NID Regional Water Supply Project
Technical Memorandum
Hydroelectric Power Generation Feasibility

November 2010

Prepared for
Nevada Irrigation District
City of Lincoln

Prepared by
Stantec
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ES EXECUTIVE SUMMARY

ES.1 BACKGROUND

To address the projected demand for the treated water in the City of Lincoln (City) and Nevada Irrigation District (NID), NID and the City joined cooperatively and selected ECO:LOGIC Engineering now Stantec Consulting Services, Inc. to perform a study to evaluate and select a site for a new regional water treatment plant (WTP) facility. The results were presented in the Lincoln Area Water Treatment Plant Planning and Site Study, by ECO:LOGIC, August 2005 (2005 Site Study).

Subsequent to the 2005 Site Study, ECO:LOGIC Engineering was selected to prepare a planning and predesign study for the NID Regional Water Supply Project (Project). This study was commissioned by NID to further investigate the feasibility of the project, and to recommend the location, size, and configuration of project components. The purpose of the Planning and Predesign Study is to recommend feasible alternatives to the project as a whole, as well as alternatives for individual project components, and then incorporate these recommendations into a proposed Project Description for use in the Draft Environmental Impact Report (Draft EIR).

Specifically, this technical memorandum provides a feasibility evaluation of the hydroelectric power generation (HPG) sites and recommends the proposed sites to be evaluated in the Draft EIR.

ES.2 APPROACH

During the Planning and Predesign Study, four potential raw water storage sites were initially screened and compared to identify the two most desirable sites, i.e., the preliminary sites. These sites were the Big Hill and Whisky Run raw water storage sites. With these two sites being the two likely sites for a reservoir, they were established as potential sites for hydroelectric power generation. Ray Toney and Associates (RTA), specializes in the planning, design, and construction of HPG facilities and was part of the project team. RTA completed a feasibility
study of the HPG facilities within the project. They initially evaluated the following three sites: Big Hill Reservoir, Whisky Run Reservoir, and the Hydraulic Control/Metering Station (HC/MS).

The Raw Water Storage Facility Siting Study, prepared by ECO:LOGIC, dated January 2010, recommended that the Big Hill Site be the proposed raw water storage site for the Regional Water Supply Project. As a result, RTA included an evaluation of the HPG facility at the WTP, assuming there would be no HPG site at the Whisky Run reservoir site. RTA’s final evaluation included the following sites: Big Hill Reservoir, Whisky Run Reservoir, water treatment plant, and the Hydraulic Control/Metering Station (HC/MS); which are the sites further discussed in the remainder of this TM. RTA’s analysis is included herein, as Appendix A.

Based on hydraulic grade line profiles and the flow estimates for initial and buildout conditions, as well as estimations of potential power purchase agreement values, financing schedules, and operation and maintenance variables; each alternative site was evaluated at a planning level to preliminarily quantify the following:

- HPG potential (i.e., power plant capacity)
- Anticipated monthly power production
- Capital Costs
- Operations and Maintenance Costs
- Anticipated Revenues

With each of those preliminarily quantified, the planning level feasibility of each site was assessed. Upon consideration of the potential revenue and costs for each site, the recommended proposed HPG facility sites were identified. The recommended proposed sites will be included in the proposed project description for use in the Draft EIR.

**ES.3 Results**

Based on the feasibility analysis, herein, the HPG plants on the raw water pipeline at the Big Hill Reservoir and the new WTP are economically feasible as the project flow approaches the buildout capacity. With the combination of less flow available, larger flow variations, and significantly larger head variations on the treated water line at the HC/MS, an HPG facility at the HC/MS is significantly less likely to be economically feasible in the near future.

In addition to the potential for capital costs along with operations and maintenance costs to change between now and when these HPG facilities are to be constructed, there are many variables that have the potential to dramatically impact the revenue potential and overall feasibility of each of the three HPG sites. Those variables include, but are not limited to, the method of operating the facilities, the value of electricity, carbon credits available, the cost of permitting and licensing, the lengths and distances of power line upgrades required, and the actual flows in the system. Since all of the HPG plant Sites have potential to generate revenue, and the future value of electricity and carbon credits, among other things is not quantifiable at this time; all three of the HPG plants are feasible.
The recommended locations for HPG facilities are the Big Hill Reservoir, the WTP, and the HC/MS sites. These sites will be included in the proposed project description to be incorporated into the Draft EIR. Site layouts for the Big Hill, WTP, and HC/MS HPG facilities will be incorporated into preliminary (10 percent design) drawings being prepared based on the recommendations herein. Due to the proximity of these facilities to and the operational interaction of these facilities with the pressure reducing facilities along the pipeline corridor, the HPG site layouts shall be shown on the preliminary drawings included with the Pipeline and Related Facilities Predesign TM.

The designs of the HPG facilities at the Big Hill Reservoir, the WTP, and HC/MS may be finalized following certification of the Final EIR, during detailed design.

1.0 INTRODUCTION

This memorandum provides a technical analysis and description of the incorporation of hydroelectric power generation on the Regional Water Supply Project (Project). The project team, as it relates to this technical memorandum (TM), includes key staff from the Nevada Irrigation District (NID); the City of Lincoln (City); and the consultant team, including McCall Engineering (NID representative), C.F. Bradham Consulting Engineer (City representative), ECO:LOGIC Engineering now Stantec Consulting Services, Inc., Ray Toney & Associates (RTA), Blackburn Consulting, Inc. (BCI), Bender Rosenthal, Inc (BRI), Andregg Geomatics, and J. Harrison Public Relations Group.

1.1 BACKGROUND

To address the projected demand for treated water in the City of Lincoln (City) and within the NID service area, NID and the City joined in a cooperative study to identify a site for a new regional water treatment plant (WTP). ECO:LOGIC Engineering prepared the initial engineering study for the water treatment plant site evaluation and selection. Robertson-Bryan, Inc. prepared an environmental constraints analysis to screen the various sites to identify potential constraints or fatal flaws that would prevent or jeopardize the construction of the facilities. The results were presented in the Lincoln Area Water Treatment Plant Planning and Site Study, by ECO:LOGIC, August 2005 (2005 Site Study).

The proposed WTP and related facilities will serve the portion of the City and its sphere of influence (SOI) within NID’s service area, as well as unincorporated areas (i.e. soft service areas) outside of the City but within NID’s service area. The addition of the new water supply to the City, in conjunction with the City’s groundwater well network and the service from the Placer County Water Agency (PCWA), will make-up the City’s treated water supply through the planned buildout included in the City of Lincoln General Plan and Background Report, by Mintier and Associates and Matrix Design Group Inc. dated March 2008 (General Plan).

Subsequent to the 2005 Site Study, ECO:LOGIC Engineering was selected to prepare a planning and predesign study for the Project. This study was commissioned by NID to further investigate the feasibility of the project, and to recommend the location, size, and configuration of project
components. The purpose of the Planning and Predesign Study is to recommend feasible alternatives to the project as a whole, as well as alternatives for individual project components, and then incorporate these recommendations into a proposed Project Description for use in the Draft EIR. Specifically, this TM provides an evaluation of the potential for and feasibility of hydroelectric power generation (HPG) facilities throughout the project.

