OUTPUT ASSESSMENT FOR AUGLAIZE HYDROELECTRIC PLANT

1 SUPPLEMENT TO APPLICATION

The City of Bryan ("the City") has significantly invested in the Auglaize hydroelectric plant since purchasing the plant in 1996, and has applied to certify the four remaining (uncertified) units as Ohio Renewable Energy Resources (RENs) under the state's Alternative Energy Portfolio Standard.[1] Per section 4928.64 of the Revised Code, "alternative energy resource" includes renewable energy resources created on or after January 1, 1998, by the modification or retrofit of any facility placed in service prior to January 1, 1998. Without significant rehabilitative work, continuing maintenance, and improvement projects since 1998, Auglaize hydroelectric plant would not be able to provide reliable, renewable generation. Therefore, the City has applied for all remaining capacity to be certified as RENs.

However, the City understands another interpretation is that—even though the existing usable capacity would not exist if not for the investments made since January 1, 1998—only the capacity available today that is above the capacity available on January 1, 1998 should be certified as renewable. In light of this, the City has requested MWH to assess available generation data and comment on the capacity of the Auglaize hydroelectric plant that is incremental to the capacity available in 1998.

The following assessment is a supplement the applications submitted on November 2, 2010.

A summary of capacities (proposed and incremental) is shown in Table 1, below.

Table 1: Summary Renewable Capacity Estimates

Unit	Proposed REN Capacity (kW)	Incremental Capacity (kW)
Unit 1	800	150
Unit 2	*N/A; already certified*	*N/A; already certified*
Unit 3	1,100	1,100 (new unit) or 229 kW (above 1998 levels)
Unit 4	800	150
Unit 5	800	150
Unit 6	*N/A; already certified*	*N/A; already certified*

2 BACKGROUND

The Auglaize hydroelectric plant is located on the Auglaize River, just south of Defiance, Ohio. The original dam was built in 1912 by the Auglaize Power Company. The original power plant was decommissioned in 1962, and the generating equipment was relocated. In the 1980s, Power Dam Corporation bought and recommissioned the plant. The City purchased Auglaize hydroelectric plant on October 30, 1996.

[1] Case reference numbers for Units 1, 3, 4, and 5 are 10-2363, 10-2368, 10-2364, and 10-2365, respectively.

Since 1996, the City has invested significant funds in rehabilitating and upgrading the facility. Upgrades include (but are not limited to) the following:

- In March 2002, flashboards were installed at the dam, increasing the gross head by 9%—from 22 ft. to 24 ft.
- In mid-2004, two new units (Unit 2 and Unit 6) were commissioned and online.
- In 2004, Unit 3 was replaced following a fire to the Unit 3 generator in 2002 (caused by lightning striking the powerhouse).
- In April 2012, generator rewinds were completed for Unit 1 and Unit 4; the generator rewinds added 10% more copper to the windings and increased insulation. The generator rewinds removed operational/output constraints that were due to temperature limitations.
- In spring of 2013, the Unit 5 generator rewind was completed.

The estimated capacity (in kilowatts, kW) of each unit is shown in Table 2, below. [2]

Table 2: Unit Capacity (kW)[2]

Unit	1998 Capacity (kW)[3]*	2013 Capacity (kW)
Unit 1	650	800
Unit 2	0	1,100
Unit 3	871	1,100
Unit 4	650	800
Unit 5	650	800
Unit 6	0	140
Total Plant	***2,821***	***4,740***

The two newest units, Unit 2 and Unit 6, have been certified as RENs under the Ohio's Alternative Energy Portfolio Standard, which allows them to produce Renewable Energy Credits (RECs) for each megawatt of generation. These are certified as "Auglaize Hydroelectric Plant" (certificate ID: 10-HYD-OH-GATS-0060; case reference 09-1062), approved on February 24, 2010 for 1.09 MW.

3 ASSESSMENT

The generator rewinds and flashboard installation have increased output capacity; at a minimum, this incremental capacity qualifies as REN capacity under Chapter 4901:1-40, Alternative Energy Portfolio Standard. The City has requested that MWH look at the available generation data to estimate the increased capacity provided by these enhancements.

