

## **Appendix C**

### **June 1, 2018 Clark Fork River Hydroelectric Project Qualifying Upgrades Report**

**Avista Corporation**

## **Introduction**

This appendix provides details about the calculation of qualifying renewable energy output from incremental hydroelectric upgrades on the Company's Clark Fork River Hydroelectric Project. The Clark Fork River Project includes hydroelectric projects located near Clark Fork, Idaho and Noxon, Montana. The plants operate under a FERC license through 2046.

Under certain circumstances, incremental electricity produced as a result of efficiency improvements completed after March 31, 1999 may qualify as an eligible renewable resource for purposes of compliance with Washington's Energy Independence Act, RCW 19.285.030(10)(b). Three methodologies to calculate the amount of incremental hydroelectric generation associated with efficiency improvements are available. All of the acceptable methodologies consider the state of the hydroelectric project in question without the incremental improvements, then with the incremental improvements, and the resulting difference between the generation before and after the incremental improvements constitutes the amount of qualifying generation available to satisfy the Company's goals under the Energy Independence Act.

The accepted methodologies for calculating incremental hydroelectric generation under Docket UE-110523 include:

1. "Annual calculation using hydroelectric model and actual inflows or generation;"
2. "One-time calculation of renewable electricity percentage using an historical period of inflow or generation;" or

3. “One-time calculation of renewable electricity using an historical period of inflow or generation.”

Avista utilizes the third method using historical inflows from 2002 through 2011. This method entails the use of historical inflow or generation based on a minimum of five years or up to the available inflow record of generation. The qualifying amount of renewable energy output for the before and after incremental improvement states are calculated with a hydroelectric model. The megawatt-hour value difference between the two states is used for the future years as the amount of available renewable energy. The Company modeled the two states using Avista’s Hydro Optimization Package (Hydro Model). The Hydro Model used for the studies in this appendix is the same model the Company uses to optimize its system operations for short- and long-term planning, budgeting, hydro project market valuation studies, supporting hydroelectric upgrade option studies, and general rate case submissions (Docket No. UE-100467 for the Clark Fork Hydro Model). The Hydro Model is a mixed-integer linear programming-based system emulating the operation of the Company’s projects. It was developed to support system operations, financial forecasting, and hydroelectric upgrades. Operating on an hourly time-step, the model accurately represents individual turbine and reservoir operations. The model honors all license constraints such as minimum flows and elevation limits in all periods.

