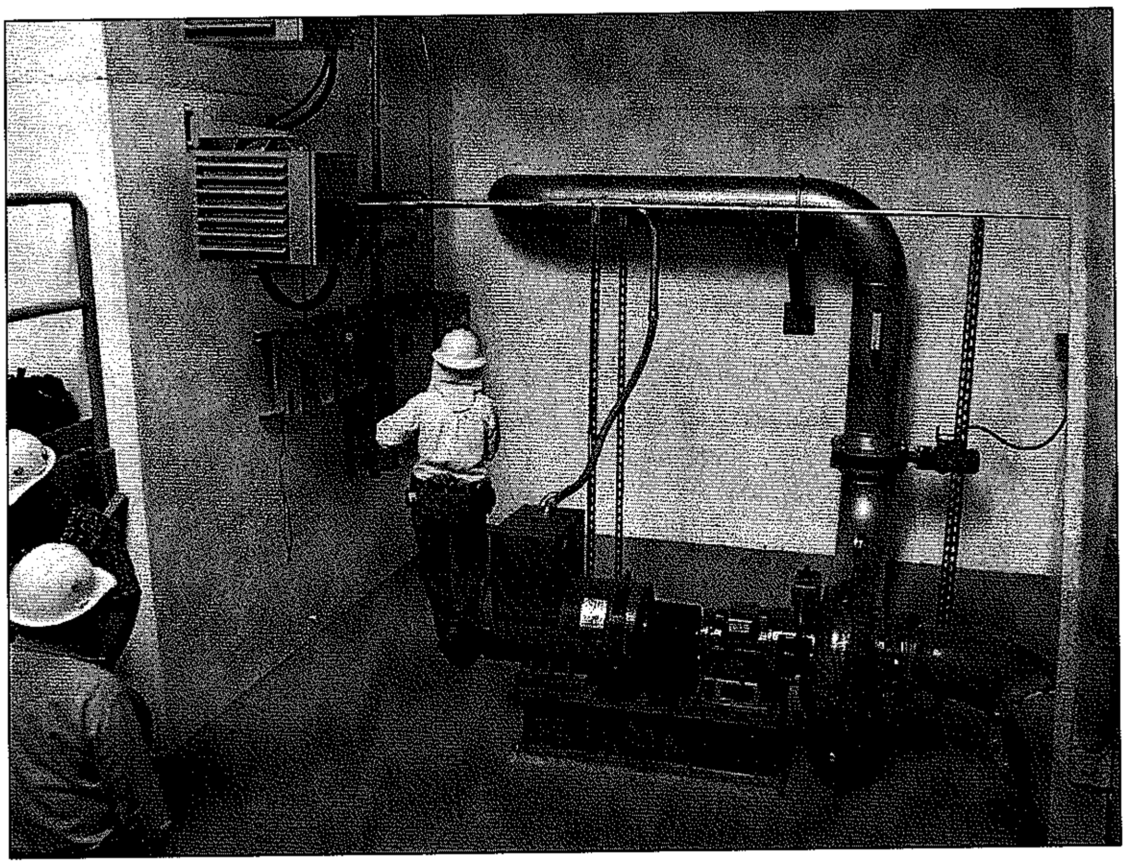
Based on results from these efforts, the GDS Team has concluded that it is feasible to develop a micro-hydro generation facility adjacent to the storage tank on the Garrison Street Reservoir site. An installed capacity of approximately 250 kW (from two 125 kW micro-hydro turbines) could be supported through this new small hydroelectric generation facility based on current daily, monthly, seasonal and annual flow rates, with room for a third micro-hydro turbine within the proposed powerhouse to handle future increased flow/city water demand.

More information and key findings associated with each of these topics is presented in the sections below.

1.0 Potential Powerhouse Locations Based on Capabilities of the Potable Water Transmission Line

1.1 *Micro-hydroelectric Turbine Type*

For this application the GDS Team recommends a "pump as turbine" technology. The primary advantage of a pump operated in reverse flow, as a turbine, is that it can be used much like pressure reducing valves yielding a reduced pressure discharge into a downstream pipe at a pressure still adequate to meet downstream system needs. Other types of turbines discharge freely to the atmosphere through nozzles and would require that the powerhouse be constructed at a location higher than the maximum water surface elevation of the reservoir. An additional advantage of the "pump as turbine" technology is that the potable water remains contained in the pipeline and is protected from possible contamination or loss of residual chlorine. The following photograph shows a typical "pump as turbine" installation.



Example Pump as Turbine Installation

Locating the powerhouse at the Garrison Street Reservoir site is fully compatible with using "pump as turbine" technology. Alternatively, the powerhouse could be located up to 2 ¾ miles upstream (toward the water treatment plant.) Any location between there and the Garrison Street site could be used. The governing requirement is that the elevation at the powerhouse must be low enough to allow full utilization of the excess head while still maintaining a positive pressure in the downstream pipeline. The only advantage of such an upstream location would be a moderate reduction in the maximum static pressure in the pipeline from about 270 pounds per square inch (psi) at the lowest point in the pipeline to about 200 psi upstream of the turbine if the turbine is located upstream of Sag 3. Note that ductile iron pipe suitable for rated working pressures of up to 350 psi, plus a 100 psi surge allowance is readily available. Surge control features will need to be incorporated into the final facility design to prevent excessive surges in case of a load shedding event (a temporary outage during which the turbines are flowing but no load is imposed upon them from the grid).