[2] Note that these reflect approximate unit capacity under operating conditions. These are not rated capacity; some of the units are rated for conditions different from those at Auglaize, and thus the nameplate unit rating is not accurate. For example, the low flow unit (Unit 6) is rated at 240 kW, but can only achieve approximately 140 kW at the site.

[3] The 1998 capacities were estimated based on discussions with plant staff, available historic generation, flashboard increase calculations, reported output increases due to generator rewinds, and current maximum output. This is described more in Section 3.

3.1 Review of Generation Data

The assessment of increased capacity is limited by a lack of detailed generation data before 1998. In addition, the most recent improvements were only just completed; the dataset for the post-improvement condition is not extensive. That said, looking at the available datasets and comparing output on days with similar hydrological conditions provides one way to estimate increased capacity due to plant improvements.

Bryan Municipal Utilities (BMU) provided MWH with SCADA output that contained unit output in megawatts (MW) at 1-minute intervals for the period June 22, 2013, 10:41 PM through August 7, 2013, 10:55 AM.[4] For historic data, records of daily generation (kWh) as well as which units were on and offline were available in physical paper records. These were entered in a Microsoft Excel spreadsheet and provided to MWH in this electronic format.

In order to compare the 1998 performance with the post-improvement performance, the 2013 SCADA data were aggregated by day for each unit to compute daily generation (kWh). The generation for Units 1, 3, 4, and 5 (i.e. the units that are not approved as RENs, and the units that existed in 1998) was combined to yield a daily value that could be compared to the 1998 records for the same time period. This comparison is shown graphically in Figure 1, below, along with the daily average flow at USGS gage 04191500 ("Auglaize River near Defiance OH") from June 23, 2013, through August 6, 2013.

[4] From the provided SCADA dataset, the maximum unit outputs were as follows: Unit 1, 841 kW; Unit 3, 1080 kW; Unit 4, 833 kW; Unit 5, 884 kW.

