A09002

City of Corvallis Rock Creek Water Treatment System Hydroelectric Feasibility Evaluation

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Executive Summary

This project evaluated the opportunity for generating electricity using a small-scale hydropower facility installed at the city's Rock Creek Water Treatment Plant (WTP). The proposed installation, if implemented, will make use of existing raw water pipelines that convey water to the plant. The pipelines deliver water to the plant with more pressure than necessary and this excess pressure can be used to generate electricity.

The city first investigated the possibility of generating electricity from the Rock Creek WTP raw water flow in the 1970s. A second evaluation was performed in 1980. The March 1980 report found that the present worth value of the installation compared to the revenue from generated electricity resulted in a negative return on investment. The city decided to forgo the installation based on this economic analysis.

Triple Bottom Line Analysis

The City of Corvallis Council Policy Manual CP 04-1.08 addresses organization sustainability. The policy states that, to the extent possible, the sustainable initiatives of the city will meet more than one of the triple bottom line (TBL) components. These three components are environmental sustainability, economic sustainability, and social sustainability. Therefore, in keeping with city policy, this feasibility evaluation of a Rock Creek WTP hydropower generation system included a TBL analysis. The decision regarding the hydropower system is not a choice among several implementation options but is rather a decision to implement the project or not to implement the project. For assessment of a single option, a business case evaluation based upon the three elements of the TBL is most appropriate. A business case evaluation compares benefits to costs, with benefits in this case including environmental and social as well as economic benefits.

Water Rights

Water in Oregon is publically owned and the state requires a water right for its use, whether the use is consumptive (for drinking water) or non-consumptive (for hydropower). The city could follow either an expedited or standard water rights process to obtain permission for hydropower generation. The expedited process limits the water used for hydropower generation to the withdrawals that would otherwise be made for producing drinking water. The standard process would allow the city to withdraw water to the full extent of its water rights, even if the withdrawn amount exceeded water used beneficially for drinking water production. This memo focuses on the expedited process because it provides a more certain outcome and avoids withdrawal of additional water from two miles of Rock Creek.

Net-Metering Opportunity

Net-metering is the terminology applied to energy generation facilities that are connected to the existing electrical grid and which allow the movement of electricity from the electrical utility's grid to the facility or from the facility to the electrical grid. Contact was made with the electrical utility that services the Rock Creek WTP, Consumers Power Inc. (CPI), to discuss the potential of hydropower generation at the Rock Creek WTP. CPI is supportive of renewable energy projects within its grid and indicated that the least complicated approach for using on-site hydropower generation is to take advantage of a net-metering program. The net-metering program is intended for a project where the energy generation is less than or only slightly exceeds, on an annual basis, the energy demand of a particular facility.

Hydropower Potential

The generation of electricity from hydropower is directly proportional to the flow rate and the pressure head. Many hydropower turbine-generators are most efficient over a relatively narrow range of flows at a given head. The WTP's records were used to estimate typical flow and head values by month to assess seasonal variability.

Since available flow was found to vary significantly between summer and winter values, an impulse turbine is recommended. This type of turbine can maintain its efficiency over a wider range of flows than other types of turbines. In addition, its behavior during sudden shutdowns minimizes the flow and pressure transients imposed on the upstream pipeline. Such pressure surges are a concern because they could damage some sections of the existing raw water pipelines. The disadvantage of an impulse turbine is that it requires a specific physical arrangement for its installation, although a retrofit into the Rock Creek WTP appears feasible.

The estimated annual energy production is 177,000 kilowatt hours (kWh), which is about 80 percent of the plant energy use for fiscal year 2007-2008. Since the energy production is less than the annual use, the installation will qualify for a net-metering program. The city will realize an annual benefit of approximately $10,500 for the reduction in electricity purchase that it would allow.

Incentive Programs

This project may qualify for a renewable energy incentive from CPI. CPI's incentive program varies from year to year, but current information provided by CPI suggests that the project would qualify for a $14,000 incentive award.

There do not appear to be other incentive programs, either through the state or Bonneville Power Administration (BPA), which would apply to this proposed project. The Energy Trust of Oregon provides renewable energy incentives for similar projects but only those served by Pacific Power or Portland General Electric. BPA channels its renewable energy incentives through local utilities such as CPI.

The city may have an opportunity to obtain additional benefits from the project through the sale of renewable energy credits (RECs), which are also called Green Tags. The Northwest market for hydropower Green Tags is uncertain and so no cost benefit was assigned to the project for the sale of Green Tags.

Economic Sustainability

Economic sustainability is represented by the calculation of capital costs, lifecycle costs, revenue generation, and electricity cost offsets. The present worth for the capital and operating costs for the proposed project was estimated at $400,000. This exceeds the present worth of the projected revenue stream, which is $180,000. Therefore, the project has a negative return on investment – the project costs more than the revenue it will produce and is not economically sustainable. Since the project has a negative return on investment, the question is whether or not the environmental and social sustainability benefits are enough to offset the negative economic return.

Environmental Sustainability

The following environmental items from the city's sustainability policy, both benefits and consequences, are applicable to this hydropower decision:

- The implementation of the proposed hydropower project contributes to a long-term reduction in greenhouse gases.
- The project will allow the city to provide approximately 80 percent of the Rock Creek WTP electricity from a renewable source.
- It will involve some transaction costs for permitting.
- There will be short-term environmental impacts during construction.