The disadvantages of an upstream location include additional property acquisition costs and possibly higher costs to connect to the electric grid if the selected site does not have nearby electric lines suitable for connection. Since the Garrison Street site is already owned by the City and has suitable electric service on site, this feasibility study is based on using the Garrison Street site for the proposed turbine installation.

1.2 Flow Considerations and Pipeline Characteristics

Water production records for the City of the Dalles, Oregon for the year 2008 were examined. Minimum, maximum, and average daily water production for each month are shown on Figure 1. Water production varies widely in response to varying water demand through the year as illustrated by the following summary:

- The average daily water production varied from 1.76 million gallons per day (MGD; 2.73 cfs) in December, to 5.58 MGD (8.64 cfs) in July.
- The minimum recorded water production for a single day was 0.91 MGD (1.41 cfs).
- The maximum water production for a single day from the Wicks Water Treatment Plant was 5.4 MGD[1] (8.36 cfs).
- The annual average water production is about 3.1 MGD (4.8 cfs).

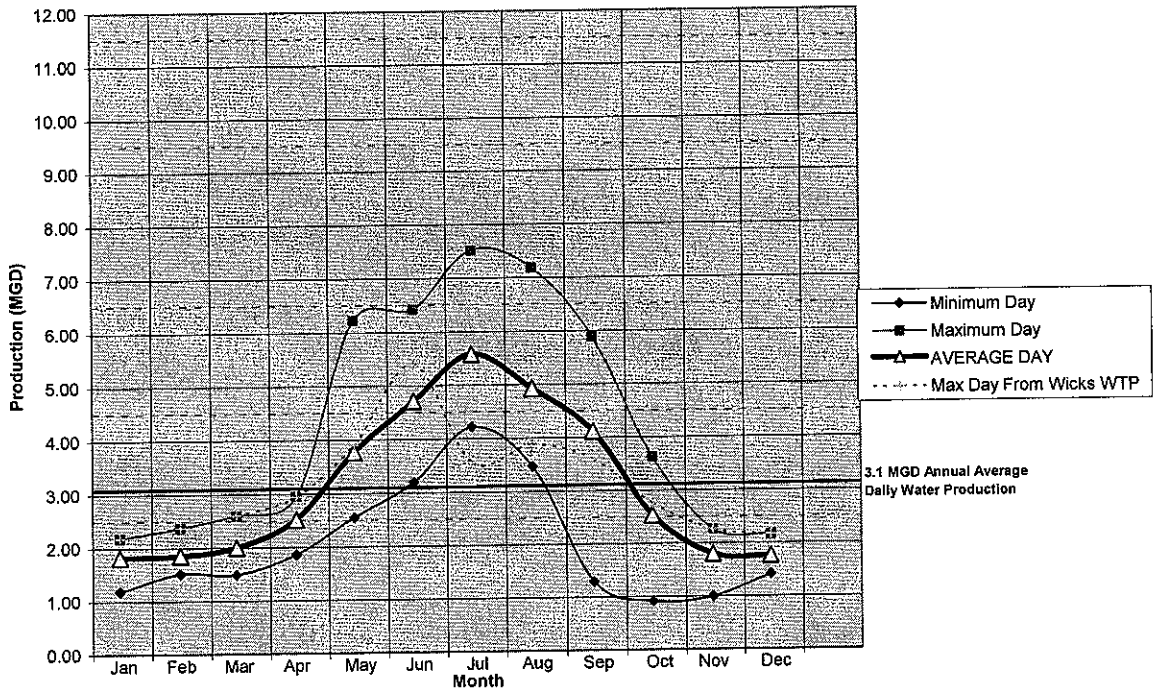
Based on a 1% annual rate of growth of water demand, the maximum daily flow obtained from the Wicks plant could reach 6.6 MGD (10.2 cfs) in 20 years.

The City's 2005 Water Master Plan indicates that ultimately the City of the Dalles could obtain up to 12 MGD (18.6 cfs) from the Wicks Plant. At production rates on the order of 12 MGD, there would be corresponding large pipeline head losses and the turbines may need to be bypassed during times of maximum production.

For this study, turbines were chosen to reflect efficient operation for a range of average daily flows between 3.1 and 3.8 MGD (4.8 and 5.9 cfs) (one turbine operating) and maximum daily flows between 5.4 and 6.6 MGD (8.4 and 10.2 cfs) (two turbines operating). Predicted operating points are presented in Section 6.

[1] Maximum production at the Wicks Water Treatment Plant is less than the maximum average July production.

