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May 31, 2012

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

BELL BEND NUCLEAR POWER PLANT
ENVIRONMENTAL AUDIT NEED FOR INFORMATION RESPONSES:
FIRST SUBMITTAL
BNP-2012-131 Docket No. 52-039

The purpose of this letter is to formally document PPL's responses to NRC Need for Information (NFI) requests that were accepted by the NRC at the Bell Bend Supplemental Environmental Audit held the week of May 14, 2012. Additional letters providing the remainder of NFI responses requested by NRC at the audit will be provided in coming weeks.

Responses to the following NFIs are included in this letter as Enclosure 1:

- ACC-10
- AE-01
- AE-02
- AE-07
- AE-08
- AE-09
- AE-11
- AE-21
- AE-25
- AE-30
- ALT-04
- CR-07
- LU-05
- LU-15
- NFP-01
- NRHH-04
- NRHH-05
- NRHH-07
- NRW-01
- NRW-02
- NRW-03
- NRW-04
- S/EJ-01
- TE-03
- TE-09
- TE-10
- TE-14
- TE-15
- TE-16
- TE-17
- TE-21
- TE-26
- TE-28
- TE-29
- TE-30
- TE-32
- TE-33

Additional supporting enclosures are as follows:

- Enclosure 2 – AE-02 - 2012 Ecology III, Inc. / King's College Environmental Program Report and CV for Dr. Brian Mangan
- Enclosure 3 - AE-08 – 2010 Ecology III Report
- Enclosure 4 – AE-08 – 2011 Ecology III Report
- Enclosure 5 – LU-15 – Professional Planning Analysis For PPL Bell Bend Nuclear Power Plant Conditional Use Application
- Enclosure 6 – NRHH-05 – 1995 Ecology III Report
- Enclosure 7 – TE-09 – Transmission Line Vegetation Management, PPL, 2011, Vegetation Management (PPLWeb.com), 2012, PPL VMP Indiana Bat Protection Policy, PPL, 2007, Specification for Right-of-Way Clearing, LA-79827-8, PPLEU, 2010
- Enclosure 8 – TE-26 – Leaf-on Noise Survey, 2008
- Enclosure 9 – TE-26 – Leaf-off Noise Survey, 2008
- Enclosure 10 – TE-26 – Estimated Cooling Tower Sound Emissions, 2008

D102
NRO

This letter contains one new commitment: PPL commits to provide to the NRC the smallmouth bass study currently planned for September 2012, upon completion.

Should you have questions or need additional information, please contact the undersigned at 610.774.7552.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on May 31, 2012.

Respectfully,

Rocco R. Sgarro

RRS/kw

Enclosures:
1) Need For Information Responses
2) AE-02 - 2012 Ecology III, Inc. and King's College Environmental Program and Brian Mangan CV
3) AE-08 – 2010 Ecology III Report
4) AE-08 – 2011 Ecology III Report
5) LU-15 – Professional Planning Analysis For PPL Bell Bend Nuclear Power Plant Conditional Use Application
6) NRHH-05 – 1995 Ecology III Report
7) TE-09 - Transmission Line Vegetation Management, PPL, 2011, Vegetation Management (PPLWeb.com), 2012, PPL VMP Indiana Bat Protection Policy, PPL, 2007, Specification for Right-of-Way Clearing, LA-79827-8, PPLEU, 2010
8) TE-26 – Leaf-on Noise Survey, 2008
9) TE-26 – Leaf-off Noise Survey, 2008
10) TE-26 – Estimated Cooling Tower Sound Emissions, 2008

cc: (w/ Enclosures)

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Enclosure 1

Need for Information Responses

ACCIDENTS (ACC)

ACC-10: Provide an SME to discuss applicant's methodology for performing rad dose consequence calculations for DBAs and Severe Accidents. Should include a clear reference (e.g. cross reference table) between the ER and DCD. Provide calculation package that besides describing the specific calculation, include specific core inventories that were used for DBA and Severe Accident calculations.

Audit Disposition: Upon review of this NFI response NRC requested to be provided a docketed copy of the cross reference table between the ER and DCD. This table is provided in its entirety below.

Response:

BBNPP ER and U.S. EPR DC – Cross Reference of Sections and Tables

BBNPP ER Section or Table	U.S. EPR DC Section or Table
Design Basis Accidents	
Section 7.1 Design Basis Accidents	Section 15.0.3 Radiological Consequences of Design Basis Accidents (subsections 15.0.3.1 through 15.0.3.13)
Table 7.1-1 - Design Basis Accidents	Table 15.0-1 (DBA entries)
Table 7.1-2 - U.S. EPR Design Basis Primary Coolant Activity	Table 15.0-15 - U.S. EPR Primary Coolant Bounding Concentrations
Table 7.1-3 - U.S. EPR Design Basis Secondary Coolant Activity	Table 15.0-16 - U.S. EPR Secondary Coolant Bounding Concentrations
Table 7.1-4 - U.S. EPR Core Inventory[1]	Table 15.0-14 - Design Basis Core Radionuclide Inventory[2]
Table 7.1-5 - 50th Percentile BBNPP Site Atmospheric Dispersion Factors	Table 2.1-1 - U.S. EPR Site Design Envelope (Accident section)
Table 7.1-6 - Steam System Piping Failure	Table 15.0-30 - MSLB Time Line, through Table 15.0-34 - MLSB Dose Summary
Table 7.1-7 - Reactor Coolant Pump Locked Rotor Accident / Broken Shaft with 8% Fuel Rod Clad Failure	Table 15.0-35 - LRA Time Line, through Table 15.0-38 - RCP LRA Dose Summary
Table 7.1-8 - Failure of Small Lines Carrying Primary Coolant Outside Containment	Table 15.0-20 - Design Input for Failure of Small Lines Carrying Primary Coolant Outside Containment, through Table 15.0-23 - Small Line Break - Dose Results
Table 7.1-9 - Steam Generator Tube Rupture	Table 15.0-24 - SGTR Accident Time Line, through Table 15.0-29 - SGTR Dose Summary
Table 7.1-10 - Loss of Coolant Accident	Table 15.0-49 - LOCA Radiological Sequence of Events Post-LOCA, through Table 15.0-53 - Radiological Consequences of U.S. EPR Design Basis Accidents (rem TEDE) (LOCA)
Table 7.1-11 - Fuel Handling Accident	Table 15.0-45 - Fuel Handling Accident Timeline, through Table 15.0-48 - FHA Dose Summary

BBNPP ER and U.S. EPR DC – Cross Reference of Sections and Tables (continued)

BBNPP ER Section or Table	U.S. EPR DC Section or Table
Table 7.1-12 - Rod Ejection Accident	Table 15.0-39 - Rod Ejection Accident Timeline, through Table 15.0-44 - REA Dose Summary
Table 7.1-13 - Summary of the DBA Radiological Consequences at Offsite Receptors from BBNPP	Table 15.0-12—Radiological Consequences of U.S. EPR Design Basis Accidents (rem TEDE)
Table 7.1-14 through Table 7.1-25 Radionuclide Releases to Atmosphere (for DBAs)	N/A
Severe Accidents	
Section 7.2 Severe Accidents	
Table 7.2-1— Release Category Descriptions[3]	Table 19.1-19 - Release Category Definitions
Table 7.2-2— Source Term Input to MACCS2	Table 19.1-20 - Source Terms for Each Release Category
Table 7.2-3— U.S. EPR Severe Accidents Analysis Impacts - 50-Mile Radius and 2050 Population	N/A
Section 7.3 Severe Accident Mitigation Design Alternatives	ANP-10290 Revision 1 AREVA NP Environmental Report Standard Design Certification
Table 7.3-1 - Severe Accident Cost Impact	Table 4-1 Severe Accident Impact
Table 7.3-2 - Maximum Benefit for Sensitivity Cases (Point Estimate CDF with 2008 Replacement Power Costs)	Table 4-2 Maximum Benefit for Sensitivity Cases (Point Estimate CDF with 2008 Replacement Power Costs)
Table 7.3-3 - Maximum Benefit for Sensitivity Cases (Mean Value CDF with 2008 Replacement Power Costs)	Table 4-3 - Maximum Benefit for Sensitivity Cases (Mean Value CDF with 2008 Replacement Power Costs
Table 7.3-4 - SAMDA Candidates - Already Implemented[4]	Table 6-1 - SAMDA Candidates - Already Implemented

[1] "Bounding" values for all accidents except FHA and REA, and "maximized" values for the FHA and REA; see table notes for details.
[2] "Bounding" values only; the "maximized" source term is a BBNPP departure and is not in the DC.
[3] It should be noted that there are a total of 25 RCs, however two of them have zero frequency (i.e., RC601 and RC801) and are not included in the Level 3 PRA or in the results of this analysis.
[4] This table includes two SAMDA candidates that are not identified in Table 6-1 of the AREVA NP ER (i.e., HV-03 and OT-03).

References:

- U.S. EPR Final Safety Analysis Report Revision 4, Tier 2, Chapters 15 and 19
- ANP-10290 Revision 1, AREVA NP Environmental Report, Standard Design Certification

AQUATIC ECOLOGY (AE)

AE-01: Provide an SME to discuss nature and extent of impervious and nearly impervious surfaces that exist at the present SSES site and the Walker Run watershed Environmental Standard Review Plan (ESRP) 2.2.1. Not in ER. (AE-2 provides a partial response, June 29, 2009).

Audit Disposition: Upon review of this NFI response the NRC requested to be provided a docketed copy, included in its entirety below.

Response:

- Total area of Walker Run watershed is 2,450 acres with a total of 145 acres (6%) being impervious surfaces (urban/built-up and roads).
- The total area of the Walker Run watershed within the BBNPP Project Boundary is 527 acres with 31 acres (6%) being impervious surfaces.
- Most of the Walker Run watershed is comprised of pervious surfaces that include forested land, agricultural land, and wetlands.
- Most of the SSES site is not located within the Walker Run watershed and is located in an adjacent watershed.
- A total of approximately 200 acres of impervious surfaces exist at the present SSES site. A small portion of existing buildings/structures associated with the SSES are within the Walker Run watershed totaling approximately 13 acres of impervious surfaces.

Reference:

USGS, 1999. Land Cover Data Set, U.S. Geological Survey, Website: http://www.pasda.psu.edu/uci/MetadataDisplay.aspx?entry=PASDA&file=nlcd_pa_tiff_alb.xml&dataset=339, Date accessed, March 15, 2008.

AE-02: Provide an SME to discuss recent (since 1976) water temperature trends in the Susquehanna River and winter conditions including frequency and extent of ice. (Figure 2.3-10 provides coarse scale information).

Audit Disposition: Upon review of this NFI response the NRC requested to be provided a docketed copy, included in its entirety below. The referenced report (Mangan, 2012) and the author's resume was also requested, and are included as Enclosure 2 of this letter.

Response:

Susquehanna River Water Temperature Trends

Ecology III, Inc. collects river temperature data associated with regular SSES monitoring activities. River temperature data were collected from a temperature probe stationed at the bottom of the river adjacent to the SSES Environmental Laboratory, near Berwick, Pennsylvania.

Data collected from1974 to 2010 describe an increasing trend in average annual water temperatures as shown on Figure 1, below.

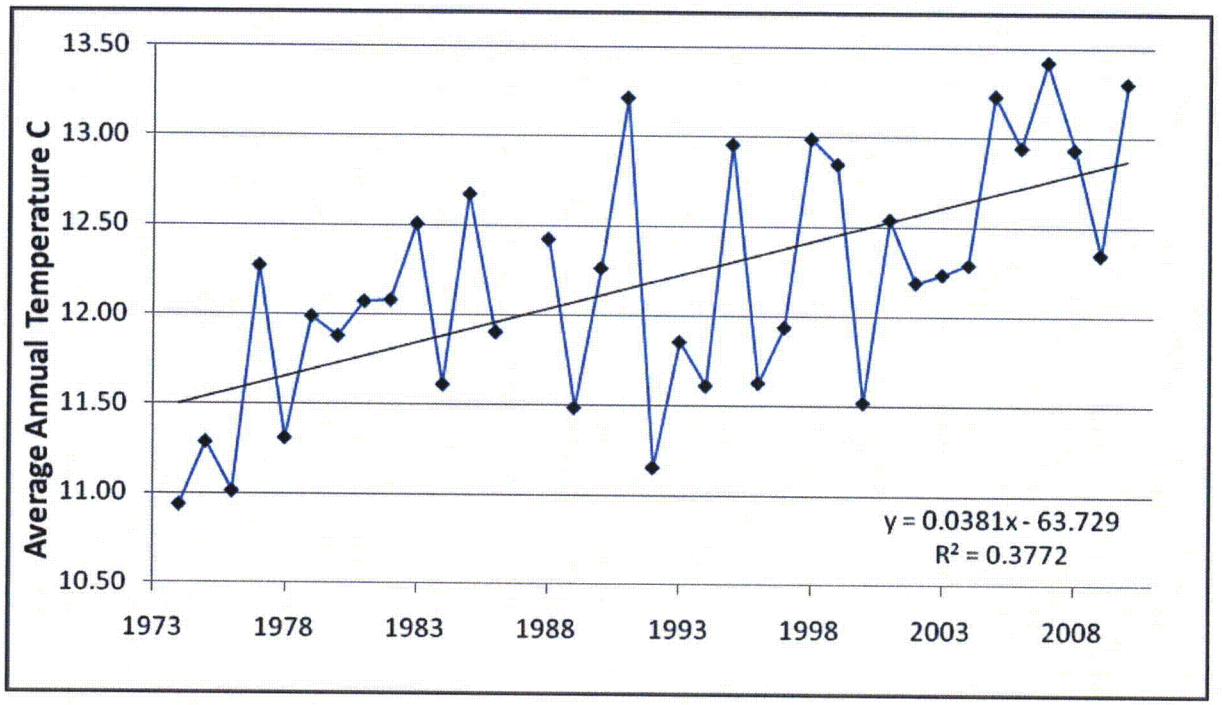


Figure 1. Average annual river temperatures from the Susquehanna River, 1974-2010. The trend line is the result of a simple linear regression ($P<0.05$).

Winter Conditions and Ice Formation

In regard to ice formation in the Susquehanna River, PPL does not have any formal data set representing the frequency or extent of ice on the river, and is not aware of formal records on ice formation. The only winter-specific monitoring activity (associated with SSES) is temperature data collection.

Ice formation is a function not only of air and water temperature, but also river flow and river position. In addition, hydrologists recognize various types of ice, e.g. thermal ice vs. frazil ice, and each type tends to form under different conditions. In recent years, the general observation has been less ice floe and cover in the Susquehanna River in the vicinity of the Susquehanna Steam Electric Station. Provision of anecdotal information on the perception of ice floe trends (was) provided via discussions at the audit.

AE-07: Provide information on submerged vegetation in the Susquehanna River. ESRP 2.4.2. Not in ER.

Audit Disposition: During review and discussion of this NFI response at the audit, the NRC requested to be provided a docketed copy of the smallmouth bass study planned for September 2012. PPL commits to provide to the NRC the smallmouth bass study currently planned for September 2012 upon completion.

AE-08: Provide information on fish and invertebrate sampling in Susquehanna River completed since 2007. Include the upcoming mussel survey.

Audit Disposition: Upon review of this NFI response the NRC requested to be provided docketed copies of the Ecology III 2010 and 2011 reports. These two reports are included as Enclosure 3 (Ecology III 2010) and Enclosure 4 (Ecology III 2011) to this letter.

Enclosure 3:

Ecology III, 2010. Environmental Studies in the vicinity of the Susquehanna Steam Electric Station, 2009 water quality and fishes. Prepared for PPL Susquehanna, LLC, September 2010.

Enclosure 4:

Ecology III, 2011. Environmental Studies in the vicinity of the Susquehanna Steam Electric Station, 2010 water quality and fishes. Prepared for PPL Susquehanna, LLC, November 2011.

AE-09: Describe nuisance species in the project area including occurrence of zebra mussels at the SSES site (spray pond) and to clarify the current zebra mussel distribution in the Susquehanna River.

Audit Disposition: Upon review of this NFI response the NRC requested to be provided a docketed copy, included in its entirety below. *Note: the final SSES Annual Environmental Operating Report (Nonradiological) has since been issued and no substantive changes occurred to this response.*

Response: The biofouling mollusk monitoring program continued at the Susquehanna SES in 2011. With the arrival of Asiatic clams in the vicinity of the plant, the program has shifted the monitoring emphasis to searching for living clams in the Emergency Service Water Spray Pond by scuba survey. In 2011, there were no living Asiatic clam specimens observed in the Spray Pond. However, live zebra mussels were discovered for the first time in the Spray Pond attached to pump screens in the pump forebays. The mussel specimens were large enough to indicate that they had survived previous molluscicide treatments of the pond, probably due to the lack of water circulation during treatment into the forebay areas. No mussels have yet been observed living in the main body of the pond. (Ref. Susquehanna SES, Units 1 & 2, 2011 Annual Environmental Operating Report (Nonradiological), April 2012 (Draft)).

River substrates were inspected at select sites during the summer of 2008 from Great Bend to Halifax, PA. The Asiatic clam is present in the vicinity of the Susquehanna SES and southward in the river. In September 2008, personnel from Ecology III performed a profile of the current zebra mussel population north of the Susquehanna SES, in the vicinity of Hallstead, PA (near the New York border).

Zebra mussels have now been reported in the southern Susquehanna River. Adult mussels have been collected in the vicinity of the Conowingo Hydroelectric Dam and Muddy Run Pump Storage Facility. (Ref. Susquehanna SES Units 1 & 2, 2008 Annual Environmental Report, April 2009)

AE-11: Discuss the debris grating for the intake system (p.3-30). ESRP 3.4.2. Not in ER. Need confirmation that RAI 3.4-1 response from 8-11-2009 is accurate after site layout changes.

Audit Disposition: Upon review of this NFI response the NRC requested to be provided a docketed copy, included in its entirety below.

Response: The specification for the dimension is beyond the current conceptual design for the intake structure, but a typical installation for a trash rack would consist of 3/8 inch thick steel bars spaced two inches apart, similar to the intake at the Susquehanna Steam Electric Station. The opening between the vertical bars would therefore be one and five eighths inches.

Final design will be compliant with Clean Water Act (CWA) standards for impingement and entrainment (EPA Phase II, Track 1). The intake velocity will be 0.5 feet per second or less at the intake screens which have .08 inch (2mm) square mesh as described in ER Revision 3 Section 3.4.2.1.

AE-21: Discuss consumptive use.

1. **What is the maximum CU expected ?**
2. **Explain the low flow values used in the 7Q10 calculations in Section 5 versus those in Table 5.2-3 and Section 9.3.2.1.3, and the calculation of the % of the total lost.**
3. **Resolve the discrepancy in the presentation of water use values versus the 7Q10.**

Audit Disposition: Upon review of this NFI response the NRC requested to be provided a docketed copy without data tables, and this material is provided below.

Response:

PPL's water withdrawal and consumptive use applications to the SRBC that were filed via letter dated January 14, 2011 (BNP-2011-005) provide a thorough description of expected Bell Bend water withdrawal and consumptive use. Calculated amounts are provided in Enclosures 1 and 2 of the letter. A water balance diagram is also provided that reflects peak day water use. Seasonal water use and availability was also discussed in a PPL letter to the SRBC dated July 8, 2010 (BNP-2010-165). Table 1 from Enclosure 1 of that letter is provided as an attachment (page 4).

The attached table provides the basis for the various 7Q10 flows delineated in BBNPP ER Sections 5 and 9.

Path/Allowance	Description	Value (gpm)
1	Main Cooling Tower Evaporation	16,026
2	Main Cooling Tower Drift	8
3	ESWS Cooling Towers Evaporation	448
4	ESWS Cooling Towers Drift	2
5	Power Plant Consumptive Use	40
6	ESWEMS Retention Pond Evaporation	34.3
7	Combined Waste Water Retention Pond Evaporation	14.1
Allowance	In-river Evaporation	61.1
Allowance	Instrument Accuracy	1,329
	TOTAL	17,962.5

AE-25: Discuss deicing onsite and public roads near the site, and discuss if onsite deicing at parking lots and bridges.

A. What materials will be used to deice roads, parking lots, and bridges on the site and the public roads near the site (e.g., Market Street)

B. Average frequency of application of such materials in a given winter

C. What is potential ecological effects of these materials from new bridges which cross aquatic resources on or near the site

D. Will be measure in place to reduce runoff from these sites (roads, bridges) from going into aquatic habitats?

ESRP 5.6.2. Not in ER. Partial answer in RAI AE-31 response June 29, 2009.

Audit Disposition: Upon review of this NFI response the NRC requested to be provided a docketed copy, included in its entirety below.

Response: The current winter maintenance activities at the SSES site are representative of winter maintenance activities that would occur at the future BBNPP site. The current winter maintenance activities at SSES include plowing to remove snow and application of several types of deicing materials including rock salt (NaCl and CaCl), cinders, and non-skid materials such as sand to roadways, parking lots, and walkways. Rock salt is the most commonly used deicing material and is used both at onsite and offsite locations in the vicinity of the SSES site. Non-skid and cinder materials are utilized in areas where rock salt use is prohibited and include the roadways around the SSES spray pond and cooling towers.

A.) Based on the current SSES maintenance program rock salt will be used for deicing roadways near the future BBNPP site including N. Market Street and Beach Grove Road.

B.) The frequency of application of deicing materials varies annually depending on the amount of snowfall and icing. Application is on an as-needed basis with applicator's discretion for the amounts of deicing materials applied to roadways, parking lots, and walkways. The maintenance program seeks to achieve safe conditions for vehicles and personnel traveling to the SSES site.

C.) Ecological effects of deicing materials are likely to be minimal. The existing offsite roads and parking areas in the vicinity of BBNPP (N. Market St. and Beach Grove Rd.) are separated spatially from Walker Run by a substantial riparian buffer (ER 4.3.1) which would aid in capturing runoff containing deicing materials. The new bridges constructed across Walker Run and tributaries would increase the potential for deicing materials to enter the stream. However, these small sections of bridges are unlikely to increase loads of rock salt to the stream to levels that would be deleterious to aquatic organisms. Previous studies of aquatic communities have documented increased chloride concentrations associated with surface runoff in heavily urbanized streams with large transportation corridors. This is not the case with Walker Run which does not drain large areas that will be subject to de-icing with rock salt. Blasius and Merritt (2002) documented the effect of road salts on stream macroinvertebrate communities in Michigan. This study concluded that current salt loading in most Michigan streams did not represent a great risk to stream macroinvertebrate communities. They also concluded that most aquatic invertebrates that were investigated are tolerant of NaCl concentrations well above the levels experienced in most streams subjected to road salt runoff. The stream macroinvertebrate communities that were studied in Blasius and Merritt (2002) include many of the same taxa that are common in Pennsylvania streams including Walker Run.

D.) A 50-ft buffer zone will be maintained around wetlands and streams within the Walker Run watershed (ER 4.3.1). This buffer zone will capture and filter surface runoff from roadways and minimize the amount of deicing materials that enter onsite aquatic habitats.

References:

Blasius, 2002. Field and laboratory investigations on the effects of road salt (NaCl) on stream macroinvertebrate communities, Environmental Pollution, Volume 120, Pages 219-231, B. Blasius and R Merritt, 2002.

AE-30: Provide a knowledgeable expert to discuss the implications of the Federal Highlands Conservation Act on the aquatic resources on and near the Martins Creek Alternative site. Specifically:

1. The designation of Buckhorn Creek and the Delaware River as Open Water Protected Areas that have associated buffer zones.

2. The occurrence of a small wetlands area associated with Buckhorn Creek that appears to be on the site (just downstream from a short dog-leg to the east in the creek).

3. The watershed value designation of Moderate for the site.

4. The Riparian Corridor Integrity Score of Moderate assigned to much of the site, including Buckhorn Creek and the Delaware River shoreline.

5. The occurrence of several Prime Groundwater Recharge Areas on the site.

6. The land use designation of much of the site as a Conservation Zone (including Buckhorn Creek) or as a Protection Zone (the Delaware River shoreline).

Audit Disposition: Upon review of this NFI response the NRC requested to be provided a docketed copy without figures, and this material is provided below.

Response:

1) Buckhorn Creek and the Delaware River in the vicinity of the Martins Creek site are designated as Highlands Open Water Protection Areas occurring adjacent to Agricultural Resource Areas with no significant natural areas or preserved lands nearby (State of New Jersey Highlands Water Protection and Planning Council [New Jersey Highlands Council], 2008). Highlands Open Water Protection Areas have a requirement for a 300-ft buffer from major development within the Highlands Preservation Area, but the buffer does not extend into the Highlands Planning Area by statute (New Jersey Statutory Authority [NJSA], 2004). The Martins Creek site is within the designated planning area and not within the preservation area and is, therefore, not subject to the 300-ft buffer requirement. The designation of Buckhorn Creek and the Delaware River as Open Water Protected Areas would not have any effect on aquatic resources with regard to potential impacts that would result from development of the Martins Creek site.

2) As provided in ER Rev. 3 Table 9.3-12 and as shown in Figure 9.3-37, there are no wetlands along Buckhorn Creek or elsewhere within the Martins Creek site. A 100-year floodplain area (also 500-year floodplain) is indicated along Buckhorn Creek as it passes through the site.

3) The Martins Creek site is categorized as moderate watershed resource value with moderate integrity riparian area within the New Jersey Highlands Region (New Jersey Highlands Council, 2008). These watersheds have a reduced proportion of natural vegetation in the adjacent riparian buffer zone which typically correlates to loss of aquatic habitat and impaired water quality due to sedimentation and embeddedness associated with runoff (Allan, 1995). The portions of Buckhorn Creek and the Delaware River in this section of the Highlands Region are listed as having impaired water quality due to excessive levels of nitrates (a component of eutrophication) presumably associated with the agricultural land use of the area (New Jersey Highlands Council, 2008). In addition to the moderate resource value for water, the portion of the Highlands Region containing the Martins Creek site is classified as having low resource values for forest and biodiversity and high resource value for farming (U.S. Department of Agriculture [USDA], 2002).Because of the relatively low values for biological uses and the high values for farming, the effects of altering the land use from an actively maintained agricultural pasture with little riparian buffer zones to an industrialized complex with associated stormwater

controls and best management practices to minimize stormwater impacts would be insignificant and would not be expected to adversely affect aquatic resources.

4) Moderate integrity riparian areas contain a higher incidence of impervious area, agricultural uses, and road crossings, and a reduced proportion of natural vegetation, including reduced proportions of high quality habitat for water or wetland dependent species (New Jersey Highlands Council, 2008). The riparian corridor along the Delaware River through the Martins Creek site is generally narrow (less than 100 feet in places) and provides poor protection from runoff associated with the grassed pastures adjacent to the river. The riparian corridor of Buckhorn Creek is even narrower – providing little to no protection from runoff. The effects of altering the land use from an actively maintained agricultural pasture with little riparian buffer zones to an industrialized complex with associated stormwater controls and best management practices to minimize stormwater impacts would be insignificant to the overall integrity of the receiving watersheds and would not be expected to adversely affect aquatic resources.

5) Prime groundwater recharge areas have the highest recharge rates in a sub-watershed and vary by soil, precipitation, and land cover. The Martins Creek site contains some prime groundwater recharge areas. However, the Martins Creek site is limited to approximately 420 acres and the adjacent lands that would be unimpacted contain a greater number of prime groundwater recharge areas. Any impacts to groundwater recharge as a result of development of the site would be minimal and would not be expected to adversely affect aquatic resources.

6) The Martins Creek site is classified as a Conservation Zone – an area with significant agricultural lands interspersed with associated woodlands. The Conservation Zone designation for the Martins Creek site is for the presence of agricultural land, not for biological resources. The general vicinity of the Martins Creek site is classified as having moderate resource value for water, low resource values for forest and biodiversity, and high resource value for farming (USDA, 2002). Conservation and preservation of farmland is a major component of the Highlands Water Protection and Planning Act (NJSA, 2004).

The Protection Zone designation for Delaware River is to maintain riparian buffer to protect against non-point source pollution entering the river. Development of the Martins Creek site would include post construction stormwater controls that would prevent non-point source pollution entering the Delaware River and would be consistent with the protection zone designation. Impacts to aquatic resources as a result of non-point source pollution from the development of the Martins Creek site would be small or non-existent.

Data Sources:

Allan, J. D, 1995. Stream Ecology – Structure and Function of Running Waters, School of Natural Resources and Environment, University of Michigan, USA; Kluwer Academic Publishers, The Netherlands; First Edition, 388pp.Note: Copyright protected. Electronic version not available for printing. Reference available for purchase.

New Jersey Highlands Council, 2008. Highlands Regional Master Plan, State of New Jersey Highlands Water Protection and Planning Council.

NJSA, 2004.Highlands Water Protection and Planning Act, New Jersey Statutory Authority, Assembly Committee Substitute for Assembly, No. 2635, State of New Jersey 211th Legislature, Adopted June 7.

USDA, 2002. New York – New Jersey Highlands Regional Study: 2002 Update, NA-TP-02-03, U.S. Department of Agriculture, Forest Service, Northeastern Area State and Private Forestry, M.G. Phelps, and M.C. Hoppe, compilers, December.

ALTERNATIVE SITES (ALT)

ALT-04: Provide a SME to discuss features of candidate sites, candidate areas, and potential sites.

Audit Disposition: Upon review of this NFI response the NRC requested to be provided a docketed copy, included in its entirety below.

Response: As stated in Section 9.3.1.2, Candidate Areas refer to one or more areas within the Region of Interest (ROI) (the ROI being portions of Pennsylvania and Maryland and all of New Jersey and Delaware)that remain after unsuitable areas have been removed by screening the ROI using exclusionary criteria. The resulting Candidate Areas are areas within the ROI that are located (1) within15 mi (24.1 km) of a cooling water source capable of providing 50 million gallons per day (MGD) (189 million liters per day [mld]) or more (i.e., Susquehanna River, Juniata River, Lehigh River, Patuxent River, Delaware River, Chesapeake Bay, Barnegat Bay, Lake Wallenpaupack, and the Atlantic Ocean), (2) within 30 miles (mi) (48.3 kilometers [km]) from a 345 kV or higher transmission line, (3) in a sparsely populated area (that is, located in an area with less than 300 persons per square mile) (300 persons per 2.6 km2), and not on dedicated land (e.g., within national or state parks, tribal lands, etc.). The Candidate Areas are shown on ER Rev. 3 Figure 9.3-3.

As stated in Section 9.3.1.1, various brownfield sites, remediation sites, other power facilities, and a greenfield site were considered as possible locations for a new nuclear power plant within the ROI. More than 8,000 sites within the ROI were initially identified for consideration. Of this initial pool of 8,000 sites within the ROI, 356 sites are located within the Candidate Areas and are shown on ER Rev. 3 Figure 9.3-14.

As stated in Section 9.3.1.2, a de-selection criterion was applied to the Candidate Areas and 356 sites within the Candidate Areas to narrow the list of sites within the Candidate Areas to a short list of Potential Sites for more detailed evaluation. All sites with less than 420 ac (170 ha) were screened out in this step leaving a total of 14 Potential Sites:

♦Bainbridge (MD)
♦Baltimore/Washington International (BWI) Airport (MD)
♦Beiler (MD)
♦Conowingo (MD)
♦Delaware City Plant (DE)
♦Humboldt Industrial Park (Humboldt) (PA)
♦Keystone Industrial Port Complex (PA)
♦Martins Creek (NJ)
♦Montour (PA)
♦Peach Bottom (PA)
♦Seedco Industrial Park (Seedco) (PA)
♦Sparrows Point (MD)
♦Wallenpaupack (PA)
♦Indian River (DE)

A brief description of these Potential Sites follows.

Bainbridge –The approximately 420-acre Bainbridge site is a brownfield site located within the Bainbridge Naval Training Center property, which consists of approximately 1,100 acres, in Port Deposit, Cecil County, Maryland. The Bainbridge site is located within the upland section of the Piedmont Plateau physiographic province. The southwestern edge of the site is adjacent to the

Susquehanna River. Refer to Section 9.3.3 of NUREG-1936 (NRC, 2011) for further description of the Bainbridge site.

BWI Airport – The approximately 420-acre BWI site under consideration is located within the southern portion of the approximately 3,600 acre BWI Airport property south of Baltimore in Anne Arundel County, Maryland. The area is primarily undeveloped, forested land but includes some cleared land.

Beiler – The approximately 420-acre Beiler site under consideration is located within a larger approximately 612-acre remediation site. The site is located in the Delmarva Peninsula Region of the Coastal Plain physiographic province (Maryland Geologic Survey [MGS], 1981). The site is flat and primarily agricultural.

Conowingo – The approximately 420-acre Conowingo site is proposed to be located within the approximately 760-acre Conowingo Hydroelectric Generating Station near Conowingo on the lower Susquehanna River in Cecil and Harford Counties, Maryland. The site is located in the upland section of the Piedmont Plateau physiographic province (MGS, 1981). The site is primarily forested with deep gullies.

Delaware City – The approximately 420-acre Delaware City site under consideration is located within the 5,000-acre Delaware City Refinery, a refinery being closed in Delaware City, New Castle County, Delaware. The refinery, located on the Delaware River, was purchased in 2010 by a new owner and reopened in October 2011 (PBF Energy, 2011). The Delaware City site is flat and agricultural.

Humboldt – The approximately 420-acre Humboldt site is located within the Humboldt Industrial Park, an approximately 3,800-acre industrial park, located west of Hazleton, in Luzerne County, Pennsylvania. The site is located in the Anthracite Upland Section of the Ridge and Valley physiographic province (DCNR, 2009). Refer to Section 9.3.2.3 for further description of the Humboldt site.

Keystone – The approximately 420-acre Keystone site under consideration is located within the approximately 2,500 acre Keystone Industrial Port Complex on the Delaware River in Fairless Hills, Bucks County, Pennsylvania. The brownfield site was the former site of U.S. Steel Fairless Works. Soil and groundwater contamination present at the site is in the process of being remediated. (Western Pennsylvania Brownfields Center, 2012)

Martins Creek – The approximately 420-acre Martins Creek site is a greenfield site located within a larger approximately 543-acre property in a rural area adjacent to the Delaware River south of the town of Belvidere in Warren County, New Jersey. The site is located in the Valley and Ridge physiographic province (NJDEP, 2009). Refer to Section 9.3.2.5 for further description of the Martins Creek site.

Montour – The approximately 420-acre Montour site is a greenfield site that is located north of the existing Montour coal-fired power plant on approximately 2,500 acres owned by PPL in Derry Township, northeast of the borough of Washingtonville in Montour County, Pennsylvania. The site is located in the Susquehanna Lowland Section of the Ridge and Valley physiographic province (DCNR, 2009).Refer to Section 9.3.2.2 for further description of the Montour site.

Peach Bottom – The approximately 420-acre Peach Bottom site is proposed to be located within the western portion of the 620-acre property housing the Peach Bottom Atomic Power Station, a two-unit nuclear power plant, in Peach Bottom Township in York County, Pennsylvania. The Peach Bottom Atomic Power Station property is located on the west side of Conowingo Pond, which was formed when the Conowingo Dam was constructed across the Susquehanna

River.(Exelon, 2001)The site is located in the Piedmont Upland Section of the Piedmont physiographic province (DCNR, 2009). There are approximately 320 feet of relief across the heavy wooded site (UniStar, 2011).

Seedco – The approximately 420-acre Seedco site is a brownfield site located within the Seedco Industrial Park, an approximately 1,061-acre industrial park located east/southeast of the community of Ranshaw and the City of Shamokin in Northumberland County, Pennsylvania. The site is located in the Anthracite Upland Section of the Ridge and Valley physiographic province (DCNR, 2009).Refer to Section 9.3.2.4 for further description of the Seedco site.

Sparrows Point – The approximately 420-acre Sparrows Point site under consideration is a brownfield site located within northern portion of the 2,300 acre Sparrows Point Shipyard and Industrial Complex in Sparrows Point, Baltimore County, Maryland on the Patapsco River and Chesapeake Bay. The site is primarily flat and undeveloped, although warehouses are present on a portion of the site. (Sparrows Point Shipyard, 2012)

Wallenpaupack -The approximately 420-acre site is proposed to be located within the larger approximately 882-acre Wallenpaupack Hydroelectric Power Plant property adjacent to the Lackawaxen River in Pike County, Pennsylvania. The site is located in the Glaciated Low Plateau section of the Appalachian Plateaus physiographic province (DCNR, 2009). The site is primarily forested but contains a cleared transmission corridor running the length of the site.

Indian River - The approximately 420-acre site is proposed to be located within the larger approximately 837-acre Indian River Power Plant, a coal-fired power plant on the Indian River near Millsboro, Sussex County, Delaware. The site is located in the Delmarva Peninsula region of the Coastal Plain physiographic province (MGS, 1981). The site is relatively flat with over 50 percent forested and an area of marsh land in the northernmost portion of the site.

The next step in the process was to confirm whether the Potential Sites were licensable and otherwise viable sites for constructing a new nuclear power station. Of these 14 locations, the BWI Airport, Delaware City Plant, Keystone Industrial Port Complex, and Sparrows Point sites were determined not to be licensable due to population density within a 20 mi (32.2-km) radius of the site significantly exceeding NRC's Regulatory Guide 4.7 criterion of 500 ppsm. In addition, the BWI Airport site is adjacent to a major commercial airport.

The Beiler site was determined not to be a viable option after obtaining reconnaissance level information (needed to support scoring) and cursory evaluation identified that: (1) the nearest water source, Sassafras Creek, does not meet the lowest 7-day average flow with a 10-year return frequency (7Q10) volume requirements, and (2) the next nearest water source, the confluence of Sassafras and Chesapeake Bay, which is over 12 mi away at its nearest point, is too shallow to support an inlet structure and would require significant dredging several more miles out, which would be beyond the 15 mi (24.1 km) exclusionary criterion.

The remaining 9 sites comprise the Candidate Sites, which were further evaluated, scored, and ranked. In addition to the brief description above, information to support the scoring of the Candidate Sites was added to Appendix C of the Alternative Site Evaluation Report (UniStar, 2011) in response to RAI 5022 EIS 9.3-11 (BNP-2011-177, September 23, 2011).

Data Sources:

PBF Energy, 2011. PBF Announces Major Project at the Delaware City Refinery, Parsippany, NJ, December 21.

DCNR, 2009. Pennsylvania Geological Survey: Landforms of Pennsylvania - Map 13, Website: http://www.dcnr.state.pa.us/topogeo/map13/map13.aspx, date accessed: July 25, 2009.

Exelon, 2001. License Renewal Application, Peach Bottom Atomic Power Station Units 2 and 3, Docket Nos. 50-277 and 50-278, Appendix E, Applicant's Environmental Report, July.

MGS, 1981. Maryland Geologic Survey, A Brief Description of the Geology of Maryland, Website: http://www.mgs.md.gov/esic/brochures/mdgeology.html, date accessed: June 17, 2009.

NJDEP, 2009. I-Map NJ Geology Map, website: http://njgin.state.nj.us/dep/DEP_iMapNJGeology/viewer.htm, date accessed: July 29, 2009.

NRC, 2011. Environmental Impact Statement for the Combined License (COL) for Calvert Cliffs Nuclear Power Plant Unit 3, Final Report, U.S. Nuclear Regulatory Commission, Office of New Reactors, and U.S. Army Corps of Engineers, U.S. Army Engineer District, Baltimore, NUREG-1936, Volume 1, May.

Sparrows Point Shipyard, 2012. General Information, Sparrows Point Shipyard Industrial Complex, Website: http://www.spshipyard.com/general.aspx, date accessed: April 13, 2012

UniStar Nuclear Energy (UniStar), 2011. Bell Bend Nuclear Power Plant Alternative Site Evaluation, V. 2, in Bell Bend Nuclear Power Plant Alternative Site Evaluation Report, Revision 2, BNP-2011-102, Docket No. 52-039, Proprietary, May.

Western Pennsylvania Brownfields Center, 2012. Keystone Industrial Port Complex, Case Studies – Western Pennsylvania Brownfields Center – Carnegie Mellon University, Website: http://www.cmu.edu/steinbrenner/brownfields/Case%20Studies/index.html, date accessed: April 13, 2012.

CULTURAL RESOURCES (CR)

CR-07: Provide a SME to discuss the plan for inadvertent discoveries – human remains and all other cultural sites.

Audit Disposition: Upon review of this NFI response the NRC requested to be copied on submittal of the BBNPP Cultural Resources Protection Plan to the SHPO, including redacted and non-redacted copies. Letter BNP-2012-130, including redacted and non-redacted copies of the plan, was sent to the SHPO and to the NRC on May 30, 2012.

LAND USE (LU)

LU-05: Discuss land use plans that include the site and vicinity.

Audit Disposition: Upon review of this NFI response the NRC requested to be provided links to the Bloomsburg, Berwick Borough, and Lackawanna-Luzerne land use plans. These links were sent via email on 16 May 2012, and are reproduced below.

Response:

2010 State Land Use and Growth Management Report
http://newpa.com/get-local-gov-support/community-planning/land-use-reports/2010-state-land-use-and-growth-management-report

Lackawanna/Luzerne Regional Plan, 2011
http://www.luzernecounty.org/county/departments_agencies/planning_commission/lackawannaluzerne-metropolitan-planning-organization/mpo-plansdocuments

Columbia County Comprehensive Recreation, Parks, Greenways and Open Space Plan, 2007
http://www.dcnr.state.pa.us/ucmprd1/groups/public/documents/document/d_001222.pdf

Town of Bloomsburg 2009 Comprehensive Plan
http://www.bloomsburgpa.org/compplan.htm

Borough of Berwick, Columbia County, Comprehensive Plan, November 2000
http://www.berwickborough.org/documents/File/Berwick%20Borough%20Comprehensive%20Plan%20FY%202000.PDF

Open Space, Greenways & Outdoor Recreation Master Plan, Lackawanna and Luzerne Counties, Pennsylvania
http://www.dcnr.state.pa.us/ucmprd1/groups/public/documents/document/d_001197.pdf

LU-15: Provide a knowledgeable expert who can discuss how the operation of the BBNPP would complement or conflict with existing land-use plans, including communication between the applicant and relevant agencies regarding this topic.

Audit Disposition: Upon review of this NFI response the NRC requested to be provided a docketed copy of the report entitled "Professional Planning Analysis for PPL Bell Bend Nuclear Power Plant Conditional Use Application". This report is provided as Enclosure 5 to this letter.

NEED FOR POWER (NFP)

NFP-01: Update the Need for Power analysis using more recent market information sources. For example, any forecast should reflect the effect of the current prolonged recession. Analysis should reflect which factors have changed between 2008 and 2012 in the likely power market area relative to the need for the proposed Action.

Audit Disposition: Upon review of this NFI response the NRC requested to be provided a docketed copy, included in its entirety below.

Response: In order to attempt to be responsive to this broad Information Need request, a sensitivity analysis was performed on the conclusions in each section of ER Rev. 3 Chapter 8 to identify whether there are changes to the conclusions based on more recent market information sources and to provide updated data/tables for any conclusions which may have changed and for key information contained in the Need for Power analysis.

Section 8.1, Description of Power System

Section 8.1 provides a description of the power system. Although more current data sources are available for this section, there are no changes to the conclusions in Section 8.1. That is to say that the following conclusions are still accurate: the PJM reliability evaluation process is (1) systematic, (2) comprehensive, (3) subject to confirmation, and (4) is responsive to forecasting uncertainties. Therefore, the PJM process is responsive to the data and information needs of Sections 8.1, 8.2, 8.3, and 8.4 as described in NUREG-1555.

Section 8.2, Power Demand

Although there are no conclusions for ER Rev. 3Section 8.2, data from 2008 through 2011, as applicable, has been included below to provide an update for the power system description and anticipated electrical power demand.