### **Cabinet Gorge Project Upgrade Descriptions**

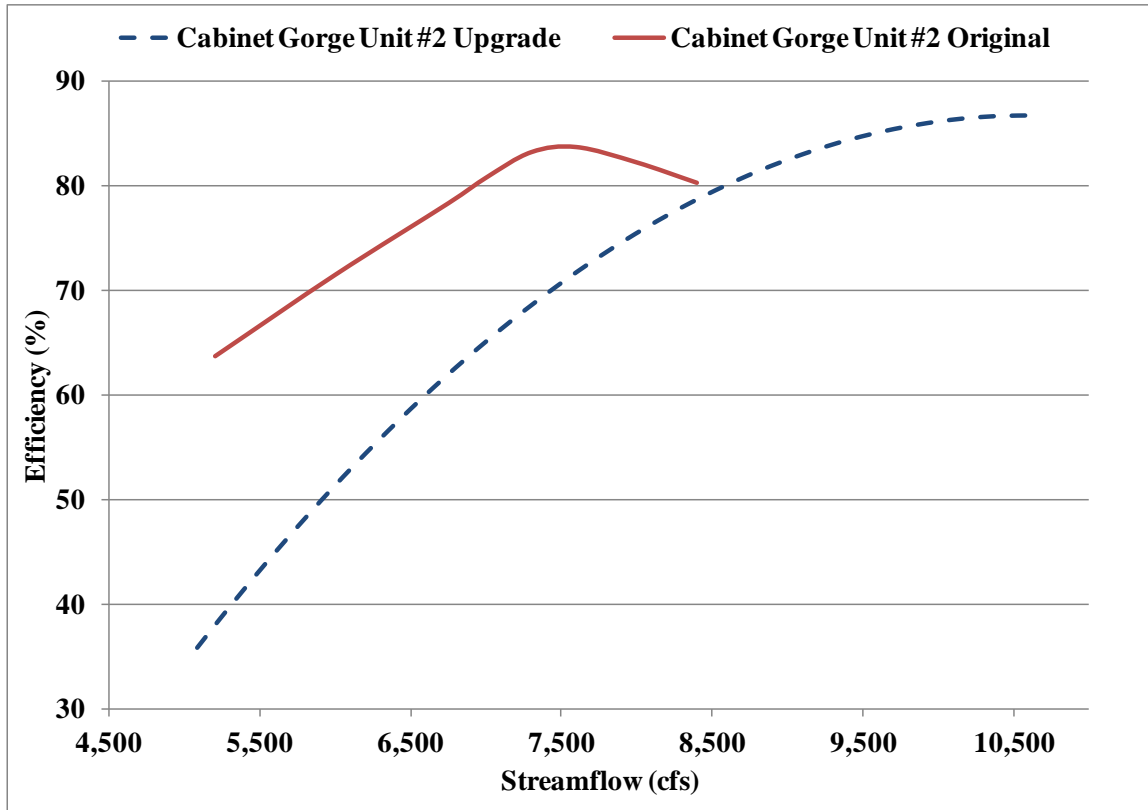
Qualifying hydroelectric upgrades to Cabinet Gorge Units # 2 – 4 were completed between 2001 and 2007. Details about each upgrade is provided below, along with the

annual incremental renewable energy output for each unit and the turbine efficiency curves before and after the upgrades.

### **Cabinet Gorge Unit #2 Upgrade**

The Company completed an upgrade of Cabinet Gorge Project Unit #2 in March 2004. The upgrade included the removal and replacement of the original 1952 propeller runner with a modern design mixed-flow runner. Following the upgrade, the Company realized a 17 MW increase in capacity, from 55 MW to 72 MW. The Hydro Model study for Cabinet Gorge Unit #2 resulted in 29,008 MWh of annual qualifying renewable energy. Illustration 1 shows the original and upgraded turbine curves for Cabinet Gorge Unit #2. The upgraded turbine produces energy more efficiently at the higher streamflow conditions where this unit typically operates. The Commission reviewed the Cabinet Gorge Unit # 2 upgrade in Docket No. UE-050482.