FIGURE 1 - Water Produced Each Month for the Year 2008



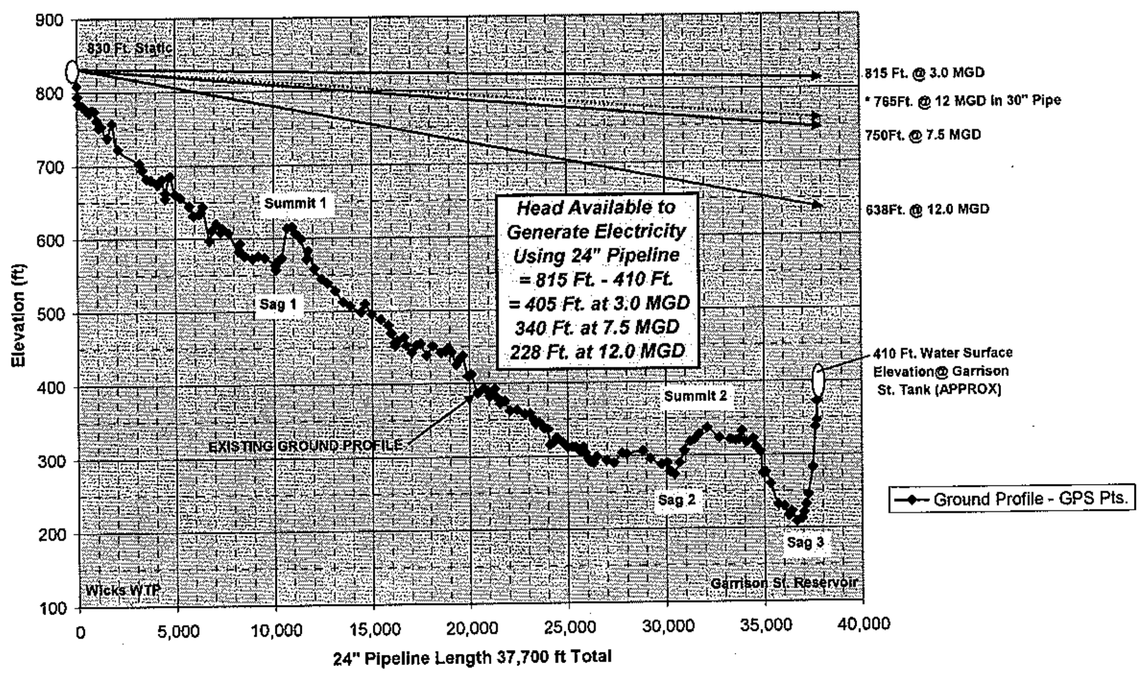
1.3 *Head Loss Considerations*

The proposed Mill Creek pipeline will be about 38,000 feet long from the Wicks Water Treatment Plant to the Garrison Street Tank site. The pipeline will be located almost entirely within public road right-of-way. To develop a ground elevation profile along this pipeline, GIS data were used. Head losses due to pipeline friction were calculated for various flow rates and plotted as hydraulic grade lines above the pipeline profile. This information is all shown on Figure 2. Key information illustrated by Figure 2 includes the following:

- At a potential long-term maximum flow of 12 MGD (18.6 cfs) the total head loss in a 24 inch pipe would be 192 feet (elevation 830 ft. – 638 ft.)
- At flows of 7.5 MGD (11.6 cfs), the head loss would be 80 feet.

If future flows in the Mill Creek Pipeline are not expected to greatly exceed 8 MGD (12.4 cfs), the turbine units would remain operational, but with reduced head and output due to the pipeline head loss (see Section 6).

