Executive Summary

An Economic Analysis of the Conowingo Hydroelectric Generating Stations

Prepared for: Water Power Law Group

An analysis was conducted by Energy and Environmental Economics, Inc. (E3) to estimate the range of market revenues for Conowingo Hydropower Dam, assuming it remains a merchant generator in the Mid-Atlantic electricity market, in order to inform how much economic headroom (i.e., excess profits) exists to mitigate the incremental impacts of the Dam's continued operation on ecological resources of the Susquehanna River and Chesapeake Bay. The analysis focused on identifying market revenue estimates for the project, costs associated with owning and operating the project, how benefits and costs change under different operational scenarios and how much economic headroom is potentially available.

E3 used publicly available information including river flow information and market data from PJM, the regional electricity transmission organization in the Mid-Atlantic, to develop estimates for electricity generation and associated market revenues for a variety of operational scenarios. E3 estimated economic headroom through financial *proforma* modeling.

Estimates for the total revenues for Conowingo range between $115 million to $121 million annually. Estimates for available headroom---after a 10% rate of return--- ranged from $27 million to $44 million annually depending on the operational scenario and climate conditions, as well as the range of revenue estimates. These values translate to a present value capital investment that could be used towards mitigation efforts of at least $268 million (real 2008 $).

The estimates of revenues and headroom, did not include the following sensitivities. First, compensation through renewable energy markets, for example a Renewable Energy Credit (REC) payment that the project could potentially be eligible for if it were able to get certified as an eligible resource, was not explicitly assessed. This additional value stream could potentially increase the revenues Conowingo could earn over the term of their requested license. Based on preliminary estimates, the REC payment necessary to offset revenue losses is within range of REC market values. Secondly, it is likely that revenues for Conowingo have declined in recent years due to the suppression of energy market prices in PJM. In addition, the total generation from Conowingo seems to vary significantly from year to year, which may change the revenue estimates for the project. Finally, this analysis does not include the operations or economics of Muddy Run pumped storage, rather it focused on the incremental economics of Conowingo dam. The operations and combined economics of the projects were filed with FERC.

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Final: August 8th, 2017

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1 Background

Energy and Environmental Economics, Inc. (E3) was retained by the Water and Power Law Group PC ("WPLG" or "client") to perform an economic analysis of the Conowingo Hydroelectric Generating Station ("Conowingo" or "Project"), which is wholly owned and operated by Exelon Corporation. The project is a 570 MW hydroelectric peaking plant located on the Susquehanna River in northern Maryland.[1]

The purpose of this analysis is to provide an estimation of the range of market revenues for Conowingo assuming it remains a merchant generator in the PJM market[2]. This analysis has been performed to help WPLG, The Nature Conservancy and the Chesapeake Bay Foundation develop a more informed strategy associated with Exelon's relicensing process for the Project with the Federal Energy Regulatory Commission (FERC) and Maryland regulatory agencies. Ultimately, the economic valuation can be used to inform how much economic headroom exists to support Exelon's investment in mitigating its effects on ecological resources of the Susquehanna River and Chesapeake Bay.

We address the following questions with this report:

+ What are the market revenue estimates for the project?
+ What are the costs associated with owning and operating the project?
+ How do these benefits and costs change under different operational scenarios?
+ How much headroom is potentially available for mitigation efforts in the Susquehanna River and Chesapeake Bay?

[1] More details can be found on Exelon's website: **http://www.exeloncorp.com/locations/power-plants/conowingo-hydroelectric-generating-station**

[2] PJM Interconnection is a regional transmission organization (RTO) responsible for maintaining wholesale electricity markets for energy, capacity and ancillary services in all or parts of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia and the District of Columbia. More details can be found here: **http://www.pjm.com/about-pjm/who-we-are.aspx**

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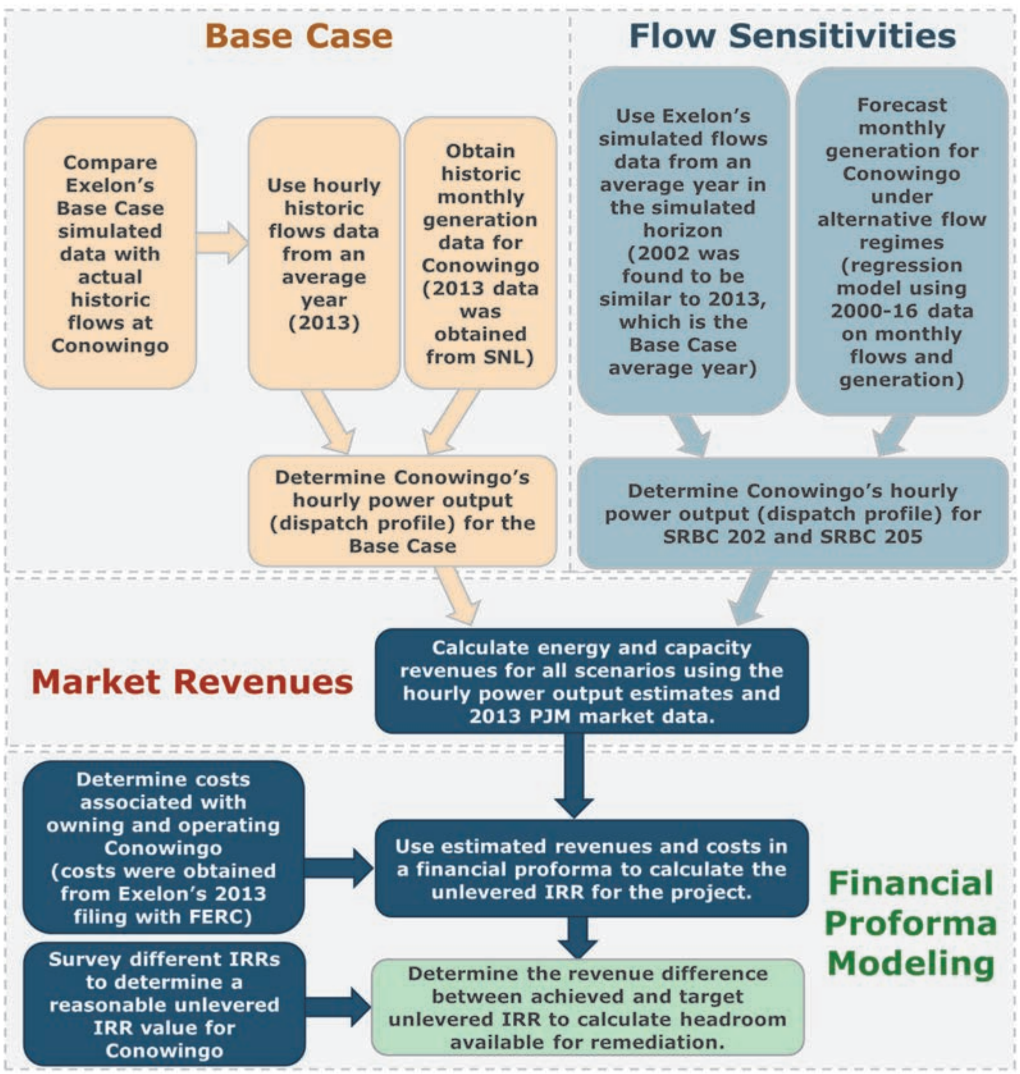
2 Analysis Approach

The inputs and methodology used in the analysis are described in detail in sections 2.1 and 2.2 respectively. For the analysis, E3 used available flows and PJM market data, and developed estimates for hourly Conowingo generation and associated market revenues for the Base Case as well as the flow scenarios. An overview of the analysis is shown in Figure 1.

Figure 1: Analysis overview for the Base Case as well as the flow scenarios.



2.1 Input Data, Assumptions and Limitations

2.1.1 INPUTS

In order to identify which year to use for the Base Case, E3 analyzed PJM market prices, USGS flows at Conowingo, and historic generation levels for the project. Table 1 shows the values for the parameters used to identify an 'average' year for the Base Case. Even though annual average flows at Conowingo are closer to the period average in 2010 and 2014, E3 picked 2013 as an average year due to the annual average day ahead LMP and total annual generation at Conowingo being close to the period average.

Table 1: Base Case Selection - 2013 flows, prices, and generation approximate the average values in the 2010-2016 period.