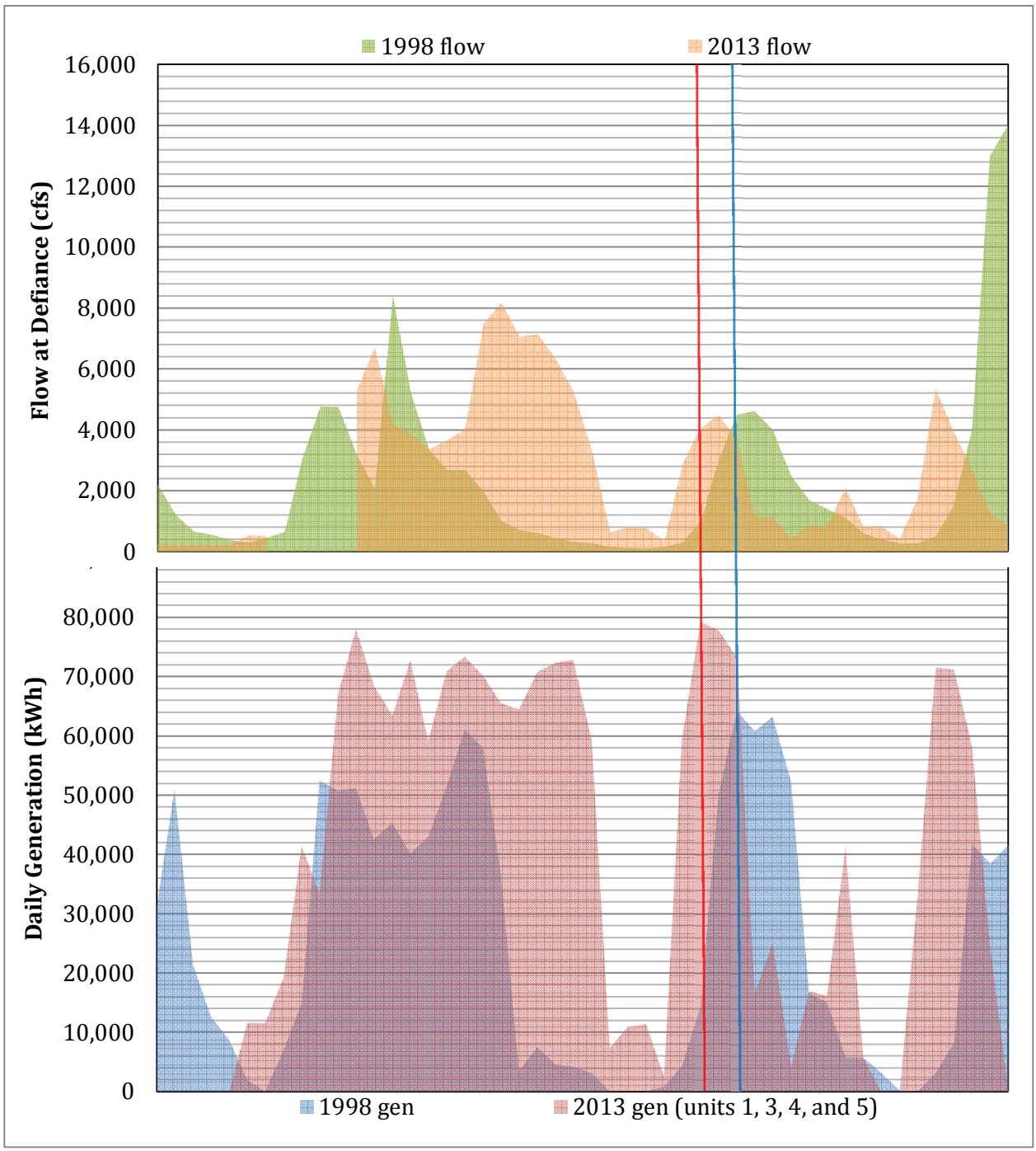

Figure 1: Comparison of 1998 and 2013 flow and generation for Units 1, 3, 4, ad 5 at Auglaize

It can be seen here that the peak output for both the 1998 series and the 2013 series occurs at approximately the same recorded river flow—between 4,000 and 4,500 cfs. The 2013 maximum output for the subject period is 79,256 kWh with a recorded flow of 4,070 cfs at USGS gage 04191500 (July 22, 2013); this corresponds to a capacity factor of 94.4% based on the capacity estimates provided in Table 2. The 1998 maximum output for the subject period is 64,220 kWh with a recorded flow of 4,500 cfs at USGS gage 04191500 (July 24, 1998); this corresponds to a

capacity factor of 94.9% based on the capacity estimates provided in Table 2. From both datasets, the output reflects Units 1, 3, 4, and 5 operating (in the 2013 dataset, the contribution of Unit 2 and Unit 6 were excluded); that is, all units of interest were operating during the two highest output days. This high level review of generation data would indicate that approximately 627 kW of capacity has been added amongst Units 1, 3, 4 and 5 (assuming consistent conditions throughout the day).

3.2 Contribution due to Flashboards (All Units) – 2002

BMU staff report that before the generator rewinds and flashboard installation, the three 800 kW units (Units 1, 4, and 5) could not operate above 650 kW. Gross head increased just over 9% after flashboards were installed, indicating that the potential output rose to 709 kW per unit, 59 kW above the previous unit maximum output. However, prior to the generator rewinds, the units were constrained by temperature limitations associated with the old windings. Therefore, this peak output increase may not have been realized until after the generator rewinds for Units 1, 4, and 5.

Just before the Unit 3 outage that resulted in replacing the unit, the maximum output of this unit was reportedly 950 kW. This is believed to be the maximum output after flashboard installation. Removing the approximately 9% increase attributed to flashboard installation from the 950 kW output potential of Unit 3, the maximum output prior to the increase in gross head is estimated to be 871 kW.

3.3 Contribution due to Unit Replacement (Unit 3) – 2004

In April 2002, lightning struck the plant and caused the Unit 3 generator to catch fire. The generator had to be replaced, and a new unit was commissioned in 2004. After the unit was replaced with a new unit, the maximum observed output has been approximately 1,100 kW.

This unit replacement (1,100 kW) may be considered entirely new capacity; the unit in operation—defined by the generator, turbine runner, and auxiliary equipment—did not exist in 1998. However, if only considering the incremental capacity to the estimate 1998 capacity, the contribution from the flashboard increase (just over 9% of 871 kW, or 79 kW) and the efficiencies from the unit replacement (new generator, turbine runner, and auxiliary equipment; 150 kW) yields an incremental estimate of 229 kW.