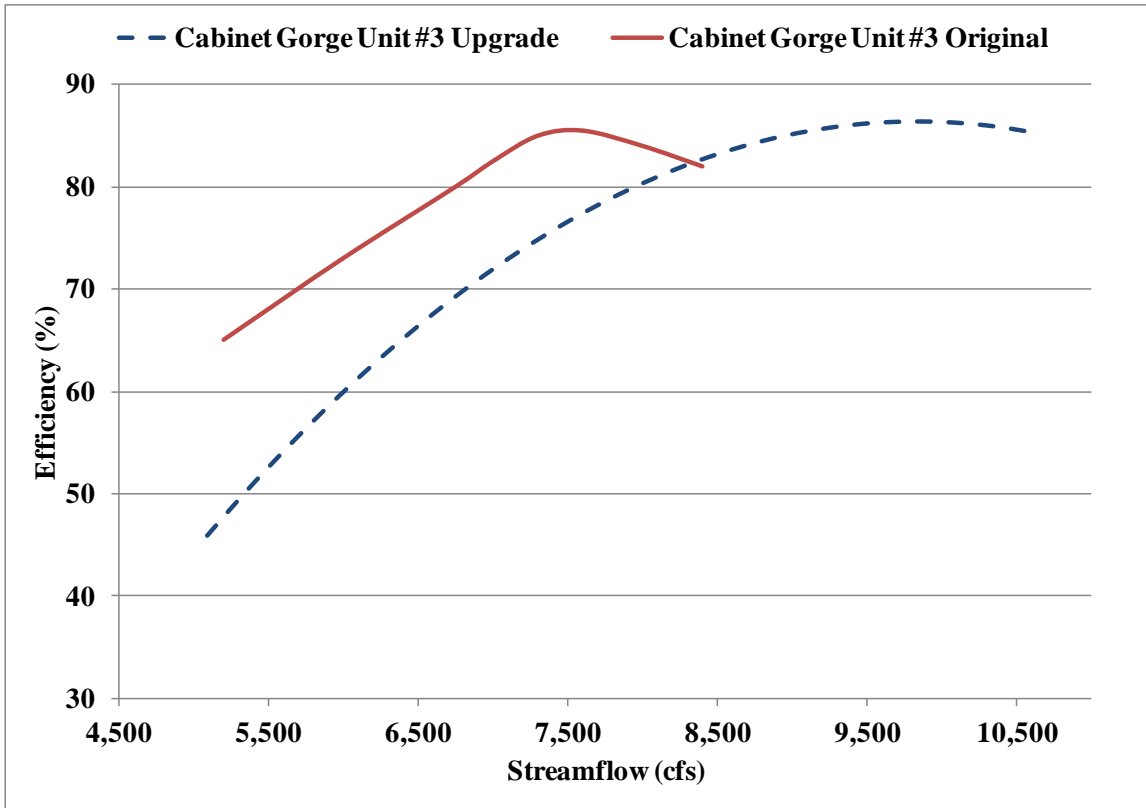
**Illustration 1: Cabinet Gorge Unit #2 Turbine Curves**



**Cabinet Gorge Unit #3 Upgrade**

Avista completed an upgrade project in 2001 for Cabinet Gorge Project Unit #3, which included a runner replacement and generator rewind. The capacity of the unit increased from 55 MW to 72 MW. The Hydro Model study for Cabinet Gorge Unit #3 