FIGURE 2 - Hydraulic Grade Line at Various Flow Rates Using 24" Pipe

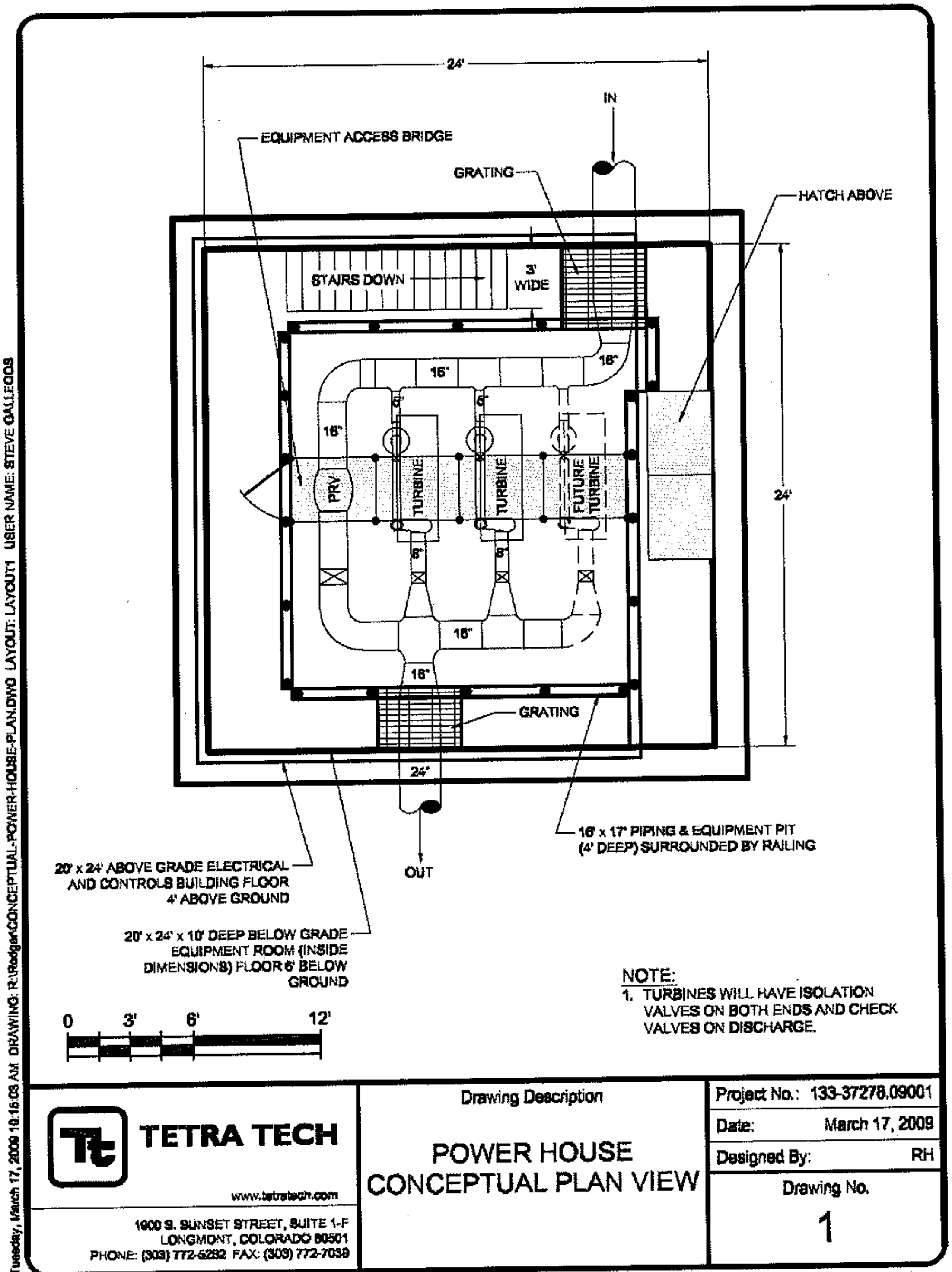


2.0 Minimum Size of a Tract of Land for the Project

Based on the physical size of turbine equipment tentatively selected, a conceptual powerhouse plan view has been developed (Drawing 1).

The conceptual drawing indicates that a 24-foot by 24-foot building could conveniently house two turbines, inlet and outlet piping and appurtenances, a bypass line with a PRV, and space for a future third turbine. The conceptual layout envisions that the equipment would be housed in a below grade basement. An above ground room, above the equipment room, would be provided for electrical equipment, controls, and heating/ventilation equipment. The entire powerhouse would be designed for convenient access. The area occupied by the powerhouse would be only about 600 square feet and could be easily incorporated into the existing Garrison Street Reservoir site.

If a different location is selected, a total site size of about ¼ acre should suffice depending on setback requirements and parking requirements.


24'
IN
EQUIPMENT ACCESS BRIDGE
GRATING
HATCH ABOVE
STAIRS DOWN
3' WIDE
16"
6"
PRV
TURBINE
TURBINE
FUTURE TURBINE
24'
8"
16"
GRATING
24"
OUT
16' x 17' PIPING & EQUIPMENT PIT (4' DEEP) SURROUNDED BY RAILING
20' x 24' ABOVE GRADE ELECTRICAL AND CONTROLS BUILDING FLOOR 4' ABOVE GROUND
20' x 24' x 10' DEEP BELOW GRADE EQUIPMENT ROOM (INSIDE DIMENSIONS) FLOOR 6' BELOW GROUND
NOTE:
1. TURBINES WILL HAVE ISOLATION VALVES ON BOTH ENDS AND CHECK VALVES ON DISCHARGE.
0 3' 6' 12'
TETRA TECH
www.tetratech.com
1900 S. SUNSET STREET, SUITE 1-F
LONGMONT, COLORADO 80501
PHONE: (303) 772-5282 FAX: (303) 772-7039
Drawing Description
POWER HOUSE CONCEPTUAL PLAN VIEW
Project No.: 133-37278.09001
Date: March 17, 2009
Designed By: RH
Drawing No.
1
Tuesday, March 17, 2009 10:15:03 AM DRAWING: R:\Rodger\CONCEPTUAL-POWER-HOUSE-PLAN.DWG LAYOUT: LAYOUT1 USER NAME: STEVE GALLEGOS

3.0 Timeframe for Completion of the Project

Permitting, design and construction of the hydroelectric facilities would require approximately 24 months to complete. Construction is not feasible until the seven-mile long Mill Creek pipeline is constructed. Although the GDS Team understands that a firm timeline for that project is yet to be determined, we are confident that permitting, design and construction of the micro-hydro generation project could all be completed within the timeframe required for similar activities associated with the larger new pipeline development project.

4.0 Potential Hazards or Complications Associated with Pipeline and Water Quality

The proposed micro-hydro installation should not adversely affect pipeline integrity as long as hydraulic surge control measures are properly designed. The control of pressure surges needs to be addressed in design of the pipeline even if micro-hydro facilities are not included. Otherwise, the facility will have no more impact on drinking water quality than would a pumping facility or a pressure relief valve (PRV) installation. The only effect of the proposed hydroelectric facilities on customers would be that customers upstream of the facilities would need to have individual PRVs on their service lines so that the maximum head available for power generation is maintained. The turbine will not affect water quality, since there is no internal lubrication to the blades and the water will not be exposed to air.