Social Sustainability

Review of the city's sustainability policy also points to a number of social features, both benefits and consequences, which are applicable to this hydropower decision. The applicable social sustainability criteria are the following:

- The hydropower facility would provide equal benefit to the entire city.
- Although the current Public Works and Rock Creek WTP operations staff would be responsible for maintenance of the hydropower facility, little additional effort is anticipated. The positive portion of this additional work is the opportunity for the staff to learn new skills and take pride in their contribution to sustainability.
- No permanent jobs would be created as part of this investment.
- Perhaps the single most positive social benefit is the furthering of the city's sustainability image

- One operator safety concern is high levels of noise. The proposed location for the generation equipment is separated from the operator's office by a window, and the unit will have noise levels between 90 and 100 decibels. It may be necessary to provide noise attenuation as part of the equipment package.

Recommendation

CH2M HILL does not recommend immediate implementation of the proposed hydropower project at the Rock Creek WTP because the environmental and social benefits do not appear to be sufficient to offset the negative economic return on investment. However, because the values of the environmental and social benefits are subjective, the decision of whether or not to implement the hydropower project is a policy decision that should be made by the city staff and council.

If the city decides not to implement the project at this time, CH2M HILL recommends that the city track electricity rates, the value of incentive programs from CPI, the potential for energy tax credits, and the value of hydropower Green Tags. It is possible that the economic sustainability will improve in the near future as these factors change.

Background

Rising energy costs coupled with the city's strong commitment for sustainability warranted a fresh evaluation of the feasibility of generating hydropower using the raw water flow into the Rock Creek WTP.

The city's Rock Creek WTP is one of two plants that serve the city. The Rock Creek WTP is located to the west of the city on the east slope of Marys Peak. The source water for the plant is obtained from Rock Creek and Griffith Creek. There is a river intake on the South Fork of Rock Creek, a dam with an outlet structure on the North Fork of Rock Creek, and a river intake on Griffith Creek. The two Rock Creek sources feed the plant through the Rock Creek raw water pipeline. The water from Griffith Creek is fed to the plant via the Griffith Creek pipeline.

Both of the raw water supply pipelines deliver water to the plant via gravity flow, with no pumping involved. The excess pressure is reduced through control valves on each pipeline that are located just upstream of their interconnection point.

The Rock Creek WTP runs 24 hours per day for 364 days per year. It is normally shut down only one day per year for cleaning of the flocculation and sedimentation basins. At a maximum, the plant delivers approximately 3 million gallons per day (mgd) of treated drinking water to the city. The production from this plant is limited by water availability in the watershed and is not dictated by customer water demands. The city's goal is to maximize production from this plant, which means that it produces the most water in the wet months when more water is available in the watershed. The remaining city customer water demands are met by the Taylor WTP, which obtains water from the Willamette River.

The city first investigated the possibility of generating hydropower from the raw water flow to the Rock Creek WTP in the 1970s. A second evaluation was performed in 1980. The March 1980 report estimated that the value of the generated power was approximately

$4,500 per year compared to a capital cost for the installation of $225,000. Considering operation and maintenance costs, the total present value was a negative $300,000. The city decided to forgo the installation based on this economic analysis.

The 1980 analyses assumed flow and head conditions that do not reflect the proposed operating scenario described in this memo. The updated proposed operating scenario (using the expedited water rights process, as explained in a subsequent section of the memo) results in a lower flow than assumed in the 1980 study. However, the available head is higher than the value used in the 1980 study. In addition, the following changes suggest that a revised evaluation was warranted:

- The cost of energy has increased since 1980 and concern about energy shortages and high fuel costs suggests that significant increases can be expected for the foreseeable future.
- The city's previous analyses of Rock Creek WTP hydropower considered only the economics—the city's current policy manual places a high value on sustainability as evaluated through a triple bottom line analysis.
- Current financial incentives or energy credits may be available for developing renewable energy.

The overall goal for the city is to assess the feasibility of installing a hydroelectric facility, considering the economic, social, and environmental benefits and consequences. This feasibility study was conducted to provide the city with sufficient information and confidence to make a decision to proceed with implementing the project or to further delay implementation until the economic sustainability improves.

Feasibility Assessment Using Triple Bottom Line

The City of Corvallis Council Policy Manual CP 04-1.08 addresses organization sustainability. The policy states that, to the extent possible, the sustainable initiatives of the city will meet more than one of the triple bottom line (TBL) components. These three components are environmental sustainability, economic sustainability, and social sustainability. The city departments, through changes in daily and long-term operations, are to target positive impacts on the environment, the economic efficiency of the city government, and the social character of the workplace.

Therefore, in keeping with city policy, the feasibility evaluation of the Rock Creek WTP hydropower generation system was performed using a TBL analysis. The decision regarding the hydropower system is not a choice among several implementation options but is rather a decision to implement the project or not to implement the project. For assessment of a single option, a business case evaluation based upon the three elements of the TBL is most appropriate. A business case evaluation compares benefits to costs, with benefits in this case including environmental and social as well as economic benefits.