Year	Annual Average Day Ahead LMP[3] ($/MWh)	Annual Average Flows (cfs)	Total Annual Generation (MWh)
2010	49	35,528	1,645,359
2011	45	72,090	2,518,452
2012	33	31,697	1,639,132
2013	38	33,351	1,699,398
2014	52	34,927	1,594,647
2015	32	30,909	1,597,488
2016	23	27,295	1,369,003
Average 2010-16	39	37,971	1,723,354

Table 2 summarizes the data used for the analysis, and the corresponding sources, for the Base Case and the two sensitivity scenarios.

[3] (LMP) Locational marginal pricing

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Table 2: Key data inputs and a description of data sources.

Key Inputs	Base Case	SRBC 202	SRBC 205
Flows: Flows at Conowingo	Historic hourly flows for 2013 from United States Geological Survey (USGS)	2002 SRBC 202 hourly flows simulated by Exelon (provided to E3 by the Nature Conservancy)	2002 SRBC 205 hourly flows simulated by Exelon (provided to E3 by the Nature Conservancy)
Power Production: Monthly generation	Historic 2013 monthly generation data obtained from SNL Energy	Forecasted from 2002 cumulative monthly flows simulated by Exelon for SRBC 202	Forecasted from 2002 cumulative monthly flows simulated by Exelon for SRBC 205
Generation profile: Hourly power production	Calculated by E3 using hourly to monthly flow ratios to allocate 2013 historic monthly generation	Calculated by E3 using hourly to monthly flow ratios to allocate forecasted 2002 SRBC 202 monthly generation	Calculated by E3 using hourly to monthly flow ratios to allocate forecasted 2002 SRBC 205 monthly generation
Market data: PJM energy and capacity market data	2013 historic PJM market data used across all flow scenarios - Hourly energy prices - Seasonal capacity prices		

2.1.2 ASSUMPTIONS AND LIMITATIONS.

It is important to note that Exelon operates Conowingo and Muddy Run, which is a pumped hydro storage facility upstream of Conowingo, as a coordinated facility. Conowingo pond provides the after bay for generation at Muddy Run. For the purpose of this analysis, E3 has focused on Conowingo only, and assumed Muddy Run's impacts on Conowingo operations are captured in historic operations data, as well as Exelon's simulated data for the alternative flow regimes (SRBC 202 and SRBC 205).

In addition, energy prices and flow regimes for a Base Year (2013) were assumed to be constant for the study horizon. Changes to either would change the valuation results, but the examination of those sensitivities is outside of the scope of the analysis.

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2.2 Methodology Description

In order to address the four study questions, E3 utilized a combination of publicly available data published market and hydro flow data, and generation data developed by Exelon and provided by The Nature Conservancy. E3 analyzed three scenarios, described in more detail below.

E3's methodology included the following steps for each scenario:

1. Determining flows at Conowingo
2. Developing Conowingo dispatch profile
3. Estimating market revenues
4. Estimating target and achieved unlevered IRR
5. Calculating annual and upfront capital available for mitigation

These steps are described in detail below.

2.2.1 STEP 1: DETERMINING FLOWS AT CONOWINGO

2.2.1.1 Overview of Operational Scenarios

For this study, the economics of Conowingo dam were estimated using three operational scenarios; the base case scenario and two potential future scenarios that were developed and proposed by stakeholders through the FERC re-licensing process.[4] A description of each scenario is included in Table 3 and the operational parameters for each scenario are included in Appendix 5.2. The scenarios are approximations based on best available data, therefore each has limitations in its ability to simulate future conditions.

[4] TNC MOI 2015.

Scenario Name		Description
The Base Case		Current operations with primary goal of maximizing revenue. This does not include moderate increases to minimum flow releases proposed by Exelon in their recent CWA 401 application.
Alternative Flow Regimes	SRBC 202	Potential future operations to restore up to 50% of maximum available habitat. Includes higher minimum releases, a capped maximum generation flow during key spawning and reproductive months and a guided rate of change.
	SRBC 205	Potential future operations, similar to SRBC 202, but include run-of-river operations during spring to improve migratory fish habitat. It is hypothesized that this level of mitigation may make the facility eligible for compensation under renewable energy markets.[5]

The Base Case was developed using data from a year representative of average PJM market prices, average Conowingo flows, and average annual power generation at the dam. The client was also interested in understanding the impact of alternative flow regimes at Conowingo on the revenues, and consequently the available headroom. The alternative flow regimes analyzed were SRBC 202 and SRBC 205. SRBC 202 is an alternative flow regime proposed by a group of stakeholders in the relicensing proceeding of Conowingo in Maryland, provided to E3 by The Nature Conservancy. Base Case Flows: Benchmarking Exelon's simulated flows

[5] It is noted that this is hypothetical. In order to be eligible for RPS in Pennsylvania, the facility requires Low Impact Hydropower Institute certification. LIHI certification requires the applicant to meet eight criteria including ecological flows and fish passage.

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For the Base Case, E3 compared historic flows data from an average year obtained from the United States Geological Survey (USGS) website to Exelon's Base Case hydro simulation. With this verification analysis, E3 confirmed that currently, Exelon operates Conowingo in a manner consistent with its Base Case hydro flow simulation.[6]. For the verification analysis E3 compared the hourly USGS flows to Exelon's simulated hourly flows for the Base Case. The datasets had overlap for the October 2007 to December 2007 period.

Figure 2: Benchmarking hourly average Exelon and USGS flows at Conowingo – October 2007 to December 2007.

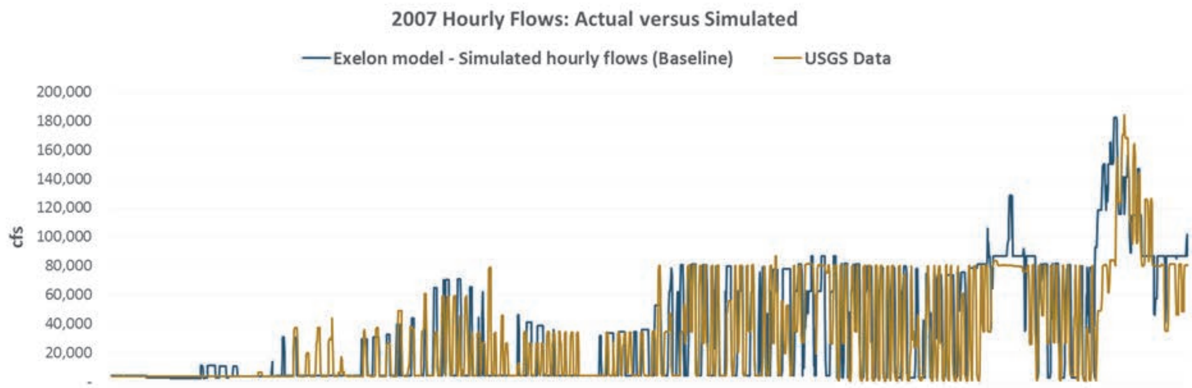
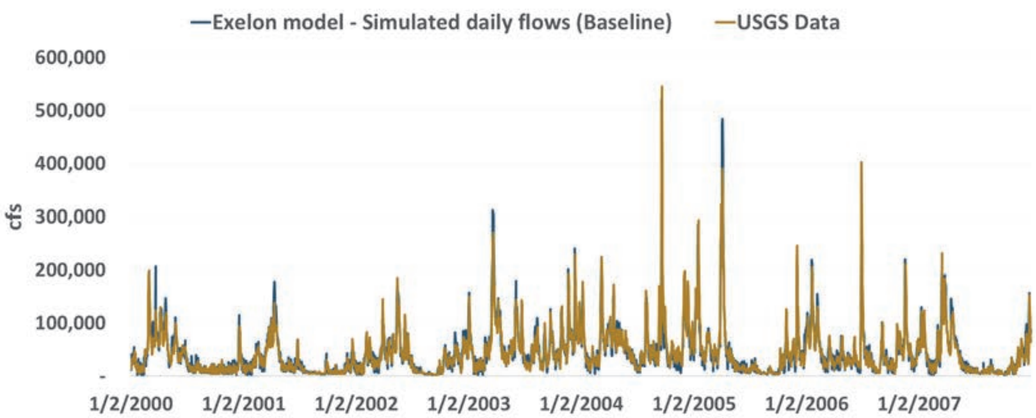


Figure 3: Benchmarking daily average Exelon and USGS flows at Conowingo – 2000 to 2007.