resulted in 45,808 MWh of annual qualifying renewable energy. Illustration 2 shows the turbines curves for Unit #3 before and after the project upgrade. The upgraded turbine produces energy more efficiently at the higher streamflow conditions where this unit typically operates.

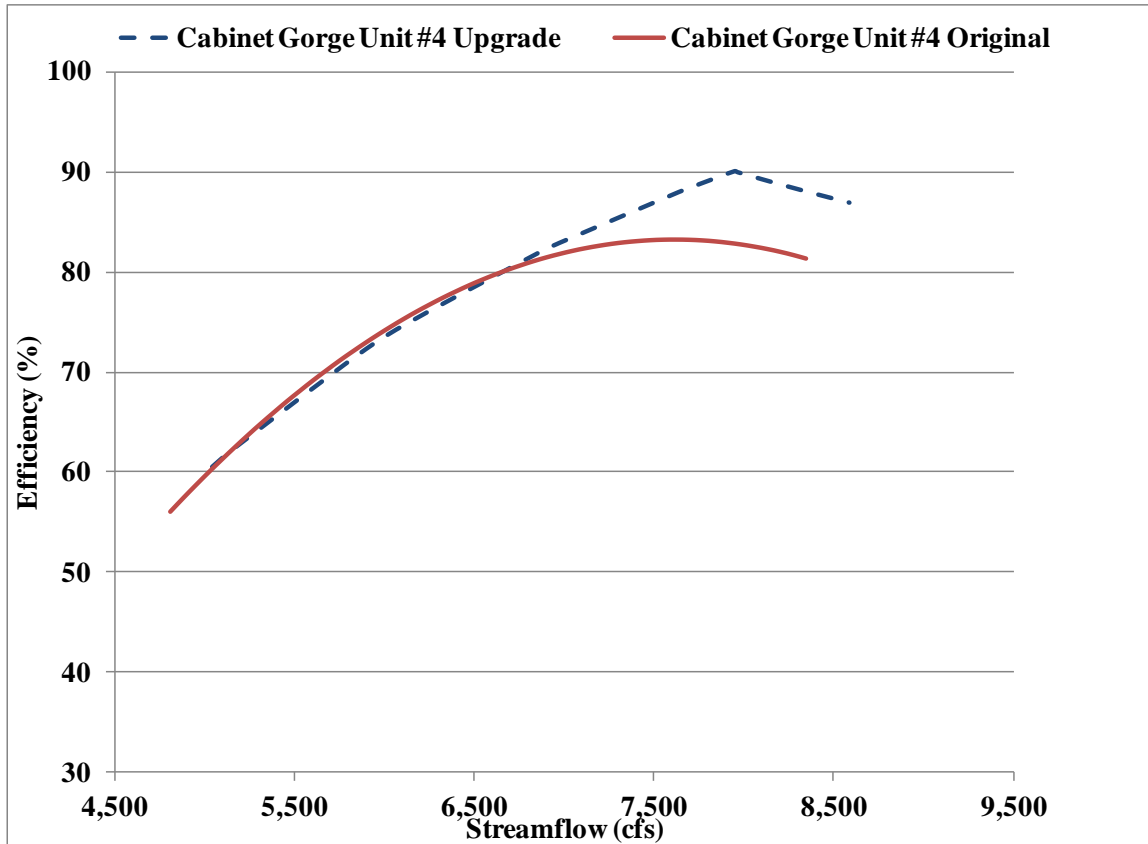
**Illustration 2: Cabinet Gorge Unit #3 Turbine Curves**



