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November 30, 2009

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

BELL BEND NUCLEAR POWER PLANT RESPONSE TO ENVIRONMENTAL REQUESTS FOR ADDITIONAL INFORMATION, SEVENTH SUBMITTAL
BNP-2009-342 Docket No. 52-039

References: 1) Letter from U.S. NRC Document Control Desk to R.R. Sgarro (PPL), "Requests for Additional Information Related to the Environmental Review for the Combined License Application for Bell Bend Nuclear Power Plant," dated July 10, 2009

The purpose of this letter is to respond to several Environmental Report (ER) requests for additional information (RAIs) identified in the referenced NRC correspondence to PPL Bell Bend, LLC. These RAIs address environmental issues, as discussed in Part 3 of the Bell Bend Nuclear Power Plant Combined License Application (COLA).

Enclosure 1 provides the current ER RAI response status, the planned submittal dates for the remaining responses, and a page index of responses in Enclosure 2. The planned submittal date for some of the RAIs has been changed as compared to the schedule provided in PPL letter BNP-2009-313, dated October 19, 2009. These RAIs are identified with a footnote in Enclosure 1. Since PPL letter BNP-2009-313 was submitted, PPL Bell Bend has investigated the potential to re-locate the physical siting of the Nuclear Island, Turbine Island, supporting buildings and structures within the PPL-owned property area. The majority of the items listed with a planned submittal date of January 15, 2010 (in Enclosure 1) have been identified as impacted by the abovementioned plot plan change. PPL plans to update the NRC staff on the schedule for these items by January 15, 2010.

PPL plans to transmit a series of responses to the RAIs on or before the planned submittal dates provided in Enclosure 1. The planned submittal schedule is subject to change as PPL collects/develops the information required for the responses. PPL will keep the NRC staff informed of schedule changes during our periodic status updates in addition to updates in our subsequent submittals. Enclosure 2 provides responses to 17 RAIs. Several RAIs include revised COLA content. A Licensing Basis Document

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Change Request has been initiated to incorporate these changes in a future revision of the COLA.

The first commitment contained in this submittal is the future revision of the COLA as indicated in Enclosure 2. The second commitment contained in this submittal is implementation of cultural resources protection measures as outlined in the RAI CR 2.5-7 response.

Additional enclosures contain the following information:

3) RAI AE 9.3-1 and RAI CR 2.5-8 – Montour Site information
4) RAI CR 2.5-7 – PPL Susquehanna Cultural Resources Plan
5) RAI H 5.3-1 – 1987 SSES Thermal Plume Study
6) RAI H 5.3-1 – 2008 SSES Thermal Plume Study
7) RAI H 5.3-1 – GEMSS Input files
8) RAI H 5.3-1 – USACE Bathymetry files
9) RAI H 5.3-1 – USACE Bathymetry files transmittal letter
10) RAI H 5.3-1 – Ecological study report
11) RAI H 5.3-1 – Sargent and Lundy report 2008-06824.

If you have any questions, please contact the undersigned at 570-802-8102.

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

Executed on November 30, 2009

Respectfully,

Rocco R. Sgarro

RRS/kw

Enclosures:

1) Response Status for Environmental Requests for Additional Information, Bell Bend Nuclear Power Plant, Luzerne County Pennsylvania

2) Responses to Environmental Requests for Additional Information, Bell Bend Nuclear Power Plant, Luzerne County Pennsylvania

3) RAI AE 9.3-1 and RAI CR 2.5-8, EDR Montour Site Inquiry, Bell Bend Nuclear Power Plant, Luzerne County Pennsylvania

4) RAI CR 2.5-7, PPL Susquehanna Cultural Resources Protection Plan, Bell Bend Nuclear Power Plant, Luzerne County Pennsylvania

5) RAI H 5.3-1, SSES Thermal Plume Study, 1987, Bell Bend Nuclear Power Plant, Luzerne County Pennsylvania

6) RAI H 5.3-1, SSES Thermal Plume Study, 2008, Bell Bend Nuclear Power Plant, Luzerne County Pennsylvania

7) RAI H 5.3-1 - GEMSS Input Files, Bell Bend Nuclear Power Plant, Luzerne County Pennsylvania (Compact Disc)

8) RAI H 5.3-1 – USACE Bathymetry Files, Bell Bend Nuclear Power Plant, Luzerne County Pennsylvania (Compact Disc)

9) RAI H 5.3-1 – USACE Bathymetry Files Transmittal Letter, Bell Bend Nuclear Power Plant, Luzerne County Pennsylvania

10) RAI H 5.3-1 – Ichthyological Associates Ecological Studies, 1984, Bell Bend Nuclear Power Plant, Luzerne County Pennsylvania

11) RAI H 5.3-1 – Sargent and Lundy Report 2008-06824, Bell Bend Nuclear Power Plant, Luzerne County Pennsylvania

cc: Mr. Samuel J. Collins
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Enclosure 1

Response Status for Environmental Requests for Additional Information
Bell Bend Nuclear Power Plant
Luzerne County Pennsylvania

NRC Response Status for Environmental Requests for Additional Information (RAIs)		
RAI	**Review Plan Section**	**Planned Submittal Schedule**
ACC 7.1-1	ESRP 7.1 10	Submitted August 10, 2009
ACC 7.1-2	ESRP 7.1	Submitted August 5, 2009
ACC 7.2-1	ESRP 7.2	Submitted August 10, 2009
ACC 7.2-2	ESRP 7.2	Submitted August 10, 2009
ACC 7.2-3	ESRP 7.2	Submitted August 10, 2009
ACC 7.2-4	ESRP 7.2	Submitted August 10, 2009
ACC 7.2-5	ESRP 7.2	Submitted August 10, 2009
ACC 7.2-5, (revised response)	ESRP 7.2	Submitted October 19, 2009
ACC 7.2-6	ESRP 7.2	Submitted August 10, 2009
ACC 7.3-1	ESRP 7.3	Submitted September 17, 2009
ACC 7.3-2	ESRP 7.3	Submitted August 10, 2009
ACC 7.3-3	N/A	Submitted August 10, 2009
ACC 7.3-4	N/A	Submitted September 25, 2009
ACC 7.3-5	N/A	Submitted August 10, 2009
MET 2.7-1	ESRP 2.7	January 15, 2010[1,2]
MET 2.7-2	ESRP 2.7	Included in Enclosure 2
MET 2.7-3	ESRP 2.7	Submitted September 11, 2009
MET 2.7-4	ESRP 2.7	Submitted September 17, 2009
MET 5.3-1	ESRP 2.7, ESRP 5.3.3.1	Included in Enclosure 2
MET 5.3-2	ESRP 2.7, ESRP 5.3.3.1	Submitted August 10, 2009
MET 5.3-3	ESRP 5.3.3.1	Submitted August 10, 2009
MET 5.3-4	ESRP 5.3.3.1	Submitted September 11, 2009
MET 5.3-5	ESRP 5.3.3.1	Submitted August 10, 2009
MET 6.4-1	ESRP 2.7, ESRP 6.4	Submitted September 17, 2009
MET 6.4-2	ESRP 6.4	Submitted September 17, 2009
ALT 9.3-1	ESRP 9.3	Included in Enclosure 2
ALT 9.3-2	ESRP 9.3	Submitted October 19, 2009
ALT 9.3-3	ESRP 9.3	Submitted September 11, 2009
ALT 9.3-4	ESRP 9.3	Submitted September 25, 2009
ALT 9.3-5	ESRP 9.3	Included in Enclosure 2
AE 2.3-1	ESRP 2.3.1	Submitted October 19, 2009
AE 2.3-2	ESRP 2.3.1	Submitted August 5, 2009
AE 2.3-3	ESRP 2.3.1	Submitted September 25, 2009
AE 2.4-1	ESRP 2.4.2	Submitted August 5, 2009
AE 2.4-2	ESRP 2.4.2	Submitted August 5, 2009
AE 2.4-3	ESRP 2.4.2	Submitted August 5, 2009
AE 2.4-4	ESRP 2.4.2	Submitted August 5, 2009
AE 2.4-5	ESRP 2.4.2	Submitted August 5, 2009
AE 3.4-1	ESRP 3.4.2	Submitted August 10, 2009
AE 3.4-2	ESRP 3.4.2	Included in Enclosure 2
AE 3.4-3	ESRP 3.4.2	Submitted August 10, 2009
AE 3.4-4	ESRP 3.4.2	Submitted August 10, 2009
AE 4.3-1	ESRP 4.3.2	Submitted August 5, 2009
AE 4.3-2	ESRP 4.3.2	January 15, 2010[1]
AE 4.3-3	ESRP 4.3.2	Submitted October 19, 2009
AE 4.3-4	ESRP 4.3.2	Included in Enclosure 2
AE 5.3-1	ESRP 5.3.1.2	Submitted August 10, 2009
AE 5.3-2	ESRP 5.3.1.2	Submitted August 5, 2009
AE 9.3-1	ESRP 9.3	Included in Enclosure 2
AE 9.3-2	ESRP 9.3	Submitted September 17, 2009

NRC Response Status for Environmental RAIs (continued)		
RAI	**Review Plan Section**	**Planned Submittal Schedule**
AE 9.3-3	ESRP 9.3	Submitted September 17, 2009
AE 9.3-4	ESRP 9.3	Included in Enclosure 2
CR 2.5-1	ESRP 4.1.3, ESRP 5.1.3	Submitted August 10, 2009
CR 2.5-2	ESRP 4.1.3	Submitted August 10, 2009
CR 2.5-3	ESRP 4.1.3, ESRP 5.1.3	Submitted August 10, 2009
CR 2.5-4	ESRP 4.1.3, ESRP 5.1.3	Submitted August 10, 2009
CR 2.5-5	ESRP 2.5.2, ESRP 2.5.3	Submitted August 10, 2009
CR 2.5-6	ESRP 2.5.2, ESRP 2.5.3	January 15, 2010[1,2]
CR 2.5-7	ESRP 4.1.3, ESRP 5.1.3	Included in Enclosure 2
CR 2.5-8	ESRP 4.1.3, ESRP 5.1.3	Included in Enclosure 2
STO 1-1	N/A	Submitted October 19, 2009
STO 2.1-1	ESRP 2.2, 2.4, 2.5, 4.3	January 15, 2010[1,2]
STO 2.1-2	ESRP 2.1	Submitted August 10, 2009
STO 2.2-1	ESRP 2.2	Submitted September 17, 2009
STO 2.3-1	ESRP 2.3	Submitted September 25, 2009
GEO 2.6-1	ESRP 2.6	Submitted September 11, 2009
H 2.3-1	ESRP 2.3-2	Submitted September 17, 2009
H 2.3-2	ESRP 2.3-2	Submitted September 17, 2009
H 3.4-1	ESRP 3.4.1	Submitted September 25, 2009
H 3.6-1	ESRP 3.6.1	Submitted September 17, 2009
H 3.6-2	ESRP 3.6.1	Submitted August 5, 2009
H 4.2-1	ESRP 4.2.1	January 15, 2010[1,2]
H 5.2-1	ESRP 5.2.2	Submitted September 25, 2009
H 5.3-1	ESRP 5.3.2.1	Included in Enclosure 2
H 6.3-1	ESRP 6.3	Submitted October 19, 2009
H 9.3-1	ESRP 9.3	Included in Enclosure 2
H 9.4-1	ESRP 9.4.2	Submitted August 10, 2009
H 9.4-2	ESRP 9.4.2	Submitted August 10, 2009
H 9.4-3	ESRP 9.4.2	Submitted September 11, 2009
LU 2.2-1	ESRP 2.2.1	Submitted August 5, 2009
LU 3.7-1	ESRP 4.1	January 15, 2010[1]
LU 4.1-1	ESRP 4.1	January 15, 2010[1]
LU 5.1-1	ESRP 4.1	January 15, 2010[1]
LU 5.1-2	ESRP 4.1	January 15, 2010[1]
NRHH 10.5-1	N/A	Submitted August 10, 2009
RHH 4.5-1	ESRP 4.5, ESRP 5.4-2	Submitted August 10, 2009
RHH 4.5-2	ESRP 4.5	Submitted October 19, 2009
RHH 4.5-3	ESRP 4.5	Submitted September 25, 2009
RHH 5.4-1	ESRP 5.4.2	Submitted September 11, 2009
SE 2.5-1	ESRP 2.5.1	Submitted August 5, 2009
SE 2.5-2	ESRP 2.5.1	Included in Enclosure 2
SE 2.5-3	ESRP 2.5.2	Submitted October 19, 2009
SE 2.5-4	ESRP 2.5.2	Submitted October 19, 2009
SE 2.5-5	ESRP 2.5.2	Submitted August 10, 2009
SE 2.5-6	ESRP 2.5.2	Submitted August 5, 2009
SE 2.5-7	ESRP 2.5.2	Submitted October 19, 2009
SE 2.5-8	ESRP 2.5.2	Submitted October 19, 2009
SE 2.5-9	ESRP 2.5.2	Submitted September 11, 2009
SE 2.5-10	ESRP 2.5.4	Submitted September 17, 2009
SE 2.5-11	ESRP 2.5.4	Submitted August 10, 2009
SE 2.5-12	ESRP 2.5.4	Submitted August 10, 2009

NRC Response Status for Environmental RAIs (continued)		
RAI	**Review Plan Section**	**Planned Submittal Schedule**
SE 2.5-13	ESRP 2.5.4	Submitted September 17, 2009
SE 4.4-1	ESRP 4.4.1	Submitted August 10, 2009
SE 4.4-2	ESRP 4.4.1	Submitted August 10, 2009
SE 4.4-3	ESRP 4.4.2	Submitted September 25, 2009
SE 4.4-4	ESRP 4.4.2	Included in Enclosure 2
SE 4.4-5	ESRP 4.4.2	Submitted August 5, 2009
SE 4.4-6	ESRP 4.4.2	Submitted August 10, 2009
SE 4.4-7	ESRP 4.4.2	Submitted September 17, 2009
SE 4.4-8	ESRP 4.4.2	Submitted September 17, 2009
SE 4.4-9	ESRP 4.4.2	January 15, 2010[1,2]
SE 4.4-10	ESRP 4.4.2	Submitted September 17, 2009
SE 4.4-11	ESRP 4.4.2	Submitted October 19, 2009
SE 4.4-12	ESRP 4.4.2	Submitted September 25, 2009
SE 4.4-13	ESRP 4.4.2	Submitted October 19, 2009
SE 4.4-14	ESRP 4.4.3	Submitted September 17, 2009
SE 5.8-1	ESRP 5.8.2	Submitted September 17, 2009
SE 5.8-2	ESRP 5.8.2	Submitted August 5, 2009
CB 10.4-1	ESRP 10.4.2	January 15, 2010[1,2]
TE 2.4-1	ESRP 2.2.1	Submitted August 10, 2009
TE 2.4-1 (revised response)	ESRP 2.2.1	Submitted October 19, 2009
TE 2.4-2	ESRP 2.2.1	Submitted August 5, 2009
TE 2.4-3	ESRP 2.4.1	Submitted September 11, 2009
TE 2.4-4	ESRP 2.4.1	Submitted August 10, 2009
TE 2.4-5	ESRP 2.4.1	Submitted August 5, 2009
TE 2.4-5, (revised response)	ESRP 2.4.1	Submitted September 11, 2009
TE 2.4-6	ESRP 2.4.1	January 15, 2010[1]
TE 2.4-7	ESRP 2.4.1	January 15, 2010[1]
TE 2.4-8	ESRP 2.4.1	January 15, 2010[1]
TE 4.3-1	ESRP 4.3.1	January 15, 2010[1]
TE 4.3-2	ESRP 4.3.1	January 15, 2010[1]
TE 4.3-3	ESRP 4.3.1	Submitted September 11, 2009
TE 4.3-4	ESRP 4.3.1	January 15, 2010[1]
TE 4.3-5	ESRP 4.3.1	Submitted August 10, 2009
TE 4.3-6	ESRP 4.3.1	Submitted August 10, 2009
TE 4.3-7	ESRP 4.3.1, ESRP 9.3	January 15, 2010[1]
TE 4.3-8	ESRP 4.3.1	January 15, 2010[1]
TE 4.3-9	ESRP 4.3.1	Submitted September 25, 2009
TE 4.3-10	ESRP 4.3.1	January 15, 2010[1]
TR 4.7-1	ESRP 4.7	Submitted September 25, 2009
TR 4.7-2	ESRP 4.7	Submitted August 10, 2009

USACE Response Status for Environmental RAIs	
RAI	**Planned Submittal Schedule**
USACE-1	January 15, 2010[1,2]
USACE-1a	January 15, 2010[1,2]
USACE-1b	January 15, 2010[1,2]
USACE-2	January 15, 2010[1,2]
USACE-2a	January 15, 2010[1,2]
USACE-2b	Included in Enclosure 2
USACE-2c	Included in Enclosure 2
USACE-2d	Included in Enclosure 2
USACE-2e	January 15, 2010[1,2]
USACE-2f	January 15, 2010[1,2]
USACE-2g	Submitted September 25, 2009
USACE-2h	January 15, 2010[1,2]
USACE-3	January 15, 2010[1,2]

[1]The responses to these RAIs were requested to be provided within 30 calendar days. Based on vendor review and input, the time required to complete the necessary work will exceed this timeframe and PPL requests additional time, as indicated above.

[2]The planned submittal date for this RAI response has been revised since submittal of BNP-2009-313 on October 19, 2009.

Page Index of Responses	
RAI	Enclosure 2 Page
MET 2.7-2	2
MET 5.3-1	22
ALT 9.3-1	30
ALT 9.3-5	31
AE 3.4-2	34
AE 4.3-4	55
AE 9.3-1	69
AE 9.3-4	72
CR 2.5-7	77
CR 2.5-8	78
H 5.3-1	80
H 9.3-1	95
SE 2.5-2	96
SE 4.4-4	103
USACE-2b	104
USACE-2c	108
USACE-2d	117

Enclosure 2

Responses to Environmental Requests for Additional Information
Bell Bend Nuclear Power Plant
Luzerne County Pennsylvania

MET 2.7-2

Summary: *Provide the period of record for the data used to construct the windrose plots in the ER for Figures 2.7-89, 2.7-90, and Figures 2.7-91. Provide a comparison of the NWS windrose plots to the annual 10- and 60-meter windrose plots for SSES in Figures 2.7-55 and 2.7-72, respectively. Provide an explanation for the increased frequency of winds from the NNE and NE at SSES when compared to the NWS stations.*

Full Text: ESRP 2.7 directs staff to evaluate onsite meteorological data in context with other regional sites. In the ER, Figures 2.7-89 through 2.7 -91 are windrose plots from nearby National Weather Service (NWS) sites, but the years plotted and data sources are not identified. In addition, there are obvious differences between the NWS windroses and the 10-m and 60-m windrose plots for SSES (Figures 2.7-55 and 2.7-72, respectively). Specifically, there is an increased frequency of winds from the NNE and NE at SSES when compared to the NWS sites. Describe and explain why these differences might exist.

Response: The period of record for the data used to construct ER Figure 2.7-89 is: 1984-1987, 1989, 1991-1992.

The period of record for the data used to construct ER Figure 2.7-90 is: 1984-1992.

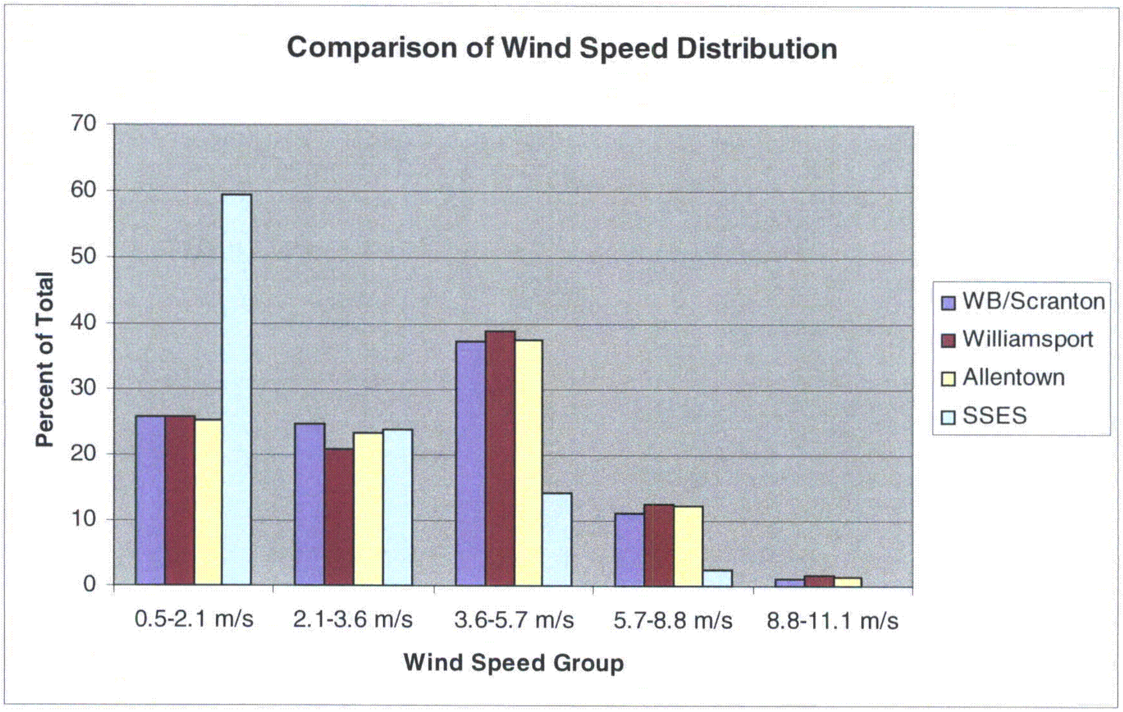
The period of record for the data used to construct ER Figure 2.7-91 is: 1984-1992.

Revised figures constructed using the same period of record as was used for the SSES wind rose plots (2001-2006) are presented below. For comparative purposes, a revised 10 meter wind rose for SSES, ER Figure 2.7-55, is presented below. The 60 meter wind rose is not used in the comparison since the NWS towers do not take measurements at that height.

The BBNPP site is located in the Ridge and Valley Region of Pennsylvania. The predominant southwest to northeast orientation of topographic ridge lines in the vicinity of the BBNPP site has a large influence on low level winds. The ridges and the Susquehanna River Valley funnel a localized, low level wind flow up or down the valley. This provides a common factor between the BBNPP site and the National Weather Service sites at Wilkes-Barre/Scranton and Williamsport. All three of these sites experience air flow predominantly along the ridges/river valley.

The SSES 10 meter annual wind rose and the Wilkes-Barre/Scranton and Williamsport annual wind roses indicate air flow up and down the river valley is a major component of the overall air flow. The flow at Allentown is channeled by the topography east of the airport that runs from the northeast to the southwest. The increased frequency of winds from the NNE and NE measured by the SSES tower (used for the pre-operational phase for BBNPP) are due to low-speed drainage flows down the river valley.

A graph comparing the wind speed group frequency distributions is shown below.



From the figure, it can be seen that there are more than twice as many low-wind speed events measured at SSES than at the three NWS sites as represented by the 0.5 to 2.1 m/s (1.1 to 4.7 mph) wind speed group. All four sites have comparable frequencies of the 2.1 to 3.6 m/s (4.7 to 8.1 mph) wind speed group. SSES measures less than half as many 3.6 to 5.7 m/s (8.1 to 12.8 mph) events and less than a third as many 5.7 to 8.8 m/s (12.8 to 19.7 mph) events as the three NWS sites. Finally, SSES measures less than a tenth as many 8.8 to 11.1 m/s (19.7 to 24.8 mph) events as the three NWS sites. This may be due to the differing goals of the measurement programs – atmospheric dispersion (low-wind speed events more important) versus general aviation (high-wind speed events more important).

The SSES primary meteorological tower is located at 650 feet above mean sea level. The Wilkes-Barre/Scranton tower is located 955 feet above mean sea level. The Williamsport tower is located 540 feet above mean sea level. The Allentown tower is located 375 feet above mean sea level.

The zero for the river gauge on the Susquehanna River in Wilkes-Barre is 535 feet above mean sea level; the zero for the river gauge in Williamsport is 496 feet above mean sea level. USGS topographic maps indicate the river height due west of the Wilkes-Barre/Scranton airport is 525 feet above mean sea level, the river height due east of the SSES meteorological tower is approximately 490 feet above mean sea level, and the river height due south of Williamsport airport is approximately 500 feet above mean sea level. The SSES and Williamsport towers are located close to the river; the Wilkes-Barre/Scranton and Allentown towers are not located close to the river.

The SSES tower measures more than twice as many low-wind speed events than the three NWS sites (mainly drainage flow down the river valley). And yet the Williamsport tower is located near the river with regard to both elevation and distance. That the Williamsport tower does not measure more (non-calm) low-wind speed events than the other two NWS sites would seem to lend credence to the idea that differences in wind speed group frequencies may be attributable to instrument differences due to the differing goals of the measurement programs.

COLA Impact:
BBNPP COLA FSAR Sections 2.3.2.1.1 will be revised, and FSAR figures 2.3-34, 2.3-35, and 2.3-36 will be revised, as follows, in a future revision of the COLA:

2.3.2.1.1 Wind Speed and Direction

Figure 2.3-34 through Figure 2.3-36 present multi-year average annual wind rose plots for National Weather Service (NWS) stations around BBNPP (Wilkes-Barre/Scranton, Allentown, and Williamsport, Pennsylvania). Meteorological data used to create the plots were received from the U.S. National Climatic Data Center ~~Environmental Protection Agency Support Center for Regulatory Air Models~~ and were measured at approximately 33 ft (10 m) above ground level. ~~For Wilkes-Barre/Scranton, the meteorological data were from 1984 through 1987, 1989, 1991 and 1992.~~ For all three stations ~~Allentown and Williamsport~~, the meteorological data were from 2001 through 2006 ~~1984 through 1992~~.

The annual prevailing wind direction (the direction from which the wind blows most often) at the SSES site at the 33 ft (10 m) level is from the east-northeast, approximately 15% of the time (Table 2.3-30). This is due primarily to low-speed drainage flows down the Susquehanna River Valley. The next most prevalent wind direction is from the southwest approximately 11% of the time. Winds from the north-northeast through east-northeast sectors occur approximately 32% of the time. Conversely, winds from the west through northwest sectors occur approximately 9% of the time. The annual prevailing wind direction at the SSES site at the 197 ft (60 m) level is from the north-northeast, approximately 15% of the time (Table 2.3-31). The next most prevalent wind direction is from the southwest approximately 12% of the time. Winds from the north through northeast sectors occur approximately 32% of the time. Conversely, winds from the east through southeast sectors occur approximately 10% of the time. As is normally the case, there are more observations of calm winds at the lower level than at the higher level (0.05% versus 0.01%). At both levels, winds occur most infrequently from the west-northwest (approximately 2% of the time).

The annual prevailing wind direction at Wilkes-Barre/Scranton, Pennsylvania, is from the southwest, approximately 13% of the time (Figure 2.3-34). At Allentown, Pennsylvania, the annual prevailing wind direction is from the west-southwest, approximately 13.5% ~~10%~~ of the time (Figure 2.3-35). At Williamsport, Pennsylvania, the annual prevailing wind direction is from the west, approximately 24% ~~12%~~ of the time (Figure 2.3-36).

During the winter season, the prevailing wind direction at the 33 ft (10 m) level at SSES is from the southwest, approximately 12% (Table 2.3-32). The prevailing wind direction at the 197 ft (60 m) level at SSES is from the west-southwest, approximately 16% (Table 2.3-36). During the spring season, the prevailing wind direction at the 33 ft (10 m) level is from the east-northeast, approximately 12% of the time (Table 2.3-33). The prevailing wind direction at the 197 ft (60 m) level at SSES is from the north-northeast, approximately 14% (Table 2.3-37).

During the summer season, the prevailing wind direction at the 33 ft (10 m) level at SSES is from the east-northeast, approximately 18% of the time (Table 2.3-34). The prevailing wind direction at the 197 ft (60 m) level at SSES is from the north-northeast, approximately 18% (Table 2.3-38). During the autumn season, the prevailing wind direction at the 33 ft (10 m) level is from the east-northeast, approximately 17% of the time (Table 2.3-35). At the 197 ft (60 m) level, the prevailing wind direction is from the north-northeast, approximately 18% (Table 2.3-39).

The most prevalent wind speed class at SSES on an annual basis for the 33 ft (10 m) level is the 0.5-1.0 mps (1.1-2.2 mph) class, which occurs approximately 27% of the time (Table 2.3-30). The most prevalent wind speed class on an annual basis for the 197 ft (60 m) level is the 2.1-3.0 mps (4.7-6.7 mph) class, which occurs approximately 19% of the time (Table 2.3-31). ~~Note that there are more observations of calm winds at the three NWS sites than at SSES. This may be due to:~~

- ~~The use of different wind measurement instruments due to the different needs at the sites. The NWS sites are at airports, where high wind speeds are more important than low wind speeds since they have a greater impact on aviation. At SSES, wind measurements are made to determine atmospheric dispersion to aid in dose assessment; therefore, low wind speeds are more important since they will lead to less dispersion and higher dose.~~

The average wind speed at Wilkes-Barre/Scranton, Pennsylvania, is 3.72 mps (8.3 mph) ~~3.67 mps (8.2 mph)~~ and there have been observations of wind speeds up to 11 mps (25 mph) (Figure 2.3-34). At Allentown, Pennsylvania, the average wind speed is 3.79 mps (8.5 mph) ~~3.92 (8.8 mph)~~ and there have been observations of wind speeds greater than 11 mps (25 mph) (Figure 2.3-35). At Williamsport, Pennsylvania, the average wind speed is 3.87 mps (8.7 mph) ~~3.44 (7.7 mph)~~ and there have been observations of wind speeds greater than 11 mps (25 mph) (Figure 2.3-36). Note that the most prevalent wind speed class on an annual basis for the 10-meter (33-feet) level at SSES (0.5-1.0 mps (1.1-2.2 mph)) is lower than the average annual wind speeds at the same measurement height for these three NWS stations; this would lead to more conservative atmospheric dispersion estimates using the SSES onsite meteorological data.