1.2 PURPOSE AND SCOPE

Raw water will be conveyed from the Combie Ophir I (COI) Canal to the proposed WTP site. The overall elevation change is approximately 945 feet, which provides an opportunity to generate hydroelectric power with the potential energy resulting from the elevation difference. There is an additional 140 foot drop in elevation between the WTP and the hydraulic grade line maintained by the COL downstream of the hydraulic control/metering station (HC/MS), which will control the pressure and flow of water entering the City’s transmission system, and provides another opportunity for HPG.

Costs associated with the HPG facilities, including capital and long-term operation and maintenance (O&M) must be compared to the potential revenue resulting from power generation reimbursed through a power purchase agreement (PPA) with the electric utility, who in this case is Pacific Gas and Electric (PG&E). When the revenue from power generation exceeds the expenses of the initial capital cost, typically in the form of debt service, combined with O&M costs there is a financial benefit to incorporate HPG facilities into the project.

The purpose of this memorandum is to:

- Identify potential sites along the raw and treated water pipelines for HPG facilities within the project area
- Estimate capital and O&M costs associated with the construction and operation of the HPG facilities compared with the anticipated revenues resulting from the power generation
- Evaluate the feasibility of each site for electric HPG facilities
- Recommend which sites should be included in the Project Description for the California Environmental Quality Act (CEQA) process

Ray Toney and Associates (RTA) specializes in the planning, design, and construction of HPG facilities and was part of the project team. RTA completed a feasibility study of the HPG facilities within the project. Results of the analysis are incorporated into this TM within the context of the proposed project. The original feasibility study produced by RTA is included in Appendix A.

The scope of this TM includes:

- Identification of the potential sites for the HPG facilities
- Identification of the basic configuration for the power plant(s)
Hydroelectric Power Generation Feasibility

- Identification of the HPG facilities’ potential power generation capacity
- Estimation of the planning level capital and operation/maintenance costs
- Estimation of planning level anticipated power generation revenues
- Determination of the planning level feasibility of an HPG facility at each site
- Recommendation of which HPG facilities sites should be included in the Project Description for the California Environmental Quality Act (CEQA) process for the project

HPG facilities will be integrated with other water supply project components. As noted later in this memorandum, implementation of the HPG will not likely occur in the initial phases of the water supply improvements associated with water delivery when system flows are low.

Flows will increase overtime due to increased water demands within the project service area and as such the potential power revenues will also increase. When revenues from power production exceed project costs associated with each HPG site, including O&M and debt service, the installation of the HPG will make economic sense.

The potential sites, the basic design criteria, and the estimated costs and revenue from the HPG sites are included in this TM. The HPG facility layouts are included in separate TM’s associated with the water supply facilities and are identified herein.

References used in preparation of this predesign TM, include analyses and technical memorandums (TM) prepared as part of the project, which are:

- “Hydro Electric Generation Analysis of the Proposed Nevada Irrigation District Raw Water and Treated Water Lines to Lincoln”, Ray Toney and Associates, August 2009. (Appendix A)
- “Environmental Constraints Analysis”, ECO:LOGIC, October 2009
- “Land Use and Water Demands - Revised”, ECO:LOGIC, October 2009
- “Raw and Treated Water Pipelines Corridor Evaluation”, ECO:LOGIC, January 2010
- “Raw Water Storage Facility Siting Study”, ECO:LOGIC, January 2010

2.0 HYDROELECTRIC POWER GENERATION POTENTIAL ANALYSIS

An evaluation of the hydroelectric power generation potential is included in this section. The initial evaluation was completed by RTA in the Hydroelectric Power Generation Analysis of the NID Raw Water and Treated Water Pipelines to Lincoln (August 2009). The specific information from the RTA Report is supplemented and provided context within the overall framework of the Project in this section.
2.1 POTENTIAL HPG SITES

The primary purpose of the Project is to provide treated water service to NID customers within the NID service area in Western Placer County. Major Project facilities include raw and treated water pipelines, raw water reservoirs, a water treatment plant, and a hydraulic control and metering station, which are described in other technical memoranda.

The incorporation of HPG facilities within the Project is considered a potential benefit and would be incorporated when revenue generated by the installation exceeds the expense of debt and operation and maintenance costs. The water supply facilities at the potential sites will be configured to accommodate the HPG components.

Key characteristics of HPG facility locations within the proposed project include:

- Maximizing the HPG potential based on the largest elevation drop to develop maximum pressure without exceeding the design criteria used for the pipeline of 250 psi, where practical – (limiting the pressure reduces the cost of the pipeline and appurtenances, and simplifies operation)
- Maximizing accessibility to the HPG site
- Placing the HPG site near other planned project facilities

The raw and treated water pipeline corridor was divided into three potential HPG elements. The HPG elements used for the purposes of the HPG analysis are described in Table 1. Figure 1 includes the overall project, including the potential HPG sites and elements in relation to the water supply improvements.

The three sites evaluated in this TM for the HPG facilities include:

- Big Hill HPG facility
- WTP HPG facility
- HC/MS HPG facility

<table>
<thead>
<tr>
<th>Table 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydroelectric Power Generation Elements</td>
</tr>
<tr>
<td>HPG Element</td>
</tr>
<tr>
<td>I</td>
</tr>
<tr>
<td>II</td>
</tr>
<tr>
<td>III</td>
</tr>
</tbody>
</table>

Stantec Consulting Services, Inc. NID/City of Lincoln NID07-001 6 Regional Water Supply Project
A potential HPG site was considered at the Whisky Run raw water reservoir site, which is about 6,000 feet from the WTP site and located at an elevation of approximately 660 feet. The Whisky Run Raw Water Reservoir Site was eliminated in favor of the Big Hill Raw Water Reservoir Site. The raw water reservoir site selection is included in the Raw Water Storage Reservoir Siting Study (January 2010). The HPG facilities considered at the Whisky Run raw water reservoir site were evaluated at the WTP site.

2.2 HYDRAULIC DESIGN CRITERIA

Hydroelectric power will be produced from the energy carried in the raw and treated water pipelines in the form of flow and pressure. Pressure is generated by the elevation differences as water flows from the upper elevations within the project area near the Combie Reservoir down to the City of Lincoln. Pressure in terms of elevation in feet of head is referred to as the hydraulic grade line (HGL). The HGL elevation, which is specific to the location along the pipeline corridor, is established based upon initial pressures minus the amount of headloss within the pipeline and is used for calculating the potential for power generation at a given location. Project flows, including raw and treated water, will increase as development within the service area increases, which results in additional flow of water through the pipelines. The HPG potential increases as flows increase throughout the life of this project.

Unlike the flows, which will increase over the life of the project, pressure, which is primarily determined by the elevation drop throughout the project area, will remain relatively constant other than increased headlosses with increased flows from friction within the pipe. The system pressure available to generate power is determined based on the elevation difference throughout each HPG element and the pressure drop through the pipeline resulting from friction.

The pressure generated by the elevation difference is called static head and remains constant. The friction losses are related to the pipeline characteristics (diameter, length, and material) and the flow rates.
The HGL is calculated from the combination of the static pressure, dynamic losses and the elevation and used to determine the HPG potential. Tables 2 through 4 summarize the boundary conditions for each site related to flow and static pressure.