**Cabinet Gorge Unit #4 Upgrade**

The Company completed an upgrade project in April 2007 for the Cabinet Gorge Project Unit #4, which included a runner replacement and generator rewind. The capacity of the unit increased from 55 MW to 68 MW. The Hydro Model study for Cabinet Gorge Unit #4 resulted in 20,517 MWh of annual qualifying renewable energy. Illustration 3 shows the turbines curves for Unit #4 before and after the project upgrade. The upgraded turbine produces energy more efficiently at the higher streamflow conditions where this unit typically operates. The Commission reviewed the Cabinet Gorge Unit # 4 upgrade in Docket No. UE-070804.

**Illustration 3: Cabinet Gorge Unit #4 Turbine Curves**



### **Noxon Rapids Project Upgrade Descriptions**

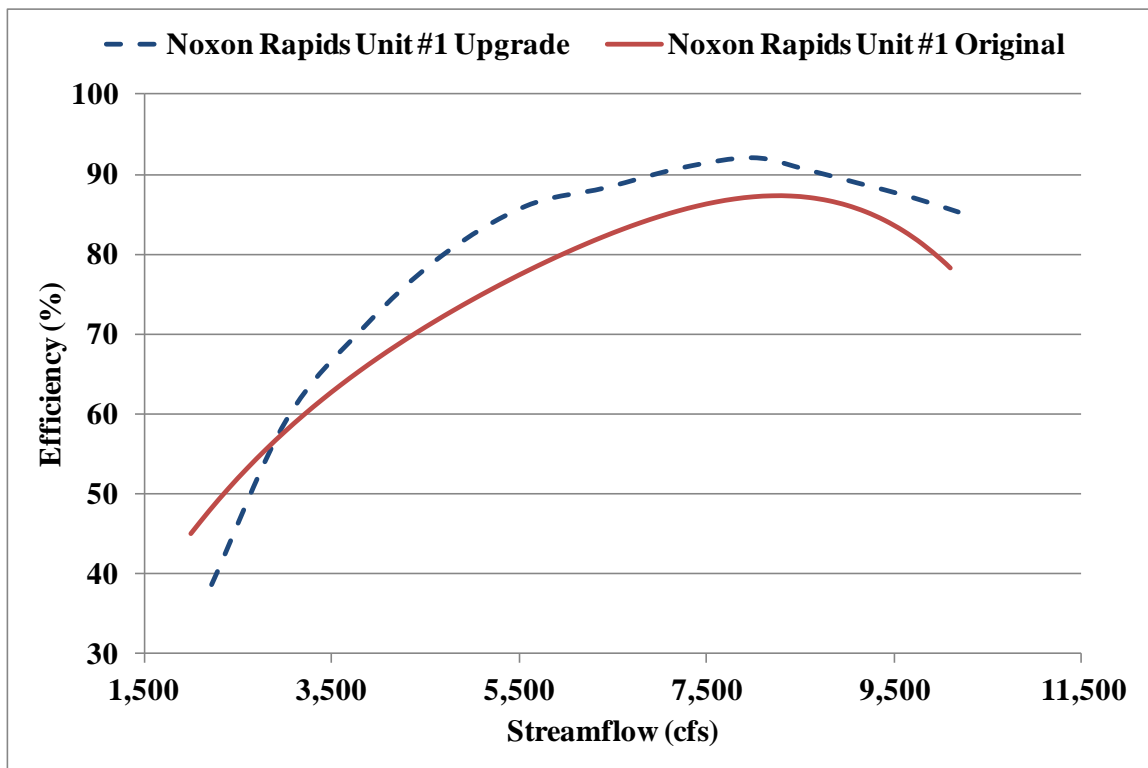
Qualifying hydroelectric upgrade projects to Noxon Rapids Units # 1 – 4 started in 2008 and finished in 2012. The following section provides details about the upgrades, along with the annual incremental renewable energy output for each unit and illustrations of the turbine efficiency curves before and after the upgrades.

#### **Noxon Rapids Unit #1 Upgrade**

The Noxon Rapids Unit #1 upgrade began July 2008 and finished in March 2009. The upgrade included replacement of the stator core, stator rewind, new turbine installation,

and a complete mechanical overhaul. The upgrade increased the unit rating from 105 MW to 112.5 MW. The costs and additional generation of this project were approved for recovery in Docket No. UE-080416. The Hydro Model study for Noxon Rapids Unit #1 resulted in 21,435 MWh of annual qualifying renewable energy. Illustration 4 shows the turbines curves for Unit #1 before and after the upgrade. The upgraded turbine produces energy more efficiently at the streamflow conditions where this unit typically operates.