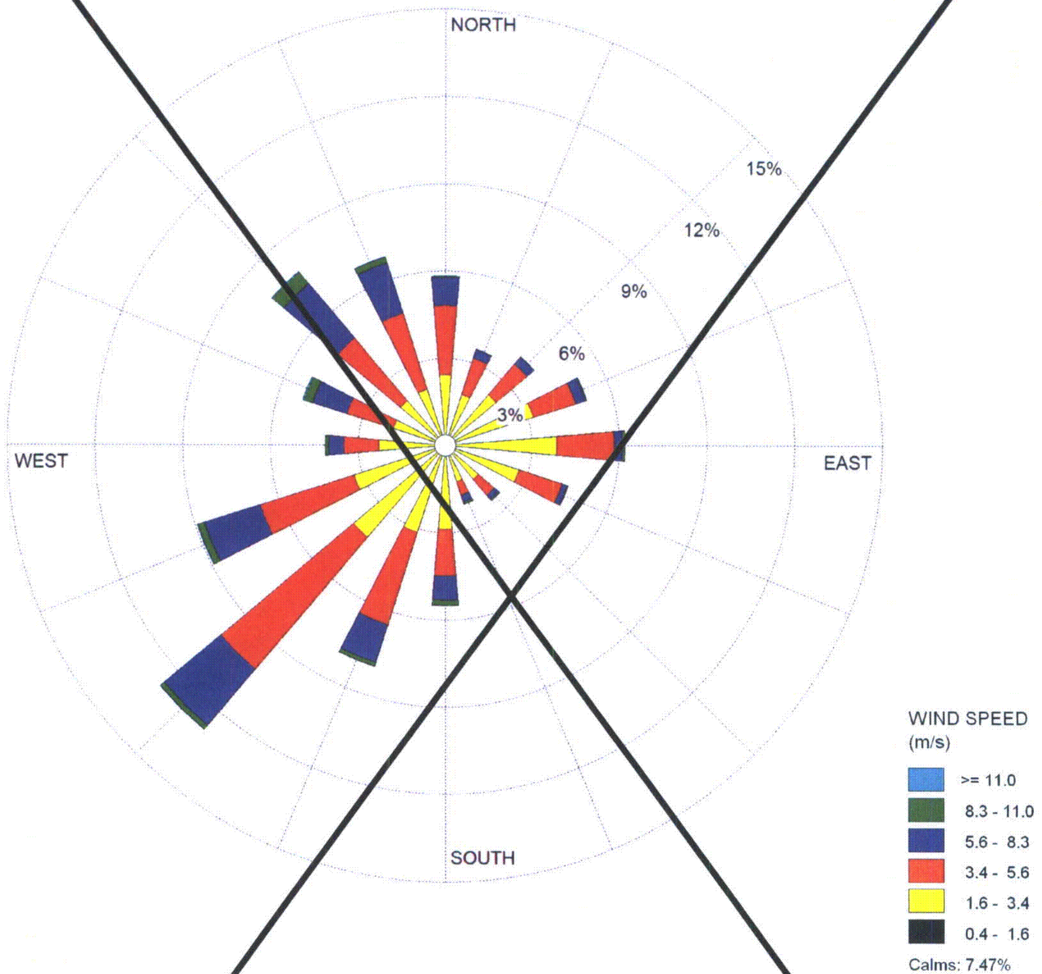
Figure 2.3-34 {Wilkes-Barre/Scranton, Pennsylvania, Wind Rose}

WIND ROSE PLOT:

Station #14777 - WILKES-BARRE/WB-SCRANTON WSO, PA

DISPLAY:

Wind Speed
Direction (blowing from)



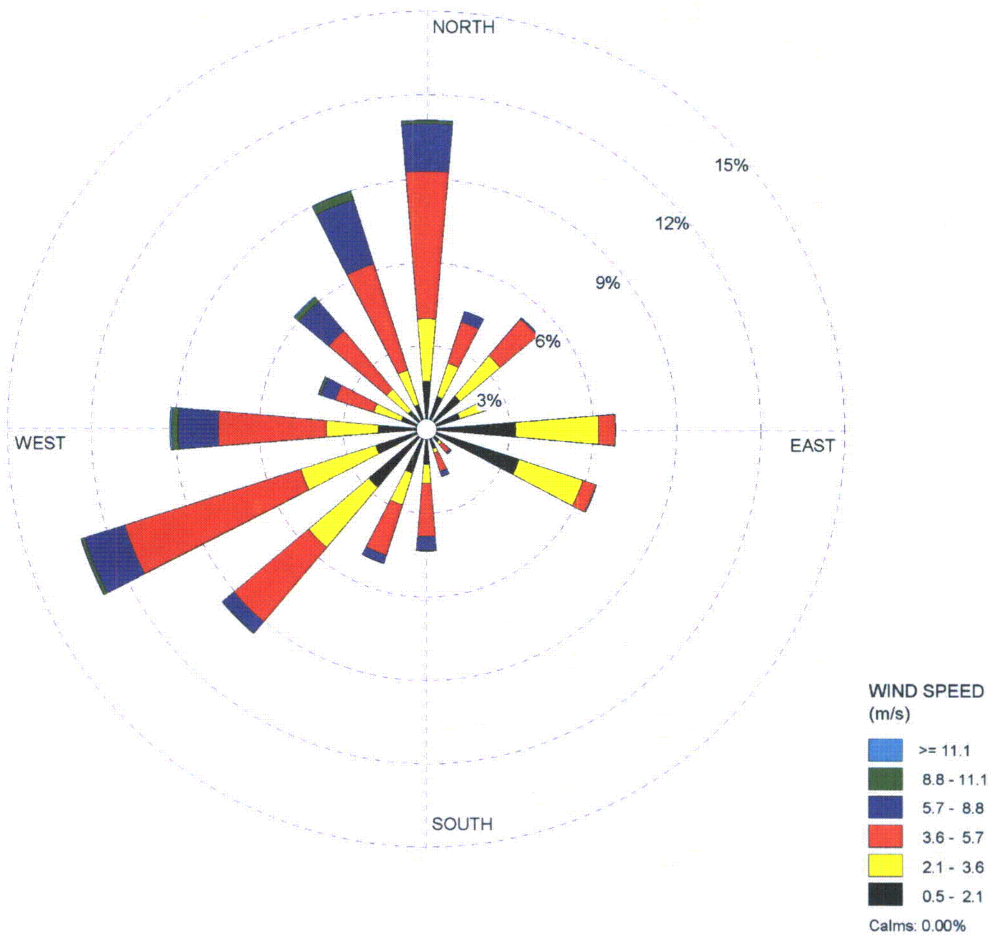
DATA PERIOD: **1984 1985 1986 1987 1989 1991 1992** **Jan 1 - Dec 31** **00:00 - 23:00**	COMPANY NAME: **AREVA NP**
CALM WINDS: **7.47%**	TOTAL COUNT: **61368 hrs.**
AVG. WIND SPEED: **3.67 m/s**	DATE: **2/19/2008**

WRPLOT View - Lakes Environmental Software

Revised Figure 2.3-34 {Wilkes-Barre/Scranton, Pennsylvania, Wind Rose}

WIND ROSE PLOT:
Station #14777 - WILKES-BARRE/WB-SCRANTON WSO, PA

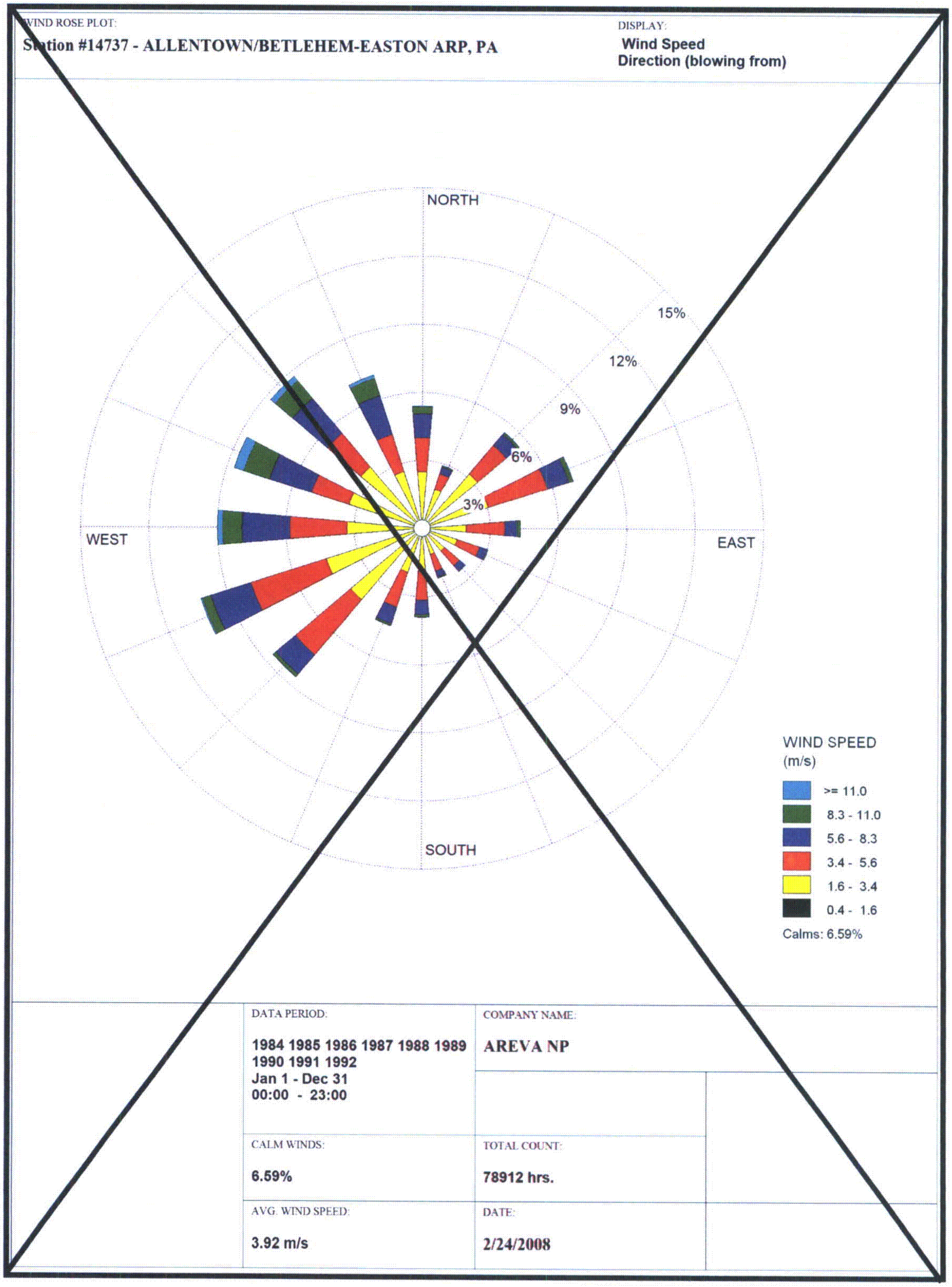
DISPLAY:
Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2001 2002 2003 2004 2005 2006 **Jan 1 - Dec 31** **00:00 - 23:00**	**AREVA NP Inc**	
		MODELER: **T.A. Messier**	AREVA
	CALM WINDS: **0.00%**	TOTAL COUNT: **37061 hrs.**	
	AVG. WIND SPEED: **3.72 m/s**	DATE: **7/27/2009**	PROJECT NO.:

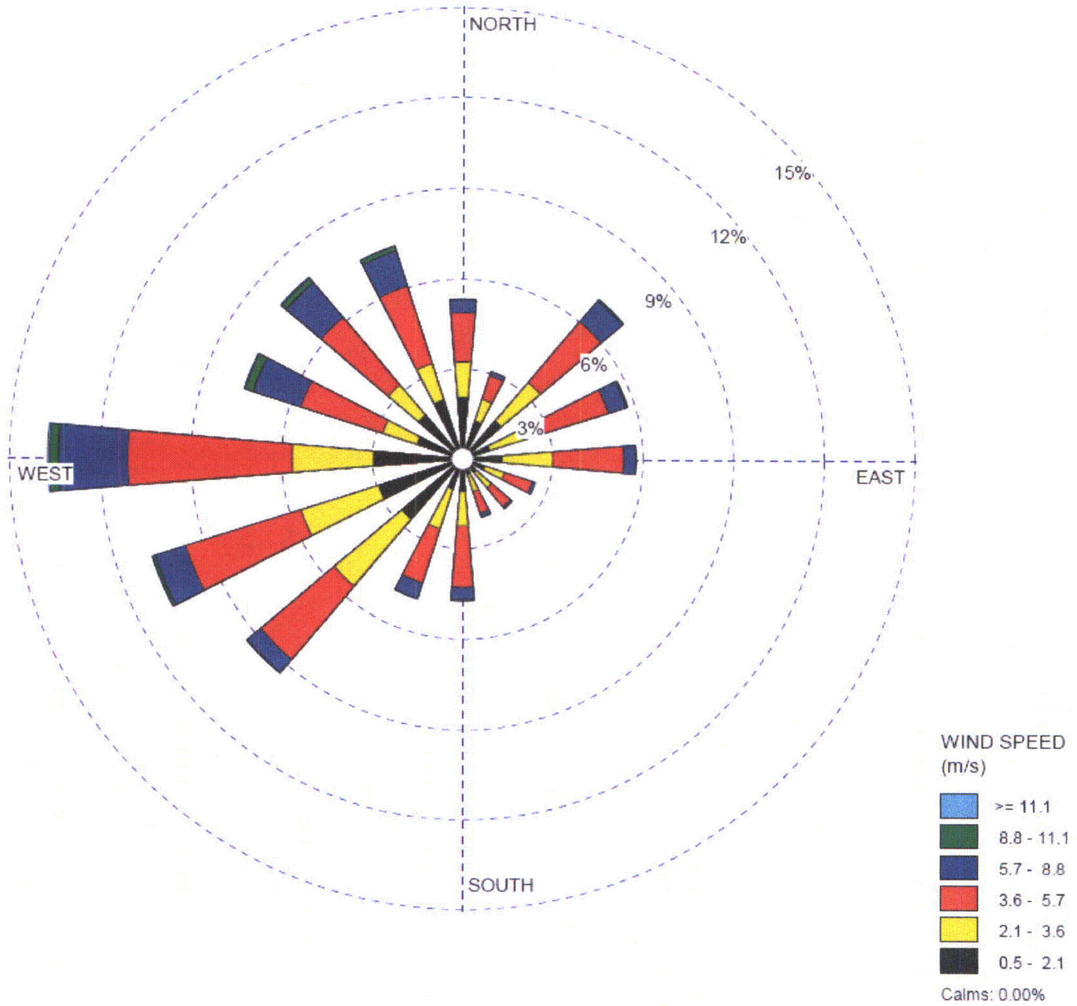
WRPLOT View - Lakes Environmental Software

Figure 2.3-35 {Allentown, Pennsylvania, Wind Rose}



Revised Figure 2.3-35 {Allentown, Pennsylvania, Wind Rose}

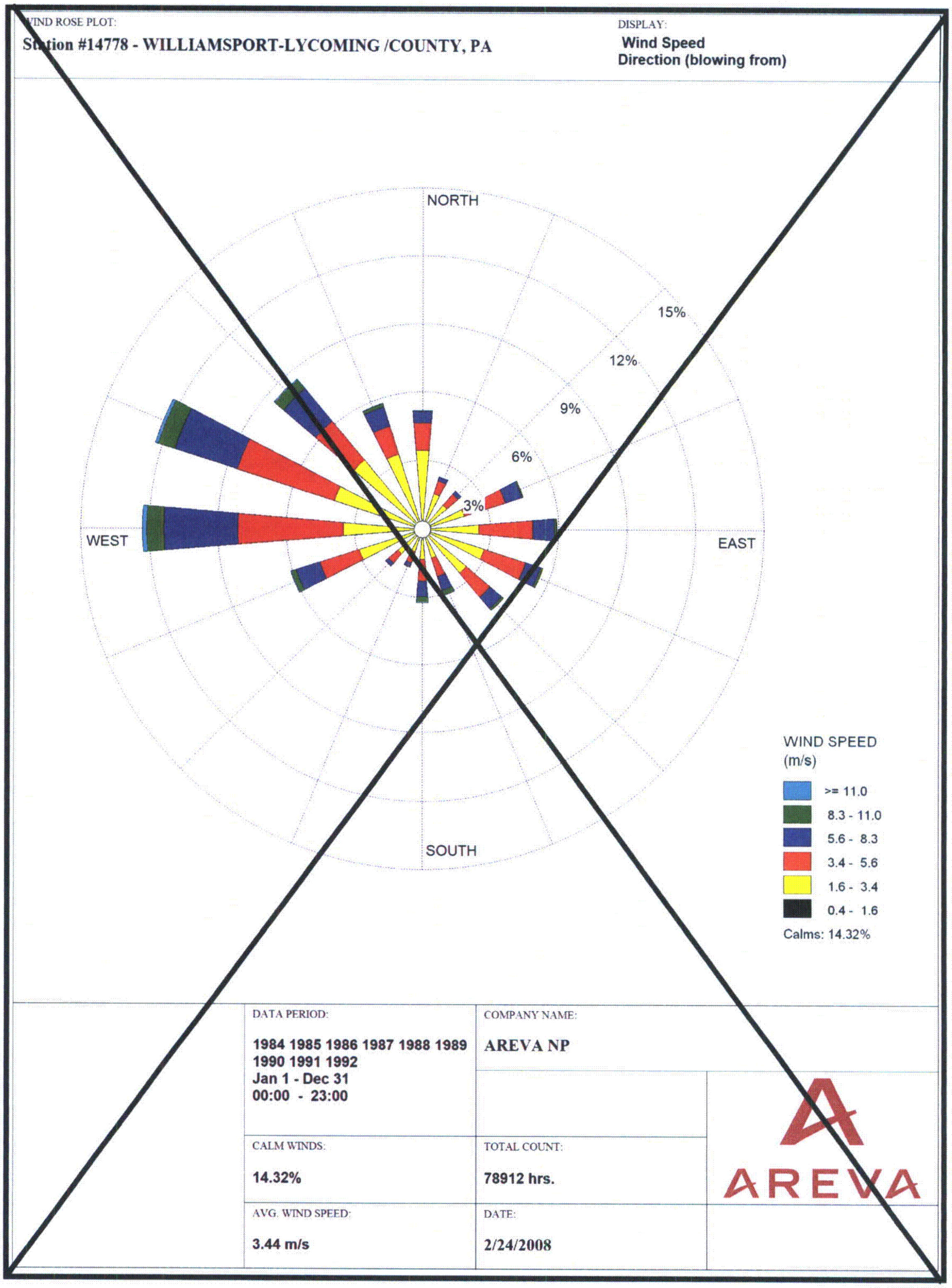
WIND ROSE PLOT:	DISPLAY:
Station #14737 - ALLENTOWN/BETLEHEM-EASTON ARP, PA	**Wind Speed** **Direction (blowing from)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2001 2002 2003 2004 2005 2006 **Jan 1 - Dec 31** **00:00 - 23:00**	**AREVA NP Inc**	
		MODELER: **T.A. Messier**	AREVA
	CALM WINDS: **0.00%**	TOTAL COUNT: **41136 hrs.**	
	AVG. WIND SPEED: **3.79 m/s**	DATE: **7/27/2009**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

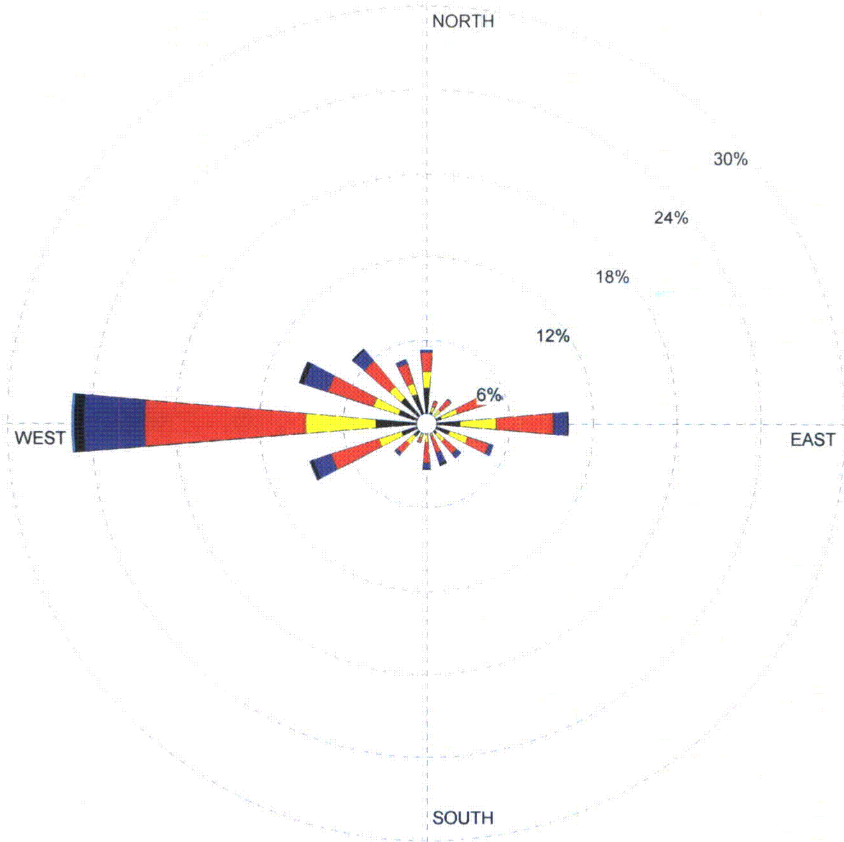
Figure 2.3-36 {Williamsport, Pennsylvania, Wind Rose}



Revised Figure 2.3-36 {Williamsport, Pennsylvania, Wind Rose}

WIND ROSE PLOT:
Station #14778 - WILLIAMSPORT-LYCOMING /COUNTY, PA

DISPLAY:
Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2001 2002 2003 2004 2005 2006 **Jan 1 - Dec 31** **00:00 - 23:00**	**AREVA NP Inc**	
		MODELER: **T.A. Messier**	AREVA
	CALM WINDS: **0.00%**	TOTAL COUNT: **34511 hrs.**	
	AVG. WIND SPEED: **3.87 m/s**	DATE: **7/27/2009**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

BBNPP COLA ER Sections 2.7.4.5 and 2.7.8 will be revised, and ER Figures 2.7-55, 2.7-89, 2.7-90, and 2.7-91 will be revised, as follows, in a future revision of the COLA:

2.7.4.5 Wind Speed and Direction

Table 2.7-57 through Table 2.7-90 present annual, seasonal, and monthly joint frequency distributions of wind speed and direction as a function of atmospheric stability derived from the SSES onsite meteorological monitoring program. These tables were developed using six years of onsite meteorological data (2001-2006) following the guidance in Regulatory Guide 1.23, Revision 0 (NRC, 1972).

The annual prevailing wind direction (the direction from which the wind blows most often) at the SSES site at the 33 ft (10 m) level is from the east-northeast, approximately 15% of the time. This is due primarily to low-speed drainage flows down the Susquehanna River Valley. Winds from the southwest are the next most dominant, occurring approximately 11% of the time. The least prevalent wind direction is from the west-northwest, approximately 2% of the time. The annual prevailing wind direction (the direction from which the wind blows most often) at the SSES site at the 197 ft (60 m) level is from the north-northeast, approximately 15% of the time. Winds from the southwest are the next most dominant, occurring approximately 12% of the time. The least prevalent wind direction is from the west-northwest, approximately 2% of the time.

...

Table 2.7-91 through Table 2.7-93 present monthly and annual summaries of wind speed and direction for three stations around the BBNPP site (Wilkes-Barre/Scranton, Allentown, and Williamsport, Pennsylvania) (NCDC, 2006a) (NCDC, 2006b) (NCDC, 2006c). Note that the most prevalent wind speed class on an annual basis for the 33 ft (10 m) level is lower than the average annual wind speeds at the same measurement height presented for these three stations (7.5 mph (3.3 mps), 7.9 mph (3.5 mps), 6.9 mph (3.1 mps), respectively); this would lead to more conservative atmospheric dispersion estimates using the SSES onsite meteorological data.

Figure 2.7-55 through Figure 2.7-88 depict annual, seasonal, and monthly wind rose plots made using six years of SSES onsite meteorological data (2001-2006) for the 33 ft (10 m) and 197 ft (60 m) elevations.

Figure 2.7-89 through Figure 2.7-91 depict multi-year summaries of wind speed and direction for three NWS stations around BBNPP (Wilkes-Barre/Scranton, Allentown, and Williamsport, Pennsylvania) ~~(AREVA, 2008d) (AREVA, 2008e) (AREVA, 2008f)~~ (NCDC, 2009).

BBNPP is located in the Ridge and Valley Region of Pennsylvania. The predominate southwest to northeast orientation of topographic ridge lines in the vicinity of BBNPP has a large influence on low level winds. The ridges and the Susquehanna River Valley funnel a localized, low level wind flow up or down the valley. This provides a common factor between the BBNPP site and the National Weather Service sites at Wilkes-Barre/Scranton and Williamsport. All three of these sites experience air flow predominately along the ridges/river valley.

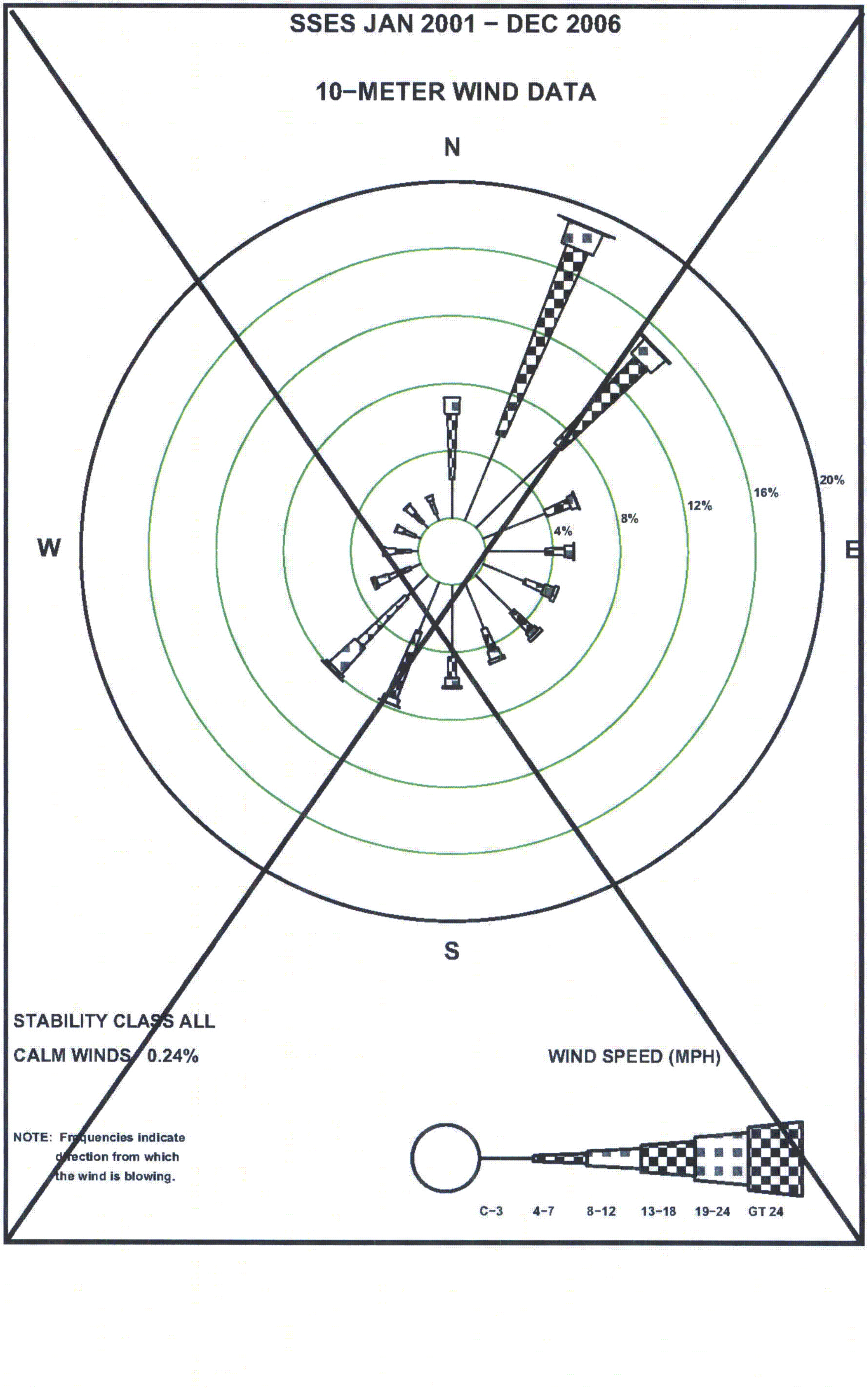
The SSES 10-m annual wind rose and the Wilkes-Barre/Scranton and Williamsport annual wind roses indicate air flow up and down the river valley is a major component of the overall air flow. The flow at Allentown is channeled by the topography east of the airport that runs from the northeast to the southwest. The increased frequency of winds from the NNE and NE measured by the SSES tower (used for the pre-operational phase for BBNPP) are due to low-speed drainage flows down the river valley.

A comparison of Figure 2.7-55 with Figures 2.7-89, 2.7-90, and 2.7-91 indicates that there are more than twice as many low-wind speed events measured at SSES than at the three NWS sites. This lends credence to the idea that differences in wind speed group frequencies between the BBNPP site and the three NWS sites may be attributable to the differing goals of the meteorological measurement programs – atmospheric dispersion (low-wind speed events more important) versus general aviation (high-wind speed events more important).

2.7.8 References

NCDC, 2009. U.S. National Climatic Data Center, Integrated Surface Hourly Observations for 2001-2006, 2009.