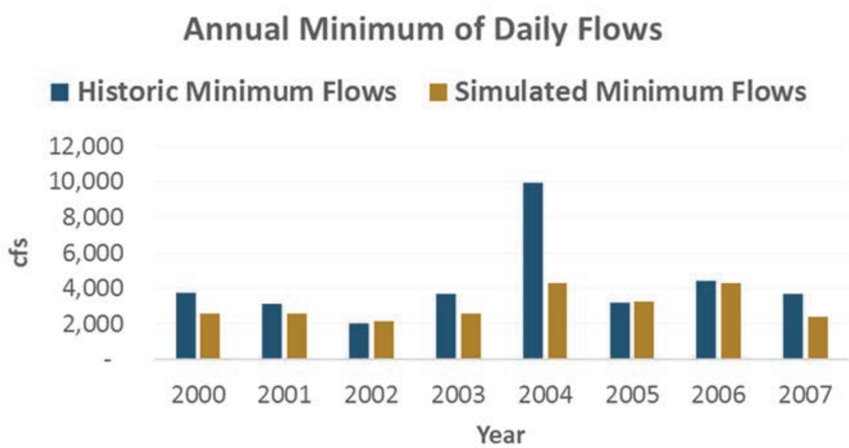


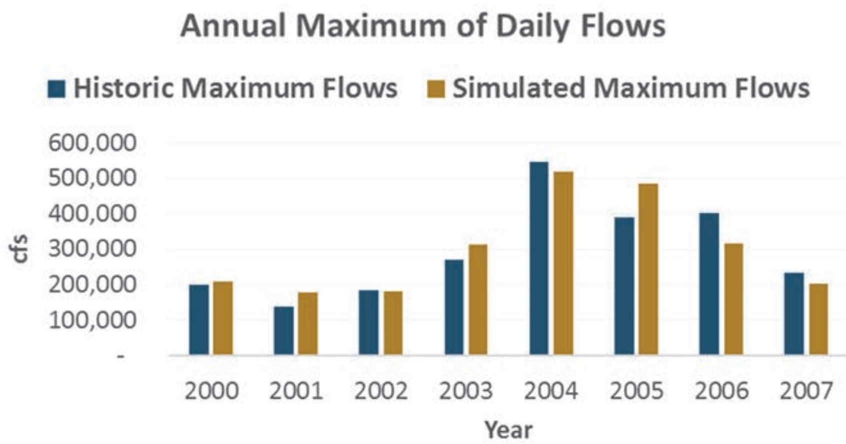
[6] Historical flows data was obtained from USGS: https://waterdata.usgs.gov/usa/nwis/uv?01578310

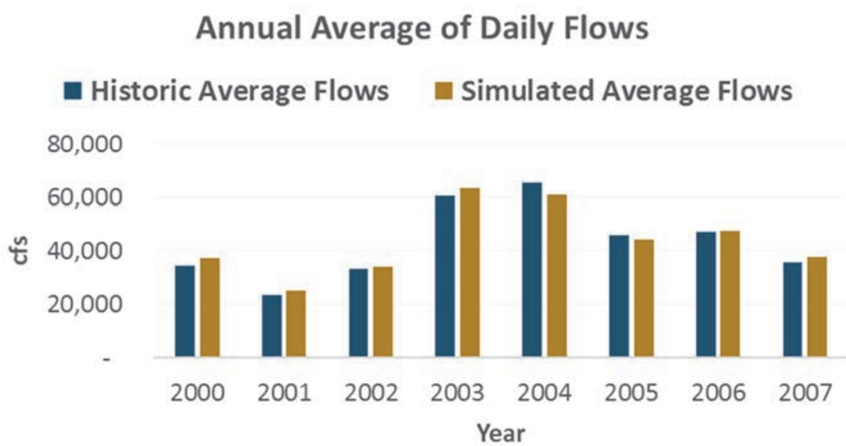
In addition to comparing the flows at the hourly time step, E3 also verified that the historical daily flows were similar to the Base Case daily flows simulated by Exelon. As seen in Figures 2 and 3, Exelon's simulated daily flows in the 2000-2007 timeframe match historically observed data from USGS. Given the similarity in actual and simulated flows, E3 utilized actual flows from 2013 to estimate Conowingo's dispatch profile.

Figure 4 show the comparison between annual minimum, maximum and average flows for the 2000-2007 time horizon.

Figure 4: Comparison of historic and simulated annual daily minimum, maximum and average Conowingo flows.







The comparison of hourly flows by month and daily flows by year can be found in Appendix B.

2.2.1.2 Alternative flow scenarios: SRBC 202 and SRBC 205

For the alternative flow scenarios (SRBC 202 and SRBC 205), E3 used flows data simulated by Exelon,[7] and provided to E3 by The Nature Conservancy. The simulated data was available for the 1967-2007 period. In order to keep the scenario analysis consistent with the Base Case year assumptions, E3 tried to identify a year in the simulation period with flows closely resembling 2013 flows for Conowingo.

[7] The Nature Conservancy provided E3 with data simulated by Exelon for Conowingo flows under different regimes

After comparing the annual minimum, maximum and average flows levels, E3 concluded that year 2002 has similar hydrological conditions at Conowingo to year 2013. E3 also compared the flow duration curves of daily flows, which are the daily flows for the years sorted from the highest to lowest values, for the two years. The comparison is shown in Figure 5.

Table 3 shows the minimum, maximum, average and total flows for the 1980-2007 horizon, and how the values for each of those years compare to the Base Case average year 2013. Figure 3 shows the comparison of the flow duration curves for the year selected from the simulation period (2002) and the Base Case average year (2013).

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Table 3: Comparison of flows in the 1980 – 2007 time horizon to the Base Case average year 2013 (target year shown in green in the table).

	Baseline flows	Baseline flows	Baseline flows	Baseline flows	Difference from target year	Difference from target year	Difference from target year	Difference from target year
	Minimum	Maximum	Average	Total	Minimum	Maximum	Average	Total
2013	3,680	192,000	33,351	12,173,220	-	-	-	-
1980	719	215,000	28,430	10,405,422	(2,961)	23,000	(4,921)	(1,767,798)
1981	726	301,000	30,358	11,080,514	(2,954)	109,000	(2,994)	(1,092,706)
1982	781	211,000	34,619	12,635,852	(2,899)	19,000	1,267	462,632
1983	848	357,000	41,928	15,303,806	(2,832)	165,000	8,577	3,130,586
1984	798	470,000	49,779	18,219,256	(2,882)	278,000	16,428	6,046,036
1985	821	165,000	30,469	11,121,262	(2,859)	(27,000)	(2,882)	(1,051,958)
1986	938	361,000	41,242	15,053,248	(2,742)	169,000	7,890	2,880,028
1987	893	236,000	32,263	11,776,040	(2,787)	44,000	(1,088)	(397,180)
1988	2,260	184,000	27,159	9,940,180	(1,420)	(8,000)	(6,192)	(2,233,040)
1989	2,900	232,000	39,859	14,548,460	(780)	40,000	6,508	2,375,240
1990	4,270	215,000	48,311	17,633,450	590	23,000	14,960	5,460,230
1991	3,810	199,000	29,665	10,827,810	130	7,000	(3,686)	(1,345,410)
1992	1,730	163,000	35,497	12,991,830	(1,950)	(29,000)	2,146	818,610
1993	4,120	467,000	52,476	19,153,600	440	275,000	19,124	6,980,380
1994	2,560	358,000	51,700	18,870,530	(1,120)	166,000	18,349	6,697,310
1995	2,770	174,000	27,972	10,209,960	(910)	(18,000)	(5,379)	(1,963,260)
1996	5,270	622,000	63,467	23,228,860	1,590	430,000	30,116	11,055,640
1997	3,620	118,000	29,705	10,842,380	(60)	(74,000)	(3,646)	(1,330,840)
1998	1,550	332,000	41,327	15,084,440	(2,130)	140,000	7,976	2,911,220
1999	2,110	222,000	26,831	9,793,150	(1,570)	30,000	(6,521)	(2,380,070)
2000	3,760	199,000	34,350	12,572,060	80	7,000	999	398,840
2001	3,100	138,000	23,560	8,599,260	(580)	(54,000)	(9,792)	(3,573,960)
2002	1,990	185,000	33,386	12,185,850	(1,690)	(7,000)	35	12,630
2003	3,680	271,000	60,681	22,148,730	-	79,000	27,330	9,975,510
2004	9,910	545,000	65,536	23,986,310	6,230	353,000	32,185	11,813,090
2005	3,200	390,000	45,805	16,718,950	(480)	198,000	12,454	4,545,730
2006	4,400	403,000	47,075	17,182,500	720	211,000	13,724	5,009,280
2007	3,660	232,000	35,618	13,000,610	(20)	40,000	2,267	827,390

Figure 5: 2002 and 2013 flow duration curves (log scale).