5.0 Regulatory Issues

5.1 FERC Permitting

The Federal Energy Regulatory Commission has jurisdiction over non-Federal dams and hydroelectric energy production in the United States. Under Section 18 of the Code of Federal Regulation, Subpart J, the project would qualify for a small conduit exemption. FERC defines a small conduit hydroelectric facility as "an existing or proposed hydroelectric facility that is constructed, operated, or maintained for the generation of electric power, and includes all structures, fixtures, equipment, and lands used and useful in the operation or maintenance of the hydroelectric facility, but excludes the conduit on which the hydroelectric facility is located or the transmission lines associated with the hydroelectric facility." The small conduit hydroelectric facility must utilize for electric power generation the hydroelectric potential of the conduit, must be located entirely on non-Federal lands, have an installed capacity of 15 MW or less (40 MW for a municipal facility), cannot be an integral part of a dam and discharge the water that it uses into a conduit, directly to a point of agricultural, municipal, or industrial consumption, or into a natural water body if a quantity of water equal to or greater than the quantity discharged from the hydroelectric facility is withdrawn from that water body downstream into a conduit that is part of the same water supply system as the conduit on which the hydroelectric facility is located. Further the hydroelectric facility cannot rely upon the construction of a dam, which construction will create any portion of the hydrostatic head that the facility uses for power generation unless that construction would occur for agricultural, municipal, or industrial consumptive purposes even if hydroelectric facilities were not installed. Based on this definition the project would qualify for a small conduit exemption.

Permitting requirements for a small conduit exemption are less burdensome than for either minor or major waterpower projects. Because of the capacity of the project, it would also qualify for a small hydropower project exemption. A small conduit exemption application is required to contain an introductory statement, Exhibits A, E, F and G, an appendix containing documentary evidence that the applicant has the real property interests to develop and operate the project, and identification of all Indian tribes that may be affected by the project.

The required Exhibit A is a description of the facility and proposed mode of operation. The information can be submitted in tabular form. It must include a description of the conduit, intake facility, powerhouse, and any other structure associated with the facility; the proximate natural sources of water that supply the conduit, the purpose of the conduit, the number of generating units and capacity, and provision for future units; type of hydraulic turbine; a description of plan operation; estimates of annual generation, average head, hydraulic capacity, average flow of the conduit, average amount of flow available for generation; planned date for beginning construction; description of the nature and location of the point of consumption; and a description of the nature and extent of any construction of a dam that would occur in association with the construction of the facility.

The required Exhibit E is an Environmental Report and must be prepared pursuant to FERC's consultation regulations (i.e., Section 4.38). The Environmental Report must be prepared commensurate with the scope and environmental impact of the facility's construction and operation. Because the unit would be constructed within the conduit, the Environmental Report should not be onerous. However, the Report must include a description of the environmental setting, including vegetative cover, fish and wildlife resources, water quality and quantity, land and water uses, recreational use, socio-economic conditions, historical and archeological resources and visual resources. It is anticipated that this information would be available for the permitting of the conduit itself. The Environmental Report must also describe the expected environmental impacts from construction and operation, including any protection and enhancement measures. Based on the small size of the facility, these impacts should be relatively simple to describe. Lastly the Environmental Report must describe the alternative means of obtaining an equivalent amount of power to be provided by the facility.

The required Exhibit G is a map of the project and boundary, and Exhibit F is a set of drawings showing the structures and equipment.

5.2 State Regulation

The Water Resources Department regulates water rights in Oregon. A separate water right may be required to produce power even if there is an existing water right for other uses.

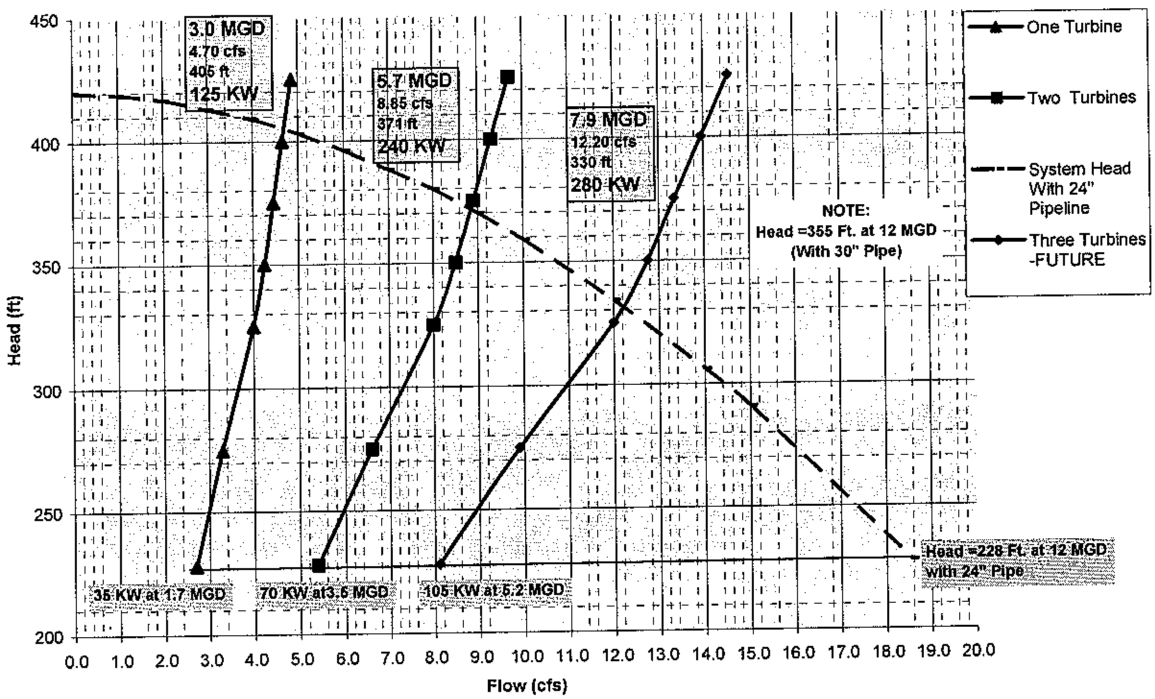
6.0 Technical and Economic Feasibility

6.1 Flow Considerations – Turbine Selection

The static (zero flow) point on the system head curve is about 420 feet at the Garrison Street Tank site which equates to the water surface elevation difference from the tank at the water treatment plant to the tank at the Garrison Street site. The available head for generation of electricity will be less than the static head by an amount equal to the head losses due to friction in the pipeline. Head losses will vary with flow rate in direct proportion to the square of the flow velocity. The available head decreases as flow increases and would drop to about 371 feet at a flow of 5.7 MGD (8.8 cfs) as shown on Figure 3 - Representative Turbine Outputs.