3.4 Contribution due to Generator Rewinds (Units 1, 4, and 5) – 2012 and 2013

The stators and rotors of Units 1, 4, and 5 were rewound with 10% more copper and H class insulation in 2012 and 2013. Based on staff information, the observed maximum output for Units 1, 4, and 5 was 650 kW before the generator rewinds, and has been 800 kW since the generator rewinds. It is understood that the 650 kW maximum output was observed before the flashboard installation; therefore, the 150 kW (per unit) gain includes the increase in output potential from the flashboard installation, which increased gross head. It is estimated that the generator rewind enabled the plant to realize a 59 kW per unit from the flashboard installation, and an additional 91 kW from removing the temperature limitations.

3.5 SUMMARY

Based on this assessment, the following incremental increases in unit capacities between 1998 and 2013 are estimated for Auglaize hydroelectric plant units 1, 3, 4 and 5:

Table 3: Renewable Capacity Estimates for Units 1, 3, 4, and 5

Unit	1998 Capacity (kW)*	2013 Capacity (kW)	Incremental Capacity (kW)
Unit 1	650	800	150
Unit 3	871	1,100	1,100 (new unit) or 229 kW (above 1998 levels)
Unit 4	650	800	150
Unit 5	650	800	150
Total	***2,821***	***3,500***	***1,550 (new Unit 3) or 679 (above 1998 level)***

The incremental generation appears to be at least 679 kW based on information provided by BMU staff; this is supported by reviewing a small subset of historic generation data, where a similar increase (627 kW) was observed (see Section 3.1).

Without ongoing improvement projects and maintenance investments, the plant that existed in 1998 would not be operational. Hydropower is a clean, reliable, renewable resource, but requires ongoing investments in order to maintain its safety and reliability. While nearly 700 kW of incremental capacity can be traced back to distinct investments, the ongoing routine maintenance and small improvement projects have kept the plant online. The 3,500 kW of renewable energy capacity at Auglaize [between Units 1, 3, 4, and 5] would not be available if not for continued investments in renewable resources made since 1998.

4 DETERMINING RENEWABLE GENERATION FOR A SUBSET OF CAPACITY

If the Public Utilities Commission of Ohio chooses to certify only a portion of the current unit capacities, the RECs that are submitted each month may not necessarily be equal to the full unit output. Based on other programs that certify partial unit output, the eligible generation would be up to the maximum contribution of the approved incremental capacity. For example, if 150 kW was approved for Unit 1, the generation eligible for Unit 1 would be up to the product of the approved capacity (0.15 MW) and the hours in the month. If Unit 1 generation exceeded that amount, the generation above the approved maximum would not be eligible for creating associated RECs. If the monthly generation for Unit 1 was below the calculated generation eligible for RECs, then the RECs for that month would be equal to Unit 1's generation in that month (the lesser of the two values). The maximum monthly RECs using the incremental capacities presented in this document are presented in Table 4, below.

Table 4: Maximum Monthly RECs associated with Estimated Incremental Capacities

	Hours per month	**Unit 1**	**Unit 3**, incremental	**Unit 4**	**Unit 5**
Incremental capacity (kW)	--	*150*	*229*	*150*	*150*
January	*744*	111	170	111	111
February (leap year)	*672 (696)*	100 (104)	153 (159)	100 (104)	100 (104)
March	*744*	111	170	111	111
April	*720*	108	164	108	108
May	*744*	111	170	111	111
June	*720*	108	164	108	108
July	*744*	111	170	111	111
August	*744*	111	170	111	111
September	*720*	108	164	108	108
October	*744*	111	170	111	111
November	*720*	108	164	108	108
December	*744*	111	170	111	111

If the replacement unit for Unit 3 is recognized as a new renewable resource since 1998, then the total generation for Unit 3 would be eligible for RECs rather than the subset presented in Table 4, above.

Summary: Amended Application Supplement to application: assessment of incremental capacity electronically filed by Kathleen M King on behalf of MWH and Ms. Kathleen M. King