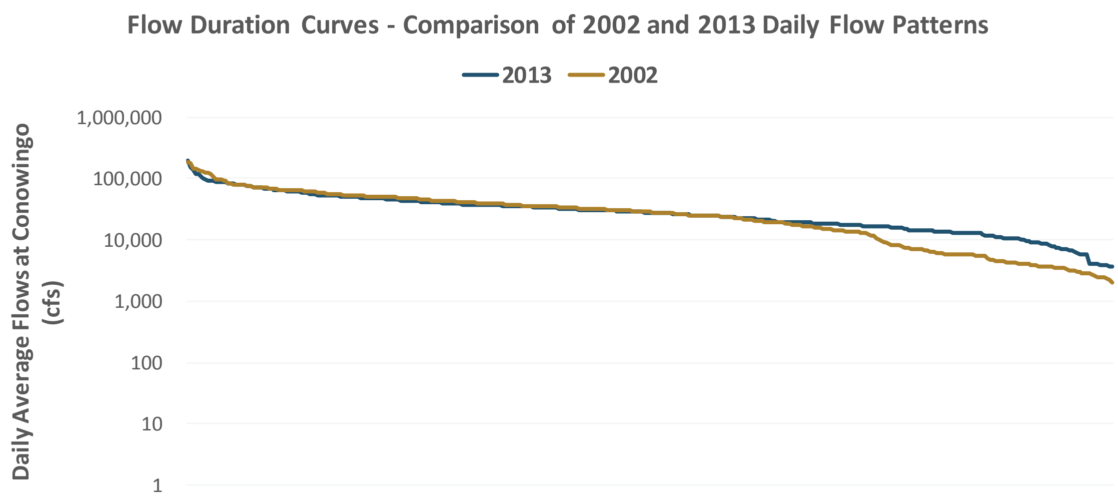

Figure 5 shows that the flows on the lower end are much lower in 2002 than in 2013. However, relative to the other years in the 1980 – 2007 sample, 2002 has mean, minimum, maximum as well as total cumulative flows closest to 2013, which is the Base Case year. All other years have cumulative annual flows, minimum flows and/or maximum flows that are considerably more different from 2013 than 2002 is.

The selection of 2002 as the analysis year for the flow scenarios implies that E3 estimates for total annual generation, as well as corresponding revenues for Conowingo under SRBC 202 and SRBC 205 are likely underestimated.

2.2.2 STEP 2: DEVELOPING HOURLY CONOWINGO DISPATCH PROFILE

Once the flows for the Base Case, SRBC 202 and SRBC 205 were obtained, E3 developed generation data associated with these flow regimes. For the Base Case, E3 was able to utilize historic data on Conowingo's monthly power output obtained from SNL energy, given that historic generation at Conowingo is consistent with the Base Case generation profile.[8] For determination of the generation associated with SRBC 202 and SRBC 205, E3 developed a regression model that utilized historic relationships between monthly cumulative flows and monthly power output. Using the regression model, E3 was able to predict what Conowingo's monthly generation would be for the SRBC 202 and SRBC 205 regimes by using Exelon's simulated data for the monthly flows associated with those two operational regimes.[9]

2.2.2.1 Base Case

E3 obtained monthly generation data from SNL. No hourly generation was available for Conowingo. To estimate power output from flows, E3 used the following formula:

[8]Can be downloaded at: **https://www.snl.com/web/client?auth=inherit#powerplant/PP_GenerationChart?ID=2487**
[9] Please see Appendix 5.3

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Equation 1: Determining the hourly power output from monthly power generation, hourly flows, and cumulative monthly flows.

Hourly power generation = Monthly power generation x (Hourly flows/Monthly flows)

E3 allocated the total historic monthly generation in 2013 to each hour consistent with how total monthly flows were allocated to the hours of the month. This implies that the relationship between flows and power generation is linear, which is a simplifying assumption made for this analysis.

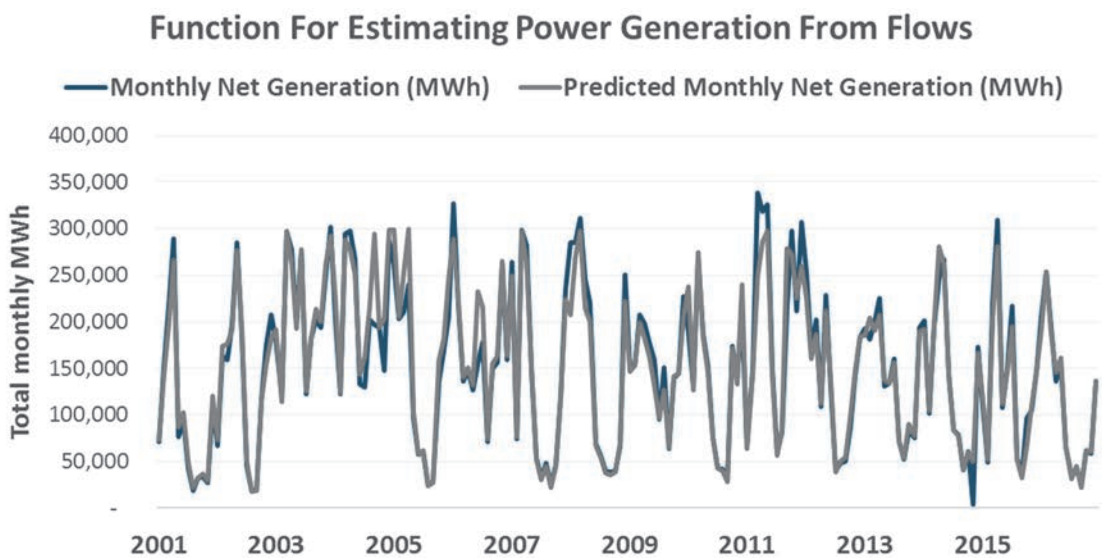
For some hours, using this allocation resulted in power generation that exceeded the project's nameplate capacity. For those hours, the generation was capped at the maximum power output of the project (nameplate capacity), and the difference between the estimated generation and maximum possible generation in each hour was assumed to be compensated at the average annual on-peak energy price.

2.2.2.2 Stakeholder Scenarios (SRBC 202 and SRBC 205)

E3 could not use historic power generation at Conowingo for analyzing SRBC 202 and SRBC 205 as flow regimes, because current operations at Conowingo are different from those two regimes. To estimate generation for the SRBC 202 and SRBC 205 flow regimes, E3 developed a regression model[10] to establish the relationship between cumulative monthly flows and total monthly generation. E3 used 2001 to 2016 historic monthly flows and generation data to develop the model due to Conowingo historic generation data only being available from 2001[11]. Using the relationship established with this simple model, E3 estimated what the monthly power generation for the 2002 simulated year would be, under the SRBC 202 and SRBC 205 operational regimes, by utilizing the monthly cumulative flows provided by Exelon for the two regimes.

[10] Specifications of the model can be found in the Appendix.
[11] SNL data for monthly generation at Conowingo only begins in 2001.

Figure 6: Regression model prediction of monthly flows and actual monthly flows for the 2001-2016 time frame.



E3 compared the estimates from this regression model to Exelon's estimates of the changes in power generation relative to the Base Case for each of these flow scenarios.

For both the sensitivity analyses, E3 used the same methodology for allocating the monthly total generation to create an hourly profile described in Equation 1.

2.2.3 STEP 3: ESTIMATING MARKET REVENUES

Using the estimated dispatch profile for the project, E3 calculated the energy market revenues by multiplying the hourly estimated power output for the different flow regimes (Base Case, SRBC 202, and SRBC 205) and the average year's (2013) hourly day-ahead energy market prices.

In addition, E3 calculated the potential capacity revenues in PJM that could be earned by Conowingo by multiplying the project's unforced capacity value (UCAP) by the average year's seasonal capacity prices posted by PJM. These were assumed to be constant across all the flow regimes.

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For ancillary services revenues, E3 used the values filed by Exelon in 2013 to develop revenue estimates the project could potentially earn in the ancillary service markets for the Base Case. E3 decreased the Base Case ancillary services revenues proportionally to the decline in energy revenues for the SRBC 202 and SRBC 205 flow regimes.