Pumps operating as turbines have an individual head vs. discharge curve. The curves for one, two, and three turbines based on the manufacturer's published curve for Cornell Turbine Model 5 TR3 have been plotted on Figure 3 along with the system head curve that shows the head available at the Garrison Street site for flows of up to 12 MGD (18.6 cfs) in a 24 inch pipe. Points of intersection between the two types of curves (turbine curves vs. system head curve) represent an operating point.

FIGURE 3 - Representative Turbine Outputs
Using Cornell Pump Co. Turbine Performance Curve Model 5 TR3



For example, if no bypassing of flows was possible and a single turbine was running it would pass a flow of 4.70 cfs (3 MGD) at a head of 405 feet. Under this condition the turbine would generate about 125 KW as determined by a curve for Turbine Output KW shown on the same manufacturer's sheet as the head vs. flow plot. The manufacturer's sheet for Cornell Turbine Model 5 TR 3 is attached at the end of this report. Annotations along the bottom of Figure 3 also show that if the total flow through the pipeline reached 12 MGD (18.6 cfs), the available system head would drop to 228 feet and each turbine would pass only 1.7 MGD (2.6 cfs). With three turbines in use, the total flow through the turbines would be three times as much (5.2 MGD; 7.9 cfs). The remaining 6.6 MGD of flow (12.0 MGD – 5.2 MGD) that could not be passed by the turbines would go through the PRV bypass line. Turbine output would be only 35 KW per turbine. For comparison, at 5.7 MGD (8.8 cfs) total flow a head of 371 feet would be available and each turbine would have an output of 120 KW (240 KW with both turbines in use.)

A bypass around the turbines is necessary to handle required flows in excess of the flows that can be passed by the turbines and to permit operation when the turbines are offline. The bypass line would contain a pressure reducing valve set to open only when downstream pressure dropped below the residual pressure needed to fill the reservoir. This would allow the turbines to pass their maximum possible flow before bypassing through the PRV would begin.

6.2 *Operational Considerations*

As described in preceding sections, a turbine without bypass flows will operate at a fixed point where the turbine curve intersects the system head curve. For the tentative turbine selection and a 24-inch pipeline size this point is 3.0 MGD (4.7 cfs) for one turbine. When the daily total flow needed is less than the predicted operating point, the turbine can be operated for only a portion of the day. This could be achieved by storing water at the treatment plant for the remainder of the day and releasing it in "batches" each day as needed. Turbine output predictions in the following section are based on recorded daily flows for 2008 and the above described operating regime.

6.3 *Predicted Turbine Output*

Basis: 125 KW with one turbine operating passing flow at a rate of 3.0 MGD (4.7 cfs) and 240 KW combined with two turbines operating passing a combined flow of 5.7 MGD (8.8 cfs). Space in the proposed powerhouse layout has been provided for a future third turbine. This could accommodate flows through the turbines at 7.9 MGD (12.2 cfs) generating a combined 280 KW. Excess flows beyond this capacity would flow through a PRV but would reduce the available head and generating potential substantially as previously described.

The following table shows the fractional number of days of each month of 2008 that either a single turbine could have been operated (daily demand less than 3 MGD) or two turbines could have been operated (daily demand over 3 MGD.) The table also shows the total KW-Hrs. that might have been generated for the year and assigns a value of $30,712 for the electricity produced assuming that its value is 2.733 cents per kilowatt hour the rate that the local power utility pays for electricity purchased from the Bonneville Power Authority. This amount has been used in cost considerations shown in the next section.

Current Potential Power Generation - Garrison Street Tank Site
Based on Daily Water Production Records for 2008

	GENERATING CAPACITY (KW)		
Month	**125**	**240**	**Total Days**
Jan	17.91		17.91
Feb	17.89		17.89
Mar	20.67		20.67
Apr	25.17		25.17
May	2.8	19.04	21.84
Jun		24.09	24.09
Jul		28.08	28.08
Aug		25.79	25.79
Sep	0.43	21.42	21.85
Oct	18.47	4.01	22.48
Nov	18.05		18.05
Dec	18.13		18.13
Days at Each KW Capacity	139.52	122.43	261.95
Total KW-Hrs Generated	418,560	705,197	1,123,757
		Annual Value at $.02733 per KW Hr	**$30,712**

TURBINE CAPACITIES BASED ON THE FOLLOWING:

125 KW = One Turbine in use When Flow is 0 to 3.0 MGD
240 KW = Two Turbines in use When Flow is More Than3.0 MGD

When flow is less than 3 MGD the single turbine generating 125 KW will run for a fraction of each day

When flow is between 3.0 and 5.7 MGD two turbines generating a combined 240 KW will run for a fraction of each day

When flow is more than 5.7 MGD two turbines generating a combined 240 KW will run for the full day (currently about 28 days per year)

Under the third scenario flow in excess of 5.7 MGD will flow through a bypass pressure reducing valve (PRV)

6.4 Cost Considerations

Based on 2008 flow data had the turbines been in place they could have produced 1,124,000 KW-Hrs. of electricity for the year. At a wholesale rate of $0.02733 per KW-Hr. this represents about $30,700 per year of income to the City.