Figure 2.7-55 SSES 10m Annual Wind Rose



Revised Figure 2.7-55 SSES 10m Annual Wind Rose

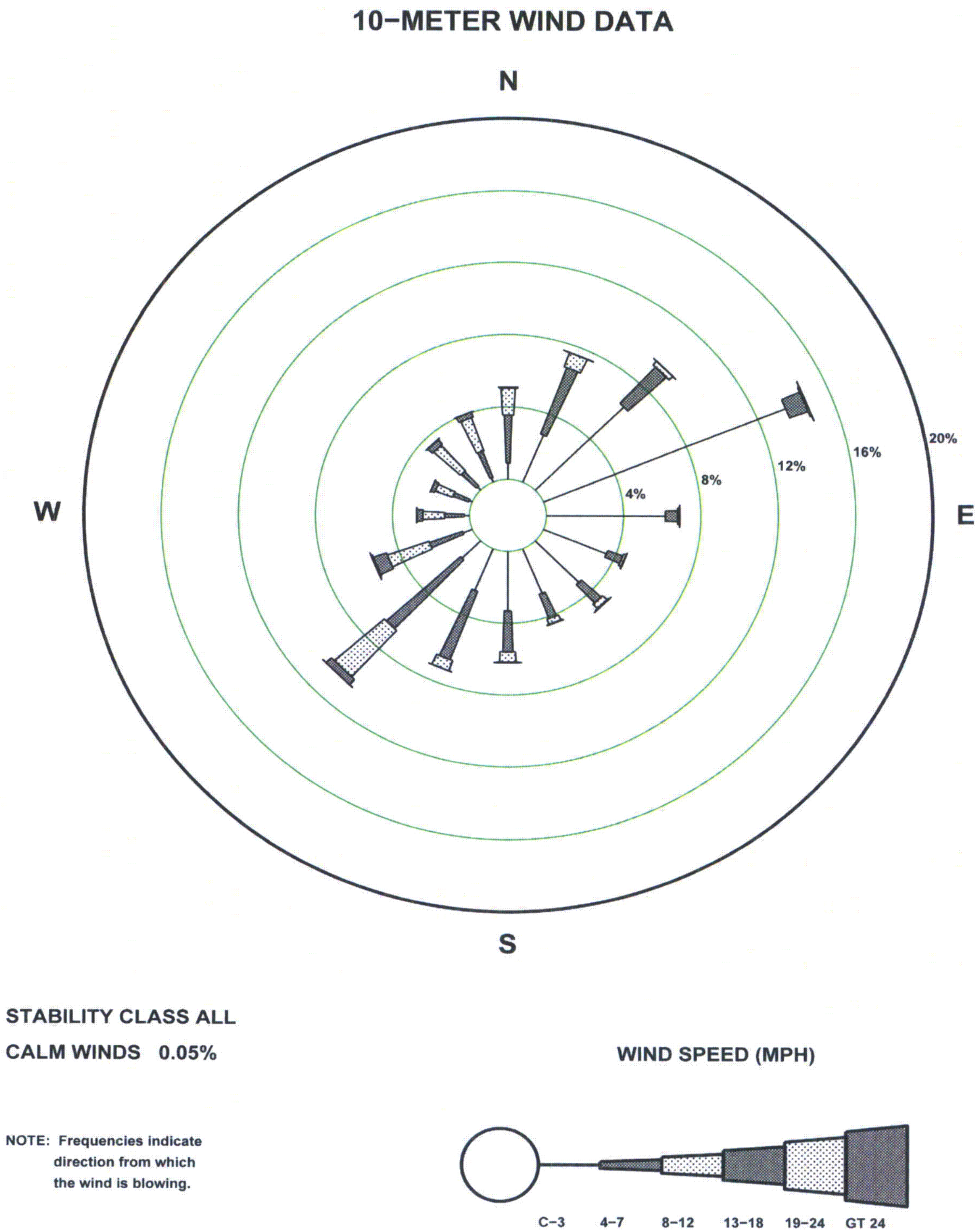
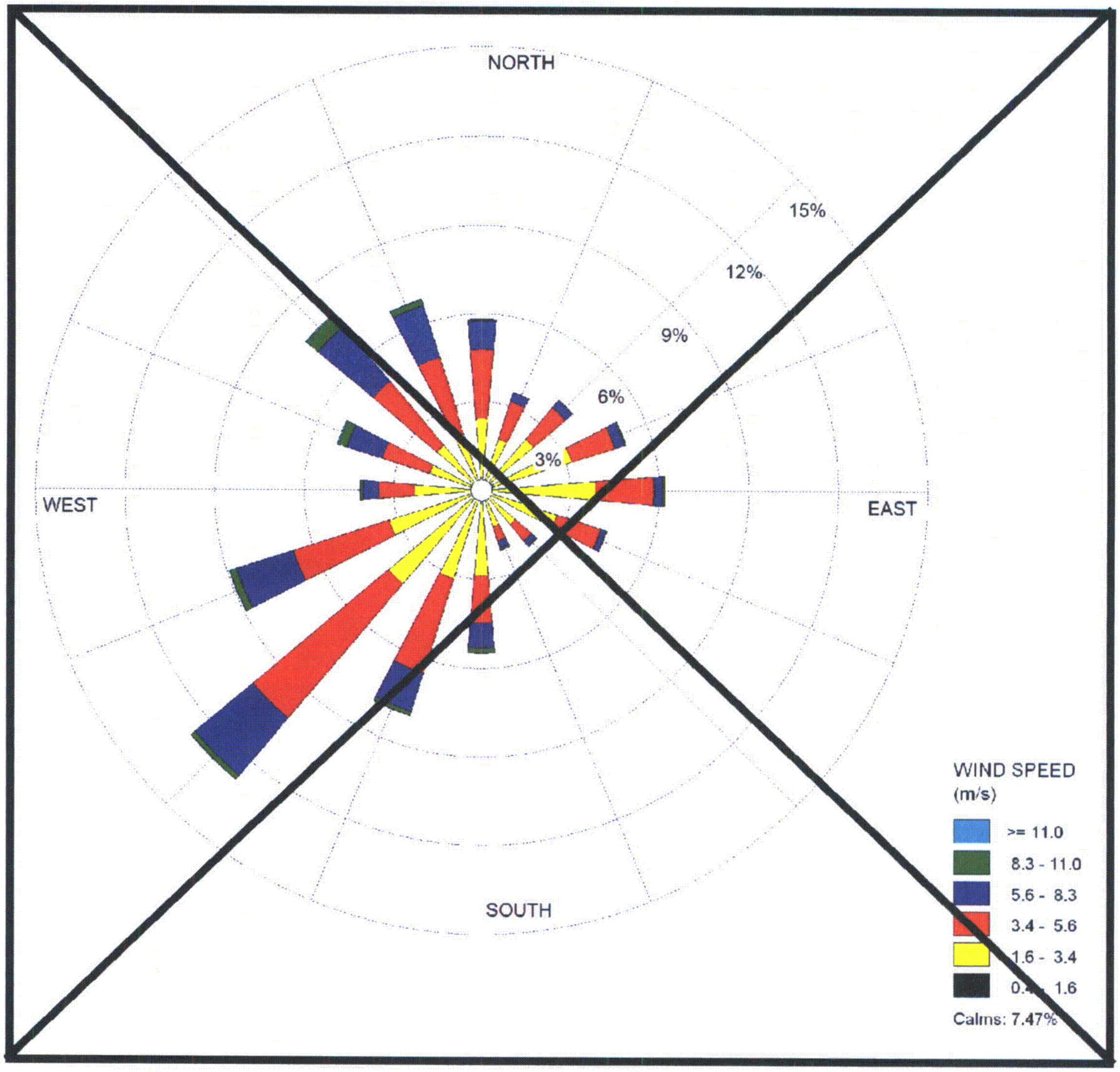


Figure 2.7-89 Wilkes-Barre/Scranton, PA, Wind Rose



Revised Figure 2.7-89 Wilkes-Barre/Scranton, PA, Wind Rose

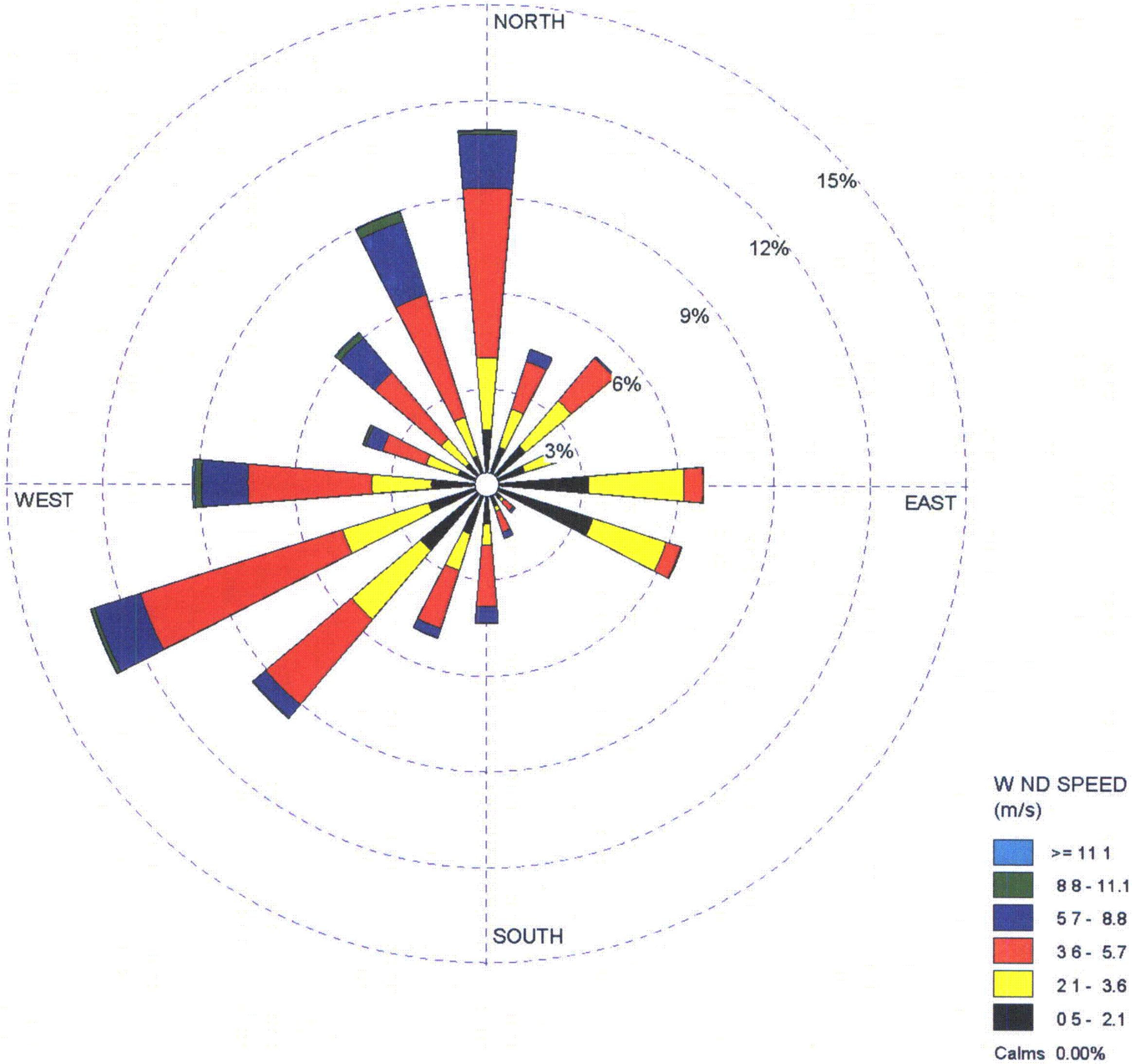
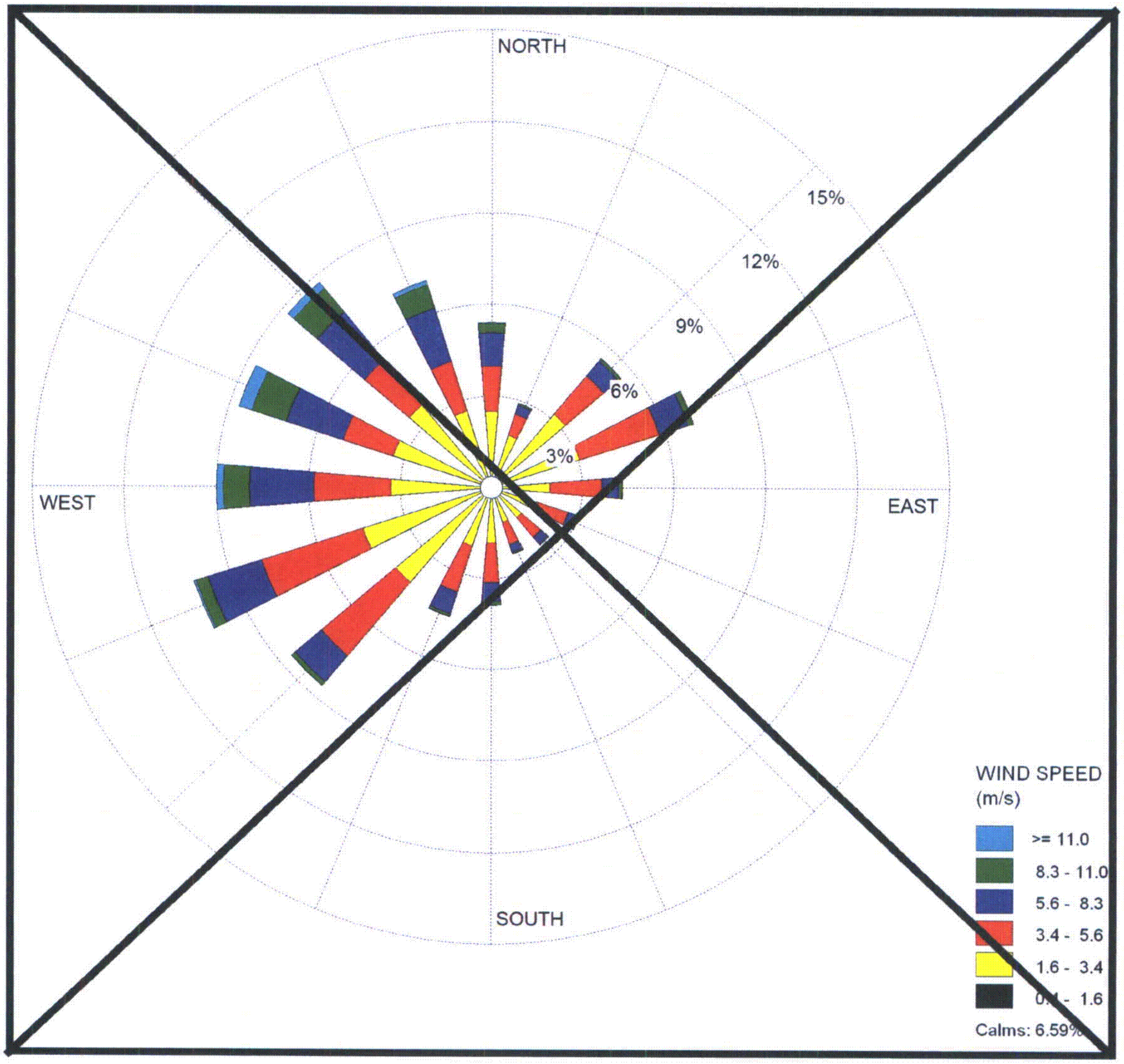


Figure 2.7-90 Allentown, PA, Wind Rose



Revised Figure 2.7-90 Allentown, PA, Wind Rose

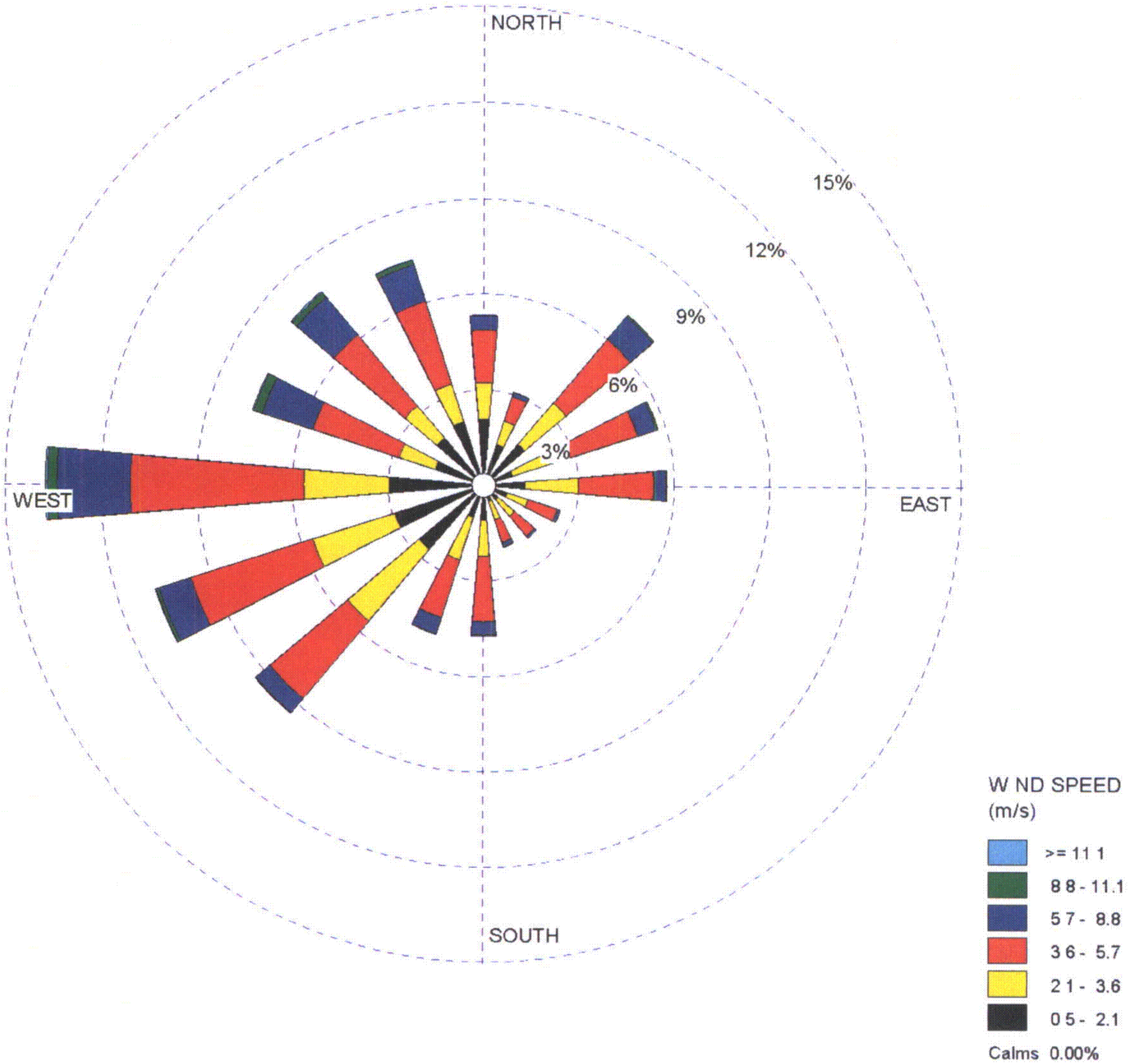
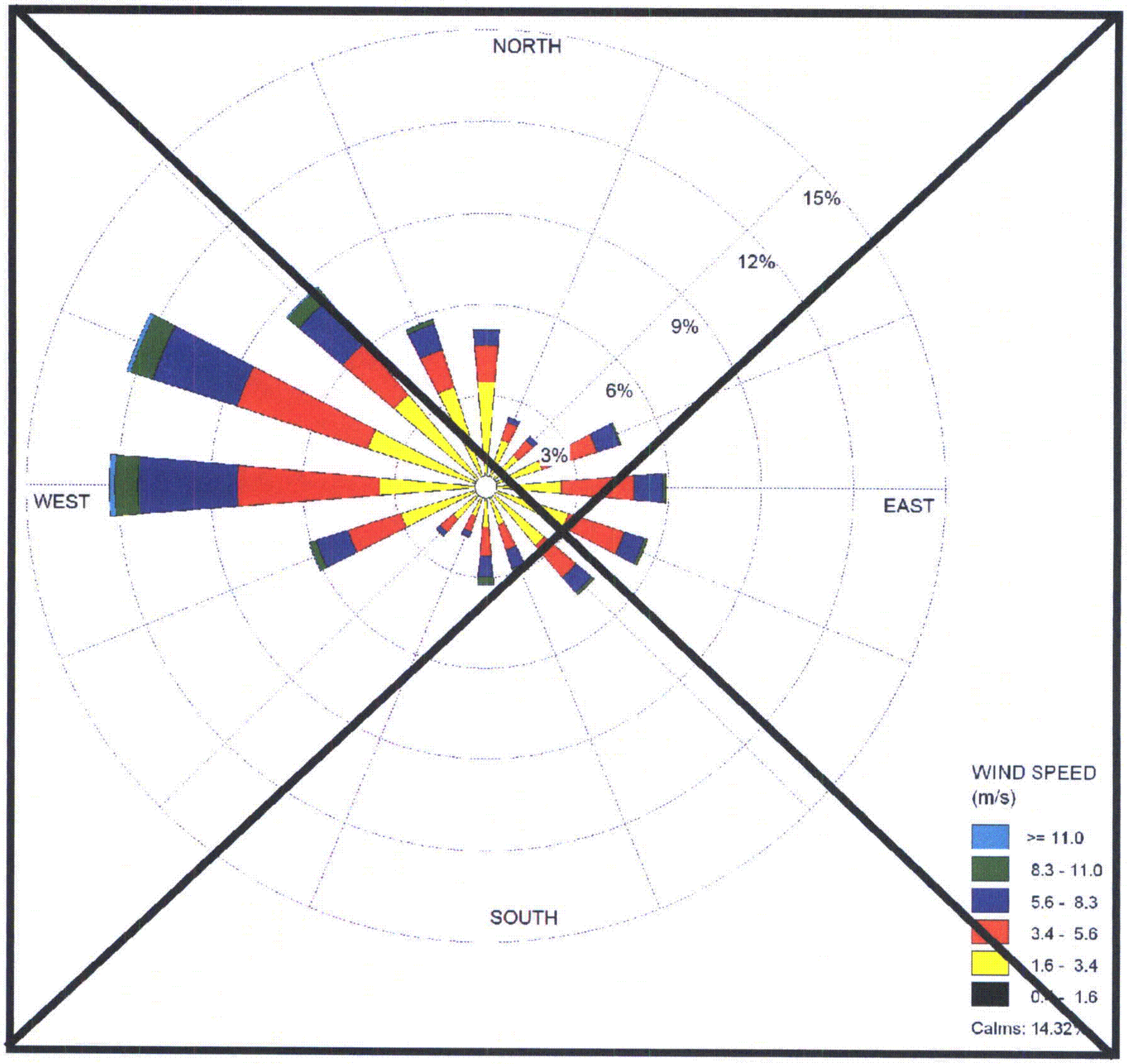
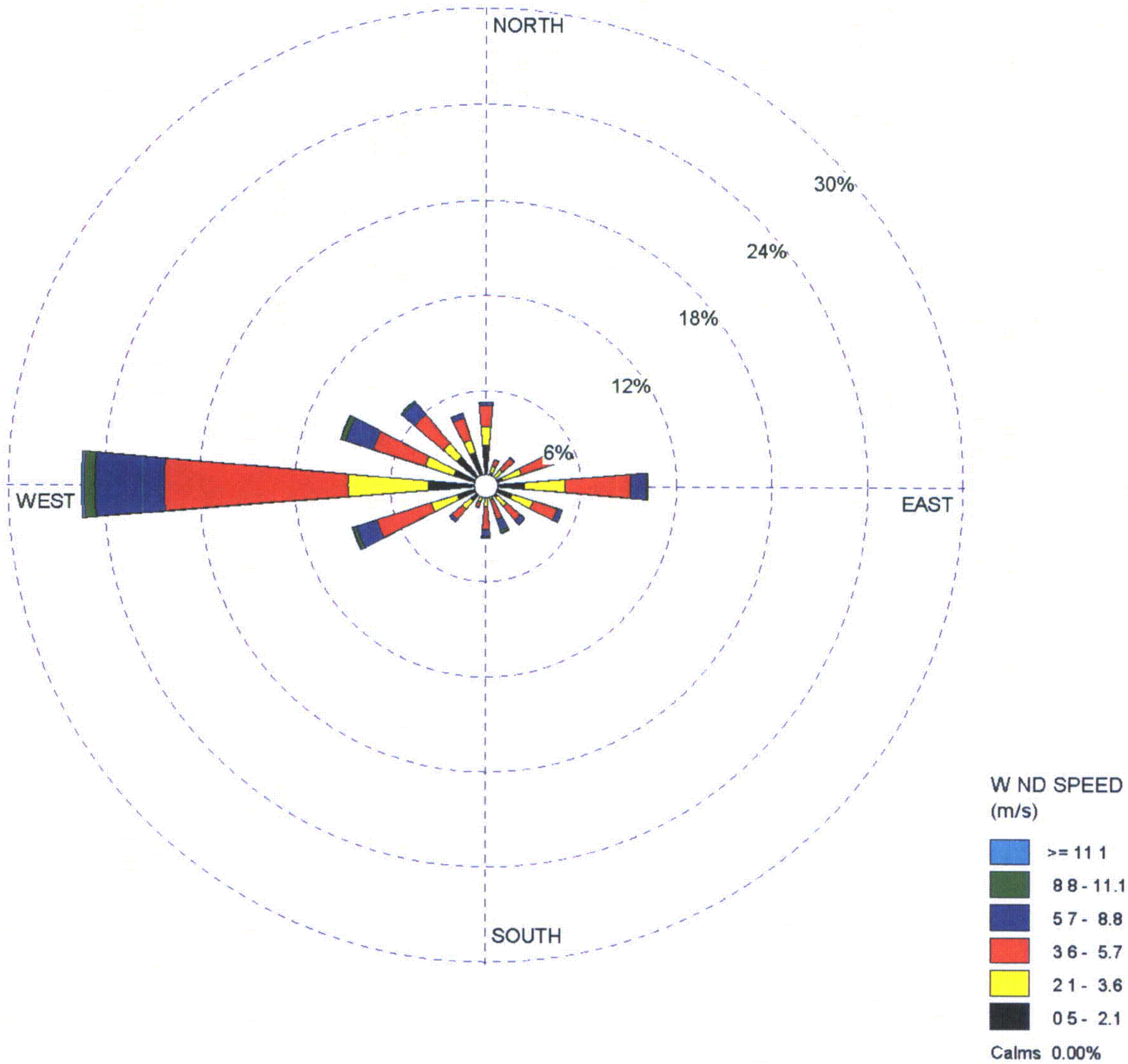


Figure 2.7-91 Williamsport, PA, Wind Rose



Revised Figure 2.7-91 Williamsport, PA, Wind Rose



MET 5.3-1

ESRP 2.7

ESRP 5.3.3.1

Summary: *Provide a justification for using Wilkes-Barre Scranton meteorological data instead of site-specific data, including how these data are representative of the BBNPP site, and how these data meet Regulatory Guide 1.23 Revision 1 specifications for onsite meteorological measurements.*

Full Text: ESRP 5.3.3.1 directs staff to evaluate various aspects of vapor plumes from cooling towers, such as plume length and frequency, solids deposition, ground-level humidity increase and fogging, cloud shadowing, and additional precipitation. Onsite meteorological data measurements are used in these evaluations. Section 5.3.3.1.1 of the ER indicates that dry bulb and dew point measurements from Wilkes-Barre Scranton are used in the analysis. Justify the representativeness and use of these data in this analysis, including whether the data meet regulatory guidance (Regulatory Guide 1.23 Revision 1) specifications for onsite meteorological measurements.

Response: For the Bell Bend Nuclear Power Plant (BBNPP), the impacts from fogging, icing, shadowing, and drift deposition were modeled using the Electric Power Research Institute's Seasonal/Annual Cooling Tower Impact (SACTI) prediction code. Meteorological data from the Susquehanna Steam Electric Station (SSES) meteorological tower (MET) were used for the BBNPP SACTI calculations with the exception of the ambient temperature and dew point temperature data, which were obtained from the National Weather Service (NWS) station at the Wilkes-Barre Scranton (WBS) airport, located 28 miles northeast of the BBNPP site, and were used in the SACTI calculations. These data were used rather than the data from the SSES MET because some of the dew point temperature data collected during the period used in the study (2001-2006) were considered to be anomalous.

The ambient temperature data collected at SSES MET were not anomalous. Both the ambient and dew point temperatures are used together in the SACTI modeling. Since some of the collected dew point temperature data were anomalous, it was decided to use both the ambient temperature and dew point temperature from WBS in the SACTI cooling tower calculations. This was done in order to use the most accurate data then available in the region. In order to justify using the data from WBS, a comparison was prepared of the ambient temperature data between the SSES MET and the WBS Automated Surface Observing System (ASOS) for the period January 2001, through September 2009. The results of this comparison can be found in Table 1, which shows the overall difference between the two sites was only 0.3°F. The same type of comparison was prepared for dew point temperature for the two sites for the period November 1, 2008, through September 30, 2009. The results of this comparison can be found in Table 2, which shows the overall difference between the two sites was only 0.8°F. During the period November 1, 2008, through September 30, 2009, none of the dew point temperature data collected at the SSES MET were found to be anomalous.

The data from the NWS site at WBS was collected using the NWS ASOS. The ASOS User's Guide (USN, 1998) was used to determine if the measurements taken at WBS meet the requirements for NRC Regulatory Guide 1.23, Rev. 1 (NRC, 2007), for onsite meteorological measurements. As specified in Table 1 of the ASOS User's Guide (Temperature Sensor – Range, Accuracy Resolution) the accuracy of the ASOS temperature sensor is 0.9°F which is the same as the NRC site requirement stated in RG 1.23. For the dew point temperature the accuracy value(s) given in Table 1 of the ASOS User's Guide depend on the dew point temperature value. It is broken into three ranges that are shown in Table 3. The dew point accuracy is then dependant on the calculated dew point depression for dew point temperature values in each range. Dew point depression is defined as the ambient temperature value minus the dew point temperature value for each hour. Using the eight year period of hourly data from 2001 through 2008 for WBS it was determined that the average dew point depression was 12.76°F, 12.56°F and 9.81°F for the three dew point temperature ranges, as can be seen in Table 3. As discussed in Section 3.1.1 of the ASOS User's Guide there are three ranges of values for the dew point temperature accuracy that covers a dew point depression range from 0°F to 63°F. The dew point depression values of 12.76, 12.56 and 9.81 convert to dew point accuracies of 4.1, 3.2 and 1.7°F respectively as shown in Table 4. The three groups represent 0.5, 38.7 and 60.8% of the hourly values in the eight year WBS data base. The NRC RG 1.23 accuracy requirement for dew point temperature is 2.7°F. Using a weighted average for each of the three groups based on the percentage of the hourly data in each group the overall accuracy was determined to be 2.29°F.This justifies that the ambient and dew point temperature measurements at WBS meet the system accuracy temperature requirements of Reg. Guide 1.23 Rev. 1 (NRC, 2007).