**Table 2**

**Big Hill Raw Water Reservoir Site**

<table>
<thead>
<tr>
<th>Condition</th>
<th>MGD</th>
<th>Beginning Elevation (a)</th>
<th>Ending Elevation</th>
<th>Maximum ΔH Ft (b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
<td>10</td>
<td>1,505</td>
<td>1,040</td>
<td>465</td>
</tr>
<tr>
<td>Buildout</td>
<td>40</td>
<td>1,535 (c)</td>
<td>1,040</td>
<td>495</td>
</tr>
</tbody>
</table>

(a) Beginning elevation at the COI turnout.
(b) Static pressure without regard to pipeline losses.
(c) The beginning elevation could increase to 1605 depending on future modifications to the existing outlet configuration on Combie Reservoir.

**Table 3**

**Water Treatment Plant Site**

<table>
<thead>
<tr>
<th>Condition</th>
<th>MGD</th>
<th>Beginning Elevation (a)</th>
<th>Ending Elevation</th>
<th>Maximum ΔH Ft (b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
<td>10</td>
<td>1,040</td>
<td>570</td>
<td>470</td>
</tr>
<tr>
<td>Buildout</td>
<td>40</td>
<td>1,040</td>
<td>570</td>
<td>470</td>
</tr>
</tbody>
</table>

(a) Beginning elevation is the maximum water surface elevation at the Big Hill Reservoir.
(b) Static pressure without regard to pipeline losses.

**Table 4**

**Hydraulic Control/Metering Station Site**

<table>
<thead>
<tr>
<th>Condition</th>
<th>MGD</th>
<th>Beginning Elevation (a)</th>
<th>Ending Elevation (b)</th>
<th>Maximum ΔH Ft (c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
<td>10</td>
<td>531.5</td>
<td>391</td>
<td>140.5</td>
</tr>
<tr>
<td>Buildout</td>
<td>40</td>
<td>531.5</td>
<td>391</td>
<td>140.5</td>
</tr>
</tbody>
</table>

(a) Beginning elevation is the maximum water surface elevation in the WTP treated water storage tanks.
(b) Hydraulic grade line downstream of the HC/MS.
(c) Static pressure without regard to pipeline losses.

Average monthly flows were distributed based on the historical water use within the City, as summarized in Table 5. They are intended to provide a means to estimate the monthly HPG potential. The flows provided herein represent a hypothetical flow regime, and in actuality will vary from those presented in Table 5 and will also vary from day to day or year to year. The average flows were used to estimate monthly power production, in order to quantify the anticipated revenue; however, as discussed later in this TM, the sizing of the HPG facilities is based on the anticipated peak flows.
Table 5
Monthly Average Day Flow Estimates, MGD

<table>
<thead>
<tr>
<th>Month</th>
<th>Raw Water Pipeline (a)</th>
<th>Hydraulic Control / Metering Station (b)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Initial</td>
<td>Buildout</td>
</tr>
<tr>
<td>January</td>
<td>1.7</td>
<td>6.3</td>
</tr>
<tr>
<td>February</td>
<td>1.8</td>
<td>6.9</td>
</tr>
<tr>
<td>March</td>
<td>1.7</td>
<td>6.3</td>
</tr>
<tr>
<td>April</td>
<td>2.0</td>
<td>7.3</td>
</tr>
<tr>
<td>May</td>
<td>4.9</td>
<td>18.4</td>
</tr>
<tr>
<td>June</td>
<td>6.2</td>
<td>23.1</td>
</tr>
<tr>
<td>July</td>
<td>7.4</td>
<td>27.5</td>
</tr>
<tr>
<td>August</td>
<td>7.0</td>
<td>26.3</td>
</tr>
<tr>
<td>September</td>
<td>6.0</td>
<td>22.6</td>
</tr>
<tr>
<td>October</td>
<td>4.5</td>
<td>16.8</td>
</tr>
<tr>
<td>November</td>
<td>2.6</td>
<td>9.6</td>
</tr>
<tr>
<td>December</td>
<td>2.0</td>
<td>7.6</td>
</tr>
</tbody>
</table>

(a) The raw water facilities and the WTP are designed to deliver a maximum daily demand flow of 40 MGD and will be initially operated at a maximum daily demand flow of 10 MGD.
(b) The hydraulic control/metering station is designed to accommodate hourly flows ranging from 0 to 43.5 MGD.

Hydroelectric Power Generation facilities operate most efficiently under a consistent flow and have the maximum generating potential at the locations with the largest differential pressure. The HGL of the pipeline varies with the flow. The head available to generate hydroelectric power is the difference between the HGL elevation on the upstream side of the HPG facility and the HGL elevation at the downstream side of the HPG facility, i.e. the pressure differential across the turbine. Therefore, the amount of hydroelectric power generated in any particular power plant is a function of the flow, the location, and the maximum allowable pressure drop through the HPG facility.

Figure 2 is adapted from the RTA report and includes the potential electrical generation capacity vs. flow for each of the sites. The HPG potential varies at each site and ranges from approximately 350 kilowatt (kW) [0.35 megawatt (MW)] up to 1,000 kW (1.0 MW). The maximum HPG potential coincides with the maximum flow. The estimated monthly revenue for each site is based on the raw water flow for that month during initial and buildout conditions.

The specifics about each of the three sites are discussed in the following sections.
2.3 **BIG HILL RESERVOIR POWER PLANT**

The Big Hill Reservoir power plant under consideration will be located adjacent to the proposed Big Hill Reservoir. The elevation drop between the turnout on the Combie Ophir Canal is approximately 465 feet (1505 ft-1040 ft). Maximum flow through the unit coincides with the anticipated maximum day demand of the proposed WTP and is 40 MGD; however NID may route additional raw water used to supply irrigation customers through the pipeline and/or reservoir, which could increase the hydroelectric production potential.

Free discharge from the HPG facility is anticipated due to the presence of the reservoir. Discharging to atmosphere results in the maximum possible pressure differential and associated power potential. After passing through the turbine, the water will flow into the tailrace and fill the reservoir.

Impulse type turbines are more efficient than reaction type turbines. They have efficiencies that range from 85 to 90 percent and are suitable for free discharge into a tailrace. Two commonly used impulse turbines are Turgo and Pelton units. A single multi jet Turgo type impulse turbine is recommended because of its ability to handle a wide range of flows expected on the Project and to create minimal transient pressures at the discharge. Although Pelton type turbines have slightly higher efficiencies, the range of anticipated flows at the facility would necessitate the use of two Pelton type turbines at the site. Additional information on the turbine selection is found in the RTA Report included in Appendix A.

RTA’s analysis concluded that based on anticipated raw water flows utilized for the production of treated water throughout the life of the project, the peak production anticipated from the unit will be approximately 1 MW. Estimated monthly power production in kWh at the Big Hill
Power Plant site was calculated and is shown in Figure 3. The actual power generation rate will vary depending on actual monthly flows from the Project, in conjunction with additional raw water flow that the NID may reroute through the raw water pipeline to use for irrigation within its existing service area and not intended for consumptive use as treated water.

As shown in Figure 3, the estimated monthly power production at the Big Hill Power Plant Site increases significantly in the summer months when the treated water demands within the project service area are higher, and the annual power production increases by more than 350 percent when the flow increases from the initial demand of 10 MGD to the estimated buildout demand of 40 MGD.