**Illustration 4: Noxon Rapids Unit #1 Turbine Curves**



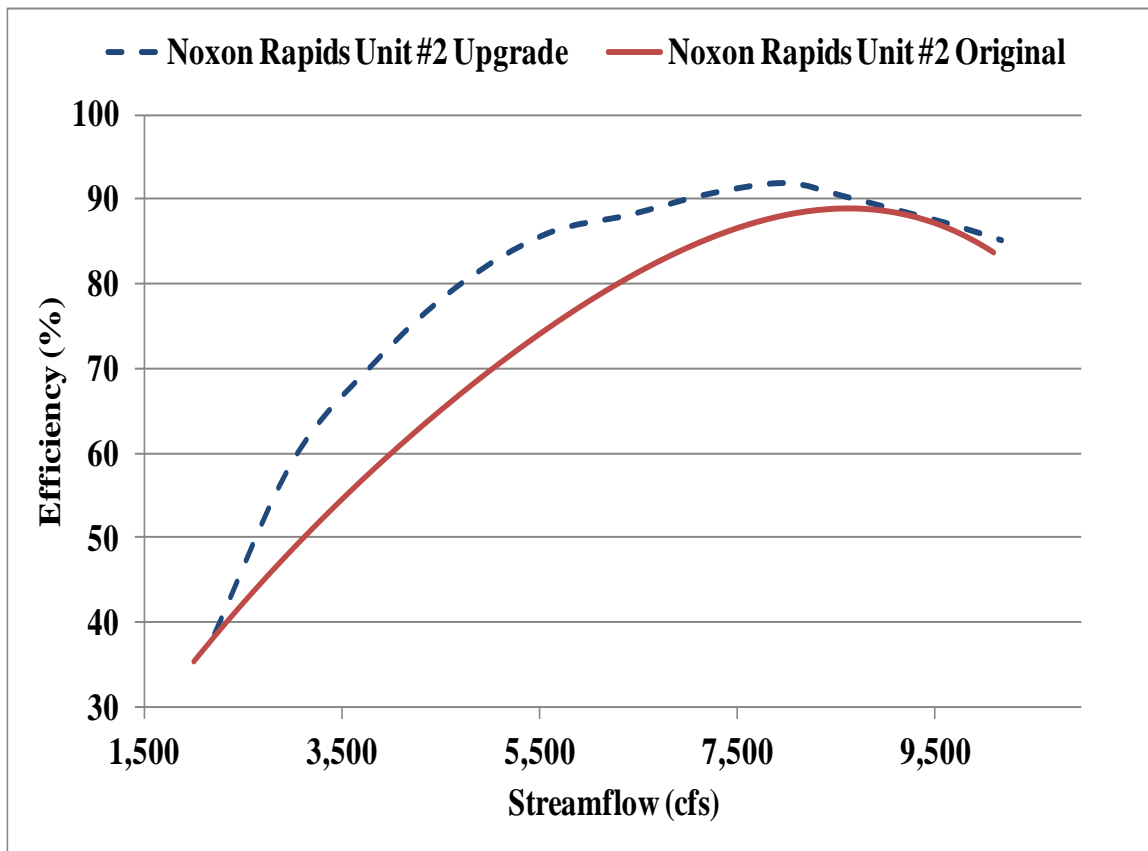
### **Noxon Rapids Unit #2 Upgrade**

The Noxon Rapids Unit #2 upgrade included a new turbine and complete mechanical overhaul which was completed in May 2011. This upgrade increased the unit rating by 7.5 MW. The costs and additional generation for Unit #2 were approved for recovery in



Docket No. UE-100467. The Hydro Model study for Noxon Rapids Unit #2 resulted in 7,709 MWh of annual qualifying renewable energy. Illustration 5 shows the turbines curves for Unit #2 before and after the project upgrade. The upgraded turbine produces energy more efficiently at the streamflow conditions where this unit typically operates.