Water Rights

On behalf of the city, GSI Water Solutions, Inc., prepared a technical memorandum on the subject of water rights related to hydropower generation at the Rock Creek WTP. The final version of this memo is dated May 18, 2009, and is attached to this technical memo. The following paragraphs are excerpted from the conclusion section of this memo:

> "If the city wishes to generate hydroelectricity from the water it diverts in the Rock Creek basin, OWRD [the Oregon Water Resources Department] will require the city to obtain a hydroelectric water right for this use of water, since the production of hydroelectricity is not authorized use under a municipal water right. The city can choose between two processes to apply for a state hydroelectric water right: (1) the expedited process, or (2) the standard process. The expedited process could allow the city to obtain a hydroelectric certificate for water being used for municipal purposes under an existing water right. A hydroelectric water right certificate issued under this process would not, however, allow the city to divert additional water for power generation beyond the amount the city uses for municipal purposes under its original water right certificates."
>
> Alternatively, the city could apply for a hydroelectric water right through OWRD's standard process for a new minor public hydroelectric project. This application and review process would be significantly more complex than the expedited process. A resulting hydroelectric water right would, however, allow the city to generate hydroelectricity using up to the full rate authorized in the hydroelectric water right, without regard to the amount of water that the city puts to beneficial use under its municipal water rights. Consequently, the city could divert the full rate authorized under its hydroelectric right, generate hydroelectricity with that water, return some portion of the water to the stream, and use the remaining portion of the water for municipal purposes, as authorized by its municipal water rights."

The analysis presented in this memo focuses on the expedited water rights process. Under the expedited process, the city will be limited to generating hydropower using the flow that is being diverted for treatment through the Rock Creek WTP.

The standard water rights process would allow the city to divert flow for hydropower generation up to the maximum value of the city's water rights provided there is sufficient water from the dam and intake to supply that quantity of water. This increases the hydropower that can be generated but involves a more uncertain regulatory process and results in reducing the flow in about two miles of Rock Creek over what otherwise would occur. This does not appear to be a favorable approach for the city to pursue.

Flow and Head Scenarios

The power generation capacity is proportional to the flow and head. These two factors are discussed in the following subsections. A summary of the estimated flow and head values is provided in Exhibit 1. Values are presented for both water rights options to provide a comparison.

EXHIBIT 1
Estimated Monthly Head and Flow Values for Two Water Rights Options

Month	Expedited Water Rights Process		Standard Water Rights Process	
	Head (feet)	Flow (cfs)	Head (feet)	Flow (cfs)
Jan	92	5.1	82	8.1
Feb	93	4.9	82	8.1
Mar	92	5.1	82	8.1
Apr	92	5.1	82	8.1
May	93	4.9	88	6.2
Jun	100	2.9	100	2.9
Jul	100	2.9	100	2.9
Aug	100	2.9	100	2.9
Sep	100	2.9	92	5.0
Oct	96	4.2	82	8.1
Nov	95	4.5	82	8.1
Dec	92	5.0	82	8.1

Flow

As described in the preceding water rights section, the flow rate that can be used for hydropower generation varies depending on which water rights process is selected by the city. The estimates for the expedited water right process are based on historical records provided by the city for 1993-2002 plus direction provided by city staff regarding recent adjustments to the practices at the plant. The flow values for the standard water rights process represent the city's full water rights from the South Fork of Rock Creek and the dam on the North Fork of Rock Creek, with appropriate reductions in the summer months to account for less water availability.

Griffith Creek water is delivered to the plant via a separate transmission pipeline that connects with the Rock Creek transmission line just before the entry point to the plant. The operators generally use this source in place of the Rock Creek sources for brief periods such as winter periods when the turbidity in Griffith Creek is less than in other sources or during the summer to supplement low production from Rock Creek.

Head

The overflow elevation for the flocculation basins at the Rock Creek WTP is at elevation 531 feet (August 1981 Contract Documents, Specifications and Reduced Drawings for Rehabilitation and Modernization of Rock Creek and Taylor Water Treatment Plants). The necessary inlet head at the plant slightly exceeds 531 feet to account for losses through the meter, valves, and inlet connection.

The South Fork intake elevation is 630 feet. The normal pool elevation for the North Fork Reservoir is 658 feet and the lowest use level in the reservoir is 626 feet. The total length of the 24- and 20-inch pipeline from the South Fork intake to the Rock Creek WTP is approximately 15,000 feet. As the flow increases, the available head for generating hydropower decreases because of increasing friction losses in this delivery pipeline. The head values are based on estimations of the pipeline head losses. The Rock Creek WTP operators reported pressure readings (head values) at the plant for a flow condition to help verify assumptions used for the calculations, and the reported values were in agreement with the calculations presented in this report.

The Griffith Creek intake elevation is 620 feet, or slightly lower than the South Fork intake. Therefore, the ideal turbine selection would be one that operates at variable head, to cover the range from the full pool in the North Fork Reservoir (658 feet) down to the Griffith Creek intake (620 feet). The turbine would need to be located downstream of the interconnection of the pipelines from Rock Creek and Griffith Creek.

Preliminary Estimate of Power Generation

The potential generating capacity of a site is proportional to the flow and the head, or differential pressure, across the turbine. The power formula for a hydraulic turbine-generator is:

Power = (Q * H * e) / 11.8

Where:

- Power is in kilowatts (kW)
- Flow (Q) is in cubic feet per second
- Head (H) is in feet
- e = efficiency of power generation = approximately 65 percent for preliminary estimation purposes (accounts for turbine and generator efficiency)
- 11.8 is a conversion factor to account for the above units

The energy produced in kilowatt-hours (kWh) equals the average power multiplied by the operating time in hours. The operating time in hours accounts for routine maintenance.