2.4 WTP POWER PLANT

The HPG facility will be located at the north end of the WTP near the headworks and is located at an elevation of approximately 570 feet. The elevation drop between the Big Hill Reservoir site and the water treatment plant site is approximately 470 feet (1,040 – 570). Maximum flow through the unit coincides with the anticipated maximum day demand of the proposed WTP, which is 40 MGD.

At the WTP power plant, a free discharge on the downstream side of the turbine into a reservoir is not recommended. Therefore, water passing through the turbine will remain within the pipe, exiting the turbine at a much lower pressure. The pressure drop across the turbine will utilize most of the elevation drop and the downstream pressure remaining after the turbine will be just
enough to flow into the WTP process; as a result almost all of the potential energy will be utilized.

Without a free discharge, a reaction type turbine is best suited for this site. Reaction type turbines are basically a reversible turbine pump with typical efficiencies of 55 to 65 percent. A free discharge would be possible; however the site layout would necessitate the need to pump the water from an equalization basin into the WTP process and negate any efficiency increases. Additional information on the turbine selection is found in the RTA Report in Appendix A.

Based on the anticipated raw water flows to the project shown in Table 5, the peak production anticipated from the WTP unit will be approximately 0.85 MW. Estimated monthly power production in kWh at the WTP site is shown in Figure 4. Actual monthly generation rates will vary and depend on the actual flow to the water treatment plant.

As shown in Figure 4, the monthly power production at the WTP Power Plant Site increases significantly in the summer months when the water demands within the project are higher, and the annual power production increases by more than 350 percent when the flow increases from the initial demand of 10 MGD to the buildout demand of 40 MGD.

The anticipated static pressures in the raw water pipeline just upstream of the WTP will be over 200 psi. The process at the water treatment plant utilizes gravity flow. Pressures must be reduced to less than 5 psi prior to entering the first hydraulic structure at the WTP. Initially, pressure reduction will be provided via the pressure reducing station adjacent to the WTP power plant site. As flows to the WTP increase, the addition of HPG facilities will become more economically beneficial.
Once installed and when in operation, the HPG facility at WTP will reduce pressures in the pipeline. However, the PRS must remain in service to reduce pressure when the HPG facilities are offline. As the flows exit the PRS or the HPG at the WTP they flow to the screening facility, which operates at atmospheric pressure.

### 2.5 Hydraulic Control/Metering Station Power Plant

The proposed power plant is located at the end of HPG Element III as shown in Figure 1, which is at the hydraulic control/metering station (HC/MS) located west of the intersection of McCourtney and Wise roads. The elevation drop between the maximum water surface elevation in the storage tanks at the WTP and the hydraulic grade line on the downstream side of the HC/MS is approximately 140 feet (532-392). After passing through the HC/MS, treated water will enter the City’s distribution system.

Similar to the WTP power plant, at the HC/MS power plant, the discharge from the hydroelectric generator will be to a pressure pipe. Therefore, water passing through the turbine will remain within the pipe, exiting the turbine at a lower pressure, and a reaction type turbine is best suited for this site. A Francis turbine is recommended for this application. Additional information on the turbine selection is found in the RTA Report in Appendix A.

The City’s distribution system will operate at a pressure of approximately 100 psi in vicinity of the HC/MS. To maintain the system pressure, only a portion of the available energy will be converted to electric power.

Based on anticipated treated water flows, the peak production anticipated from the unit will be approximately 0.35 MW. Unlike the Big Hill and WTP sites, this site is planned to accommodate peak hourly flows of 13 to 44 MGD during the initial and buildout conditions, respectively, and could fluctuate rapidly based on system demands depending on how the system is controlled. Flow fluctuations through the generator are undesirable and result in less efficient power production.

Based upon the flows shown in Table 5, the estimated monthly power production in kWh at the HC/MS Power Plant site was calculated and is shown in Figure 5.

The monthly power production at the HC/MS Power Plant Site increases significantly in the months where the water demands are higher, and the annual power production increases by more than 265 percent when the flow increases from the initial demand of a peak hourly flow of 13 MGD to the buildout demand peak hourly flow of 44 MGD.
3.0 COST AND FEASIBILITY ANALYSIS

The decision to install hydroelectric facilities will be driven by economics; when the facility generates adequate revenue derived from power sales, installation will make sense. In order to assess the overall feasibility of the HPG facilities and their ability to provide an economic benefit, it is necessary to consider both capital costs as well as operation and maintenance costs. This section includes a discussion of the economic viability of including HPG at the sites discussed in Section 2. Costs included herein are planning level probable costs used in the feasibility analysis.

3.1 CAPITAL COSTS

Capital costs include the planning, design, and construction of facilities. The Project will provide treated water to portions of the NID service area in Western Placer County, and as a result, the facilities will be installed regardless of whether HPG facilities are included. Therefore, the raw and treated water pipeline costs are not included in this economic analysis. A summary of initial construction costs estimated for each site is included in Table 6.

The annual payment assuming 100 percent financing of the capital cost, 6 percent interest, and a 20-year term for each site is included in Table 7. Contingencies to account for uncertainties have not been included. Variables such as the interest rate, the term of the loan, the power purchase agreements, defining the revenue, etc. will vary over time and the periodic updates of the cost...
and revenue potential will be needed to determine when the addition of the HPG facilities will “pencil out”.

Table 6
Planning Level Capital Costs for the HPG Facilities

<table>
<thead>
<tr>
<th>Project Component</th>
<th>Big Hill HPG</th>
<th>WTP HPG</th>
<th>HC/MS HPG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permits / License</td>
<td>$125,000</td>
<td>$125,000</td>
<td>$95,000</td>
</tr>
<tr>
<td>Engineering</td>
<td>$200,000</td>
<td>$200,000</td>
<td>$200,000</td>
</tr>
<tr>
<td>Powerlines Upgrade (a)</td>
<td>$90,000</td>
<td>$0</td>
<td>$90,000</td>
</tr>
<tr>
<td>Site Work</td>
<td>$75,000</td>
<td>$75,000</td>
<td>$75,000</td>
</tr>
<tr>
<td>Piping</td>
<td>$154,000</td>
<td>$154,000</td>
<td>$154,000</td>
</tr>
<tr>
<td>Powerhouse and Structures</td>
<td>$225,000</td>
<td>$210,000</td>
<td>$210,000</td>
</tr>
<tr>
<td>Turbines / Generators</td>
<td>$990,000</td>
<td>$690,000</td>
<td>$670,000</td>
</tr>
<tr>
<td>Surge Suppression</td>
<td>$0</td>
<td>$45,000</td>
<td>$30,000</td>
</tr>
<tr>
<td>Switchgear and Controls</td>
<td>$235,000</td>
<td>$230,000</td>
<td>$195,000</td>
</tr>
<tr>
<td>Switchyard</td>
<td>$295,000</td>
<td>$290,000</td>
<td>$240,000</td>
</tr>
<tr>
<td>Grid Intertie</td>
<td>$25,000</td>
<td>$25,000</td>
<td>$25,000</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>$50,000</td>
<td>$50,000</td>
<td>$50,000</td>
</tr>
<tr>
<td><strong>Total Project Construction Cost</strong></td>
<td><strong>$2,464,000</strong></td>
<td><strong>$2,094,000</strong></td>
<td><strong>$2,034,000</strong></td>
</tr>
</tbody>
</table>

(a) At the Big Hill HPG site and the HC/MS site there is an estimated 3 mile single phase powerline that will need to be upgraded to a 3 phase system for the HPG facilities. This cost can be adjusted at $30,000 per mile when the actual length is determined.