Power System Description

Between 2007 and 2011, the PPL Generation owned or controlled generating capacity in the U.S. increased from 11,418 to 18,693 megawatts (MW), mainly through the addition of subsidiaries in Ohio and Kentucky and increased capacity. In Pennsylvania, PPL Generation power plants increased their total capacity from of 9,076 to 10,508 MW during this same timeframe (PPL, 2012). Between 2006 and 2011, PPL Electric Utilities Corporation total energy sales decreased 1.9 percent (%) from 37.7 to 36.9 billion kilowatt hours (kWh). A partial explanation for this decrease is the company's reclassification of commercial and industrial (C&I) customers; i.e., utility restructuring, the commercial class now includes small C&I (non-residential secondary voltage), and the industrial class includes large C&I (primary and transmission voltage) (Pennsylvania Public Utility Commission [PPUC], 2011).

Pennsylvania's aggregate retail electricity sales in 2010 totaled 144,119 gigawatt-hours (GWh), a 3.3 percent increase from 2009, while the number of customers increased by 0.3 percent. Residential sales represented 36.1 percent of the total sales, followed by industrial (35.1 percent) and commercial (26.9 percent). Aggregate non-coincident peak sales increased to 29,515 MW in 2010, an increase of 7.0 percent over 2009. The current aggregate five-year projection of growth in energy demand is 0.9 percent. This includes a residential growth rate of 0.4 percent, a commercial rate of 1.2 percent and an industrial rate of 1.45 percent. PJM installed generating capacity totaled 166,512 MW at the end of 2010, which was dominated by coal (40.8 percent), natural gas (29.1 percent) and nuclear (18.3 percent). A 2010 generation of 734,678 GWh included 49.3 percent coal and 34.6 percent nuclear. The generating capacity

located in Pennsylvania totals 46,580 MW. Proposed new generating plants and increased capacity of existing plants located in Pennsylvania total 7,795 MW through 2018; this capacity does not include the proposed BBNPP. These facilities are either active, under construction, partially in-service or in-service. Natural gas projects make up over 40 percent of queued capacity. This additional capacity may be used to serve Pennsylvania customers or out-of-state customers (PPUC, 2011). In 2012, PJM dispatched more than 185,600 MW of generation capacity over65,441 miles (mi) in an area that includes over 60 million people, up from over 164,000 MW and 56,000 mi in an area that includes about 51 million people in 2007 (PJM, 2012a).

Power Demand

Power growth and demand in the primary market area, the eastern part of the PJM classic market area, has changed since 2007 with respect to prices. As one of the dominant fuel types in the PJM region, natural gas prices for electric power have fluctuated dramatically from 2007 to 2011. The price per thousand cubic feet of this fuel increased from $7.31 in 2007 to $9.26 in 2008. The price decreased to $4.93 in 2009 and increased in 2010 to $5.27 only to decrease again to $4.87 in 2011 (EIA, 2012a). Number 2 (light) oil prices 2008 to 2011 have decreased slightly from $3.84 to $3.75 per gallon (EIA, 2012b). Imported Number 6 (heavy) oil prices initially decrease from 2008 to 2009 with the cost dropping from $98.64 to 63.11 per barrel only to increase to $79.79 in 2010 to $104.68 in 2011 (EIA, 2012c). As of February 2012, the average retail price for electricity (all sectors) in Pennsylvania, New Jersey, Delaware, Maryland, and Virginia was 10.13, 13.63, 10.88, 11.43, and 9.21 cents per kWh, respectively (EIA, 2012d).

As of 2011, PJM has about $19 billion dollars of transmission expansion projects (mainly baseline upgrades) planned in 11 states and they received more than 309,000 MW of new generation interconnection requests since 1997. System enhancements planned by PJM to date will support more than 50,000 MW of new in-service generation. This generation enhances system reliability, supply adequacy and competitive markets for PJM's market participants and the customers they serve. The generation additions represent various fuel types, including natural gas, wind, and coal. Pennsylvania leads the in-service generation with an overwhelming majority of those projects—over 14,000 MW (PJM, 2012b).

Updated actual and projected peak load requirements through 2015 for PPL Electric Utilities Corporation is provided in Table 8.1-2 (see Attachment A, PPUC, 2011). Updated actual and projected energy demand is provided in Tables 8.1-3 (residential customers), 8.1-4 (commercial customers), and 8.1-5 (industrial customers) (see Attachment A, PPUC, 2011).

Section 8.3, Power Supply

ER Rev. 3 Section 8.3 does not include any conclusions, however, updated information on the power supply has been provided below.

In 2011, PJM's installed capacity was178,846.5 MW, an increase of over 15,000 MW from 2007. This installed capacity was provided by coal units (46.9 percent), nuclear units (34.2 percent),natural gas units (14.4 percent), hydroelectric units (2.0 percent), wind units (1.5 percent), waste units (0.7 percent), and oil units (0.3 percent).(PJM, 2012c) A revised Table 8.3-1 (see Attachment A) presents the installed capacity (in MW) by relevant PJM control zones in the BBNPP Region of Interest (ROI) and unit type as of December 31, 2011.

Current information from PJM shows that, as of December 31, 2011, 90,725 MW of capacity were in generation request queues for construction through 2018, compared to approximately 46,372 MW of capacity in PJM's generation request queues for construction at the end of 2006.

Wind projects account for approximately 37,792 MW, 41.75 percent of the capacity in the queues, and combined-cycle projects account for 34,138 MW, 37.6 percent of the capacity in the queues (PJM, 2012c). An updated Table 8.3-6 (see Attachment A) illustrates the capacity additions (in MW) in active or under-construction queues by PJM control zones located in the BBNPP ROI identified by PJM as of December 31, 2011.

As discussed in ER Rev. 3Section 8.3,the known retirements between 2002 and 2007 totaled 6,045 MW of generating capacity. Recent planned deactivation/retirement information shows that a total of 1,322.3 MW of generation capacity retired in 2011, and in 2012, approximately 41 percent or another 7,189 MW is expected to retire. From 2011 through 2019, a total of 18,886 MW are expected to retire. Most of this capacity is expected to retire by the end of 2015. (PJM, 2012c).

A potentially significant change in the distribution of unit types within the PJM region is likely as a combined result of the location of generation resources in the queue and the location of units likely to retire. Throughout many of the relevant PJM Control Zones within the PJM market area, the capacity mix is likely to shift to more natural gas-fired combined cycle and combustion turbine capacity. Elsewhere in the PJM region, continued reliance on steam (mainly coal) is likely, although changes in environmental regulations have had an impact on coal units throughout the PJM region.

Section 8.4, Assessment of Need for Power

The need for new capacity based on projected demand is discussed in Section 8.4 of the ER. Total capacity in 2011 consists of 70.3 percent baseload capacity, 10.8 percent intermediate capacity, and 18.9 percent peak capacity (PJM, 2012c). The demand for capacity includes expected peak load plus a reserve margin. The reliability goal is to have total supply equal to, or slightly above, the demand for capacity.

In their 2011 Reserve Requirement Study, PJM recommendsa15.6% Installed Reserve Margin (IRM) for the 2012/2013Delivery Year, and a15.4% IRM for the 2013/2014, 2014/2015 and 2015/2016Delivery Years (PJM, 2011a).Existing certain capacity and future planned capacity are counted towards meeting the reserve requirement in PJM. Conceptual capacity is fully counted only when an Interconnection Service Agreement is executed. All proposals for new generation come through the PJM Regional Transmission Expansion Process (RTEP) to determine required transmission expansion if necessary. Reliability*First* Corporation's (RFC's) 2011 Long Term Resource Assessment includes a projected reserve margin for the PJM RTO of 26.0 percent in 2012 and 18.3 percent in 2021, based on net internal demand (NID) and existing, future and conceptual Net Capacity Resources (RFC, 2011). The RFC report indicates that these reserve margins are adequate to satisfy the PJM reserve margin requirements throughout the assessment period (RFC, 2011).

However, according to the North American Electric Reliability Corporation (NERC), the planning reserve margin for several assessment areas, including PJM, are unable to meet the NERC Reference Margin Level by 2021 with Anticipated Resources alone. NERC's 2011 Long-Term Reliability Assessment concludes that to maintain sufficient reserve capacity in the long-term, additional resources may be needed in the PJM area. (NERC, 2011) Long-term planning, however, is uncertain because of factors such as varying market practices and regulatory conditions. There are a number of environmental regulations that have completed or are nearing their final rulemaking. Compliance with these new regulations may cause or accelerate generator owners' decisions to retire some of the units that otherwise need retrofit work to continue operating.

Using the NERC moderate case assumptions (NERC, 2011), nearly 9,800 MW of capacity in PJM would be retired by2018, potentially reducing the reserve margin in 2021 from 18.3 percent to 12.4 percent. Beginning in 2019, PJM would need additional resources beyond those identified in this assessment. In this scenario, the projected reserve margin deficit in 2019 is 1,200 MW increasing to 4,800 MW by 2021. (RFC, 2011)

Similarly, the potential candidates for retirement under the strict case assumptions for PJM that were in the NERC 2011 Long-Term Reliability Assessment amount to 4,535 MW by 2013, 13,412 MW by 2015 and 14,592 MW by 2018. The strict case impact on the PJM reserve margins would be a decrease in 2021 from 18.3 percent without the potential retirements to 9.5 percent with the strict case retirements. This implies that PJM would need additional resources to satisfy reserve margins beginning in 2017. In this scenario, the projected reserve margin deficit in 2017 is 1,300 MW increasing to 9,600 MW by 2021. (RFC, 2011)

In summary, as stated in ER Rev. 3 Section 8.4.3, the following benefits are provided by the BBNPP:

- The proposed BBNPP would alleviate existing congestion in the west-to-east transmission of energy across the Allegheny Mountains.
  - This benefit remains unchanged.
- The proposed BBNPP would provide much needed baseload power for an area that is expected to have the average annual peak forecast grow between 1.2 and 1.5% per year over the next 10 years.
  - Summer peak load for the PJM Mid-Atlantic Region is forecasted to grow at an average annual rate of 1.2 percent over the next 10 years and 1.0 percent over the next 15 years (PJM, 2011b). This is consistent with the information presented in the ER Rev. 3.
- The proposed BBNPP would allow PJM to continue to meet the growing demand for an average of 1,654 MW per year of added capacity since 2000.
  - According to NERC, the recent economic recession has significantly reduced short-term demand projections and increased uncertainty in long-term projections across North America. The average annual compound growth rate for the 2011 demand forecast is the lowest 10-year forecast growth rate since NERC began recording this data in 1967. However, there are indications that the decline in 10-year forecast growth rates is not as severe as predicted. The 2011 summer peak Total Internal Demand forecast for the United States is more aligned with the previous year's projections, indicating the beginning of some recovery activity after two years of decline. Projected average annual growth rates are still declining, but at a significantly slower rate than observed in prior years. (NERC, 2011)
- The proposed BBNPP would enable PJM to sustain the reserve margins necessary to prevent a reduction in the supply of energy and to meet the expected future demand trends.
  - - As stated above, based on the NERC 2011 Long-Term Reliability Assessment, PJM would need additional resources of 1,300 MW as early as 2017 to satisfy reserve margins. The BBNPP would enable PJM to sustain the reserve margins for several years, although projected reserve margin deficits would exceed the additional capacity provided by the BBNPP before 2021.

- Given concerns throughout the northeastern United States about climate change and carbon emissions, the proposed BBNPP serves another important need by reducing carbon emissions. The proposed BBNPP would displace significant amounts of carbon as soon as the plant becomes operational, as compared to the coal fired generation that likely would be expected to meet the identified need for power.

  - This benefit remains unchanged.

As stated in ER Rev. 3 Section 8.3.4, it is expected that RTOs (i.e., PJM) prepare need-for-power evaluation for proposed generation and transmission facilities. The BBNPP will be located within the PJM RTO. As shown in ER Section 8.1, PJM evaluations are systematic, comprehensive, subject to confirmation and responsive to forecasting uncertainty. Therefore, the BBNPP's Need for Power assessment satisfies the criteria noted in NUREG-1555, Section 8.4.

Data Sources:

DOE, 2010. Database of State Initiatives for Renewables & Efficiency (DSIRE™), U.S. DOE Energy Efficiency and Renewable Energy, North Carolina Solar Center, "RPS Policies, April 2012," Website: http://www.dsireusa.org/documents/summarymaps/RPS_map.pdf, Date accessed: May 3, 2011.

Energy Information Administration (EIA), 2012a. Independent Statistics and Analysis, Short-Term Energy Outlook, Short-Term Energy and Summer Fuels Outlook, Release Date: April 10, 2012, Real Prices Viewer, U.S. Natural Gas Electric Power Price, Website: http://www.eia.gov/forecasts/steo/realprices/, Date accessed: May 3, 2012.

Energy Information Administration (EIA), 2012b. Independent Statistics and Analysis, Short-Term Energy Outlook, Short-Term Energy and Summer Fuels Outlook, Release Date: April 10, 2012, Real Prices Viewer, Heating Oil Retail Prices, Website: http://www.eia.gov/forecasts/steo/realprices/, Date accessed: May 3, 2012.

Energy Information Administration (EIA), 2012c. Independent Statistics and Analysis, Short-Term Energy Outlook, Short-Term Energy and Summer Fuels Outlook, Release Date: April 10, 2012, Real Prices Viewer, Imported Crude Oil Prices, Website: http://www.eia.gov/forecasts/steo/realprices/, Date accessed: May 3, 2012.

Energy Information Administration (EIA), 2012d."Electric Power Monthly, April 2012, with Data for February 2012,"DOE Office of Electricity, Renewables & Uranium Statistics, DOE/EIA-0226 (2012/04).

NERC, 2011. 2011 Long-Term Reliability Assessment, November.

PJM, 2011a. PJM Reserve Requirement Study, 11-year Planning Horizon: June 1st 2011 - May 31st 2022, Analysis Performed by PJM Staff, October 13.

PJM, 2011b. PJM Load Forecast Report, January 2011, Prepared by PJM Resource Adequacy Planning Department.

PJM, 2012a. PJM "About PJM, Company Overview",Website:http://www.pjm.com/about-pjm/who-we-are/company-overview.aspx, Date accessed: May 3, 2012.

PJM, 2012b. PJM 2011 RTEP Summaries, February 28.

PJM, 2012c. State of the Market Report for PJM, 2011, Volume 2, Detailed Analysis, prepared for PJM by Monitoring Analytics LLC, March15.

PJM, 2012d. PJM 2011 Regional Transmission Expansion Plan (RTEP) in Review, Book 1, 178 pp, February 28.

PPL, 2012. PPL Corporation Annual Report 2011, April 3.

PPUC, 2011. "Electric Power Outlook for Pennsylvania, 2010-2015", Pennsylvania Public Utility Commission, July 2011.

RFC, 2011. Reliability*First* Corporation Long-Term Resource Assessment, 2012-2021, September.

ATTACHMENT A

Table 8.1-2 PPL Electric Utilities Corporation Actual and Projected Peak Load (MW)

Year	Actual	Projected Peak Load Requirements (Year Forecast Was Filed)										
		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2001	6583	6850										
2002	6970	6960	7000									
2003	7197	7060	7070	6790								
2004	7335	7170	7040	6860	7200							
2005	7083	7270	7120	7000	7300	7200						
2006	7577		7200	7140	7410	7290	7310					
2007	7163			7320	7510	7390	7410	7200				
2008	7414				7610	7490	7510	7270	7410			
2009	6845					7580	7610	7340	7450	7180		
2010	7365						7710	7400	7500	7250	7270	
2011								7480	7580	7320	7227	7101
2012									7680	7360	7283	7138
2013										7450	7366	7142
2014											7487	7216
2015												7282

Source: PPUC, 2011

ATTACHMENT A

Table 8.1-3 PPL Electric Utilities Corporation Actual and Projected Residential Energy Demand (GWh)

Year	Actual	Projected Residential Energy Demand (Year Forecast Was Filed)										
		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2001	12269	12176										
2002	12640	12324	12391									
2003	13266	12478	12514	12868								
2004	13441	12634	12650	13062	13308							
2005	14218	12799	12803	13259	13505	13950						
2006	13714		12955	13462	13728	14311	14099					
2007	14411			13671	13962	14675	14392	14180				
2008	14419				14198	15019	14555	14422	14469			
2009	14218					15349	14794	14565	14584	14341		
2010	14206						15036	14702	14562	14340	14384	
2011								14828	14608	14246	14390	14142
2012									14770	14350	14226	14120
2013										14443	14164	14005
2014											14325	14161
2015												14335

Source: PPUC, 2011

ATTACHMENT A

Table 8.1-4 PPL Electric Utilities Corporation Actual and Projected Commercial Energy Demand (GWh)

Year	Actual	Projected Commercial Energy Demand (Year Forecast Was Filed)										
		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2001	11778	11291										
2002	12117	11431	11850									
2003	12273	11561	12033	12212								
2004	12576	11699	12219	12507	13275							
2005	13157	11848	12411	12757	13601	12967						
2006	13140		12602	13101	13975	13436	13188					
2007	13756			13418	14286	13946	13562	13184				
2008	13913				14631	14517	13836	13476	13676			
2009	13818					15068	14166	13777	14028	14258		
2010	10667						14492	14045	14253	14486	14098	
2011								14290	14596	14631	14642	10756
2012									14907	14926	14907	10860
2013										15228	15295	11022
2014											15827	11251
2015												11499

Source: PPUC, 2011

NOTE: The 2010 actual and 2011 forecast are based on a reclassification of the commercial and industrial classes.

ATTACHMENT A

Table 8.1-5 PPL Electric Utilities Corporation Actual and Projected Industrial Energy Demand (GWh)

Year	Actual	Projected Industrial Energy Demand (Year Forecast Was Filed)										
		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2001	10319	10963										
2002	9853	11255	10780									
2003	9599	11521	11135	10355								
2004	9611	11777	11425	10503	9938							
2005	9720	12010	11702	10641	10035	9750						
2006	9704		11970	10795	10155	9926	9968					
2007	9482			10924	10253	10136	10048	9965				
2008	9551				10346	10349	10084	9999	9625			
2009	8418					10577	10150	10032	9570	9401		
2010	12045						10214	10059	9228	9141	8506	
2011								10084	9005	8879	8365	12151
2012									9009	8866	8211	12116
2013										8864	8110	12269
2014											8054	12450
2015												12686

Source: PPUC, 2011

NOTE: The 2010 actual and 2011 forecast are based on a reclassification of the commercial and industrial classes.

ATTACHMENT A

Table 8.3-1— Installed Capacity (MW) by Relevant PJM Control Zone and Unit Type (December 31, 2011)

Relevant PJM Control Zone	Combined Cycle	Combustion Turbine	Diesel	Hydroelectric	Nuclear	Solar	Steam	Storage	Wind	Total
AECO	154	661	21	0	0	37	1,110	0	8	1,991
BGE	0	835	7	0	1,705	0	3,007	0	0	5,554
DPL	1,125	1,773	96	0	0	0	1,825	0	0	4,819
JCPL	1,693	1,225	33	400	615	0	15	0	0	3,981
Met-Ed	2,041	416	42	20	805	0	844	0	0	4,168
PECO	3,209	836	7	1,642	4,541	3	1,505	1	0	11,744
PPL	1,810	618	49	581	2,470	0	5,527	0	220	11,275
PSEG	2,960	2,863	5	5	3,493	83	2,125	0	0	11,534
RECO	0	0	0	0	0	0	0	0	0	0
Total	12,992	9,227	260	2,648	13,629	123	15,958	1	228	55,066

Notes:
AECO = Atlantic Electric Company
BGE = Baltimore Gas and Electric Company
DPL = Delmarva Power and Light Company
JCPL = Jersey Central Power and Light Company
Met-Ed = Metropolitan Edison Company
PECO = PECO Energy
PPL = PPL Electric Utilities
PSEG = Public Service Electric and Gas Company
RECO = Rockland Electric Company

ATTACHMENT A

Table 8.3-6— Capacity Additions (MW) in Active or Under-Construction Queues by Control Zone (December 31, 2011)

Relevant PJM Control Zone	Combined Cycle	Combustion Turbine	Diesel	Hydroelectric	Nuclear	Solar	Steam	Storage	Wind	Total
AECO	1,775	753	9	0	0	685	15	0	2,541	5,779
BGE	678	0	29	0	1,640	0	132	0	0	2,479
DPL	1,759	56	0	0	0	337	22	34	850	3,058
JCPL	2,729	27	30	0	0	1,178	0	0	0	3,964
Met-Ed	3,510	0	21	0	39	183	0	3	0	3,756
PECO	663	7	6	0	490	21	0	2	0	1,189
PPL	1,354	11	4	3	1,700	146	34	20	268	3,540
PSEG	3,065	1,083	9	0	50	361	105	2	20	4,695
RECO	0	0	0	0	0	0	0	0	0	0
Total	15,533	1,937	108	3	3,919	2,911	308	61	3,679	28,459

Notes:
AECO = Atlantic Electric Company
BGE = Baltimore Gas and Electric Company
DPL = Delmarva Power and Light Company
JCPL = Jersey Central Power and Light Company
Met-Ed = Metropolitan Edison Company
PECO = PECO Energy
PPL = PPL Electric Utilities
PSEG = Public Service Electric and Gas Company
RECO = Rockland Electric Company

NON-RADIOLOGICAL HUMAN HEALTH (NRHH)

NRHH-04: Provide an SME to discuss etiological agents or diseases of concern for the region where the plant is to be built, and report the incidents of infection in the receiving waters in the past ten years.

Audit Disposition: Upon review of this NFI response the NRC requested to be provided a docketed copy, included in its entirety below.

Response: Etiological agents or diseases of concern for the region are discussed in NUREG 1437, Supplement 35 (NRC, 2009, Section 4.1.2), which evaluates the effects of microbiological organisms on human health from the Susquehanna Steam Electric Station (SSES) Units 1 and 2 closed-cycle cooling system and the magnitude of the potential public health impacts associated with thermal enhancement of enteric pathogens.

NUREG 1437, Supplement 35, noted that:

1. Pathogenic microorganisms that are of concern in the nuclear power reactor operation, such as species from genus Legionella, typically have optimal growing temperatures of approximately 99°F (37°C), and

2. Thermophilic bacteria generally occur at temperatures of 77 to 176°F (25 to 80°C), with optimal growth occurring between 122 and 150°F (50 and 66°C) and minimum tolerance of 68°F (20°C).

NUREG 1437, Supplement 35, further noted that the ambient temperatures of the Susquehanna River near the SSES site vary from freezing (approximately 32°F [0.0°C]) in the winter to 85°F (29°C) in the summer. As a result, the NRC staff concluded that ambient river conditions are not likely to support the proliferation of pathogenic organisms of concern.

Similarly, the NRC staff concluded that impacts on public health from thermophilic microbiological organisms from continued operation of SSES would be small. The NRC staff's conclusion was based on the evaluation of ambient river temperatures during periods of low river discharge flows, the size of the mixing zone and temperatures at its edge, as well as regulatory requirements placed on the SSES discharge by the Pennsylvania NPDES discharge permit.

Based on the small increase in the surface temperatures from the combined BBNPP and SSES discharges, the NRC staff's evaluation relating to microbiological organisms in NUREG-1437, Supplement 35 (NRC, 2009), applies to BBNPP as well.

Reference:

NRC, 2009. NUREG 1437, Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 35, Regarding Susquehanna Steam Electric Station, Units 1 and 2, Final Report, U.S. Nuclear Regulatory Commission, March 2009. ADAMS No. ML090700454.

NRHH-05: Provide a knowledgeable expert to discuss historical and any recent algal blooms in local water bodies in the vicinity of the site.

Audit Disposition: Upon review of this NFI response the NRC requested to be provided a docketed copy, included in its entirety below, as well as the Ecology III, Inc. 1995 reference, which is included as Enclosure 6 to this letter.

Response: Based on conversations with Dr. Brian Mangan of Kings College, Wilkes-Barre, PA (April 2012) there is no anecdotal or documented information on any historical or recent algal blooms in local water bodies in the vicinity of the site, including Walker Run and its tributaries, Lake Took-A-While, or the Susquehanna River.

The only relevant data known to be available are from studies by Ichthyological Associates/Ecology III from 1977 to 1994 on the Susquehanna River in the vicinity of the site (Ecology III, Inc. 1995). Phytoplankton data (free-floating microalgae generally responsible for algal "blooms") from these studies is provided below. Please note that sample location Bell Bend and Bell Bend I represent algae collection sites, named based on the river location, and are not intended as a specific reference to the current project location.

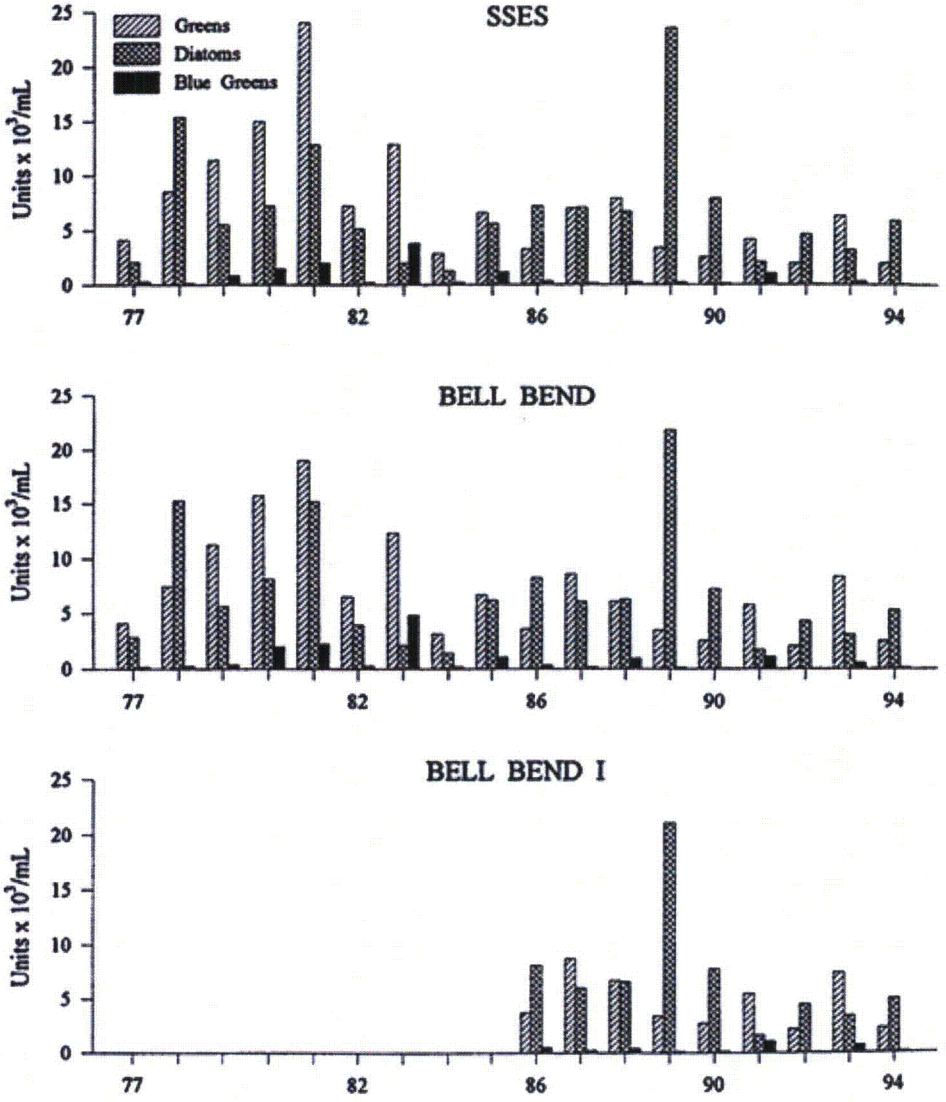
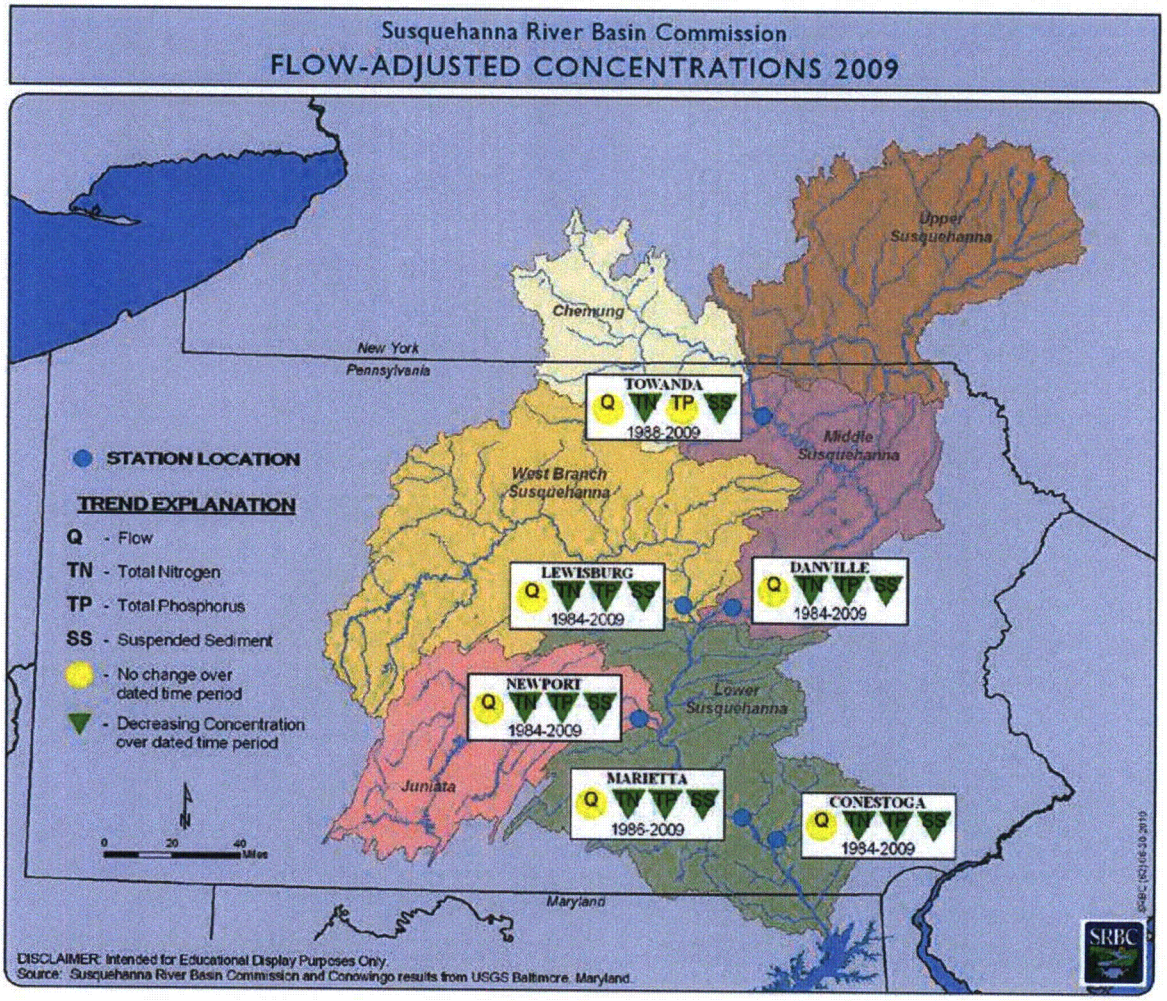


Fig. B-2

Standing crop of phytoplankton at SSES, Bell Bend, and Bell Bend I on the Susquehanna River during preoperation (1977-82) and operation (1983-94) of the Susquehanna SES.

Ecology III, Inc. 1995, page 56.

It should also be noted that the limiting nutrients that lead to algal blooms, nitrogen and phosphorus, based on an analysis by the Susquehanna River Basin Commission (SRBC) at Danville (see figure below) have been decreasing in the middle branch of the Susquehanna River over the past 25 years (1984 to 2009). (SRBC, 2010)



References:

Ecology III, Inc. 1995. Environmental Studies in the Vicinity of the Susquehanna Steam Electric Station, 1994 Annual Report. Prepared for PA Power and Light Co. Ecology III, Inc., Berwick, PA. 139 pp.

SRBC, 2010. State of the Susquehanna, Susquehanna River Basin Commission (SRBC) Sediment & Nutrient Monitoring Program, http://www.srbc.net/stateofsusq/documents/SRBCSedimentNutrientMonitoringFeatureArticle.pdf

NRHH-07: Provide an SME to discuss potential ozone from the power transmission system. (ER 5.6.3)

Audit Disposition: Upon review of this NFI response the NRC requested to be provided a docketed copy, included in its entirety below.

Response: Two related NRC documents discuss potential ozone from the power transmission system:

- NUREG-1437 (NRC, 1996) and NUREG-1437, Supplement 35 (NRC, 2009). NUREG-1437, the Generic Environmental Impact Statement (GEIS) for License Renewal of Nuclear Plants, referred as the GEIS, discusses the issue generically.

- NUREG-1437, Supplement 35, discusses the specific environmental impacts of PPL's application to renew the license for the Susquehanna Steam Electric Station (SSES) Units 1 and 2.

Together, these documents provide sufficient information to determine if potential ozone from the BBNPP power transmission system is an environmental issue.

- NUREG-1437, GEIS (Section 4.5.2), discusses the production of ozone by transmission lines during corona, a phenomenon that occurs when air ionizes near isolated irregularities on the conductor surface such as abrasions, dust particles, raindrops, and insects. Studies referenced in the GEIS quantified the amount of ozone generated and concluded that the amount produced by even the largest lines in operation (765 kV) as insignificant. The GEIS concluded that ozone concentrations generated by transmission lines are too low to cause any significant effects and determined the issue to be Category 1 – i.e., for nuclear plant license renewal, the issue is generic to all plants and that the environmental impact is small. For issues that meet the Category 1 criteria, no additional plant-specific analysis is required, unless new and significant information is identified.

- NUREG-1437, Supplement 35 (Section 4.2), noted that the NRC staff did not identify any information that is either new or significant related to Category 1 issues applicable to SSES that would call into question the conclusions in the GEIS. Therefore, the NRC staff relied upon the conclusions of the GEIS for all of the Category 1 issues applicable to SSES. As a result, potential ozone from the power transmission system remained a Category 1 at SSES, with a small environmental impact and that additional plant-specific mitigation measures would not be sufficiently beneficial to be warranted.

- The transmission lines at BBNPP are 500 kV, much less than the 765 kV lines evaluated in the GEIS, and connected to the existing SSES transmission system (ER Section 5.6.3.1).

- For the above reasons, the potential ozone environmental impacts from the BBNPP transmission lines should be similar, if not the same, to that described for SSES in NUREG 1437, Supplement 35 (NRC, 2009, Section 4.2).

References:

NRC, 1996. NUREG 1437, Generic Environmental Impact Statement for License Renewal of Nuclear Plants, U.S. Nuclear Regulatory Commission, May 1996.

NRC, 2009. NUREG 1437, Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 35, Regarding Susquehanna Steam Electric Station, Units 1 and 2, Final Report, U.S. Nuclear Regulatory Commission, March 2009. ADAMS No. ML090700454.

NON-RADIOLOGICAL WASTE (NRW)

NRW-01: Provide a knowledgeable expert to discuss capacity at landfills to handle construction and demolition debris during building.

Audit Disposition: Upon review of this NFI response the NRC requested to be provided a docketed copy, included in its entirety below.

Response: For the purposes of this response, C&D debris is considered to include the following items per PA regulation:

Definition 271.1 Construction/demolition waste —Solid waste resulting from the construction or demolition of buildings and other structures, including, but not limited to, wood, plaster, metals, asphaltic substances, bricks, block and unsegregated concrete. The term does not include the following if they are separate from other waste and are used as clean fill:

(i) Uncontaminated soil, rock, stone, gravel, brick and block, concrete and used asphalt; and

(ii) Waste from land clearing, grubbing and excavation, including trees, brush, stumps and vegetative material.

Materials produced during BBNPP construction in significant volume that would be defined as C&D debris would be predominantly unsegregated waste concrete, metal, wood (pallets and blocking), and small amounts of debris from construction of buildings and utility installation, such as wire, plastic, sheetrock, vinyl, or roofing materials.

As described in the response to NFI NRW-3, BBNPP will employ a vigorous recycling program that will reuse or recycle nearly all wood, metal, and both unsegregated and wasted concrete on the site. Materials too degraded to be reused will be segregated and recycled, preventing wood, paper, plastic, and metals from being disposed of at a C&D (or other sanitary) landfill.

The USEPA keeps a list of all licensed C&D landfills (doc. PB95-208914), including several in eastern PA that continue to accept C&D debris, such as the Bethayres Reclamation Landfill in Huntingdon Valley, PA. PPL will utilize this facility or another identified via the PPLEU generation services fleet waste alliance to dispose of the small amount of C&D debris considered unsuitable for reuse or recycling.

NRW-02: Provide a knowledgeable expert to discuss any treatment and/or restoration plans for temporary waste storage sites used during construction or discuss why they would not be necessary.

Audit Disposition: Upon review of this NFI response the NRC requested to be provided a docketed copy, included in its entirety below,

Response: There are only two temporary waste sites proposed. The first is a temporary sedimentation pond associated with the concrete batch plant. The second is the temporary dredge pond at the intake/discharge structure.

Materials collected in these ponds qualify as unregulated clean fill and the basins will be retired in place. Retirement for the temporary dredge pond involves regrading as shown on NPDES Drawing CS1516, and reseeding per the NPDES Post Construction Stormwater Management Plan. The temporary sedimentation pond at the concrete batch plant will be converted into a permanent infiltration basin (shown as "Basin 18" in the NPDES Drawings CS1510 and CS1515).

NRW-03: Provide a knowledgeable expert to discuss the environmental impacts that could result from the generation, handling, and disposal of nonradioactive waste during building activities for the proposed plant, including the waste types, destinations (on- and offsite), regulations, mitigation measures, and potential impacts of the waste on land, water, and air. Be prepared to discuss estimates of the combined non-radioactive waste generated from preconstruction and NRC-authorized construction.

Audit Disposition: Upon review of this NFI response the NRC requested to be provided a docketed copy, included in its entirety below.

Response: Land, air, and water impacts associated with non-radiological waste (NRW) generated during construction activities are considered to be comparatively minor due to the moderate volume of waste produced, and the recycling programs proposed to allow reuse of a large component construction related NRW. Work site control procedures, including neat work area rules and extensive use of BMPs and appropriate signage are proposed to control migration of worksite materials outside of appropriate areas, preventing impact to nearby environmental resources.

Items such as wooden pallets, blocking, select packing materials, and even waste concrete will be recycled and reused onsite during construction. Wood, metal, paper, plastic, and cardboard will be collected and sent to local recycling facilities for reuse, and only limited common refuse will be sent to local waste collection facilities. Stumps, slash, and non-marketable wood will be chipped and used on site. Impacts associated with the handling of NRW include vehicle emission associated with transportation, and these trips have been accounted for in the fuel usage estimate, emissions inventory, and traffic impact assessments for BBNPP.

While reuse, recycling, and offsite disposal of limited common refuse will account for a majority of the NRW produced at BBNPP, additional information on select waste streams is also discussed in the following documents:

- BBNPP ER Section 3.6, Non-Radioactive Waste Systems, and ER Section 4.6, Measures and Controls to Limit Adverse Impacts During Construction, discuss the environmental impacts that could result from the generation, handling, and disposal of nonradioactive waste during building activities for the proposed plant, including the waste types, destinations (on- and offsite), regulations, mitigation measures, and potential impacts of the waste on land, water, and air during operation and construction.

- Preconstruction and NRC-authorized construction are discussed in ER Section 4.2.1.2, Construction Activities, ER Section 4.2.1.4, Surface Water Bodies Receiving Construction Effluents that Could Affect Water Quality, and ER Section 4.2.1.5, Construction Impacts.

NRW-04: Provide a knowledgeable expert to discuss nonradioactive solid, liquid, gaseous, hazardous, and mixed waste generated by other past, present, and reasonably foreseeable future projects in the geographical area of interest. Not in ER.

Audit Disposition: Upon review of this NFI response the NRC requested to be provided a docketed copy, included in its entirety below.

Response: A knowledgeable expert will be available during the audit to discuss non-radioactive solid, liquid, gaseous, hazardous and mixed waste generated by other past, present and reasonably foreseeable future projects in the geographical area of interest.

NON-RADIOACTIVE WASTE

As discussed in ER Rev. 3, Section 5.5.1, all non-radioactive waste generated at the proposed BBNPP (i.e., solid wastes, liquid wastes, air emissions) will be managed in accordance with applicable federal, Pennsylvania, and local laws, regulations, and permit requirements. Management practices will be similar to those implemented at the SSES Units 1 and 2. Quantities, composition, and frequency of waste discharges to water, land, and air are discussed in ER Rev. 3 Section 3.6.

Solid waste will be reused or recycled to the extent possible. Solid wastes appropriate for recycling or reclamation (e.g., used oil, antifreeze [e.g., ethylene or propylene glycol], scrap metal, and universal waste) will be managed using approved and licensed contractors. Non-radioactive solid waste destined for offsite land disposal will be disposed of at approved and licensed offsite commercial waste disposal sites.

Past, present, and reasonably foreseeable future projects within the geographical area of interest (i.e., 50 mile radius of each Alternative Site, as well as the proposed BBNPP facility) are listed in ER Rev. 3 Table 9.3-23. Most present and reasonably foreseeable future projects will generate some non-radioactive solid waste, such as construction debris, during construction activities. However, transportation and other infrastructure development, mine reclamation, parks/community development, flood control, landfill improvement, watershed improvement and protection, and urbanization projects are not expected to generate waste after the completion (i.e., construction) of the project.

Projects that are likely to generate non-radioactive waste (solid, liquid, gaseous, and/or hazardous waste) for the duration of the project include the Susquehanna Steam Electric Station (SSES), combustion power generating facilities, Marcellus Shale natural gas extraction, wastewater treatment plants, and manufacturing and warehouse/distribution facilities. Facilities that generate residual waste (i.e., non-hazardous industrial waste) in Pennsylvania are identified in generator reports from the PADEP (Pennsylvania Department of Environmental Protection [PADEP], 2009). Information on the top hazardous waste generator facilities in Pennsylvania is provided in Pennsylvania's Hazardous Waste Facilities Plan (PADEP, 2011).

Marcellus Shale Waste

The overall impacts attributed to waste disposal associated with Marcellus Shale development has received increased focus from the PADEP and sister state agencies in New York, Ohio and West Virginia. In addition, industry associations, state universities and environmental groups have also voiced varying opinions on the regulation and disposal of waste materials.

The disposal of brine, frac fluid and drilling materials from hydraulic fracturing (a.k.a., fracking) operations has become subject to new regulations during 2011. The PADEP has stated that "gas well fracturing fluids are considered residual waste and must be managed in accordance with applicable laws." "Drilling companies must also identify where the produced wastewater will be stored, treated and disposed. Pits or impoundments with an embankment for temporarily storing drilling wastes must meet DEP standards for construction (e.g., synthetic liners) and may also require a DEP dam permit. Waste water (fluids) must be reused and recycled, or collected and treated at an authorized waste water treatment facility. DEP approval is required before the receiving treatment facility can accept the wastewater for processing and/or disposal". (Pennsylvania House of Representatives, 2012)

NY State Water Resources Institute recently cited a PADEP 2011 report on disposal of waste fluids during the first 6 months of 2011. PADEP's data indicated that 53 percent of the waste was reused; 36 percent was subject to industrial treatment; 6 percent was replaced by injection well; 1 percent was disposed of at area landfills; less than 1 percent was transported to Publicly-Owned Treatment Works facilities; and the remaining 5 percent was either not determined or used other disposal methods. (New York State Water Resources Institute, 2012)

An analysis of 2011 PADEP data found that of the 10.1 million barrels of shale wastewater generated in the last half of 2011, about 97 percent was either recycled, sent to deep-injection wells, or sent to a treatment plant that does not discharge into waterways (Thetimes-tribune.com, 2012). Given the high percentage of these waste that is reused or subject to industrial treatment and with less than 1 percent disposed of in landfills, it appears that this waste will have little or no long-term impacts on waste disposal operations in Pennsylvania. Marcellus Gas.Org identifies 353 waste facilities in the Marcellus Shale area that may be used for disposal of brine, frac fluid and drilling materials based on information reported to the PADEP by the gas well operating companies. (MarcellusGas.Org, 2012)

Non-Radioactive Waste Facilities

Cumulative impacts from non-radioactive waste are dependent upon the amount of waste generated and the available capacity of area treatment and disposal facilities. Information on the capacity of landfills to handle construction and demolition debris during construction has been provided in the response to NFI NRW-01. The response to NFI NRW-02 discusses temporary waste storage sites during construction. The response to NRW-03 discusses non-radioactive waste generated from preconstruction and NRC-authorized construction.