When the potential power generation benefits are significant, using two or more turbine/ generator sets to take advantage of a full range of operating conditions may be worthwhile. Two or more units are not recommended for the proposed Rock Creek WTP because of space limitations at the location where the unit(s) would need to be installed and because of the higher cost. Even though a single unit will not generate power at an optimum efficiency over the range of flows, the incremental power generation benefits from multiple units is not worth the added expense.

Exhibit 2 illustrates the theoretical power production for the two water rights scenarios. These values assume a generation efficiency of approximately 65 percent. The actual production will depend on the specific match between the available head and flow and a specific turbine-generator selection. On an annual basis, the standard water rights process may increase the energy production by about 140 percent based on the flow comparison between the two water rights scenarios.

EXHIBIT 2
Theoretical Power Production

Month	Theoretical Power Generation (kW)	
	Expedited Water Rights Process	Standard Water Rights Process
Jan	26	37
Feb	25	37
Mar	26	37
Apr	26	37
May	25	30
Jun	16	16
Jul	16	16
Aug	16	16
Sep	16	25
Oct	22	37
Nov	23	37
Dec	25	37

Electrical Interconnection

The following information relating to electrical power interconnection requirements and net-metering arrangements is based on discussions between CH2M HILL and Consumers Power Inc. (CPI) regarding the potential of hydropower generation at the Rock Creek WTP. CPI is the electric utility that provides power to this plant.

Customer-generation systems that produce, on an annual basis, less energy than the facility demands can be governed by the Oregon net-metering laws. The benefit to the power generator is the savings for purchasing less electricity from the utility. CPI has informally indicated, as understood from meetings conducted during the course of this study, they would apply net-metering regulations for a Rock Creek WTP power generation facility provided that the annual energy produced was less than or only slightly exceeded the annual energy consumption by the WTP. Therefore, CPI has indicated that there is some flexibility in application of the net-metering program. Because the energy generation estimate described for this potential project is less than the annual energy use at the Rock Creek WTP, it will qualify for a net-metered arrangement. No further details are presented on a non-net-metered installation as the energy generation potential for the Rock Creek WTP does not exceed the annual energy requirements of the plant.

The city would be responsible for all costs associated with constructing, operating, and maintaining the net-metered generation system. CPI is required to install, at no charge to the city, a net-meter capable of measuring incoming and outgoing power at the plant. No other CPI system upgrades are expected, with the possible exception of a new meter base to accommodate the new net-meter. The cost for a new meter base may be passed on to the city. The rough order of magnitude estimate for a new meter base, if required, is $800 installed. The allowance for the electrical work to install the generation system includes this cost.

The city should provide a generation system that includes controls to monitor voltage and frequency, coordinate with backup generation equipment at the plant, and to automatically disconnect itself from CPI's electrical system if the CPI system goes out of service. These features are included in the cost for the proposed turbine for this application. The city must also provide a lockable disconnect switch dedicated to the generation system and accessible by CPI. The rough order of magnitude estimate for a disconnect switch is $500 installed. The allowance for the electrical work to install the generation system includes this cost.

Although the costs for the electrical installation items (new meter base and disconnect switch) are relatively low, there could be significant costs associated with conduit, wiring, and other on-site work performed by an electrician. An allowance has been included in the cost estimate for this electrical work.

Corvallis will need to request permission of CPI to install a net-metered system via a letter sent to Mr. James Ramseyer at CPI. Mr. Ramseyer is the Director of Energy Services and Key Accounts (jamesra@cpi.coop). This letter should briefly summarize the project including the proposed electrical capacity. The request will be reviewed by the CPI board for approval of the project. Mr. Ramseyer indicated that approval of the project was likely (personal communication, June 1, 2009).

The electrical service from CPI to the Rock Creek WTP falls under CPI Schedule 45, General Service-Three Phase (Small). The energy charge for this schedule is $0.05926 (5.926 cents) per kWh. As long as energy produced by the generation system is less than plant energy use, this $0.05926 per kWh number can be used as the value of the power generated by the hydropower system. (If the hydropower system was to generate energy in excess of the plant use, on an annual basis, CPI would reimburse the city at a rate of $0.032 per kWh for the surplus energy.)

In summary, the most efficient approach to making use of on-site hydropower generation is to take advantage of the net-metering program. The net-metering program is intended for an application where the annual energy generation is less than or only slightly exceeds the annual power demand, which is the case for this project. The energy is valued at $0.05926 per kWh for the reduction in purchased electricity.

Site Specific Data for Generation Equipment and Costs

Two broad categories of hydropower generation equipment exist for small scale applications like the Rock Creek WTP, one using pump derivative technology and the other using conventional hydro-turbine technology scaled for small applications.

Pump Derivative Technology

Pump-derivative technology has the advantage of being essentially off-the-shelf and therefore, relatively inexpensive. This type of technology looks very much like a conventional pump driven by an electric motor except that it runs in reverse, with water spinning the impeller and driving a generator. The disadvantage is that while a pump-derivative system can operate efficiently for a constant head-flow condition, its performance falls off rapidly for other head-flow combinations. In the Rock Creek watershed, the available flow varies seasonally by up to 50 percent, making it difficult to select a unit to match conditions. Employing multiple smaller units, each sized to take a fraction of the flow and combining in staged operation to cover the entire available flow range, could be considered but this approach adds complexity and cost to the piping and controls associated with the system. In addition, a pump- derivative system is a reaction-type turbine, whose operation requires a positive downstream pressure and whose behavior during sudden shutdowns will cause a pressure surge in the supply pipeline.