TABLE 1
Comparison of SSES Ambient Temperature Data with Data from the NWS ASOS at WBS Airport for the Period January 2001, through September 2009

SSES Ambient Temperature Data January 2001, through September 2009 (°F)											
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**Monthly Average**	**Seasonal Average**
January	27.2	33.7	22.2	20.5	25.8	35.3	32.3	30.5	22.3	27.8	29.8
February	31.7	35.1	25.8	28.9	30.6	31	22.2	29	31.4	29.5	
March	34.7	39.8	37	39.9	33.5	38.9	36.8	37.3	39.2	37.5	48.7
April	49.1	51.1	48	49.9	51.1	50.7	45.5	52.4	51.1	49.9	
May	59.6	56.5	56.4	65.7	55.2	58.9	61.4	55.2	58.9	58.6	
June	68	67.8	64.4	65.3	70.7	66.1	67.7	69	65.1	67.1	69.3
July	68.1	72.5	70.4	69.4	73.2	73.2	69.6	71.3	67.5	70.6	
August	72.2	72.4	70.6	68.3	72.8	70.1	70.3	66.2	69.8	70.3	
September	71	64.3	62.6	63.6	66.5	60	64.1	63.4	60.9	64.0	53.1
October	52.4	49.7	48.6	50.2	53.4	49.9	58.1	48.4		51.3	
November	46.5	40.4	43.4	42.9	43.5	45	39.9	40.5		42.8	
December	36.6	29.3	31.8	32.1	27.8	38.2	32.1	32.2		32.5	
Annual	50.6	51.2	48.6	49.6	50.4	51.5	50.1	49.7	51.8	50.4	50.4

TABLE 1 (Continued)

WBS Ambient Temperature Data January 2001, through September 2009 (°F)											
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**Monthly Average**	**Seasonal Average**
January	26.8	33.6	21.1	19.4	23.8	34.9	31.9	30.3	21.6	27.0	29.2
February	30.4	34.9	24.7	27.3	29.7	30	21	28.8	31	28.6	
March	33.2	39.6	37	39.6	31.7	36.3	35.6	36.1	39.5	36.5	48.2
April	47.6	50.8	47.3	49.2	51.7	50.2	44.9	52.3	51.9	49.5	
May	59.8	56.2	56.4	63.9	55.6	58.5	61.3	55.6	59.5	58.5	
June	68	68.2	63.7	65	71.1	65.9	68.2	69.2	65.5	67.2	69.5
July	66	72	71	69.3	75	73.3	70	72.4	67.9	70.8	
August	71.7	72.2	70.3	66.9	74.8	70.3	70.9	67.3	69.9	70.5	
September	60.6	64.7	61.5	63.2	67.8	60.3	65.1	64	60.6	63.1	52.8
October	52.9	49.9	48.7	50.3	52.2	49.9	58.6	48.8		51.4	
November	45.4	40.3	44	42.5	44	45.3	40.1	40.7		42.8	
December	37	29.2	31.5	31.2	27.5	38.7	31.5	31.7		32.3	
Annual	50	51.1	48.2	49.1	50.5	51.3	50.2	49.7	52	50.2	50.1

TABLE 2
Comparison of SSES Dew Point Temperature Data with Data from the NWS ASOS at WBS Airport for the Period of November 2008, through September 2009

SSES Dew Point Temperature Data November 2008, through September 2009 (°F)	
	2008
November	29.6
December	21.3
	2009
January	11.1
February	17.2
March	21.8
April	32.1
May	44.8
June	54
July	55.9
August	59.7
September	51.2
Average	36.3

TABLE 2 (Continued)

WBS Dew Point Temperature Data November 2008, through September 2009 (°F)	
	2008
November	29.5
December	23.5
	2009
January	11.9
February	17.7
March	22.7
April	31.5
May	45
June	55.8
July	57.2
August	61.2
September	52.1
Average	37.1

TABLE 3
Summary of Average Dew Point Depression for Wilkes-Barre Scranton

Dew Point Temperature Ranges		2001	2002	2003	2004	2005	2006	2007	2008	8 yr Average Dew Point Depression (hourly data)
	Month	Average	Average	Average	Average	Average	Average	Average	Average	
-80°F to -0.4°F	1	-	-	10.97	11.08	9.83	-	10.50	12.10	
	2	-	-	15.56	16.25	-	15.59	14.51	14.25	
	3	-	-	13.61	-	13.25	-	14.50	-	
	4	-	-	-	-	-	-	-	-	
	5	-	-	-	-	-	-	-	-	
	6	-	-	-	-	-	-	-	-	
	7	-	-	-	-	-	-	-	-	
	8	-	-	-	-	-	-	-	-	
	9	-	-	-	-	-	-	-	-	
	10	-	-	-	-	-	-	-	-	
	11	-	-	-	-	-	-	-	-	
	12	-	16.00	-	8.86	10.21	-	30.00	15.67	**12.76**
-0.4°F to 32°F	1	7.92	11.07	7.86	8.09	6.14	7.69	7.71	10.51	
	2	11.92	15.69	9.72	11.16	12.07	12.93	11.01	10.00	
	3	11.52	15.90	11.05	14.26	11.34	15.09	15.53	16.03	
	4	18.86	16.97	16.10	20.88	23.16	22.94	17.23	24.37	
	5	30.11	19.23	25.19	20.10	20.28	29.55	29.59	25.74	
	6	8.00	0.00	0.00	0.00	0.00	25.00	-	-	
	7	0.00	0.00	0.00	33.00	-	-	-	0.00	
	8	6.78	0.00	0.00	0.00	0.00	0.00	-	-	
	9	9.00	0.00	0.00	0.00	11.00	57.00	-	65.00	
	10	17.16	9.69	10.54	13.94	10.75	14.22	12.64	14.35	
	11	13.39	10.08	11.56	12.83	14.48	12.46	12.80	12.19	
	12	9.11	9.69	9.74	10.80	8.75	13.64	8.84	10.51	**12.56**
32°F to 86°F	1	1.06	6.79	3.82	2.38	1.90	6.16	4.50	7.00	
	2	5.00	5.64	2.38	1.37	4.85	9.11	3.00	3.16	
	3	3.09	7.66	8.02	7.83	3.32	10.13	8.09	4.31	
	4	10.56	9.46	12.83	10.51	12.65	12.67	10.60	13.89	
	5	12.81	10.47	8.46	9.68	12.26	11.88	15.09	12.87	
	6	11.32	9.75	7.63	9.62	10.95	8.41	12.51	11.51	
	7	11.56	13.21	10.29	8.52	12.16	9.82	12.97	11.94	
	8	10.61	12.69	7.17	7.43	13.09	11.27	10.89	11.85	
	9	9.35	10.83	6.52	6.95	14.67	7.32	11.55	10.54	
	10	10.87	6.96	7.17	7.36	7.66	8.13	9.47	10.13	
	11	8.27	6.16	4.80	7.11	10.17	6.96	6.29	7.01	
	12	7.40	3.65	3.78	4.55	2.78	6.98	2.65	4.92	**9.81**
Annual Average All Groups		11.27	11.25	8.86	9.54	11.49	11.19	11.69	11.86	**10.89**

Table 4 Calculation of Dew Point Temperature Accuracy Using ASOS Methodology

Dew Point Temperature Range 1 -80° to -0.4°F. (representing 0.5% of the hourly data)
Average Dew Point Depression = 12.76°F is 20.2% of the total range of 0-63°F
Accuracy for Range 1 = 3.1 to 7.9°F
20.2% of Range 1 Accuracy = 4.1°F
Dew Point Temperature Range 2 -0.4° to 32°F. (representing 38.7% of the hourly data)
Average Dew Point Depression = 12.56°F is 19.9% of the total range of 0-63°F
Accuracy for Range 2 = 2.0 to 7.9°F
19.9% of Range 1 Accuracy = 3.2°F
Dew Point Temperature Range 3 32° to 86°F. (representing 60.8% of the hourly data)
Average Dew Point Depression = 9.81°F is 15.6% of the total range of 0-63°F
Accuracy for Range 3 = 1.1 to 4.7°F
15.6% of Range 3 Accuracy = 1.7°F
Using a Time Weighted Average of Each Range Based on the Percentage of Hours
0.5, 38.7 and 60.8% Respectively
The Overall Average Accuracy for the Eight Year Time Period = 2.29°F

References cited in this response:

NRC, 2007. Regulatory Guide 1.23, Meteorological Monitoring Programs for Nuclear Power Plants, Rev. 1, U.S. Nuclear Regulatory Commission, March 2007.

USN, 1998. Automated Surface Observing System (ASOS) User's Guide, National Oceanic and Atmospheric Administration, Department of Defense, Federal Aviation Administration, United States Navy, March 1998.

COLA Impact:

No changes to the BBNPP COLA ER are required as a result of this RAI response.

ALT 9.3-1

ESRP 9.3

Summary: *Provide a detailed description of the alternative site screening process documentation that supports the selection of the alternatives sites listed in the ER, including a description of the criteria used to rank alternative sites.*

Full Text: ESRP 9.3 indicates that the applicant's process for identifying alternate sites for evaluation is acceptable if *"the applicant has employed a practicable site-selection process with the principal objective of identifying candidate sites that would be among the best that could be reasonably found for the proposed plant"* and the process is ultimately supportive of a determination that there are or are not obviously superior sites to the proposed site. More detail is needed regarding the screening criteria and ranking system.

Response: The alternative site screening process described in Section 9.3 of the BBNPP ER has been superseded by a revised process consistent with ESRP 9.3. The new process is described in the Bell Bend Nuclear Power Plant Alternative Site Evaluation report, Appendices A and B (PPL, 2009a) and a revision to Section 9.3 of the COLA (PPL, 2009b). The original alternative site evaluation has been reperformed based on the new process. This has resulted in the deletion of two previously identified alternative sites and the addition of two new alternative sites.

References cited in this response:
PPL, 2009a. Bell Bend Nuclear Power Plant Alternative Site Evaluation, BNP-2009-257, dated September 9, 2009.
PPL, 2009b. Bell Bend Nuclear Power Plant Environmental Report Section 9.3, Alternative Sites, BNP-2009-371, dated November 25, 2009.

COLA Impact:
No changes to the BBNPP COLA ER are required as a result of this RAI response.

ALT 9.3-5

ESRP 9.3

Summary: *Provide a docketable version of the information provided during the audit on the availability of services at the alternative sites.*

Full Text: Availability, or unavailability, of services such as potable water, electrical power, and sanitary waste water treatment affects the comparison of alternative sites and assessment of the impacts of the proposed action at each site as provided under ESRP 9.3.

Response: The alternative site screening process described in Section 9.3 of the BBNPP ER has been superseded by a revised process. The revised process including all of the siting factors and their weighting is contained in a new Alternative Site Evaluation report (PPL, 2009a). The revised process has resulted in the deletion of two previously identified alternative sites and the addition of two new alternative sites.

Information on the Montour Site (Alternative Site 1) and the new alternative sites Humboldt Industrial Park and Seedco Industrial Park (Alternative Sites 2 and 3 respectively) is provided below and included in the revised ER Section 9.3 (PPL, 2009b).

Montour Site (Alternative Site 1)

According to the USEPA, Montour County has seven community public water systems (PWSs), which are defined by the PADEP as a "system that provides piped water for human consumption to at least 15 service connections or serves an average of at least 25 people for at least 60 days each year. PWSs can be community, non-transient non-community, or transient non-community systems" (PADEP, 2009c). These seven systems provide treated water to over 7,000 people throughout Montour County. Of these seven systems, four use groundwater as the primary water source, while the remaining three use surface water (USEPA, 2009b). In addition, Montour County has one major and three minor public (municipal) wastewater/sanitary sewer treatment plants. The total wastewater flow to these four municipal public sewer systems within the county is approximately 3.9 MGD (14.8 mld) (PADEP, 2009d).

Within the Montour County Comprehensive Plan (the Plan), the subject of sewer system capacity and how critical and urgent this issue is within the county is discussed in detail. Future strategic actions within the Plan acknowledge the vital link between adequate sewer system capacity and the growth, infrastructure enhancement, and development within Montour County, especially Valley Township. Valley Township includes an essential portion of a growth corridor, identified by the Plan, and with the present capacity restrictions at the Valley Township Wastewater Treatment Plant, development within this area is directly impacted. The Plan recommends a multi-municipal approach to resolving the sewage treatment capacity issues. The recommended approach involves either an expansion of the local Valley Township Wastewater Treatment Plant or a conveyance to the Danville Borough Plant that currently has the reserve capacity to serve this area of Montour County. The Plan also recommends the extension of water and sanitary sewer service for a portion of Cooper Township within another designated growth corridor, by expanding treatment via the Danville Borough Plant. (Montour County Planning Commission [MCPC], 2009)

Humboldt Industrial Park (Alternative Site 2)

According to the USEPA, Luzerne County has 91 community PWSs, which are defined by the PADEP as a "system that provides piped water for human consumption to at least 15 service connections or serves an average of at least 25 people for at least 60 days each year. PWSs can be community, non-transient non-community, or transient non-community systems" (PADEP, 2009c). These 91 systems provide treated water to over 274,000 people throughout the County. Of the 91 systems, seven of them use surface water as the primary water source, while the remaining 84 use groundwater. (USEPA, 2009c) In addition, Luzerne County has four major and nine minor public (municipal) wastewater/sanitary sewer treatment plants. The total wastewater flow to these 13 municipal public sewer systems within Luzerne County is approximately 73.6 MGD (278.6 mld) (PADEP, 2009d). According to Luzerne County, Dupont Borough recently completed a modern $5-million sewer collection system (Luzerne County, 2009b), and the Township of Salem is currently in the process of initiating a new sewer system in the residential areas of East Berwick and Beach Haven (Luzerne County, 2009c).

Seedco Industrial Park (Alternative Site 3)

According to the USEPA, Northumberland County has 13 community PWSs, which are defined by the PADEP as a "system that provides piped water for human consumption to at least 15 service connections or serves an average of at least 25 people for at least 60 days each year. PWSs can be community, non-transient non-community, or transient non-community systems" (PADEP, 2009c). These 13 systems provide treated water to over 86,000 people throughout Northumberland County. Three of these systems use surface water as the primary water source, while eight use groundwater and two use groundwater that is under the influence of surface water (USEPA, 2009d). In addition, Northumberland County has five major and 14 minor public (municipal) wastewater/sanitary sewer treatment plants. The total wastewater flow to these 19 municipal public sewer systems within Northumberland County is approximately 19.6 MGD (74.2 mld) (PADEP, 2009d).

References cited in response:

Luzerne County, 2009b. Luzerne County Living, Dupont Borough, Website: http://www.luzernecounty.org/living/municipalities/dupont_borough, Date accessed: October 14, 2009.

Luzerne County, 2009c. Luzerne County Living, Township of Salem, Website: http://www.luzernecounty.org/living/municipalities/township_of_salem, Date accessed: October 14, 2009.

MCPC, 2009. Montour County Planning Commission, Montour County Comprehensive Plan, April 2009.

PADEP, 2009c. Pennsylvania Department of Environmental Protection, Water Standards and Facility Regulation Performance Measures Glossary, Website: http://www.depweb.state.pa.us/watersupply/cwp/view.asp?a=1450&q=512599#POTW, Date accessed: October 9, 2009.

PADEP, 2009d. Pennsylvania Department of Environmental Protection, Water Standards and Facility Regulation, Wastewater Facilities and Permits, Municipal Sewage NPDES Permits Excel Spreadsheet, Updated June 2009, Website: http://www.depweb.state.pa.us/watersupply/cwp/view.asp?a=1450&q=535524#spreadsheet, Date accessed: October 9, 2009.

PPL, 2009a. Bell Bend Nuclear Power Plant Alternative Site Evaluation, BNP-2009-257, dated September 9, 2009.

PPL, 2009b. Bell Bend Nuclear Power Plant Environmental Report Section 9.3, Alternative Sites, BNP-2009-371, dated November 25, 2009.
USEPA, 2009b. U.S. Environmental Protection Agency, Safe Drinking Water Information System (SDWIS), List of Water Systems in SDWIS, Community Water Systems, Montour County, Pennsylvania, Website: http://oaspub.epa.gov, Date accessed: October 9, 2009.
USEPA, 2009c. U.S. Environmental Protection Agency, Safe Drinking Water Information System (SDWIS), List of Water Systems in SDWIS, Community Water Systems, Luzerne County, Pennsylvania, Website: http://oaspub.epa.gov, Date accessed: October 14, 2009.
USEPA, 2009d. U.S. Environmental Protection Agency, Safe Drinking Water Information System (SDWIS), List of Water Systems in SDWIS, Community Water Systems, Northumberland County, Pennsylvania, Website: http://oaspub.epa.gov, Date accessed: October 9, 2009.

COLA Impact.
No changes to the BBNPP COLA are required as a result of this RAI response.

AE 3.4-2

ESRP 3.4.2

Summary: *Discuss the design of the discharge pipe and resolve apparent inconsistencies within the ER and with the FSAR regarding:*

- *The length of the diffuser and of the total pipeline as it extends into the river*
- *The number of ports*
- *The width of the concrete pad that will support the discharge pipeline anchors*
- *The height of the pad above the river bottom*
- *Any planned burial of the discharge pipe in the Susquehanna River*

Full Text: There are various discussions in the ER text that indicate different lengths for the discharge pipe. The text (Ch. 3) describes the cooling system discharge pipe as extending 212 ft from shore with a diffuser that is 106.5 ft long from first port to last with 72 4-in.-diameter ports spaced at 1.5-ft intervals. The text in ER Ch. 5 describes a 120-ft-long diffuser, which would give a total pipe length of 332 ft. The text on ER Rev 1, p. 5-22 describes a 200 ft pipe. Figure 3.4-6 appears to show the diffuser as being only 40.5 ft from first port to last with 28 4-in.-diameter ports spaced at 1.5-ft intervals. Note also that text in aquatic ecology impacts seems to differ (ER Rev 1, p.4-45) but is close to dimensions in ER Chapter 5.

Response: See Figure 1 below for a BBNPP discharge plan-view dimensions sketch.

First Bullet

The diffuser is 119'-6" in length. The retention basin discharge pipe extends into the river at plan-view length along the pipe of approximately 258 feet. The discharge pipe meets up with the diffuser at a distance 203 ft perpendicular from the shoreline. The first port of the diffuser is 212 ft perpendicularly from the shoreline. The combined plan-view length along the pipe/diffuser of the discharge pipe and the discharge diffuser in the Susquehanna River is 377-6". The end of the discharge diffuser is approximately 310 ft perpendicular from the shoreline.

Second Bullet

There are 72 4-inch diameter ports on the discharge diffuser angled 45° above the horizontal in direction of the river flow and arranged 1'-6" apart (center-to-center) spanning a total length of 106'-6" on the diffuser.

Third Bullet

The concrete pad that supports the diffuser is 7 ft wide.

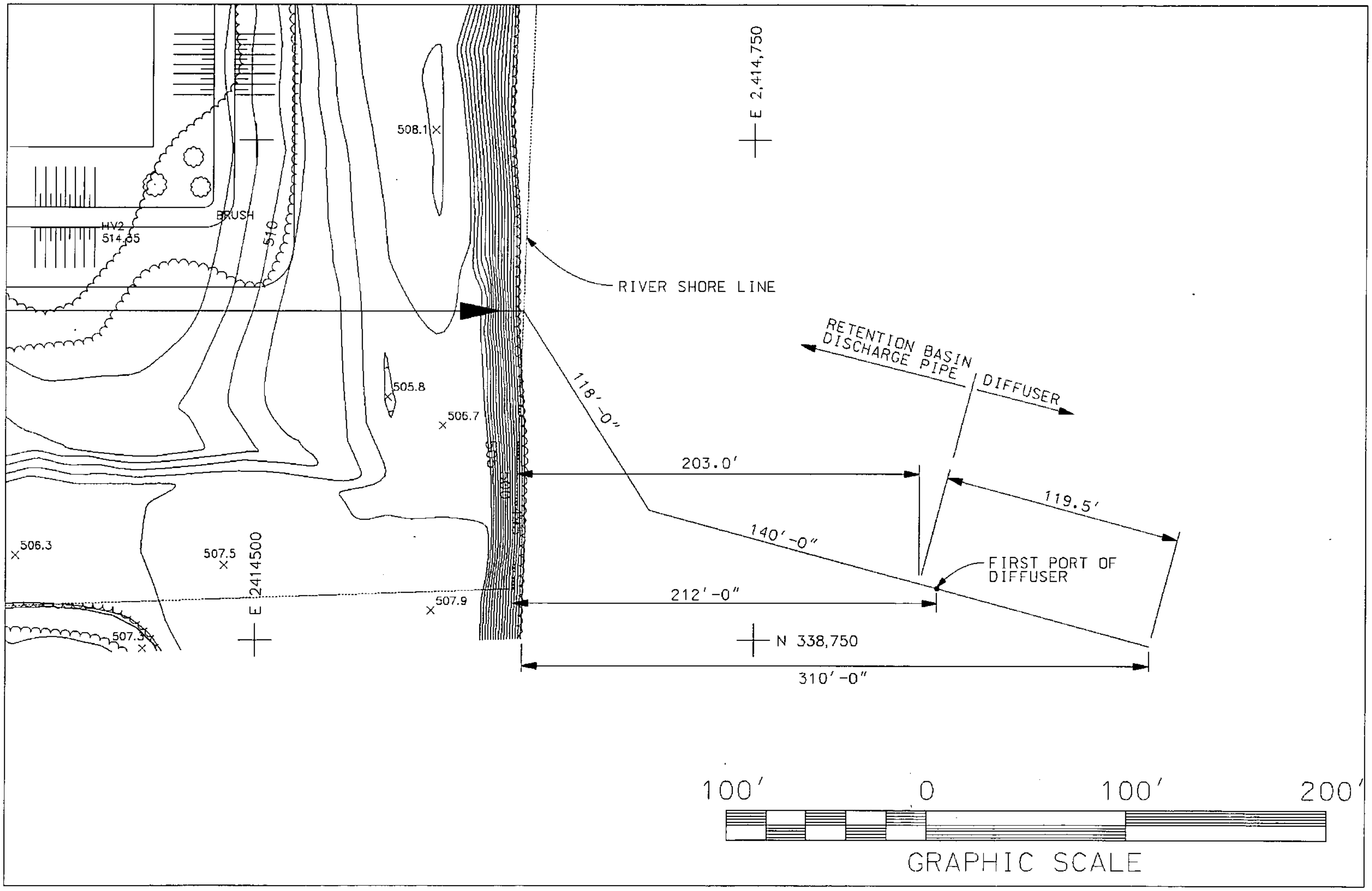
Fourth Bullet

The top of the concrete pad is at the same elevation as the centerline of the discharge diffuser, Elevation 476 feet. The height of the top of the pad above the river bottom varies (but is not less than 2 ft) as the river bottom elevation varies.

Fifth Bullet

The discharge pipe is buried until it reaches the proximity of the diffuser.

Figure 1 - BBNPP Discharge Plan View Dimensions Sketch



COLA Impact:
The BBNPP COLA FSAR will be revised as follows in a future revision of the COLA:

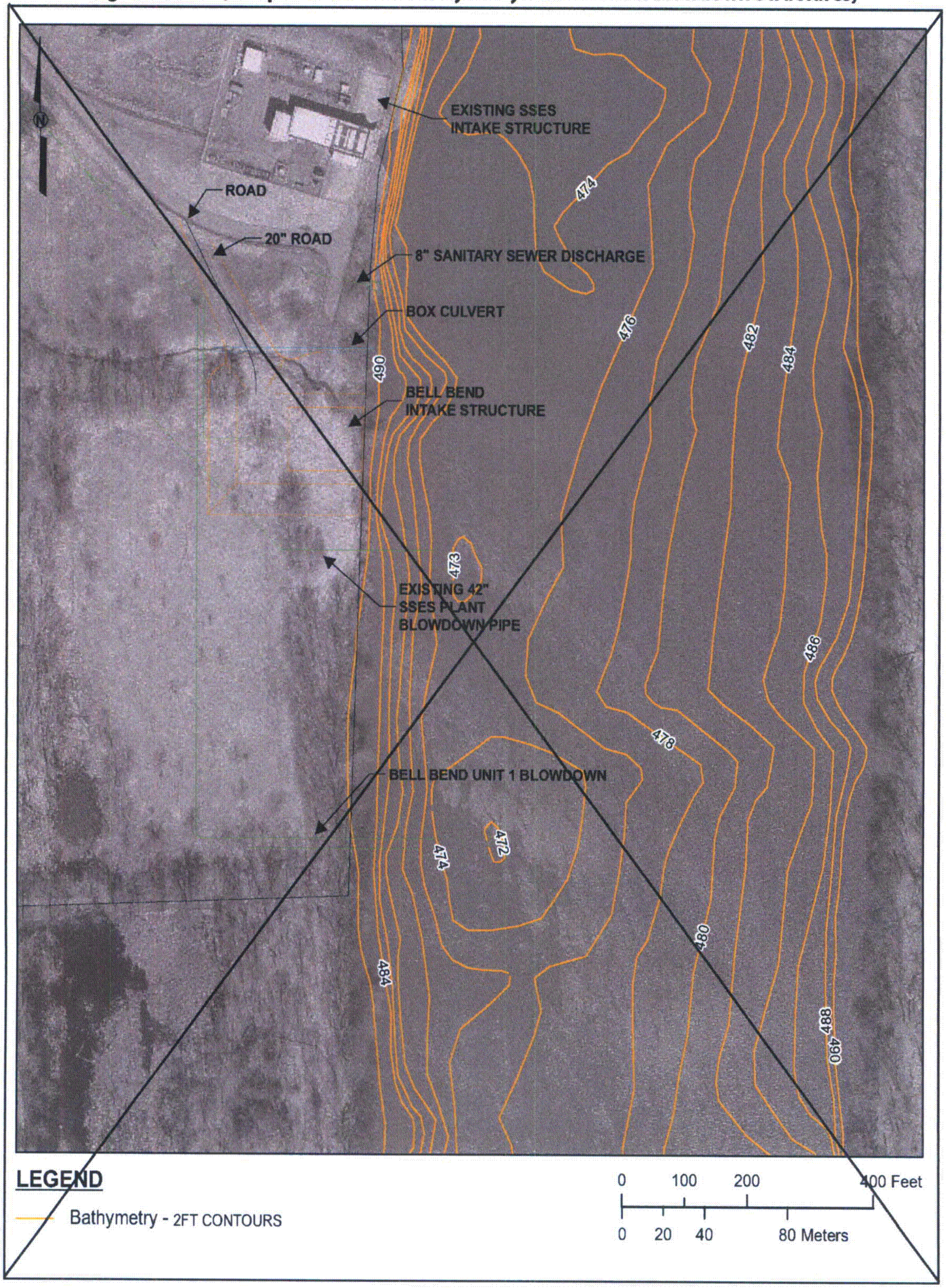
2.4.7.3 Intake and Discharge Structures

Plant effluent going back to the Susquehanna River from BBNPP consists of cooling tower blowdown from the CWS cooling towers and the ESWS cooling towers, and miscellaneous low volume wastewater streams from the Power Block. The blowdown line extends approximately ~~200 ft (61 m)~~ <u>310 ft (95 m)</u> into the Susquehanna River below the design minimum water level of 484 ft (148 m) msl. Ice or ice flooding will be no problem at the discharge structure, as the warm discharge water will keep the outfall open.

2.4.11.1 Low Flow in Rivers and Streams

The BBNPP discharge pipe extends approximately ~~200 ft (61 m)~~ <u>310 ft (95 m)</u> into the Susquehanna River (Figure 2.4-10). As a conservative approach, the probable minimum flow of 532 cfs (15 m^3/s) recorded at Wilkes-Barre was used as the design basis. The flow of 532 cfs (15 m^3/s) will bring the water level near the discharge line to approximately elevation 485.3 ft (147.9 m) msl (Soya, 1991). The CWS Makeup Water Intake Structure Design will accommodate river levels as low as 484 ft (148 m) msl. The centerline of the discharge line is at elevation of 476 ft (145 m) msl, approximately 9 ft (3 m) below the estimated water level near the discharge line and 8 ft (2 m) below the established design low water level for the CWS intake; thus low water levels will not uncover the discharge pipe or affect the non-safety-related makeup water supplies.

Figure 2.4-10 {Susquehanna River Bathymetry near Intake & Blowdown Structures}



Revised Figure 2.4-10 {Susquehanna River Bathymetry near Intake & Blowdown Structures}

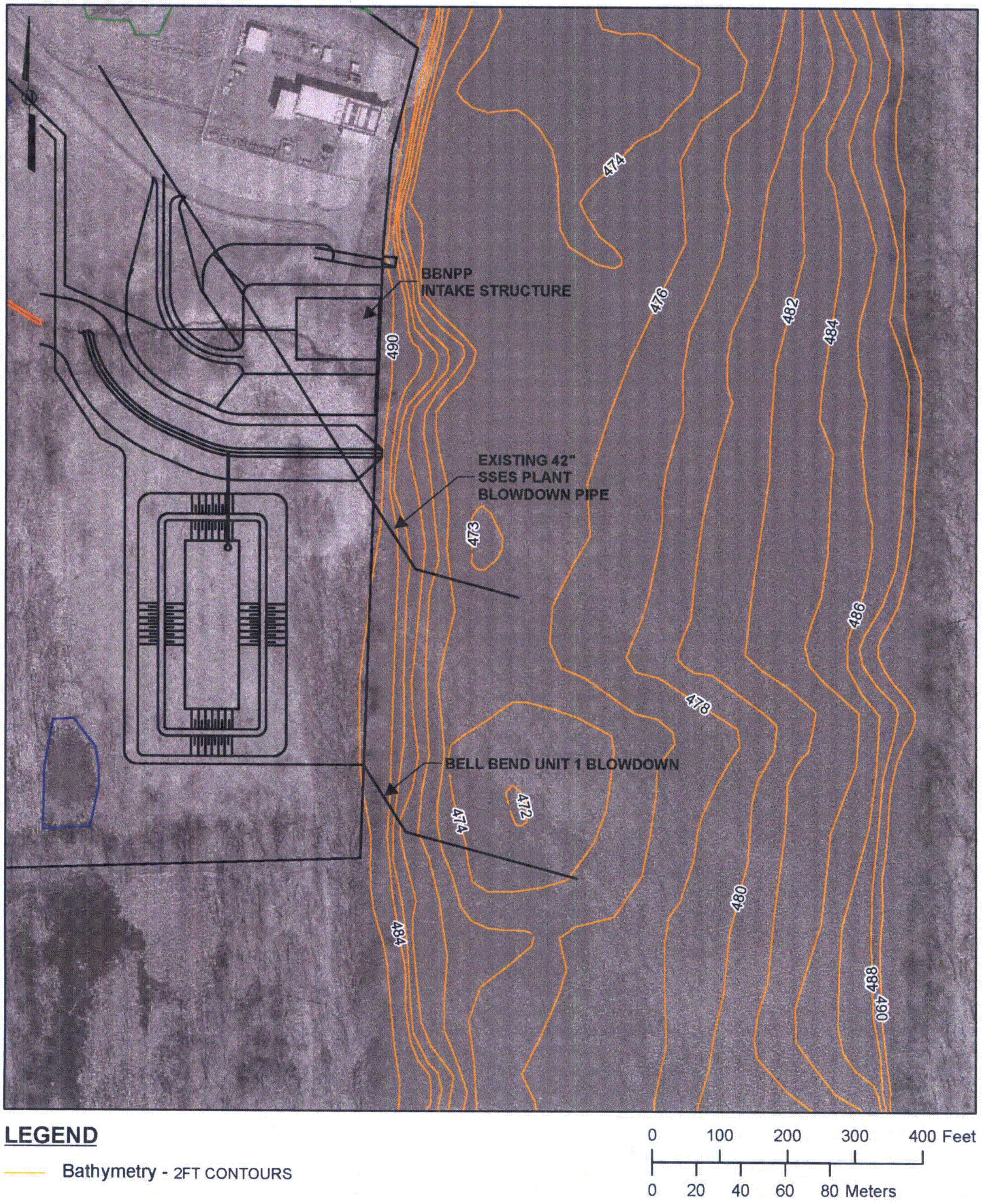
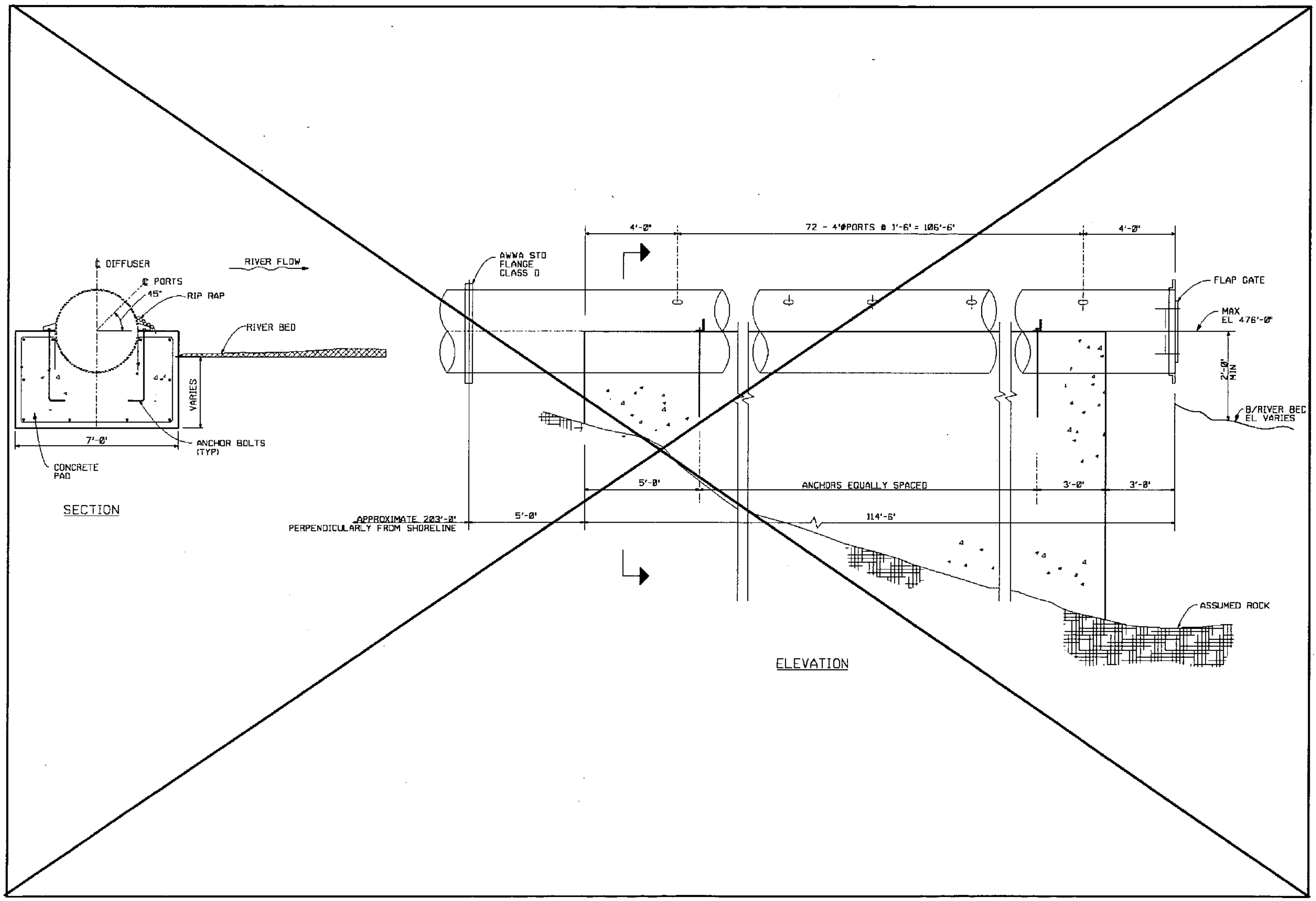
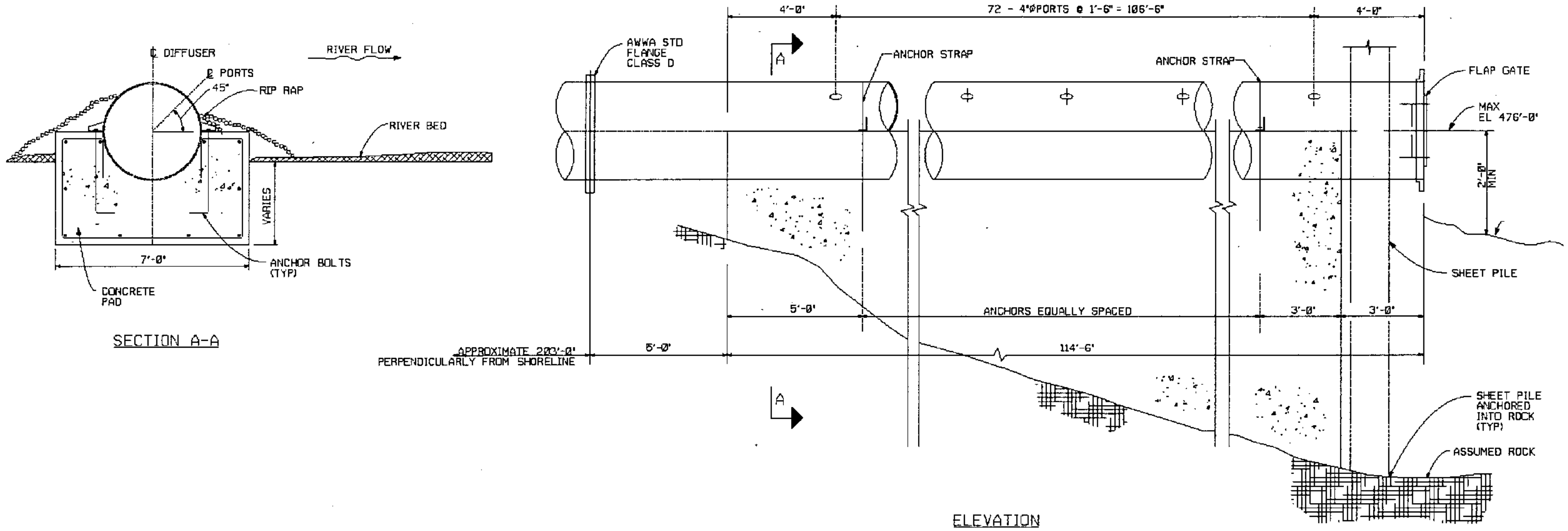