PPL plants and facilities, such as the SSES, participate in a Waste Alliance with Veolia Environmental Services (ES) and Waste Management for recycling, treatment and disposal of non-radioactive wastes. Using this alliance, wastes may go to any one of number of recycling, treatment and/or disposal facilities operated by Veolia ES, Waste Management, or others, either in Pennsylvania or out-of-state. Veolia ES audits the identified waste facilities to make certain they are operating within regulatory limits. The proposed BBNPP facility is expected to utilize the same or similar waste alliance for disposition of non-radioactive wastes.

An effort is being made to create a Regional Solid Waste Plan (the Plan) that will meet the collective needs of the region, including Columbia, Montour, Lycoming, Union and Snyder Counties. The County Commissioners of the Five-County Region have initiated a comprehensive effort for development of the Plan with Lycoming County acting as the lead agency for its development. Although Northumberland County is not included in the Regional Solid Waste Plan study area, the Plan developers plan to coordinate with them since the county falls within the geographic limits of the area of interest. The Plan will be presented for adoption by each County in 2012, and a one-year implementation period will follow. A Solicitation of Interest (SOI) was prepared that requests facilities to commit up to ten years of processing/

disposal capacity for acceptance of the 5-County Region's municipal waste. A total of 17 responses were received (Lrkimball.com, 2012).

Information on landfill waste receipts by county for each landfill in Pennsylvania is provided by PADEP (PADEP, 2012). In 2009, Pennsylvania had 46 active landfills and six resource-recovery (waste-to-energy) facilities. As of 2009, landfills in Pennsylvania have been reported to collectively have remaining average capacity available for another 16 years based on data from the Environmental Protection Agency (EPA). (American Society of Civil Engineers [ASCE], 2010)

Information on commercial hazardous waste facilities in Pennsylvania is included in Pennsylvania's Hazardous Waste Facilities Plan. As concluded by the PADEP in Pennsylvania's Hazardous Waste Facilities Plan, hazardous waste generators in Pennsylvania have adequate commercial treatment and disposal capacity. The EPA no longer requires capacity assurances from the states and re-confirmed in 2009 that adequate national capacity exists for hazardous waste treatment, storage, and disposal through December 31, 2034. (PADEP, 2011)

MIXED WASTE

As discussed in ER Rev. 3 Section 5.5.2, nuclear power plants, in general, are not significant generators of mixed waste, with quantities accounting for less than 3 percent of the annual low level radioactive waste generated. Mixed waste generation at SSES, in particular, is very limited. In addition, a source reduction plan has been developed for SSES Units 1 and 2. Based on the size of the proposed BBNPP compared to SSES Units 1 and 2, the types and quantities of mixed waste generation are anticipated to be bounded by SSES Units 1 and 2. BBNPP will institute a waste minimization plan that will reduce the accumulation of these wastes.

Generation of mixed waste by other past, present, and reasonably foreseeable future projects within the geographic area of interest would be limited to other nuclear projects, various hospitals and industrial facilities that use radioactive materials, and some Superfund sites. Active Superfund sites within the geographic area of interest are currently investigating and/or removing radiological contamination from a Safety Light Corporation Site (Columbia County, Town of Bloomsburg), a former DOE storage site (Wayne Township, Passaic, NJ), and the Middlesex Sampling Plant Site (Middlesex, NJ). Although the Superfund projects may generate mixed waste concurrent with the proposed BBNPP project, the waste streams generated by the Superfund projects (e.g., remediation waste, soil, sample waste, etc.) would not be expected to be the same as the radioactive and mixed wastes generated by the proposed BBNPP and described in ER Rev. 3 Section 3.6. The only other projects within a 50-mile radius geographic area of interest of the proposed BBNPP that are expected to generate mixed wastes similar to BBNPP are SSES Units 1 and 2 (adjacent to the proposed BBNPP site).

Facilities for disposal of mixed waste are typically located further from the proposed project than facilities for other waste streams. For treatment and disposal of radioactive and mixed waste, Energy Solutions is the dominant company providing these services at several locations in the U.S. On April 27, 2012, low-level radioactive waste disposal operations began at Waste Control Specialists LLC's (WCS's) 1,338-acre facility in west Texas, providing additional capacity for treatment and disposal of radioactive and mixed waste(WCS, 2012). The WCS facility is the designated disposal repository for low-level radioactive waste for the Texas Waste Compact and is licensed and permitted for treatment, storage, and disposal of radioactive, hazardous, and mixed waste (WCS, 2007). The Utilities Service Alliance (USA), comprised of 8 utilities, including SSES, operating nuclear reactors in the U.S., has committed to begin shipping low

level radioactive waste to WCS' Texas Compact Repository for disposal after the facility is opened (World Nuclear News [WNN], 2012; USA, 2012).

Data Sources:

ASCE, 2010. 2010 Report Card for Pennsylvania's Infrastructure: Keystone in Crisis, Website: http://www.pareportcard.org/, Date accessed: May 8, 2012.

Lrkimball.com, 2012. Regional Solid Waste Plan Development, Website: http://www.lrkimball.com/five-county-regional-waste-plan.aspx, Date accessed: May 8, 2012.

MarcellusGas.Org, 2012. Waste Facility Information, Updated May 1, 2012, Website: http://www.marcellusgas.org/waste/waste.php, Date accessed: May 7, 2012.

New York State Water Resources Institute, 2012. "Waste Management of Cuttings, Drilling Fluids, Hydrofrack Water and Produced Water", Gas Wells, updated March 21, 2012, Website: http://wri.eas.cornell.edu/gas_wells_waste.html, Date accessed: May 8, 2012.

PADEP, 2009. Residual Waste Program, 2008 Pennsylvania Residual Waste Generator Report, Source: 2008 Pennsylvania Residual Waste Biennial Report, Pennsylvania Department of Environmental Protection, Bureau of Waste Management, Division of Reporting and Fee Collection, Website: http://www.portal.state.pa.us/portal/server.pt/community/residual_waste/14093, November 17.

PADEP, 2011. Pennsylvania's Hazardous Waste Facilities Plan, September.

PADEP, 2012. Municipal Waste Disposal Info, "Landfill Waste Receipts in Tons of Waste", First Quarter 2012, Commonwealth of Pennsylvania Department of Environmental Protection, Bureau of Land Recycling and Waste Management, Division of Reporting and Fee Collection , Website: http://files.dep.state.pa.us/Waste/Bureau%20of%20Waste%20Management/WasteMgtPortalFiles/SolidWaste/Municipal_Waste/Reports/facility_2012_1.pdf, Date accessed: May 8, 2012.

Pennsylvania House of Representatives, 2012. Representative Jaret A. Gibbons, PA House of Representatives 10th Legislative District, About the Marcellus Shale, Facts: Regulation of Marcellus Shale Drilling. Website: http://www.pahouse.com/Gibbons/Marcellus-About.asp, Date accessed: May 7, 2012.

Thetimes-tribune.com, 2012. "Marcellus Shale Gas Drillers Recycling More Waste", The Associated Press, published February 17, 2012, Website: http://thetimes-tribune.com/news/marcellus-shale-gas-drillers-recycling-more-waste-1.1273083#ixzz1uEAeLWpk, Date accessed: May 8, 2012.

Utilities Service Alliance (USA), 2012. Utilities Service Alliance, The Members of USA, Website: http://www.usainc.org/members/index.html, Date accessed: May 8, 2012.

WCS, 2007. Waste Control Specialists LLC, Primary Authorizations, Licenses, and Permits, January.

WCS, 2012. WCS Begins LLRW Disposal Operations, April 27, 2012, Website: http://wcstexas.com/, Date accessed: May 7, 2012.

WNN, 2012. Utilities sign up to use Texas repository, October, 17, 2011, Website: http://www.world-nuclear-news.org/WR-Utilities_sign_up_to_use_Texas_repository-1710117.html, Date accessed: May 8, 2012.

S/EJ-01: Provide the author of the demographics analysis to discuss the availability of updated census data to identify current demographic and economic characteristics within the 50 square mile geographic area of comparison in the two county region of influence. Be prepared to discuss the availability of updated census data for all relevant socioeconomic and environmental justice sections of the ER.

Audit Disposition: Upon review of this NFI response the NRC requested to be provided a docketed copy, included in its entirety below.

Response: The following is a comparison of the socioeconomics and environmental justice ER sections, which were prepared using 2000 U.S. Census data, with updated census data. Since the 2000 U.S. Census data was published, the U.S Census Bureau has published the 2006–2010 American Community Survey (ACS) data and the 2010 Decennial Census data. The comparison is for the 50-mile (80-kilometer) geographic area around the BBNPP site and the two-county region of influence (ROI) that includes Luzerne County and Columbia County. A review of updated census data indicates that there is not a large change in the demographic composition of the population between the 2000 and 2006-2010 census periods.

1. Socioeconomic Characteristics

To determine whether the socioeconomic characteristics of the 50-mile study area have changed over the last 10 years, key socioeconomic variables such as total population, age, gender, employment, housing, ethnic composition, and poverty were reviewed across the 2000, 2010 and 2006-2010 datasets.

As shown in Table 1, between 2000 and 2010 the population within the Commonwealth of Pennsylvania grew by 3.4%, from 12,281,054 persons to 12,702,379 persons. This rate of growth is much lower than the levels reported within the United States on average. Nationwide, population growth between the two census periods was reported to be 9.7%, from 281.4 million in 2000 to 308.7 million in 2010. During the same period, the 22 counties located within the 50-mile radius circle of the proposed Bell BBNPP site, grew by 7%, from 2,815,105 persons to 3,010,800 persons, an increase of 195,695 persons. Based on the 2006-2010 ACS data, growth rate in the 22-county area was greater than that of the Commonwealth. The 22-county area grew by 6% and the Commonwealth grew by 2.7%. The fastest growing counties, such as Pike, Monroe, and Carbon Counties, are all located east of the proposed BBNPP site towards the outer periphery of the study area. Growth within Columbia and Luzerne Counties shows mixed trends. Between 2000 and 2010, Columbia County reported a growth of 4.9%, whereas Luzerne County reported a modest 0.5% growth. Combined, the two counties had a population growth of 1.3%, less than both the 22-county region and the Commonwealth.

Table 1: Population Change, 2000 and 2010

Geographic Area	Census 2000	2006-2010 American Community Survey	Census 2010	Change: 2000 to 2010	
	Number	Number	Number	Number	Percent
Pennsylvania	**12,281,054**	**12,612,705**	**12,702,379**	**421,325**	**3.4%**
Berks	373,638	407,310	411,442	37,804	10.1%
Bradford	62,761	62,415	62,622	-139	-0.2%
Carbon	58,802	64,563	65,249	6,447	11.0%
Columbia	***64,151***	***66,642***	***67,295***	***3,144***	***4.9%***
Dauphin	251,798	264,823	268,100	16,302	6.5%
Lackawanna	213,295	213,731	214,437	1,142	0.5%
Lebanon	120,327	131,341	133,568	13,241	11.0%
Lehigh	312,090	343,946	349,497	37,407	12.0%
Luzerne	***319,250***	***319,120***	***320,918***	***1,668***	***0.5%***
Lycoming	120,044	116,376	116,111	-3,933	-3.3%
Monroe	138,687	168,080	169,842	31,155	22.5%
Montour	18,236	18,152	18,267	31	0.2%
Northampton	267,066	294,536	297,735	30,669	11.5%
Northumberland	94,556	94,099	94,528	-28	0.0%
Pike	46,302	56,993	57,369	11,067	23.9%
Schuylkill	150,336	148,288	148,289	-2,047	-1.4%
Snyder	37,546	39,400	39,702	2,156	5.7%
Sullivan	6,556	6,467	6,428	-128	-2.0%
Susquehanna	42,238	43,343	43,356	1,118	2.6%
Union	41,624	44,866	44,947	3,323	8.0%
Wayne	47,722	52,302	52,822	5,100	10.7%
Wyoming	28,080	28,262	28,276	196	0.7%
Total (22 county area)	**2,815,105**	**2,985,055**	**3,010,800**	**195,695**	**7.0%**

Source: U.S Census Bureau, 2000 and 2010 Census. 2006–2010 American Community Survey Data.

Table 2 shows the socioeconomic characteristics of the population within the block groups that are either fully within or partially within the 50-mile study area. Between the 2000 and 2010, the population within the study area increased by 99,181 persons, an increase of just 5.6% over the 10-year period. In terms of age distribution of the population, persons 18 years and over increased by 7.5% over the 10-year period and seniors, while persons above the age of 65 years, increased by 2.2%. The number of females in the study area increased from 900,643 persons in 2000 to 942,120 persons in 2010, an increase of 4.6% over the 10-year period.

Table 2: Socioeconomic Characteristics of Population

Demographic and Economic Characteristics	0-10 mi	10-20 mi	20-30 mi	30-40 mi	40-50 mi	0-50 mi	0-50 mi Percent Change (2000 and 2010)	0-50 mi Percent Change (2000 and 2000-2006 ACS)
Total Population (2000)	68,732	320,441	364,475	552,939	822,679	1,760,217		
Total Population (2006-2010 ACS)	70,840	324,451	361,547	562,162	887,011	1,842,752		4.7%
Total Population (2010)	71,969	325,418	363,231	570,285	898,126	1,859,398	5.6%	
Age Composition								
Persons under 5 years (2000)	3,353	15,738	17,887	29,539	46,856	94,329		
Persons under 5 years (2006-2010 ACS)	3,289	16,440	17,984	29,057	50,766	100,134		6.2%
Persons under 5 years (2010)	3,427	16,719	17,927	29,370	49,785	99,864	5.9%	
Persons 18 years and over (2000)	53,402	253,247	287,028	425,423	624,769	1,361,146		
Persons 18 years and over (2006-2010 ACS)	55,857	259,424	289,537	443,739	684,515	1,444,109		6.1%
Persons 18 years and over (2010)	57,711	260,443	292,055	451,545	695,989	1,463,432	7.5%	
Persons 65 years and over (2000)	11,688	61,430	70,617	89,492	126,043	302,783		
Persons 65 years and over (2006-2010 ACS)	12,309	56,842	66,592	91,821	135,902	304,124		0.4%
Persons 65 years and over (2010)	12,867	55,937	67,932	94,817	139,746	309,455	2.2%	
Gender Composition								
Females (2000)	34,628	166,062	185,946	279,799	416,081	900,643		
Females (2006-2010 ACS)	35,901	164,935	181,630	283,152	447,168	935,038		3.8%
Females (2010)	36,084	164,737	182,860	286,953	451,866	942,120	4.6%	

Sources: U.S Census Bureau, 2000 and 2010 Census; 2006–2010 American Community Survey Data.

Based on 2010 census block data, the population within the 50 -mile study area increased by 5.6%, a little more than 2% above the Commonwealth of Pennsylvania, which increased by 3.4%. When comparing census block level data to the 22 counties within which the study area is located, the study area reported a lower rate of growth, 5.6% versus 7%, respectively. The distribution of the data by age-cohorts and gender within the study area is also similar to the percentages exhibited by the population within larger 22 county area and the Commonwealth of Pennsylvania. Overall, there is not a large change in the demographic composition of the population between the two census periods.

Employment

Based on the most recent employment data (Table 3), the two-county ROI has been affected by the recent downturn in the nationwide economy. Unemployment rates in both counties have increased post 2006, but differently depending on the county. The unemployment rate in Luzerne County, for instance, has nearly doubled over the last 10 years, from 5.6% to 10.5%. The unemployment rate in Columbia County, on the other hand, has increased marginally over the same period (5.5% to 6.0%). The unemployment rate in the combined two-county ROI is about the same as in the Commonwealth of Pennsylvania, 9.8% versus 9.6%, respectively.

Table 3: Employment Characteristics

Labor Force	Luzerne County	Columbia County	Commonwealth of Pennsylvania	U.S.
	Number	Number	Number	Number
Individuals in Labor Force (2000)	151,869	32,403	6,000,512	138,820,935
Civilian Labor Force	151,748	32,376	5,992,886	137,668,798
Employed	143,492	30,006	5,653,500	129,721,512
Unemployed	8,256	2,370	339,386	7,947,286
Percent of Civilian Labor Force Unemployed	5.40%	7.3%	5.7%	5.8%
Individuals not in Labor Force	108,543	20,096	3,692,528	78,347,142
Individuals in Labor Force (2006)	156,404	33,251	6,277,605	152,193,214
Civilian Labor Force	156,352	33,211	6,269,806	151,203,992
Employed	147,674	31,398	5,881,115	141,501,434
Unemployed	8,678	1,813	388,691	9,702,558
Percent of Civilian Labor Force Unemployed	5.6%	5.5%	6.2%	6.4%
Individuals not in Labor Force	101,710	21,194	3,710,321	82,050,749
Individuals in Labor Force (2010)	159,375	32,790	6,470,008	156,966,769
Civilian Labor Force	159,305	32,741	6,463,490	155,917,013
Employed	142,502	30,787	5,842,790	139,033,928
Unemployed	16,803	1,954	620,700	16,883,085
Percent of Civilian Labor Force Unemployed	10.5%	6.0%	9.6%	10.8%
Individuals not in Labor Force	105,592	23,601	3,803,556	86,866,154

Sources: U.S Census Bureau, 2000 and 2010 Census; 2006–2010 American Community Survey Data.

As noted in ER Sections 2.5.2.1.3 and 2.5.2.1.4, the construction industry has historically been a small contributor to the overall employment pool, representing approximately 5% to 7% of the total labor force within the two counties. The trend continues based on 2008-2010 American

Community Survey data, with approximately 6% of the labor force within each county is employed in construction-related fields.

Housing

As described in ER Sections 2.5.1 and 2.5.2, a large portion of the construction and maintenance/operations workforce for the proposed BBNPP site are expected to reside within Luzerne and Columbia Counties. In 2000, the two counties had a combined residential vacancy rate of 19.9%, or a total of 16,817 vacant units. In 2010, vacancy rates within the two counties increased marginally to 21.5%, or a total of 19,835 units. See Table 4.

Table 4: Housing Characteristics

Housing Units	Luzerne County		Columbia County	
	Number	Percent	Number	Percent
2000				
Total Housing	144,686	100.00%	27,733	100.00%
Total Occupied Units	130,687	90.3%	24,915	89.8%
Owner-Occupied	91,914	70.3%	18,030	72.4%
Renter-Occupied	38,773	29.7%	6,885	27.6%
Total Unoccupied Units	13,999	9.7%	2,818	10.2%
Year-around Units	11,482	7.9%	1,514	5.5%
Seasonal, recreational, or occasional use	2,517	1.7%	1,304	4.7%
2006				
Total Housing	147,321	100.0%	28,811	100.0%
Total Occupied Units	130,034	88.3%	25,302	87.8%
Owner-Occupied	94,840	72.9%	19,569	77.3%
Renter-Occupied	35,194	27.1%	5,733	22.7%
2010				
Total Housing	148,748	100.0%	29,498	100.0%
Total Occupied Units	131,932	88.7%	26,479	89.8%
Owner-Occupied	89,742	68.0%	18,387	69.4%
Renter-Occupied	42,190	32.0%	8,092	30.6%
Total Unoccupied Units	16,816	11.3%	3,019	10.2%
Year-around Units	13,404	9.0%	1,801	6.8%
Seasonal, recreational, or occasional use	3,412	2.3%	1,218	6.6%

Sources: U.S Census Bureau, 2000 and 2010 Census; 2006–2010 American Community Survey Data.

Based on the analysis presented in ER Section 4.4.2.4, the in-migration construction workforce could require up to 1,690 housing units. An estimated 550 housing units would be required for the operational workforce (ER Section 5.8.2.2). The total number of housing units required is calculated assuming all persons would choose to rent or purchase existing homes and not reside in apartments, hotels, or townhome communities.

As noted above, the two counties have 19,835 vacant units (Table 4). The 550 housing units required represents approximately 2.8% of the available housing units. As a result, the demand from the in-migration of construction and operations work force will continue to be as described in the ER, namely, no adverse effect to the housing market within the ROI, including demand, prices, or rents.

2. Environmental Justice

To determine whether the environmental justice analysis performed in ER Section 2.5.4 has changed over the last 10 years, the minority and low income populations residing within a 50-mile study area were reviewed across the 2000 and 2010 datasets. The review applied the same methodology, definitions, and NRC guidance used in the ER.

Minority Populations

From NRC guidance, a minority population exists if either of the following two criteria is met:

1. The minority population of the census block group or environmental impact area (in this case the 50-mile comparative geographic area) exceeds 50%; or

2. The minority population percentage of the environmental impact area is significantly greater (typically at least 20 percentage points) than the minority population percentage in the geographic area chosen for comparative analysis (in this case the 50-mile comparative geographic area).

Table 5 shows the percentage of minority persons within the study area. In 2000, the percentage of minorities within the study area is estimated at 5.29%. Based on 2010 data, that percentage increased to 9.94%. The percentage of minorities within the Commonwealth of Pennsylvania is 18.1% of the total population (2010 U.S. Census), which is higher than the percentage of minorities within the study area. Based on 2000 Census data, 126 block groups were identified as having minority populations using the criteria identified above. In 2010, that number dropped to 112 block groups. Median household incomes within the study area have increased between 2000 and 2010.

Table 5: Ethnic Composition and Income Characteristics

Area - 50 mile (80 km) radius	African-Americans	Native Americans, Indians, or Alaskans	Asians	Native Hawaiians or Other Pacific Islanders	Some Other Race	Multi-Racial	Aggregate (Total) of Racial Minorities	Percent of Hispanic/ Latino
Percentage (2000)	2.26%	0.13%	0.79%	0.02%	1.21%	0.88%	5.29%	2.85%
Percentage (2010)	3.94%	0.21%	1.30%	0.03%	2.81%	1.65%	9.94%	6.71%
Income Characteristics	**0-10 mile**	**10-20 mile**	**20-30 mile**	**30-40 mile**	**40-50 mile**	**0-50 mile**		
Median Household Income (2000)	$38,164	$35,279	$35,821	$39,431	$44,289	$39,531		
Median Household Income (2010)	$46,405	$43,203	$46,003	$50,127	$55,791	$49,919		

Source: U.S Census Bureau, U.S Census 2000 and 2010. [1]

[1] Variation in the wording of the Census questionnaires between the 2000 and 2010 Census and aggregation of responses on persons of Hispanic Origin may have led to the large increase in minority persons between the two census periods.

Figures 3 and 4 (figures located at end of response) show the locations of the block groups that exhibited a higher percentage of minority persons based on the two criteria mentioned above. Figure 3 shows the locations of block groups based on 2000 U.S Census data and Figure 4 shows the locations of block groups based on 2010 Census data. As shown in Figure 4, high minority areas within the 50-mile circle radius are low in number and there is no concentration of these blocks groups in any one area. Additionally, there is not a marked change in the distribution of these high minority areas between 2000 and 2010. As a result, the information provided in ER Section 2.5.4 regarding minority populations would remain applicable.

Low-Income Populations

To determine the number and locations of low-income populations within the 50-mile study area, the Census Bureau's definition of a low-income household, based on governmental statistical poverty thresholds, was used. Because the Census Bureau did not report poverty-related data at the census block level as part of the 2010 Census data releases, census tract information was used. For the purposes of presenting these data, poverty data at the census tract level for both the 2000 and 2006-2010 American Community Survey data were compared. A census tract is considered to be low income if either of the following two criteria is met:

1. The number of low-income households in the census tract or the environmental impact site (in this case the 50-mile geographic area) exceeds 50%; or

2. The percentage of households below the poverty level in an environmental impact area is significantly greater (typically at least 20 percentage points) than the low-income population percentage in the geographic area chosen for comparative analysis (in this case, the 50-mile [80-kilometer] comparative geographic area).

Within the 50-mile study area, the percentage of persons below the poverty level was reported as 9.8% in 2000 and 11.7% in 2010. Figures 5 and 6 show the locations of census tracts that exceeded that threshold by 20 percentage points or more in 2000 and 2010, respectively. Between 2000 and 2010, the number of census tracts identified as low-income has increased from 14 to 24. As shown in Figure 6, there are very few concentrations of low-income persons within 50 miles of the site. There is also little change in the locations of low-income persons between 2000 (Figure 5) and 2010 (Figure 6). As a result, the information provided in ER Section 2.5.4 regarding low –income populations remains applicable.

3. Summary

Based on the information above, there is limited trend change in the following key socioeconomic variables in the 50-mile comparative geographic area between the 2000 and 2010 census periods:

- Population growth in the two-county ROI is less than the 50-mile study area, where the largest population growths occurred towards the outer periphery of the study area.

- Unemployment is about the same in the two-county ROI as in the Commonwealth of Pennsylvania.

- Ample housing units still remain to support the in-migration of construction and operations work force.

- The percentage of minority and low-income populations remain within NRC guidelines for environmental justice as to whether there are disproportionately high effects to these groups.

As a result, Revision 3 to the ER uses information that presents a realistic representation of the demographics and socioeconomic characteristics within the 50-mile geographic area of comparison and the two county region of influence.

References:

U.S. Census Bureau (USCB), 2000. U.S. Census Bureau, U.S. Department of Commerce. SF1 and SF3 data tables. Website: http:// www.census.gov, Data accessed April 11, 2012.

USCB, 2011. U.S. Census Bureau, U.S. Department of Commerce. American Community Survey 2006–2010 Estimates. Website: http://www2.census.gov/acs2006_5yr/summaryfile/, Date Accessed April 11, 2012.

USCB, 2011. U.S. Census Bureau, U.S. Department of Commerce. American Community Survey 2008–2010 Estimates. Website: http://www2.census.gov/acs2006_5yr/summaryfile/, Date Accessed April 16, 2012.

USCB, 2011. U.S. Census Bureau, U.S. Department of Commerce. Website: http://www.factfinder2.census.gov/, Date Accessed April 12, 2012.

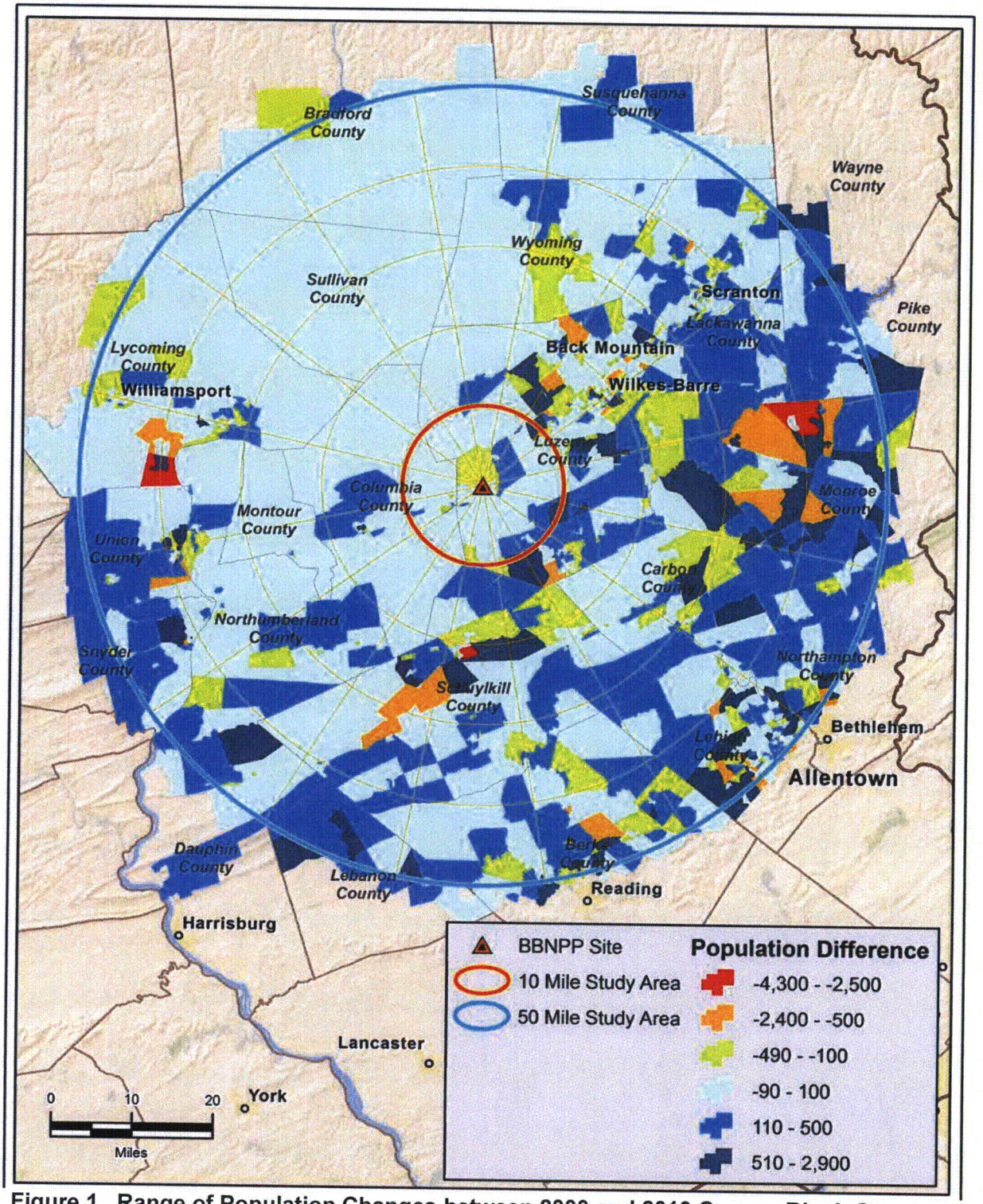


Figure 1. Range of Population Changes between 2000 and 2010 Census Block Groups

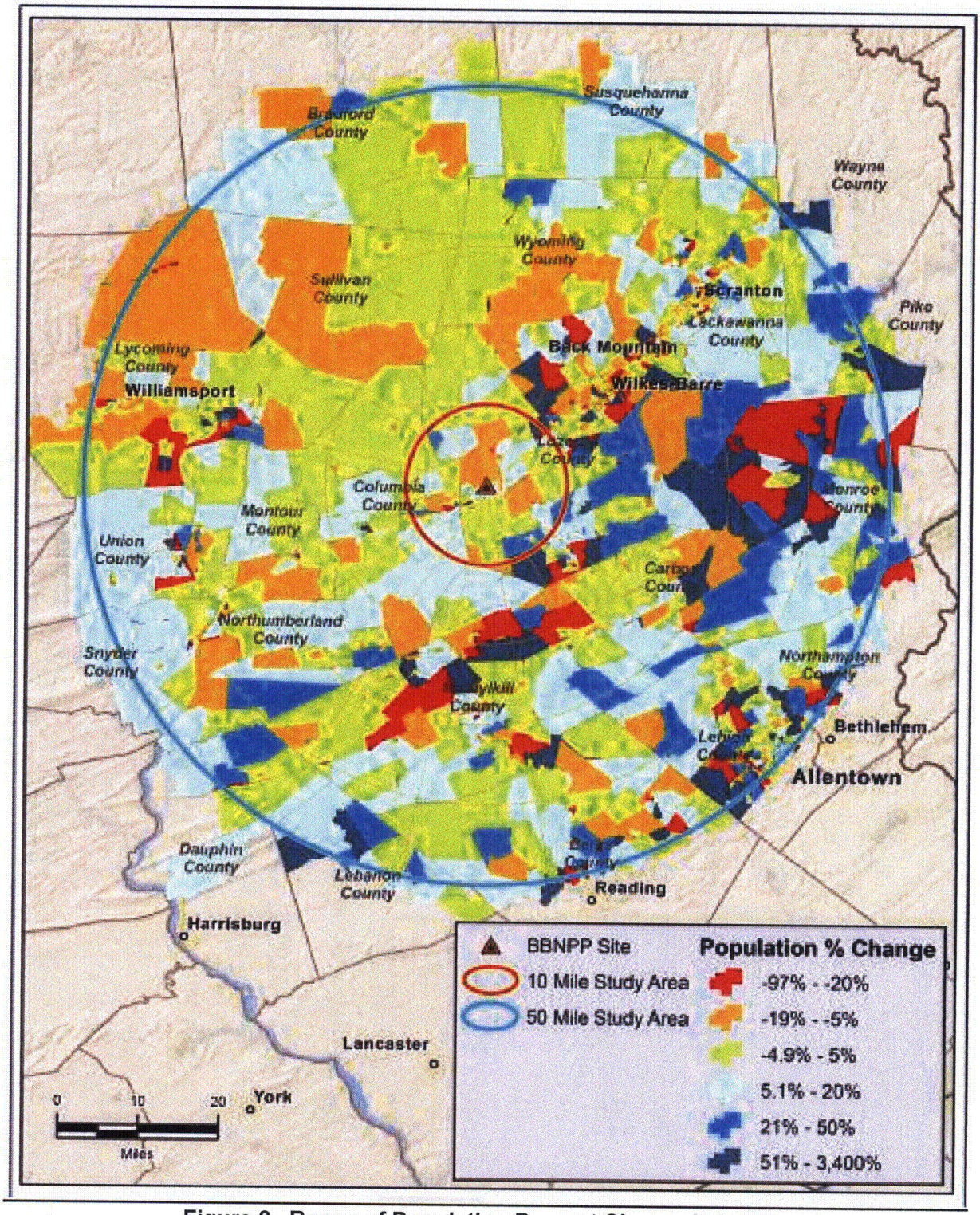


Figure 2. Range of Population Percent Change between 2000 and 2010 Census Block Groups

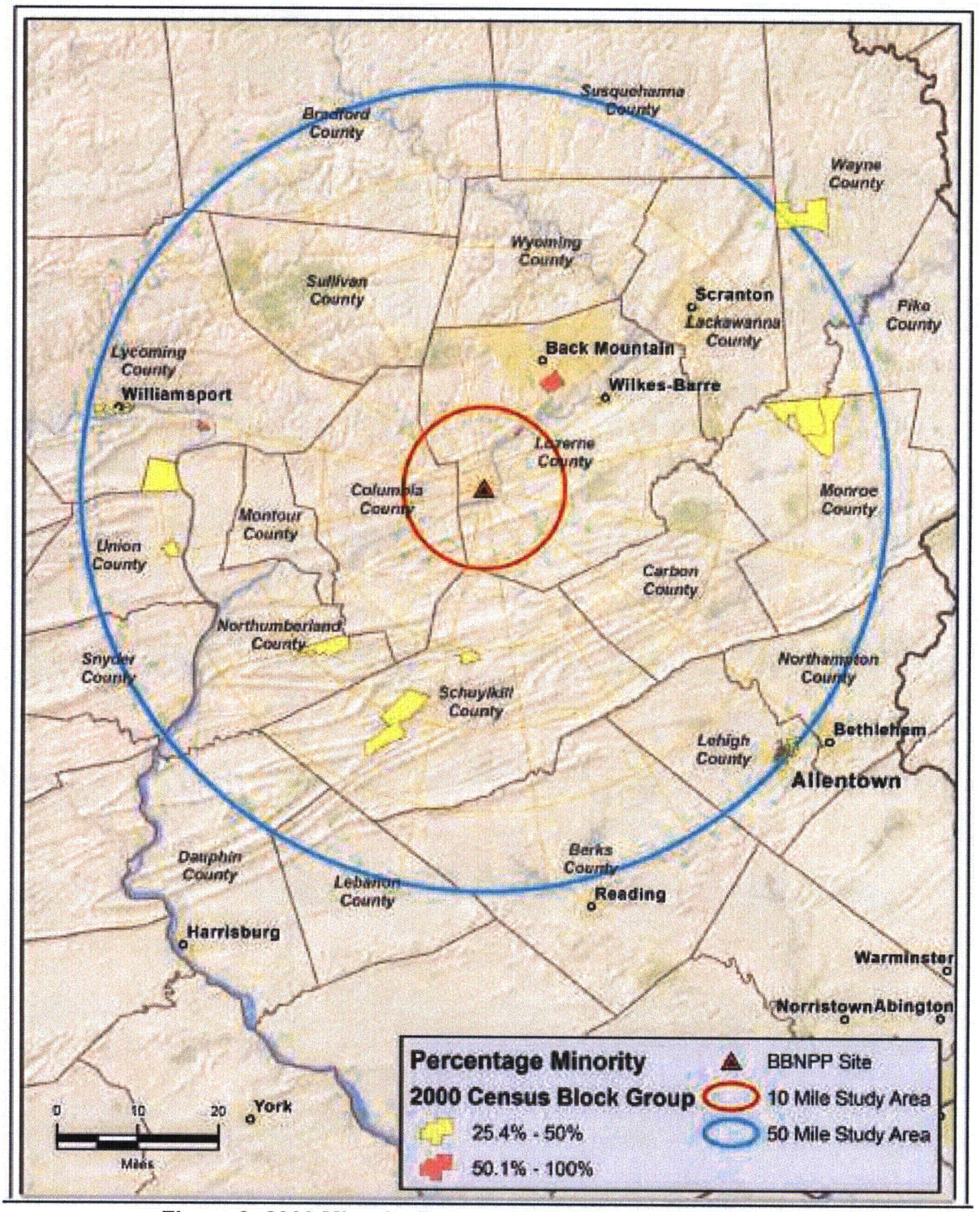


Figure 3: 2000 Minority Populations by Census Block Group

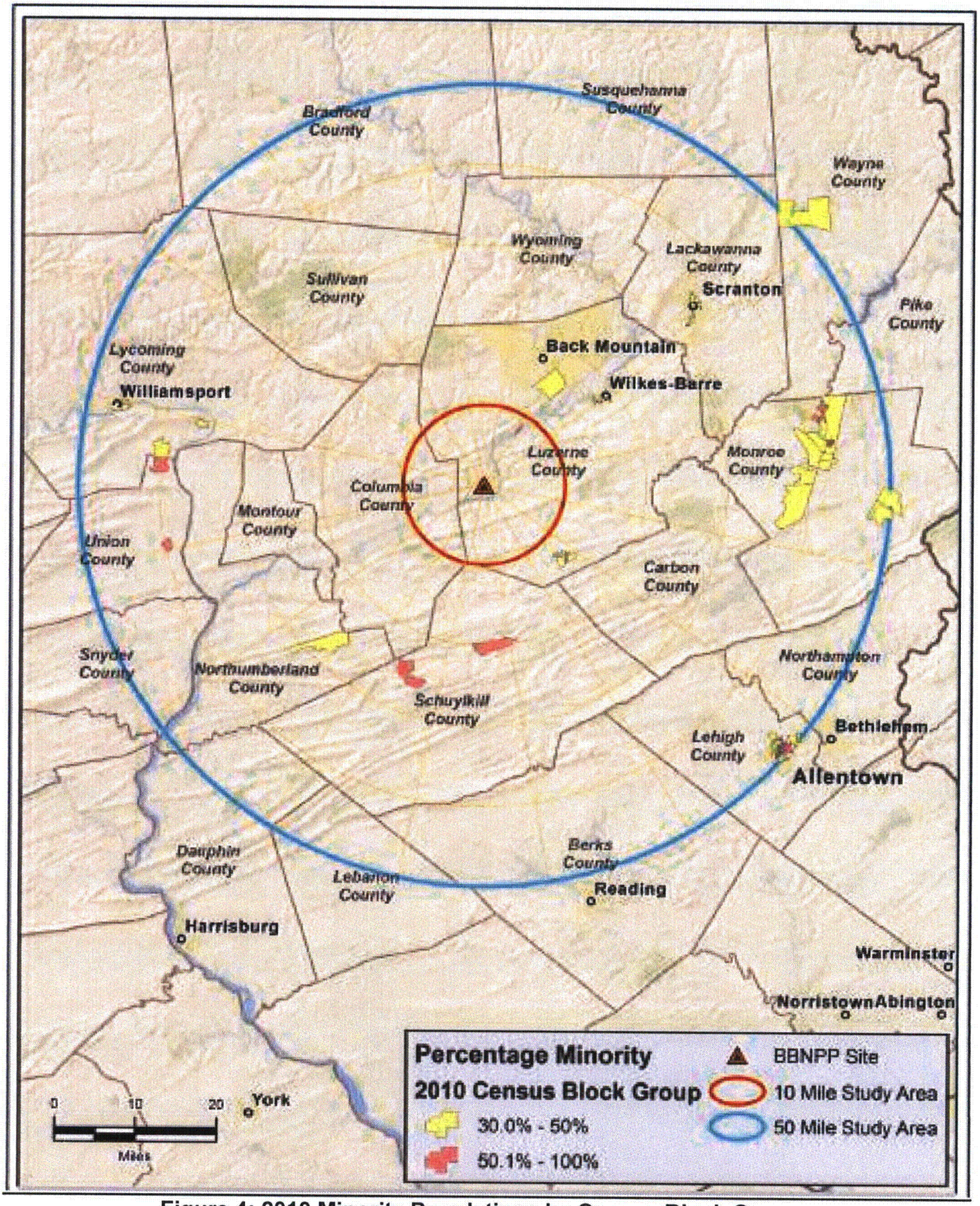


Figure 4: 2010 Minority Populations by Census Block Group

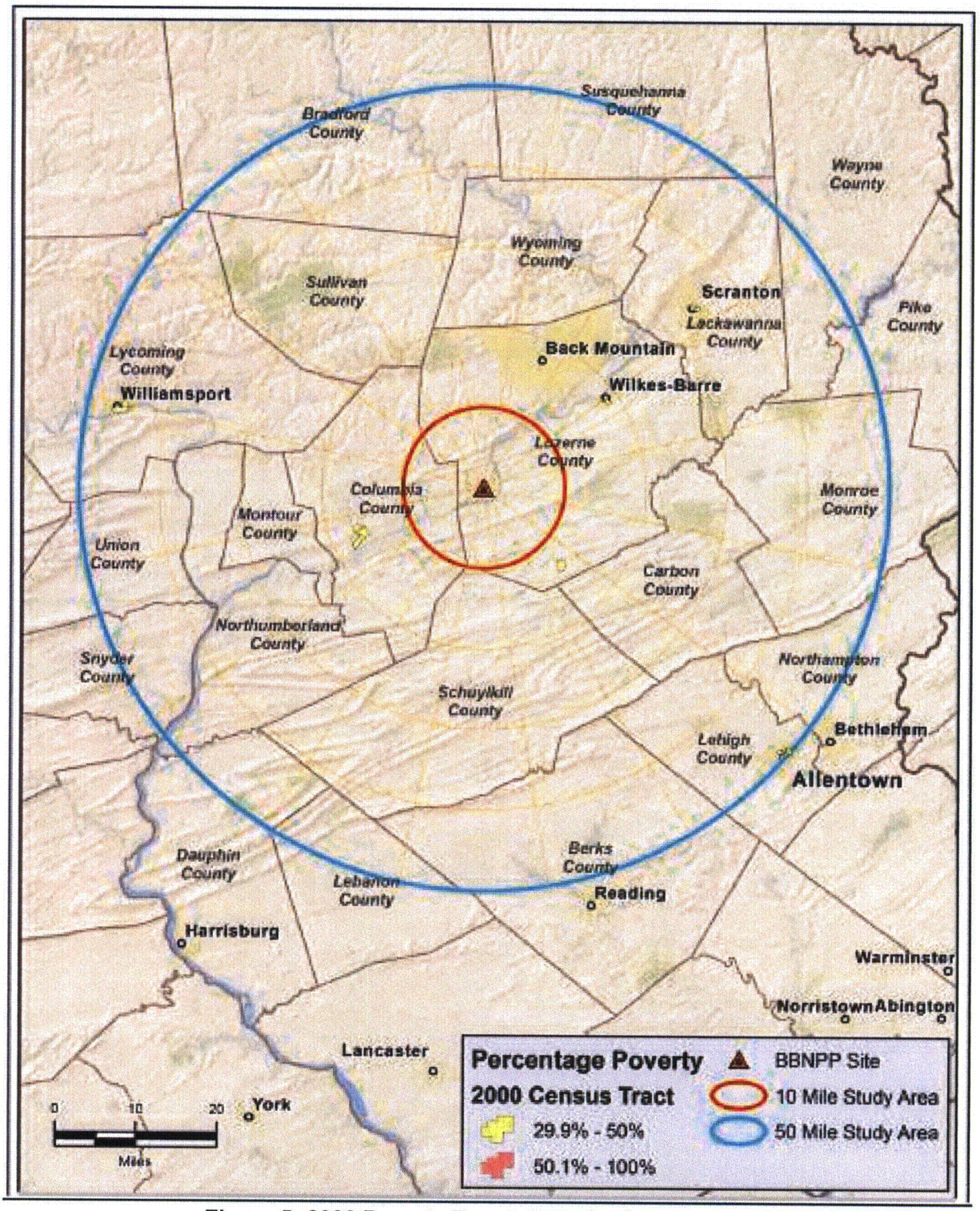


Figure 5: 2000 Poverty Populations by Census Tract

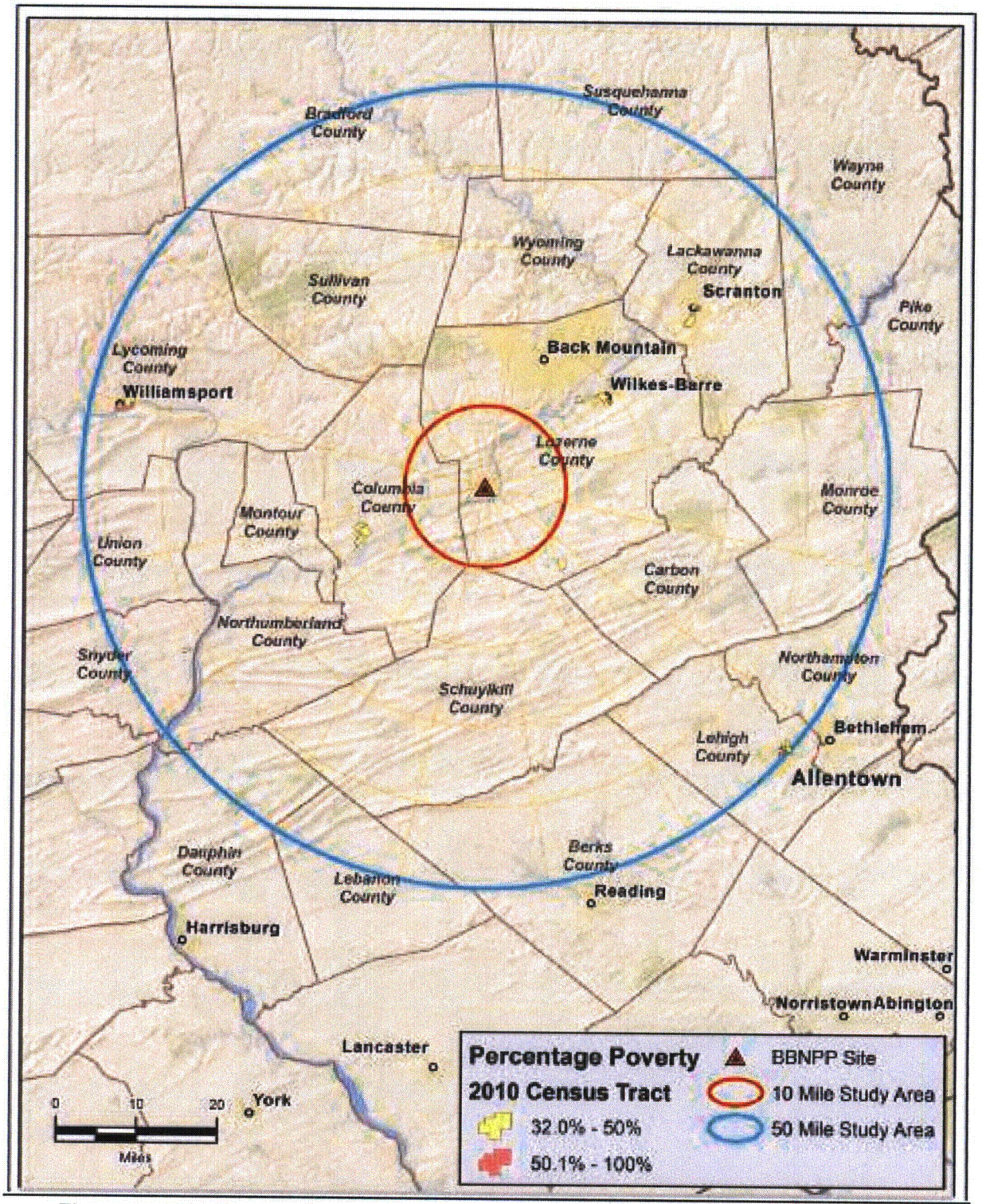


Figure 6: 2010 Poverty Populations by Census Tract Using 2006-2010 ACS Data

TERRESTRIAL ECOLOGY (TE)

TE-03: Provide an SME to discuss provision of mitigation via nesting structures for negative impacts to bald eagles, peregrine falcons, and osprey.