Conventional Technology

Conventional hydro-turbine technology can be generally divided into two turbine classifications, reaction and impulse. Reaction turbine runners use enclosed curved vanes, similar to pump impellers, to convert axially flowing water into mechanical energy to drive generators. They typically run submerged with some amount of downstream pressure. Impulse turbines run at atmospheric pressure, discharging into an open channel below the runner, and convert jets of water into mechanical energy. Impulse turbines have two major advantages for the proposed Corvallis project.

1. Because impulse turbines operate in a free discharge state, the rejection of the electrical load at the generator, which results in rapid turbine shut down, does not create transient pressures in the upstream piping (turbine flow is deflected by vanes rather than shut off by valves or gates). Therefore, surge mitigating measures or pipe replacement is usually not required.

2. While less efficient for a specific head and flow combination, impulse turbines have relatively flat performance curves making them more efficient over a wide range of flow conditions.

Based on the variable flow conditions at the Rock Creek WTP site, the existence of sections of old transmission pipe that may not withstand significant pressure surges, and the availability of equipment in the desired size range, this study focused on the use of an impulse turbine with matched induction generator. There are a number of suppliers of this type of equipment. For evaluation purposes, a standard design from Canyon Hydro Industries of Deming, Washington, was selected for a site-specific evaluation.

Sample Impulse Turbine Selection and Site Modification Requirements

The Canyon Hydro 1525-2 Pelton turbine was selected as a representative equipment package. This impulse turbine unit, nominally sized at 28 kW, was matched to a belt-driven induction generator with a name plate capacity of 30 kW. This sample equipment package is illustrated in Exhibit 3. It has a footprint of about 13 feet by 3.5 feet, with a height of about 6 feet. The budgetary cost of this unit, including the turbine, generator, matched switchgear, delivery, and manufacturer's services, is approximately $90,000. The cost estimate in the economic analysis provided later in this memo includes a contractor mark-up for the equipment.

The water supply connects directly to the turbine inlet using a flanged pipe connection. Upstream of the connection, a reducer section will be required to transition from the 16-inch raw water pipeline at the plant site to the 10-inch inlet pipe for this unit. For maintenance purposes, an upstream valve would be installed to isolate the turbine and divert flow through a pipe discharging to the same basin as the turbine. The equipment package includes switchgear for connection to the local grid and basic controls. The induction generator, manufactured by Marathon Electric, is a 3-phase, 480 V, 60 Hz unit matched to the turbine.

An impulse turbine requires a free water surface discharge. This is illustrated in the elevation view shown in Exhibit 3. The unit needs to be installed above the flocculation basin so that the water discharge from the turbine falls into the basin.

The existing raw water pipeline is buried up to the edge of the treatment building. The existing pipeline passes through a meter located in a vault just prior to its entry into the two-story plant building. The pipe enters the building on the lower floor, at which point the coagulant chemical is added. The pipeline connects to a vertical, concrete chamber, through which it rises to a second-floor level to a free discharge opening into the flocculation basin.

Based on a review of the design drawings for the plant and a site visit, it appears that it may be possible to mount the turbine/generator unit on a metal platform that spans the width of the flocculation basin, much as the flocculation impeller motors and gearboxes are mounted above the basin. The turbine and generator would be installed with the long direction of the equipment oriented across the basin, set in close to the building. Modifications to the existing basin will be needed to capture the discharge and route it to behind the existing wood baffle to distribute the flow evenly across the width of the basin.

The installation would involve connecting a pipe to the 16-inch raw water pipeline where it enters the vertical chamber. The first section of pipeline could be a 16-inch by 10-inch reducer. The 10-inch line would then use 90-degree elbows to run the pipe vertically and then out into the basin through the existing opening. The last section would be a vertical, 90-degree bend up to above the turbine platform with a tee to connect the turbine. The other side of the tee would include a valve to allow for bypass when the turbine is not in use. The existing opening would need to be filled in to avoid stagnant water in the vertical chamber.

Using the machine-specific characteristics and the head-flow relationships presented previously for the expedited water rights process, the potential power generation and financial benefits of this turbine installation are summarized in Exhibit 4. The analysis in this table assumes that the generator operates for 95 percent of the time for 11 months a year, and then operates 50 percent of the time during July. The reduced operation in July accounts for annual maintenance and also for the amount of time that the Griffith Creek intake, at a lower head, may be used for supplying water to the plant.

The predicted annual energy production equals 177,000 kWh, which is approximately 80 percent of the plant energy use for fiscal year 2007-2008 of 222,000 kWh. Since the production is less than the annual use, the installation will qualify for the net-metering program. The city will realize an annual benefit of $10,500 for the reduction in electricity purchase at the rate of $0.05926 per kWh.