Table 7
Annual Debt Service

<table>
<thead>
<tr>
<th>Power Plant Site</th>
<th>Annual Payment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Big Hill Power Plant</td>
<td>$211,836</td>
</tr>
<tr>
<td>WTP Plant</td>
<td>$180,024</td>
</tr>
<tr>
<td>HC/MS</td>
<td>$174,864</td>
</tr>
</tbody>
</table>

3.2 Operation and Maintenance Costs

The facilities will require routine and non-routine maintenance and repair. Periodic site visits will be needed to monitor system operations. Routine maintenance tests such as checking and changing lubricants, monitoring vibration, operating temperatures, etc. will be needed. More intensive servicing performed at longer internals include monitoring bearing and runner wear, rewinding generator windings, etc. will also be needed and add to operating costs.
Annual operation and maintenance costs were conservatively estimated for the proposed facilities, and are shown in Table 8. Estimates reflect economies of scale based on operating multiple facilities, including NID’s other HPG facilities. Upward variations in the estimated operation and maintenance costs would result and less net revenue. In contrast, downward variations in the estimated operation and maintenance costs would increase the net revenue generated by the project, and would make the installation of HPG facilities more economically feasible at lower flow rates. An annual reserve of 20 to 25 thousand dollars a year was also included to replace the major mechanical equipment as it reaches the end of it useful life.

<table>
<thead>
<tr>
<th>Description</th>
<th>Big Hill</th>
<th>WTP</th>
<th>HC/MS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operations</td>
<td>$50,000</td>
<td>$45,000</td>
<td>$35,000</td>
</tr>
<tr>
<td>Maintenance</td>
<td>$35,000</td>
<td>$25,000</td>
<td>$20,000</td>
</tr>
<tr>
<td>Reserve account (a)</td>
<td>$25,000</td>
<td>$20,000</td>
<td>$20,000</td>
</tr>
<tr>
<td><strong>Total Annual O&amp;M</strong></td>
<td><strong>$110,000</strong></td>
<td><strong>$90,000</strong></td>
<td><strong>$75,000</strong></td>
</tr>
</tbody>
</table>

(a) It is advisable to contribute to an annual reserve fund to be used for significant repairs as they arise.

### 3.3 ANTICIPATED REVENUE

Anticipated revenues are dependent upon the amount of flow through the power plant as well as the power purchase agreement (PPA) with the utility company. In addition, there is potential for carbon credits to become available in the future for such projects which could encompass other indirect revenue streams and influence timing of improvements. Anticipated revenues, without consideration of the carbon credits, were estimated and are based upon a conservatively assumed PPA of $0.08 per kWh. Based upon this conservative PPA value, annual income was estimated at each of the sites for both the initial condition and the buildout condition. They are shown in Table 9. The revenue is dependent on the rate paid per kWh and will likely change in the future. Therefore, it will be important that the rate be determined prior to implementing a project. If the PPA rates are higher than $0.08 per kWh, the income, and cost effectiveness of the HPG facilities will increase.

<table>
<thead>
<tr>
<th>Power Plant Site</th>
<th>Estimated Annual Income</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Initial Condition</td>
</tr>
<tr>
<td>Big Hill</td>
<td>$151,179</td>
</tr>
<tr>
<td>WTP</td>
<td>$99,493</td>
</tr>
<tr>
<td>HC/MS</td>
<td>$16,036</td>
</tr>
</tbody>
</table>

Table 8

Table 9

Estimated Annual Income
3.4 Feasibility

The economic feasibility of these facilities is determined as the difference between the costs and the revenues as shown in Tables 10 and 11. Because the annual income is dependent upon the volume of flow the feasibility analysis was assessed for both the initial flow conditions as well as the buildout flow conditions.

Table 10
Annual Profit/Loss at Initial Conditions

<table>
<thead>
<tr>
<th>Description</th>
<th>Big Hill</th>
<th>WTP</th>
<th>HC/MS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Income</td>
<td>$151,179</td>
<td>$99,493</td>
<td>$16,036</td>
</tr>
<tr>
<td>Annual payment</td>
<td>($211,836)</td>
<td>($180,024)</td>
<td>($174,864)</td>
</tr>
<tr>
<td>O &amp; M Costs</td>
<td>($110,000)</td>
<td>($90,000)</td>
<td>($75,000)</td>
</tr>
<tr>
<td>Profit / (Loss)</td>
<td>($170,657)</td>
<td>($170,531)</td>
<td>($233,828)</td>
</tr>
</tbody>
</table>

Table 11
Annual Profit/Loss at Buildout Conditions

<table>
<thead>
<tr>
<th>Description</th>
<th>Big Hill</th>
<th>WTP</th>
<th>HC/MS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Income</td>
<td>$604,716</td>
<td>$397,972</td>
<td>$64,146</td>
</tr>
<tr>
<td>Annual payment</td>
<td>($211,836)</td>
<td>($180,024)</td>
<td>($174,864)</td>
</tr>
<tr>
<td>O &amp; M Costs</td>
<td>($110,000)</td>
<td>($90,000)</td>
<td>($75,000)</td>
</tr>
<tr>
<td>Profit / (Loss)</td>
<td>$282,880</td>
<td>$127,948</td>
<td>($185,718)</td>
</tr>
</tbody>
</table>

The annual profit and loss results indicate that the Big Hill and WTP power plants have the potential to be profitable at buildout conditions. The HC/MS site is not profitable under either demand condition. At initial conditions, the Big Hill and WTP sites will become slightly profitable, anywhere from about $9,000 to $41,000 per year, only after the 20-year loan has been paid off. If the HPG facilities are installed and run under the initial demand condition for the 20-year loan period, there will have been 20 years of losses of more than $150,000 loss per year per site, which equates to a loss of more than $6 million, not including the HC/MS site. However, if the HPG facilities are installed at the Big Hill and the WTP sites and run under the buildout demand condition for the 20-year loan period, there will have been 20 years of revenue of $283,000 and $128,000 per site, which equates to a gain of about $8 million in revenue.

The initial and buildout conditions represent the extreme boundary conditions. It may be possible to consider installation of HPG facilities at some point in the future depending on the variables that affect the economics such as the PPA terms, carbon credits, advances in turbine design and costs, or even installation of a smaller generator that could be used and eventually replaced with a larger unit as flows increase. NID should revisit the governing conditions annually to determine if and when implementing the HPG component is prudent.
4.0 PRELIMINARY SITE LAYOUTS

The basic site plans are included in Appendix A for each site. The overall site layout for Big Hill, WTP, and HC/MS HPG facilities will be incorporated into preliminary (10 percent design) drawings for each of the sites shown on the drawings included with the Big Hill Reservoir and Related Facilities Predesign TM, and the Pipeline and Related Facilities Predesign TM.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Conclusions and recommendations regarding the feasibility and potential location for HPG facilities to be included in the Project are presented in this section.

5.1 CONCLUSIONS

Conclusions drawn from the analysis include:

1. Three locations within the Project have potential for HPG facilities that could be included in the project and include the Big Hill Raw Water Reservoir, the water treatment plant site and the HC/MS site.