For SRBC 205, E3 estimated the REC price that would be needed for the lost energy and ancillary service revenues due to more constrained operations to be compensated for through the REC markets, i.e. E3 calculated the REC payment that would be needed per MWh of energy generated to make up for the lost PJM market revenues.

For this, E3 calculated the expected revenue losses for SRBC 205 relative to the Base Case, and divided them by the expected change in generation. E3 calculated the implied REC price for Exelon to be indifferent between the Base Case and SRBC 205 using both E3 modeled revenue losses and change in generation, as well as those filed by Exelon and provided by The Nature Conservancy.

2.2.4 STEP 4: ESTIMATING TARGET AND ACHIEVED UNLEVERED IRR

Using the estimated market revenues, and projections of the capital and operating costs associated with owning and operating of Conowingo filed by Exelon with FERC, E3 calculated the 46-year unlevered Internal Rate of Return (IRR) for the project under different flow regimes. We utilized the unlevered IRR metric because return on equity is driven by the amount of debt in the capital structure.

2.2.4.1 Financing Costs

E3 developed a financial proforma model to estimate the unlevered after-tax IRR for Conowingo. To estimate annual capital and operating costs, E3 used Exelon's 2011 and 2013 FERC filings, which had values for annual operations and maintenance costs (O&M), property taxes, capital expenditures, relicensing fees, as well as costs associated with any protection, mitigation and enhancement measures (PM&E). The O&M costs (including O&M associated with environmental measures), and property taxes are assumed to be incurred on an annual basis, whereas the estimated acquisition cost is a one time cost. The estimates for costs associated with the 2016

Fish Passage Settlement Agreement are assumed to be reflected in the annual ongoing PM&E capital expenditures. A summary of the costs can be found in Table 4.

E3 calculated the after-tax unlevered IRR using these cost assumptions, and the revenues for each scenario. Exelon acquired Conowingo in 2008, and is requesting a renewed license to operate the asset through 2055. For calculation of the IRRs, E3 assumed that the revenues stayed constant in each scenario for the 2008 – 2055 time frame.

Table 4: Capital and operating costs from Exelon's 2011 and 2013 FERC filings.

Component	Value
O&M costs	$16M (escalated at 2%)
Property taxes	$3.8M
Estimated 2008 acquisition cost	$281.7M
Annual ongoing capital expenditures	$15.7M
Relicensing costs	$15M
PM&E O&M costs	$55M
PM&E capital costs	$5.4M

2.2.4.2 Determining a reasonable target IRR

E3 compared the unlevered IRR achieved for the different flow regimes to what a reasonable unlevered IRR for the project would be. A reasonable IRR provides Exelon with an unlevered, after-tax return commensurate with the risk it bears owning and operating Conowingo. If Conowingo were fully contracted, the unlevered after-tax IRR should be priced greater than the off-taker's weighted average cost of capital (WACC). For instance, Potomac Electric's WACC is currently

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8.01%.[12] However, Conowingo, as a fully merchant project in PJM, bears energy and capacity market risk, so the expected return would need to be higher than 8%.

E3 researched appropriate rates of return for a fully merchant project and found two potentially appropriate benchmarks. The benchmarks were used to estimate an after-tax IRR that would be reasonable for Conowingo, and compensate Exelon appropriately for the risk associated with Conowingo. The California State Board of Equalization's 2017 capitalization rate study, which is used to assess property taxes, recommends IRRs of 11.2% to 12.8%.[13] This range is based on analysis of independent power producers that hold a mix of contracted and merchant generation assets (Calpine, AES, NRG Energy, Dynegy) and diversified electric utilities (Xcel Energy, Duke Energy, NextEra Energy). A Brattle report prepared in 2014 for 2018 online dates recommends an 8% after-tax IRR in PJM.[14]

Given this range, E3 determined 10% to be a reasonable target IRR.

2.2.5 STEP 5: CALCULATING ANNUAL AND UPFRONT CAPITAL AVAILABLE FOR REMEDIATION

2.2.5.1 Annual Headroom Available

E3 utilized the proforma model to determine what level of annual revenues would provide a 10% unlevered IRR for Conowingo. After determining this revenue level, E3 calculated the annual headroom available for remediation to be the difference between these target revenues and Base Case revenues estimated as described in section 2.2.3.

[12] Can be found on Exelon's investor relations webpage: http://www.exeloncorp.com/investor-relations/recent-rate-cases
[13] https://www.boe.ca.gov/proptaxes/pdf/2017capratestudy.pdf
[14] The report can be downloaded at: http://www.brattle.com/system/publications/pdfs/000/005/010/original/Cost_of_New_Entry_Estimates_for_Combustion_Turbine_and_Combined_Cycle_Plants_in_PJM.pdf?1400252453

2.2.5.2 Upfront Capital Available

After calculating the annual headroom available for remediation by using the methodology described in section 2.2.5.1, E3 estimated the upfront capital available for remediation as the present value (10%) of the annual headroom stream for the 2008-55 period.

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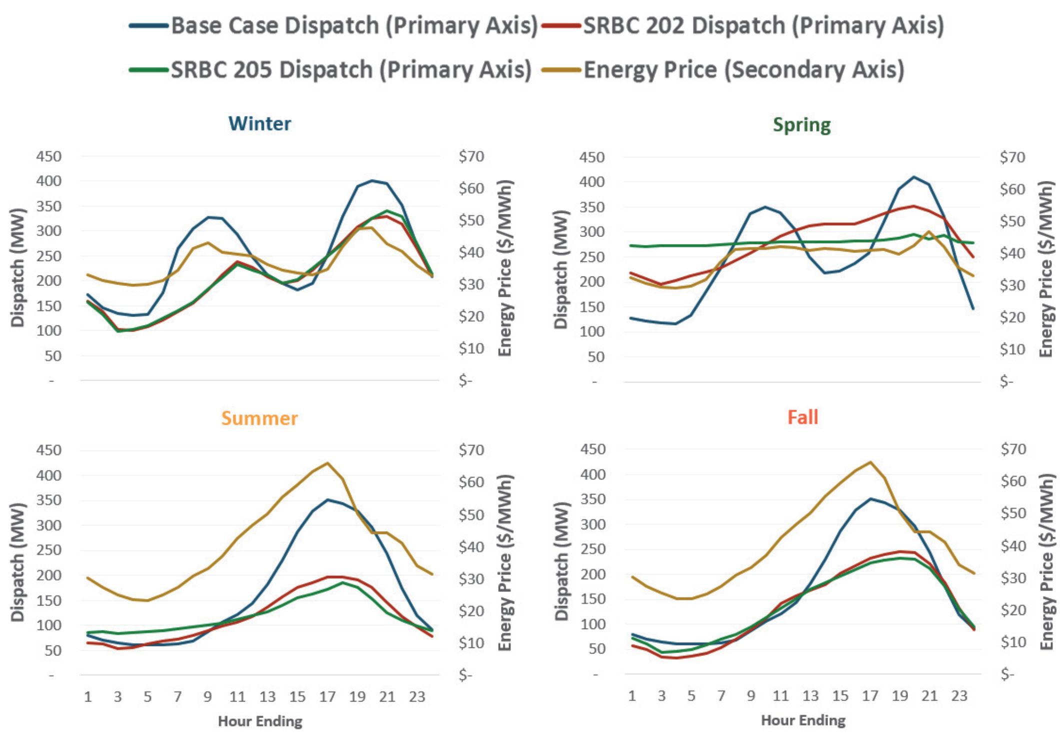
3 Results

3.1 Conowingo Hourly Dispatch

Using the approach described in section 2.2.2., E3 estimated the operations of Conowingo. In general, the project's dispatch seems to be correlated with energy prices in the Base Case, except in the spring. Under the Base Case, the Project is likely more constrained in its operations in the spring due to higher seasonal run-off. For the stakeholder alternatives (SRBC 202 and SRBC 205), in the spring, the project is constrained in its peaking ability; SRBC 202 includes higher minimum flows, maximum flows and ramping rates and SRBC 205 is instantaneous run-of-river in the Spring.

Figure 7: 2013 Average seasonal prices and dispatch for Conowingo. Figure represents average of hourly prices and estimated hourly power output for all the months in the season.



3.2 Market Revenues

Using the methodology described in Section 2, E3 calculated the total revenues from Conowingo in the Base Case to be $121 million annually. These estimates are higher than Exelon's 2013 FERC filings by $11.5 million, but in the same overall range, with the exception of capacity market revenues. The breakdown of the different revenue components, and how they compare to Exelon's filing is summarized in Table 5.