EXHIBIT 3
Turbine-Generator Arrangement

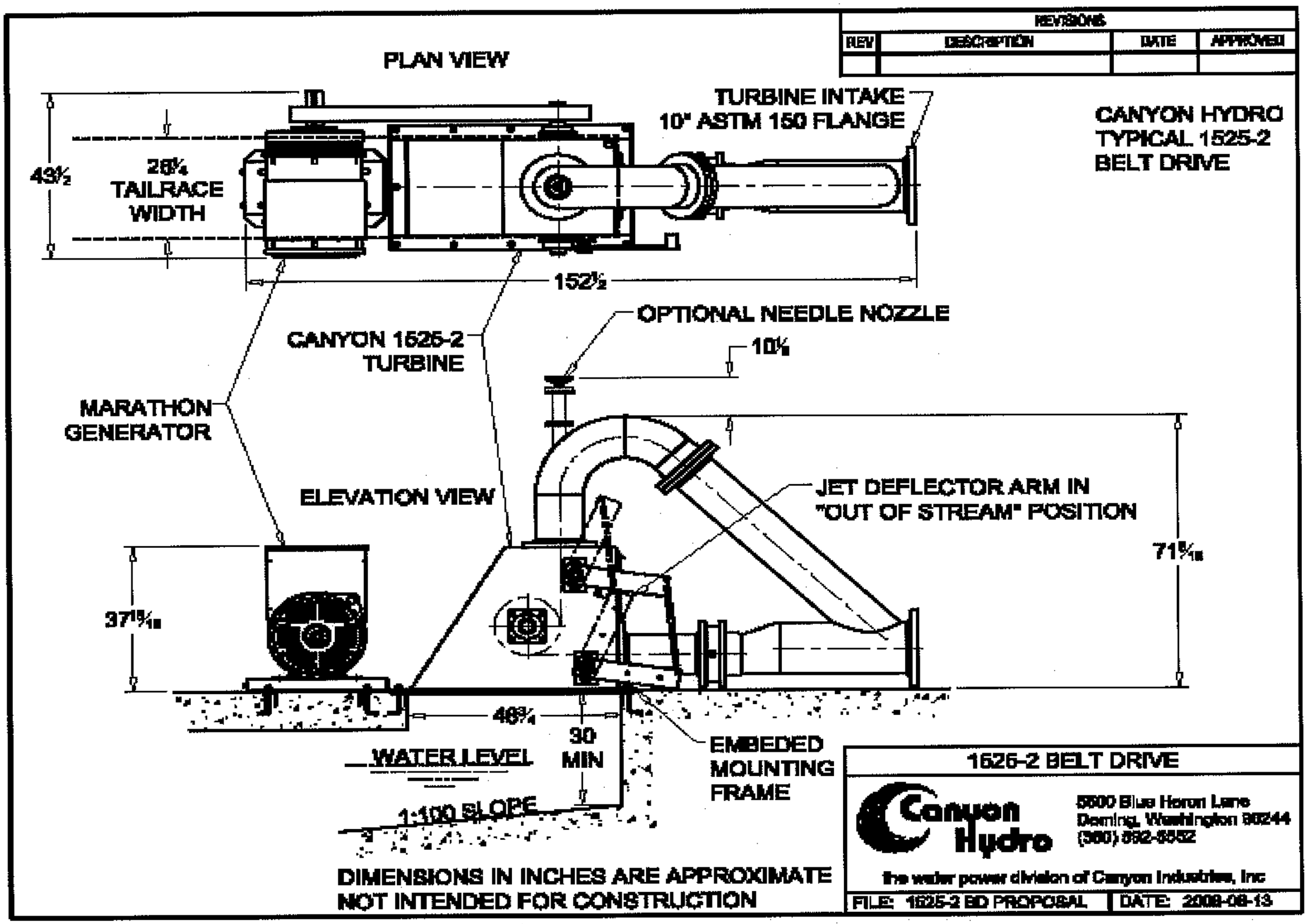

EXHIBIT 4
Power and Revenue Generation Based on Using Canyon Hydro 1525-2 Turbine

	Rock Creek WTP Electrical Demand[1]		Potential Power Generation[2,3]		
Month	**kWh**	**Cost**	**Hours**	**Power (kW)**	**kWh**
Jan	24,720	$1,805	710	26	18,300
Feb	26,520	$1,912	640	25	16,100
Mar	25,800	$1,867	710	26	18,200
Apr	20,840	$1,504	680	26	17,400
May	21,760	$1,600	710	25	17,800
Jun	18,000	$1,334	680	16	11,000
Jul	12,480	$951	370	16	6,000
Aug	13,240	$954	710	16	11,500
Sep	11,760	$853	680	16	11,000
Oct	13,320	$947	710	22	15,800
Nov	15,560	$1,120	680	23	15,900
Dec	17,680	$1,360	710	25	17,900
Sum	**222,000**	**$16,200**	**7,990**		**177,000**
Total reduction in energy use				177,000	
Reduction in energy purchase[4]				$10,500	
Total surplus energy production				0	
Compensation for surplus energy generation				$0	

Notes:

1. Based on Rock Creek WTP records for fiscal year 2007-2008
2. Generation potential based on use of Canyon Hydro 1525-2 Pelton Turbine
3. Assumes that turbine operates 95% of available hours, except for July when it operates for 50% of available hours. The reduced operating time in July accounts for maintnenance and lower head of Griffith Creek supply.
4. Financial benefits based on CPI estimates of $0.0593 per kWh for reduced energy purchase and $0.0320 for surplus generation

Incentive and Tax Credit Programs for Renewable Energy

This project may qualify for a renewable energy incentive from CPI. CPI (Mr. Ramseyer) indicated that their current calendar year budget (through December 2009) could provide a $500 per kW incentive payment (personal communication, June 2009). This project, according to the generator-specific calculations for expedited water rights scenario, would be sized at 28 kW, making it eligible for a $14,000 incentive award. CPI indicated that their incentive program changes from year to year based on their budget and competing applications for the incentive program, so the actual award may vary from this amount.