2. HPG facilities range in size from 0.35 to 1 MW based on project flows related to treated water supplies. Power generation potential could be slightly higher depending whether the NID conveys additional raw water through the pipeline to supplement raw water deliveries.

3. During the initial phase of the Project, expenses including operation and maintenance and debt service, will likely exceed revenues. As flows increase, the potential power generation rates will increase. Under buildout conditions, the HPG facilities at the Big Hill reservoir site and water treatment plant could produce net revenue of approximately $280k and $130k, respectively, based on the assumptions used herein. The revenue generated from hydroelectric generation facilities at the HC/MS site will not cover expenses at buildout based on the assumptions included herein.

4. Power purchase agreements will influence revenue and would change the economics and feasibility in the future and could accelerate the implementation of the HPG facilities.

5. Installation of smaller/temporary HPG facilities may be considered in the future and could be less expensive to construct and operate and may offer a means to generate power profitably and could prove to be economically feasible before buildout conditions.

6. In addition to the potential for capital costs along with operations and maintenance costs to change between now and when these HPG facilities are to be constructed, there are many variables that have the potential to dramatically impact the revenue potential and overall feasibility of each of the HPG sites discussed in this TM. Those variables include, but are not limited to, the method of operating the facilities, the value of electricity, carbon credits available, the cost of permitting and licensing, the lengths and distances of power line upgrades required, and the actual flows in the system.
5.2 RECOMMENDATIONS

Recommendations from the analysis include:

1. HPG facilities should be included in the project description for the California Environmental Quality Act (CEQA) process at the following proposed sites for the Regional Water Supply Project: Big Hill Reservoir, WTP, and the Treated Water HC/MS.

2. Incorporate site layouts for the HPG facilities at each site in the appropriate predesign memorandum including:
   - Big Hill Raw Water Reservoir Site
   - WTP Basis of Design Report
   - HC/MS Technical Memorandum

3. Complete environmental surveys in the spring and summer of 2010 on lands that comprise the Big Hill Reservoir and Related Facilities, the WTP, and the Treated Water HC/MS, which will include the lands associated with each of the three proposed HPG facilities.

4. Following certification of the Final Environmental Impact Report, perform additional site work including topographic surveys and detail geotechnical evaluation in preparation of the detailed design of the facilities.

5. Conduct additional feasibility analyses prior to final design, to determine capital costs, operation and maintenance costs, and anticipated revenue, when additional information regarding operational techniques, flow regimes, and energy costs can be estimated at a higher level of detail than the planning level estimates currently available.

6. Coordinate with regulatory agencies and power suppliers including Pacific Gas and Electric (PG&E).
Appendix A

Hydroelectric Power Generation Analysis of the NID Raw and Treated Water Pipelines
HYDRO ELECTRIC GENERATION ANALYSIS OF THE PROPOSED NEVADA IRRIGATION DISTRICT RAW WATER AND TREATED WATER LINES TO LINCOLN

AUGUST 2009
HYDRO ELECTRIC GENERATION ANALYSIS OF THE NID RAW WATER AND TREATED LINES TO LINCOLN

Based on our analysis and experience with over 20 sites in the size range of these projects we consider the hydro power plants on the raw water pipeline at the Big Hill Reservoir (Big Hill) and the new Water Treatment Plant (WTP) to be highly economically feasible as the project flow approach the build out capacity. A hydro power plant on the treated water line at the hydraulic control / metering station (HC/MS) down stream of the Water Treatment Plant is significantly less likely to be economically feasible.

The hydro plants on the raw water will line accommodate daily flows provided by ECO:LOGIC which at build out vary from 6.0 mgd to 40 mgd with a head loss of fluctuations of up to 20 percent of the total static head. These are relative common parameters which usually accommodate a feasible hydro site. The flows at the hydraulic control / metering station (HC/MS) must accommodate peak hourly flows which at build out vary from 13 to 40 mgd with a head loss fluctuation of as much as 75 percent of total static head depending on flows and storage tank levels. There is also approximately 10 to 12 percent less total flow available for power generation at the HC/MS because of consumption between the WTP and HC/MS The combination of less flow available, larger flow variations, and significantly larger head variations contribute to this site being significantly less likely to be an economically feasible hydro site.

Based on the value of electricity and carbon credits available as this project approaches build out capacity the economic feasibility of all the sites could change significantly.

Our analysis is based on the drawings dated January 2009 and data supplied by ECO:LOGIC and our understanding of the conceptual design. The 63,000-foot 42-inch diameter raw water line from Combie-Ophir canal turnout to Valley View Water treatment plant (WTP) site is divided into two hydraulic elements which are: 1) from the existing Combie-Ophir canal to the new Big Hill reservoir, and 2) from the new Big Hill reservoir to a pressure reducing station at the new WTP. The raw water system will be sized to deliver a maximum daily demand of 40 million
gallons per day (mgd) and operated initially at a maximum of 10 mgd. Hourly flow fluctuations will be managed by storage down stream of the WTP. The treated water from the WTP to Lincoln is divided in to two hydraulic elements which are 1) a 48-inch 25,000-foot line to a pressure reducing/ metering station and 2) a pipeline to the Lincoln distribution and storage system. The flows will be controlled by flow control valves at the end of each hydraulic element which will be regulated by the down stream reservoir level.

There are three potential hydroelectric sites in this system; one at the discharge into Big Hill reservoir, a second at the pressure reducing station at the WTP, and a third at the hydraulic control / metering station (HC/MS) down stream of the WTP. The potential power plant size at the Big Hill site would be approximately a 1 MW installation, at the WTP site would be approximately an 850 kW installation, and at the hydraulic control/metering station (HC/MS) site would be approximately a 350 kW installation.

The following chart shows the generating capacity of each site based on the available head and flow.

![POWER PLANT SITE CAPACITY](image)

POWER TURBINE SELECTION

All of these sites have relative long pipelines (penstocks) up-stream of the power house which makes the consideration of transient pressure waves (hydraulic hammer) critical in the selection of the turbine. A preliminary analysis of these pipelines is that safe uniform rate of flow change from full capacity to shut off needs to occur over a time period in excess of 3 to 5 minutes. A hydro generator is frequently tripped off the electrical grid by slight frequency or
voltage variations caused by lighting, momentary load spikes, downed power lines, storms, or some other momentary or longer malfunction of the electrical grid. The generator can easily be restored to the grid automatically when the grid failure is short term and it is cleared. When the hydro generator is tripped off electrical grid there is no resistance to the turbine and the turbine immediately, less than 2 tenths of a second, goes into runaway speed and the flow to the turbine runner must be shut-off or deflected in reasonably short period of time. This common change of flow conditions causes transient pressure waves in the penstock which are worse in long penstocks such as we have in all of our potential sites. These transient pressures waves uncontrolled will cause significant pressure rises and will rupture the penstock. The detailed design of the hydro scheme at each location will require a detailed transient wave analysis.

Impulse type turbines such as pelotons and turgos which require a free discharge to a reservoir easily accommodate the generator being tripped off the power grid with the use of flow deflectors. When the generator is tripped off the power grid and the turbine instantaneously goes into runaway speed the deflectors instantaneously deflect the flow from the turbine runner until the turbine shut off valve (TSV) can slowly shut the pipeline flow off in a time which will accommodate the transient pressure parameters of the pipeline.