Audit Disposition: Upon review of this NFI response the NRC requested to be provided a docketed copy, included in its entirety below.

Response: Bald eagles, peregrine falcons, and ospreys are known to exist in the region. However, none of these species or potential nesting sites were observed during project-related ecological field studies. Accordingly, no impact to bald eagle, peregrine falcon, or osprey nesting is expected from the construction and operation of BBNPP, and no mitigation in the form of nesting structures has been proposed.

Section 7 consultation with the USFWS and NRC is underway, and PPL will comply with all conditions of any permit or finding issued for the project.

TE-09: Provide an SME to discuss existing PPL transmission line ROWs procedures in terms of the frequency and timing of inspection and maintenance actions, including herbicide application, tree cutting, mowing and other maintenance. Also provide documentation for practices within/near wetlands and water bodies, and important terrestrial species occurrences.

Audit Disposition: Upon review of this NFI response the NRC requested to be provided a docketed copy, included in its entirety below. Enclosure 7 to this letter provides the attachments referenced in this response.

Response: PPL EU is in the third year of a three year program to reclear all existing PPL transmission line ROW's. The reclearing includes tree trimming, danger tree removal, mowing of the r/w and herbicide applications. Work is performed as per the r/w agreements and PPL Transmission Specifications. After this initial r/w clearing, transmission lines will be maintained on a three year cycle, following a wire zone/border zone approach, please see attached brochure Transmission Line Vegetation Management and information from a PPL EU web page, Vegetation Management Keeping your electric service reliable.

One species of special concern along transmission right-of-ways in this area is the Indiana Bat. Guidelines for protection of the Indiana Bat were established on May 4, 2007, please see attached memo.

Refer to attached PPLEU specification LA-79827-8 in regard to practices near wetlands and use of herbicides.

The documents included in Enclosure 7 demonstrate PPL's compliance with applicable regulations.

TE-10: Provide an SME to discuss any wetland and riparian buffer areas in light of the recommendations in the referenced A Natural Areas Inventory, Luzerne County PA (Update 2006) by the PA Natural Heritage Program, 2006, and how they are expected to prevent wildlife impacts in such areas. (ER 4.3.1.1)

Audit Disposition: Upon review of this NFI response the NRC requested to be provided a docketed copy, included in its entirety below.

Response:

The 2006 update to *A Natural Areas Inventory* recommends 100-foot buffers for riparian areas and wetlands based on a review of scientific literature. It is suggested by PNHP that implementation of buffer zones of this width provide numerous benefits, including protecting water quality and providing habitat for wildlife.

The guidance in *A Natural Areas Inventory* is advisory in nature, and PNHP has no authority to require the use of buffer zones. Through the Chapter 102 Erosion and Sediment Control regulations, the PADEP does regulate buffer zones adjacent to certain categories of waterways, however such waterways do not exist at BBNPP.

PPL recognizes the value of buffer zones, and has voluntarily included buffer zones of 50 feet or greater into BBNPP design to protect wetlands and waterways on site. The buffers proposed at BBNPP represent the maximum practical width of buffer zone that can be provided while continuing to allow use of the site for EPR development.

ER Rev. 3 Section 4.3.2.1 and the JPA describe the buffer zones proposed by PPL adjacent to wetlands and riparian areas within the Walker Run watershed. These buffer zones are intended to provide numerous benefits, including preventing wildlife impacts by maintaining travel corridors, moderating water temperatures, providing food, cover, and connected breeding and foraging habitat, and creating a stable streamside ecosystem.

Reference:

Pennsylvania Riparian Buffer Forest Guidance (November 27, 2010). The Pennsylvania Clean Streams Law P.L. 1987, Act 394 of 1937 as amended (35 P.S. 691.1 et seq.)

TE-14: Provide an SME to discuss PPL's intentions regarding measures such as reducing lighting on cooling towers (CTs) to the FAA-allowed minimum or to use flashing lights for the purposes of reducing bird collisions with the CTs.

Audit Disposition: Upon review of this NFI response the NRC requested to be provided a docketed copy, included in its entirety below.

Response:

- PPL intends to follow FAA requirements regarding lighting on the cooling towers.
- Strobe lights and minimal lighting levels dictated by FAA regulations will be used to reduce bird collisions.
- Bird mortality associated with cooling towers is discussed in ER 4.3.1.2.

TE-15: Provide an SME to describe results of on-site bird surveys in areas where the transmission line crosses wetlands not affected by the project and any potential need for diverters or application of avian power line interaction committee guidelines for reducing potential for avian collisions and electrocutions.

Audit Disposition: Upon review of this NFI response the NRC requested to be provided a docketed copy, included in its entirety below.

Response: Bird surveys are presented in ER Rev. 3 Section 2.4.1.2.2, and Section 11J of the COLA.

Proposed transmission lines will cross several wetlands and waterbodies at BBNPP. These areas do not attract large concentrations of foraging or migrating birds, and are largely within or adjacent to lands with numerous existing transmission lines.

Based on discussions with SSES plant personnel, bird mortality at that facility has not been observed to be a problem in the ~30 years since construction, and deceased birds beneath existing transmission lines are rarely found. While scavenging by predators (coyotes, etc.) would remove many birds killed by collision with transmission lines, it would not be as significant within the switchyards and fenced areas with overhead lines, and birds are very rarely observed in these locations. Consequently, diverters or other methods to prevent avian collisions are not proposed or considered necessary at BBNPP.

TE-16: Provide an SME to discuss the discrepancy in impacted habitat acreage reported in ER 4.3-1 and Tables 4.3-2, 4.3-2, 4.3-4, 4.3-6, 4.3-7.

Audit Disposition: Upon review of this NFI response the NRC requested to be provided a docketed copy, included in its entirety below.

Response: PPL has reviewed the referenced tables in ER Revision 3 and has not found any errors or discrepancies in habitat or land use acreages.

There are many values regarding land use and pre- and post-construction habitat acreages in the ER and supporting source reports. In some instances, the ER presents numbers that are the sum or derivative of values in ER tables, and do not appear in the tables.

For example, the ER page 4-44 describes impacts to non-wetland terrestrial habitat as 368 acres. Page 4-44 also list the impacts to wetlands as 1.4 acres. Table 4.3-1 lists permanent losses to plant communities as 369.4 acres. This value (369.4) is the sum of the 368 acres of non-wetland terrestrial habitat added to the 1.4 acres of permanent wetland habitat impact. While the ER follows a standard approach in reporting and describing these values, there may be confusion due to the large number of values and the various ways the data is presented and discussed.

TE-17: Provide an SME to discuss inconsistencies in the aerial extent of disturbance at the cooling water intake structure at ER 4.3-1, and figures 4.1-1, 4.1-2, and 4.1-3.

Audit Disposition: Upon review of this NFI response the NRC requested to be provided a docketed copy, included in its entirety below.

Response:

- A previous RAI (TE 4.3-10, from the 2009 Environmental Audit) offers a partial response to this question.
- ER Rev. 3.0 Figures 4.1-1, 4.1-2, and 4.1-3 illustrate the permanent grading impact areas associated with BBNPP construction.
- ER Rev. 3.0 Figure 4.3-1 illustrates the total area of disturbance associated with construction at BBNPP.
- The difference in the aerial extent of disturbance is based on the differences between the types of impacts that are illustrated in the Figures. Figures 4.1-1, 4.1-2, and 4.1-3 show the permanent grading impact area and Figure 4.3-1 shows the total area of disturbance which includes all disturbance including wetland and stream mitigation and enhancement activities.
- ER Rev. 3.0 Figure 4.3-1 includes impacts associated with wetland mitigation and enhancement within the Riverlands (1.24 acres) (ER 4.3.1.6). This area is located to the west of the cooling water intake structure and explains the apparent discrepancy in the extent of disturbance.

TE-21: Provide an SME to discuss other public or private sector projects of all sizes in the areas that could affect terrestrial resource in a similar way to the BBNPP project.

Audit Disposition: Upon review of this NFI response the NRC requested to be provided a docketed copy, included in its entirety below.

Response: Present or known future projects within the region that could affect terrestrial resources in a similar way as the BBNPP project would include projects that could result in temporary and/or permanent disturbance of approximately 700 acres or more of land with associated impacts to approximately 1.5 acres of wetlands or approximately 400 or more acres of forest. The geographic area of interest for the analysis includes the area within 50 miles of BBNPP and also within the Anthracite Upland and Susquehanna Lowlands Sections of the Ridge and Valley Physiographic Province.

As stated in ER Rev. 3 Section 9.3.2, the direct and indirect effects of coal mining have affected the terrestrial ecology of the geographic area of interest. Remedial work has corrected some past damage but mining-related environmental impacts will persist into the future, particularly with ongoing anthracite strip mining in the area.

Currently, the proposed Susquehanna-Roseland electrical transmission line, which would run from a substation near Berwick, Pennsylvania to a substation in Roseland, New Jersey for a total distance of approximately 145 mi (233km), is a within the region with the potential to affect terrestrial resources in a similar way as the BBNPP project. While this proposed electrical transmission line would follow an existing power transmission corridor for about 95 percent of its route, it will traverse terrain that has been relatively undisturbed, such as a national recreation area, the Pocono Mountains, and state parks. Other land use types crossed include developed lands, freshwater wetlands, and forest lands. Because impacts associated with the Susquehanna-Roseland electrical transmission line would be along a linear project and would be minimized by following an existing power line corridor for 95 percent of the route, the project would have less impact in any specific area than development of a single geographically consolidated project. (PPL Electric Utilities, 2012)

Publicly-available sources indicate that there are 17 existing or planned electrical generation projects, including 4 that would be constructed concurrent with the development of the proposed project and 1 planned for future development, within the geographic area of interest. Some of these projects could have comparable impacts to terrestrial resources as the BBNPP project, depending upon site-specific conditions.

Large industrial complexes, industrial/business parks, airports, and construction of suburban subdivisions also could have comparable impacts to terrestrial resources as the proposed BBNPP project if they are of a comparable size. Historical developments of these types have contributed to the current condition of terrestrial resources, but specific projects cannot be singled out. Review of the planning documents for governments in the region did not indicate any current or planned industrial complexes, industrial/business parks, or subdivision development in the region.

Data Source:

PPL Electric Utilities, 2012. Susquehanna-Roseland Project, Project Updates, Website:http://www.pplreliablepower.com/projectupdates.htm, Date accessed: April 26, 2012.

TE-26: Provide the 2008 and 2010 noise reports. Discuss ambient noise levels in the vicinity of the SSES CTs and projected cumulative noise in combination with BBNPP cooling towers in relation to distance from these noise sources and noise thresholds for wildlife.

Audit Disposition: Upon review of this NFI response the NRC requested to be provided a docketed copy, included in its entirety below.

Response: The 2008 noise reports were included in BB COLA Rev 2, Part 11L, and are provided as an attachment to this response. They include the following documents:

- Report Number 062608-1, Baseline Environmental Noise Survey, Leaf-on Season, Bell Bend Nuclear Power Plant (BBNPP) Project, June 2008 (Enclosure 8)

- Report Number 041808-1, Baseline Environmental Noise Survey, Leaf-off Season, Bell Bend Nuclear Power Plant (BBNPP) Project, June 2008 (Enclosure 9)

- Report Number 080108-1, Estimated Cooling Tower Sound Emissions For the Bell Bend Nuclear Power (BBNPP) Expansion Project, August 2008 (Enclosure 10)

These noise reports were supplemented/revised in 2010 to account for the relocation of the BBNPP power block. The 2010 noise reports include additional noise receptor data covering the area of the relocated power block. The 2010 revised/supplemental reports, which supersede the 2008 reports, are included in BB COLA Rev 3, Part 11L and are listed below:

- 2010 Baseline Environmental Noise Survey, Supplement to HAI Reports 041808-1 & 062608-1 Bell Bend Nuclear Power Plant (BBNPP), July 2010

- Report Number 080108-1, Estimated Cooling Tower Sound Emissions for the Bell Bend Nuclear Power (BBNPP) Project, Revision A, June 2010

ER Section 4.3.1.2 discusses noise levels, noise thresholds for wildlife, and impacts to wildlife at the BBNPP site. Noise measurements associated with the SSES CTs is included in Section 4.0 of the 2006 SSES Units 1 & 2 License Renewal Application.

No operational noise from SSES was detected at BBNPP noise monitoring locations during any of the 6 survey periods when noise measurements were made (ER 2.7.7.3 and 2010 Baseline Environmental Noise Survey). Locations 4, 6, and 7 are in the vicinity of the SSES cooling towers. To evaluate potential cumulative noise impacts from the combined operation of both SSES and BBNPP, estimates of noise were completed in 2010 with background conditions that included the SSES Units in operation. All measured ambient sound levels were attributed to normal environmental sources, and accordingly no cumulative noise impacts from concurrent operation of SSES and BBNPP are anticipated (ER 2.7.7.3).

TE-28: Provide an SME to discuss the length of the transmission and water pipeline corridors at the Humboldt, Seedco, Montour, and Martin's Creek Alternative Sites and the habitats and acreages that would be impacted.

Audit Disposition: Upon review of this NFI response the NRC requested to be provided a docketed copy without maps, and this material is provided below.

Response: An SME will be provided to discuss the length of the transmission and water pipeline corridors at the Humboldt, Seedco, Montour, and Martins Creek Alternative Sites and to discuss the habitats and acreages that would be impacted.

Information on the habitats crossed by the conceptual transmission and water pipeline corridors is provided in the Environmental Report in the following sections and tables:

	Alternative Site			
Section/Table	**Montour**	**Humboldt**	**Seedco**	**Martins Creek**
Land Use Section, Including Description of Water Pipeline Corridor	9.3.2.2.1	9.3.2.3.1	9.3.2.4.1	9.3.2.5.1
Terrestrial Ecology and Sensitive Species Section, Including Description of Terrestrial Habitats Along Transmission and Water Pipeline Corridors	9.3.2.2.4	9.3.2.3.4	9.3.2.4.4	9.3.2.5.4
Aquatic Ecology and Sensitive Species Section, Including Description of Aquatic Habitats Along Transmission and Water Pipeline Corridors	9.3.2.2.5	9.3.2.3.5	9.3.2.4.5	9.3.2.5.5
Transmission Corridors Section, Including Description of Land Use Along Transmission Corridor	9.3.2.2.10	9.3.2.3.10	9.3.2.4.10	9.3.2.5.10
Applicable Tables Containing Habitat Information for Federal and State Threatened and Endangered Species Along Transmission and Water Pipeline Corridors	9.3-16, 9.3-17, and 9.3-18	9.3-19	9.3-16, 9.3-17, and 9.3-18	9.3-20, 9.3-21, and 9.3-22

In addition, Tables 9.3-12, 9.3-13, and 9.3-14 include a discussion of the waters and wetlands crossed by the conceptual transmission and water pipelines.

Attachments A through D are figures depicting the conceptual routes of the transmission and water pipeline corridors for the Montour, Humboldt, Seedco, and Martins Creek sites.

Please also refer to the responses to RAI No. 5026 EIS USACE-19 and EIS USACE-17 for descriptions and lengths of the conceptual transmission line and conceptual water pipeline corridors/routes, respectively, for each of the alternative sites.

In addition, please refer to the responses to RAI No. 5042 EIS 9.3-41 and RAI No. 5043 EIS 9.3-46 for land use by category within each corridor and forested and unforested acreages within each corridor, respectively.

TE-29: Provide a reference for the statement "stationary transmission lines present a lesser threat to birds than moving wind turbine blades." (ER 9.3.2.2.4)

Audit Disposition: Upon review of this NFI response the NRC requested to be provided a docketed copy, included in its entirety below.

Response: The statement "stationary transmission lines present a lesser threat to birds than moving wind turbine blades" is the result of evaluation of multiple published reports on avian collisions with regard to relative risk based on number of collisions per unit area per unit time. While the literature is clear that under certain circumstances power lines can be a significant cause of mortality to certain bird groups (i.e., raptors, ducks, and colonial wading birds), under most circumstances, the rate of collisions is minor. The project areas discussed do not contain habitat features that would tend to attract flocks of ducks or wading birds and they are not in areas where raptors would congregate. In contrast, due to the need for sustained winds, wind turbines normally are placed in areas where migrating birds would be likely to travel, which results in a greater mortality per unit area per unit time compared to power lines traversing the general landscape.

Evaluated references are listed below:

Erickson, W.P., G.D. Johnson, and D.P. Young, Jr. 2005. "A Summary and Comparison of Bird Mortality from Anthropogenic Causes with an Emphasis on Collisions," In Bird Conservation Implementation and Integration in the Americas: Proceedings of the Third International Partners in Flight Conference, Volume 2, C.J. Ralph and T.D. Rich, editors. General Technical Report PSW-GTR-191, Albany, CA: U.S. Dept. of Agriculture, Forest Service, Pacific Southwest Research Station, 1294 pp.

Hunting, K, 2002. Avian power line collisions: Potential impact on Central Valley bird populations, Central Valley Bird Club Bulletin Vol. 5, No. 4: pp 61-65.

Jenkins, A.R., J.J. Smallie, and M. Diamond, 2010, "Avian collisions with power lines: a global review of causes and mitigation with a South African Perspective," Bird Conservation International, pp: 1-16.

Manville, A.M, II, 2005. "Bird Strikes and Electrocutions at Power Lines, Communication Towers, and Wind Turbines: State of the Art and State of the Science – Next Steps Toward Mitigation," In Bird Conservation Implementation and Integration in the Americas: Proceedings of the Third International Partners in Flight Conference, Volume 2, C.J. Ralph and T.D. Rich, editors. General Technical Report PSW-GTR-191, Albany, CA: U.S. Dept. of Agriculture, Forest Service, Pacific Southwest Research Station, 1294 pp.

Manville, A.M, II, 2009. "Towers, Turbines, Power Lines, and Buildings – Steps Being Taken by the U.S. Fish and Wildlife Service to Avoid or Minimize Take of Migratory Birds at These Structures," In Proceedings of the 4th International Partners in Flight Conference: Tundra to Tropics, 13–16 February 2008, McAllen, Texas. T.D. Rich, C. Arizmendi, D.W. Demarest, And C. Thompson, editors. pp 262-272.

National Wind Coordinating Committee (NWCC), 2001. Avian Collisions with Wind Turbines: A Summary of Existing Studies and Comparisons of Avian Collision Mortality in the United States, National Wind Coordinating Committee Resource Document, August.

Ove Arup & Partners Hong Kong Ltd, 2002. "Bird Collision with Manmade Structures with Reference to the Proposed Shenzhen Western Corridor," Appendix 9B in Agreement No. CE 39/2001, Shenzhen Western Corridor – Investigation and Planning, Environmental Impact Assessment Report, September.

TE-30: Provide an SME to discuss the species of damselflies and dragonflies referred to and why they are ecologically important. (ER 9.3.2.3.4)

Audit Disposition: Upon review of this NFI response the NRC requested to be provided a docketed copy, included in its entirety below.

Response: An SME will be available during the audit to discuss the species of damselflies and dragonflies referred to and why they are ecologically important.

The species of damselflies and dragonflies that could occur on the Humboldt Site are identified in Table 9.3-19, specifically:

- Aeshna constricta, Lance-tipped Darner
- Aeshna verticalis, Green-striped Darner
- Boyeria grafiana, Ocellated Darner
- Cordulia shurtleffi, American Emerald
- Enallagma boreale, Boreal Bluet
- Enallagma laterale, New England Bluet
- Gomphus adelphus, Mustached Clubtail
- Gomphus descriptus, Harpoon Clubtail
- Helocordulia uhleri, Uhler's Sundragon
- Ophiogomphus carolus, Riffle Snaketail
- Ophiogomphus mainensis, Maine Snaketail
- Somatochlora elongata, Ski-tailed Emerald

There are two general subsets of this group – those that could occur in emergent wetlands and those that could occur in rocky streams (i.e., Stony Creek). While given no legal protection status in Pennsylvania, these dragonfly and damselfly species are tracked by the Pennsylvania Natural Heritage Program and may occur on the Humboldt Site. All are considered rare within Pennsylvania. Therefore, these dragonfly and damselfly species were considered to be ecologically important.

TE-32: Provide an SME to discuss the basis for the statement that "[construction] would remove a potential flight corridor for bats." (ER 9.3.2.2.4)

Audit Disposition: Upon review of this NFI response the NRC requested to be provided a docketed copy, included in its entirety below.

Response: The Montour site is predominantly open land that is crossed by a wooded riparian corridor in the southeastern portion of the site. For the alternative site evaluation, it was assumed that all areas within the site boundary would be disturbed, which may not be the case once actual engineering design is completed. However, at the conceptual level of the alternative site evaluation, development of the Montour site would result in removal of the wooded riparian corridor in the southeastern portion of the site. Many bat species fly along wooded riparian corridors as they provide an open flight path (over the water) in proximity to cover from potential predators (the tree canopy layer). Removal of the wooded riparian corridor would be a deterrent to some bats flying across the property after development and would constitute removal of a potential flight corridor.

TE-33: Provide an SME to discuss the efforts to determine if there were any important natural areas or communities in the vicinity of the Montour, Humboldt, Seedco and Martin's Creek Alternative Sites and associated transmission and water pipeline corridors.

Audit Disposition: Upon review of this NFI response the NRC requested to be provided a docketed copy, included in its entirety below.

Response: County Natural Area Inventories prepared by the Pennsylvania Natural Heritage Program (PNHP) and the Pennsylvania Science Office of The Nature Conservancy were reviewed to determine whether there were any important natural areas or communities in the vicinity of the Montour, Humboldt, and Seedco sites. The Luzerne County Natural Areas Inventory was referenced in the Environmental Report (PNHP, 2006).The Columbia, Montour, and Northumberland County inventories (The Nature Conservancy, 2004; The Nature Conservancy, 2005a; and PNHP, 2008), which were reviewed but not specifically referenced in the Environmental Report, are listed below under Data Sources.

The New Jersey Wildlife Action Plan sections for the Delaware River Valley and for the Northern Highlands were reviewed to determine whether there were any important natural areas or communities in the vicinity of the Martins Creek Site. References to these Wildlife Action Plan sections were included in the Environmental Report as New Jersey Division of Fish and Wildlife (NJDFW) 2008a, 2008b, and 2008c.

For Martins Creek, "A Natural Areas Inventory of Lehigh and Northampton Counties, Pennsylvania, Update 2005" (The Nature Conservancy, 2005a) was also reviewed for important natural areas that may be located near the Martins Creek site but across the Delaware river in Pennsylvania.

Data Sources:

New Jersey Division of Fish and Wildlife (NJDFW), 2008a.New Jersey Wildlife Action Plan: NJ Wildlife Action Plan Map, NJDEP Division of Fish and Wildlife, Website: http://www.nj.gov/dep/fgw/ensp/wap/wap_zones.htm, Date accessed: September 29, 2011.

New Jersey Division of Fish and Wildlife (NJDFW), 2008b.NJ Wildlife Action Plan: Delaware and Musconetcong River Valleys. pp 588-607 in New Jersey Wildlife Action Plan, Website: http://www.nj.gov/dep/fgw/ensp/wap/wap_zones.htm, Date accessed: September 29, 2011.

New Jersey Division of Fish and Wildlife (NJDFW), 2008c.NJ Wildlife Action Plan: Northern Highlands. pp 563-587 in New Jersey Wildlife Action Plan, Website: http://www.nj.gov/dep/fgw/ensp/wap/wap_zones.htm, Date accessed: September 29, 2011.

PNHP, 2006.A Natural Areas Inventory Luzerne County, Pennsylvania: Update – 2006. Prepared for Luzerne County Board of Commissioners.

PNHP, 2008.Northumberland County, Natural Heritage Inventory Update 2008; A Natural Areas Inventory of Northumberland County, Pennsylvania, Update 2008; Prepared for Northumberland County Planning Commission, Prepared by Pennsylvania Natural Heritage Program.

The Nature Conservancy, 2004.Columbia County Natural Areas Inventory 2004, Submitted to The Columbia County Planning Commission, Prepared by The Pennsylvania Science Office of The Nature Conservancy.

The Nature Conservancy, 2005a.A Natural Areas Inventory of Lehigh and Northampton Counties, Pennsylvania, Update 2005, Prepared by The Pennsylvania Science Office of The Nature Conservancy for Lehigh Valley Planning Commission.

The Nature Conservancy, 2005b.Montour County Natural Areas Inventory 2005, Submitted to Montour County Planning Commission, Prepared by The Pennsylvania Science Office of The Nature Conservancy.

Enclosure 2

AE-02: 2012 Ecology III, Inc. and
King's College Environmental Program
Report and CV for Dr. Brian Mangan

Significant Increasing Trend in Susquehanna River Water Temperature 1974-2010

Brian P. Mangan
Ecology III, Inc. and
King's College Environmental Program
4 May 2012

Introduction

Warming trends of surface temperature have been measured from across the planet for the past 50 years (IPCC 2007). As a result, water temperatures of streams and rivers have also been increasing (Webb and Walling 1992, Webb and Nobilis 1995, Bonacci *et al.* 2008, Pekarova *et al.* 2008). Similar increasing trends have also been reported for streams and rivers across the United States (Bartholow 2005, Kaushal *et al.* 2010).

I analyzed a long-term data set from the Susquehanna River to determine if a significant warming trend was evident. Such warming could have considerable negative consequences for the ecology of the river.

Methods

River temperature data were collected from a temperature probe stationed at the bottom of the river adjacent to the Susquehanna SES Environmental Laboratory, near Berwick, Pennsylvania. The probe was regularly calibrated using a NIST standardized thermometer.

The data were recorded continuously either by graph paper or digital datalogger. Some gaps occurred in the data because of datalogger malfunctions. Attempts will be made to fill these gaps for future analysis. However, at this time I do not think that these gaps will significantly change the outcome of these results.

Data were analyzed for trends by simple linear regression. This analysis is similar to that used by others research trends in stream and river temperatures (Kaushal *et al.* 2010). Alpha was set at 0.05.

Results

A significant increasing trend was evident in average annual water temperatures from 1974-2010 ($P<0.05$, Figure 1). The regression equation describing the linear model predicts an annual increase of 0.038°C yr^{-1}, or an increase of 3-4°C over a century, if this rate of warming continues. While there is a considerable amount of "noise" evident in the data, the temporal variable accounts for 38% of the variation in river temperature over this 35-year time period.

Discussion

The Susquehanna River's rate of warming is consistent with the warming rates of other streams and rivers in the northeastern United States (Table 1, modified from Kaushal *et al.* 2010). For many locations where increases in water temperature have been documented, significant linear increase in air temperature also occurred. Regression equations for these streams and rivers reported very similar coefficients of determination.

Serious ecological consequences can result from increases in average water temperatures in rivers like the Susquehanna. It is thought that warmer temperatures will assist invasive species, decrease community biodiversity, disrupt the spawning and development of species, and change the relative abundance and distribution of species. In addition, the overall metabolism of ecosystems can be altered and this can subsequently increase the toxicity of a number of environmental contaminants (Kaushal *et al.* 2010).

Table 1. Select data on warming of streams and rivers in the northeastern United States (modified from Kaushal *et al.* 2010).

Name	Nearby City	Time Range	(°C yr^{-1})	R^2
Susquehanna River	Berwick, PA	1974-2010	0.038	0.37
Delaware River	Hale Eddy, NY	1986-2007	0.040	--
Delaware River	Chester, PA	1965-2007	0.077	0.39
Brandywine Creek	Chadds Ford, PA	1972-2007	0.070	0.28
Gunpowder River	Baltimore, MD	1983-2007	0.059	--
Potomac River	Washington, DC	1922-2006	0.046	0.43
Patuxent River	Solomons, MD	1938-2006	0.022	0.38

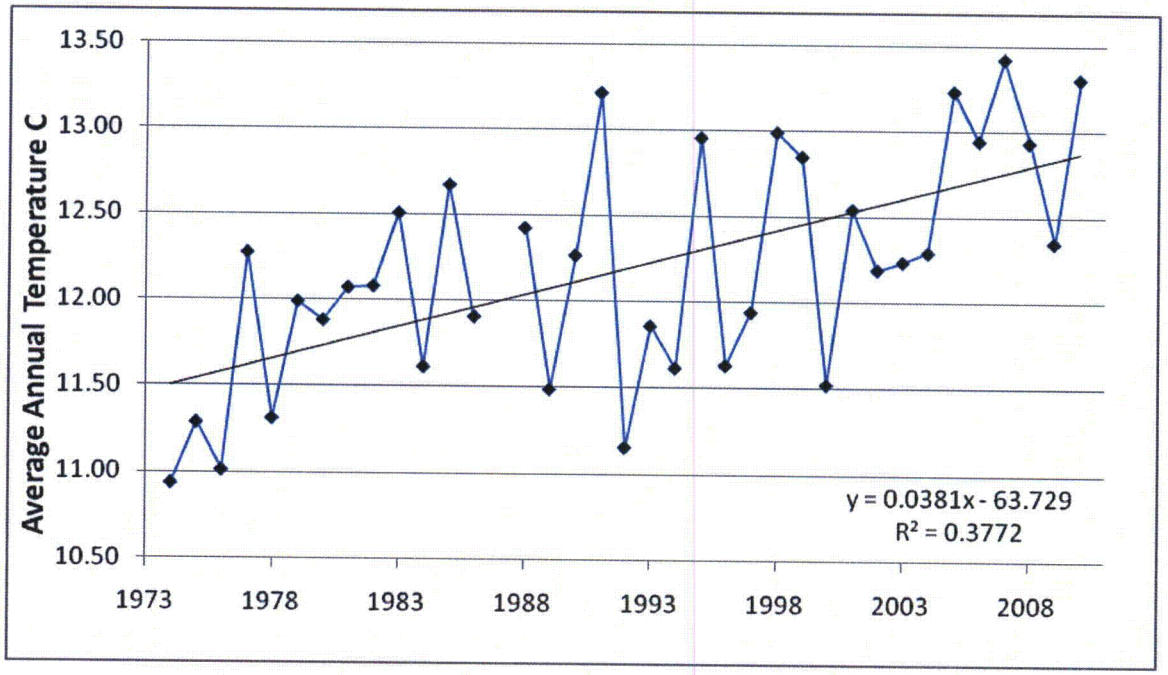


Fig. 1. Average annual river temperatures from the Susquehanna River, 1974-2010. The trend line is the result of a simple linear regression ($P<0.05$).

Literature Cited

Bartholow, J.M. 2005. Recent water temperature trends in the lower Klamath River, California. *North American Journal of Fisheries Management* 25(1):152-162.

Bonacci, O., D. Trninić, and T. Roje-Bonacci. 2008. Analysis of the water temperature regimen of the Danube and its tributaries in Croatioa. *Hydrological Processes* 22(7):1014-1021.

IPCC (Intergovernmental Panel on Climate Change). 2007. Climate change 2007. Synthesis report. A contribution of Working Groups I, II, and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK: Cambridge University Press.

Kaushal, S.S., G.E. Likens, N.A. Jaworski, M.L. Pace, A.M. Sides, D. Seekell, K.T. Belt, D.H. Secor, and R.L. Wingate. 2010. Rising stream and river temperatures in the United States. *Frontiers in Ecology and the Environment* 9(8):461-466.

Peckarova, P., D. Halmova, P. Miklanek, and M. Onderka. 2008. Is the water temperature of the Danube River at Bratislava, Slovakia, rising? Journal of Hydrometeorology 9(5):1115-1122.

Webb, B.W. and F. Nobilis. 1995. Long term water temperature trends in Austrian rivers. *Hydrological Sciences Journal* 40(1):83-96.

Webb, B.W. and D.E. Walling. 1992. Long term water temperature behavior and trends in a Devon, UK, river system. *Hydrological Sciences Journal* 37(6):567-579.

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Titles

Director, Environmental Program and Professor of Environmental Science/ Biology, King's College, Environmental Program, Wilkes-Barre, PA
Founder/ Director, Susquehanna River Institute, King's College, Wilkes-Barre, PA
Senior Environmental Biologist, Ecology III, Inc., Susquehanna SES Environmental Laboratory, Berwick, PA

Education

Ph.D., Ecology, Pennsylvania State University, State College, PA (1999)
Dissertation: The Influence of Flow on Habitat Use by Fish in a Large River
M.S., Biology, Bloomsburg University of Pennsylvania, Bloomsburg, PA (1988)
Thesis: Oviposition and First-instar Larval Behavior of the Dobsonfly (*Corydalus cornutus*)
B.S., Biology, Pennsylvania State University, State College, PA (1982)

Continuing Education

Zebra Mussel Workshops and Meetings (New York Sea Grant)
Stream Habitat Assessment Workshop (American Fisheries Society)
Principles and Techniques of Electrofishing (U. S. Fish and Wildlife Service)
Small Mammal Ecology (National Science Foundation)

Certifications

Open Water Scuba Diver (Professional Diving Instructor Corp.)
First Aid, Cardiopulmonary Resuscitation (American Red Cross)
Boating Safety (PA Fish & Boat Commission)
Nuclear Quality Assurance Auditor

Professional Organizations

The American Fisheries Society
The Ecological Society of America
The Wildlife Society
Society for Conservation Biology
North American Lake Management Society
American Association for the Advancement of Science
The Pennsylvania Association of Environmental Professionals
The Pennsylvania Academy of Science

Honors

Phi Kappa Phi Honor Society
Who's Who Among America's Teachers
Manchester Who's Who among Executives and Professionals

Professional Experience

2000-present: Director, Environmental Program and Professor of Environmental Science/ Biology
King's College, Wilkes-Barre, PA

Department Chair for majors in environmental studies and sciences at King's College. Responsible for teaching, curricula, budget, assessment, research and grants. Courses taught are listed in the last section of this c.v.

2000-present Founder and Director, The Susquehanna River Institute

Responsible for the organization and promotion of a non-profit institute devoted to education and research focused on the Susquehanna River.

1996-2000: Adjunct Instructor (Bioscience)
Penn State University - Hazleton Campus, Hazleton, PA

1988-present: Senior Environmental Biologist
Ecology III, Inc., 804 Salem Blvd., Berwick, PA

Manage research and monitoring of aquatic organisms in the Susquehanna River, SSES ESSW Spray Pond, and LTAW.

Responsible for biofouling mollusk monitoring in the Susquehanna River and Susquehanna SES.

Monitor and control of invasive exotic plant species in the Susquehanna Riverlands.

Quality Assurance Representative/Lead Auditor for the Radiological Environmental Monitoring Program - Responsible for internal auditing to ensure adherence to pertinent procedures. Initiate, review, and update procedures. Also responsible for training of sample collectors involved in this program.

Provide underwater environmental support work at the Susquehanna SES Environmental Laboratory.

1985-1987: Environmental Biologist
Ecology III, Inc., R. R. #1, Berwick, PA

Non-radiological Environmental Monitoring Program (NEMP): Collection, identification, and report preparation of fisheries data relative to an ecological survey of the Susquehanna River in the vicinity of the Susquehanna Steam Electric Station (SES); monitor biofouling mollusks near the Susquehanna SES.

Professional Experience (cont.)

REMP Sample Collection Coordinator (1985-1992): Oversaw scheduling and collection of environmental radiological samples as well as the initiation and revision of procedures relative to this program at the Susquehanna SES; assisted with preparation of annual REMP reports to Nuclear Regulatory Commission; and prepared an annual land use census report of residences, gardens, and dairy farms in the vicinity of the Susquehanna SES.

Section Leader (1985-1992): Responsible for direction and processing of environmental radiological samples, spikes, and cross-checks for analyses, such as gross alpha/beta, gamma, and tritium analyses, and also procedural preparation and revision for this processing.

Sample collector for the Radiological Environmental Monitoring Program (REMP) and Emergency Radiological Environmental Monitoring Program (EREMP).

Scuba Diver: Sample collection for benthic macroinvertebrate program; underwater construction and environmental support work at the Susquehanna SES.

1984-1985: Research Biologist
Ichthyological Associates, Inc., R. R. #1, Berwick, PA.

Same responsibilities as listed for Ecology III, Inc. (1985-87)

1982-1984: Research Technician
Ichthyological Associates, Inc., R. R. #1, Berwick, PA

Assisted with collection, analyses, interpretation, and report preparation of water quality data and freshwater fishes (larval and adult) as related to the ecological survey of the Susquehanna River.

1981-1982: Laboratory Assistant
Dr. James Wright, Dept. of Biology, Pennsylvania State University, State College, PA

Assisted in preparation of salmonids for genetic studies using starch gel electrophoresis.

Scientific Publications

Mangan, B. P. 1986. Natural reproduction of the muskellunge (*Esox masquinongy*) in the Susquehanna River near Berwick, Pennsylvania. Proc. Pa. Acad. Sci. 60: 200.

_____. 1992. Oviposition of the dobsonfly (*Corydalus cornutus* Megaloptera) on a large river. Am. Midl. Nat. 127: 348-354.

_____. 1994. Pupation ecology of the dobsonfly *Corydalus cornutus* (Corydalidae: Megaloptera) along a large river. J. Freshwater Ecology 9: 57-62.

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_____. 2002. Range expansion of the Asiatic clam, Corbicula fluminea, into the North Branch Susquehanna River. J. Pa. Acad. Sci. 76(1): 40-42.

_____. 2003. A field evaluation of the efficiency of rotenone-laced fish food for removing fish from a small artificial impoundment. J. Freshwater Ecology 18(2): 299-303.

_____ and J. G. Rish. 2005. Wind power in Pennsylvania: It isn't easy being green. J. Pa. Acad. Sci. (79(2/3): 75-80.

_____, A. D. Ciliberto, and M. T. Homewood. 2009. A versatile and economical trap for capturing wild crayfish. J. Freshwater Ecology 24(1): 119-124.

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Professional Presentations

"Oviposition of the dobsonfly, *Corydalus cornutus*. Entomological Society of Pennsylvania (Annual Meeting, 1986)

"Fishes of the Susquehanna River" - Susquehanna Energy Information Center (1986)

"The Susquehanna SES Biological Laboratory" - Luzerne County Conservation Service (1988)

"Environmental Impacts of Nuclear Power" –Nuclear Energy Seminar for Teachers, PPL annual guest lecture (1990-present)

Professional Presentations (cont.)