There do not appear to be other incentive programs, either through the state or Bonneville Power Administration (BPA), that would apply to this proposed project. The Energy Trust of Oregon provides renewable energy incentives for similar projects but only those served by Pacific Power or Portland General Electric. BPA channels its renewable energy incentives through local utilities such as CPI.

The Oregon Business Energy Tax Credit has the potential of providing cost savings for implementation of the project; however, it does not appear to be a feasible alternative during the economic downturn in 2009. Under this plan, business owners and others who invest in renewable energy resource generation projects in Oregon may be eligible for a state tax credit. The tax credit is 50 percent of eligible project costs. For Corvallis to qualify under this program, the city would need to partner with an Oregon business or a resident. The city has used the Business Energy Tax Credit in the past for the transit system and for pump upgrades at the Taylor WTP, so this partnership can work. However, in the current economy, it will be hard to find an Oregon business in need of tax credits.

The city may have an opportunity to obtain additional financial benefits from the project through the sale of renewable energy credits (RECs), which are also called Green Tags. Owners can typically sell Green Tags for hydropower projects if the project meets the Renewable Portfolio Standards for the State of Oregon and if the project can be Green-e certified through the Center for Resource Solutions (San Francisco, CA). The city would need to prepare and submit an application to the Center for Resource Solutions, including the payment of a fee and the provision of ongoing monitoring and verification. The potential monetary benefits to the city are uncertain because there has not been an active market in the Pacific Northwest for hydropower Green Tags. There is an organization that buys Green Tags for solar and wind energy (NW Solar Cooperative), but no similar Pacific Northwest organization for purchase of hydropower Green Tags. Therefore, Green Tags have not been assigned a dollar value in the analysis presented in this report.

Triple Bottom Line Analysis: Economic Sustainability

Economic sustainability is represented by the calculation of capital costs, lifecycle costs, revenue generation, and electricity cost offsets. Exhibit 5 summarizes the estimated costs and revenue benefits for the proposed hydropower project. The total present worth of the capital and lifecycle cost of the investment at $400,000 is more than the present worth of the projected revenue stream of $180,000. Therefore, the project has a negative return on investment – the project costs more than the revenue it will produce and is not economically sustainable. It has a benefit to cost ratio of less than 1.0. Since the project has a negative return on investment, the question remains whether or not the environmental and social sustainability benefits are enough to offset the negative economic return.

EXHIBIT 5
Cost and Revenue Summary

Item	Cost	Notes
Capital Costs		
Turbine and generator	$100,000	Canyon Hydro 1525-2 Pelton Turbine plus Marathon Generator (includes shipping, manufacturer's startup services, and 10% markup)
Install supports and grating for turbine / generator; installation, 10" piping connection, electrical connection	$90,000	Mount turbine/generator on platform over flocculation basin; replace inlet chamber with 10" hard-pipe connection, electrical connection work
Subtotal construction	**$190,000**	
Contingency	$57,000	30% of subtotal
Total construction	**$247,000**	
Engineering services	$49,000	Allowance at 20% of total construction
Administrative and legal services	$25,000	Allowance at 10% of total construction
Total capital	**$321,000**	
CPI incentives	$14,000	Based on $500 per kW for average 28 kW production rating
Total capital minus incentive	**$310,000**	Rounded up to nearest $10,000
Present Worth Analysis		
Annual O&M	$5,000	Estimated at 5% of turbine and generator cost; assumes that no additional labor is required (that WTP operators can add the O&M to their present duties)
Present worth of O&M costs	$82,000	For 20-year period; discount rate = 7%, interest rate = 5%
Present worth cost	**$400,000**	Rounded up to nearest $10,000
Benefit-Cost Analysis		
Annual revenue	$10,500	Based on revenue projection table
Present worth of revenue	**$180,000**	For 20-year period; discount rate = 7%, interest rate = 5%; rounded up to nearest $10,000
Net present worth of project	**-$220,000**	
Benefit-cost ratio	**0.45**	The benefit-cost ratio of less than 1.0 indicates that the proposed project has a negative return on investment

Triple Bottom Line Analysis: Environmental and Social Sustainability

The intent is to present the environmental and social elements and define additional 'costs' and/or 'benefits'. The decision makers may then determine if these benefits offset the negative economic sustainability. As described in the following paragraphs, it appears that the proposed hydropower facility results in insignificant impacts and benefits to environmental sustainability.

Environmental Sustainability

Review of the city's sustainability policy points to environmental features, both benefits and consequences, which are applicable to this hydropower decision.

Reduction of greenhouse gases. The project will allow the city to provide approximately 80 percent of the Rock Creek WTP electricity from a renewable source. Hydropower produces no greenhouse gases. However, the City of Corvallis currently purchases power through CPI which obtains its power from the Bonneville Power Administration (BPA). The vast majority of BPA's power is generated through renewable resources (hydropower). The City's transfer of power from purchasing through CPI to generating its own provides an extremely small reduction in greenhouse gas emission.

Another way to look at greenhouse gas is the avoidance of building a new power plant. If the northwest region has an increase in electric power demands, the most likely method to meet this need would be with the construction and operation of a fossil-fuel driven electricity generating facility. By reducing electricity demand, the demand for a new greenhouse gas producing electricity facility is avoided. Although the City of Corvallis water treatment facility is miniscule in relation to the total output of a new electric power generating facility, this use of hydropower at the water treatment plant does help avoid the need for a new power producing facility.