Reaction turbines such as Francis turbines and pump type turbines do not have flow deflectors like the impulse type. When the generator connected to a reaction turbine is tripped off the power grid the turbine also instantaneously goes into runaway speed and instantaneously changes the flow in the pipeline. At full turbine capacity, which is usually the worst case, when the turbine goes into runaway speed there is an instantaneous 15 to 25 percent flow reduction, which will cause a transient pressure wave in the pipeline. At other flow conditions the flow will instantaneously go to 75 to 85 percent of full flow which will also cause a transient pressure wave in the pipeline. The turbine and generator will remain in runaway speed condition until the TSV can safely shut the flow off or the flow transferred to alternate routes. Electronic controls to shut off or transfer flow are not considered reliable enough. The transfer or shut off of the flow must be accomplished through a mechanical system such as mechanical linkage, hydraulic with battery back up or surge tanks.

The Big Hill sites easily accommodate an impulse type turbine because it discharges to the Big Hill reservoir. We have selected a single multi jet turgo type impulse turbine. The advantage of multi-jet turgo turbines is they can closely match the wider range of flow requirements and create minimal transient pressures at turbine flow rejection with a reasonable 85 to 90% turbine efficiency. There are several manufacturers of these turbines in the 1MW range. The pelton type impulse turbine which has slightly higher efficiencies would also accommodate this site but would require two turbines to accommodate the range of flows.
At both the WTP and the HC/MS sites turbine discharge is a lower pressure pipe line rather than a free discharge. The turbines available for these applications are essentially reversible turbine pumps which have been used to capture the energy from pressure reducing stations. There are a few manufacturers of these types of turbines. They generally have an efficiency of 55 to 65 percent which is considerably less than most other types of turbines. They are a reaction type turbine and often referred to as a barrel type or pump type turbine. Depending upon the precise turbine selected they will have a significant flow change when the generator is separated from the power grid. This flow change will be in from 15 to 20% of full flow and will cause significant transient pressure wave if un abated. These turbines will require fail proof transient pressure wave suppression system to protect the penstock. A common reliable method which is included herein is a series of hydro pneumatic surge tanks.

POWER PRODUCTION

The following average estimated daily flows were supplied to us by ECO:LOGIC. Based on these flows we have calculated the monthly kWh production for each site which is shown in the following charts for each site. The hydraulic control / metering station has approximately 12% less total flow due to the service between the WTP and metering station.

NID REGIONAL WATER SUPPLY ESTIMATIONS FOR HYDRO ANALYSIS

<table>
<thead>
<tr>
<th>MONTH</th>
<th>RAW WATER LINE</th>
<th>PRV / METERING STATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>INITIAL PHASE 10 MGD</td>
<td>BUILDOUT PHASE 40 MGD</td>
</tr>
<tr>
<td>JAN</td>
<td>1.7</td>
<td>6.3</td>
</tr>
<tr>
<td>FEB</td>
<td>1.8</td>
<td>6.9</td>
</tr>
<tr>
<td>MAR</td>
<td>1.7</td>
<td>6.3</td>
</tr>
<tr>
<td>APR</td>
<td>2.0</td>
<td>7.3</td>
</tr>
<tr>
<td>MAY</td>
<td>4.9</td>
<td>18.4</td>
</tr>
<tr>
<td>JUN</td>
<td>6.2</td>
<td>23.1</td>
</tr>
<tr>
<td>JUL</td>
<td>7.4</td>
<td>27.5</td>
</tr>
<tr>
<td>AUG</td>
<td>7.0</td>
<td>26.3</td>
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<tr>
<td>SEP</td>
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<td>OCT</td>
<td>4.5</td>
<td>16.8</td>
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<td>NOV</td>
<td>2.6</td>
<td>9.6</td>
</tr>
<tr>
<td>DEC</td>
<td>2.0</td>
<td>7.6</td>
</tr>
</tbody>
</table>

Average daily flow in MGD
The annual income derived from the hydroelectric sites will be based on the power purchase agreement from the utility company. Usually that agreement is based on the price per kWh. The following chart will allow one to estimate the annual income based on a range of prices per kWh.
POWER LINES

The power generated by all of these potential hydro sites is easily accommodated on standard distribution 12,000 volt power lines to the sites. Each site has electrical power requirements to operate even the initial phase of the system prior to construction of hydro power phase. The Big Hill and hydraulic control/metering stations sites will require power from the electrical distribution system for operation of pressure reducing, flow control valves lighting, and etc. The WTP will have significant electrical power requirements for operation of the treatment facility. The common method for providing electrical power is through the construction of a 12,000 volt aerial power line to the site with a step-down transformer at the site for site power requirements. Consequently, the basic power line facilities will be in place prior to hydro site construction and not part of this analysis except for potential up grades required for hydro generation.

The power line serving the WTP will likely need to be 3 conductor 3 phase power lines to economically serve required motors at the site. Consequently it is unlikely any modifications to the power line for the WTP hydro generation will be needed. However, the power requirements for the Big Hill and HC/MS sites could be easily accommodated with 2 conductor single phase power lines. The power lines to Big Hill and HS/MS would likely have to be upgraded to a 3 conductor 3 phase power line which will cost $20 to $30,000 per mile provided the initial single phase construction is planned to accommodate a third conductor. All new power line construction must accommodate raptors in the area. Design and construction of powerlines should be based on Suggested Practices for Raptor Protection on Powerlines available from the USF&W or the Edison Electric Institute. Following is a typical 12,000 volt distribution powerline configuration which provides raptor protection.
ACCESS ROADS

The access roads required to construct and maintain the raw water system will be adequate for construction and maintenance of the hydro facilities when constructed at a later date. The most remote site is the Big Hill site. The water system construction access will need to provide for heavy earth moving equipment to construct the planed reservoir, concrete delivery trucks for structures, pipe delivery trucks, and etc. An access that will provide for these construction activities will be more than adequate for the construction of the future hydro facility.

Also required access for operation and maintenance of the Big Hill reservoir and flow control valve will be adequate for operation and maintenance of the hydro facility. Periodic visits of personnel in maintenance vehicles to the Big Hill reservoir and flow control valve will be necessary. The operation and maintenance of the hydro facility will require the same level of access although it may be more frequently, usually 4 to 7 site visits per week.

The construction and maintenance costs for the future hydro facilities are based on reasonable access being provided for the construction and maintenance of the raw water system and those will be left in place. The access requirements for the construction of the future relatively small hydro facilities will be less demanding than requirements for the water system.

CONSTRUCTION COSTS

The following construction costs are based on the following:

- Current costs and pricing
- Practices and quality consistent with public works contracts
- Current General Prevailing Wages for the State of California

The economy of at least two of the projects will be permitted, engineered, and constructed at the same time. Proceeding on an individual project basis could add 10 to 20% to the costs.

The access for the construction of the water facility will be left in place and available where needed for the construction of the hydro facilities.

SCADA The proposed water supply and control facilities will require remote monitoring, reporting, and possibly control. This same system will be used for the Hydro facilities.
The powerline installed for Big Hill and the HC/MS water system is a 3 mile single phase powerline and will need to be upgraded to a 3 phase system for the hydro facilities. This cost can be adjusted at $30,000 per mile when the actual length is determined.