"Where Have All The Fish Gone?" - Nuclear Technology Group, Pennsylvania Power & Light Company (Nov 1996)

"Environmental Monitoring at Susquehanna SES" – Bryn Mawr College (1996-2009)

"Long-term Ecological Monitoring" – Conference of PA Department of Environmental Protection Biologists (Nov 2002)

"North Branch Fishes and Other Environmental Indicators" – From the branches to the Confluence: The Upper Susquehanna River Basin and Its Communities, Bucknell University (Sep 2006)

"PPCPs in the Water: The Effects of Fluoxetine on Fish Behavior" – Annual meeting of the American Fisheries Society, Lake Placid, NY (Sep 2006)

"Trends in Fishes of the Susquehanna River"—First Annual Susquehanna River Conference, Bucknell University (Sep 2006)

"Wind Power and the Municipality" – Conference on the Small City, King's College (Oct 2006)

"Wind Energy and Site Evaluation in Pennsylvania" -- Wildlife and Utility-Scale Wind Energy Development of the Central Appalachians within Maryland, Pennsylvania, Virginia, and West Virginia—the Risks and Trade-offs, Kutztown University, (Dec 2006)

"Environmental Education: A Bridge Between Academia and Industry"-- No Child Left Inside—Pennsylvania Association of Environmental Educators Annual Conference, Wilkes-Barre (Apr 2007)

"Density and Size Range of Asian Clams in the Susquehanna River: Profile of an Invasion"—Ecology of a Region in Changing Landscapes, Mid-Atlantic Ecological Society of America Conference, Wilkes-University (Apr 2008) and at the 64th Annual Northeast Fish and Wildlife Conference, Galloway, NY (Apr 2008)

"A Versatile and Economical Trap for the Capture of Wild Crayfish"-- Ecology of a Region in Changing Landscapes, Mid-Atlantic Ecological Society of America Conference, Wilkes-University (Apr 2008) and at the 64th Annual Northeast Fish and Wildlife Conference, Galloway, NY (Apr 2008)

"Comparison of Two Traps Used for the Capture of Wild Crayfish"--65th Annual Northeast Fish and Wildlife Conference, Lancaster, PA (Apr 2009)

"First record of phoresy between chironomid larvae and crayfish"-- 95th Ecological Society of America Annual Meeting, Pittsburgh, PA (Aug 2010)

"Crayfish of the Susquehanna River"—140th Annual Meeting of the American Fisheries Society, Pittsburgh, PA (Sep 2010)

"Pharmaceuticals in the Environment"—*Power to Save* TV Show WNEP-16, Wilkes-Barre, PA (Sep 2010)

"Medications in Our Waterways"—*Pennsylvania Outdoor Life* TV Show WNEP-16, Wilkes-Barre, PA (Oct 2010)

"Crayfish of the Susquehanna River"—Exploring Our Vital Resource, Bucknell University (Oct 2010)

"Phoretic Midges on Hellgrammites (*Corydalis cornutus*: Megaloptera) from the Susquehanna River"—Northeast Natural History Conference, Albany, NY (Apr 2011)

Professional Presentations (cont'd)

"Comparison of Two Artificial Cover Object Grid Densities for Sampling Terrestrial Salamanders"—Northeast Natural History Conference, Albany, NY (Apr 2011)

"Mercury in a Common Riparian Forest Salamander: Morph Matters"—2012 Conference of the Pennsylvania Chapter of The Wildlife Society, State College, PA (Mar 2012) and the 2012 Conference of the Northeastern Natural History Conference, Syracuse, NY (Apr 2012)

"Mercury in the Forest Spider *Micrathena gracilis*: Does the Mercury Burden Vary with Location?"--2012 Conference of the Pennsylvania Chapter of The Wildlife Society, State College, PA (Mar 2012) and the 2012 Conference of the Northeastern Natural History Conference, Syracuse, NY (Apr 2012)

Many radio, television and newspaper articles on environmental topics –WKOK Radio, Sunbury, PA; *Times Leader*, Wilkes-Barre, PA, Citizen's Voice, Wilkes-Barre, PA; Chesapeake Bay Foundation, Annapolis, MD, *PA Outdoor Life*, WNEP-TV, *Call the Doctor*, WVIA, etc.

Grants

PPL Inc. 2001 PI ($5000 grant towards The Susquehanna River Institute)
PPL Inc. 2001 PI ($2000 grant for incentive scholarships in EDUC 5270)
NSF Equipment Grant, CoPI ($103,000 for gas chromatograph)
PPL Inc. 2002 PI ($1500 to investigate remediation of soil contamination)
PA DEP Growing Greener Grant PI ($110,000 grant towards reclamation of the Little Wapwallopen Creek)
PPL Inc. 2003 PI ($2500 equipment grant for environmental education initiatives)
Central Susquehanna Community Foundation 2005 PI ($6,500 to study environmental connections to human health and wellness)
Hazleton City Authority Water Department 2005 PI ($6350 to compile baseline water-quality data for Quakake Creek, Schuylkill County)
Foundation for the Alleghenies 2008 Student Internships ($5000)
Margaret A. Cargill Foundation Grant 2009-14 ($438,600)
Foundation of Pennsylvania Watersheds 2009 Student Internships ($5000)
PPL Corporation Environmental Education Grant 2010 ($5000)
PPL Corporation Environmental Education Grant (River Institute; $1000)
Community Foundation for the Alleghenies 2010 ($2000)
Foundation for Pennsylvania Watersheds 2010 Mercury & Internships ($10,000)
Foundation for Pennsylvania Watersheds 2010 Student Internships ($4000)
PA Fish and Boat Commission 2010 Unassessed Waters Grant ($3600)
Degenstein Foundation 2011 Mercury & Internships ($10,000)
PA Fish and Boat Commission 2011 Unassessed Waters Grant ($2300)
Degenstein Foundation 2012 Mercury & Internships ($10,000)
Foundation for the Alleghenies ($3500)

Total to date $736,850

College/Community Service

King's College Environmental Program – Director (2000-present)
Susquehanna River Institute – Founder/ Director (2000-present)
King's College Environmental Club – Advisor (2000-present)
Environmental Studies Committee – Chair (2000-2010)
PA Consortium for Interdisciplinary Environmental Policy – College Representative (2000-present)
Morris K. Udall Scholarship – College Representative (2001-present)
Susquehanna River Heartland Coalition for Environmental Studies – College Representative (2003-present)
Barry M. Goldwater Scholarship – College Representative (2002-2005)
Middle States Faculty Study Group – Member (2003)
Lake Silkworth Protective Association – Advisor (2003-2005)
PA Wildlands Recovery Project – Scientific Advisor (2003)
Wyoming Valley Watershed Coalition – College Representative (inactive)
Shoval Center for Community Engagement and Learning, Service Learning Project Team (2005-present)
King's College Climate Change Working Group -- Chair (current)

Undergraduate Courses Taught

Environmental Science I
Environmental Science II
Environmental Art
Environmental Seminar
Conservation Biology
Wildlife Ecology & Management
Ecotoxicology
Wildlife Techniques
Water Quality Analysis
Chesapeake Bay Ecology
Adirondack Park Ecology
Environmental Health
Wildlife Natural History
Independent Study
Environmental Research
Environmental Internship

Graduate Courses Taught

Susquehanna River Ecology
Energy and the Environment
Pennsylvania Wildlife
Chesapeake Bay Ecology

Enclosure 3

AE-08 – 2010 Ecology III Report

ENVIRONMENTAL STUDIES
IN THE VICINITY OF THE
SUSQUEHANNA STEAM ELECTRIC STATION

2009
WATER QUALITY
FISHES

Prepared by

Ecology III, Inc.
Susquehanna SES Environmental Laboratory
804 Salem Boulevard
Berwick, Pennsylvania 18603

For

PPL Susquehanna, LLC
769 Salem Boulevard
Berwick, PA 18603

SEPTEMBER 2010

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INTRODUCTION

PPL Susquehanna, LLC (PPL) contracted Ecology III, Inc. to conduct nonradiological monitoring of the Susquehanna River in the vicinity of the Susquehanna Steam Electric Station (Susquehanna SES) in 2009. The Susquehanna SES is a nuclear power station with two boiling water reactors, each with a net electrical generating capacity of approximately 1,230 megawatts. It is located on about 1,700 acres on the west side of the Susquehanna River in Salem Township, Luzerne County, 5 miles northeast of Berwick, Pennsylvania. In addition, approximately 700 acres of mostly undeveloped and recreational lands owned by PPL are located on the east side of the Susquehanna River in Conyngham and Hollenback Townships. PPL owns 90 percent of the station and the Allegheny Electric Cooperative, Inc. owns 10 percent.

The objective of the nonradiological environmental monitoring program is to assess the impact of operating the Susquehanna SES on the Susquehanna River water quality and relative abundance of fishes. This was accomplished in 2009 by comparing data at control and indicator stations and by evaluating results of preoperational (1971-1982) and operational (1983-2008) studies (Ichthyological Associates 1972, Ichthyological Associates, Inc. 1973-1985, Ecology III, Inc. 1986-2009). Monitoring was done at sites within a control station (SSES) upriver from the Susquehanna SES river intake structure and indicator station (Bell Bend) downriver from the discharge diffuser.

To more objectively assess the impact of operating the Susquehanna SES on the Susquehanna River, a statistical procedure called BACI (Before-After:Control-Impact) analysis was applied to preoperational and operational fishes monitoring data.

This report presents results of water quality and fishes studies.

WATER QUALITY

PROCEDURES

Water quality of the Susquehanna River relative to operation of the Susquehanna SES was monitored throughout 2009 at four locations (Table 1, Fig. 1). Susquehanna River water samples were collected quarterly at SSES (control) and Bell Bend (indicator). In addition, water samples were also collected quarterly from the cooling tower blowdown of the Susquehanna SES. River flow and temperature were monitored continuously at the Environmental Laboratory (Table 2).

Most of the water sample parameters were analyzed by the Chemical Laboratory personnel at the PPL System Facilities Center, Hazleton, Pennsylvania. This laboratory has state accreditation with the Pennsylvania Department of Environmental Protection (PADEP; Commonwealth of PA 2006), identified as Lab #40-00568 (www.dep.state.pa.us). Water temperature and dissolved oxygen were measured by Ecology III personnel and river level was recorded with the SSES data (Table 2). PPL Susquehanna, LLC personnel provided data for Susquehanna River water withdrawal and blowdown discharge.

RESULTS AND DISCUSSION

River Flow, River Water Withdrawal, and River Temperature

In 2009, Susquehanna River flow was above the 48-year average for June, July, August, and October, and below average for the remaining months (Fig. 2). The annual

precipitation at Avoca, PA (about 30 miles upriver from the Susquehanna SES) was 35.46 inches (www.erh.noaa.gov/bgm/climate/avp.shtml, accessed 1 February 2010).

Daily mean river flow ranged from 1,940 to 85,500 cubic feet per second (cfs; Table 3). The Susquehanna River Basin Commission designated Luzerne County as abnormally dry from March through May 2009. However, there were no drought watches issued by PADEP since 11 January 2009 (www.srbc.net/hydrologic/drought_center.htm link: Pennsylvania Department of Environmental Protection Drought Center, accessed 18 February 2010). Cumulatively, an estimated 410 billion cubic feet of water flowed through this section of the Susquehanna River during 2009 (Fig. 3). This flow was within the 35th percentile of the last 49 years.

Susquehanna SES river water withdrawal of river flow ranged from 0.08% on 10 and 11 March to 3.90% on 26 September (Fig. 4). Daily river water withdrawal of the plant was ≤2% of river flow for most of 2009. River water withdrawal exceeded 2% of river flow on 29 days last year.

Daily mean river temperature ranged from 0.4 C on 31 December to 26.5 C on 18 August (Table 4). The hourly minimum river temperature of 0.2 C occurred at 0300 h on 15 January. The hourly maximum river temperature of 27.3 C occurred at 1300 and 1400 h on 18 August. November had the second warmest (exceeded by 0.2 C in 1982) monthly mean river temperature on record since 1974 and April was the fourth warmest in 36 years. River temperature was above average every month except January, June, July, August, and October. However, these temperature comparisons did not take into account variations in river flow among the months.

River Water Quality at the Susquehanna SES

Control and indicator data were compared to PADEP specific water quality criteria (Commonwealth of PA 2009; Table 5). The parameters with published specific water quality criteria include alkalinity, ammonia nitrogen, chloride, dissolved oxygen, fluoride, total and dissolved iron, manganese, nitrogen (nitrate), pH, sulfate, and temperature. In 2009, Susquehanna River water did not meet the published criteria for total alkalinity in March at both the control and indicator sampling sites (Table 6). The total alkalinity concentration in March was below the minimum criteria of 20 mg/L. While the total iron concentrations in March and October exceeded 1.5 mg/L, these did not technically violate the criterion because the criterion is based on a 30-day average. The March sample was collected when the river was in a high flow stage, 80,300 cfs, just one day after the highest crest of the year. The October sample was collected when the river was in a condition of increasing flow (3,960 to 21,800 cfs in five days), following an extended period of low flow (<10,000 cfs for 52 days). These concentrations were not a result of power plant operation since they occurred at both the control and indicator sites. Still, this relatively high iron concentration is reflective of the legacy of anthracite coal mining upstream from the power plant in the Wyoming Valley and Mocanaqua regions.

A new minimum for sulfate was established for the database in 2009. The sulfate concentration at SSES on 12 March (9.8 mg/L) was 1.5 mg/L lower than the previous minimum of 11.3 mg/L. There have been significant decreases over time in certain indicators of abandoned mine discharge such as total iron and sulfate concentrations (Table 7, Fig. 5), and Ecology III, Inc. has long reported the biotic recovery in the river associated with these improvements.

Blowdown

Blowdown is river water used in the nuclear power plant cooling cycle that is discharged back to the river. It has elevated conductivity and dissolved solids concentrations because of evaporative loss from the cooling towers (14.3-40.9 million gallons/day during 2009 operation). In 2009, the daily average blowdown discharge rate to the river ranged from 2.4-17.3 million gallons/day (MGD; Fig. 6). This resulted in the blowdown being 0.02-0.95% of the Susquehanna River flow (1,250-55,500 MGD).

Control and Indicator Site Comparisons

Control and indicator water quality data were similar on most of the sampling dates during 2009 (Table 6). Higher concentrations of total suspended solids and some metals at the control site were the exception in the March sample. This sample was collected during a high flow period. Of the 209 samples collected since 1983, the flow was exceptionally high on this date.

Since most of the water taken from the river for plant operation is evaporated in the cooling process, the remaining cooling water returned to the river subsequently contains concentrated mineral solids. Mineral solids concentrations in the blowdown sample were 3.2 to 6.6 times greater than those of the river control (Table 6). However, the dilutive effect of high river flow tends to equalize values at the control and indicator sites. This is evident when TMS values of the blowdown are compared to the control and indicator TMS results (Tables 8 and 9). It has been previously demonstrated that TMS concentrations at SSES are the best predictor of TMS concentrations at Bell Bend at most river flows. In addition, if operation of the Susquehanna SES is to influence the water quality at the

indicator site, then the probability of that occurring should be greatest at low river flows (Ecology III, Inc. 2008).

Conclusion

Susquehanna River flow exceeded the 48-year average during four months in 2009 and was below average for the remaining months. The maximum river water withdrawal of river flow by Susquehanna SES was 3.9% on 26 September. On most days during 2009, however, river water withdrawal was ≤2% of river flow. Exceptionally warm river temperatures were recorded for April and November.

Other than the March total alkalinity concentration, water quality data demonstrated that river samples met the published specific water quality criteria for 12 common parameters. A new minimum for sulfate was established for the database in March. Overall, water quality of this section of the Susquehanna River continues to improve.

Our data analyses demonstrate that effects of the operation of Susquehanna SES on water quality of the Susquehanna River will likely occur at the lowest range of river flows. This is reasonable because the dilutive power of the river against plant discharge would then be minimized.

FISHES

PROCEDURES

Electrofishing

Electrofishing samples were collected once each month in May, June, July, August and October in 2009. Sampling was done at four sites, and each site was approximately 1,100-yards long and parallel to the river shoreline. These sites have been consistently sampled by boat electrofishing since 1976. Two sites were located upriver from the Susquehanna SES river intake structure along each bank of the river, and two sites were downriver from the intake (referred to as SSES and Bell Bend locations, respectively; Table 10, Fig. 1).

The 18-foot electrofishing boat was outfitted with a 5-KW generator (direct current). Electrical output was controlled by a variable-voltage pulsator, with a target of 5-6 amps delivered to the water.

During sampling the boat was driven downstream parallel to the shoreline, usually within 30 feet of the riverbank. For both safety purposes and sampling efficiency electrofishing was done at river levels less than 493.1 feet above mean sea level (msl; equivalent to 10.1 feet) as measured at the Environmental Laboratory. Sampling was done in the evening and began about one hour after sunset. Two observers stood in the bow of the boat and identified and counted fish during each sample. Data were recorded using a cassette tape recorder.

Seining

Shoreline fishes were collected by seine during August and October. Sampling was done when river levels were less than 490.2 feet above msl (equivalent to 7.2 feet at the Environmental Lab). Similar to the electrofishing sampling sites, two shoreline seine sites were above the Susquehanna SES river intake structure and two were below (Table 10, Fig. 1). High water prevented seining in June.

To seine, one end of the 25-foot bag seine (0.25-inch mesh) was kept stationary on the riverbank while the other end was extended about 20 feet into the river or as far as depth of the water allowed. The seine was then pulled upriver and onto shore. Two hauls were made in the same location at each site and the catches from both hauls were combined and considered one unit of effort. Captured fish were placed in 10% formalin in the field and returned to the laboratory. After at least two weeks in the formalin, the fish were rinsed with water, identified, and enumerated before final preservation in 40% isopropyl alcohol.

Statistical Analysis

A statistical analysis known as the Before-After:Control-Impact (BACI), was applied to the electrofishing (1976-2009) and seining data (1978-2009; Ecology III, Inc. 1990). Twenty species or categories of fish were analyzed from the electrofishing data, as were 12 species from the seining data. These species or groups were chosen based on their abundance during the years before Susquehanna SES operation.

Two different electrofishing data sets were analyzed. The first set included all months sampled by electrofishing through the years, and is referred to as the All Data set.

The second set, named Summer Data set, included only the months from June through October to reflect the reduced monitoring effort in place since1986. The seining data set analyzed by the BACI represents all of the months sampled by this method through the years.

RESULTS AND DISCUSSION

Electrofishing

Electrofishing at the SSES and Bell Bend locations in 2009 resulted in the observation of 969 fish of 18 species (Tables 11 through 13). The total numbers of fish collected above and below the SSES intake and discharge for the year were generally similar. Differences in monthly totals between upriver versus downriver sites ranged from as few as 6 fish in August to as many as 104 fish in July; most months sampled had a difference of 11 fish or less between the sampling sites. Comparatively, the range of monthly sample sizes (maxima minus minima) between the east and west banks was 34 fish at SSES and 19 at Bell Bend. Maximum monthly sample sizes occurred during July at SSES (192) and October at Bell Bend (165).

Smallmouth bass was the most abundant species overall observed at SSES and Bell Bend in 2009 (27% and 32% of the totals, respectively). Smallmouth bass and rock bass together represented 44% of the fish observed at SSES and 43% of those at Bell Bend. Smallmouth bass was also the most abundant species during most months at both SSES and Bell Bend, with the exceptions at SSES of northern hog sucker in June and August, and rock bass in July. Overall, there were considerable numbers of fish placed in

the unidentified fish category at both sites during 2009. This likely reflects the high river conditions during sampling throughout the summer.

Sixteen species were observed at SSES as were 18 at Bell Bend. Species richness in monthly samples ranged from 6 to 15 species at SSES and 8 to 15 at Bell Bend. Sucker and sunfish species dominated richness in all months during 2009.

Seining

Seining at the SSES and Bell Bend locations in 2009 resulted in the capture of 566 fish of 12 species (Tables 11 and 14). Spotfin shiner was the most abundant species captured at both SSES and Bell Bend, representing 51% and 59% of the total collections, respectively. Spotfin shiner, spottail shiner, and bluntnose minnow comprised 74% of the fishes collected at SSES and 95% of those collected at Bell Bend.

Similar to previous years, the number of fishes captured at SSES was a fraction (53%) of those collected at Bell Bend. This disparity between the upriver and downriver locations was similarly evident in both monthly samples. This may reflect increasing habitat differences between the sites. Moreover, this location is also the deepest of the four sites.

Eight species were collected at SSES and 9 species were captured at Bell Bend. At both stations, species in the minnow and sunfish families predominated.

BACI Results: Electrofishing

Of the 20 species or categories of fish that were tested with the BACI analysis, nine species from the All Data set and eight species from the Summer Data set showed

significant differences in the numbers of fishes above versus below the power plant discharge ($P \leq 0.05$, Table 15). Species in the All Data set that indicated decreases in abundance below the power plant discharge included quillback, white sucker, northern hog sucker, shorthead redhorse, muskellunge, rock bass, smallmouth bass, and unidentified fish. Brown bullhead was also significantly different; however, its numbers significantly increased at Bell Bend compared to the upriver sites. The Summer Data set demonstrated decline or increase in all of the same species except white sucker.

BACI Results: Seining

The results of the 12 seined species tested by BACI analysis indicated marginally significant differences in the numbers of spotfin shiner ($P=0.082$) and rock bass ($P=0.093$) above versus below the plant discharge. The point estimates for these species indicated that more spotfins were collected at the downriver sites versus upriver, while fewer rock bass were collected at the downriver locations.

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Table 1

Descriptions of water quality sampling sites in the vicinity of the Susquehanna SES, 2009.

SITE	LOCATION
Susquehanna SES Environmental Laboratory	West bank of the Susquehanna River: 1,620 feet (ft) upriver from the Susquehanna SES intake structure, sensors for river depth and temperature are located on river bottom within 100 ft of the bank
SSES (control)	Susquehanna River: 750 ft upriver from the center of the Susquehanna SES intake structure, 130 ft from the west bank
Blowdown	Since November 1996: Susquehanna SES Cooling Tower Blowdown Discharge Line 2S7 automatic composite sampler (ACS) about 750 feet downstream from the cooling tower basin, 0.1 air miles NNE from the stand-by gas treatment vent at 44200/N34117 (PA Grid System) December 1990-October 1996: 6S7 ACS at the Susquehanna SES sewage treatment plant about 2,880 feet downstream from the cooling tower basin
Bell Bend (indicator)	Susquehanna River: 2,260 ft downriver from the Susquehanna SES discharge diffuser, 130 ft from the west bank

Table 2

Water quality parameters and methods of analyses utilized by the Susquehanna SES Environmental Laboratory, 2009.

PARAMETER	METHOD	REFERENCE [a]
River depth (ft)	Seven-day continuous recording from an Acco Bristol, Model No. G500-15 bubbler-type water level gauge.	ACCO (1971)
River level (ft above msl)	$Level = Depth + 482.96$	Soya (1991)
River flow (cfs)	Insert river level into the appropriate regression equation. At level <486.0 ft, $\log flow = -0.05251(level)^2 + 51.478501(level) - 12612.85672$ At level ≥486.0 ft, $flow = 319.96989(level)^2 - 309316.24395(level) + 74753300$	Soya (1991)
Temperature (°F)	Constant monitor of river temperature: Seven-day continuous recording from an Omega RD-MV106-3-2-1D temperature recorder.	Omega (2001)
(°C)	River and blowdown temperature of samples collected: Calibrated, mercury-filled thermometer. Method 2550 B. Convert Fahrenheit to Celsius for tabulation: $^{\circ}C = (^{\circ}F - 32) \div 1.8$ or $\frac{^{\circ}C}{^{\circ}F - 32} = 5/9$	APHA (1995) [b] Internet site
Dissolved oxygen (mg/L)	Membrane electrode. Method 4500-O G.	APHA (1995)

[a] Listed in references cited.
[b] http://mathforum.org/library/drmath/view/58393.html. Accessed: 19 February 2009.

Table 3

Daily mean flow (cfs) of the Susquehanna River at the Susquehanna SES Environmental Laboratory, 2009.

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	40200	5590	18700	17200	6490	17700	14000	25200	14900	5590	32600	11100
2	28100	5300	24000	17700	6490	14000	15300	20700	12700	6180	25200	11100
3	22900	6180	19700	15300	6490	11900	16700	19700	9180	5880	20700	11900
4	20200	5880	15800	17700	7120	9910	16700	17200	7120	5300	18200	12700
5	18200	5880	12300	28100	7780	8470	14900	14400	5880	5300	15300	12700
6	17200	5020	11500	32600	7450	7450	14000	12700	5300	5590	13500	13100
7	16200	4480	11100	31300	7780	6800	11900	9180	4740	5590	11900	12700
8	16700	4210	11900	29400	8120	6180	10700	7450	4210	4740	11100	11100
9	17200	5590	23500	26900	9180	5880	9180	6490	4210	4210	10700	11100
10	16200	7120	77300	22900	11500	6180	8820	6800	3460	4480	9910	12700
11	15300	9540	85500	19700 [a]	10300	6180	8120	7450	3230	4740	9180	14400
12	11900	19200	80300	18700	9540	6490	8120	22900	3710	5300	8470	14900
13	10300	52600	63000	17200	8820	6800	7450	23500	4210	4740	7780	12700
14	10700	56000	48500	15800	8120	11500	6490	16700	3710	4480	7120	13500
15	9910	41600	38700	14000	8470	11100	6490	13500	3230	4480	6800	14900
16	9910	31900	31300	13100	8470	9910	6180	10700	3000	4210	6490	20200
17	8120	24600	27500	12300	14000	8470	5300	8470	3000	4210	6180	23500
18	5300	19200	24600	11100	28100	8470	4740	6800	3000	4480	5880	20700
19	5300	16700	22300	10300	26300	11100	4480	5880	2770	4480	5880	16700
20	7120	14900	24600	9540	21300	12700	4480	6490	2770	4740	6180	14000
21	7120	13500	29400	9910	15800	15800	4210	6800	2770	4480	8820	12300
22	7450	13100	28100	11100	12700	40200	4210	8120	2560	4480	11900	12300
23	7120	11500	23500	11900	9910	33900	3960	7780	2350	3960	13100	11500
24	6800	10300	20200	11100	8820	26300	3460	7780	2140	4740	11500	10300
25	7450	9540	17200	9910	8470	19200	3230	7450	2140	17200	10300	8820
26	6490	9180	14900	9540	8120	14900	3230	6490	1940	21300	9180	8820
27	5880	8470	14000	8820	8120	14900	3230	6180	2140	22300	9180	10300
28	5300	10300	14000	8120	8820	16200	3000	5590	2770	21800	9180	20700
29	6180		14000	7450	12700	16700	3000	5020	3460	33200	10300	24000
30	5590		14000	6800	17200	14400	8470	6180	3960	48500	10700	18200
31	5590		14400		21300		13100	10700		42400		16200
MEAN	12200	15300	28300	15800	11400	13300	7970	11000	4350	10400	11400	14200

[a] Calculated 11-16 April flows using USGS data.

Table 4

Daily mean temperature (C) of the Susquehanna River at the Susquehanna SES Environmental Laboratory, 2009.

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1.5	0.6	3.3	8.8	17.4	18.6	22.4	21.7	21.7	15.6	11.9	6.8
2	0.8	0.6	1.9	9.2	17.0	18.4	22.3	22.1	21.0	14.7	11.2	6.3
3	0.5	0.7	0.6	10.0	16.6	17.9	21.8	23.1	21.2	15.2	10.7	6.7
4	0.5	0.6	0.5	9.8	16.1	17.8	21.8	23.4	21.8	15.4	10.0	6.7
5	0.5	0.5	0.7	9.2	15.5	18.0	22.0	23.8	22.2	15.3	9.6	6.2
6	0.5	0.5	1.6	9.0	15.1	18.4	22.4	23.7	22.5	14.8	8.8	5.1
7	0.7	0.7	2.9	8.4	15.6	19.9	22.5	23.6	22.4	14.9	7.9	4.4
8	0.9	1.2	4.3	7.7	16.4	21.4	22.2	23.4	22.5	14.7	7.6	4.0
9	0.7	1.0	5.1	7.3	17.2	22.4	22.3	23.1	22.3	14.5	7.9	3.7
10	0.5	1.0	3.3	7.2	17.3	23.0	23.2	23.4	21.8	14.6	8.4	3.1
11	0.5	1.3	3.1	7.5	16.6	22.7	23.2	24.5	20.6	14.1	8.6	1.7
12	0.5	1.1	3.4	7.5	16.5	22.7	23.0	24.6	20.0	13.3	8.4	1.1
13	0.5	0.6	3.5	8.2	16.6	22.9	23.1	23.9	20.4	12.8	8.2	0.9
14	0.5	0.8	3.4	8.7	16.3	23.0	23.0	23.8	20.8	12.1	8.8	1.5
15	0.5	1.0	3.9	9.0	16.8	23.1	23.3	24.5	21.2	11.2	9.2	2.4
16	0.5	0.9	4.3	10.1	17.9	22.2	23.9	25.3	20.7	10.3	9.4	2.4
17	0.5	1.0	5.1	11.1	17.4	21.4	24.1	26.2	20.2	9.9	9.6	1.9
18	0.5	0.8	6.2	12.2	15.9	20.5	24.0	26.5	20.1	9.7	9.2	1.2
19	0.5	1.1	7.2	13.0	15.3	20.0	24.1	26.4	19.9	9.6	9.4	0.8
20	0.5	0.7	7.3	12.9	16.0	19.5	24.0	26.1	19.7	10.1	9.6	0.5
21	0.5	0.7	6.9	12.4	17.0	19.6	23.5	25.6	19.7	10.8	9.2	0.5
22	0.5	1.1	6.3	13.0	18.4	19.3	23.5	25.4	19.6	11.4	8.7	0.6
23	0.6	0.8	5.7	12.4	19.3	19.2	23.8	25.1	20.5	11.8	8.3	0.5
24	0.5	0.8	5.3	12.5	19.8	20.2	24.1	24.5	21.1	12.6	8.6	0.5
25	0.5	1.2	5.4	13.6	20.8	21.3	24.4	24.5	20.4	12.8	8.8	0.5
26	0.5	1.9	5.6	15.4	20.4	22.2	24.6	24.6	18.8	12.3	8.9	1.0
27	0.5	2.8	6.4	17.3	19.1	22.2	25.2	24.4	18.7	11.6	8.9	1.8
28	0.5	3.7	7.7	18.7	18.5	22.0	25.7	23.8	18.1	11.4	8.2	1.9
29	0.5		8.7	19.0	18.2	22.3	25.4	23.3	17.2	11.7	7.6	0.9
30	0.6		8.9	18.2	18.7	22.4	25.3	23.1	16.5	11.6	7.5	0.5
31	0.5		8.9		19.2		22.9	22.3		15.6		0.4
MEAN	0.6	1.1	4.8	11.3	17.4	20.8	23.5	24.2	20.5	12.8	9.0	2.5

Table 5

Pennsylvania Department of Environmental Protection specific water quality criteria for the Susquehanna River in the vicinity of the Susquehanna SES, 2009.

PARAMETER	UNIT	PERIOD	CRITERIA		AVERAGE
			Minimum	Maximum	
Alkalinity as CaCO3	mg/L		20		
Ammonia Nitrogen	mg/L			4.56	
Chloride	mg/L			250	
Dissolved Oxygen	mg/L		4.0		
		Daily Average	5.0		
Fluoride	mg/L	Daily			2.0
Iron Total	mg/L	30-Day			1.5
Dissolved	mg/L			0.3	
Manganese	mg/L			1.0	
	ug/L			1000	
Nitrite plus Nitrate as N	mg/L			10	
pH			6.0	9.0	
Sulfate	mg/L			250	
Temperature	C	January 1-31		4.4	
		February 1-29		4.4	
		March 1-31		7.8	
		April 1-15		11.1	
		April 16-30		14.4	
		May 1-15		17.8	
		May 16-31		22.2	
		June 1-15		26.7	
		June 16-30		28.9	
		July 1-31		30.6	
		August 1-15		30.6	
		August 16-31		30.6	
		September 1-15		28.9	
		September16-30		25.6	
		October 1-15		22.2	
		October 16-31		18.9	
		November 1-15		14.4	
		November 16-30		10.0	
		December 1-31		5.6	

Table 6

Water quality data collected quarterly from the Susquehanna River and the Susquehanna SES blowdown, 2009. River sites were SSES (control) and Bell Bend (indicator). Analyses were performed at the PPL Chemical Laboratory, Hazleton, PA. N.D. = Not Detected

PARAMETER	UNITS	SSES	BLOW DOWN	BELL BEND	SSES	BLOW DOWN	BELL BEND
Date		3/12/2009	3/12/2009	3/12/2009	5/21/2009	5/21/2009	5/21/2009
Time		810	714	817	748	816	740
River level	ft	499.5			490.8		
Temperature	C	2.5	14.2	2.5	15.9	21.4	15.9
Dissolved oxygen	mg/L	14.1	11.34	14.3	11.6	11.1	11.5
pH, lab		7.48	8.59	7.43	7.58	8.64	7.64
Conductivity, lab	µmho	143	764	149	184	609	186
Total alkalinity	mg/L	13.5	162	5.2	42.5	146	43
Phenolphthalein alkalinity	mg/L	0	7.4	0	0	5	0
Total suspended solids	mg/L	141	280	76	22	65	21.6
Ammonia as N	mg/L	<0.200	<0.200	<0.200	<0.20	<0.20	<0.20
Silicon dioxide	mg/L	3.58	14.76	3.53	3.42	9.51	3.41
Bicarbonate as CaCO3	mg/L	13.5	147	5.25	42.5	136	43
Carbonate as CO3	mg/L	0	14.8	0	0	10	0
Chloride	mg/L	17.8	110	19.4	18.8	75.6	21
Fluoride	mg/L	0.05	0.27	<0.100	0.071	0.229	<0.100
Nitrate as NO3	mg/L	2.19	12.3	2.33	1.33	5.27	1.49
Nitrate ion as N	mg/L	0.5	2.8	0.5	0.3	1.19	0.34
Phosphorus as PO4	mg/L	0.414	6.055	0.196	0.153	3.439	0.212
Sulfate	mg/L	9.8	56.4	11.3	16	51.3	16.4
Aluminum, dissolved	ug/L	<100	<100	<100	N.D.	<100	<100
Aluminum, total	ug/L	3740	7740	1900	440	1640	418
Barium, total	ug/L	58	172	37	30	104	30
Calcium, dissolved	mg/L	12.2	77.6	12.4	17.3	59.5	17.4
Calcium, total	mg/L	13.5	76.3	13.1	17.4	61.3	17.5
Copper, dissolved	ug/L	<20.0	<20.0	N.D.	N.D.	<20.0	N.D.
Copper, total	ug/L	<20.0	21.2	N.D.	N.D.	<20.0	N.D.
Iron, dissolved	mg/L	0.068	0.272	0.084	0.134	0.265	0.136
Iron, total	mg/L	7.66	15.9	3.76	1.17	4.24	1.14
Magnesium, dissolved	mg/L	2.31	13.9	2.33	3.82	12.4	3.82
Magnesium, total	mg/L	3.6	16.9	2.98	3.95	13.1	3.93
Manganese, dissolved	ug/L	15.1	31.3	13.7	44.3	27.1	45.1
Manganese, total	ug/L	381	814	167	116	467	116
Nickel, total	ug/L	<10.0	17.4	<10.0	<10.0	<10.0	<10.0
Potassium, dissolved	mg/L	1.21	5.24	1.19	1.18	4.06	1.21
Potassium, total	mg/L	1.61	6.12	1.46	1.28	4.3	1.28
Silver, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Sodium, dissolved	mg/L	10.1	58.7	10.3	11.4	44.7	11.4
Sodium, total	mg/L	9.94	60.3	10.1	11.2	45	11.2
Strontium, total	ug/L	38.9	246	37.4	61.9	219	61.6
Vanadium, total	ug/L	<10.0	11	<10.0	N.D.	<10.0	N.D.
Zinc, dissolved	ug/L	27	25.7	22.5	<20.0	<20.0	<20.0
Zinc, total	ug/L	35.2	76.2	<20.0	<20.0	25.1	<20.0
Beryllium, total	ug/L	<1.00	<1.00	N.D.	N.D.	N.D.	N.D.
Cadmium, total	ug/L	N.D.	<1.00	N.D.	N.D.	N.D.	N.D.
Chromium, total	ug/L	<10.0	11.2	<10.0	<10.0	<10.0	N.D.
Lead, total	ug/L	7.18	13.9	<5.00	N.D.	<5.00	N.D.
Thallium, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Arsenic, total	ug/L	2.35	5.72	1.11	<1.00	2.96	<1.00
Selenium, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Antimony, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Total mineral solids	mg/L	67.25	446.09	65.88	98.82	349.67	101.92
Calcium hardness (C)	mg/L	30.5	194	31	43.2	149	43.4
Total hardness (C)	mg/L	48.5	260	45	59.7	207	59.9

Table 6 (cont.)

PARAMETER	UNITS	SSES	BLOW DOWN	BELL BEND	SSES	BLOW DOWN	BELL BEND
Date		8/19/2009	8/19/2009	8/19/2009	10/28/2009	10/28/2009	10/28/2009
Time		657	723	650	604	744	611
River level	ft	488.1			491.7		
Temperature	C	25.2	25.9	25.3	10.5	18.7	10.5
Dissolved oxygen	mg/L	8	7.3	8	11.8	9.7	11.5
pH, lab		7.72	8.92	7.7	7.56	8.8	7.58
Conductivity, lab	µmho	238	708	237	194	623	196
Total alkalinity	mg/L	60	182	58.2	53	177	52
Phenolphthalein alkalinity	mg/L	0	19.5	0	0	11.1	0
Total suspended solids	mg/L	14.5	52	13	36.7	92	42
Ammonia as N	mg/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Silicon dioxide	mg/L	2.68	9.56	3.68	5.11	12.7	5.35
Bicarbonate as CaCO3	mg/L	60	143	58.2	53	154	52
Carbonate as CO3	mg/L	0	39	0	0	22.2	0
Chloride	mg/L	23.2	80.8	22.6	18	65.9	17.7
Fluoride	mg/L	0.079	0.261	0.078	0.058	<0.200	0.056
Nitrate as NO3	mg/L	1.4	6.9	1.43	1.38	4.98	1.36
Nitrate ion as N	mg/L	0.32	1.56	0.32	0.31	1.13	0.31
Phosphorus as PO4	mg/L	0.061	3.138	0.071	0.239	4.724	0.328
Sulfate	mg/L	22.3	69.9	22.3	12	45.4	11.7
Aluminum, dissolved	ug/L	<100	<100	N.D.	N.D.	<100	<100
Aluminum, total	ug/L	304	1070	276	831	1940	929
Barium, total	ug/L	29.3	96.2	28.9	36.6	94.9	38.2
Calcium, dissolved	mg/L	22.9	73.4	23.2	18.9	66.3	19.1
Calcium, total	mg/L	23.3	75.5	23.1	19.8	68.7	19.7
Copper, dissolved	ug/L	N.D.	<20.0	N.D.	N.D.	<20.0	N.D.
Copper, total	ug/L	N.D.	<20.0	N.D.	N.D.	<20.0	N.D.
Iron, dissolved	mg/L	0.162	0.195	0.163	0.12	0.258	0.122
Iron, total	mg/L	1.01	3.13	0.956	2.06	4.99	2.32
Magnesium, dissolved	mg/L	5.38	16.4	5.47	3.81	13.2	3.77
Magnesium, total	mg/L	5.55	17	5.5	4.1	14.1	4.12
Manganese, dissolved	ug/L	25.7	17.1	21.4	11.9	22	9.05
Manganese, total	ug/L	118	307	111	108	380	126
Nickel, total	ug/L	<10.0	<10.0	N.D.	N.D.	<10.0	N.D.
Potassium, dissolved	mg/L	1.78	5.25	1.77	2.12	6.37	2.03
Potassium, total	mg/L	1.86	5.57	1.86	2.19	6.72	2.18
Silver, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Sodium, dissolved	mg/L	13.9	47.9	14.2	11	39.4	11.2
Sodium, total	mg/L	14	47.7	13.9	11	39.8	11
Strontium, total	ug/L	93.4	278	92.4	65.5	260	65.2
Vanadium, total	ug/L	N.D.	N.D.	N.D.	N.D.	<10.0	N.D.
Zinc, dissolved	ug/L	22.7	<20.0	<20.0	<20.0	55	<20.0
Zinc, total	ug/L	N.D.	<20.0	N.D.	<20.0	22.3	<20.0
Beryllium, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Cadmium, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Chromium, total	ug/L	N.D.	<10.0	N.D.	N.D.	<10.0	N.D.
Lead, total	ug/L	N.D.	<5.00	N.D.	<5.00	<5.00	<5.00
Thallium, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Arsenic, total	ug/L	<2.00	3.71	<2.00	<2.00	3.26	<2.00
Selenium, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Antimony, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Total mineral solids	mg/L	129.53	419.32	129.48	104.13	360.16	103.47
Calcium hardness (C)	mg/L	57.2	183	57.9	47.2	166	47.7
Total hardness (C)	mg/L	81	259	80.3	66.3	230	66.2

Table 7

Total iron concentrations from the Susquehanna River at the SSES sampling site, 1975-2009. Samples were collected monthly from 1975 through 1996 and quarterly from 1997 through 2009. Analyses were performed by the PPL Chemical Laboratory, Hazleton, PA.

YEAR	NO. SAMPLES Collected	NO. SAMPLES <1.50 mg/L	% SAMPLES <1.50 mg/L	ANNUAL MEAN
1975	12	2	16.7	3.55
1976	12	3	25.0	3.08
1977	11	5	45.5	1.71
1978	12	5	41.7	1.48
1979	12	5	41.7	3.13
1980	12	5	41.7	1.74
1981	12	9	75.0	1.31
1982	12	7	58.3	2.37
1983	11	6	54.5	1.41
1984	12	4	33.3	1.71
1985	12	5	41.7	1.61
1986	12	7	58.3	1.82
1987	12	8	66.7	1.96
1988	12	7	58.3	1.28
1989	12	9	75.0	1.45
1990	12	10	83.3	1.41
1991	12	10	83.3	0.98
1992	12	12	100.0	0.92
1993	12	8	66.7	1.55
1994	11	8	72.7	1.46
1995	12	12	100.0	0.89
1996	12	9	75.0	1.42
1997	4	4	100.0	0.55
1998	4	4	100.0	0.65
1999	4	4	100.0	0.60
2000	4	4	100.0	0.70
2001	4	4	100.0	0.74
2002	4	4	100.0	0.62
2003	4	3	75.0	1.43
2004	4	3	75.0	0.94
2005	4	4	100.0	0.57
2006	4	4	100.0	0.62
2007	4	3	75.0	2.00
2008	4	3	75.0	0.98
2009	4	2	50.0	2.98

Table 8

Comparison of total mineral solids (TMS) concentrations from the Susquehanna River and the Susquehanna SES blowdown, 2009. River sites were SSES (control) and Bell Bend (indicator).

DATE	SSES		BLOWDOWN		BELL BEND	DIFFERENCE
	Flow (cfs)	TMS (mg/L)	Flow (cfs)	TMS (mg/L)	TMS (mg/L)	BELL BEND - SSES TMS (mg/L)
12 Mar	80300	67.3	19.3	446.1	65.9	-1.4
21 May	15800	98.8	17.1	349.7	101.9	3.1
19 Aug	5880	129.5	26.7	419.3	129.5	0.0
28 Oct	21800	104.1	26.6	360.2	103.5	-0.6

Table 9

Comparison of annual average total mineral solids (TMS) concentrations from the Susquehanna River and the Susquehanna SES blowdown, 1991-2009. River sites were SSES (control) and Bell Bend (indicator).

YEAR	SSES		BLOWDOWN		BELL BEND	DIFFERENCE
	Flow (cfs)	TMS (mg/L)	Flow (cfs)	TMS (mg/L)	TMS (mg/L)	BELL BEND - SSES TMS (mg/L)
1991	12600	197.3	14.6	711.8	203.7	6.4
1992	13400	155.3	7.5	600.3	156.4	1.1
1993	23700	202.8	13.1	636.2	204.4	1.6
1994	19200	174.9	13.9	660.9	175.3	0.4
1995	10200	196.7	12.9	643.9	198.8	2.1
1996	24000	151.8	19.5	438.4	152.6	0.8
1997	6490	239.0	16.9	787.7	248.6	9.6
1998	11200	242.2	19.2	649.3	247.9	5.7
1999	9120	204.1	11.2	585.1	212.0	7.9
2000	21200	160.4	12.6	449.5	163.5	3.1
2001	7190	180.2	20.8	572.5	183.9	3.7
2002	12200	136.2	17.7	523.4	142.5	6.3
2003	26900	131.3	18.7	459.0	132.5	1.2
2004	12200	134.1	18.3	446.6	136.3	2.2
2005	13500	157.1	16.2	584.0	165.4	8.3
2006	14400	137.6	17.9	522.8	138.0	0.4
2007	20810	145.7	20.4	455.1	147.9	2.2
2008	10700	164.1	23.2	505.0	165.1	1.0
2009	30900	99.9	22.4	393.8	100.2	0.3
MEAN	15800	169.0	16.7	559.2	172.4	3.4

Table 10

Descriptions of electrofishing (EL) and seining (SN) sites at SSES and Bell Bend on the Susquehanna River, 2009.