Construction cost of the facilities is estimated to be about $400,000 and includes the following opinions of probable construction cost.

- Two Cornell 5TR 3 equipment packages at $101,000 each = $202,000. Estimated prices provided by Canyon Hydro. Each turbine equipment package will consist of the following components:
  - One Cornell turbine, in horizontal direct drive configuration
  - One US Motors, 480 VAC, 60 Hz, 3 ph, 1800 rpm, induction generator
  - One Bray turbine inlet valve, hydraulic actuator open, spring closure
  - One Lot flanged inlet and outlet transition piping
  - One Hydraulic power unit for inlet valve opening, 120 VAC
  - One Custom structural steel turbine/drive/generator mounting frame
  - One Rex Omega direct drive couplings with custom drive guard
  - One Switchgear/controls package to parallel the generator with the utility grid and provide protective relays per North American utility grid standards. Control package to run and shut down turbine based on signal from existing station logic.

- Installation of equipment packages - $40,000
- 600 square foot pre-engineered building - $15,000
- Below grade concrete equipment room - $20,000
- Heating ventilation system and lighting - $20,000
- Stairs, Windows, Doors, and other building appurtenances - $10,000

SUBTOTAL: $307,000

Engineering and Contingencies (about 30%) - $93,000

TOTAL: $400,000

6.5 Financial Analysis

Using the cost estimate in section 6.4, two discounted cash flow (DCF) analyses were performed. In both analyses, a total construction cost of $400,000 and an annual operation expense of $3000 were used. All revenue and expense parameters were assumed to increase at 2.5% per annum.

The first analysis was performed to select the energy revenue needed, starting in 2009, that resulted in the project returning a 10% internal rate of return (IRR) over 20 years assuming that the entire project cost of $400,000 was entirely financed upfront by the City. This unlevered assumption results in an energy revenue of $40.50/MWh for 2009. Based on current Power Purchase Agreements (PPA) being negotiated today, energy revenue in excess of $40/MWh is easily viable.

The breakdown of key financial metrics is shown below. All items are expressed in 2009 dollars. The Net Present Value (NPV) is based on a 20-Year period from 2009 through 2028, assuming a discount rate of 10%. Negative values are shown in parentheses.

Results of First Financial Analysis	
Item	NPV (2009$)
Capital Down	(400,000)
Gross Revenue	442,000
Operating & Maintenance	42,000
Earning Before Income Tax & Depreciation & Amortization	400,000
Amortization	0
Depreciation	0
Earning Before Income Tax	400,000
Income Taxes (Federal & State)	0
Interest Payments	0
Free Cash Flow (Amount the City recoups from the project. This amount is based on the assumed 10% cost of capital.)	400,000
Net Gains (Free Cash Flow – Capital Down)	0

By definition, a net gain of zero in the table above results in an IRR equal to the assumed discount rate of 10%. As shown, an energy revenue price of $40.50/MWh results in an IRR of 10%.

The second analysis was performed using the energy revenue resulting from the first analysis but assuming that the entire project cost of $400,000 would be totally financed by the City. This 100% levered analysis assumes financing at an annual 6% loan rate and a 20 year loan term.

The breakdown of key financial metrics is shown below. Again, all items are expressed in 2009 dollars and the NPV is based on a 20-Year period from 2009 through 2028, assuming a discount rate of 10%.

Results of Second Financial Analysis	
Item	NPV (2009$)
Capital Down	0
Gross Revenue	442,000
Operating & Maintenance	42,000
Earning Before Income Tax & Depreciation & Amortization	400,000
Amortization	145,000
Depreciation	0
Earning Before Income Tax	255,000
Income Taxes (Federal & State)	0
Interest Payments	158,000
Free Cash Flow (Amount the City's recoups from the project. This amount is based on the assumed 10% cost of capital.)	97,000
Net Gains (Free Cash Flow – Capital Down)	97,000