Figure 10.4-9 {Discharge Diffuser}



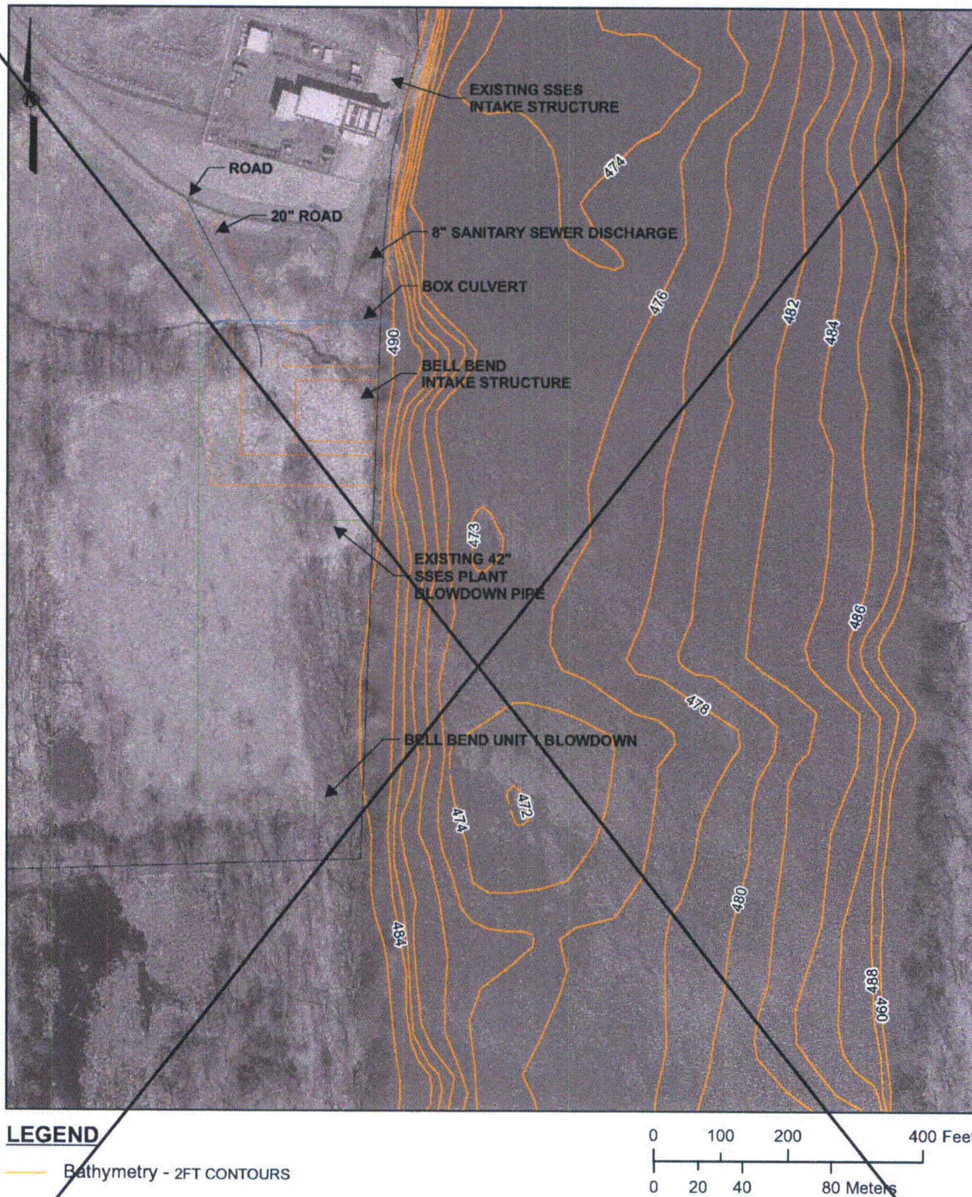
Revised Figure 10.4-9 {Discharge Diffuser}



The BBNPP COLA ER will be revised as follows in a future COLA revision.

2.3.1.1.1.8 Bathymetry of the North Branch of the Susquehanna River (NBSR)
The discharge line discussed in Section 3.4.2.2 and illustrated in Figure 3.4-6 shows that the height of the ~~28~~72-4 in (10 cm) diameter port holes ~~are located on top of the pipe at approximately elevation 476 ft (145 m) msl~~ above the river bed varies as the river bed elevation varies. The angle of discharge of the port holes is 45 degrees to horizontal. The NBSR bottom elevation ~~where the pipe discharges is at~~ along the diffuser varies but is not greater than elevation 474 ft (144.5 m) msl (Figure 2.3-11).

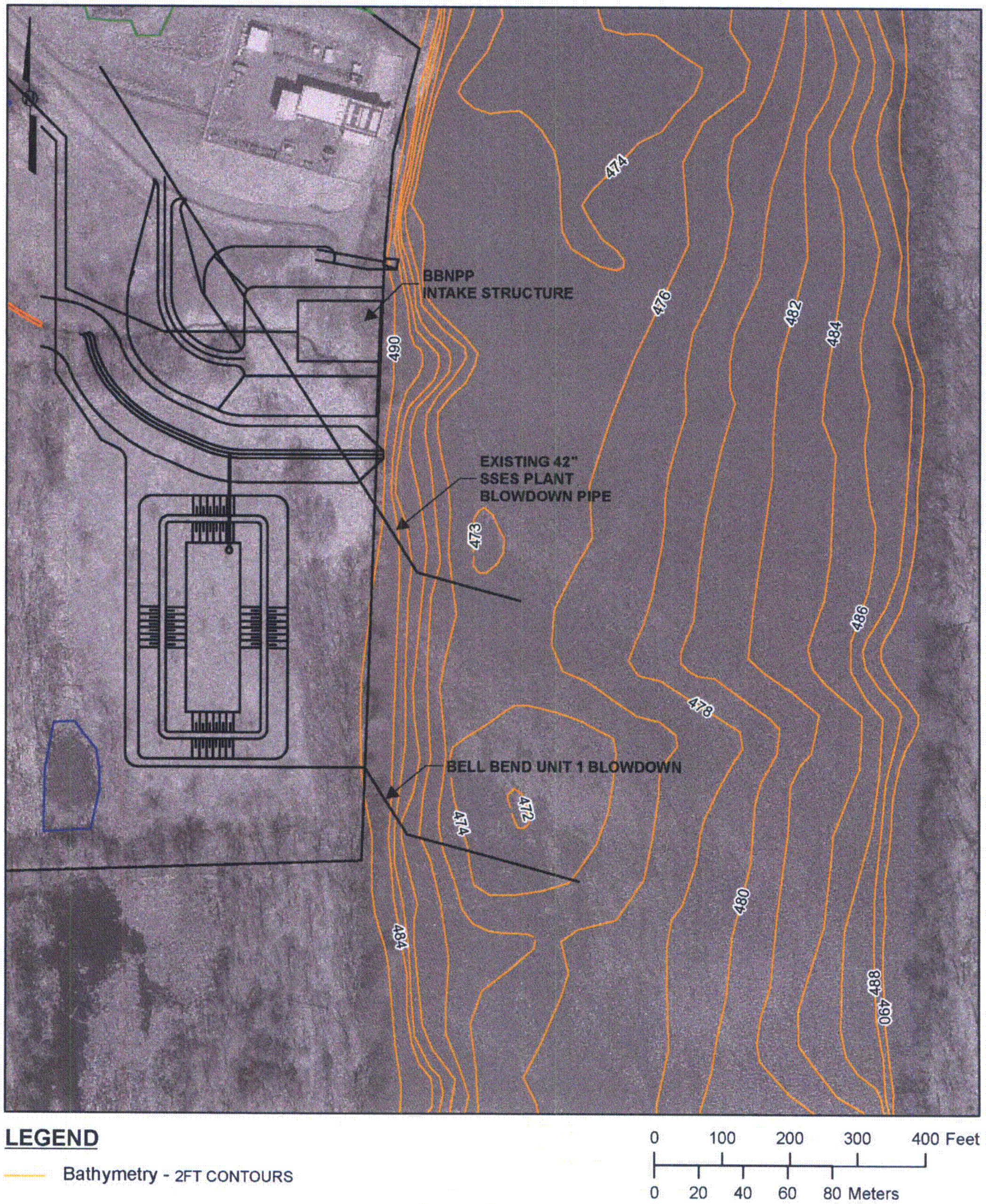
Figure 2.3-11 Susquehanna River Bathymetry Near Intake and Blowdown Structures



REFERENCES:
Regional Susquehanna River Bathymetry Data,

Sargent & Lundy, 12198-004-CSK-001.
Susquehanna River FEMA Data.

Revised Figure 2.3-11 Susquehanna River Bathymetry Near Intake and Blowdown Structures

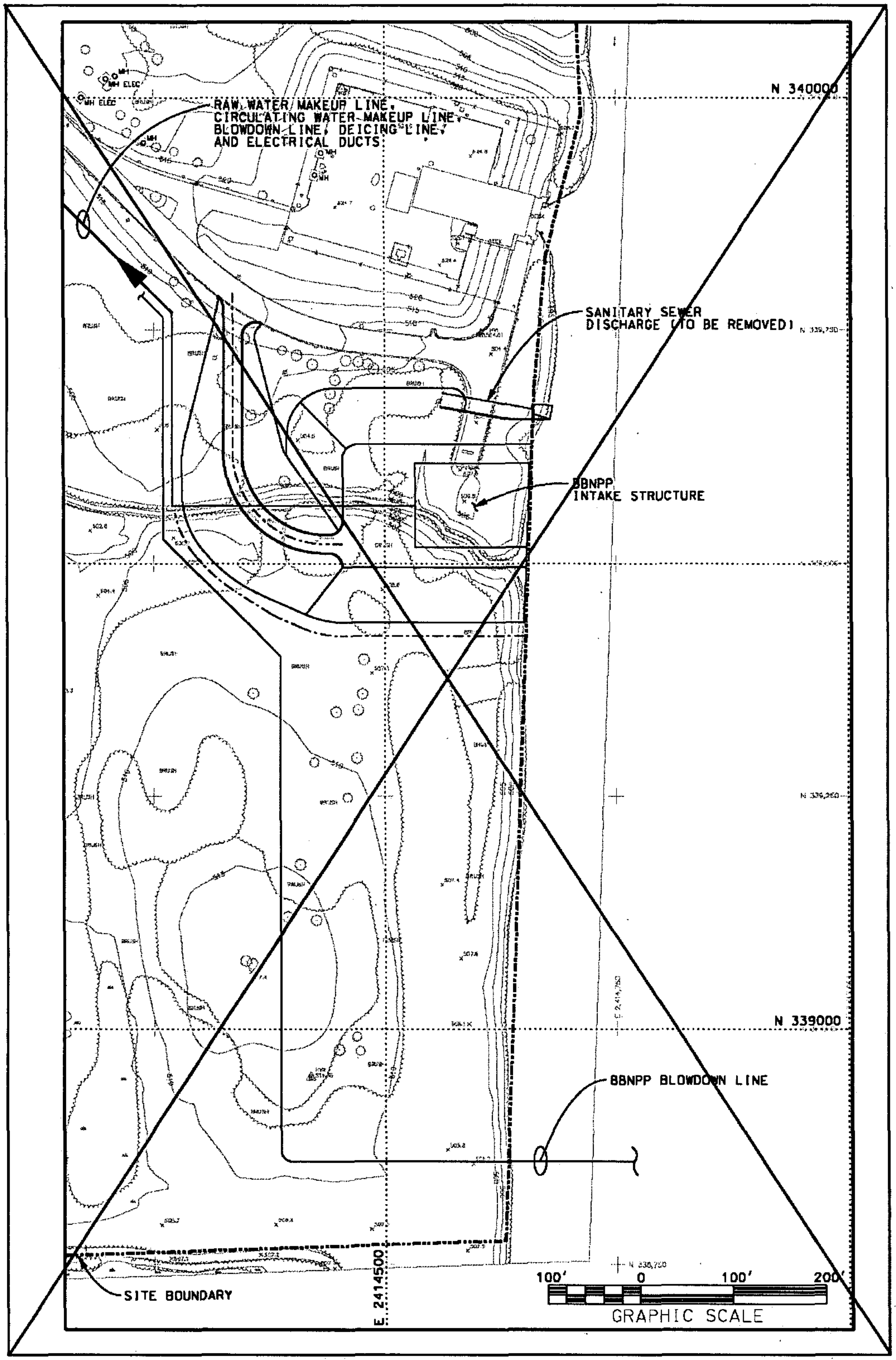


REFERENCES:
Regional Susquehanna River Bathymetry Data, Sargent & Lundy, 12198-400-010-02.
Susquehanna River FEMA Data.

3.4.2.2 Final Plant Discharge

The discharge structure is designed to meet applicable navigation and maintenance criteria and to provide an acceptable mixing zone for the thermal plume per the Commonwealth of Pennsylvania regulations for thermal discharges. The discharge ~~point~~ diffuser is near the southwest bank of the Susquehanna River approximately ~~700 ft (210 m)~~ 720 ft (220 m) south of the intake structure for BBNPP. The BBNPP discharge pipe and diffuser is aligned parallel to, and approximately 380 ft (116 m) south, of the existing Susquehanna Plant Units 1 and 2 discharge lines. Figure 3.4-3 shows the location of the intake structure and discharge lines. The 24 in (61 cm) discharge pipe extends approximately 212 ft (64.6 m), measured perpendicular from the shoreline to the first diffuser port, into the river. Connected to the discharge pipe is a 106.5 ft (32.5 m), as measured from the first to the last port, long diffuser. Figure 3.4-6 shows details of the diffuser pipe. The centerline elevation of the discharge diffuser is Elevation 476 ft (145 m) msl. The diffuser center elevation is approximately 9 ft (3 m) below the ~~estimated~~ probable minimum flow river level as discussed in FSAR Section 2.4.11. The diffuser seventy-two 4 in (10 cm) diameter port holes are spaced center-to-center at 1.5 ft (0.5 m). The height of the port holes above the river bed varies as the river bed elevation varies. The angle of discharge of the port holes is 45 degrees to horizontal. The discharge diffuser will be supported on the river utilizing equally spaced anchors embedded in a 111.5 ft (34 m) long concrete pad as shown on Figures 3.4-6 and 3.4-12.

Figure 3.4-3 Circulating Water System Intake/Discharge Structure Location Plan



Revised Figure 3.4-3 Circulating Water System Intake/Discharge Structure Location Plan

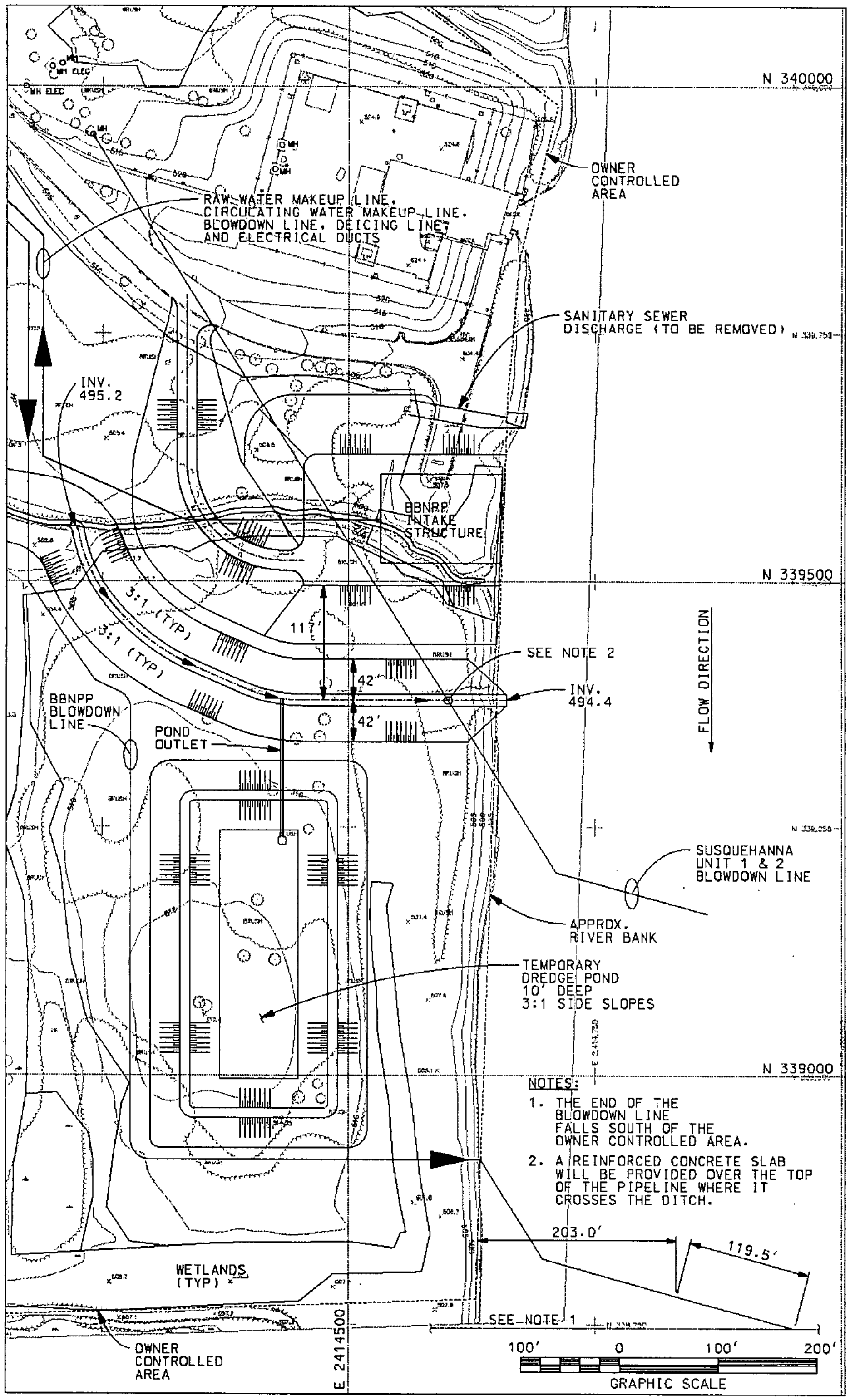
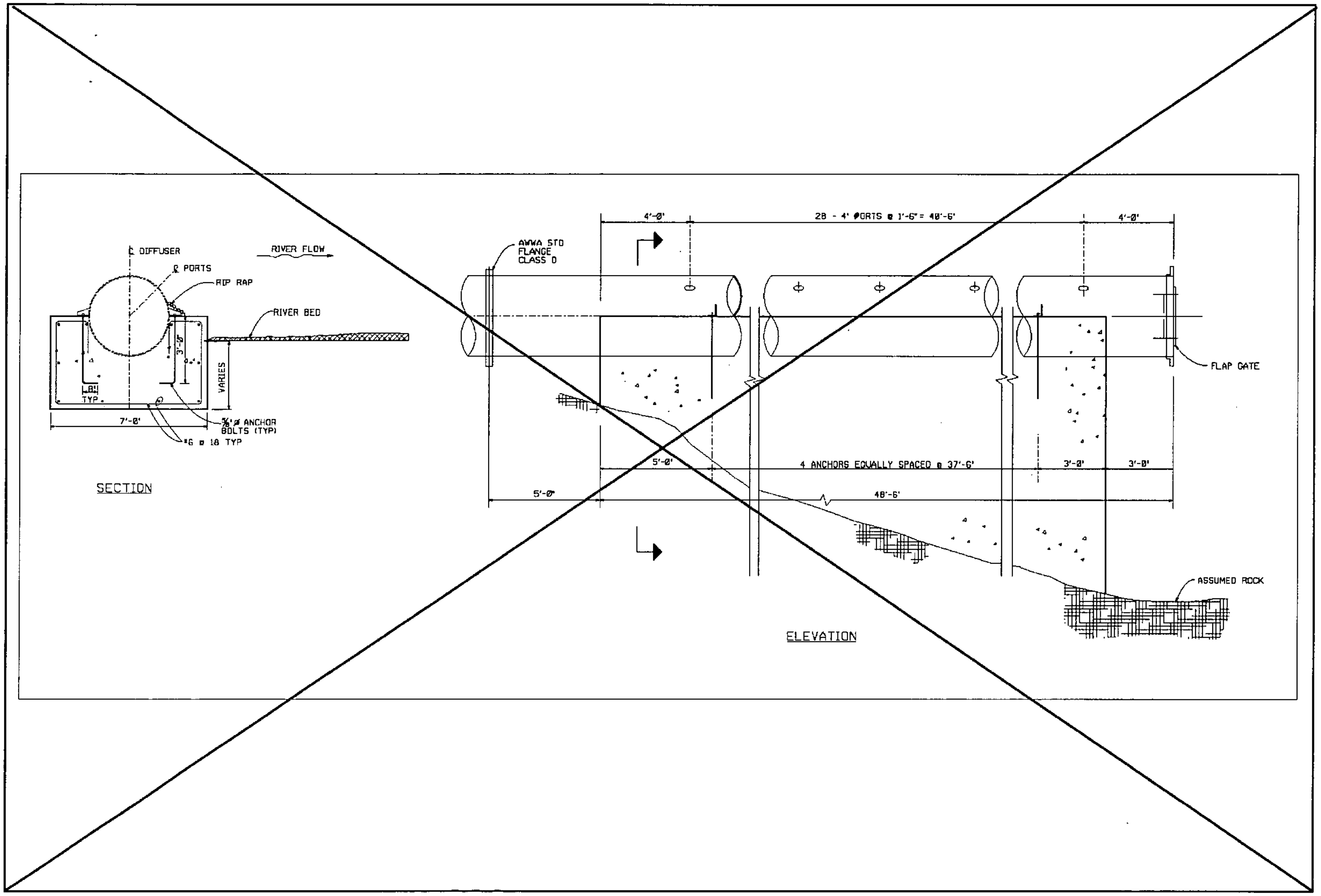


Figure 3.4-6 View of Discharge Outfall for Discharge System for BBNPP



Revised Figure 3.4-6 View of Discharge Outfall for Discharge System for BBNPP

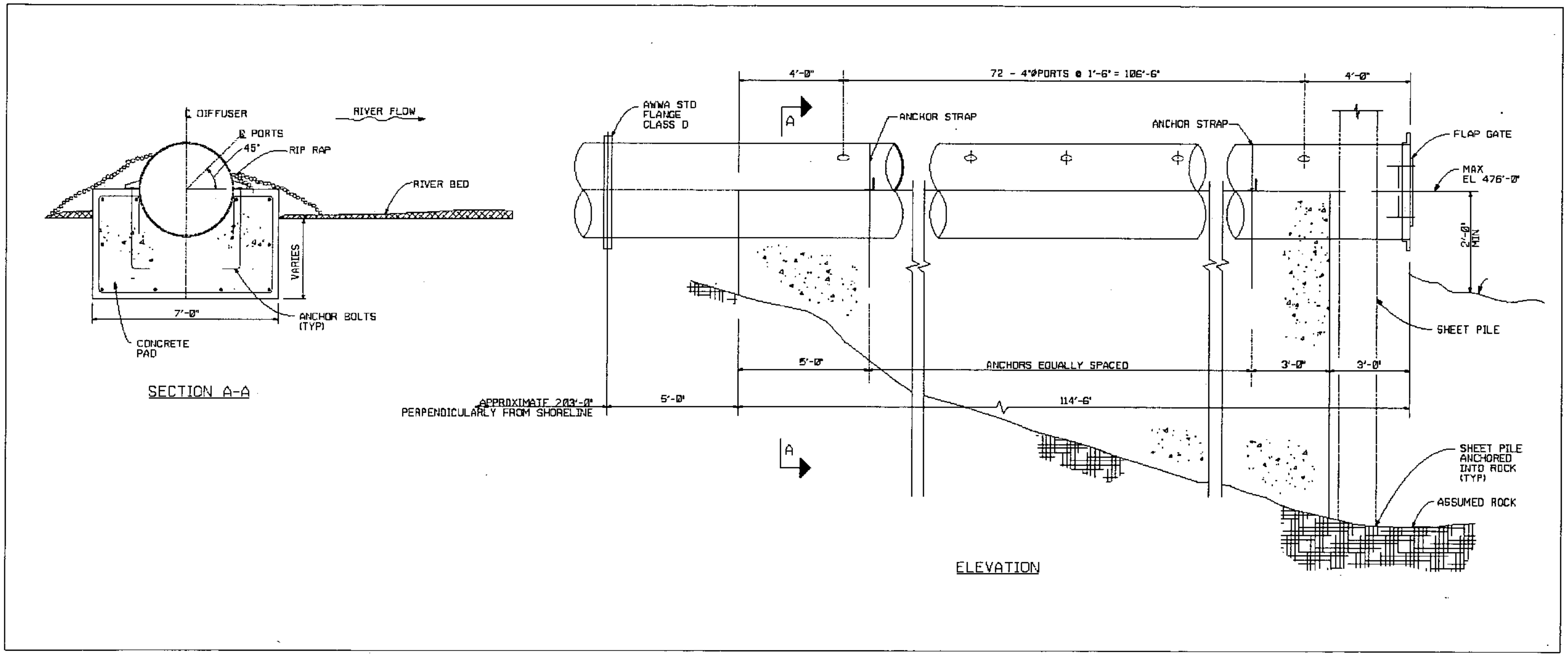
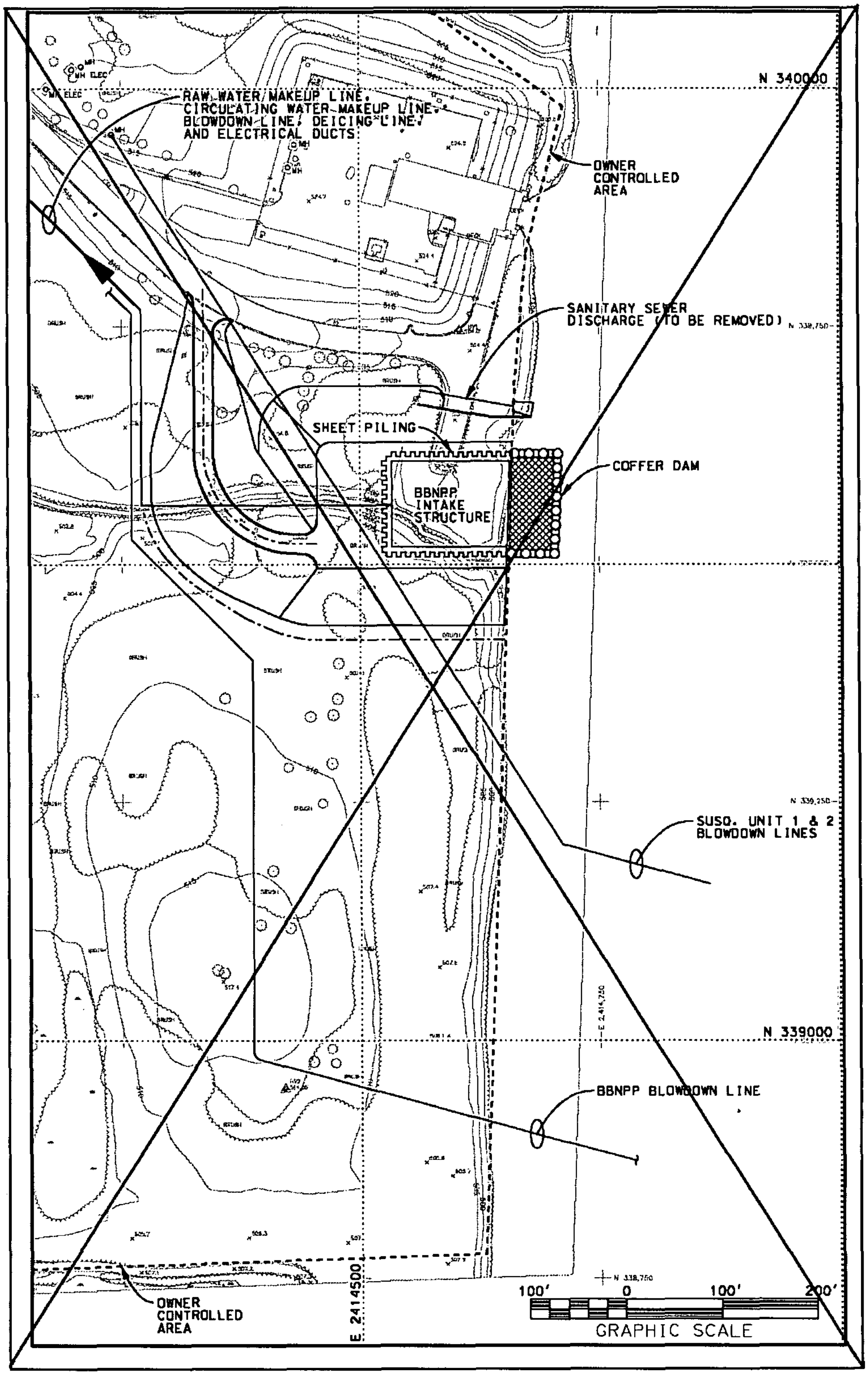
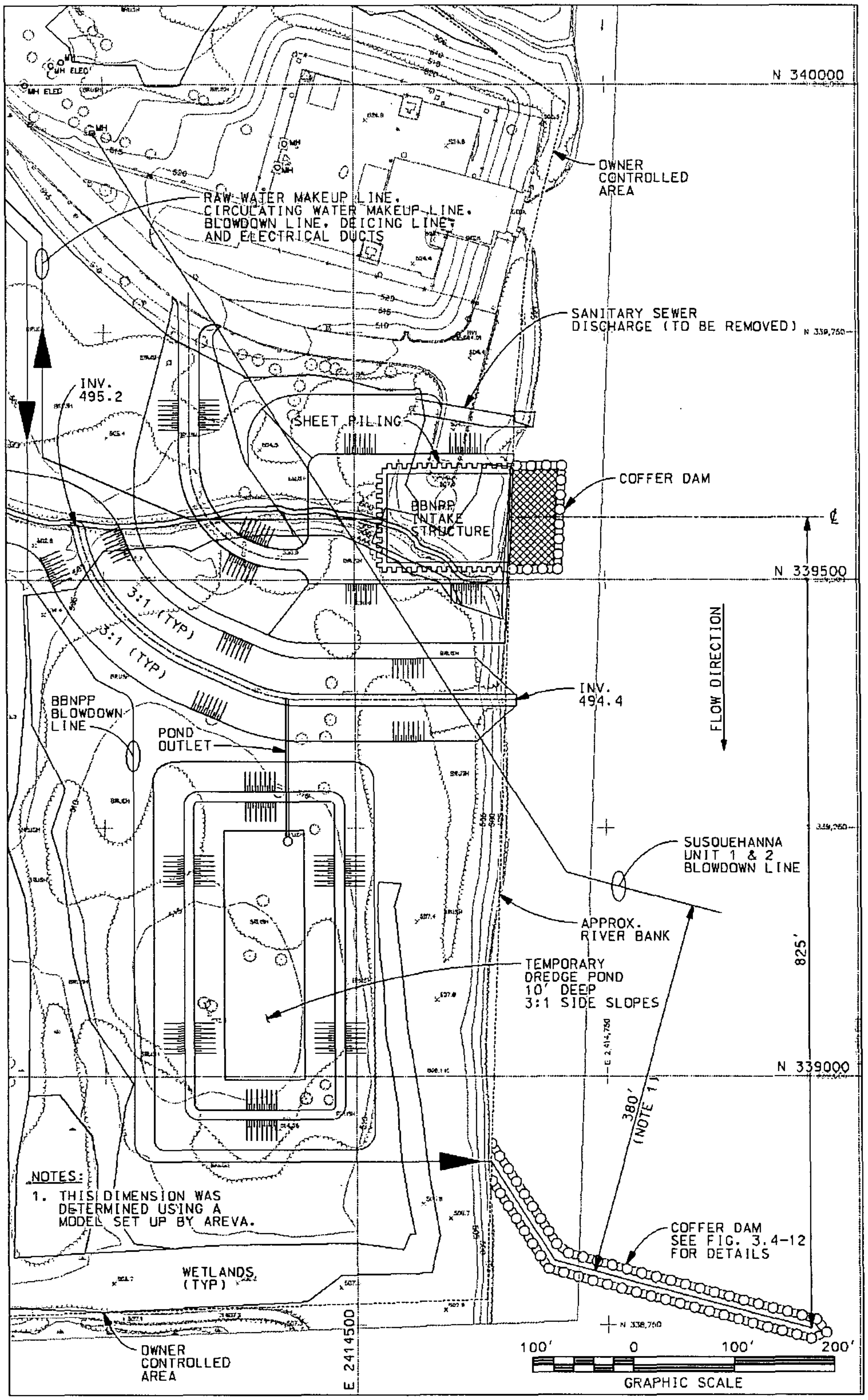