SITE	LOCATION
	SSES (Control)
EL-1	East bank, 426 feet upriver from gas-line crossing to 1,082 feet upriver from a point opposite the center of the Susquehanna SES intake structure
EL-2	West bank from gas-line crossing to a point 820 feet upriver from the center of the Susquehanna SES intake structure
SN-1	East bank, 1,837 feet upriver from a point opposite the center of the Susquehanna SES intake structure (33 feet upriver from the mouth of Little Wapwallopen Creek)
SN-2	West bank, 1,312 feet upriver from the center of the Susquehanna SES intake structure (328 feet downriver from the boat ramp at the Susquehanna SES Environmental Laboratory)
	BELL BEND (Indicator)
EL-3	East bank, 1,279 feet downriver from a point opposite the center of the Susquehanna SES intake structure to a point 1,640 feet upriver from the mouth of Wapwallopen Creek
EL-4	West bank, 1,246 feet downriver from the center of the Susquehanna SES intake structure (558 feet downriver from the discharge diffuser) to a point near the southeastern boundary of PPL's Wetlands Nature Area
SN-3	East bank, 8,528 feet (1.6 miles) downriver from a point opposite the center of the Susquehanna SES intake structure, at the launching ramp of the Berwick Boat Club
SN-4	West bank, 4,264 feet (0.8 miles) downriver from the center of the Susquehanna SES intake structure, near the southeastern boundary of PPL's Wetlands Nature Area

Table 11

Fish species that were observed while electrofishing or collected by seining at SSES and Bell Bend on the Susquehanna River, 2009. Names of fishes and order of listing conform to Nelson et al. (2004).

COMMON NAME	SCIENTIFIC NAME
Carps and Minnows	Cyprinidae
Spotfin shiner	*Cyprinella spiloptera*
Common carp	*Cyprinus carpio*
Spottail shiner	*Notropis hudsonius*
Rosyface shiner	*Notropis rubellus*
Bluntnose minnow	*Pimephales notatus*
Fallfish	*Semotilus corporalis*
Suckers	Catostomidae
Quillback	*Carpiodes cyprinus*
White sucker	*Catostomus commersonii*
Northern hog sucker	*Hypentelium nigricans*
Shorthead redhorse	*Moxostoma macrolepidotum*
North American Catfishes	Ictaluridae
Channel catfish	*Ictalurus punctatus*
Pikes	Esocidae
Northern pike	*Esox lucius*
Muskellunge	*Esox masquinongy*
Chain pickerel	*Esox niger*
Sunfishes	Centrarchidae
Rock bass	*Ambloplites rupestris*
Redbreast sunfish	*Lepomis auritus*
Green sunfish	*Lepomis cyanellus*
Pumpkinseed	*Lepomis gibbosus*
Bluegill	*Lepomis macrochirus*
Smallmouth bass	*Micropterus dolomieu*
Perches	Percidae
Tessellated darter	*Etheostoma olmstedi*
Yellow perch	*Perca flavescens*
Walleye	*Sander vitreus*

Table 12

Number, mean, and percent total of fish observed while electrofishing at SSES on the Susquehanna River, 2009.

SPECIES	27 May				25 Jun				21 Jul				25 Aug				21 Oct				OVERALL	
	East	West	Mean	% Total	East	West	Mean	% Total	East	West	Mean	% Total	East	West	Mean	% Total	East	West	Mean	% Total	Mean	% Total
Common carp	0	0	0.0	0.0	0	0	0.0	0.0	1	0	0.5	0.5	1	0	0.5	1.4	3	0	1.5	1.9	0.5	0.9
Fallfish	0	1	0.5	1.4	0	0	0.0	0.0	0	2	1.0	1.0	0	1	0.5	1.4	0	4	2.0	2.6	0.8	1.5
Quillback	0	8	4.0	11.0	3	2	2.5	12.2	4	3	3.5	3.6	1	0	0.5	1.4	10	2	6.0	7.8	3.3	6.2
White sucker	0	0	0.0	0.0	0	0	0.0	0.0	1	1	1.0	1.0	0	0	0.0	0.0	0	0	0.0	0.0	0.2	0.4
Northern hog sucker	4	0	2.0	5.5	9	1	5.0	24.4	13	32	22.5	23.4	22	6	14.0	37.8	7	11	9.0	11.7	10.5	19.7
Shorthead redhorse	1	0	0.5	1.4	1	0	0.5	2.4	1	2	1.5	1.6	1	0	0.5	1.4	0	0	0.0	0.0	0.6	1.1
Channel catfish	2	1	1.5	4.1	0	0	0.0	0.0	5	1	3.0	3.1	1	0	0.5	1.4	3	3	3.0	3.9	1.6	3.0
Muskellunge	0	0	0.0	0.0	0	0	0.0	0.0	3	0	1.5	1.6	1	0	0.5	1.4	0	0	0.0	0.0	0.4	0.7
Chain pickerel	0	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0	1	0	0.5	0.6	0.1	0.2
Pike spp.	1	0	0.5	1.4	0	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0	0.1	0.2
Rock bass	2	4	3.0	8.2	0	1	0.5	2.4	20	29	24.5	25.5	1	0	0.5	1.4	18	12	15.0	19.5	8.7	16.3
Redbreast sunfish	0	0	0.0	0.0	0	0	0.0	0.0	1	0	0.5	0.5	0	0	0.0	0.0	0	1	0.5	0.6	0.2	0.4
Green sunfish	0	0	0.0	0.0	0	0	0.0	0.0	1	0	0.5	0.5	0	0	0.0	0.0	0	0	0.0	0.0	0.1	0.2
Bluegill	0	0	0.0	0.0	0	0	0.0	0.0	0	1	0.5	0.5	0	0	0.0	0.0	0	0	0.0	0.0	0.1	0.2
Smallmouth bass	12	13	12.5	34.2	5	5	5.0	24.4	24	16	20.0	20.8	14	7	10.5	28.4	35	15	25.0	32.5	14.6	27.3
Sunfish spp.	1	2	1.5	4.1	0	0	0.0	0.0	2	4	3.0	3.1	0	0	0.0	0.0	0	0	0.0	0.0	0.9	1.7
Yellow perch	0	1	0.5	1.4	0	0	0.0	0.0	1	3	2.0	2.1	2	0	1.0	2.7	1	2	1.5	1.9	1.0	1.9
Walleye	0	7	3.5	9.6	0	1	0.5	2.4	3	6	4.5	4.7	0	6	3.0	8.1	15	10	12.5	16.2	4.8	9.0
Fish (unidentified)	8	5	6.5	17.8	7	6	6.5	31.7	4	8	6.0	6.3	8	2	5.0	13.5	1	0	0.5	0.6	4.9	9.2
TOTAL	31	42	36.5		25	16	20.5		84	108	96.0		52	22	37.0		94	60	77.0		53.4	

Table 13

Number, mean, and percent total of fish observed while electrofishing at Bell Bend on the Susquehanna River, 2009.

SPECIES	27 May				25 Jun				21 Jul				25 Aug				21 Oct				OVERALL	
	East	West	Mean	% Total	East	West	Mean	% Total	East	West	Mean	% Total	East	West	Mean	% Total	East	West	Mean	% Total	Mean	% Total
Common carp	3	3	3.0	9.1	1	1	1.0	4.2	0	2	1.0	2.3	1	1	1.0	2.9	6	3	4.5	5.5	2.1	4.8
Fallfish	0	2	1.0	3.0	1	0	0.5	2.1	0	0	0.0	0.0	1	0	0.5	1.5	4	3	3.5	4.2	1.1	2.5
Quillback	2	1	1.5	4.5	1	5	3.0	12.5	0	1	0.5	1.1	0	1	0.5	1.5	3	1	2.0	2.4	1.5	3.4
White sucker	0	0	0.0	0.0	0	0	0.0	0.0	1	0	0.5	1.1	1	0	0.5	1.5	1	0	0.5	0.6	0.3	0.7
Northern hog sucker	0	0	0.0	0.0	0	0	0.0	0.0	2	0	1.0	2.3	1	1	1.0	2.9	1	9	5.0	6.1	1.4	3.2
Shorthead redhorse	0	0	0.0	0.0	0	0	0.0	0.0	1	2	1.5	3.4	0	0	0.0	0.0	0	2	1.0	1.2	0.5	1.1
Sucker spp.	0	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0	0	1	0.5	1.5	0	1	0.5	0.6	0.2	0.5
Channel catfish	4	1	2.5	7.6	1	0	0.5	2.1	0	2	1.0	2.3	0	0	0.0	0.0	7	0	3.5	4.2	1.5	3.4
Northern pike	0	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0	1	0	0.5	1.5	0	0	0.0	0.0	0.1	0.2
Muskellunge	0	1	0.5	1.5	0	0	0.0	0.0	0	0	0.0	0.0	0	2	1.0	2.9	0	0	0.0	0.0	0.3	0.7
Chain pickerel	0	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0	0	1	0.5	1.5	0	0	0.0	0.0	0.1	0.2
Pike spp.	0	1	0.5	1.5	0	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0	1	2	1.5	1.8	0.4	0.9
Rock bass	5	0	2.5	7.6	0	1	0.5	2.1	8	6	7.0	15.9	3	0	1.5	4.4	9	14	11.5	13.9	4.6	10.6
Redbreast sunfish	0	0	0.0	0.0	0	0	0.0	0.0	0	1	0.5	1.1	0	0	0.0	0.0	0	0	0.0	0.0	0.1	0.2
Green sunfish	0	1	0.5	1.5	0	0	0.0	0.0	1	3	2.0	4.5	0	1	0.5	1.5	0	0	0.0	0.0	0.6	1.4
Pumpkinseed	0	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0	1	0	0.5	1.5	1	0	0.5	0.6	0.2	0.5
Bluegill	0	1	0.5	1.5	0	0	0.0	0.0	1	0	0.5	1.1	1	0	0.5	1.5	0	0	0.0	0.0	0.3	0.7
Smallmouth bass	10	5	7.5	22.7	8	8	8.0	33.3	14	14	14.0	31.8	20	8	14.0	41.2	11	41	26.0	31.5	13.9	32.0
Sunfish spp.	0	1	0.5	1.5	0	0	0.0	0.0	3	3	3.0	6.8	1	3	2.0	5.9	2	1	1.5	1.8	1.4	3.2
Yellow perch	0	0	0.0	0.0	1	0	0.5	2.1	2	0	1.0	2.3	1	0	0.5	1.5	4	0	2.0	2.4	0.8	1.8
Walleye	4	11	7.5	22.7	3	4	3.5	14.6	4	6	5.0	11.4	5	0	2.5	7.4	19	7	13.0	15.8	6.3	14.5
Fish (unidentified)	6	4	5.0	15.2	6	7	6.5	27.1	7	4	5.5	12.5	6	6	6.0	17.6	4	8	6.0	7.3	5.8	13.3
TOTAL	34	32	33.0		22	26	24.0		44	44	44.0		43	25	34.0		73	92	82.5		43.5	

Table 14

Number, mean, and percent total of fish captured by seining at SSES and Bell Bend on the Susquehanna River, 2009.

SPECIES	24 Aug				14 Oct				OVERALL	
	East	West	Mean	% Total	East	West	Mean	% Total	Mean	% Total
SSES										
Spotfin shiner	60	7	33.5	60.9	28	5	16.5	38.8	25.0	51.3
Spottail shiner	6	11	8.5	15.5	4	1	2.5	5.9	5.5	11.3
Bluntnose minnow	1	8	4.5	8.2	13	1	7.0	16.5	5.8	11.8
Shorthead redhorse	1	0	0.5	0.9	0	0	0.0	0.0	0.3	0.5
Muskellunge	0	0	0.0	0.0	0	1	0.5	1.2	0.3	0.5
Rock bass	2	4	3.0	5.5	1	0	0.5	1.2	1.8	3.6
Bluegill	1	2	1.5	2.7	8	0	4.0	9.4	2.8	5.6
Tessellated darter	4	3	3.5	6.4	23	0	11.5	27.1	7.5	15.4
TOTAL	75	35	55.0		77	8	42.5		48.8	
BELL BEND										
Spotfin shiner	129	27	78.0	74.3	11	53	32.0	39.8	55.0	59.3
Spottail shiner	21	13	17.0	16.2	79	3	41.0	50.9	29.0	31.3
Rosyface shiner	0	0	0.0	0.0	0	1	0.5	0.6	0.3	0.3
Bluntnose minnow	3	3	3.0	2.9	1	8	4.5	5.6	3.8	4.0
Fallfish	0	1	0.5	0.5	0	2	1.0	1.2	0.8	0.8
Rock bass	0	3	1.5	1.4	1	0	0.5	0.6	1.0	1.1
Smallmouth bass	0	1	0.5	0.5	0	1	0.5	0.6	0.5	0.5
Tessellated darter	4	3	3.5	3.3	1	0	0.5	0.6	2.0	2.2
Walleye	1	1	1.0	1.0	0	0	0.0	0.0	0.5	0.5
TOTAL	158	52	105.0		93	68	80.5		92.8	

Table 15

P-values for fish species deemed significant by the BACI analysis, 1976-2009 ($\alpha = 0.05$). Species listed decreased in number at the downriver locations, except for brown bullheads which increased at the downriver sites. Columns depict the p-values associated with the two temporal categories of data analyzed; All Data represents all months sampled, Summer Data denotes samples collected from June through October, *ns* indicates that a species was not significant in that data set.

SPECIES	ALL DATA	SUMMER DATA
Quillback	0.009	0.002
White sucker	0.042	*Ns*
Northern hog sucker	0.001	0.013
Shorthead redhorse	<0.001	<0.001
Brown bullhead	0.005	0.047
Muskellunge	<0.001	0.003
Rock bass	0.001	0.006
Smallmouth bass	0.041	0.002
Unidentified fish	0.017	<0.001

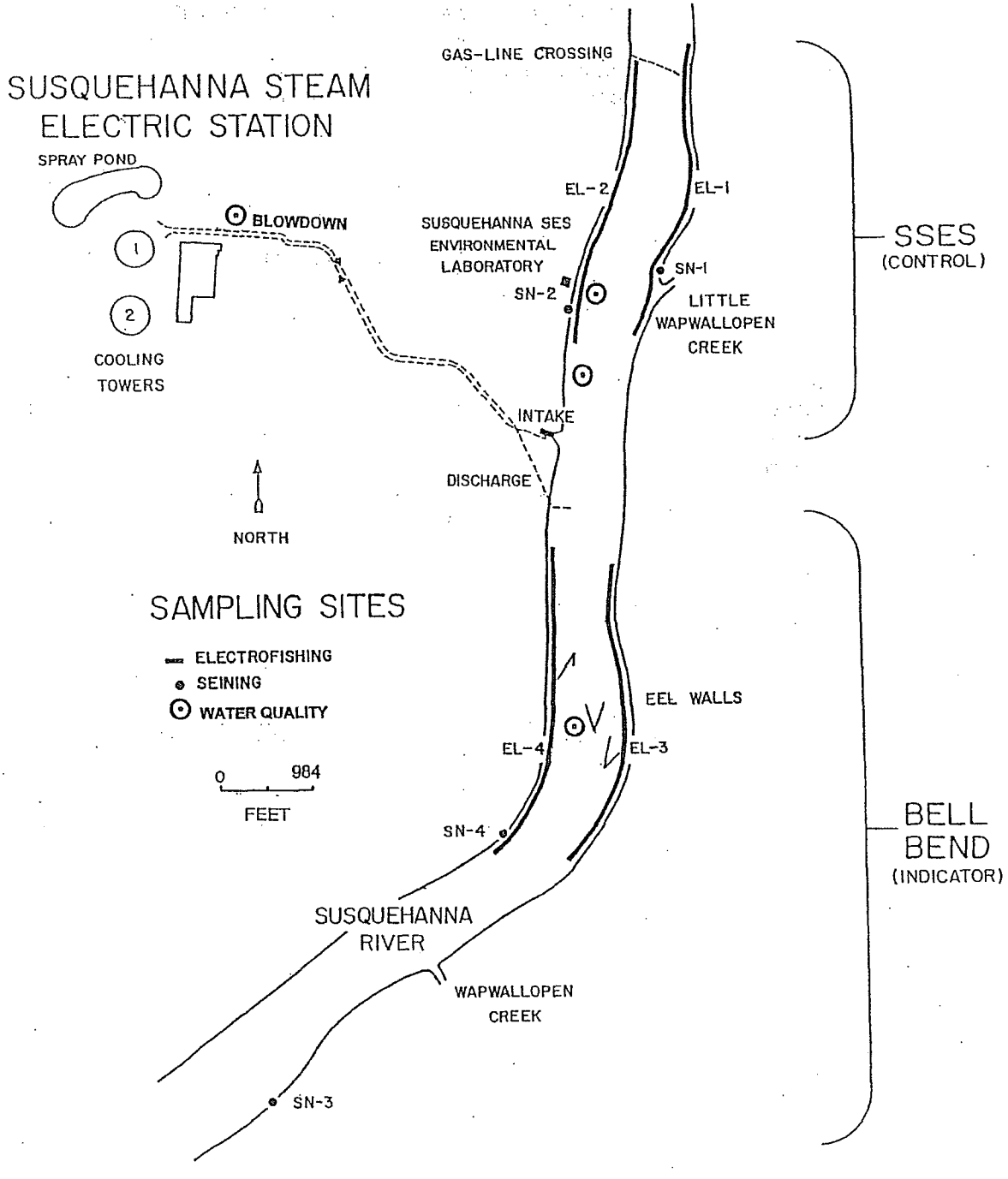

Fig. 1

Sampling sites for water quality, electrofishing (EL), and seining (SN) at SSES and Bell Bend on the Susquehanna River, 2009.

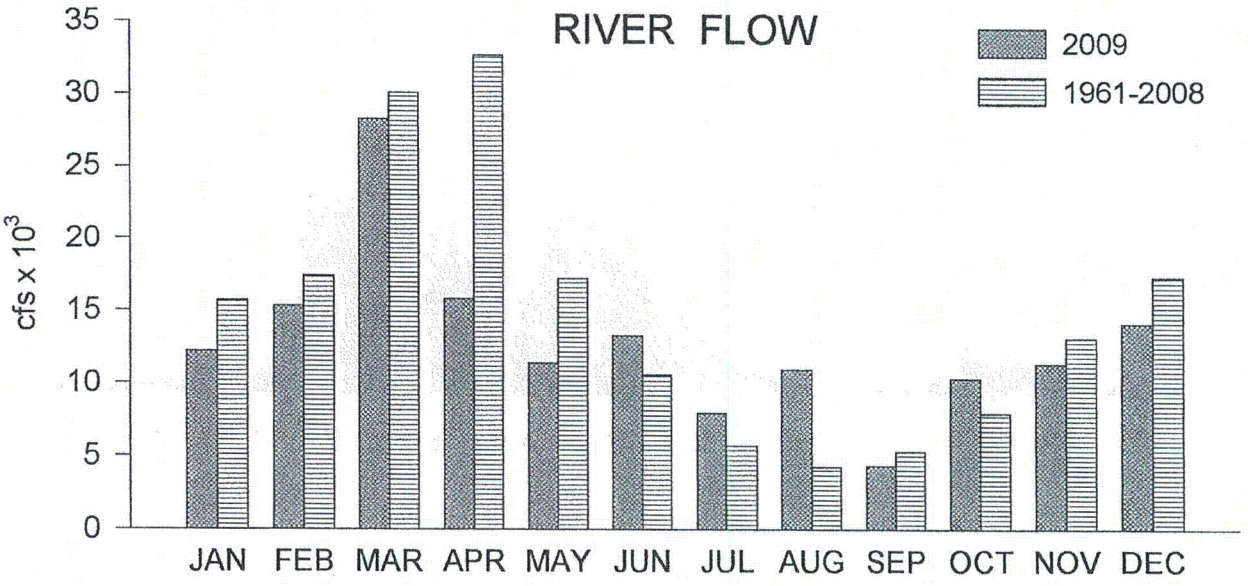

Fig. 2

The 2009 monthly mean flow of the Susquehanna River at the Susquehanna SES Environmental Laboratory compared to the 48-year (1961-2008) mean. The means were calculated from U.S. Geological Survey and Environmental Laboratory data.

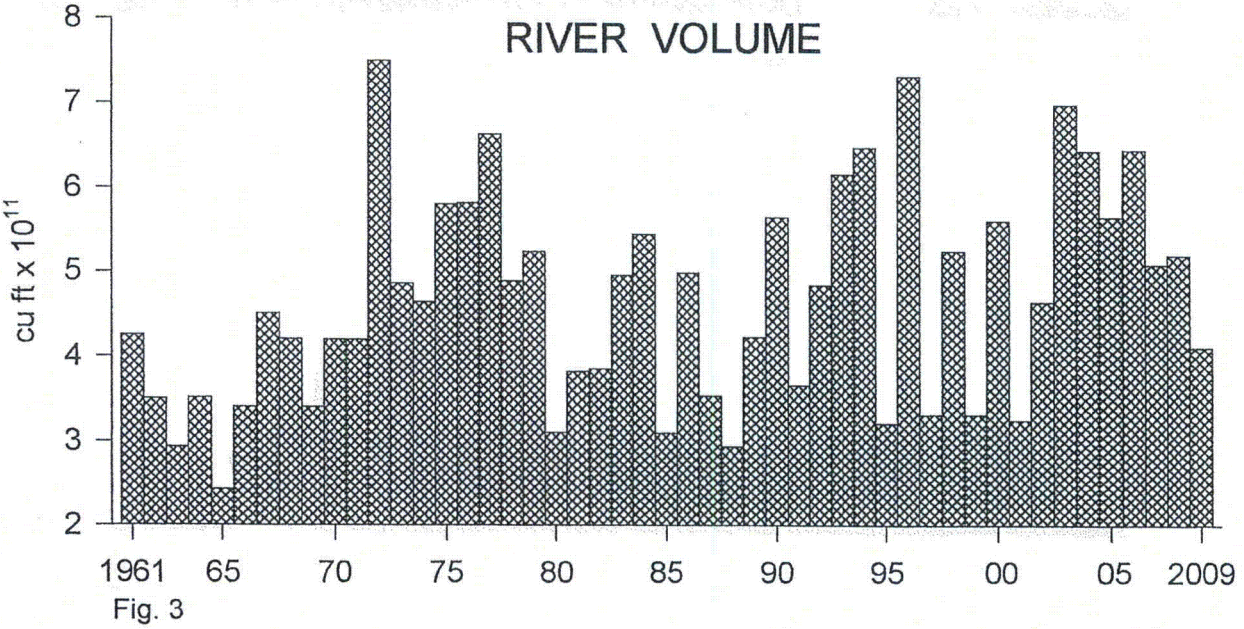

Fig. 3

Volume of Susquehanna River flow at the Susquehanna SES Environmental Laboratory, 1961-2009. The volumes were calculated from U.S. Geological Survey and Environmental Laboratory data.

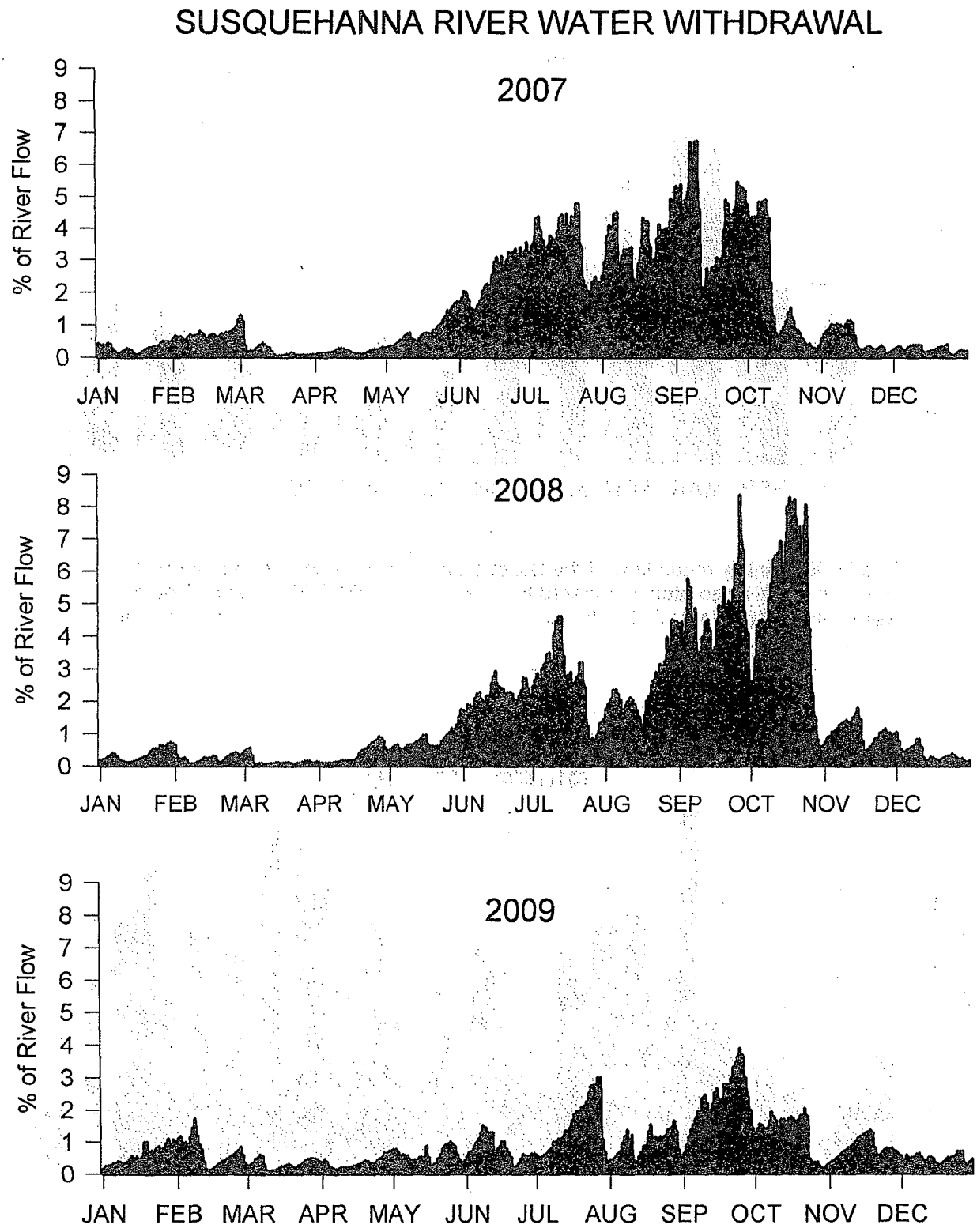

Fig. 4

Daily Susquehanna River water withdrawal by Susquehanna SES, 2007-2009.

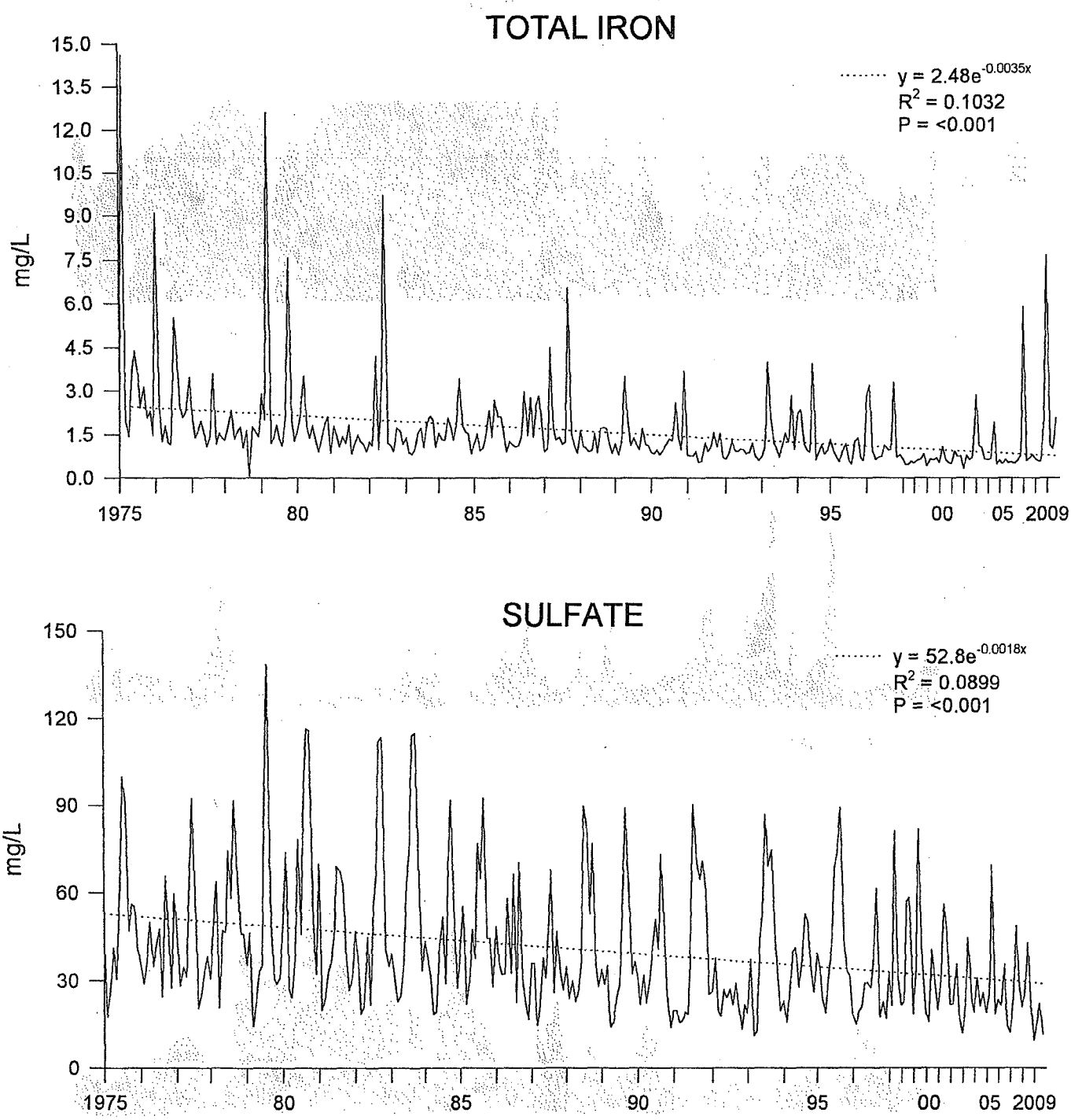

Fig. 5

Total iron and sulfate of the Susquehanna River at the SSES sampling site, 1975-2008. Samples were collected monthly 1975-1996 and quarterly 1997-2009. Analyses were performed by the PPL Chemical Laboratory, Hazleton, PA.

2009

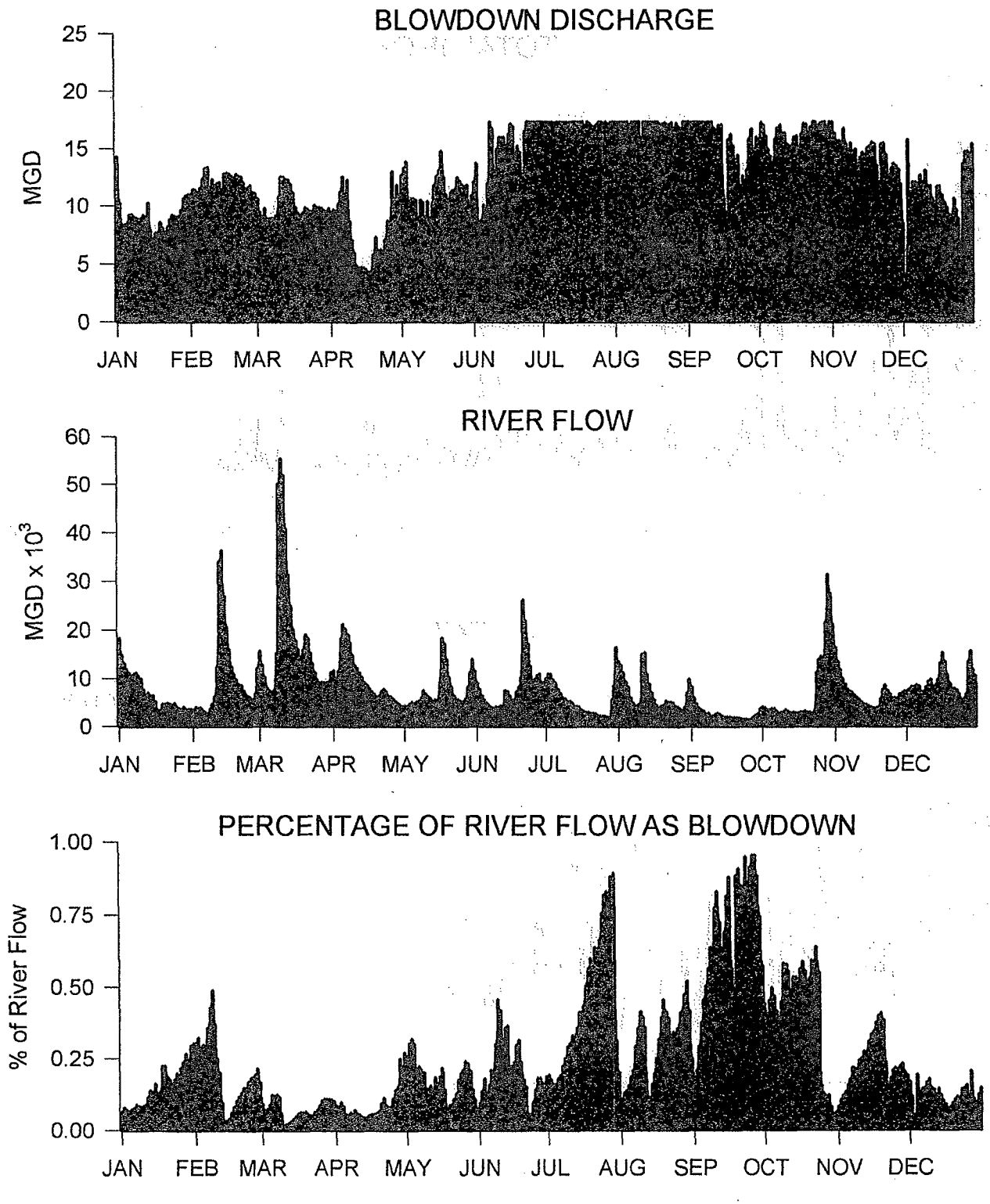

Fig. 6

Daily Susquehanna SES blowdown discharge, Susquehanna River flow and percentage of Susquehanna River flow as Susquehanna SES blowdown, 2009.

Enclosure 4

AE-08 – 2011 Ecology III Report

ENVIRONMENTAL STUDIES
IN THE VICINITY OF THE
SUSQUEHANNA STEAM ELECTRIC STATION

2010
WATER QUALITY
FISHES

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INTRODUCTION

PPL Susquehanna, LLC (PPL) contracted Ecology III, Inc. to conduct nonradiological monitoring of the Susquehanna River in the vicinity of the Susquehanna Steam Electric Station (Susquehanna SES) in 2010. The Susquehanna SES is a nuclear power station with two boiling water reactors, each with a net electrical generating capacity of approximately 1,350 megawatts. It is located on about 1,700 acres on the west side of the Susquehanna River in Salem Township, Luzerne County, 5 miles northeast of Berwick, Pennsylvania. In addition, approximately 700 acres of mostly undeveloped and recreational lands owned by PPL are located on the east side of the Susquehanna River in Conyngham and Hollenback Townships. PPL owns 90% of the station and Allegheny Electric Cooperative, Inc. owns 10%.

The objective of the nonradiological environmental monitoring program is to assess the impact of operating the Susquehanna SES on the Susquehanna River water quality and relative abundance of fishes. This was accomplished in 2010 by comparing data at control and indicator stations and by evaluating results of preoperational (1971-1982) and operational (1983-2009) studies (Ichthyological Associates 1972, Ichthyological Associates, Inc. 1973-1985, Ecology III, Inc. 1986-2010). Monitoring was done at sites within a control station (SSES) upriver from the Susquehanna SES river intake structure and indicator station (Bell Bend) downriver from the discharge diffuser.

To more objectively assess the impact of operating the Susquehanna SES on the Susquehanna River, a statistical procedure called BACI (Before-After:Control-Impact) analysis was applied to preoperational and operational fishes monitoring data.

This report presents results of water quality and fishes studies.

WATER QUALITY

PROCEDURES

Water quality of the Susquehanna River relative to operation of the Susquehanna SES was monitored throughout 2010 at four locations (Table 1, Fig. 1). Susquehanna River water samples were collected quarterly at SSES (control) and Bell Bend (indicator). In addition, water samples were also collected quarterly from the cooling tower blowdown of the Susquehanna SES. River flow and temperature were monitored continuously at the Environmental Laboratory (Table 2).

Most of the water sample parameters were analyzed by the Chemical Laboratory personnel at the PPL System Facilities Center, Hazleton, Pennsylvania. This laboratory has state accreditation with the Pennsylvania Department of Environmental Protection (PADEP; Commonwealth of Pennsylvania 2010), identified as Lab #40-00568 (www.dep.state.pa.us). Water temperature and dissolved oxygen were measured by Ecology III personnel and river level was recorded with the SSES data (Table 2). PPL Susquehanna, LLC personnel provided data for Susquehanna River water withdrawal.

RESULTS AND DISCUSSION

River Flow, River Water Withdrawal, and River Temperature

In 2010, daily mean Susquehanna River flow ranged from 996 to 128,000 cubic feet per second (cfs; Table 3, Fig. 2). The monthly mean Susquehanna River flow was above the 49-year average for January, March, October, November, and December, and below

average for the remaining months (Fig. 3). For Luzerne County, the PADEP issued a drought watch on 6 August; this was changed to a drought warning on 16 September and conditions returned to normal on 11 November (www.depweb.state.pa.us keyword: Drought, accessed 3 February 2011). The annual precipitation at Avoca, PA (about 30 miles upriver from the Susquehanna SES) was 32.30 inches (5.26 inches below normal; www.erh.noaa.gov/bgm/climate/avp.shtml, accessed 13 January 2011). Cumulatively, an estimated 445 billion cubic feet of water flowed through this section of the Susquehanna River during 2010 (Fig. 4).

Susquehanna SES river water withdrawal of river flow ranged from <0.1% on 14 and 15 March to 8.28% on 28 September (Fig. 5). Daily river water withdrawal of the plant was ≤2% of river flow for more than two-thirds of 2010. River water withdrawal exceeded 4% of river flow on 49 days last year.

Daily mean river temperature ranged from 0.4 C on 1, 2, and 10 February to 28.9 C on 8 July (Table 4, Fig. 6). The hourly minimum river temperature of 0.3 C occurred at 0100 and 0200 h on 15 January. The hourly maximum river temperature of 30.6 C occurred at 1600 h on 7 July and 1700 h on 8 July. March and April tied (5.9 C in 2000 and 12.7 C in 2008, respectively) the warmest monthly mean river temperatures on record since 1974, for those months. July had the second warmest temperature in 37 years (exceeded by 0.3 C in 2005) for that month. River temperature was above average every month except January, October and December (Fig. 7). However, these temperature comparisons did not take into account variations in river flow among the months.

River Water Quality at the Susquehanna SES

Control and indicator data were compared to PADEP specific water quality criteria (Commonwealth of Pennsylvania 2009; Table 5). The parameters with published specific water quality criteria for the critical use of the Susquehanna River in the vicinity of the Susquehanna SES include alkalinity, ammonia nitrogen, dissolved oxygen, total iron, pH, and temperature. In 2010, Susquehanna River water met the published criteria for all collected samples at the control and indicator sampling sites (Table 6).

There have been significant decreases over time in certain indicators of abandoned mine discharge such as total iron and sulfate concentrations (Table 7, Fig. 8), and Ecology III, Inc. has long reported the biotic recovery in the river associated with these improvements.

Control and Indicator Site Comparisons

Control and indicator water quality data were similar on most of the sampling dates during 2010 (Table 6). Since most of the water taken from the river for plant operation is evaporated in the cooling process, the remaining cooling water returned to the river subsequently contains concentrated mineral solids. Mineral solids concentrations in the blowdown sample were 3.2 to 5.5 times greater than those of the river control (Table 6). However, the dilutive effect of high river flow tends to equalize values at the control and indicator sites. This is evident when TMS values of the blowdown are compared to the control and indicator TMS results (Tables 8 and 9). It has been previously demonstrated that TMS concentrations at SSES are the best predictor of TMS concentrations at Bell Bend at most river flows. In addition, if operation of the Susquehanna SES is to influence

the water quality at the indicator site, then the probability of that occurring should be greatest at low river flows (Ecology III, Inc. 2008).

Conclusion

Susquehanna River flow exceeded the 49-year average during five months in 2010 and was below average for the remaining months. The maximum river water withdrawal of river flow by Susquehanna SES was 8.28% on 28 September. On most days during 2010, however, river water withdrawal was ≤2% of river flow. Exceptionally warm river temperatures were recorded for March, April and July.

Water quality data demonstrated that river samples met the published specific water quality criteria for six common parameters. Overall, water quality of this section of the Susquehanna River continues to improve.

Our data analyses demonstrate that effects of the operation of Susquehanna SES on water quality of the Susquehanna River will likely occur at the lowest range of river flows. This is reasonable because the dilutive power of the river against plant discharge would then be minimized.

FISHES

PROCEDURES

Electrofishing

Electrofishing samples were collected once each month in May, June, July, August and October in 2010. Sampling was done at four sites, and each site was approximately 1,100-yards long and parallel to the river shoreline. These sites have been consistently sampled by boat electrofishing since 1976. Two sites were located upriver from the Susquehanna SES river intake structure along each bank of the river, and two sites were downriver from the intake (referred to as SSES and Bell Bend locations, respectively; Table 10, Fig. 1).

The 18-foot electrofishing boat was outfitted with a 5-KW generator (direct current). Electrical output was controlled by a variable-voltage pulsator, with a target of 5-6 amps delivered to the water.

During sampling, the boat was driven downstream parallel to the shoreline, usually within 30 feet of the riverbank. For both safety purposes and sampling efficiency, electrofishing was done at river levels less than 493.1 feet above mean sea level (msl; equivalent to 10.1 feet) as measured at the Environmental Laboratory. Sampling was done in the evening and began about one hour after sunset. Two observers stood in the bow of the boat and identified and counted fish during each sample. Data were recorded using a cassette tape recorder.

Seining

Shoreline fishes were collected by seine during June and August. Sampling was done when river levels were less than 490.2 feet above msl (equivalent to 7.2 feet at the Environmental Lab). Similar to the electrofishing sampling sites, two shoreline seine sites were above the Susquehanna SES river intake structure and two were below (Table 10, Fig. 1). High water prevented seining in October.

To seine, one end of the 25-foot bag seine (0.25-inch mesh) was kept stationary on the riverbank while the other end was extended about 20 feet into the river or as far as depth of the water allowed. The seine was then pulled upriver and onto shore. Two hauls were made in the same location at each site and the catches from both hauls were combined and considered one unit of effort. Captured fish were placed in 10% formalin in the field and returned to the laboratory. After at least two weeks in the formalin, the fish were rinsed with water, identified, and enumerated before final preservation in 40% isopropyl alcohol.

Statistical Analysis

A statistical analysis known as the Before-After:Control-Impact (BACI), was applied to the electrofishing (1976-2010) and seining data (1978-2010; Ecology III, Inc. 1990). Twenty species or categories of fish were analyzed from the electrofishing data, as were 12 species from the seining data. These species or groups were chosen based on their abundance during the years before Susquehanna SES operation.