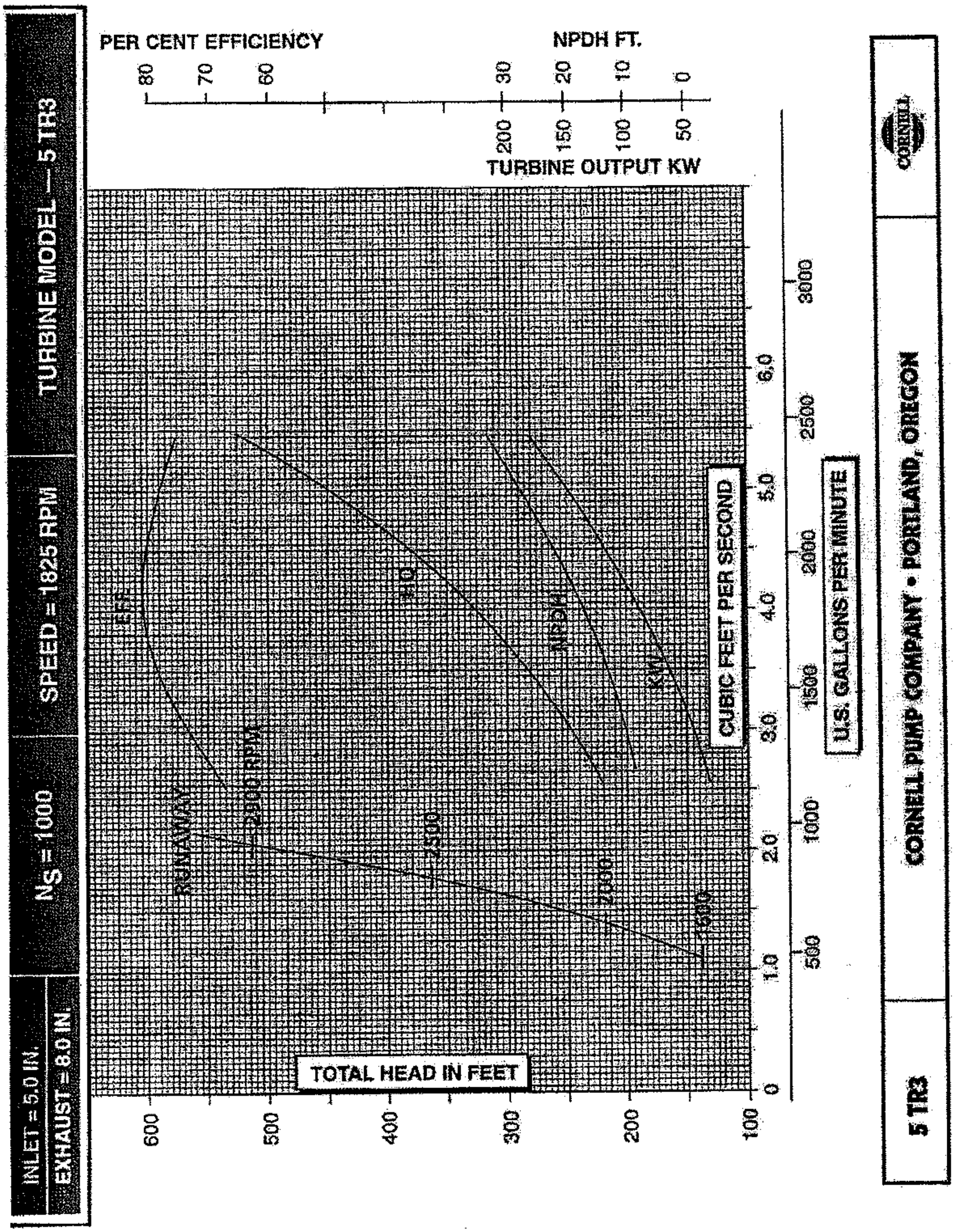
This table shows that after 20 years the net free cash flow is $97,000 NPV. This increase in free cash flow ($97,000 NPV) is due to financing the project. Financing reduces the EBIT from 400,000 NPV to 255,000 NPV. Also, since the discount rate of 10% exceeds the loan rate of 6% the sum of amortization ($145,000 NPV) plus loan interest ($158,000 NPV) is less than paying the entire project upfront ($400,000 NPV) by $97,000 NPV. This increase in free cash flow is premised on the ability of the City acquiring a 20 year loan for $400,000 at an annual interest rate of 6% and making annual payment of $35,000 (total payment over 20 years of $700,000). Although not shown, even in the first year the City will post a free cash flow of $15,000 after expenses and financing assuming that the projects produces projected energy.

At the City's discretion, any other combination of capital down and balance financing can be analyzed. Additionally, any available federal and state incentives will only improve the financial metrics. In conclusion, this investigation suggests that this project is beneficial overall to the City and should be studied in more detail.

6.6 Other Considerations

Oregon has passed a renewable portfolio standard (RPS) that will require the largest utilities in Oregon to provide 25 percent of their retail sales of electricity from newer, clean, renewable sources of energy in 2025. Smaller utilities will have similar, but lesser, obligations. Targets increase from 5 percent in 2011 to 15 percent in 2015, 20 percent in 2020 and 25 percent in 2025. Renewable energy certificates (RECs) will be issued for qualifying electricity with one REC equal to each one megawatt hour. The RECs may be traded, sold or otherwise transferred.

At the federal level, congress is currently considering a federal RPS. Draft legislation being proposed by Senator Bingaman would permit a utility to make alternative compliance payments of $30 per MWh (adjusted for inflation). This would add considerable value to each MWh generated. The recently enacted American Recovery and Reinvestment Act provides an additional $1.6 billion for Clean Renewable Energy Bonds (CREBs). Essentially these are zero interest bonds that are paid back over a 15 year period. Northern Wasco County PUD and the City of the Dalles would qualify for the CREBs.


TURBINE MODEL — 5 TR3
SPEED = 1825 RPM
NS = 1000
INLET = 5.0 IN.
EXHAUST = 8.0 IN.
PER CENT EFFICIENCY
NPDH FT.
TURBINE OUTPUT KW
TOTAL HEAD IN FEET
CUBIC FEET PER SECOND
U.S. GALLONS PER MINUTE
RUNAWAY
2900 RPM
2500
2000
1500
EFF.
KW
NPDH
CORNELL PUMP COMPANY • PORTLAND, OREGON
5 TR3