For SRBC 202 and SRBC 205, E3 estimated the annual revenues to be $116 million and $115 million respectively. These values do not include the revenues that Conowingo could make by selling into the REC market. E3 calculated the implied REC price, i.e. the value per MWh of Conowingo's generation if it were certified as a REC resource, that would be needed in the SRBC 205 scenario for Exelon to be indifferent between the Base Case operations and the SRBC 205 flow regime. E3 calculated the implied REC price using both E3 modeled revenue losses and change in generation, as well as Exelon's estimates. Exelon's revenue loss estimates include the losses for Muddy Run, and would be lower for Conowingo. Therefore, the implied REC price by using Exelon's filings is likely overestimated if only Conowingo is taken into consideration.

Table 5: Comparison of E3 estimates and Exelon 2013 filing for different components of PJM market revenues

Base Case			
Revenue Source	E3 Model Estimates	Exelon 2013 FERC Filing	Difference (E3 Estimates – FERC Filing)
Energy	$70M	$68M	$2.6M
Capacity[15]	$51M	$42M	$8.7M

[15] Exelon uses 2013 calendar year to calculate PJM's capacity prices, whereas E3 uses the capacity prices from the 2013-2014 capacity year.

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Ancillary Services	$0.4M	$0.4M	-
Total Revenues ($)	$121M	$110M	$11M
Generation (MWh)	1,699,398	1,669,000	30,398
Total Revenues ($/MWh)	$71	$66	$5

Similarly, E3 compared its estimates for the flow scenarios to the values filed in 2013 by Exelon, which are for both Conowingo and Muddy Run, and are therefore likely lower for Conowingo alone. The results are summarized in Table 6.

Table 6: Comparison of E3 estimates and Exelon's revenue estimates under alternative flow regimes (SRBC 202 and SRBC 205).

SRBC 202			
Revenue Source	E3 Model Estimates	Exelon 2013 FERC Filing[16]	Difference (E3 Estimates – FERC Filing)
Energy	$64M		
Capacity	$51M		
Ancillary Services	$0.4M		
Total Revenues ($)	$116M	$108M	$8M
Generation (MWh)	1,640,009	1,678,000	(37,991)

[16] Exelon simulated data has changes in total generation and revenues, but they were not broken out by component.

Revenue Source	E3 Model Estimates	Exelon 2013 FERC Filing[17]	Difference (E3 Estimates – FERC Filing)
Total Revenues ($/MWh)	$71	$64	$6
SRBC 205			
Revenue Source	**E3 Model Estimates**	**Exelon 2013 FERC Filing[17]**	**Difference (E3 Estimates – FERC Filing)**
Energy	$64M		
Capacity	$51M		
Ancillary Services	$0.4M		
Total Revenues ($)	$115M	$105M	$10M
Generation (MWh)	1,652,373	1,701,000	(48,627)
Total Revenues ($/MWh)	$69	$62	$8

In addition, the REC prices needed for the revenues in the SRBC 205 flow scenario to be the same as the Base Case are summarized in Table 7. Therefore, if Conowingo was able to supplement its revenues with REC prices of $3/MWh - $4.25/MWh, the revenues in the SRBC 205 operational scenario would be identical to the revenues estimated for the Base Case. With these additional REC revenues, Exelon would be indifferent between operating Conowingo consistent with the Base Case, or under the SRBC 205 operational flow regime.

[17] Exelon simulated data has changes in total generation and revenues, but they were not broken out by component.

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Table 7: REC payment needed per MWh of energy generated in SRBC 205 operational scenario by Conowingo to make up for the lost PJM energy and ancillary service market revenues using Exelon's filings as well as E3's modeled estimates.

	E3 SRBC 205	Exelon SRBC 205
Total generation (MWh)	1,652,373	1,701,000
Total revenue reduction relative to Base Case ($)	$7,023,091	$5,100,000
Implied REC price needed ($/MWh)	$4.25	$3.00

3.3 Proforma Analysis Results

With the financial proforma analysis, E3 was able to calculate the after-tax unlevered IRRs for Conowingo under different flow regimes. E3 also calculated the after-tax unlevered IRRs implied by Exelon's revenue estimates from the FERC filing. The results of this analysis are shown in Table 8.

Table 8: Comparison of after-tax unlevered IRRs for the different flow regimes.

Scenario	E3 Model Estimates	Calculations Using Exelon's Revenue Estimates
Base Case	20.84%	18.04%
SRBC 202	19.41%	17.51%
SRBC 205	19.19%	16.82%

3.4 Headroom Calculation Results

As described in section 2.2.5, E3 calculated the annual headroom and upfront capital available for investment in mitigation. The available headroom is lowest for the SRBC 205 regime, due to the overall revenues being lower, however the SRBC 205 operational regime could have access to additional revenues through sale of RECs associated with Conowingo's generation. Based on E3's analysis, the REC payment needed in the SRBC 205 flow scenario is $3/MWh to $4.25/MWh depending on whether Exelon's assumptions on market revenues and annual generation are used or E3's modeled estimates. Across the different flow scenarios, and based on differences in modeling between E3's estimates and Exelon's estimates, the annual available headroom is in the $27 million to $44 million range per year.

Exelon has already modified their Base Case operations to increase minimum flow levels. Therefore, the Base Case, although closest to their current operations, may still overestimate market revenues by assuming a higher level of dispatchability for Conowingo than currently exists due to the 401 Cert application.

Table 9: Estimate of annual headroom.

Annual headroom available ($)	E3 Model Estimates	Calculations Using Exelon's Revenue Estimates
Base Case	$44.1M	$32.2M
SRBC 202	$37.9M	$30.0M
SRBC 205	$37.0M	$27.1M

Using the annual headroom stream provided in Table 9, E3 calculated the available upfront capital that could be used for undertaking remediation efforts in the Chesapeake Bay as the present value of the annual headroom discounted at the target 10% after-tax unlevered IRR.

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Table 10: Present value (10%) of annual headroom available in the 2008 to 2055 time horizon.

PV of annual headroom available (2008$)	E3 Model Estimates	Calculations Using Exelon's Revenue Estimates
Base Case	$436.4M	$318.9M
SRBC 202	$375.9M	$297.1M
SRBC 205	$366.9M	$268.4M

It is important to note that if Conowingo were able to access REC markets and receive a payment of $3/MWh - $4/MWh for its generation in the SRBC 205 operational scenario, the headroom available for SRBC 205 would be the same as the Base Case.

4 Conclusions

E3's estimates for the total revenues for Conowingo range between $115 million to $121 million depending on the operational scenario. For the Base Case, SRBC 202 and SRBC 205 regimes, E3's calculated revenues were higher than Exelon's model estimates. The difference in revenues primarily stems from the capacity value of the project in PJM in 2013. E3 utilized the seasonal capacity values posted by PJM, whereas Exelon used a calendar year average capacity market price, which was lower. E3 utilized seasonal capacity prices due to PJM posting its capacity market clearing prices seasonally. However, if E3 were to calculate calendar year capacity revenues for the Base Case assuming annual capacity prices, the estimated revenues would be lower and more in line with Exelon's filings. In addition to differences in capacity market revenue estimates, E3's modeled energy market revenues were also higher than Exelon's.

The estimates for available headroom for remediation ranged from $27 million to $44 million annually depending on the flow regimes, access to renewable energy markets, as well as the range of revenue estimates calculated through E3's analysis versus those filed by Exelon. These values translated to a present value capital investment that could be used towards remediation efforts of $268 million (real 2008 $) to $436 million (real 2008 $), depending on the flow regime and whether E3's estimates or Exelon's filing estimates were used.

For the SRBC 205 operations regime, E3 did not include the REC payment that the project would potentially be eligible for if it were able to get certified as a REC eligible resource. This additional value stream could increase the revenues Conowingo could earn, and make Exelon indifferent between the Base Case and SRBC 205 operational regimes. In order for the total revenues for SRBC 205 to be the same as the Base Case, Conowingo would need a REC payment of $3/MWh-$4.25/MWh for its generation, depending on whether E3's modeled estimates or Exelon's filings are used.