To value this contribution of avoidance, the value of the greenhouse gases can be calculated. The water treatment plant hydropower facility is expected to generate 177,000 kWh in a typical year. The *Updated State-level Greenhouse Gas Emission Coefficients for Electricity Generation, 1998-2000, Energy Information Administration, Office of Integrated Analysis and Forecasting, April 2002*, states that 0.28 pounds of greenhouse gases are produced per kWh of energy produced, on average, by Oregon-based electricity generating facilities. The typical kWh of electricity produced times the 0.28 pounds per kWh results in 22.47 metric tons of greenhouse gases that can be avoided per year.

Based on the current (June 24, 2009) greenhouse gas credit trading value of $0.65 per metric ton from the Chicago Climate Exchange, the dollar value of this greenhouse gas avoidance is $14.60 in a year. For the life of the facility, assuming 20 years, the total value of avoided greenhouse gas contribution is $292.06.

Transaction costs for permitting. Permitting does require some investment by the city. Based upon the analysis, the expedited permitting process would be most appropriate. Assuming 0.1 FTE to process an expedited permit, and assuming the average total burdened cost of a city FTE at $100,000 per year, the cost of the expedited permit would be approximately $10,000. This is one additional financial burden that further decreases the economic return.

Short-term environmental impacts during construction. Although this hydropower facility construction would take place within the existing water treatment facility and be very short-lived, there will be some short-term construction impacts. The delivery of the equipment will have short-term greenhouse gases emissions associated with the transport. There will be a slight increase with dust and noise pollution associated with increased traffic during construction.

Long-term impacts to the environment. Since this hydropower facility is proposed completely within the confines of the water plant facility using the existing flow, there are no long-term environmental impacts.

Social Sustainability

Review of the city's sustainability policy points to a number of social items, both benefits and consequences, which are applicable to this hydropower decision. As described in the following paragraphs, it appears that the negative social impacts are insignificant with the possible exception of noise concerns for the plant operators. On the other hand, there could be positive social benefits with the support for creation of jobs and improvement in the city's image relative to sustainable performance. The decision makers may determine if these social benefits are worth the economic cost.

Equality of benefits or impacts. The hydropower facility provides equal benefit to the entire city. The reduction in costs of operating the facility, through reduced electrical costs, can be equally applied to all rate payers. No impacts to equality are expected.

Changes in work environment for employees. Little change in the work environment is expected. Although the maintenance of the hydropower facility would fall to the hands of the current Public Works and Rock Creek WTP operations and maintenance staff, little additional effort is required.

The maintenance of the facility is primarily limited to greasing bearings. Training for this maintenance amounts to identifying the lubrication locations to maintenance staff during installation. The manufacturer will provide operating manuals for start-up and shut-down. However, shut-down and start-up is an event that occurs very rarely and only if there is a problem with the operation.

The positive portion of this additional work is the opportunity for the staff to learn new skills and take pride in their contribution to sustainability.

Job creation. Investment in clean energy technology creates jobs. As reported in *BusinessGreen*, June 19, 2009, a report was released June 18, 2009, in tandem by Green for All, the Natural Resources Defense Council and the University of Massachusetts at Amherst's Political Economy Research Institute (PERI) that portrays how investments in clean energy technology will support job growth. The study, entitled Green Prosperity, investigated how green investments can raise living standards. The results of the study indicate that every $1 million in clean energy technology will support the generation of 16.7 jobs.

With this statistic, the total initial investment of approximately $300,000 for installation of a hydropower electric power facility at the City of Corvallis water treatment facility will support the creation of 5 jobs.

Community Safety. The only safety issue associated with the community is the very minimal increase in truck traffic associated with the transport and installation of the hydropower facility. The Federal Highway Administration estimates the large truck-involvement rate is 2.12 per 100 million vehicle miles traveled Assuming a 360-mile transport distance for the equipment from the manufacturer to the plant site (based on using the Canyon Hydro equipment), the increase in the risk of a truck related traffic accident is 0.0008 percent.

Employee Safety. There are minimal dangers associated with the operations and maintenance of this type of hydropower facility. A turbine and generator set will include safety guards that protect employees from moving parts.

The one safety caution is associated with noise. The operating equipment can generate a noise level of between 90 and 100 decibels inside the facility in which the equipment is operating. This level does require noise protection. The proposed location is separated from the WTP operator's office by a glass window. The noise level inside the office will increase and may be a concern. It may be necessary to provide noise attenuation as part of the equipment package.

Change in the image of the city. Another positive benefit is the image that this investment could return. The city has stated a sustainability policy. This hydropower investment could be viewed as the perfect example of the city's commitment to sustainability. Although there is a negative return on investment when strictly looking at the economics, the implementation of this project would showcase the city's commitment to sustainability.

Recommendation

CH2M HILL does not recommend immediate implementation of the proposed hydropower project at the Rock Creek WTP because the environmental and social benefits do not appear to be sufficient to offset the negative economic return on investment. However, because the values of the environmental and social benefits are subjective, the decision of whether or not to implement the hydropower project is a policy decision that should be made by the city staff and council.

If the city decides not to implement the project at this time, CH2M HILL recommends that the city track electricity rates, the value of incentive programs from CPI, the potential for energy tax credits, and the value of hydropower Green Tags. It is possible that the economic sustainability will improve in the near future as these factors change.