**ESTIMATED CONSTRUCTION COSTS**

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>BIG HILL</th>
<th>WTP</th>
<th>HS/MS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permits/license</td>
<td>125,000</td>
<td>125,000</td>
<td>95,000</td>
</tr>
<tr>
<td>Engineering</td>
<td>200,000</td>
<td>200,000</td>
<td>200,000</td>
</tr>
<tr>
<td>Powerlines upgrade</td>
<td>90,000</td>
<td>0</td>
<td>90,000</td>
</tr>
<tr>
<td>Site work</td>
<td>75,000</td>
<td>75,000</td>
<td>75,000</td>
</tr>
<tr>
<td>Piping</td>
<td>154,000</td>
<td>154,000</td>
<td>154,000</td>
</tr>
<tr>
<td>Powerhouse &amp; structures</td>
<td>225,000</td>
<td>210,000</td>
<td>210,000</td>
</tr>
<tr>
<td>Turbines/generators</td>
<td>990,000</td>
<td>690,000</td>
<td>670,000</td>
</tr>
<tr>
<td>Surge suppression</td>
<td>0</td>
<td>45,000</td>
<td>30,000</td>
</tr>
<tr>
<td>Switchgear &amp; Controls</td>
<td>235,000</td>
<td>230,000</td>
<td>195,000</td>
</tr>
<tr>
<td>Switchyard</td>
<td>295,000</td>
<td>290,000</td>
<td>240,000</td>
</tr>
<tr>
<td>Grid Intertie</td>
<td>25,000</td>
<td>25,000</td>
<td>25,000</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>50,000</td>
<td>50,000</td>
<td>50,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2,464,000</td>
<td>2,094,000</td>
<td>2,034,000</td>
</tr>
</tbody>
</table>

**OPERATION AND MAINTENANCE COSTS**

The operation and maintenance of a small hydro generating facility such as being considered as a part of the NID raw water supply to Lincoln is very similar to a 500 to 700 horsepower booster pump station.

The operation will require periodic visits of a few minutes from three to seven times per week, primarily for the purpose of someone physically needing to visit the site. This is typically done by personnel on some type of route visiting several sites. There is also the need for someone to respond to some alarms for which the hydro plant might not automatically restart after a temporary power grid interruption to reset a relay or some other protection device. There are some annual overhead cost such as insurance, connection fees, license reporting costs that are considered a part of annual operation costs.

An annual maintenance needs to be scheduled which could take from one or two days to a week depending on the level of maintenance required. This annual maintenance will include such things as checking and changing oils, station batteries, relay and other protection devices settings, and similar ancillary facilities. On a less frequent basis such as a five year cycle a more through investigation is required which will include checking the wear on bearings and runners.
This may also included replacement of some ancillary equipment such as hydraulic pumps, batteries, and electrical control components.

Often it is advisable to build an annual reserve fund for replacement or significant repair of major components such as turbine runners, bearings, transformer fluids, relays and other protection devices. These components tend to have a twenty to forty year life span and prudent fiscal planning include building annual reserves in anticipation of these costs. One percent of total project cost or five percent of major equipment costs is considered a prudent annual reserve for major repairs.

Since NID has similar hydro and water facilities the operation and maintenance cost below are based on these hydro projects being a part of the operation and maintenance of other hydro facilities or similar projects. If these projects were operated and maintained as individual units independent of other similar facilities the operation and maintenance costs would be at least doubled.

**ESTIMATED ANNUAL OPERATION AND MAINTENANCE COSTS**

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>BIG HILL</th>
<th>WTP</th>
<th>HS/MS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operations</td>
<td>50,000</td>
<td>45,000</td>
<td>35,000</td>
</tr>
<tr>
<td>Maintenance</td>
<td>35,000</td>
<td>25,000</td>
<td>20,000</td>
</tr>
<tr>
<td>Reserve account</td>
<td>25,000</td>
<td>20,000</td>
<td>20,000</td>
</tr>
<tr>
<td>TOTAL ANNUAL O&amp;M</td>
<td>110,000</td>
<td>90,000</td>
<td>75,000</td>
</tr>
</tbody>
</table>

**HYDRO GENERATION FEASIBILITY**

Based on some reasonable parameters it is easy to see the level of feasibility of each of these hydro generating facilities. We have chosen $0.08 per kWh and a 6% interest rate over a 20 year pay back to demonstrate the level of feasibility. The first table is an analysis based on the initial capacity of the raw water project of 10 mgd. The second table is an analysis based on the build out of a 40 mgd.

These tables support that the Big Hill and WTP hydro sites will not be economically feasible at the initial phase of the project but will become feasible at some time in the future as the project approaches build out. Also these tables have not included carbon credits which are likely to become available for such projects.
10 MGD SYSTEM CAPACITY

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>BIG HILL</th>
<th>WT</th>
<th>HC/MS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction Costs</td>
<td>2,464,000</td>
<td>2,094,000</td>
<td>2,034,000</td>
</tr>
<tr>
<td>Annual Income</td>
<td>151,179</td>
<td>99,493</td>
<td>16,036</td>
</tr>
<tr>
<td>Annual payment</td>
<td>(211,836)</td>
<td>(180,024)</td>
<td>(174,864)</td>
</tr>
<tr>
<td>O &amp; M Costs</td>
<td>(110,000)</td>
<td>(90,000)</td>
<td>(75,000)</td>
</tr>
<tr>
<td>PROFIT / (LOSS)</td>
<td>(170,657)</td>
<td>(170,531)</td>
<td>(233,828)</td>
</tr>
</tbody>
</table>

40 MGD SYSTEM CAPACITY

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>BIG HILL</th>
<th>WT</th>
<th>HC/MS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction Costs</td>
<td>2,464,000</td>
<td>2,094,000</td>
<td>2,034,000</td>
</tr>
<tr>
<td>Annual Income</td>
<td>604,716</td>
<td>397,972</td>
<td>64,146</td>
</tr>
<tr>
<td>Annual payment</td>
<td>(211,836)</td>
<td>(180,024)</td>
<td>(174,864)</td>
</tr>
<tr>
<td>O &amp; M Costs</td>
<td>(110,000)</td>
<td>(90,000)</td>
<td>(75,000)</td>
</tr>
<tr>
<td>PROFIT / (LOSS)</td>
<td>282,880</td>
<td>127,948</td>
<td>(185,718)</td>
</tr>
</tbody>
</table>

HYDRO POWER PLANS AND DRAWINGS

The following basic drawings of each hydro site are site specific but general in nature. They show the basic piping configuration required to accommodate a hydro generating facility in the water supply system at each site. The size and arrangement of equipment can be relied on as what is required for these size and types of facilities. They can be relied upon for planning and conceptual purposes. The final design will likely modify these drawings and add significantly more detail but should be fundamentally similar in size and scope.
CONTROLS AND SWITCH GEAR

HPU

25' 4"

30' 0"

FLOW

HYDROPNEUMATIC SURGE TANKS

TKW BARREL, TURBINES

TURBINE SHUT-OFF VALVES

WTP POWER HOUSE PLAN

DRAWN BY

DATE

8/10/09

DRAWING NO.

RET

REV. DATE

H02.1