**Illustration 5: Noxon Rapids Unit #2 Turbine Curves**

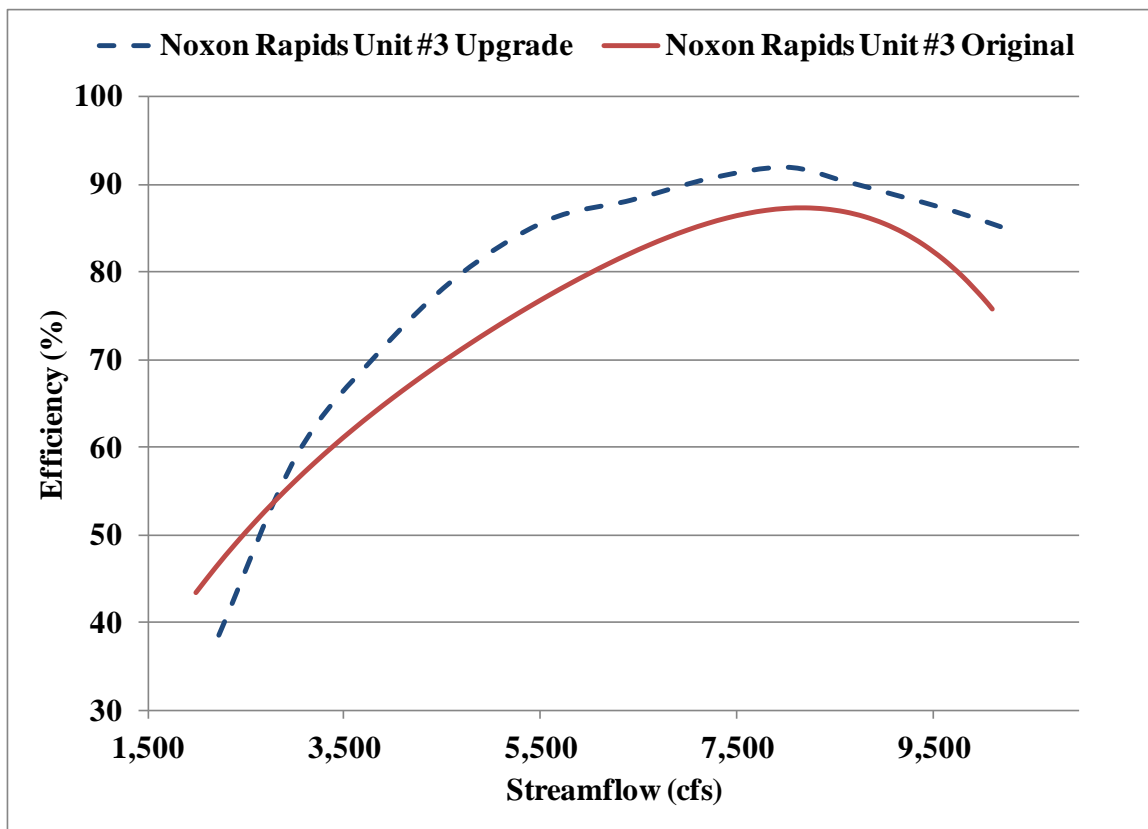


### **Noxon Rapids Unit #3 Upgrade**

The Noxon Rapids Unit #3 upgrade was completed in May 2010. The upgrade included a turbine runner replacement, which increased the unit rating by 7.5 MW. The costs and additional generation for Unit #3 were approved for recovery in Docket No. UE-090134.

The Hydro Model study for Noxon Rapids Unit #3 resulted in 14,529 MWh of annual qualifying renewable energy. Illustration 6 shows the turbines curves for Unit #3 before and after the project upgrade. The upgraded turbine produces energy more efficiently at the streamflow conditions where this unit typically operates. The Commission reviewed the Noxon Rapids Unit # 3 upgrade in Docket Nos. UE-090134 and UE-100467.