Two different electrofishing data sets were analyzed. The first set included all months sampled by electrofishing through the years, and is referred to as the All Data set.

The second set, named the Summer Data set, included only the months from June through October to reflect the reduced monitoring effort in place since1986. The seining data set analyzed by the BACI represents all of the months sampled by this method through the years.

RESULTS AND DISCUSSION

Electrofishing

Electrofishing at the SSES and Bell Bend locations in 2010 resulted in the observation of 1,594 fish of 19 species (Tables 11 through 13). The total numbers of fish collected above and below the SSES intake and discharge for the year were generally similar, with 815 fish at the upriver sites and 779 fish at the downriver sites. Differences in monthly totals between upriver and downriver sites ranged from as few as 19 fish in May to as many as 147 fish in August; in most months more fish were observed at the upriver sites than at the downriver sites. Comparatively, the range of monthly sample sizes (maxima minus minima) between the east and west banks was 92 fish at SSES and 158 at Bell Bend. At both the upriver and downriver sites, more fish were observed in most months along the eastern shore of the river. Maximum monthly sample sizes occurred during October at SSES (275) and August at Bell Bend (308).

Walleye was the most abundant species observed at SSES and Bell Bend in 2010 (31% and 39% of the totals, respectively). Walleye and smallmouth bass together represented 49% of the fish observed at SSES and 60% of those at Bell Bend. Walleye was also the most abundant species during July, August, and October at SSES and during August and October at Bell Bend. Other species leading the list at SSES were smallmouth

bass during May and northern hog sucker in June. At Bell Bend, smallmouth bass were most abundant in May, followed by yellow perch in June and rock bass in July. Overall, 5-7% of fish observed were placed in the unidentified fish category at both sites during 2010.

Fifteen species were observed at SSES, as were 18 at Bell Bend. Species richness in monthly samples ranged from 7 to 13 species at SSES and 10 to 14 species at Bell Bend. Sucker and sunfish species dominated richness in all months during 2010.

Seining

Seining at the SSES and Bell Bend locations in 2010 resulted in the capture of 575 fish of 15 species (Tables 11 and 14). Spotfin shiner was the most abundant species captured at SSES (26%), as was spottail shiner at Bell Bend (45%). Spotfin shiner, bluntnose minnow and pumpkinseed comprised 63% of the fishes collected at SSES, while spotfin shiner and spottail shiner comprised 88% of the fish collected at Bell Bend.

Similar to previous years, the number of fishes captured at SSES was a fraction (44%) of those collected at Bell Bend. The disparity between the upriver and downriver locations may reflect changing habitat differences between the sites.

Thirteen species were collected at both SSES and Bell Bend. At both stations, species in the minnow and sunfish families predominated.

BACI Results: Electrofishing

Of the 20 species or categories of fish that were tested with the BACI analysis, eight species from the All Data set and eight species from the Summer Data set showed significant differences in the numbers of fishes above versus below the power plant

discharge ($P \leq 0.05$, Table 15). Species in the All Data set that indicated decreases in abundance below the power plant discharge included quillback, northern hog sucker, shorthead redhorse, muskellunge, rock bass, smallmouth bass, and unidentified fish. Brown bullhead was also significantly different; however, its numbers increased at Bell Bend compared to the upriver sites. The Summer Data set demonstrated decline or increase in all of the same species.

BACI Results: Seining

The results of the 12 seined species tested by BACI analysis indicated marginally significant differences in the numbers of spotfin shiner ($P=0.096$), spottail shiner ($P=0.087$) and rock bass ($P=0.083$) above versus below the plant discharge. The point estimates for these species indicated that more spotfin and spottail shiners were collected at the downriver sites versus upriver, while fewer rock bass were collected at the downriver locations.

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Table 1

Descriptions of water quality sampling sites in the vicinity of the Susquehanna SES, 2010.

SITE	LOCATION
Susquehanna SES Environmental Laboratory	West bank of the Susquehanna River: 1,620 feet (ft) upriver from the Susquehanna SES intake structure, sensors for river depth and temperature are located on river bottom within 100 ft of the bank
SSES (control)	Susquehanna River: 750 ft upriver from the center of the Susquehanna SES intake structure, 130 ft from the west bank
Blowdown	Since November 1996: Susquehanna SES Cooling Tower Blowdown Discharge Line 2S7 automatic composite sampler (ACS) about 750 feet downstream from the cooling tower basin, 0.1 air miles NNE from the stand-by gas treatment vent at 44200/N34117 (PA Grid System) December 1990-October 1996: 6S7 ACS at the Susquehanna SES sewage treatment plant about 2,880 feet downstream from the cooling tower basin
Bell Bend (indicator)	Susquehanna River: 2,260 ft downriver from the Susquehanna SES discharge diffuser, 130 ft from the west bank

Table 2

Water quality parameters and methods of analyses utilized by the Susquehanna SES Environmental Laboratory, 2010.

PARAMETER	METHOD	REFERENCE [a]
River depth (ft)	Seven-day continuous recording from an Acco Bristol, Model No. G500-15 bubbler-type water level gauge.	ACCO (1971)
River level (ft above msl)	$Level = Depth + 482.96$	Soya (1991)
River flow (cfs)	Insert river level into the appropriate regression equation. At level <486.0 ft, $\log flow = -0.05251(level)^2 + 51.478501(level) - 12612.85672$ At level ≥486.0 ft, $flow = 319.96989(level)^2 - 309316.24395(level) + 74753300$	Soya (1991)
Temperature (°F)	Constant monitor of river temperature: Seven-day continuous recording from an Omega RD-MV106-3-2-1D temperature recorder.	Omega (2001)
(°C)	River and blowdown temperature of samples collected: Calibrated, mercury-filled thermometer. Method 2550 B. Convert Fahrenheit to Celsius for tabulation: $^{\circ}C = (^{\circ}F - 32) \div 1.8$ or $\frac{^{\circ}C}{^{\circ}F - 32} = \frac{5}{9}$	APHA (1995) [b] Internet site
Dissolved oxygen (mg/L)	Membrane electrode. Method 4500-O G.	APHA (1995)

[a] Listed in references cited.
[b] http://mathforum.org/library/drmath/view/58393.html. Accessed: 19 February 2009.

Table 3

Daily mean flow (cfs) of the Susquehanna River at the Susquehanna SES Environmental Laboratory, 2010.

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	13100	21300	6180	66700	14900	3960	3710	2140	3960	16200	14000	18700
2	12700	16700	6490	56800	13100	3960	3960	1940	3460	66700	12700	71400
3	13500	15300	6800	45400	11500	3710	3460	1750	3230	57700	11500	85500
4	12300	15300	6800	37300	10300	3460	3230	1750	2770	44600	10700	60300
5	8470	13500	6490	30000	9910	3710	3230	1750	2560	33200	11100	46200
6	7450	11900	6490	25700	9540	3460	3000	1570	2350	31300	12700	33200
7	8120	10300	6490	22300	8820	3960	2770	1210	2140	41600	15800	26900
8	8820	10700	6490	20200	8820	8120	2560	1210	1940	41600	16200	22900
9	8470	9540	8470	18700	9910	11500	2140	1210	1750	30600	14000	19700
10	7450	9180	13100	18700	10300	9910	2140	1210	1750	24600	12700	16200
11	6800	8820	19200	18700	10300	8470	2140	1570	1570	19700	11900	14400
12	5880	8120	30000	16700	11100	8820	2140	1570	1570	17700	11100	14000
13	6490	7780	51000	14900	11100	7780	2350	1570	1570	17200	10700	17700
14	6180	7780	78300	13500	16200	8820	2770	1940	1570	15300	9910	23500
15	5880	7450	98600	12300	15800	8470	2770	1570	1570	14000	9180	25700
16	6800	6800	77300	10700	15300	8470	2140	1750	1570	12700	8820	22300
17	7120	6800	64800	10300	14400	7780	2140	1750	1390	12300	10700	18700
18	8120	6800	53400	10300	12700	6490	2350	1750	1210	17700	24600	15800
19	13500	6490	42400	11500	11500	5880	2140	1750	1210	19200	29400	14400
20	19700	5880	35900	11900	11500	5880	1940	1570	1390	15300	24000	13500
21	17200	5880	31900	11100	11500	5590	1940	1390	1390	13100	19700	12700
22	14000	5880	30000	9910	9540	5020	1570	1940	1390	11100	17200	11100
23	11500	5880	31900	9180	8470	4740	1570	2770	1210	9540	15300	10300
24	10300	5880	45400	8120	7450	4480	1750	3710	1210	9180	14000	9540
25	15300	5880	56800	8120	6800	4210	2560	4740	996	9180	14000	8820
26	114000	6180	51800	9180	6490	3460	3230	13100	996	8820	15300	8470
27	128000	5880	47000	11900	5880	3460	3460	12300	996	9540	17200	7120
28	81400	5590	40200	19700	5300	3460	3960	8820	996	15300	19700	7450
29	56000		36600	22900	5020	3460	4210	7120	996	22300	19200	6180
30	38000		37300	18700	4740	3460	3230	5880	1940	20700	16200	6180
31	28100		51800		4210		2560	4740		16700		6490
MEAN	22600	9050	35000	20000	10100	5800	2680	3190	1760	22400	15000	21800

Table 4

Daily mean temperature (C) of the Susquehanna River at the Susquehanna SES Environmental Laboratory, 2010.

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	0.5	0.4	3.0	6.6	14.3	25.7	24.4	25.7	25.1	19.0	10.2	6.1
2	0.5	0.4	3.7	7.9	16.0	25.7	24.0	25.5	25.9	16.7	9.4	6.8
3	0.5	0.5	4.3	9.4	17.4	25.9	24.3	25.3	26.1	16.0	8.9	5.8
4	0.5	0.6	4.4	11.0	17.9	26.4	25.2	26.2	25.0	15.5	8.8	4.8
5	0.5	0.7	4.5	12.0	18.3	26.4	26.3	26.8	22.9	14.6	8.6	4.3
6	0.5	0.7	4.5	13.0	18.8	26.0	27.6	26.5	22.0	14.1	8.2	3.5
7	0.5	0.5	4.9	13.8	18.8	24.6	28.8	26.2	22.6	14.1	7.7	2.9
8	0.5	0.5	5.5	14.8	18.8	23.4	28.9	26.3	23.0	14.1	7.4	2.3
9	0.5	0.5	6.1	14.8	16.6	22.1	28.8	26.7	21.5	14.4	7.3	1.5
10	0.5	0.4	6.4	13.6	15.2	20.7	28.1	27.2	20.8	14.2	7.6	0.8
11	0.5	0.6	6.5	13.1	14.6	20.8	28.0	27.4	20.8	14.3	7.8	0.6
12	0.5	0.8	6.4	13.0	13.5	21.5	27.1	26.5	19.9	14.7	7.5	1.0
13	0.5	0.9	5.2	12.9	13.3	22.9	26.9	26.1	20.4	14.5	7.2	1.9
14	0.5	0.7	4.3	13.0	13.9	23.2	26.7	25.6	20.4	13.7	7.1	1.2
15	0.6	1.0	3.8	13.6	15.1	23.3	26.8	24.4	20.1	12.8	7.3	0.5
16	0.9	1.5	4.3	14.2	16.0	23.5	27.3	24.7	19.4	12.1	7.6	0.5
17	0.9	1.5	4.9	14.1	16.4	22.6	27.8	24.9	19.6	11.7	8.2	0.5
18	1.1	1.7	5.6	12.8	16.2	22.5	28.3	24.6	19.6	11.6	8.4	0.5
19	0.9	2.3	6.2	12.3	15.9	23.4	28.2	25.2	19.9	11.3	7.9	0.5
20	0.5	3.0	7.1	12.6	16.5	24.7	27.9	25.7	19.8	11.1	7.3	0.5
21	0.6	3.3	8.0	13.3	18.0	25.5	28.3	25.2	19.4	10.9	6.9	0.5
22	0.7	3.4	8.7	13.9	19.0	25.6	28.1	24.7	20.0	10.5	6.9	0.5
23	0.6	3.4	9.1	14.1	19.5	25.8	27.3	23.9	20.9	10.1	7.2	0.6
24	0.9	3.7	8.9	14.4	19.8	26.0	28.3	23.1	21.5	10.4	7.1	0.5
25	2.3	3.4	8.1	14.4	21.3	26.4	27.8	22.5	22.3	11.0	6.7	0.5
26	2.6	2.2	7.5	13.7	23.4	26.6	27.3	22.2	21.2	11.8	6.3	0.5
27	2.0	1.7	6.8	13.3	24.8	26.7	27.1	22.2	20.6	12.8	5.7	0.5
28	1.7	2.3	6.1	12.0	25.0	26.9	27.3	22.1	21.2	13.1	5.2	0.5
29	0.9		6.1	11.6	24.5	26.5	27.4	22.5	20.8	13.0	4.7	0.5
30	0.5		6.2	12.5	24.5	25.6	27.0	23.4	20.1	12.1	4.7	0.6
31	0.5		5.7		25.3		26.6	24.3		11.1		0.6
MEAN	0.8	1.5	5.9	12.7	18.3	24.6	27.2	25.0	21.4	13.1	7.4	1.7

Table 5

Pennsylvania Department of Environmental Protection specific water quality criteria for the Susquehanna River in the vicinity of the Susquehanna SES, 2010.

PARAMETER	UNIT	PERIOD	CRITERIA		AVERAGE
			Minimum	Maximum	
Alkalinity as CaCO3	mg/L		20		
Ammonia Nitrogen	mg/L			4.56	
Dissolved Oxygen	mg/L		4.0		
		Daily Average	5.0		
Iron Total	mg/L	30-Day			1.5
pH			6.0	9.0	
Temperature	C	January 1-31		4.4	
		February 1-29		4.4	
		March 1-31		7.8	
		April 1-15		11.1	
		April 16-30		14.4	
		May 1-15		17.8	
		May 16-31		22.2	
		June 1-15		26.7	
		June 16-30		28.9	
		July 1-31		30.6	
		August 1-15		30.6	
		August 16-31		30.6	
		September 1-15		28.9	
		September16-30		25.6	
		October 1-15		22.2	
		October 16-31		18.9	
		November 1-15		14.4	
		November 16-30		10.0	
		December 1-31		5.6	

Table 6

Water quality data collected quarterly from the Susquehanna River and the Susquehanna SES blowdown, 2010. River sites were SSES (control) and Bell Bend (indicator). Analyses were performed at the PPL Chemical Laboratory, Hazleton, PA. N.D. = Not Detected

PARAMETER	UNITS	SSES	BLOW DOWN	BELL BEND	SSES	BLOW DOWN	BELL BEND
Date		3/11/2010	3/11/2010	3/11/2010	5/20/2010	5/20/2010	5/20/2010
Time		724	755	717	741	650	737
River level	ft	491.2			489.5		
Temperature	C	5.70	19.53	5.76	15.2	21.3	15.2
Dissolved oxygen	mg/L	15.04	10.35	14.62	10.13	6.89	10.13
pH, lab		8.06	8.97	8.06	7.86	8.77	7.84
Conductivity, lab	µmho	308	1510	318	234	693	236
Total alkalinity	mg/L	61.1	306	60.6	59.5	180	59
Phenolphthalein alkalinity	mg/L	0	30.9	0	0	10.4	0
Total suspended solids	mg/L	11.7	36.7	9.14	7.3	22.6	7.2
Ammonia as N	mg/L	<0.20	<0.20	N.D.	N.D.	<0.20	N.D.
Silicon dioxide	mg/L	2.76	17.6	2.59	0.922	4.28	0.894
Bicarbonate as CaCO3	mg/L	61.1	244	60.6	59.5	160	59
Carbonate as CO3	mg/L	0	61.8	0	0	20.8	0
Chloride	mg/L	43.9	250	46.6	23.7	87.1	23.8
Fluoride	mg/L	0.073	0.263	<0.100	0.064	<0.300	0.072
Nitrate as NO3	mg/L	2.46	15.1	2.56	0.91	4.2	0.96
Nitrate ion as N	mg/L	0.555	3.41	0.579	0.205	0.95	0.218
Phosphorus as PO4	mg/L	0.172	5.291	0.107	0.196	3.221	0.113
Sulfate	mg/L	17.6	116	18.6	18.7	56.8	18.8
Aluminum, dissolved	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Aluminum, total	ug/L	260	665	198	<100	329	<100
Barium, total	ug/L	33.5	156	32.8	26.1	83.3	26.6
Calcium, dissolved	mg/L	26.6	138	26.8	22.9	69.2	23
Calcium, total	mg/L	26.9	142	27.2	22.8	69.9	22.9
Copper, dissolved	ug/L	N.D.	<20.0	N.D.	N.D.	N.D.	N.D.
Copper, total	ug/L	N.D.	<20.0	N.D.	N.D.	<20.0	N.D.
Iron, dissolved	mg/L	0.115	0.327	0.11	0.088	0.236	0.088
Iron, total	mg/L	0.799	2.97	0.664	0.442	1.48	0.41
Magnesium, dissolved	mg/L	5.42	29.2	5.39	4.98	14.4	5
Magnesium, total	mg/L	5.48	30	5.53	4.96	14.7	5
Manganese, dissolved	ug/L	52.6	66.1	51.3	29	18.4	31.2
Manganese, total	ug/L	70.9	234	66.5	69.4	208	69
Nickel, total	ug/L	N.D.	<10.0	N.D.	<10.0	<10.0	<10.0
Potassium, dissolved	mg/L	1.68	7.38	1.65	1.28	3.69	1.27
Potassium, total	mg/L	1.73	7.53	1.68	1.27	3.81	1.31
Silver, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Sodium, dissolved	mg/L	23.7	132	23.2	14.1	48.9	14
Sodium, total	mg/L	22.9	134	23.3	14	49.2	14
Strontium, total	ug/L	86.9	505	88.1	80.6	247	81.2
Vanadium, total	ug/L	<10.0	<10.0	N.D.	N.D.	<10.0	N.D.
Zinc, dissolved	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	<20.0
Zinc, total	ug/L	N.D.	<20.0	N.D.	N.D.	<20.0	<20.0
Beryllium, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Cadmium, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Chromium, total	ug/L	N.D.	<10.0	N.D.	N.D.	<10.0	N.D.
Lead, total	ug/L	N.D.	<5.00	N.D.	N.D.	<5.00	N.D.
Thallium, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Arsenic, total	ug/L	<2.00	2.21	<2.00	<2.00	<2.00	<2.00
Selenium, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Antimony, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Total mineral solids	mg/L	160.73	888.49	163.77	123.23	396.92	123.13
Calcium hardness (C)	mg/L	66.4	345	66.9	57.2	173	57.4
Total hardness (C)	mg/L	89.7	478	90.7	77.4	235	77.8

Table 6 (cont.)

PARAMETER	UNITS	SSES	BLOW DOWN	BELL BEND	SSES	BLOW DOWN	BELL BEND
Date		9/2/2010	9/2/2010	9/2/2010	11/10/2010	11/10/2010	11/10/2010
Time		710	756	714	704	736	708
River level	ft	487.2			489.9		
Temperature	C	24.7	25.8	24.8	6.01	15.55	6.01
Dissolved oxygen	mg/L	8.9	8.6	10.5	12.48	10.64	12.67
pH, lab		7.84	8.64	7.86	7.75	8.71	7.77
Conductivity, lab	µmho	276	852	278	214	640	212
Total alkalinity	mg/L	69	141	69.6	56.5	164	56
Phenolphthalein alkalinity	mg/L	0	8.9	0	0	8.9	0
Total suspended solids	mg/L	5.2	16.6	5.2	<4.00	18	<4.00
Ammonia as N	mg/L	N.D.	<0.20	N.D.	N.D.	<0.20	N.D.
Silicon dioxide	mg/L	4.6	15.3	4.6	3.36	11.5	3.42
Bicarbonate as CaCO3	mg/L	69	123	69.6	56.5	146	56
Carbonate as CO3	mg/L	0	17.8	0	0	17.8	0
Chloride	mg/L	27.7	101	28	20.2	68	20.1
Fluoride	mg/L	<0.050	0.24	0.059	0.082	0.216	0.113
Nitrate as NO3	mg/L	1.36	5.99	1.35	1.41	5.22	1.59
Nitrate ion as N	mg/L	0.306	1.35	0.305	0.318	1.18	0.36
Phosphorus as PO4	mg/L	0.163	2.988	0.175	0.04	3.491	0.009
Sulfate	mg/L	21.5	145	21.7	16.3	67.4	17.6
Aluminum, dissolved	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Aluminum, total	ug/L	<100	269	<100	<100	368	<100
Barium, total	ug/L	30.9	92.5	30.8	23.3	72.3	23.7
Calcium, dissolved	mg/L	27.2	87.3	27.6	21.4	68.6	21
Calcium, total	mg/L	27.7	88.3	27.7	21.3	70.1	21.5
Copper, dissolved	ug/L	N.D.	<20.0	N.D.	N.D.	N.D.	N.D.
Copper, total	ug/L	N.D.	<20.0	N.D.	N.D.	N.D.	N.D.
Iron, dissolved	mg/L	0.108	0.198	0.109	0.162	0.412	0.155
Iron, total	mg/L	0.479	1.45	0.449	0.41	1.65	0.396
Magnesium, dissolved	mg/L	5.61	17.3	5.65	4.26	13.4	4.2
Magnesium, total	mg/L	5.69	17.6	5.66	4.25	13.8	4.3
Manganese, dissolved	ug/L	26.2	15.3	23.2	38.6	15.9	36.5
Manganese, total	ug/L	99.8	273	93.8	47	149	45.6
Nickel, total	ug/L	N.D.	<10.0	N.D.	N.D.	<10.0	N.D.
Potassium, dissolved	mg/L	1.97	5.92	1.92	1.44	4.16	1.36
Potassium, total	mg/L	1.93	6.03	1.92	1.39	4.29	1.37
Silver, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Sodium, dissolved	mg/L	17.4	59.6	17.6	11.9	40.7	11.7
Sodium, total	mg/L	17.7	60	17.7	11.9	41.4	11.9
Strontium, total	ug/L	104	327	104	70.8	230	71.1
Vanadium, total	ug/L	N.D.	<10.0	<10.0	<10.0	<10.0	N.D.
Zinc, dissolved	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Zinc, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Beryllium, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Cadmium, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Chromium, total	ug/L	N.D.	<10.0	N.D.	N.D.	N.D.	N.D.
Lead, total	ug/L	N.D.	<5.00	N.D.	N.D.	N.D.	N.D.
Thallium, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Arsenic, total	ug/L	<2.00	3.15	<2.00	N.D.	<2.00	N.D.
Selenium, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Antimony, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Total mineral solids	mg/L	149	522	150	114	377	115
Calcium hardness (C)	mg/L	67.9	218	68.9	53.4	171	52.4
Total hardness (C)	mg/L	92.6	293	92.5	70.7	232	71.4

Table 7

Total iron concentrations from the Susquehanna River at the SSES sampling site, 1975-2010.
Samples were collected monthly from 1975 through 1996 and quarterly from 1997 through 2010.
PA DEP specific water quality criteria for total iron is 1.5 mg/L for a 30-day average.
Analyses were performed by the PPL Chemical Laboratory, Hazleton, PA.

YEAR	NO. SAMPLES Collected	NO. SAMPLES <1.50 mg/L	% SAMPLES <1.50 mg/L	ANNUAL MEAN
1975	12	2	16.7	3.55
1976	12	3	25.0	3.08
1977	11	5	45.5	1.71
1978	12	5	41.7	1.48
1979	12	5	41.7	3.13
1980	12	5	41.7	1.74
1981	12	9	75.0	1.31
1982	12	7	58.3	2.37
1983	11	6	54.5	1.41
1984	12	4	33.3	1.71
1985	12	5	41.7	1.61
1986	12	7	58.3	1.82
1987	12	8	66.7	1.96
1988	12	7	58.3	1.28
1989	12	9	75.0	1.45
1990	12	10	83.3	1.41
1991	12	10	83.3	0.98
1992	12	12	100.0	0.92
1993	12	8	66.7	1.55
1994	11	8	72.7	1.46
1995	12	12	100.0	0.89
1996	12	9	75.0	1.42
1997	4	4	100.0	0.55
1998	4	4	100.0	0.65
1999	4	4	100.0	0.60
2000	4	4	100.0	0.70
2001	4	4	100.0	0.74
2002	4	4	100.0	0.62
2003	4	3	75.0	1.43
2004	4	3	75.0	0.94
2005	4	4	100.0	0.57
2006	4	4	100.0	0.62
2007	4	3	75.0	2.00
2008	4	3	75.0	0.98
2009	4	2	50.0	2.98
2010	4	4	100.0	0.53

Table 8

Comparison of total mineral solids (TMS) concentrations from the Susquehanna River and the Susquehanna SES blowdown, 2010. River sites were SSES (control) and Bell Bend (indicator).

DATE	SSES		BLOWDOWN		BELL BEND	DIFFERENCE
	Flow (cfs)	TMS (mg/L)	Flow (cfs)	TMS (mg/L)	TMS (mg/L)	BELL BEND - SSES TMS (mg/L)
11 Mar	19200	160.7	13.4	888.5	163.8	3.1
20 May	11500	123.2	13.7	396.9	123.1	-0.1
02 Sep	3460	149.0	31.8	522.0	150.0	1.0
10 Nov	12700	114.0	33.6	377.0	115.0	1.0

Table 9

Comparison of annual average total mineral solids (TMS) concentrations from the Susquehanna River and the Susquehanna SES blowdown, 1991-2010. River sites were SSES (control) and Bell Bend (indicator).

YEAR	SSES		BLOWDOWN		BELL BEND	DIFFERENCE
	Flow (cfs)	TMS (mg/L)	Flow (cfs)	TMS (mg/L)	TMS (mg/L)	BELL BEND - SSES TMS (mg/L)
1991	12600	197.3	14.6	711.8	203.7	6.4
1992	13400	155.3	7.5	600.3	156.4	1.1
1993	23700	202.8	13.1	636.2	204.4	1.6
1994	19200	174.9	13.9	660.9	175.3	0.4
1995	10200	196.7	12.9	643.9	198.8	2.1
1996	24000	151.8	19.5	438.4	152.6	0.8
1997	6490	239.0	16.9	787.7	248.6	9.6
1998	11200	242.2	19.2	649.3	247.9	5.7
1999	9120	204.1	11.2	585.1	212.0	7.9
2000	21200	160.4	12.6	449.5	163.5	3.1
2001	7190	180.2	20.8	572.5	183.9	3.7
2002	12200	136.2	17.7	523.4	142.5	6.3
2003	26900	131.3	18.7	459.0	132.5	1.2
2004	12200	134.1	18.3	446.6	136.3	2.2
2005	13500	157.1	16.2	584.0	165.4	8.3
2006	14400	137.6	17.9	522.8	138.0	0.4
2007	20800	145.7	20.4	455.1	147.9	2.2
2008	10700	164.1	23.2	505.0	165.1	1.0
2009	30900	99.9	22.4	393.8	100.2	0.3
2010	11700	136.7	23.1	546.1	138.0	1.3
MEAN	15600	167.4	17.0	558.6	170.7	3.3

Table 10

Descriptions of electrofishing (EL) and seining (SN) sites at SSES and Bell Bend on the Susquehanna River, 2010.

SITE	LOCATION
	SSES (Control)
EL-1	East bank, 426 feet upriver from gas-line crossing to 1,082 feet upriver from a point opposite the center of the Susquehanna SES intake structure
EL-2	West bank from gas-line crossing to a point 820 feet upriver from the center of the Susquehanna SES intake structure
SN-1	East bank, 1,837 feet upriver from a point opposite the center of the Susquehanna SES intake structure (33 feet upriver from the mouth of Little Wapwallopen Creek)
SN-2	West bank, 1,312 feet upriver from the center of the Susquehanna SES intake structure (328 feet downriver from the boat ramp at the Susquehanna SES Environmental Laboratory)
	BELL BEND (Indicator)
EL-3	East bank, 1,279 feet downriver from a point opposite the center of the Susquehanna SES intake structure to a point 1,640 feet upriver from the mouth of Wapwallopen Creek
EL-4	West bank, 1,246 feet downriver from the center of the Susquehanna SES intake structure (558 feet downriver from the discharge diffuser) to a point near the southeastern boundary of PPL's Wetlands Nature Area
SN-3	East bank, 8,528 feet (1.6 miles) downriver from a point opposite the center of the Susquehanna SES intake structure, at the launching ramp of the Berwick Boat Club
SN-4	West bank, 4,264 feet (0.8 miles) downriver from the center of the Susquehanna SES intake structure, near the southeastern boundary of PPL's Wetlands Nature Area

Table 11

Fish species that were observed while electrofishing or collected by seining at SSES and Bell Bend on the Susquehanna River, 2010. Names of fishes and order of listing conform to Nelson et al. (2004).

COMMON NAME	SCIENTIFIC NAME
Herrings	Clupeidae
Gizzard shad	*Dorosoma cepedianum*
Carps and Minnows	Cyprinidae
Spotfin shiner	*Cyprinella spiloptera*
Common carp	*Cyprinus carpio*
River chub	*Nocomis micropogon*
Comely shiner	*Notropis amoenus*
Spottail shiner	*Notropis hudsonius*
Bluntnose minnow	*Pimephales notatus*
Fallfish	*Semotilus corporalis*
Suckers	Catostomidae
Quillback	*Carpiodes cyprinus*
White sucker	*Catostomus commersonii*
Northern hog sucker	*Hypentelium nigricans*
Shorthead redhorse	*Moxostoma macrolepidotum*
North American Catfishes	Ictaluridae
Channel catfish	*Ictalurus punctatus*
Pikes	Esocidae
Northern pike	*Esox lucius*
Muskellunge	*Esox masquinongy*
Topminnows	Fundulidae
Banded killifish	*Fundulus diaphanous*
Sunfishes	Centrarchidae
Rock bass	*Ambloplites rupestris*
Redbreast sunfish	*Lepomis auritus*
Green sunfish	*Lepomis cyanellus*
Pumpkinseed	*Lepomis gibbosus*
Bluegill	*Lepomis macrochirus*
Smallmouth bass	*Micropterus dolomieu*
Perches	Percidae
Tessellated darter	*Etheostoma olmstedi*
Yellow perch	*Perca flavescens*
Walleye	*Sander vitreus*

Table 12

Number, mean, and percent total of fish observed while electrofishing at SSES on the Susquehanna River, 2010.

SPECIES	27 May				24 Jun				29 Jul				26 Aug				25 Oct				OVERALL	
	East	West	Mean	% Total	East	West	Mean	% Total	East	West	Mean	% Total	East	West	Mean	% Total	East	West	Mean	% Total	Mean	% Total
Gizzard shad	0	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0	1	0	0.5	0.4	0.1	0.1
Common carp	1	1	1.0	2.3	0	0	0.0	0.0	1	2	1.5	1.7	4	1	2.5	3.1	3	1	2.0	1.5	1.4	1.7
Fallfish	1	4	2.5	5.7	0	11	5.5	9.6	0	2	1.0	1.1	4	0	2.0	2.5	0	0	0.0	0.0	2.2	2.7
Quillback	5	3	4.0	9.2	4	5	4.5	7.8	8	4	6.0	6.8	2	7	4.5	5.6	19	12	15.5	11.3	6.9	8.5
Northern hog sucker	4	2	3.0	6.9	47	3	25.0	43.5	9	8	8.5	9.6	7	2	4.5	5.6	13	8	10.5	7.6	10.3	12.6
Shorthead redhorse	1	0	0.5	1.1	0	0	0.0	0.0	2	2	2.0	2.3	3	1	2.0	2.5	0	0	0.0	0.0	0.9	1.1
Sucker spp.	0	0	0.0	0.0	1	0	0.5	0.9	0	0	0.0	0.0	0	0	0.0	0.0	0	2	1.0	0.7	0.3	0.4
Channel catfish	5	2	3.5	8.0	0	0	0.0	0.0	1	1	1.0	1.1	1	1	1.0	1.2	0	0	0.0	0.0	1.1	1.3
Muskellunge	1	1	1.0	2.3	1	0	0.5	0.9	0	0	0.0	0.0	2	0	1.0	1.2	0	0	0.0	0.0	0.5	0.6
Pike spp.	0	0	0.0	0.0	0	0	0.0	0.0	1	0	0.5	0.6	1	0	0.5	0.6	1	0	0.5	0.4	0.3	0.4
Rock bass	6	7	6.5	14.9	9	11	10.0	17.4	9	11	10.0	11.3	20	0	10.0	12.4	12	6	9.0	6.5	9.1	11.2
Green sunfish	0	0	0.0	0.0	2	1	1.5	2.6	0	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0	0.3	0.4
Pumpkinseed	0	1	0.5	1.1	0	0	0.0	0.0	0	1	0.5	0.6	3	0	1.5	1.9	0	0	0.0	0.0	0.5	0.6
Bluegill	0	0	0.0	0.0	0	0	0.0	0.0	7	2	4.5	5.1	1	0	0.5	0.6	0	0	0.0	0.0	1.0	1.2
Smallmouth bass	26	5	15.5	35.6	5	4	4.5	7.8	12	10	11.0	12.4	22	15	18.5	23.0	42	9	25.5	18.5	15.0	18.4
Sunfish spp.	1	1	1.0	2.3	1	1	1.0	1.7	4	6	5.0	5.6	1	1	1.0	1.2	0	0	0.0	0.0	1.6	2.0
Yellow perch	0	1	0.5	1.1	1	1	1.0	1.7	2	1	1.5	1.7	3	0	1.5	1.9	0	0	0.0	0.0	0.9	1.1
Walleye	2	0	1.0	2.3	1	2	1.5	2.6	25	33	29.0	32.8	44	2	23.0	28.6	48	94	71.0	51.6	25.1	30.8
Fish (unidentified)	4	2	3.0	6.9	2	2	2.0	3.5	8	5	6.5	7.3	9	4	6.5	8.1	3	1	2.0	1.5	4.0	4.9
TOTAL	57	30	43.5		74	41	57.5		89	88	88.5		127	34	80.5		142	133	137.5		81.5	

Table 13

Number, mean, and percent total of fish observed while electrofishing at Bell Bend on the Susquehanna River, 2010.

SPECIES	27 May				24 Jun				29 Jul				26 Aug				25 Oct				OVERALL	
	East	West	Mean	% Total	East	West	Mean	% Total	East	West	Mean	% Total	East	West	Mean	% Total	East	West	Mean	% Total	Mean	% Total
Common carp	2	0	1.0	2.9	0	0	0.0	0.0	4	1	2.5	6.1	7	3	5.0	3.2	3	0	1.5	1.2	2.0	2.6
River chub	1	0	0.5	1.5	0	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0	0.1	0.1
Fallfish	2	1	1.5	4.4	1	0	0.5	1.5	0	1	0.5	1.2	1	2	1.5	1.0	1	0	0.5	0.4	0.9	1.2
Quillback	3	2	2.5	7.4	13	0	6.5	19.4	2	2	2.0	4.9	3	0	1.5	1.0	9	11	10.0	7.9	4.5	5.8
White sucker	0	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0	0	1	0.5	0.4	0.1	0.1
Northern hog sucker	0	4	2.0	5.9	3	3	3.0	9.0	0	0	0.0	0.0	4	5	4.5	2.9	5	4	4.5	3.5	2.8	3.6
Shorthead redhorse	1	0	0.5	1.5	0	0	0.0	0.0	1	1	1.0	2.4	0	0	0.0	0.0	1	0	0.5	0.4	0.4	0.5
Sucker spp.	0	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0	1	0	0.5	0.4	0.1	0.1
Channel catfish	4	2	3.0	8.8	3	1	2.0	6.0	1	0	0.5	1.2	1	0	0.5	0.3	0	2	1.0	0.8	1.4	1.8
Northern pike	0	0	0.0	0.0	1	0	0.5	1.5	0	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0	0.1	0.1
Muskellunge	0	1	0.5	1.5	0	0	0.0	0.0	0	1	0.5	1.2	2	0	1.0	0.6	0	0	0.0	0.0	0.4	0.5
Pike spp.	0	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0	1	1	1.0	0.6	0	0	0.0	0.0	0.2	0.3
Rock bass	3	1	2.0	5.9	2	2	2.0	6.0	12	3	7.5	18.3	43	8	25.5	16.6	1	8	4.5	3.5	8.3	10.7
Redbreast sunfish	0	0	0.0	0.0	0	0	0.0	0.0	1	0	0.5	1.2	0	0	0.0	0.0	0	0	0.0	0.0	0.1	0.1
Green sunfish	0	0	0.0	0.0	2	1	1.5	4.5	2	1	1.5	3.7	0	0	0.0	0.0	0	0	0.0	0.0	0.6	0.8
Pumpkinseed	0	0	0.0	0.0	0	0	0.0	0.0	2	1	1.5	3.7	0	1	0.5	0.3	0	0	0.0	0.0	0.4	0.5
Bluegill	1	0	0.5	1.5	0	0	0.0	0.0	1	1	1.0	2.4	0	0	0.0	0.0	0	0	0.0	0.0	0.3	0.4
Smallmouth bass	9	18	13.5	39.7	5	3	4.0	11.9	9	4	6.5	15.9	57	11	34.0	22.1	13	31	22.0	17.3	16.0	20.5
Sunfish spp.	1	0	0.5	1.5	1	0	0.5	1.5	5	4	4.5	11.0	1	1	1.0	0.6	0	0	0.0	0.0	1.3	1.7
Yellow perch	0	0	0.0	0.0	14	0	7.0	20.9	2	0	1.0	2.4	2	0	1.0	0.6	0	0	0.0	0.0	1.8	2.3
Walleye	4	1	2.5	7.4	2	2	2.0	6.0	5	4	4.5	11.0	99	33	66.0	42.9	41	116	78.5	61.8	30.7	39.4
Fish (unidentified)	6	1	3.5	10.3	5	3	4.0	11.9	9	2	5.5	13.4	15	7	11.0	7.1	1	5	3.0	2.4	5.4	6.9
TOTAL	37	31	34.0		52	15	33.5		56	26	41.0		236	72	154.0		76	178	127.0		77.9	

Table 14

Number, mean, and percent total of fish captured by seining at SSES and Bell Bend on the Susquehanna River, 2010.

SPECIES	28 Jun				24 Aug				OVERALL	
	East	West	Mean	% Total	East	West	Mean	% Total	Mean	% Total
SSES										
Spotfin shiner	1	9	5.0	22.2	31	5	18.0	27.5	11.5	26.1
Comely shiner	0	0	0.0	0.0	1	0	0.5	0.8	0.3	0.6
Spottail shiner	0	0	0.0	0.0	2	5	3.5	5.3	1.8	4.0
Bluntnose minnow	14	0	7.0	31.1	9	4	6.5	9.9	6.8	15.3
Fallfish	2	0	1.0	4.4	0	0	0.0	0.0	0.5	1.1
White sucker	4	0	2.0	8.9	1	0	0.5	0.8	1.3	2.8
Rock bass	1	1	1.0	4.4	8	0	4.0	6.1	2.5	5.7
Redbreast sunfish	0	1	0.5	2.2	0	0	0.0	0.0	0.3	0.6
Green sunfish	0	0	0.0	0.0	11	11	11.0	16.8	5.5	12.5
Pumpkinseed	2	0	1.0	4.4	10	26	18.0	27.5	9.5	21.6
Smallmouth bass	1	0	0.5	2.2	1	1	1.0	1.5	0.8	1.7
Tessellated darter	4	4	4.0	17.8	4	1	2.5	3.8	3.3	7.4
Walleye	0	1	0.5	2.2	0	0	0.0	0.0	0.3	0.6
TOTAL	29	16	22.5		78	53	65.5		44.0	
BELL BEND										
Spotfin shiner	2	1	1.5	15.8	158	13	85.5	45.0	43.5	43.6
Spottail shiner	0	2	1.0	10.5	173	4	88.5	46.6	44.8	44.9
Bluntnose minnow	6	0	3.0	31.6	6	6	6.0	3.2	4.5	4.5
Fallfish	0	0	0.0	0.0	0	1	0.5	0.3	0.3	0.3
White sucker	2	0	1.0	10.5	0	0	0.0	0.0	0.5	0.5
Northern hog sucker	0	0	0.0	0.0	0	2	1.0	0.5	0.5	0.5
Banded killifish	0	0	0.0	0.0	3	2	2.5	1.3	1.3	1.3
Rock bass	1	0	0.5	5.3	2	2	2.0	1.1	1.3	1.3
Redbreast sunfish	0	0	0.0	0.0	0	1	0.5	0.3	0.3	0.3
Green sunfish	0	0	0.0	0.0	2	0	1.0	0.5	0.5	0.5
Pumpkinseed	0	0	0.0	0.0	1	3	2.0	1.1	1.0	1.0
Smallmouth bass	0	1	0.5	5.3	0	0	0.0	0.0	0.3	0.3
Tessellated darter	3	1	2.0	21.1	1	0	0.5	0.3	1.3	1.3
TOTAL	14	5	9.5		346	34	190.0		99.8	

Table 15

P-values for fish species deemed significant by the BACI analysis, 1976-2010 ($\alpha = 0.05$). Species listed decreased in number at the downriver locations, except for brown bullheads which increased at the downriver sites. Columns depict the p-values associated with the two temporal categories of data analyzed; All Data represents all months sampled, Summer Data denotes samples collected from June through October.

SPECIES	ALL DATA	SUMMER DATA
Quillback	0.007	0.002
Northern hog sucker	<0.001	0.011
Shorthead redhorse	<0.001	<0.001
Brown bullhead	0.005	0.047
Muskellunge	<0.001	0.003
Rock bass	<0.001	0.005
Smallmouth bass	0.032	0.001
Unidentified fish	0.024	0.001

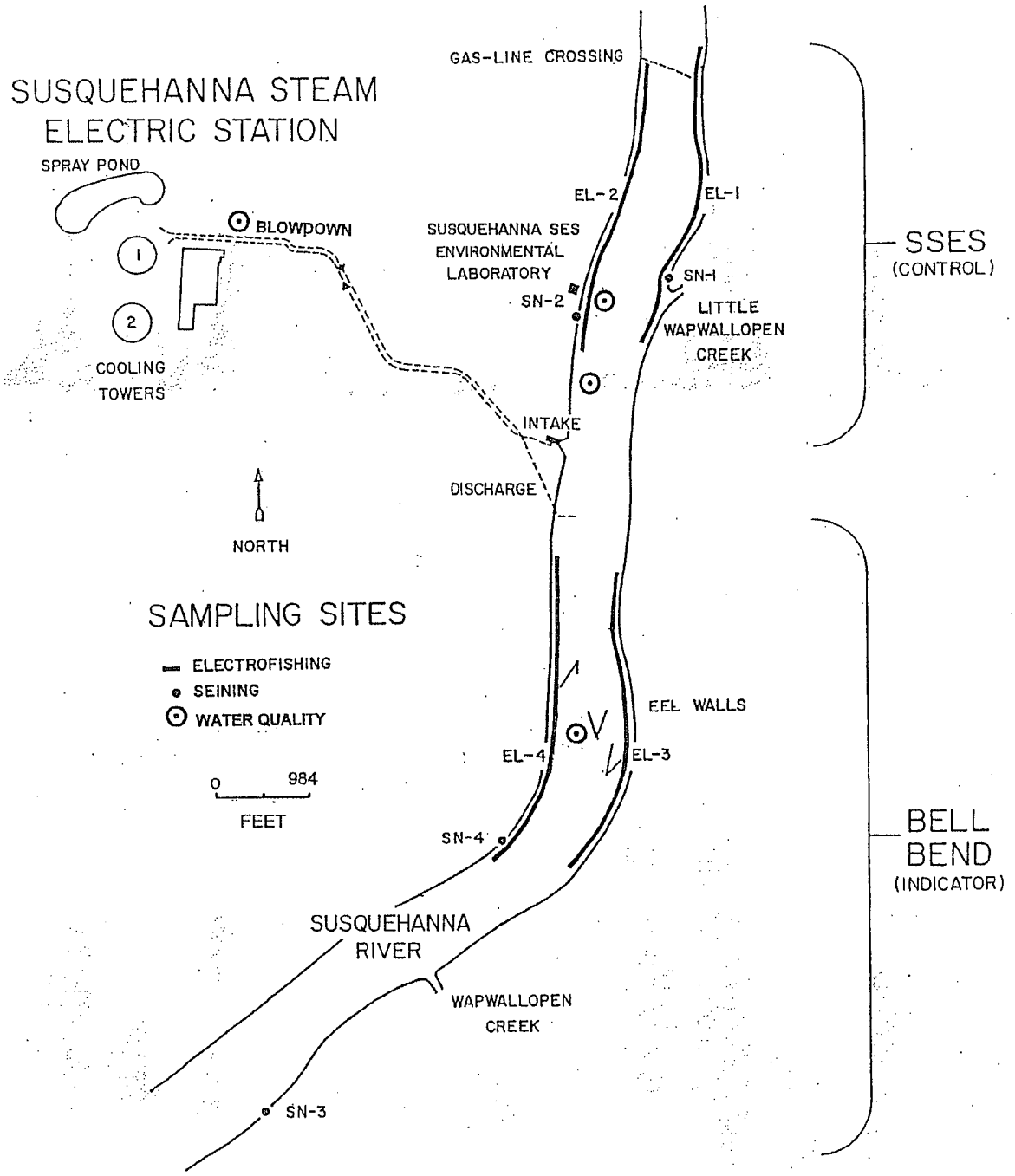


Fig. 1

Sampling sites for water quality, electrofishing (EL), and seining (SN) at SSES and Bell Bend on the Susquehanna River, 2010.