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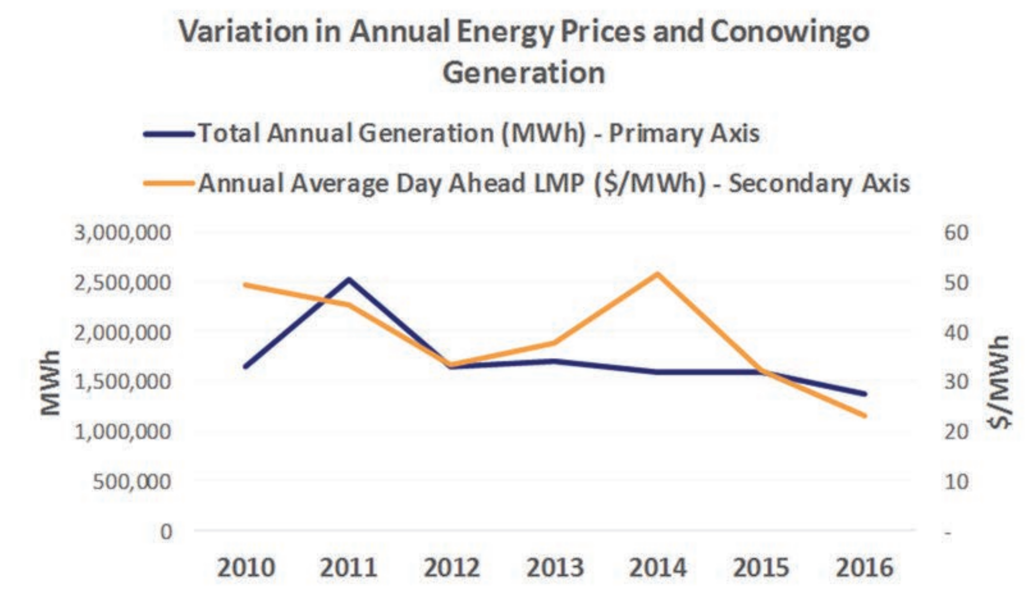
It is likely that revenues for Conowingo have declined in recent years due to the suppression of energy market prices in PJM. In addition, the total generation from Conowingo seems to vary significantly from year to year, which may change the revenue estimates for the project. Figure 6 shows the variation in total annual generation at Conowingo as well as the range of energy prices in the 2010 to 2016 horizon.

Figure 8: 2010 to 2016 variation in Conowingo annual generation and PJM energy market prices.

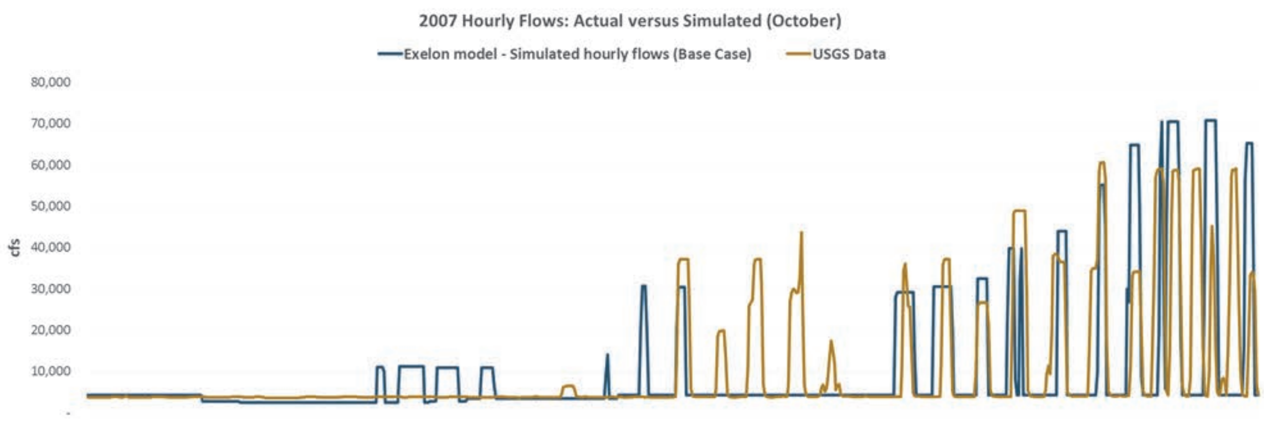


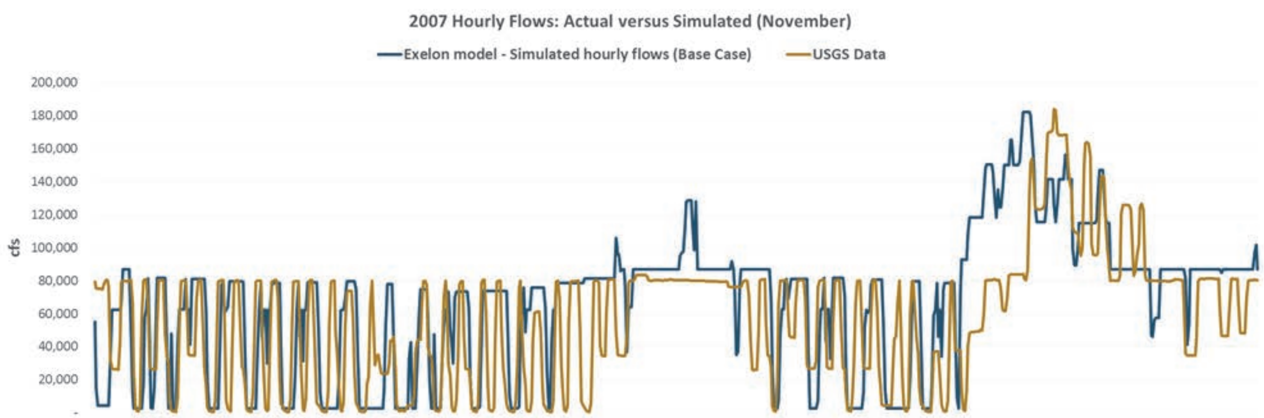
Further analysis would be needed to capture the impact of lower energy prices and changes in power generation on Conowingo's long term revenue forecasts.