**Illustration 6: Noxon Rapids Unit #3 Turbine Curves**

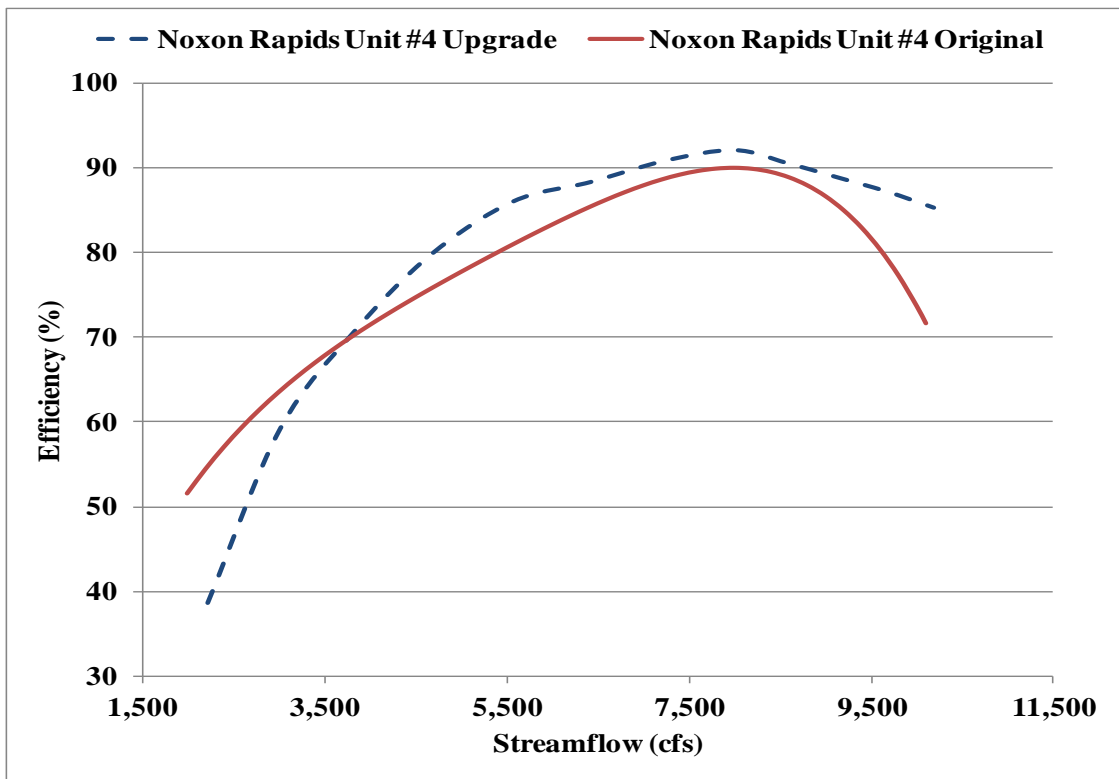


#### **Noxon Rapids Unit #4 Upgrade**

The upgrade work at Noxon Rapids Unit #4 involved the installation of a new turbine and a complete mechanical overhaul. The project started in August 2011 and was completed in May 2012. The Unit #4 upgrade increased the unit capacity rating by 7.5 MW. The

Hydro Model study for Noxon Rapids Unit #4 resulted in 12,024 MWh of incremental generation. Illustration 7 shows the estimated turbines curves for Unit #4 before and after the project upgrade. The upgraded turbine produces energy more efficiently at the streamflow conditions where this unit typically operates. The Commission reviewed the Noxon Rapids Unit # 4 upgrade in Docket No. UE-120436.

**Illustration 7: Noxon Rapids Unit #4 Turbine Curves**



**Summary of Clark Fork Upgrades**

Table 1 summarizes the annual incremental energy amounts determined by the Hydro Model for 2002 through 2011. The average annual incremental energy over the 10-year period is the amount of qualifying renewable energy output from each hydroelectric

upgrade. The supporting documentation for Table 1 is in the confidential work papers for this filing.

**Table 1: Clark Fork Annual Incremental Energy from Qualified Upgrades**

<b>Incremental MWh</b>							
<b>Year</b>	<b>Cabinet Gorge #3 Upgrade</b>	<b>Cabinet Gorge #2 Upgrade</b>	<b>Cabinet Gorge #4 Upgrade</b>	<b>Noxon Rapids #1 Upgrade</b>	<b>Noxon Rapids #3 Upgrade</b>	<b>Noxon Rapids #2 Upgrade</b>	<b>Noxon Rapids #4 Upgrade</b>
<b>2002</b>	46,810	26,882	26,104	23,508	14,667	8,894	27,663
<b>2003</b>	49,045	25,233	21,934	15,482	14,334	4,475	6,662
<b>2004</b>	57,013	16,472	24,553	18,934	10,259	6,509	8,959
<b>2005</b>	56,495	26,096	19,618	18,250	14,045	6,558	11,381
<b>2006</b>	33,813	44,828	12,959	29,488	17,737	6,400	14,587
<b>2007</b>	40,336	26,420	19,451	18,177	11,181	10,171	2,086
<b>2008</b>	36,328	32,724	11,501	25,007	19,828	7,373	27,736
<b>2009</b>	64,735	27,659	22,165	18,554	14,744	8,179	11,361
<b>2010</b>	49,588	22,827	21,658	16,795	13,119	8,685	10,042
<b>2011</b>	23,914	40,941	21,451	33,926	15,372	9,850	31,708
<b>Average</b>	<b>45,808</b>	<b>29,008</b>	<b>20,517</b>	<b>21,435</b>	<b>14,529</b>	<b>7,709</b>	<b>12,024</b>