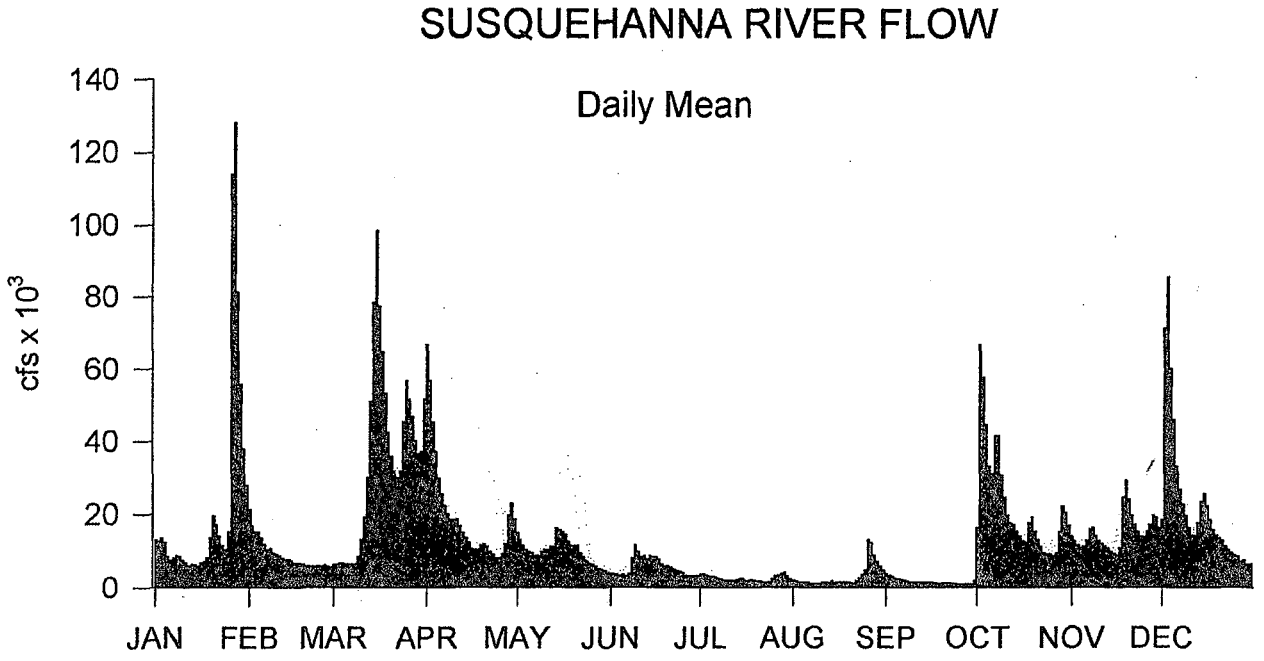


Fig. 2

The 2010 daily mean flow of the Susquehanna River at the Susquehanna SES Environmental Laboratory. The means were calculated from Environmental Laboratory data.

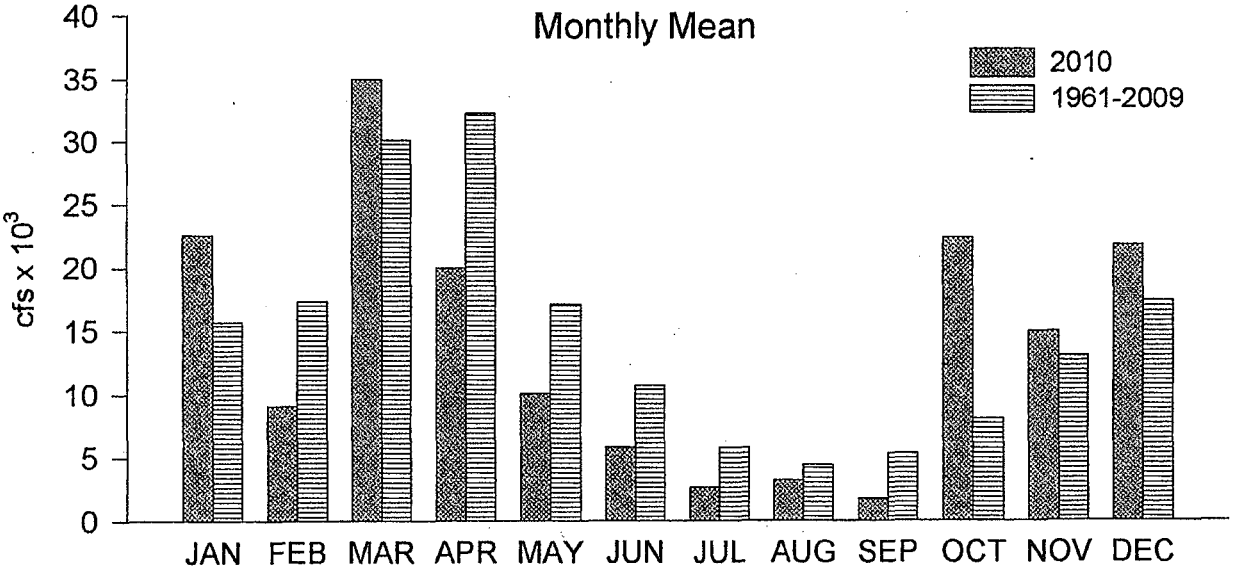


Fig. 3

The 2010 monthly mean flow of the Susquehanna River at the Susquehanna SES Environmental Laboratory compared to the 49-year (1961-2009) mean. The means were calculated from U.S. Geological Survey and Environmental Laboratory data.

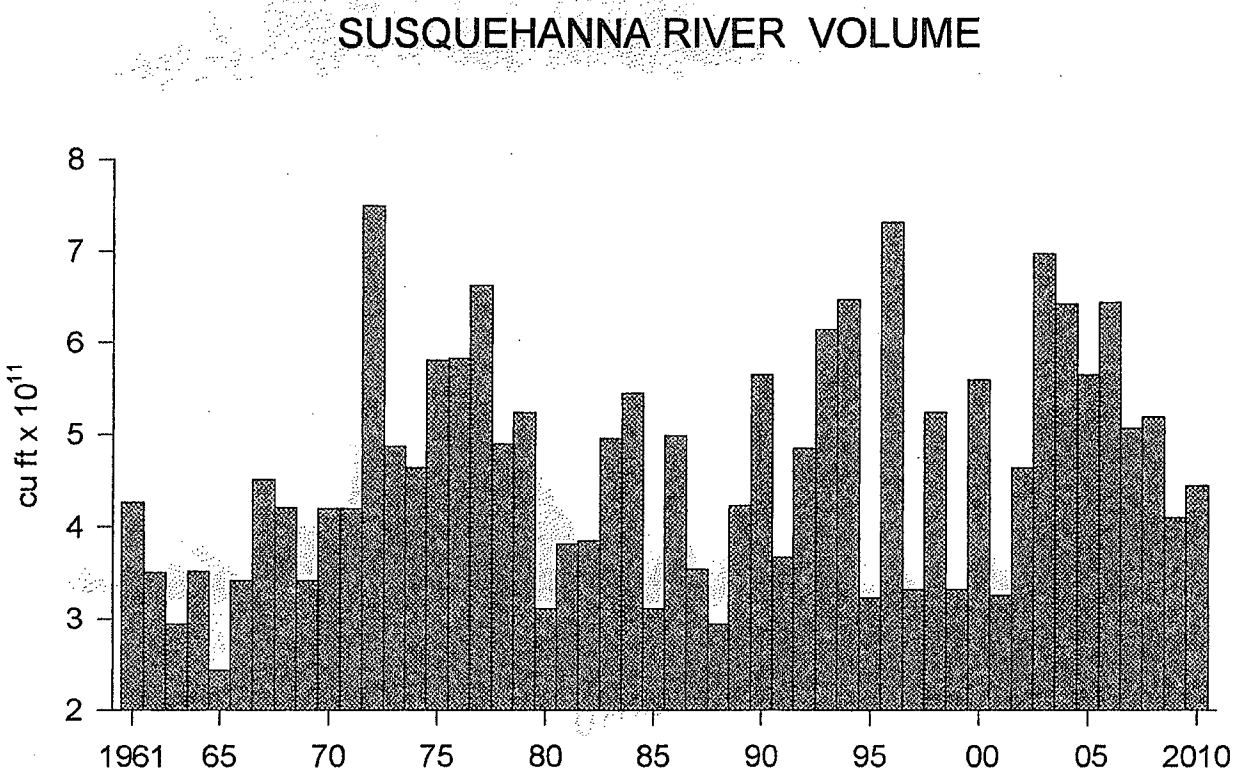


Fig. 4

Volume of Susquehanna River flow at the Susquehanna SES Environmental Laboratory, 1961-2010. The volumes were calculated from U.S. Geological Survey and Environmental Laboratory data.

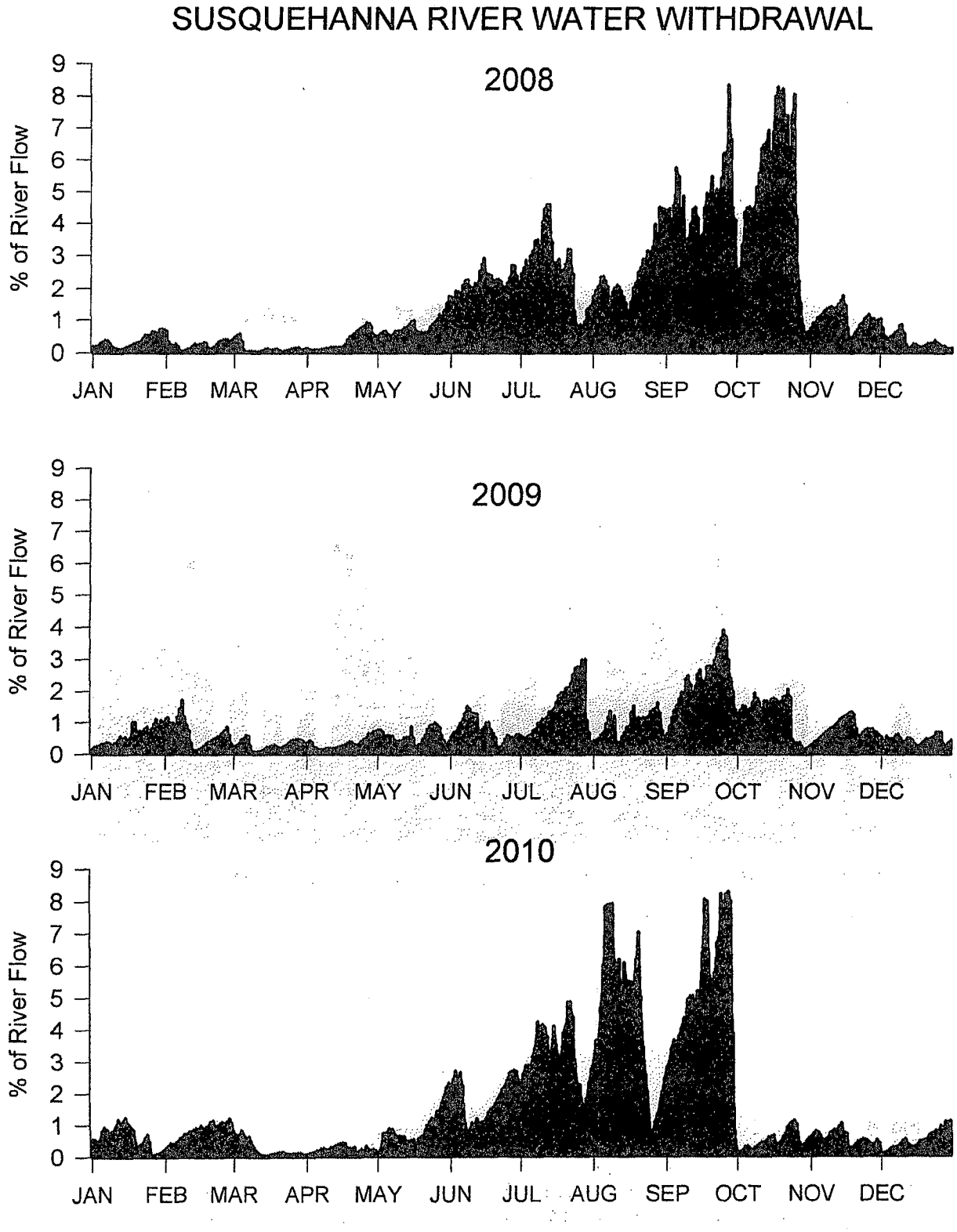


Fig. 5

Daily Susquehanna River water withdrawal by Susquehanna SES, 2008-2010.
Data provided by PPL Susquehanna, LLC personnel.

SUSQUEHANNA RIVER TEMPERATURE

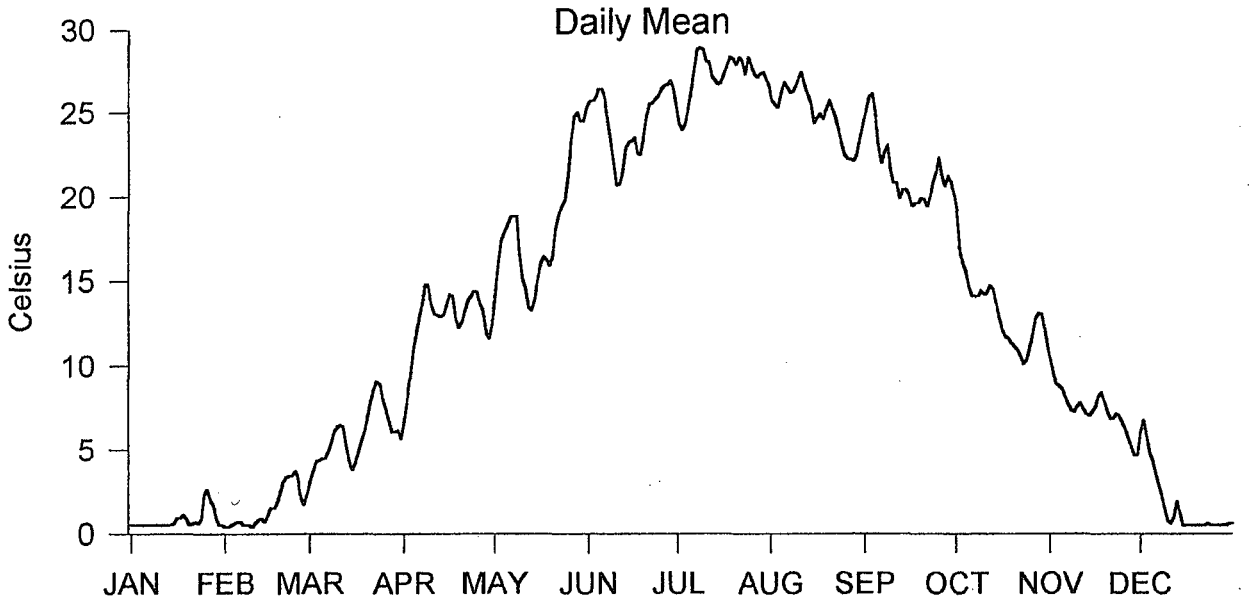


Fig. 6

The 2010 daily mean temperature of the Susquehanna River at the Susquehanna SES Environmental Laboratory.

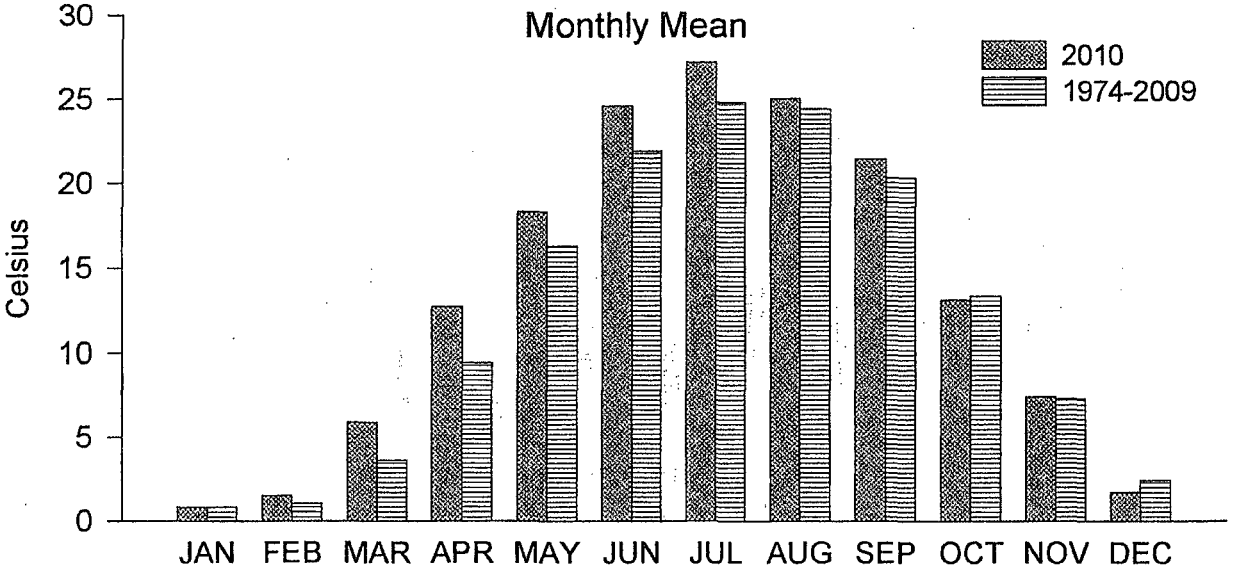
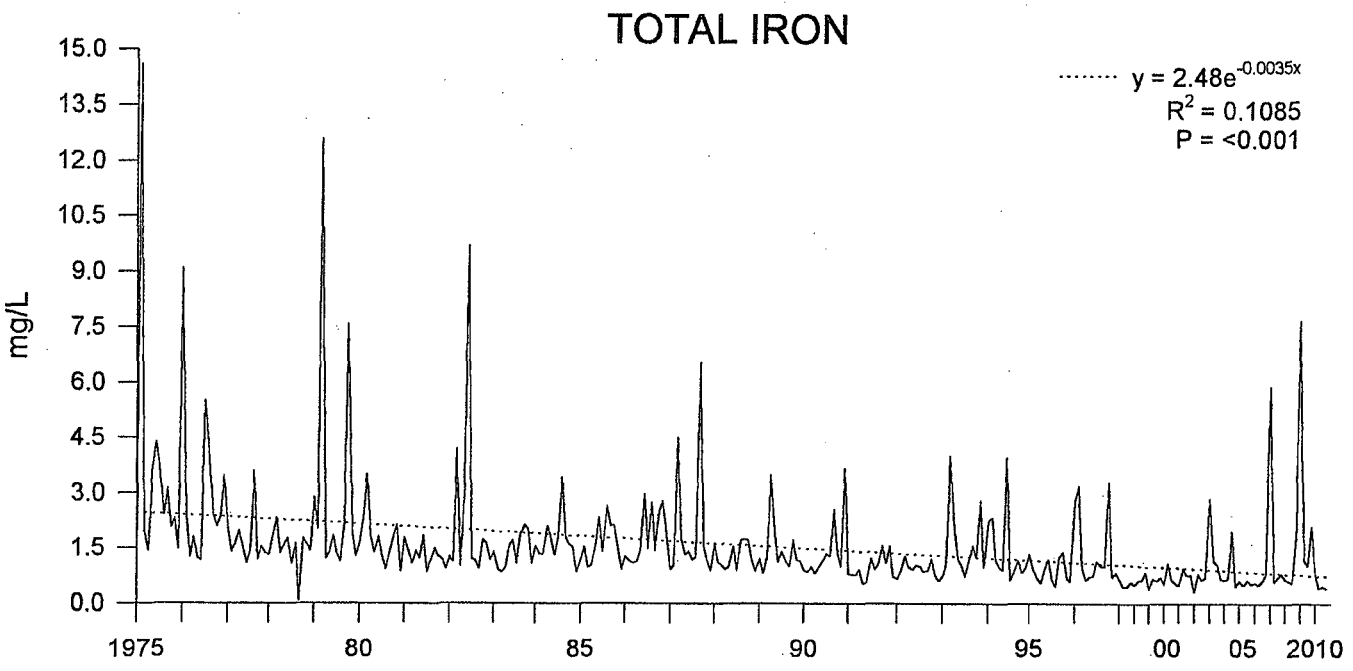


Fig. 7

The 2010 monthly mean temperature of the Susquehanna River at the Susquehanna SES Environmental Laboratory compared to the 36-year (1974-2009) mean.



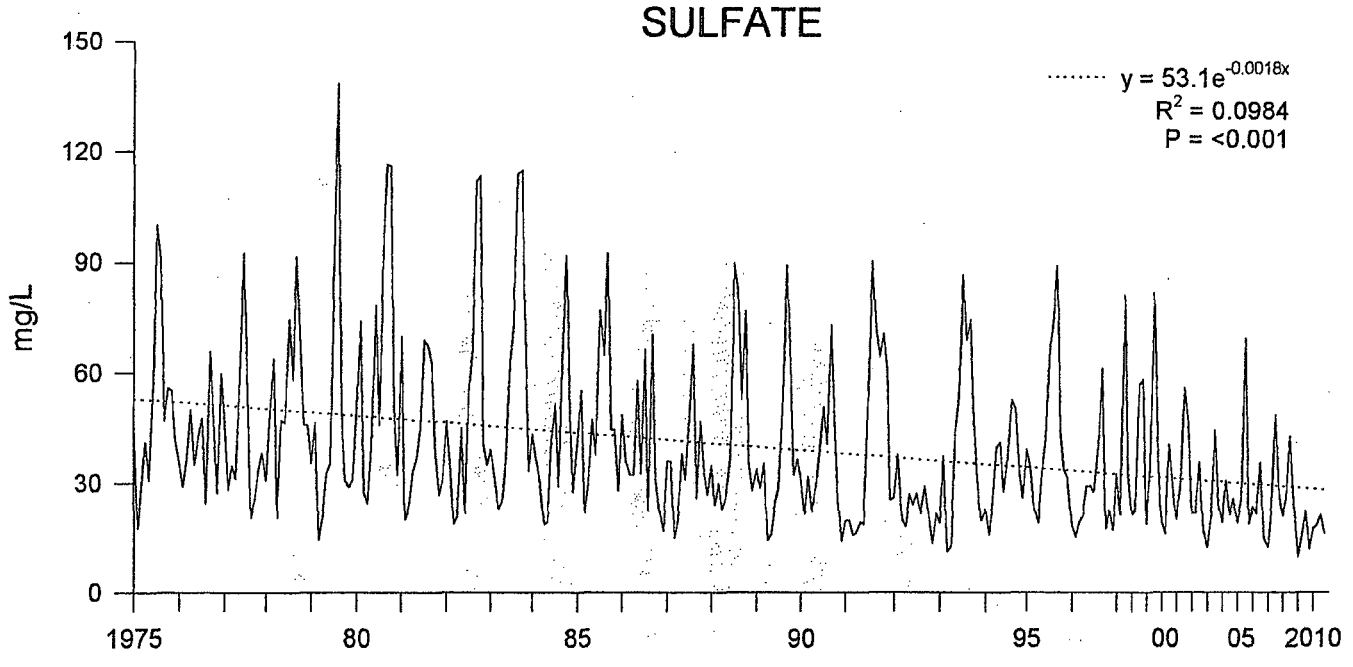


Fig. 8

Total iron and sulfate of the Susquehanna River at the SSES sampling site, 1975-2010. Samples were collected monthly 1975-1996 and quarterly 1997-2010. Analyses were performed by the PPL Chemical Laboratory, Hazleton, PA.

Enclosure 5

LU-15 - Professional Planning Analysis for PPL Bell Bend Nuclear Power Plant Conditional Use Application

PROFESSIONAL PLANNING ANALYSIS
FOR
PPL BELL BEND NUCLEAR POWER PLANT
CONDITIONAL USE APPLICATION

SALEM TOWNSHIP, LUZERNE COUNTY, PA

Document Number PPA – 001, Revision 0

MAY, 2012

PREPARED BY:

Timothy C. Cormany, AICP, Vice-President of Planning

martin and martin, incorporated

37 south main street • suite A • chambersburg, pennsylvania • 17201-2251

INTRODUCTION

PPL Bell Bend, LLC is proposing the construction of a nuclear power plant on property located in Salem Township, Luzerne County, Pennsylvania. The project site consists of approximately 2,055 acres, of which approximately 687 acres will be part of the new power plant construction. The subject property is currently zoned I-3, Special Industrial, wherein Electrical Power Generating Plants other than wind energy facilities are listed as a conditional use per Section 510.3.J. of the Salem Township Zoning Ordinance ("Zoning Ordinance"). The Zoning Ordinance was amended in 2011 via Ordinances 2011-02 and 2011-03, to create the I-3 district. The property is adjacent to the existing Susquehanna Steam Electric Station nuclear facility. It is bounded by a host of properties identified on the Conditional Use Application Plans ("The Plans"), prepared by Pennoni Associates, dated March 8, 2012, and submitted in support of this conditional use application. These adjacent properties fall within one of four zoning districts: Agricultural (A-1), Conservation (C-1), Special Industrial (I-3), or Highway Business (B-3). The proposed development site is also bounded by a number of roads including Salem Boulevard (U.S. 11), Market Street (T-436), Confers Lane (T-438), Beach Grove Road (T-419), Stone Church Road (T-483), and Thomas Road (T-435). The purpose of this report is to assess the application's planning consistency with the Township conditional use criteria established within its Zoning Ordinance.

I personally reviewed the following documents in support of this planning analysis:

- Conditional Use Application with Attachment A containing a list entitled "Property Owners for Bell Bend, LLC"; and with Attachment B containing a report entitled "Bell Bend Nuclear Power Plant Project – Overview", Document Number Con-Use-01, Revision 0, dated March 8, 2012, prepared by Pennoni Associates;

- A map entitled "Conditional Use Application Plans Properties Within 200'", Drawing Number 0200, Revision 0, dated March 8, 2012, prepared by Pennoni Associates;

- Plan set entitled "Conditional Use Application Plans", Drawing Numbers: CS1200-CS1204, CS1301-CS1335, all Revision 0, dated March 8, 2012, and prepared by Pennoni Associates;

- Environmental Impact Statement, Document Number EIS-000, Revision 0, dated March 8, 2012, prepared by Land Studies, Inc.;

- Report entitled "Traffic Impact Study related to the Proposed Construction and Operation of the Bell Bend Nuclear Power Plant, Preliminary Findings Report", Document Number 38-9085946-005, Revision 5, dated October 13, 2011, prepared by KLD Engineering, P.C.;

- Plan set entitled "Final Minor Subdivision, Lot Line Adjustment and Lot Consolidation Plans", Drawing Numbers CS7000-CS7005, all Revision 0, dated March 8, 2012, prepared by Pennoni Associates;

- Salem Township Zoning Ordinance (amended 2011);

- Salem Township Subdivision and Land Development Ordinance; and

- Salem Township Comprehensive Development Plan (1975), prepared by L. Robert Kimball.

I also performed a site investigation of the property and surrounding vicinity on December 14, 2011. Photographs from that site visit are included at the end of this report as Appendix A.

ORDINANCE 2011-02

This Ordinance is an amendment to the Salem Township Zoning Ordinance and Map, zoning the project site as I-3 Special Industrial.

ORDINANCE 2011-03

This Ordinance was adopted by the Township Board of Supervisors on February 8, 2011 and served to, among other things, establish the I-3 Special Industrial District within Salem Township. Section 510 of the Ordinance identifies the specific uses permitted by right, by special exception, or by conditional use therein. Electrical Power Generating Plants other than wind energy facilities are an identified conditional use per Section 510.3.J.

Article 8 of the Zoning Ordinance was amended to include Section 802.34, which identifies specific supplemental regulations applicable to Electrical Power Generating Plants other than wind energy facilities. Subsection A requires such uses to comply with all dimensional, use and operational requirements contained in any applicable operating permit or license issued by any federal or state agency. The applicant is in the process of seeking operating permits/licenses from the U.S. Nuclear Regulatory Commission (NRC) and the Pennsylvania Department of Environmental Protection (PADEP), among others. In consideration of the complexity of the proposed use, this is a process of significant length and detail and, as such, the need to acquire municipal conditional use approval precedes the securing of these federal and state permits/licenses. The applicant is aware of the need to ultimately comply in all aspects with all permits and licenses during construction and operation of the plant.

Subsection 802.34.B establishes dimensional regulations, unless more restrictive standards are applicable under any operating permit or license. These dimensional regulations include a minimum lot area of 10 acres and a minimum lot width of 500 feet. Per the Plans, the actual lot area within the I-3 district that is subject to this proposed development is 958.247 acres with a disturbed area of 696.693 acres. Also according to the Plans, the actual minimum lot width provided is 1,188 feet. Both of the minimum Township dimensional standards are exceeded by this proposal. Minimum building setbacks of a 75-foot front yard, a 50-foot rear yard, and 50-foot side yards are also established. Pursuant to the Plans, the closest building to the front property line is the Main Access Facility (Structure #T22) at a distance of 1,232 feet. With regard to side yards, the closest building to a side property line is the Potable Water Meter House (Structure #P11) at a distance of 74 feet. And finally, with regard to the rear yard, the closest building to a rear property line is a General Warehouse (Structure #P4) at a distance of 348 feet. This data confirms that the proposed development incorporates much greater setbacks than the prescribed minimum standards. Finally, a maximum lot coverage standard of 60% of the total lot area is established with respect to buildings or structures. A review of the total building area in comparison with the total lot area reveals that the proposed site will result in coverage of 2.3%, easily meeting the prescribed maximum coverage standard. Data concerning these specifics can be found on the Conditional Use Application Plans submitted to the Township in support of the application for approval of this project, prepared by Pennoni Associates, and dated March 8, 2012. In conclusion, the Township's dimensional zoning standards for minimum lot area, minimum lot width, minimum building setbacks, and maximum lot coverage are met, and in many instances far exceeded, by the proposed design.

Article 10 of the Township Zoning Ordinance was amended to include specific standards for off-street parking and off-street loading relative to Electrical Power Generating Plants other than wind energy facilities. The municipal standard of one space per each employee on the maximum working shift during normal operations equates to a minimum requirement of 400 parking spaces for this project. The proposed development will provide a total of 4,207 parking spaces. These spaces will be created for the construction phase. None of these spaces are proposed for elimination once construction is finalized and operations begin. This supply of parking facilities far exceeds the minimum standard prescribed by the Zoning Ordinance. Similarly, per Zoning Ordinance standards, sufficient loading and unloading spaces to allow for the safe loading and unloading of materials and supplies are provided throughout the site.

MISCELLANEOUS TOWNSHIP ZONING CRITERIA

Section 318 of the Township Zoning Ordinance establishes performance standards relative to all commercial and industrial land uses. Information regarding compliance with these standards can be found on the accompanying conditional use site plan, and in the Environmental Impact Statement submitted to the Township in support of the application for approval of this project, prepared by Land Studies, Inc., dated March 8, 2012, and its supporting documentation. Standards to be met include fire protection,

electrical disturbance, noise, smoke, air pollution, glare, erosion, and water discharge. In addition, each of these standards will be addressed through a myriad of other permitting processes including, but not limited to, NPDES permitting for erosion and sedimentation control, NRC operational permits, PADEP and USEPA environmental permits, and the establishment of detailed emergency preparedness plans and a Preparedness, Prevention and Contingency Plan.

Section 320 of the Zoning Ordinance requires that zoning approval for any use and/or development that includes the construction of a driveway onto a State or Township road, shall be conditioned upon the applicant securing a Highway Occupancy Permit from the applicable governing body or agency. This site access will be via a new driveway accessing one State Road (U.S. 11). Therefore, the applicant will comply with all applicable driveway and access permitting requirements per PennDOT regulations. A Traffic Impact Study, prepared by KLD Engineering, Inc., dated October 13, 2011, has also been prepared and accompanies this conditional use application. The study provides findings and solutions to the identified impacts that will be of vital importance as part of the aforementioned permitting process.

TOWNSHIP CONDITIONAL USE REQUIREMENTS

Article 6 of the Zoning Ordinance deals specifically with Conditional Use procedures and provisions. As part of the application process, a plan is required and must include, at a minimum, the elements listed in Section 603.A. Such plans were prepared by the project's civil engineer, Pennoni Associates, Inc., and have been designed to meet all of the criteria required for conditional use site plans. These plans were submitted as part of the overall application package to the Township (Conditional Use Application Plans, prepared by Pennoni Associates, dated March 8, 2012). Section 603.A also requires the submission of a Soil Erosion and Sedimentation Control Plan for review and approval by the Luzerne County Conservation District. The applicant has previously initiated this process via the NPDES permit application and the review process is underway. A copy of these materials has also been provided to Salem Township. Finally, the applicant must also submit a narrative outlining and fully describing all proposed uses or development of the site, along with all operational aspects, features and/or activities related to the proposed uses or development of the site. Said narrative was submitted as part of the overall conditional use application.

A number of general standards are applicable to all conditional use reviews within the Township per Section 604 of the Zoning Ordinance.

A. *The proposed use shall not jeopardize the "Community Development Objectives" of this Ordinance or the public health, safety and welfare.*

A series of 17 community development objectives are listed in Section 105 of the Township Zoning Ordinance. These objectives were developed to carry out the defined goals and objectives of the Township Comprehensive Plan. The proposed nuclear power plant is consistent with and furthers the stated objectives. While several of the objectives are simply not applicable to this specific conditional use application, others can certainly be highlighted as being a focus of the planning and development process for the facility.

Objectives C and D discuss environmental preservation efforts, impacts to groundwater resources and air quality, and attempts to avoid all forms of pollution. The applicant continues to work with a plethora of regulatory agencies through various review and permitting processes to ensure that the development will represent the utmost in environmental integrity.

Objective I encourages the enhancement of recreational systems. Ample considerations have been incorporated into the design process to preserve natural features, enhance open space, satisfactorily mitigate any unavoidable impacts, and to improve and restore the North Branch Canal and its associated trail system.

Objective J promotes an adequate transportation system and the safe movement of people and goods within the Township. The associated Traffic Impact Study submitted as part of this application was developed in an effort to satisfy all affected agencies that a comprehensive strategy is in place to deal with the impacts of additional traffic volumes during both the construction and operation phases of the proposed facility.

Objective K encourages new industrial development in selected areas according to the market needs of the region. The proposed PPL Bell Bend nuclear power plant qualifies as such a development and, based on economic research more fully detailed in the accompanying Economic Impact Study, will generate significant tax revenue and employment opportunities for both the Township and the region while simultaneously filling a market need for the production of affordable and efficient electricity.

Objectives L and M concern ensuring the proper design for storm water management, erosion and sedimentation control, and floodplain management. Each of these design elements has been a focus of the project engineers in preparation of the site plans accompanying this application and as part of the NPDES permitting process currently underway through the Conservation District and PADEP. In addition, the Federal Emergency Management Agency (FEMA) is part of the floodplain review via the Conditional Letter of Map Revision (CLOMR) permitting process.

B. Public services and facilities such as streets, sewage disposal, water, police and fire protection shall be adequate for the proposed use.

The applicant has prepared a Traffic Impact Study demonstrating the manner in which the project will be designed to ensure the continued adequacy of the region's street network. Additionally, the local water and sewer authorities, Pennsylvania American Water Company and the Berwick Area Joint Sewer Authority, have indicated their ability to serve the project's needs. Some water needs for the plant's cooling and operation purposes will come from a water withdrawal from the Susquehanna River. This withdrawal will be permitted through the Susquehanna River Basin Commission. Finally, the applicant will work very closely with local emergency responders and Federal and State regulatory agencies to ensure that services and protection are coordinated to ensure the safest environment possible. Emergency preparedness plans will be an important resource in the planning and operation of this large-scale regional facility.

C. Existing and future streets and access to the site shall be adequate for emergency services, for avoiding undue congestion, and for providing for the safety and convenience of pedestrian and vehicular traffic.

Per the project's Traffic Impact Study, every effort is being made to design the proposed facility in a way that provides for the highest degree of traffic adequacy in terms of emergency services, safety, convenience and the avoidance of congestion. The applicant will also reach out to educate and satisfy local emergency service providers as preparedness plans are developed to ensure the adequacy of emergency access.

D. The relationship of the proposed use to other activities existing or planned in the vicinity shall be harmonious in terms of location and size relative to the proposed operation and the nature and intensity of the operation involved.

The proximity of the proposed PPL Bell Bend nuclear power plant to the existing Susquehanna Steam Electric Station nuclear facility provides an unparalleled sense of harmony in terms of location, size, nature and intensity of operations. With respect to other surrounding uses, both existing and planned, the immediate vicinity is primarily limited to farmland, forest, and a few scattered single-family residences. The section of property dedicated to access along Salem Boulevard (U.S. 11) is an area populated by a mix of single-family homes and a few small businesses. The properties subject to the proposed development were rezoned by the Township Board of Supervisors to the new I-3, Special Industrial district in 2011 following months of discussion, deliberation and public hearings. These same issues of land use consistency were of paramount importance at that time as well. Therefore, it is my professional opinion that the relationship of the proposed use to other activities in the vicinity will prove harmonious in terms of location and size relative to the proposed operation and the nature and intensity of the operation involved.

E. *The relationship of the proposed use to other activities existing or planned in the vicinity shall be harmonious in terms of the character and height of buildings, walls and fences, so that the use, development and value of adjacent property is not impaired.*

The uses noted in the preceding paragraph will not be adversely affected by the proposed use in terms of use, development or value of their respective properties. The presence of the existing Susquehanna Steam Electric Station nuclear facility has previously set a standard for the character and height of site features, which will remain unchanged by this development. The subject site was also part of an extensive Township rezoning effort in 2011 that considered similar factors in its evolution. Through a thorough and well-planned process, the successful development of this site will not impact neighboring properties in any negative fashion and will ultimately provide significant benefits to the vicinity and the region at large. Therefore, it is my professional opinion that the relationship of the proposed use to other activities in the vicinity will also prove harmonious in terms of the character and height of buildings, wall and fences, so that the use, development and value of adjacent properties is not impaired.

F. *The proposed use shall not be more objectionable in its operation in terms of noise, fumes, gases, smoke, vapors, heat, glare, odors, vibration, lighting or electrical disturbances than would be the operations of any permitted use in the district.*

The proposed use will be subject to a host of environmental regulations and permits to address all of these operational concerns. In addition, the use will be subject to the same performance standards, the same level of scrutiny, and the same responsibility as all other uses within the I-3 district and the Township. Finally, the proposed facility can be expected to exhibit many of the same operational characteristics as the neighboring Susquehanna Steam Electric Station facility. The Environmental Impact Statement, as well as its supporting documentation, addresses many of these issues in greater detail.

G. *The submission of any reports and/or studies within the context of the definition "Impact Analysis" as defined within Article 2 of this Ordinance, which conclusively demonstrates that the proposed use or development will not have a negative impact upon the particular subject or subjects as defined by the Board of Supervisors. In their review of an Impact Analysis, the Board of Supervisors shall have the discretion to retain the services of firms or agencies which have expertise within the subject or subject s addressed therein. All fees and costs incurred for such consultation shall be paid by the applicant.*

As defined in the Zoning Ordinance, an "Impact Analysis" may be required at the discretion of the Board of Supervisors prior to conditional use approval to determine the potential impact of the proposed use on activities, utilities, traffic generation and circulation, surrounding land uses, community facilities, environmental features,

critical areas, the public health, safety and welfare, and other factors directly, indirectly or potentially affected. This application is supported by a comprehensive series of reports including this professional planning report along with a traffic impact study, civil engineer's report, environmental report, economic impact study, environmental impact statement, and detailed site plan. The pertinent issues of Section 604.G. have been addressed therein.

H. Any other reasonable conditions and safeguards, in addition to those expressed in this Ordinance, may be imposed by the Board of Supervisors in the interest of protecting the health, safety and welfare of the public.

The applicant is prepared to discuss any such reasonable conditions and safeguards with the Board during the conditional use process.

Section 606 requires submission of an Environmental Impact Statement in accordance with specific report criteria. Accompanying the application is such a report entitled "Environmental Impact Statement", prepared by Land Studies, Inc., dated March 8, 2012, that addresses each of the required elements and includes a detailed section concerning impacts and proposed mitigation.

SALEM TOWNSHIP COMPREHENSIVE PLAN

The Salem Township Comprehensive Development Plan was prepared in 1975 and adopted in 1976 by the Board of Supervisors. Municipalities are generally required to update their comprehensive plans once every ten years. Therefore, the 36-year age of the document doesn't allow for a tremendous degree of consistency or insight with regard to recent trends and emerging issues. In reviewing this plan for its applicability to the proposed conditional use, we did find several references to the planned nuclear facility that later became operational as the Susquehanna Steam Electric Station in 1983. Therefore, much of the Township's long-range planning was done without benefit of a full realization of the plant's impacts on the community. The Future Land Use Plan discusses how no additional industrial uses are shown on the Proposed Land Use Map due to the sizable acreage that the PPL power plant site will utilize upon its completion. It is also noted from a land use perspective that land uses in the agricultural and conservation categories, which are the primary adjoiners to the proposed conditional use site, "will also form natural open space buffers zones between conflicting land uses." This statement still rings true today in terms of the high value placed on maintaining natural buffers to reduce the impacts of land use incompatibility.

From a strict interpretation of the Comprehensive Plan and its relationship to this conditional use application, it is difficult to find many common threads between 1975 and 2012. However, understanding the nature of recent zoning amendments within the Township, and that these actions also reflect amendments to the Township's planning identity, it becomes apparent that Salem Township has utilized vehicles other than its comprehensive plan to perpetuate an evolving philosophy with respect to municipal land use planning and a changing Township landscape.

SUMMARY

My review of the available data indicates that the proposed PPL Bell Bend nuclear power plant meets all of the required conditional use criteria established by Salem Township within its Zoning Ordinance. The use is permitted as designed in the I-3 Special Industrial district pending the results of all outside agency permitting and Township subdivision and land development plan approval. The application's various reports and detailed site plan provide a glimpse of the herculean efforts associated with responsibly designing and permitting a facility of such size and significance. Steps have been taken to identify the extent of any and all perceived impacts and to provide sound strategies to mitigate the same. The areas of study include site engineering, land use planning, utilities, storm water management, erosion and sedimentation control, transportation, economics, the environment, community facilities and emergency services. It is my professional opinion that the granting of conditional use approval is warranted based upon the information provided in this application.