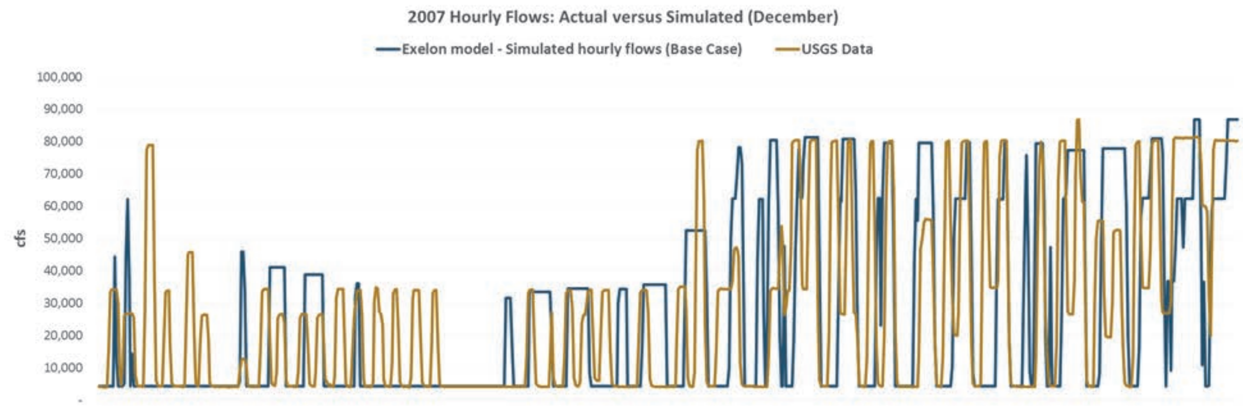
5 Appendix

5.1 Comparison of historic and simulated flows

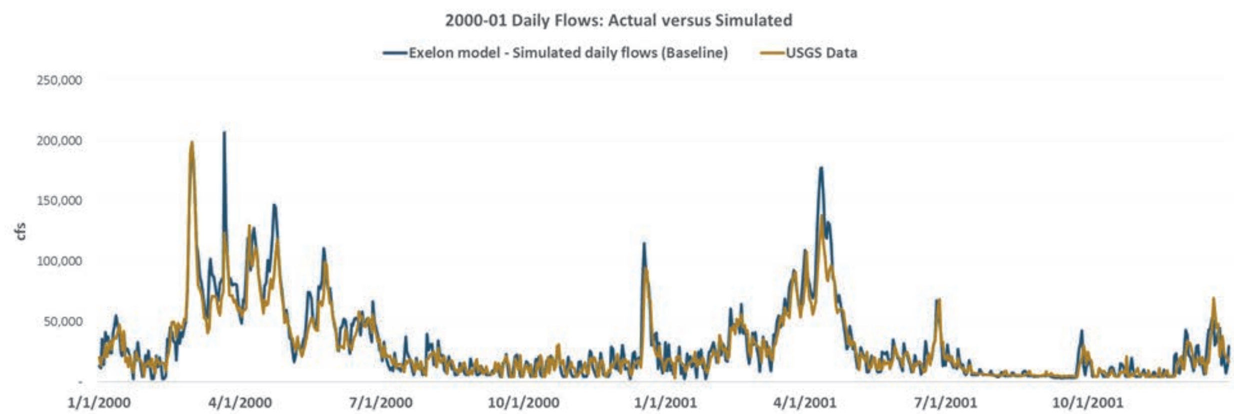
5.1.1 COMPARISON OF HOURLY FLOWS: OCTOBER 2007 – DECEMBER 2007

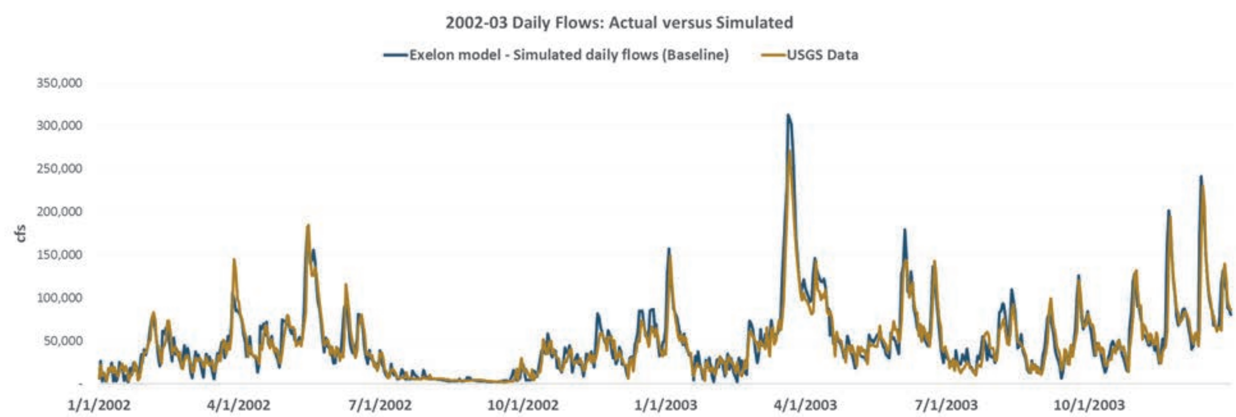


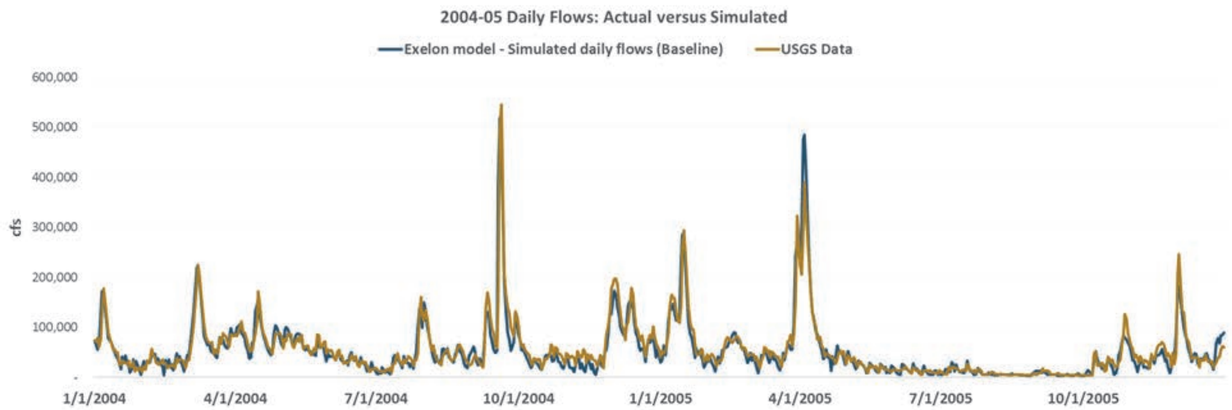


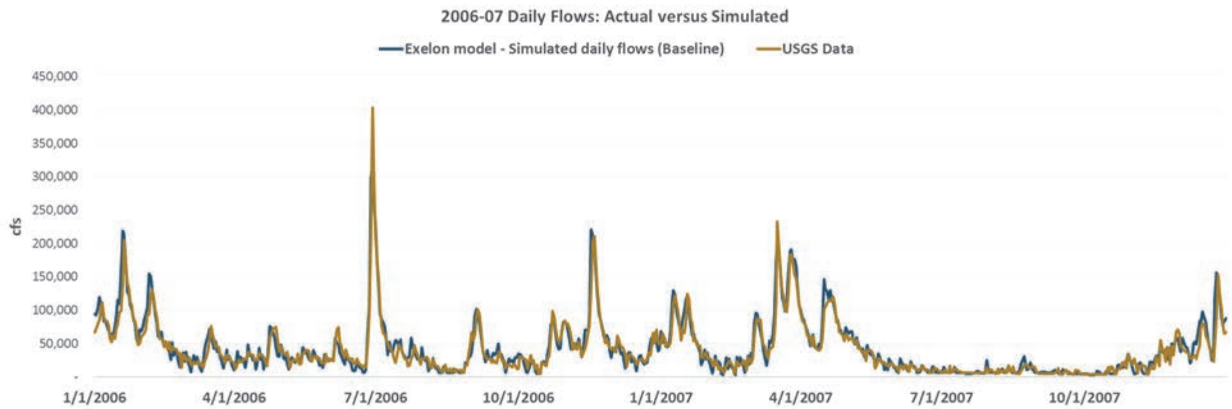


5.1.2 COMPARISON OF DAILY FLOWS: 2001 – 2007









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5.2 Operational parameters for flow scenarios

Scenario name	Hourly Min Flow (cfs)		Hourly Max Flow (cfs)		Hourly Flow Change (cfs/hr)
Base Case	Jan	1,750		86,000 cfs	86,000 cfs
	Feb	1,750			
	Mar	3,500			
	Apr	10,000			
	May	7,500			
	Jun	5,000			
	Jul	5,000			
	Aug	5,000			
	Sept. 1-15	5,000			
	Sept. 15-30	3,500			
	Oct	3,500			
	Nov	3,500			
	Dec	1,750			
SRBC 202	1/1-1/31	10,900	4/1 to 11/30:	65,000	20k
	2/1-2/29	12,500	otherwise:	86,000	
	3/1-3/31	24,100			
	4/1-4/30	29,300			
	5/1-5/31	17,100			
	6/1-6/30	9,700			
	7/1-7/31	5,300			
	8/1-8/31	5,000			
	9/1-9/30	5,000			
	10/1-10/31	4,200			
	11/1-11/30	6,100			
	12/1-12/31	10,500			
SRBC 205	1/1-1/31	10,900	4/1 to 11/30:	65,000	5k if flow < 10k cfs
	2/1-2/29	12,500	otherwise:	86,000	10k if flow <30k cfs
	3/1-3/31				20k of flow <86k
	4/1-4/30	Marietta flow +			
	5/1-5/31	intervening inflow			

	6/1-6/15		
	6/16-6/30	9,700	
	7/1-7/31	5,300	
	8/1-8/31	4,300	
	9/1-9/30	3,500	
	10/1-10/31	4,200	
	11/1-11/30	6,100	
	12/1-12/31	10,500	

5.3 Regression model for determining relationships between cumulative monthly flows and total monthly generation for Conowingo

SUMMARY OUTPUT

Regression Statistics	
Multiple R	97%
R Square	94%
Adjusted R Square	94%
Standard Error	20396
Observations	192

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	1.29316E+12	6.46578E+11	1554.221331	4.5487E-118
Residual	189	78626695703	416014263		
Total	191	1.37178E+12			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-8.22E+03	3.65E+03	-2.25E+00	2.56E-02	-1.54E+04	-1.01E+03	-1.54E+04	-1.01E+03

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Sum of monthly flows	7.42E-03	1.99E-04	3.72E+01	6.57E-89	7.03E-03	7.81E-03	7.03E-03	7.81E-03
Sum of monthly flows squared	-4.48E-11	2.14E-12	-2.09E+01	5.48E-51	-4.90E-11	-4.05E-11	-4.90E-11	-4.05E-11