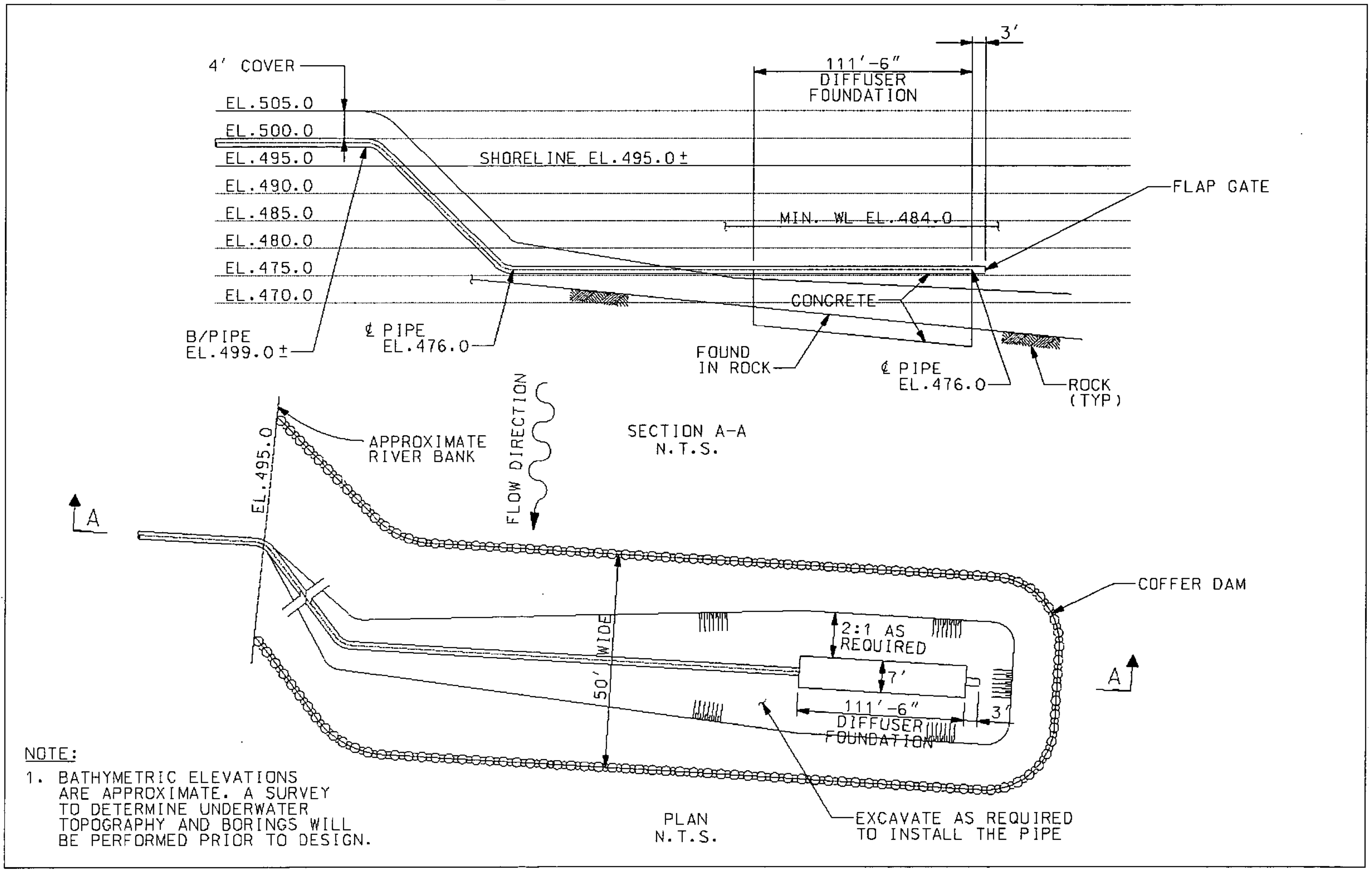
Figure 3.4-11 CWS Makeup Water Intake Structure Construction Coffer Dam



Revised Figure 3.4-11 CWS Makeup Water Intake Structure Construction Coffer Dam



New Figure 3.4-12 End of Blowdown Line



4.3.2.2 Impacts to the Susquehanna River and Offsite Streams

A similar process will be employed during diffuser pipe installation. The diffuser begins 203 ft (62 m) perpendicular from the shoreline, and ~~extends~~ is 119.5 ft (36 m) ~~into the river channel~~ in length. The axial distance along the discharge pipeline to the diffuser is approximately ~~210 ft (64 m)~~ 258 ft (79 m). Thus the trench for the pipeline and the diffuser will extend approximately ~~329.5 ft (100 m)~~ 377.5 ft (115 m), i.e., ~~210 ft (64 m)~~ 258 ft (79 m) plus (+) 119.5 ft (36 m), into the river, and will be approximately 50 ft (15 m) wide. The total disturbed area during construction will be approximately ~~16,500 ft^2 (1,533 m^2)~~ 18,875 ft^2 (1,754 m^2). After installation of the pipe and the riprap protection, the final disturbed area will be slightly narrower, with a disturbed area of approximately ~~329.5 ft (100 m)~~ 377.5 ft (115 m) by 20 ft (6 m) for a total of ~~6,600 ft^2 (613 m^2)~~ 7,550 ft^2 (701 m^2).

5.2.1.2.1 Surface Water

BBNPP is designed to use the minimum amount of water necessary to ensure safe, long-term operation of the plant. The intake for BBNPP (Circulating Water System (CWS) Intake Structure) will be located just downstream of the existing intake structure for SSES. The discharge outfall will enter the Susquehanna River downstream of the existing SSES discharge system through a buried pipe that will be connected to an approximately 120 ft (36.6 m) long multi-port diffuser positioned ~~perpendicular to the Susquehanna River flow~~ aligned parallel to, and approximately 380 ft (116 m) south of, the existing Susquehanna Plant Units 1 and 2 discharge line with 72 individual 4 in (10.2 cm) diameter ports spaced center-to-center 18 in (46 cm) apart. The first port will be located approximately 212 ft (64.6 m) offshore, measured perpendicular to the shoreline. Additional details on the intake and discharge systems are presented in Section 3.4. Water withdrawals for the operation of BBNPP are described in detail in Section 3.3.1.

5.2.3.4 Discharge Mixing Zone

The discharge outfall for BBNPP will be located in the Susquehanna River, approximately 380 ft (116 m) downstream of the SSES discharge structure. The discharge piping will extend out from the river bank and connect to an approximately 120 ft (36.6 m) long multi-port diffuser. The diffuser will consist of a pipe having 72, 4-in (10-cm) diameter port holes spaced at 18 in (45 cm) intervals. The centerline ~~elevation~~ of the discharge ~~ports is 12 in (18 cm)~~ diffuser is at the 476 ft (145 m) elevation, a minimum of 2 ft (0.6 m) above the ~~normal~~ river bottom.

5.3.2.1 Thermal Description and Physical Impacts

In assessing the impact of the thermal discharge from the BBNPP, the average total effluent discharge flow was conservatively estimated to be 11,172 gpm (42,290 lpm). The BBNPP discharge structure will consist of a subsurface multi-port diffuser located approximately 720 ft (220 m) south of the CWS Makeup Water Intake Structure, extending about 310 ft (95 m) into the river at a low river flow depth of 10 ft (3.05 m). The diffuser will be similar to the existing SSES diffuser and will consist of seventy-two, 4 in (10 cm) nozzles located close to the bottom. The subsurface diffuser will rapidly mix blowdown discharge with the Susquehanna River.

5.3.2.1.1 Susquehanna River Datasets

Bathymetric data in the vicinity of BBNPP were developed from two sources: US Army Corps of Engineers, Philadelphia District (USACE) provided digital terrain maps (TIN's), shoreline data in ARC/INFO interchange file format (e00), and cross-section data from their FEMA HEC-RAS model (Arabatzis, 2008). More spatially-detailed bathymetric contours in the immediate vicinity of the SSES intake and discharge (1978) are provided in Figure 2.3-11. ~~The elevation of the bottom of the Susquehanna River at the BBNPP discharge is 476 ft (145 m)~~ The centerline of the discharge diffuser is at the 476 ft (145 m) elevation, a minimum of 2 ft (0.6 m) above the river bottom.

9.4.2.1 Intake and Discharge Systems

As described in Section 3.4.2.2, the discharge structure will be designed to meet all applicable navigation and maintenance criteria, and to provide an acceptable mixing zone for the thermal plume per the Commonwealth of Pennsylvania regulations for thermal discharges. Figure 3.4-6 shows details of the discharge system. The discharge point is near the southwest bank of the Susquehanna River approximately ~~700 ft (210 m)~~ 720 ft (220 m) south of the intake structure for BBNPP and extends about ~~150 ft (46 m)~~ 310 ft (95 m) into the river through a 24 in (61 cm) discharge pipe with diffuser port holes at the end of the line.

AE 4.3-4

ESRP 4.3.2

Summary: *Provide information about use of cofferdams to aid in the installation of the intake system, the outfall pipeline, and the diffuser:*

- *describe how the cofferdam would be installed and how would it be anchored to the bedrock;*
- *if a barge would be used, describe the type of barge (vessel operated, jack-up) and the potential impacts from its use;*
- *if pile driving is used, describe the process including details about the sheet pile type, and support piers, and the type of hammer;*
- *describe the potential noise impacts to aquatic organisms in the river.*
- *describe any surveys for the occurrence of important freshwater mussel species and any steps that would be taken to reduce possible impacts to the green floater and yellow lampmussel and other mussels of concern;*
- *describe any additional disturbance that would occur when the cofferdam is removed and the area of this disturbance:*
- *provide details about how the excavation of the trench for the diffuser pipeline would be accomplished.*

Full Text: ER Rev 1, p.3-27 (section 3.4.2.1) states that the cofferdam would be installed from shore, but sections farther out in the river might be installed by barge or from the top of the cofferdam.

ER Rev 1, pp 4-12; 4-52 mentions pile driving during construction. Describe the potential impacts from this activity to aquatic organisms.

ER Rev 1, p. 4-45 states the when the cofferdam is removed, an additional area would be disturbed such that total disturbed area is 26,400 ft^2 (0.61 ac). Please describe this area and how it would be disturbed.

Response:

First Bullet

The cofferdam will be driven to refusal into the underlying bedrock to form a seepage cutoff. Utilizing the cellular type cofferdam, the individual steel sheets would be driven in a near circular formation. The initial cells could be installed using a crane and pile driver from the shore. As the work progresses, the crane could be mounted on the cofferdam if it has a sufficient diameter to support the crane. If the cell is too small, then a crane mounted on a barge could be used to drive the sheet piles. As the cells are completed, special interconnecting pieces are installed between the cells to maintain the water tight effect. The stability of the cells is maintained by the friction of the cell on the bottom of the river in conjunction with the lateral resistance provided by the lateral pressure from their embedment in the soil substrate in the river bottom.

Second Bullet

The barge is expected to be a commercially available barge pushed into position by a small tug or boat capable of navigating the Susquehanna River. If no commercial barges are available, then the barge can be trucked to the site in sections and assembled nearby before floating it to the site. A small boat or tug would be needed to maneuver the barge into position. Jacks or spuds would be needed at the corners of the barge to stabilize it in the river during sheet pile installation. After the barge is fixed in its location, the boat would not be needed until the barge was to be relocated. Thus the effects of the boat would be equivalent to normal river boat traffic. The barge would be located within the area of the excavation for most of the sheet pile installation, thus minimizing the effects of the jacks on the river bottom.

A similar approach would be utilized for the construction of the discharge pipeline and the diffuser. The barge would be set up on the equivalent interior (downstream) side of the cofferdam and thus would have minimal net effect on the Susquehanna River.

Third Bullet

The sheet piles would probably be PS-27.5, PS-31, or equivalent straight sections and interlock in a near circular formation with interconnecting pieces. Either a drop hammer, hydraulic hammer, or a vibratory hammer will be used to install the sheet pile sections. This is typically the contractor's choice and familiarity with the equipment necessary to drive the sheet piles to refusal in the bedrock. The circular cells would be designed to be self-supporting in conjunction with the interconnecting pieces to maintain a continuous seepage cutoff. Thus, no additional support piers would be required.

Fourth Bullet

During the construction of cofferdams, sheet piles will be installed and sounds will be created from the use of drop, hydraulic, or vibratory hammers. Fish in the immediate area of the construction will likely be disturbed by noises and other activities that precede sheet pile installation and will swim from the area prior to sheet pile-driving. This initial movement of fish out of the construction area will greatly reduce the likelihood of fish stress or injury from the construction noises. Once sheet pile-driving is initiated the sounds caused by this activity will likely be loud enough to cause most of the fish remaining in the vicinity of the installation to be disturbed and swim away from the area. It is possible that some fish remaining in the immediate vicinity of the pile-driving could be subjected to physical injury or mortality from the impact sound associated with the pile-driving. Current scientific research in the area of the effects of sound on fish from pile-driving is limited but there is concern over fish injury or mortality from pile-driving (Hastings and Popper, 2005). Physical injury or mortality from the sounds created by pile-driving are known to be species specific and are typically more severe the closer the fish is to the pile-driving. However, fish injury or mortality for construction of the BBNPP intake and diffuser structures will be minimal based on the characteristics of the fish community within the Susquehanna River. That is, fish are not concentrated in this section of the river, no migratory fish species occur within this section of the river, and no schooling fish species occur within this section of the river. Lastly, it is important to note that no threatened or endangered fish species occur within the section of the river where construction will take place. Construction activities will only cause a temporary disturbance and fish that vacate the area will likely return after installation of the sheet piles and other construction activities are completed.

Other less mobile aquatic organisms that are unable to leave the area could be affected by the noises depending on their proximity to the hammers. Mussels living in the area directly adjacent to the footprint of disturbance may be disturbed by the noise. If disturbed by the noise, these mussels would likely suspend normal feeding activity until after construction activities were completed for the day. This pattern of mussel disturbance would continue until construction was completed. This would only be a temporary disturbance and mussels would resume normal activities once the construction activities ceased. It is also possible that the noises generated during construction will cause some insects to drift from the area. This will also be a temporary disturbance as insects and other organisms will recolonize the substrate subsequent to completion of sheet pile installation (Skelly and Loy, 2005).

Fifth Bullet

A mussel survey was completed during the fall of 2007 in the Susquehanna River in the vicinity of the proposed BBNPP intake system. ER Section 2.4.2.2 describes the mussel survey. Impacts to mussels will be reduced by utilizing construction practices that minimize sedimentation and physical disturbance of the stream bottom. Mussel surveys within the actual footprint of disturbance for the intake and diffuser may be necessary to determine their density and species composition within these areas. If mussels of concern are present within these areas, it is likely that they will need to be relocated to another portion of the river. Coordination with the Pennsylvania Fish and Boat Commission, once the actual footprint of the in-river disturbed area is fixed, will be necessary to determine the need for and scope of a more detailed mussel survey and potential relocation effort. The process of relocating mussels of special concern is a practice that has been employed in Pennsylvania when mussels may be subjected to mortality from construction related activities. For example, a mussel relocation was completed during 2005 in the North Branch Susquehanna River, approximately 10 miles downstream of the BBNPP intake structure, for a sewer main crossing in the river (Skelly and Loy, 2005). During the survey all mussel species, including green floater and yellow lampmussel, were removed from the footprint of disturbance and relocated to a downstream location with suitable mussel habitat (Skelly and Loy, 2005).

Sixth Bullet

After completion of the construction of the intake structure and excavation of the area in front of the intake structure but inside the cofferdam, the cofferdam and any sheet piling in the river is removed from in front of the structure. The sheet piling used on the three land sides for the excavation of the intake structure may be left in place and used as formwork for the concrete walls of the structure. This does not have any effect on the river. Dredging may not be required for the forebay area if this area is within the limits of the cofferdam. However, some dredging is required in the river in front of the structure to remove the material from within the cofferdam and to shape the slope on all three sides to the design elevation of the forebay area to minimize sedimentation in the structure. The area of disturbance due to the cofferdams would be approximately 400 feet in length (the length of the cellular cofferdam in the river) by the diameter of the cofferdam (consider 16 feet in diameter). This area of disturbance would be approximately 6400 square feet.

A similar approach would be utilized for the construction of the discharge pipeline and the diffuser. The barge could be set up on the equivalent interior (downstream) side of the cofferdam and thus would have minimal net effect on the Susquehanna River. The area of disturbance for the removal of the cofferdam would be approximately 400 feet long by 30 feet wide (two sides) for a disturbed area of 12,000 square feet.

Seventh Bullet

The trench for the discharge pipeline and the diffuser will be excavated similar to the approach for the intake structure. A cellular cofferdam will be installed to bedrock to provide a seepage cutoff around the excavation. Since the excavation for the diffuser is performed within the limits of a cofferdam, the work is performed under dry conditions after the river water is pumped out. Some of the river bottom materials will be removed to allow placement of the discharge pipeline below the river level as shown on Figures 3.4-6 and 3.4-12. After the concrete pad, diffuser, anchors, and soil backfill are installed, the riprap is placed using a backhoe. After completion of the pipe installation, the cofferdam will be removed. If no material is placed within the cofferdam cells, then no additional dredging will be required in the river after sheet pile removal because the river bottom should be basically at its original level.

References cited in this response:

Hastings and Popper, 2005. Effects of Sound on Fish. Subconsultants to Jones & Stokes under California Department of Transportation Contract No. 43A0139, Task Order 1. January, 2005. M. C. Hastings and A.N. Popper.

Skelly and Loy, 2005. Mifflinville Sewer Forcemain Project Freshwater Mussel Survey and Relocation Report. Prepared for Greenland Construction, October 2005.

COLA Impact:
The BBNPP COLA ER will be revised as follows in a future COLA revision.

3.4.2.1 Circulating Water System (CWS) Makeup Water Intake Structure

In order to perform the excavation and construction of the intake structure in dry conditions, a seepage cutoff and retaining walls will be required. A cofferdam will need to be installed in front of the CWS Makeup Water Intake Structure to prevent the river flow from entering the excavation. ~~The sheet pile sections can be installed partially from the river bank while the sections farther out in the river will be installed either from a barge or from on top of the cofferdam. They will be driven to the top of rock to provide stability to the wall and to form a seepage cutoff.~~ The cofferdam will be driven to refusal into the underlying bedrock to form a seepage cutoff. Utilizing the cellular type cofferdam, the individual steel sheets would be driven in a near circular formation. The initial cells could be installed using a crane and pile driver from the shore. As the work progresses, the crane is expected to be mounted on the cofferdam if it has a sufficient diameter to support the crane. If the cell is too small, then a crane mounted on a barge would be used to drive the sheet piles. As the cells are completed, special interconnecting pieces are installed between the cells to maintain the water tight effect. The stability of the cells is maintained by the friction of the cell on the bottom of the river in conjunction with the lateral resistance provided by the lateral pressure from their embedment in the soil substrate in the river bottom. The barge would be a commercially available barge pushed into position by a small tug or boat capable of navigating the Susquehanna River. If no commercial barges are available, then the barge can be trucked to the site in sections and assembled nearby before floating it to the site. A small boat or tug would be needed to maneuver the barge into position. Jacks or spuds would be needed at the corners of the barge to stabilize it in the river during sheet pile installation. After the barge is fixed in its location, the boat would not be needed until the barge was to be relocated. Thus the effects of the boat would be equivalent to normal river boat traffic. The barge could be located within the area of the excavation for most of the sheet pile installation, thus minimizing the effects of the jacks on the river bottom. The sheet piles would be straight sections and interlock in a near circular formation with interconnecting pieces. Either a drop hammer, hydraulic hammer, or a vibratory hammer will be used to install the sheet pile sections. The circular cells would be designed to be self-supporting in conjunction with the interconnecting pieces to maintain a continuous seepage cutoff. Thus, no additional support piers would be required.

A standard sheet pile wall will then be constructed around the remainder of the excavation and will be tied into the cofferdam for stability and as a seepage barrier. The installation of the cofferdam will occupy some space in the river but will have minimal impact on the river flow. A similar approach would be utilized for the construction of the discharge pipeline and the diffuser. The barge could be set up on the equivalent interior (downstream) side of the cofferdam and thus would have minimal net effect on the Susquehanna River. The area of disturbance for the removal of the cofferdam would be approximately 400 feet long by 30 feet wide (two sides) for a disturbed area of 12,000 square feet. The cofferdams ~~is~~ are shown on Figures 3.4-11 and 3.4-12. The cofferdam details are discussed in Section 4.3.2.2.

3.4.2.2 Final Plant Discharge

The discharge structure will be designed to meet all applicable navigation and maintenance criteria and to provide an acceptable mixing zone for the thermal plume per the Commonwealth of Pennsylvania regulations for thermal discharges. The discharge point is near the southwest bank of the Susquehanna River approximately 700 ft (210 m) south of the intake structure for BBNPP. The BBNPP discharge pipe and diffuser is aligned parallel to, and approximately 380 ft (116 m) south, of the existing Susquehanna Plant Units 1 and 2 discharge lines. Figure 3.4-3 shows the location of the intake structure and discharge lines. The 24 in (61 cm) discharge pipe extends approximately 212 ft (64.6 m), measured perpendicular from the shoreline to the first diffuser port, into the river. Connected to the discharge pipe is a 106.5 ft (32.5 m), as measured from the first to the last port, long diffuser. Figure 3.4-6 shows details of the diffuser pipe. The centerline elevation of the discharge diffuser is Elevation 476 ft (145 m) msl. The diffuser center elevation is approximately 9 ft (3 m) below the estimated minimum flow river level as discussed in FSAR Section 2.4.11. The diffuser seventy-two 4 in (10 cm) diameter port holes are spaced center-to-center at 1.5 ft (0.5 m). The height of the port holes above the river bed varies as the river bed elevation varies. The angle of discharge of the port holes is 45 degrees to horizontal. The discharge diffuser will be supported in the river utilizing equally spaced anchors embedded in a 111.5 ft (34 m) long concrete pad as shown on Figures 3.4-6 and 3.4-12. Dredging /excavation along the river bottom will be required for installation of the discharge structure and is discussed in Section 4.3.2.2. Riprap will be placed around the discharge diffuser to resist potential erosion. Any potential scouring of the river bed by the flow from the discharge diffuser is discussed in FSAR Section 2.4.11. Fish screens are not required on the diffuser since there will always be flow through the discharge piping, even during outages, to maintain discharge of treated liquid radioactive waste within the concentration limits of the applicable local, Commonwealth, and Federal requirements. The length of the diffuser flow after exiting the nozzle is approximately 54.1 ft (16.5 m). Thermal modeling of the discharge is discussed in Section 5.3.2.

4.1.1.1 The Site

Table 4.1-1 provides an estimate of the land areas that would be disturbed during construction of BBNPP and supporting facilities, including temporary features such as laydown areas, stormwater retention ponds, intake and discharge structures, and borrow areas. Approximately 630 ac (255 ha) of the BBNPP site would be disturbed by site preparation and construction. Approximately 365 ac (148 ha) would be permanently dedicated to BBNPP and its supporting facilities, and lost to other uses until after decommissioning. Approximately 265 ac (107 ha) would be temporarily impacted. Acreage not containing permanent structures would be reclaimed to the maximum extent possible.

4.3.1 TERRESTRIAL ECOSYSTEMS

Approximately 365 ac (148 ha) (developed and undeveloped) would be permanently converted to structures, pavement, or other intensively-maintained exterior grounds. These facilities will include the proposed power block, switchyards, CWS and ESWS cooling towers, ESWEMS Retention Pond, combined wastewater retention pond, water treatment plant, permanent parking and laydown areas, roads, railroad, stormwater ponds, soil stockpile and CWS Makeup Water Intake Structure. Temporary disturbance of forest cover would also be considered effectively permanent due to the time needed to recreate forest cover of similar maturity.

Approximately ~~265~~ 266 ac (~~107~~ 108 ha) (developed and undeveloped) would be temporarily disturbed, only, to accommodate the batch plant, modular assembly area, and temporary offices, warehouses, rivers intake and discharge structures, parking and laydown areas. Acreage not containing permanent structures would be restored by grading and revegating to the extent practicable.

4.3.2.2 Impacts to the Susquehanna River and Offsite Streams

The area of the river disturbed by the installation of the cofferdam will be approximately 200 ft (61 m) into the river channel, by 100 ft (30 m) parallel to the shoreline, for a total area of 20,000 ft^2 (1,858 m^2). When the cofferdam is removed some additional area will be disturbed. Some dredging is required in the river in front of the structure to remove the material from within the cofferdam and to shape the slope on all three sides to the design elevation of the forebay area to minimize sedimentation in the structure. This total area after construction will be approximately 120 ft (37 m) into the river channel, by 220 ft (67 m) for a total disturbed area of 26,400 ft^2 (2,453 m^2).

After completion of the intake structure, the cofferdams and fill material will be removed to allow the river to flow into the structure. After removal of the cofferdams a temporary increase in sediment in the water column is expected. The cofferdams will not inhibit aquatic organism movement within the river due to the small area affected by construction activity (see Figure 3.4-11).

A similar process will be employed during diffuser pipe installation. The diffuser begins 203 ft (62 m) perpendicularly from the shoreline, and extends 119.5 ft (36 m) into the river channel. The axial distance along the discharge pipeline to the diffuser is approximately 210 ft (64 m). Thus the trench for the pipeline and the diffuser will extend approximately 329.5 ft (100 m), i.e., 210 ft (64 m) plus (+) 119.5 ft (36 m), into the river, and will be approximately 50 ft (15 m) wide.

The total disturbed area during construction will be approximately 16,500 ft^2 (1,533 m^2). After installation of the pipe and the riprap protection, the final disturbed area will be slightly narrower, with a disturbed area of approximately 329.5 ft (100 m) by 20 ft (6 m) for a total of 6,600 ft^2 (613 m^2). Construction will result in removal and disruption of river substrate in the immediate vicinity of the diffuser pipe. Temporary increases in suspended sediments in the water column will result during cofferdam installation. After completion of the pipe installation, the cofferdam will be removed. If no material is placed within the cofferdam cells, then no additional dredging will be required in the river after sheet pile removal because the river bottom should be basically at its original level. ~~After~~ However, after removal of the cofferdams a temporary increase in sediment in the water column is also expected. The cofferdams will not inhibit migration of aquatic organisms within the river due to the small area affected by construction activity.

Table 4.1-1 Construction Areas Acreage and Operations Area Acreage, Land Use and Zoning

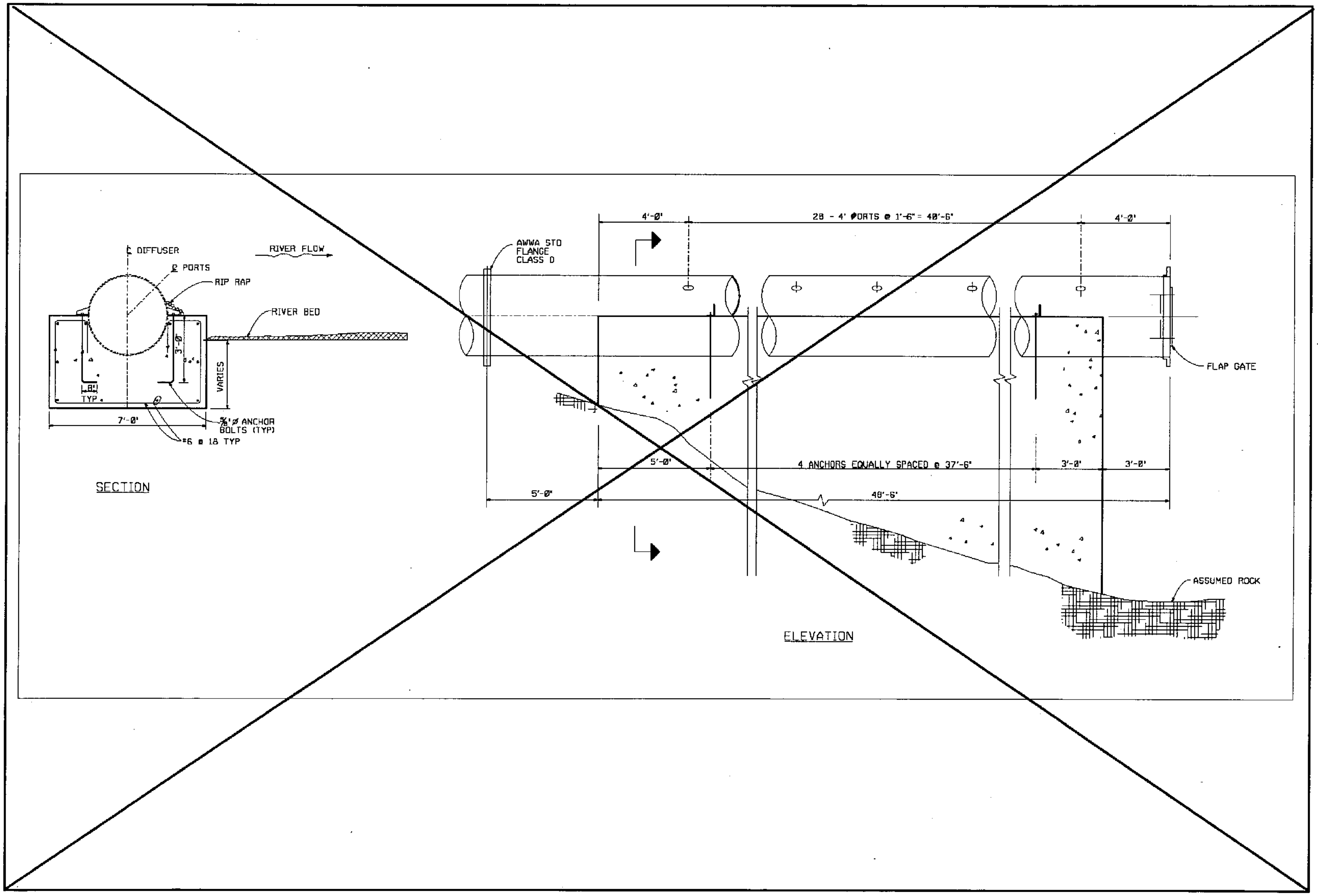
Construction Area	Construction Acreage (hectares)	Current Land Use	Current Zoning
BBNPP Power Block	61.2 (24.8)	B, F, A, U/B, W, WL	AD, CD
ESWEMS Retention (UHS) Pond and Pumphouse	9.9 (4.0)	F, A	AD
Intake Structure and Discharge Pipeline/Diffuser (Land and River)	~~0.7 (0.3)~~1.3 (0.5)	F, W, WL	CD
BBNPP Switchyard	7.5 (3.0)	F, A, WL	AD, CD
SSES Units 1 and 2 Switchyard (expansion)	11.0 (4.5)	B, F, A, U/B, W, WL	AD, HI
Cooling Towers Area	21.1 (8.5)	F, A	AD
Water Treatment	9.2 (3.7)	B, F, A	AD
Roads	16.9 (6.8)	B, F, A, U/B, WL	AD, CD, HB
Rail Roads	28.3 (11.4)	B, F, A, U/B, WL	AD, HI
Storm Water Ponds	29.7 (12.0)	F, A, U/B	AD, HI
Permanent Laydown Areas	76.3 (30.9)	F, A	AD, CD
Permanent Offices	0.9 (0.4)	F	AD
Permanent Parking	23.6 (9.6)	F, A	AD, CD
Onsite Transmission Line R/W	68.6 (27.8)	B, F, A, U/B, WL	AD, CD, HI
Total Acreage of Disturbed Area for Permanent Construction Features	**~~364.9 (147.7)~~ 365.5 (147.9)**	-	-
Batch Plant	25.5 (10.3)	B, F, A	D
Temporary Laydown Areas	119.9 (48.5)	B, F, A, U/B	AD, CD, HI
Temporary Offices	5.6 (2.3)	B, F, A	AD, HB, HI
Temporary Parking	90.0 (36.4)	B, F, A, U/B	AD, HB, HI
Onsite Transmission Line R/W	25.1 (10.2)	B, F, A	AD, CD, HI
Total Acreage of Disturbed Area for Temporary Construction Features	**265.4 (107.4)**	-	-

Notes:

Land Use categories
B = Barren
F = Forest
A = Agricultural
U/B = Urban or Built Up
W = Water
WL = Wetlands

Zoning categories
AD = Agricultural District
CD = Conservation District
HI = Heavy Industrial
HB = Highway Business

Figure 3.4-6 View of Discharge Outfall for Discharge System for BBNPP



Revised Figure 3.4-6 View of Discharge Outfall for Discharge System for BBNPP

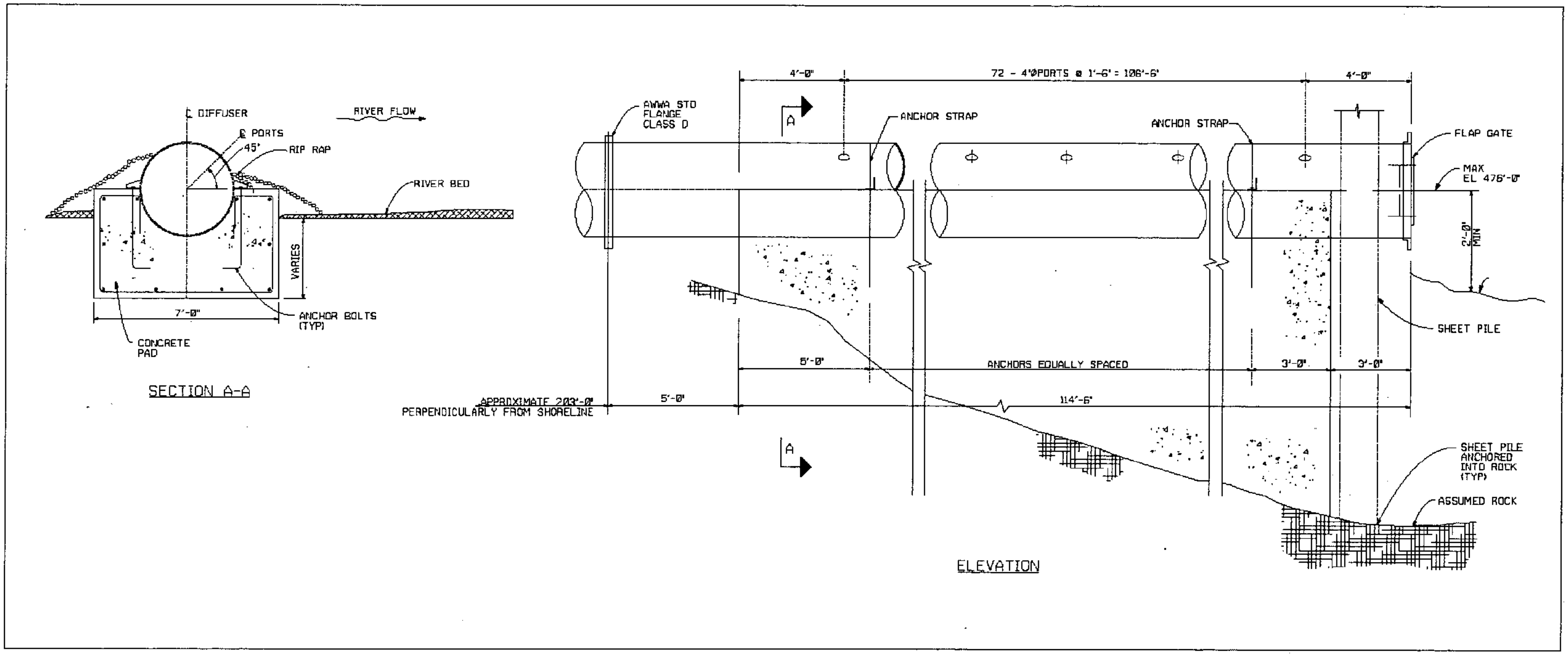
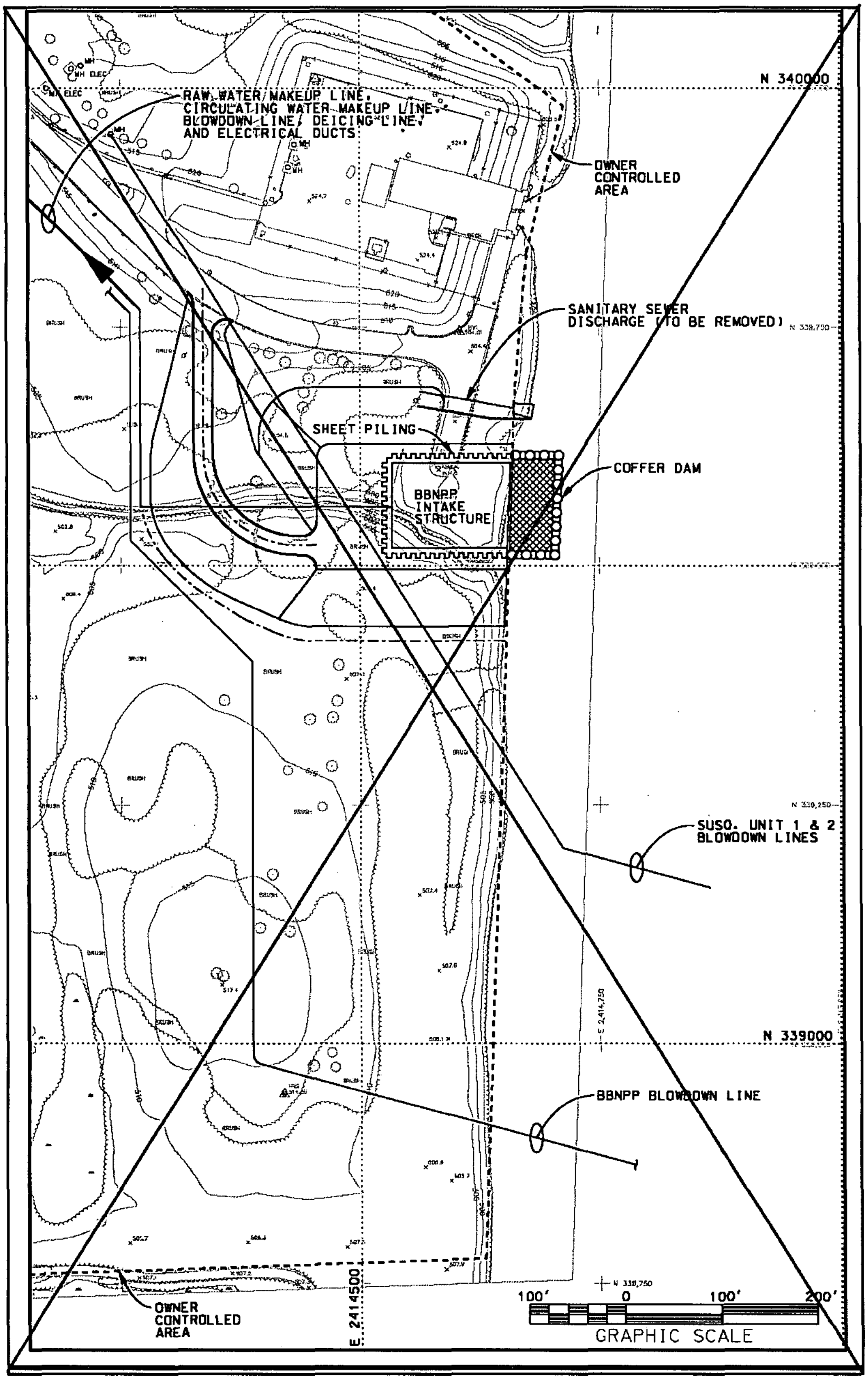
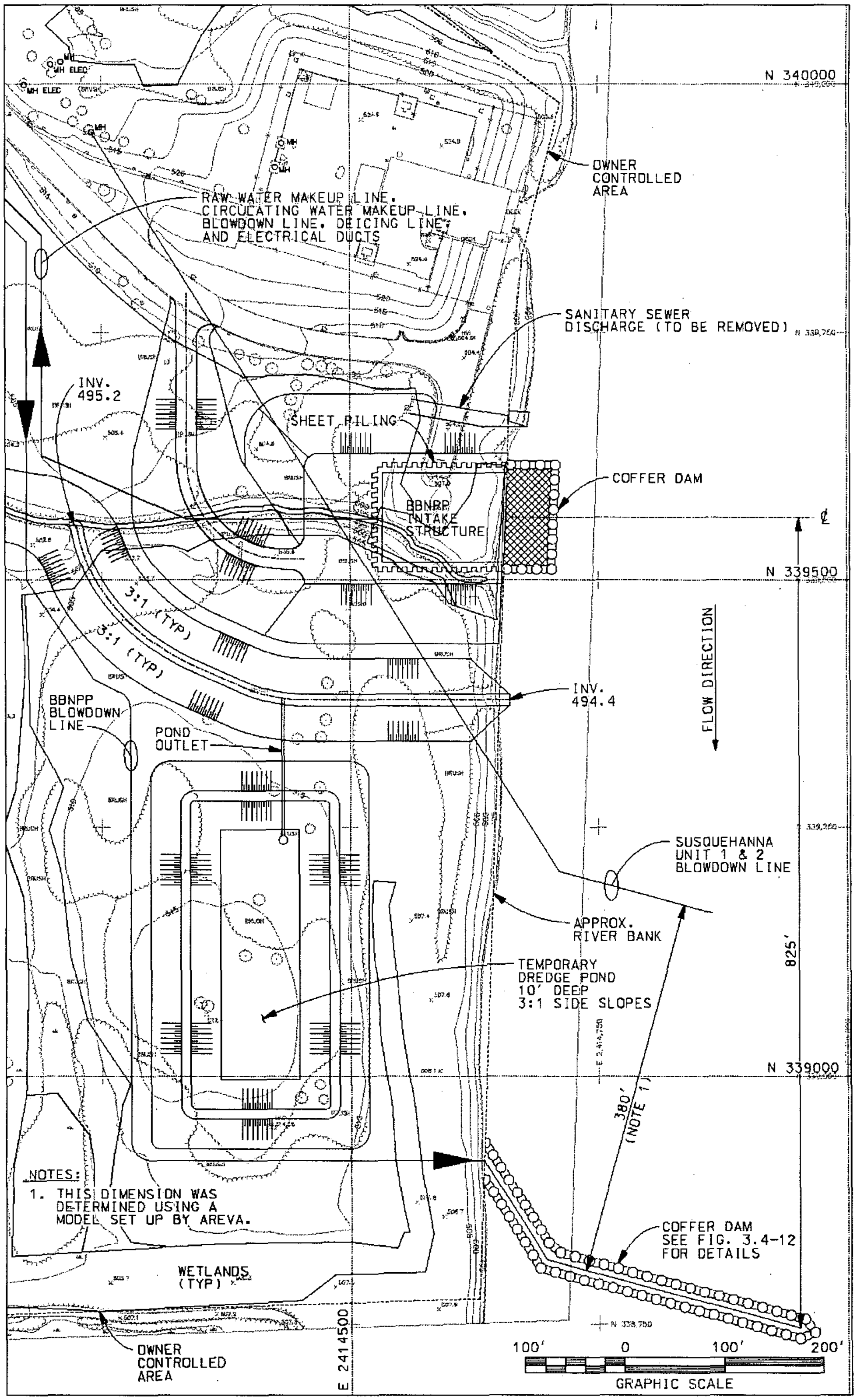


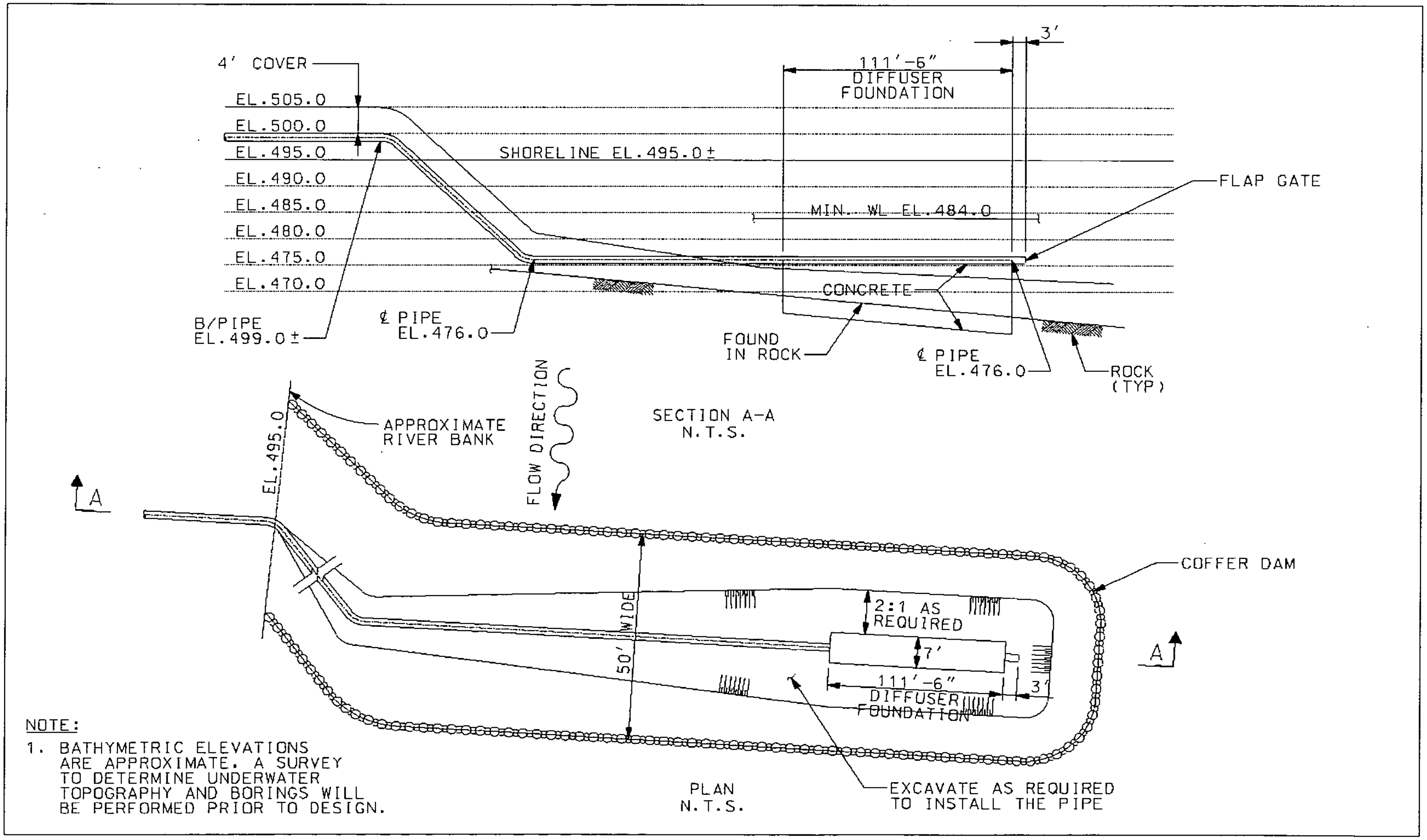
Figure 3.4-11 CWS Makeup Water Intake Structure Construction Coffer Dam



Revised Figure 3.4-11 CWS Makeup Water Intake Structure Construction Coffer Dam



New Figure 3.4-12 End of Blowdown Line



AE 9.3-1

ESRP 9.3.10

Summary: *Montour Alternative Site.*

Describe the nature of the river bottom at the Montour site to support the statement that dredging of sediment would probably be required. Describe whether or not cofferdams and excavation would be used.

Describe the range of water depth at the Montour intake/discharge site.

Describe the amount of impervious or nearly impervious surface that would be added to the site.

Describe any open-water ponds, creeks (including Chillisquaque Creek) or other water features and direct or indirect impacts to these features by construction, including lineal feet or acreage of impacts.

Describe the potential impact of a new plant to yellow lampmussel (State S3S4) that is listed in Table 9.3-1.

Provide a copy of the report documenting the threatened and endangered species at the Montour Site. "EDR, 2008a. Environmental Data Resources Incorporated, Montour Site Inquiry Number 2290046.18S, August 12, 2008."

Describe any commercial or recreational fisheries near the proposed intake/discharge areas in the west branch of the Susquehanna River and any nuisance species (e.g., zebra mussel, Corbicula) in the area.

Full Text: ER Rev 1, p. 9-64 states that dredging of *sediment* probably would be necessary at the Montour site and the impacts would be typical for dredging sediment. How does the condition of the Susquehanna River bottom in this area support the statement? The ER wording suggests that the river bottom and the construction process would be different for the Montour site as compared to the Bell Bend site, where the installation would call for using cofferdams and excavation (later text about Montour also mentions cofferdams). The river bottom at the BBNPP site is very rocky.

ER Rev 1, p. 9-64 states that "According to the EDR database, no federally-listed or state-listed threatened or endangered species are located on site (EDR, 2008a)." However, the yellow lampmussel (Statelisted as S3/S4) is listed in Table 9.3-1. Please discuss.

Discuss fisheries at the Montour site, and the occurrence of nuisance species.

Response: The Montour site lies approximately 10 mi (16 km) east of the West Branch Susquehanna River requiring the construction of pipeline from the plant site to the river. At the reconnaissance level no design of a pipeline has been performed but a conceptual route for the pipeline has been created in order to place likely impacts in perspective. Taking the topography of the area and the potential availability of existing Rights of Way (ROW) into consideration, a conceptual route consisting of a 120 ft (37 m)

ROW of more than 18 mi (29 km) in length has been developed. (The routing of this pipeline is available for NRC review in the BBNPP Electronic Reading Room.) At this reconnaissance level no specific location has been identified for the Montour site intake structure. Hence, neither nature of the river bottom nor the water depths that would be encountered can be defined.

It is assumed that a small amount of dredging would be required at the river bank in order to construct an intake structure and that additional dredging might be necessary to anchor a discharge pipe. In order to perform this construction it is probable that the area would be enclosed within a cofferdam structure. Dredging would then be accomplished within the cofferdam area.

The amount of impervious surface at the Montour site would be similar to that of the Bell Bend site which ER Section 4.2.2.2 of the COLA states as approximately 87 acres (35 ha).

Revised ER Table 9.3-12 (PPL, 2009); Comparison of Wetlands and Waterway impacts: BBNPP vs. Alternative Sites; lists the areas of wetlands and waterways that could be affected by the construction of the proposed EPR nuclear power plant at the Montour and other sites including impacts from the construction of conceptual pipelines, transmission lines, railroad spurs and roadways. It is estimated that approximately 3,891 ft (1,186 m) of the East Branch of Chillisquaque Creek would be impacted but that the Middle Branch of Chillisquaque Creek would be unaffected.

The yellow lampmussel typically occurs in larger streams and rivers with sand and gravel substrates and medium currents (NatureServe, 2009a). There would be a potential for construction-related impacts on these species along the potential pipeline and new/expanded transmission corridors. However, impacts along expanded powerlines would be small, as lines are already in place across waters along the routes and the process of expanding these existing lines would be minimally intrusive to aquatic habitat. There would be a greater potential for impacts along the potential water line corridor, but impacts on any particular water would be limited to the immediate construction area. Conditions of applicable federal, state, and local permits would be met to minimize adverse environmental impacts and to ensure that organisms are protected against potential construction-related impacts

Pennsylvania has recreationally important fisheries, including bluegill, pumpkinseed, redbreast sunfish, rock bass, black and white crappie, yellow perch, smallmouth and largemouth bass, walleye, catfish (both channel and bullhead), carp, and a variety of suckers. In addition, Brook, rainbow, and brown trout are widely stocked to support fishing for these species (PFBC, 2009a).

Most of these species, with the exception of trout, could occur in the streams within the Montour site or along the potential water line corridor. Species that prefer larger rivers and lakes, such as the black and white crappies, bluegill, pumpkinseed, walleye, catfish, and suckers, could occur in the Susquehanna River (PFBC, 2009a). Brown and rainbow trout are not stocked in the drainage proposed for the water line corridor (PFBC, 2009b), and these species would not be expected to occur at the Montour site (PFBC, 2009a).

The Asiatic clam is known from this reach of the Susquehanna River (USGS, 2009a). The zebra mussel is only known from more southern portions of the drainage, but could be migrating upstream (USGS, 2009b). These exotic invasive mussel species could foul water intake structures placed in the Susquehanna River. Appropriate BMPs would be used to manage these species.

As requested, EDR, 2008a. Environmental Data Resources Incorporated, Montour Site Inquiry Number 2290046.18S, August 12, 2008 is included in Enclosure 3.

References cited in response:

NatureServe, 2009a. An Online Encyclopedia of Life – *Lampsilis cariosa*, Website: http://www.natureserve.org/explorer/index.htm, Date accessed: October 9, 2009.

PFBC. 2009a. Pennsylvania Fish and Boat Commission, Popular Sportfishes of Pennsylvania, Website: http://www.fish.state.pa.us/fishes.htm, Date accessed: October 9, 2009.

PFBC. 2009b. Pennsylvania Fish and Boat Commission, Trout Stocking Events in Northumberland County from 3/1/2009 to 2/28/2010, Website: http://pfbc.state.pa.us/pfbc_webgis/TroutStockingDetails.aspx, Date accessed: October 9, 2009.

PPL, 2009. Bell Bend Nuclear Power Plant Environmental Report Section 9.3, Alternative Sites, BNP-2009-371, dated November 25, 2009

USGS, 2009a. USGS 01536500 Susquehanna River at Wilkes-Barre, Pennsylvania, Website: http://waterdata.usgs.gov/nwis/dv?cb_00060=on&format=gif_default&begin_date=1999-07-24&end_date=2009-07-24&site_no=01536500&referred_module=sw, Date accessed: July 25, 2009.

USGS, 2009b. USGS 01553500 West Branch Susquehanna River at Lewisburg, Pennsylvania, Website: http://waterdata.usgs.gov/nwis/dv?cb_00060=on&format=html&begin_date=1999-07-24&end_date=2009-07-24&site_no=01553500&referred_module=sw, Date accessed: July 25, 2009.

COLA Impact:

No changes to the BBNPP COLA ER are required as a result of this RAI response.

AE 9.3-4

ESRP 9.3

Summary: *Provide a more detailed, site-focused figure for each alternative site that shows the aquatic resources that would be affected by the construction and operation of a new plant.*

Show the proposed locations of the bridges that would be installed across the Juniata River at the Sandy Bend site.

Full Text: Figures 9.3-7, 9.3-9, and 9.3-11 are vicinity maps that show a much larger area than is useful for evaluating potential impacts to aquatic resources.

Response: The alternative site screening process described in Section 9.3 of the ER has been superseded by a revised process (PPL, 2009a). Using the revised process, the entire alternative site evaluation has been repeated. The revised evaluation has resulted in the Sandy Bend and Martins Creek sites being eliminated as alternatives to Bell Bend. The alternative sites discussed in revised Section 9.3 are Montour, Humboldt Industrial Park and Seedco Industrial Park (PPL, 2009b). Vicinity maps showing wetlands and water bodies, floodplains and prime farmland are shown for each site: Figure 1 – BBNPP Vicinity Map, Figure 2 – Montour Site Vicinity Map, Figure 3 – Humboldt Industrial Park Vicinity Map, and Figure 4 – Seedco Industrial Park Vicinity Map.

References cited in this response:
PPL, 2009a. Bell Bend Nuclear Power Plant Alternative Site Evaluation, BNP-2009-257, dated September 9, 2009
PPL, 2009b. Bell Bend Nuclear Power Plant Environmental Report Section 9.3, Alternative Sites, BNP-2009-371, dated November 25, 2009

COLA Impact:
No changes to the BBNPP COLA ER are required as a result of this RAI response.

Figure 1 – BBNPP Vicinity Map

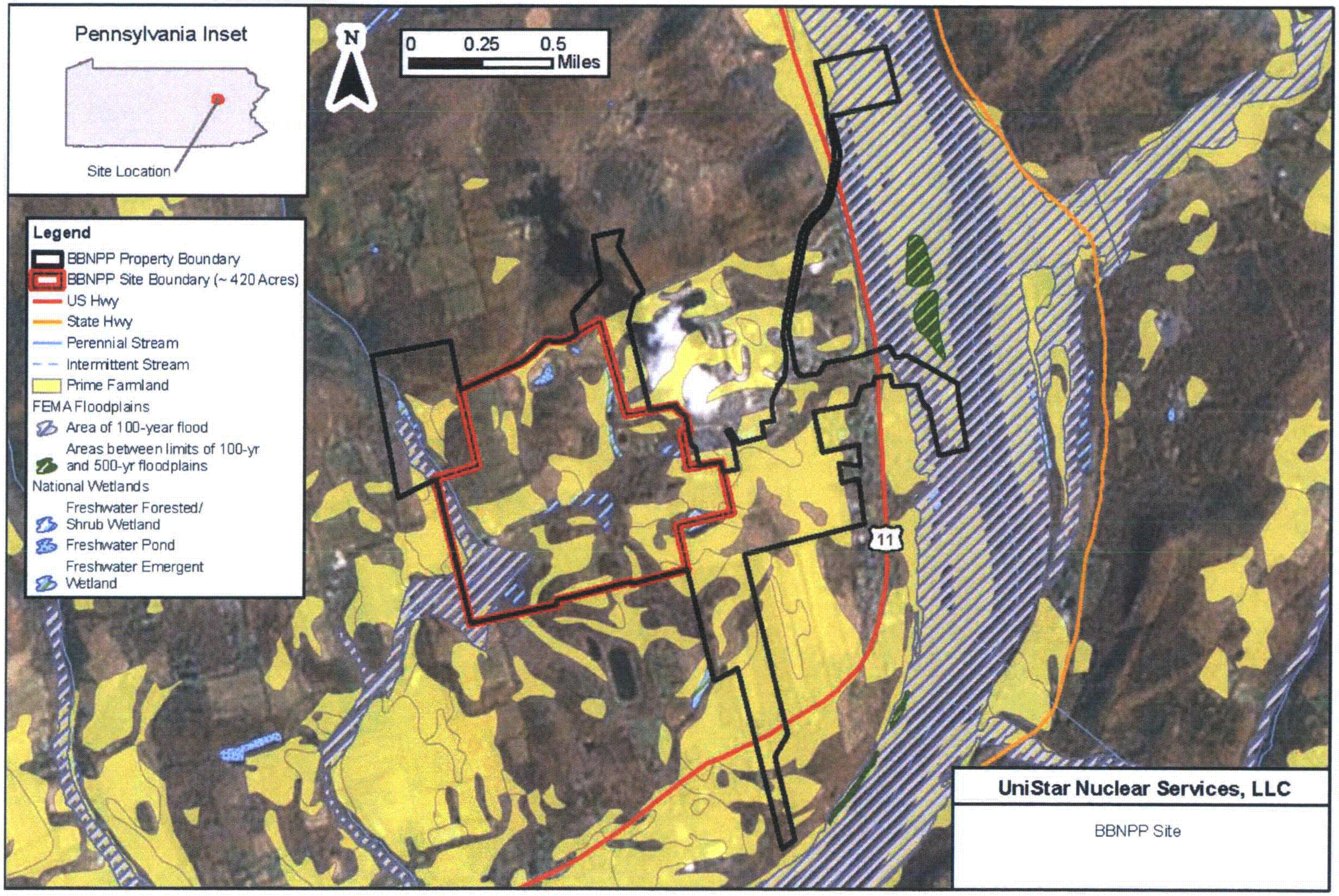


Figure 2 – Montour Site Vicinity Map

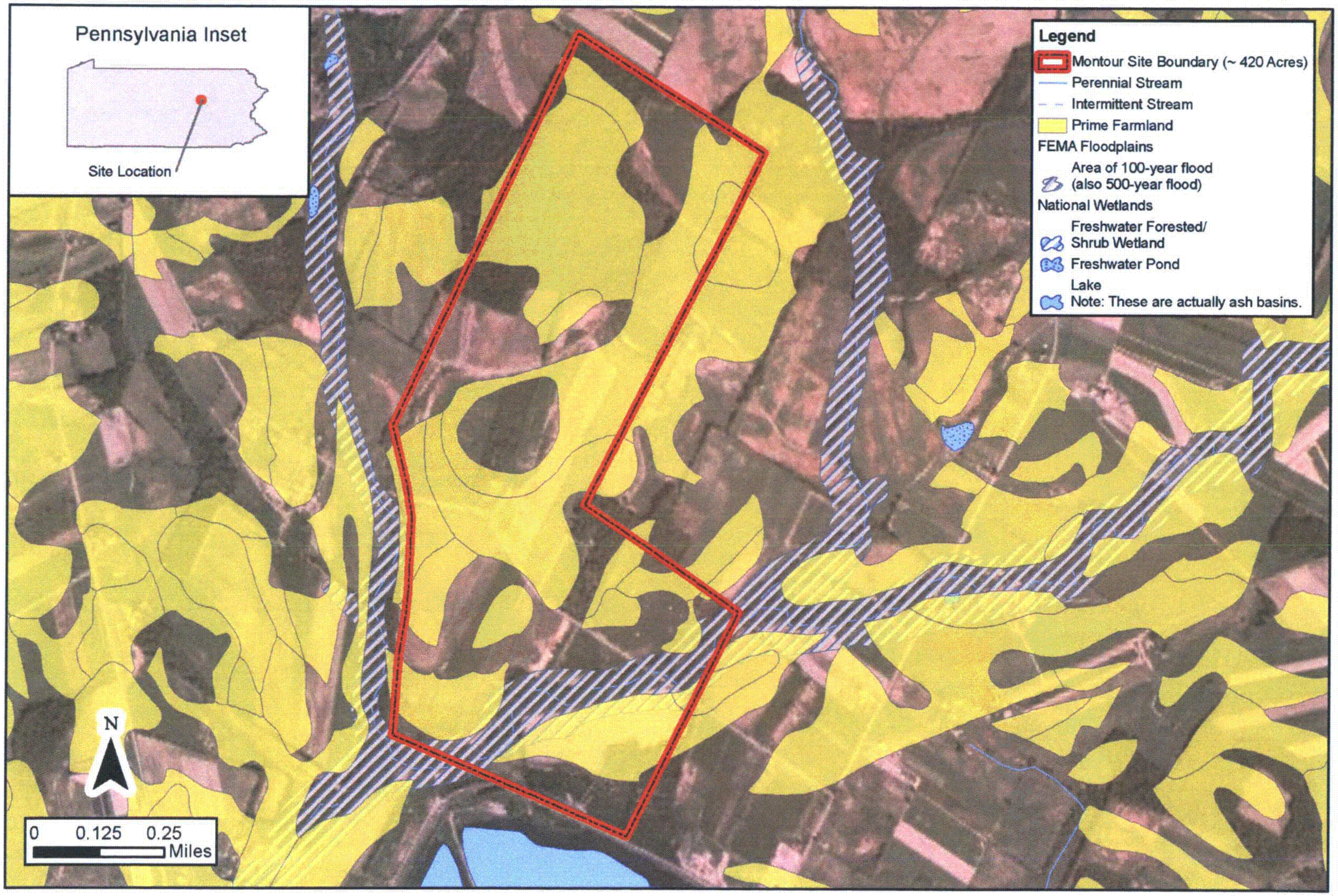


Figure 3 – Humboldt Industrial Park Vicinity Map

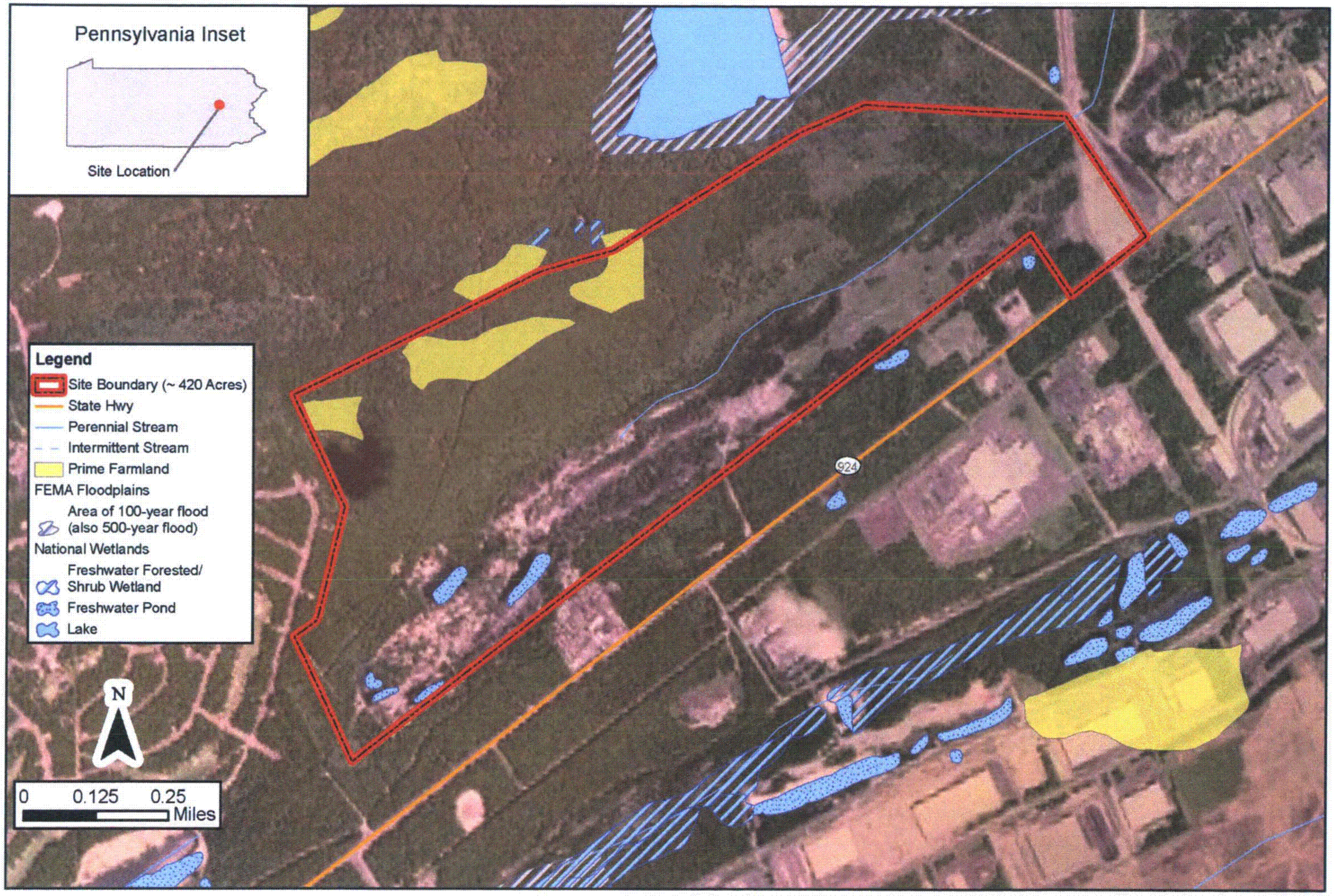
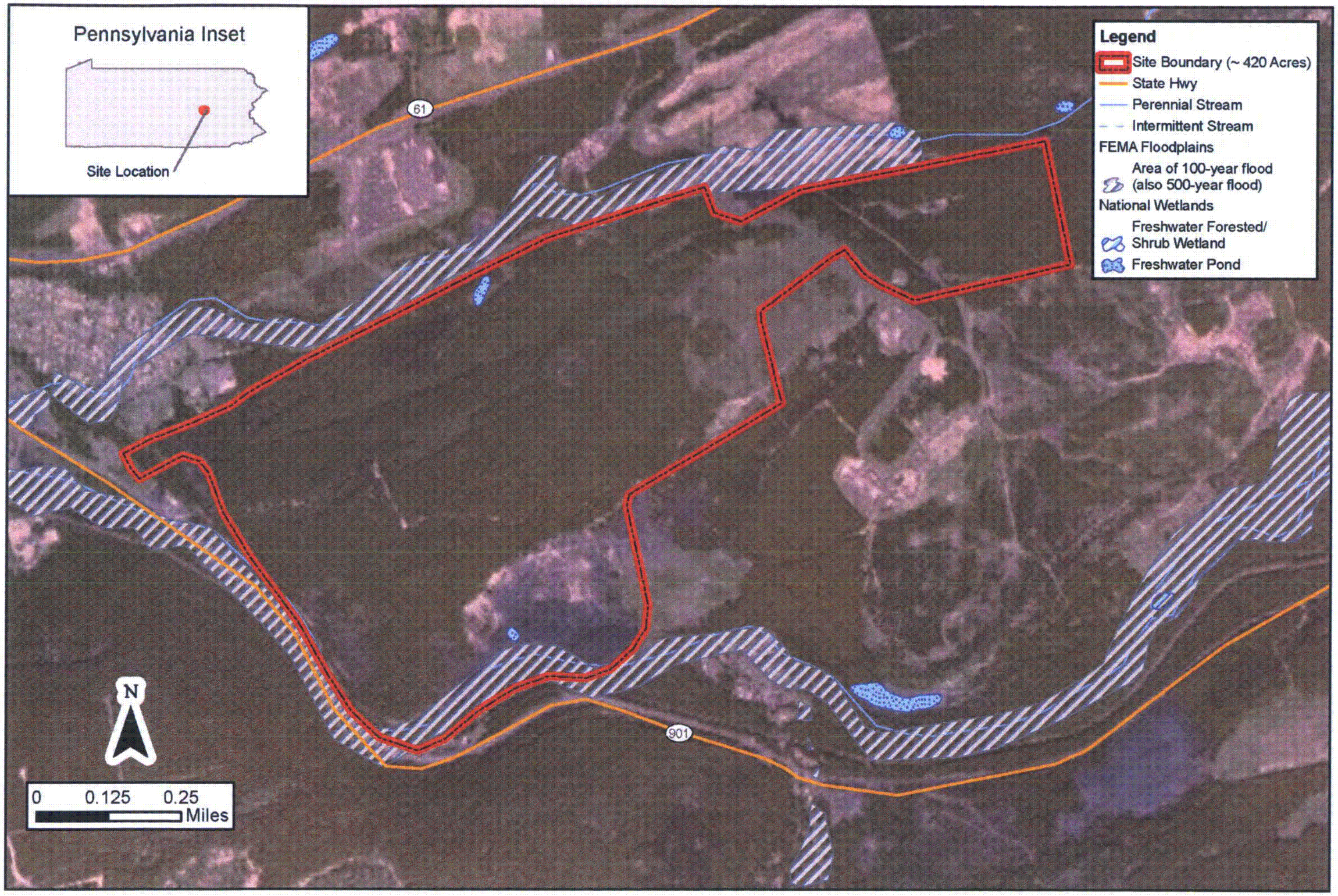


Figure 4 – Seedco Industrial Park Vicinity Map



CR 2.5-7

ESRP 4.1.3

ESRP 5.1.3

10 CFR 51.71 (d)

36 CFR 800

43 CFR 10

Summary: *In consultation with the NRC and the Pennsylvania SHPO develop a management plan for management of cultural resources. The plan should address the following matters:*

1) Procedures for dealing with inadvertent discoveries including human remains, terrestrial archaeological sites, and above ground historic structures, and procedures for avoiding or mitigating adverse impacts.

2) Procedures for assessing potential adverse impacts to cultural resources on BBNPP property located outside of the current project area.

3) Procedures for pre-job briefing for BBNPP employees and contractors on how to identify cultural resources and what actions are to be taken if cultural resources are found.

4) Procedures for consulting with NRC and the PA SHPO.

5) Consideration of potential impacts to cultural resources during pre-construction ground disturbing activities as well as construction activities.

Full Text: During the Audit several cultural resource issues and concerns were identified that dealt with inherently unknown variables. These include how to deal with inadvertent discoveries of human remains or other cultural resources during daily operations, how to ensure impacts to cultural resources are considered if there are future land acquisitions, and how to ensure that the applicant's staff is familiar with cultural resource management requirements. Please describe how these matters will be treated.

Response:

The PPL Susquehanna Cultural Resources Protection Plan (CR Plan) (Enclosure 4) describes the management plan for management of cultural resources, including inadvertent discoveries, for the Susquehanna Steam Electric Station (SSES). BBNPP intends to follow the Susquehanna Cultural Resources Protection Plan until a similar plan is completed for BBNPP.

The BBNPP CR Plan is currently being prepared and will be reviewed with the NRC and SHPO in the future. Until such time as the BBNPP CR Plan is implemented, contractors working on site will be trained and will follow the SSES CR Plan.

COLA Impact:
No changes to the BBNPP COLA ER are required as a result of this RAI response.

CR 2.5-8

ESRP 4.1.3

ESRP 5.1.3

Summary: *Explain what efforts were taken to identify cultural resources at proposed alternative sites as described in the ER. List what National Register listed, eligible or potentially eligible properties have been identified at the alternative sites.*

Full Text: At the site audit, the need to document potential impacts to cultural resources in the proposed alternative sites was discussed. The applicant provided a reference to reports that documents the baseline reconnaissance level survey data on cultural resources in or near the proposed alternative site locations. Provide these reports for review.

Response: A reconnaissance level survey, using available web-based resources, was conducted to identify cultural resources at the proposed alternative site locations. This included the use of aerial photography and United States Geologic Survey (USGS) topographic maps. Databases, such as the web-based National Register of Historic Places (NRHP) database and state historic databases, were searched and general information regarding the number and type of sites (historical/archaeological) in the vicinity of each alternative site was identified. In addition, an Environmental Data Resources, Inc. (EDR) report (EDR, 2008) (Enclosure 3), which includes the results of searches of available databases for historic properties within 1 mi (1.6 km) of the site, was also obtained and used to confirm information regarding NRHP sites near one of the alternative sites (i.e., the Montour site).

These reconnaissance level surveys did not include contact with the Pennsylvania State Historic Preservation Office for a search of their databases to obtain locational information about archaeological sites in the vicinity of the alternative sites. County websites were searched and limited historical site information was obtained, when available. No visual or physical (i.e., test pits) searches related to cultural resources were conducted as this would be beyond the reconnaissance level information that is required.

No National Register listed, eligible or potentially eligible properties have been identified at the alternative sites. The following is information on national register properties within 5 mi (8 km) of the alternative sites:

Montour site – No historic properties are located within one mile of the site (EDR, 2008; Google Earth, 2009). Seven properties are listed in Montour County (NRHP, 2009c):

- Beaver, Thomas, Free Library and Danville YMCA
- Brown, Gottlieb, Covered Bridge
- Danville Historic District
- Danville West Market Street Historic District
- Keefer Covered Bridge No. 7
- Montgomery, Gen. William, House
- Mooresburg School

As stated in ER Section 9.3.2.2.8 (PPL, 2009), of the seven historic sites in Montour County that are listed in the National Register of Historic Places (NRHP), only one, the Keefer Covered Bridge No. 7, is located within 5 mi (8 km) of the Montour site (NRHP, 2009c). The bridge is located 1.7 mi (2.7 km) from the alternative site.

The Martins Creek and Sandy Bend alternative sites have been replaced with the Humboldt Industrial Park and Seedco Industrial Park alternative sites. Therefore, the remainder of this response addresses the Humboldt Industrial Park and Seedco Industrial Park sites instead of the Martins Creek and Sandy Bend sites.

Humboldt Industrial Park site – Based on a review of NRHP data, two NRHP-listed properties are within 5 mi (8 km) but not within 1 mi (1.6 km) of the site. The Markle Bank and Trust Company and the St. Gabriel's Catholic Parish Complex are located in Hazleton City. According to the NRHP database, there are no NRHP-listed properties or NRHP-listed historic districts within 1 mi (1.6 km) of the site (NRHP, 2009a; Google Earth, 2009).

Seedco Industrial Park site – The Seedco Industrial Park site is located in Northumberland County and is within 5 mi (8 km) of Columbia County. Based on NRHP data, there are two NRHP-listed properties in Northumberland County that are within 5 mi (8 km) of the site, neither of which are less than 1 mi (1.6 km) from the site. These two resources are known as the Richards Covered Bridge and the Kreigbaum Covered Bridge. There are no NRHP-listed historic districts in Northumberland County within 5 mi (8 km) of the site. There are no NRHP-listed properties or NRHP-listed historic districts in Columbia County that are within 5 mi (8 km) of the site. (NRHP, 2009b; NRHP, 2009d; Google Earth, 2009)

References Cited in this Response:

EDR, 2008. Environmental Data Resources Incorporated, Montour Site Inquiry Number 2290046.18S, August 12, 2008.

Google Earth, 2009. National Register of Historic Places, Listed Properties in Google Earth, Northeast Region, Website: http://nrhp.focus.nps.gov/natreg/docs/Download.html, Date accessed: July 26, 2009.

NRHP, 2009a. National Park Service, The National Register of Historic Places, Luzerne County, Website: http://nrhp.focus.nps.gov, Date accessed: July 24, 25 and 26, 2009.

NRHP, 2009b. National Park Service, The National Register of Historic Places, Columbia County, Website: http://nrhp.focus.nps.gov, Date accessed: July 24, 25 and 26, 2009.

NRHP, 2009c. National Park Service, The National Register of Historic Places, Montour County, Website: http://nrhp.focus.nps.gov, Date accessed: July 24, 25 and 26, 2009.

NRHP, 2009d. National Park Service, The National Register of Historic Places, Northumberland County, Website: http://nrhp.focus.nps.gov, Date accessed: July 24, 25 and 26, 2009.

PPL, 2009. Bell Bend Nuclear Power Plant Environmental Report Section 9.3, Alternative Sites, BNP-2009-371, dated November 25, 2009.

COLA Impact:

No changes to the BBNPP COLA ER are required as a result of this RAI response.

H 5.3-1

ESRP 5.3.2.1

Summary: *Provide information related to the calculation of thermal and chemical effluent plumes from the BBNPP and SSES diffusers:*

1) Verification of model results against field data collected by Ecology III.

2) Sensitivity study, needed especially for the low flow, winter case. Adjustments to ΔT (discharge vs. ambient river) for both SSES and BBNPP, bathymetry differences, adjustment of discharges from SSES and BBNPP, low Susquehanna River discharge.

3) BBNPP plume calculations run in isolation as well as in combination with the SSES plume.

4) Sargent and Lundy report 2008-06824, "Engineering and economic evaluation of integrated heat rejection cycle, Bell Bend Nuclear Power Plant", Unistar Nuclear Energy, April 2008.

Full Text: This information was developed through several discussions with the applicant's consultant Ed Buchak (ERM Inc).

Response:

1. Verification of model results against field data collected by Ecology III.

Field surveys of the SSES thermal plume were performed in 1986, 1987 and 2008. The surveys are summarized in reports which are included as Enclosures 5 and 6 to this RAI response.

A total of five thermal plume surveys were performed. The river flows associated with the thermal plume surveys were estimated from using a "rating curve" showing estimated river flow versus surface elevation at the SSES Environmental Laboratory. The flows selected for the model study were specific statistical flows associated with river flow at the Wilkes-Barre gage, so that a direct flow comparison between the model and the survey work is slightly inaccurate, since the drainage area of the river at SSES is approximately three percent (3%) greater than at the Wilkes-Barre gauge.

The surveys were scheduled such that plumes were measured during the autumn, winter, and spring seasons (one survey each season, documented in the November 1987 report) and in the summer season (two surveys documented in the February 2009 report). The surveys consisted of about 25 vertical temperature profiles near the SSES discharge structure. About 400 temperature measurements were made during each survey. Susquehanna River flow, stage, temperature and SSES blowdown rate and temperature were recorded during the surveys.

The results of the surveys were presented as the projection onto the water surface of the 0.5°F temperature rise isotherm wherever it occurred in the water column. The 0.5°F temperature rise isotherm was generally the largest rise measured, except for a small 1°F plume observed during one of the summer surveys. The reports concluded that the thermal plumes were "relatively small" and "very limited even during low river flow conditions" and that the "size of the plume seemed to be more a function of river flow than the difference in temperature between the blowdown and ambient." (Ecology III, 1987).

Because of the small size of the plume and the method for displaying the data as the projection of the plume onto a plane, the only useful comparison metric for confirming the models is the downstream distance to the 0.5°F or 1.0°F temperature rise isotherm.

This distance is shown in Table 1, along with ambient conditions, the SSES operational data, and the model results.

For the Environmental Report (ER), near-field (CORMIX) and far-field (GEMSS) models were chosen to compute the size of the individual SSES and BBNPP thermal plumes. The survey results show that the plume is identifiable only in the near-field and consequently, only the near-field model can be reasonably verified with available data. The spatial resolution for GEMSS, the far-field model, is too coarse to resolve the near-field details of the plume. Typical horizontal resolution of the GEMSS model near the SSES and BBNPP discharge structures is 30 ft laterally by 50 ft longitudinally, and 85 ft by 5500 ft farther downstream. For comparison, the measured plume lengths for the 0.5°F temperature rise isotherm (equivalent to about a 20-fold dilution) averaged about 100 ft and covered only one or two finite difference cells in the GEMSS model.

Table 1 shows the computed plume sizes for the five surveys using CORMIX. As noted, GEMSS is not an appropriate tool for the near-field, but GEMSS results for two of the surveys are included in the table for illustration of the incompatible spatial scale of the far-field model with the survey results. The distances to the 0.5°F and 1.0°F isotherms modeled by CORMIX are sometimes shorter and sometimes longer than the field observations. Because the only detectable plume was at the very extreme of identifiable temperature rises, the agreement of computed and observed values constitutes good model performance. GEMSS provides spatial detail to allow both the surface and bottom distances to the isotherm in question to be computed. Table 1 shows that the GEMSS results overestimate the size of the plume at this small spatial scale. The uncertainty in the measurements described above also applies to the comparisons of the far-field model to the observations.

Table 1: Verification data and results

Parameter	5 Nov 1986	9 Jan 1987	14 May 1987	21 Aug 2008	3 Sep 2008
Description	Autumn	Winter	Spring	Summer 1	Summer 2
Susquehanna River flow, cfs	4,840	9,250	5,120	3,230	2,140
Susquehanna River outflow, cfs	4,791	9,201	5,071	3,170	2,080
Water surface elevation, ft	487.8	489.0	487.9	487.0	486.5
Susquehanna River temperature, °F *	47.0	33.5	65.5	74.5	74.3
K, Btu / ft^2 day °F	78.0	65.0	115.0	110.0	105.0
K, W / m^2 °C	18.5	15.4	27.2	26.1	24.9
Equilibrium Temperature, °F	40.0	27.0	66.0	77.5	66.0
Equilibrium Temperature, °C	4.4	-2.8	18.9	25.3	18.9
SSES					
Blowdown temperature, °F	62.0	61.0	75.0	81.1	84.3
Temperature rise, °F	15.0	27.5	9.5	6.6	10.0
Intake rate, gpm	30,214	30,214	30,214	39,000	39,000
Discharge rate, gpm	8,000	8,000	8,000	12,000	12,000
Distance to the 0.5°F isotherm					
Observed**	125	25	80	120	300
Computed with CORMIX, ft	27	26	9	21	498
Computed with GEMSS (surface), ft	(not run)	(not run)	0	(not run)	0
Computed with GEMSS (bottom), ft	(not run)	(not run)	1,200	(not run)	1,600
Distance to the 1.0°F isotherm					
Observed**	0	0	0	0	16
Computed with CORMIX, ft	6	6	2	4	21
Computed with GEMSS (surface), ft	(not run)	(not run)	0	(not run)	0
Computed with GEMSS (bottom), ft	(not run)	(not run)	560	(not run)	773

*When reported as variable, smaller values used; this choice may exaggerate the temperature rise.
**As reported, this is the projection of the plume onto a single, horizontal plane.

2. Sensitivity study, needed especially for the low flow, winter case. Adjustments to ΔT (discharge vs. ambient river) for both SSES and BBNPP, bathymetry differences, adjustment of discharges from SSES and BBNPP, low Susquehanna River discharge.

Because CORMIX is incapable of computing the effects of overlapping thermal plumes, this response addresses GEMSS, the far-field model.

Providing sensitivity information requires comparing the results of the sensitivity simulations with the specified base case, which is the winter (January) low flow case, identified in the ER Table 5.3-3 (Scenario 4). This case yielded the largest combined thermal plume because of the relatively low Susquehanna River flow (2,848 cfs) and large BBNPP temperature rise (ΔT) of 31.0°F. Also required for the sensitivity tests is a quantitative and representative metric for comparing the results. The metric adopted is the combined SSES and BBNPP surface and bottom areas for the 0.5°F, 1.0°F, and 5.0°F isotherms. The area metric is the most comprehensive with respect to plume size and is readily computed with the GEMSS post-processor.

The sensitivity runs consisted of decreasing Susquehanna River flows in steps to the value of the summer low flow and increasing the SSES and BBNPP ΔT's and discharge rates by 10% and 20%. The conditions and isotherm areas for the base case and seven sensitivity runs are shown in Tables 2 and 3. (Note: The increases in SSES and BBNPP discharge flows and temperatures were assumed for purposes of the sensitivity analysis and do not represent realistic or attainable values.)

Table 2: Low Susquehanna River flow sensitivity tests

Parameter	Scenario 4	Sensitivity Test 1	Sensitivity Test 2	Sensitivity Test 2a
Description	Winter low flow	Midway between winter and summer low flow	Summer low flow	Intermediate low flow
Susquehanna River flow, cfs	2,848	2,047	1,246	1,994
Susquehanna River net, cfs	2,727	1,926	1,125	1,854
Water surface elevation, ft	486.8	486.6	486.0	486.4
Susquehanna River Temperature, F	32	32	32	32
SSES				
Temperature rise, °F	31.0	31.0	31.0	34.1
Intake rate, gpm	42,300	42,300	42,300	48,645
Discharge rate, gpm	11,200	11,200	11,200	12,880
BBNPP				
Temperature rise, °F	33.8	33.8	33.8	37.2
Intake rate, gpm	34,458	34,458	34,458	39,627
Discharge rate, gpm	11,172	11,172	11,172	12,848
Area of the 0.5°F isotherm				
At the surface, acre	71.8	91.7	97.1	95.0
At the bottom, acre	98.0	110.7	110.2	113.4
Area of the 1.0°F isotherm				
At the surface, acre	0.0	63.1	91.0	82.7
At the bottom, acre	70.7	97.8	107.1	106.6
Area of the 5.0°F isotherm				
At the surface, acre	0.0	0.0	0.0	0.0
At the bottom, acre	6.2	8.0	13.5	10.7

Table 3: High heat rejection sensitivity tests

Parameter	Scenario 4	Sensitivity Test 3	Sensitivity Test 4	Sensitivity Test 5	Sensitivity Test 6
Description	Winter low flow	10% higher rates	20% higher rates	10% higher ΔT's	20% higher ΔT's
Susquehanna River flow, cfs	2,848	2,848	2,848	2,848	2,848
Susquehanna River net, cfs	2,727	2,715	2,703	2,727	2,727
Water surface elevation, ft	486.8	486.8	486.8	486.8	486.8
Susquehanna River Temperature, F	32	32	32	32	32
SSES					
Temperature rise, °F	31.0	31.0	31.0	34.1	37.2
Intake rate, gpm	42,300	46,530	50,760	42,300	42,300
Discharge rate, gpm	11,200	12,320	13,440	11,200	11,200
BBNPP					
Temperature rise, °F	33.8	33.8	33.8	37.2	40.6
Intake rate, gpm	34,458	37,904	41,350	34,458	34,458
Discharge rate, gpm	11,172	12,289	13,406	11,172	11,172
Area of the 0.5°F isotherm					
At the surface, acre	71.8	76.9	81.9	75.9	79.4
At the bottom, acre	98.0	101.2	104.3	100.5	102.6
Area of the 1.0°F isotherm					
At the surface, acre	0.0	24.1	40.4	24.3	39.8
At the bottom, acre	70.7	78.6	83.7	77.9	82.1
Area of the 5.0°F isotherm					
At the surface, acre	0.0	0.0	0.0	0.0	0.0
At the bottom, acre	6.2	6.7	7.2	6.9	7.6

As expected, the results show surface and bottom area increases as discharge flows and ΔT's increase and Susquehanna River flows decrease.

Although the size of the combined thermal plume in the Susquehanna River is a complex function of a number of interacting variables, the two most important are the amount of heat rejected to the Susquehanna River (the sum of the product of SSES and BBNPP ΔT's and discharge rates) and the flow rate in the Susquehanna River. These variables can be combined by computing the fully-mixed temperature rise for each sensitivity test and plotting the resulting areas (Figure 1 and Figure 2). The fully-mixed temperature rise is computed as follows:

$$\Delta T_{fm} = (\Delta T_{SSES} * Q_{SSES} + \Delta T_{BBNPP} * Q_{BBNPP)})/Q_{SR}$$

The plume area is proportional to the heat rejected (numerator) and inversely proportional to the flow in the Susquehanna River (denominator).

Figure 1: Fully-mixed temperature rise vs. surface area

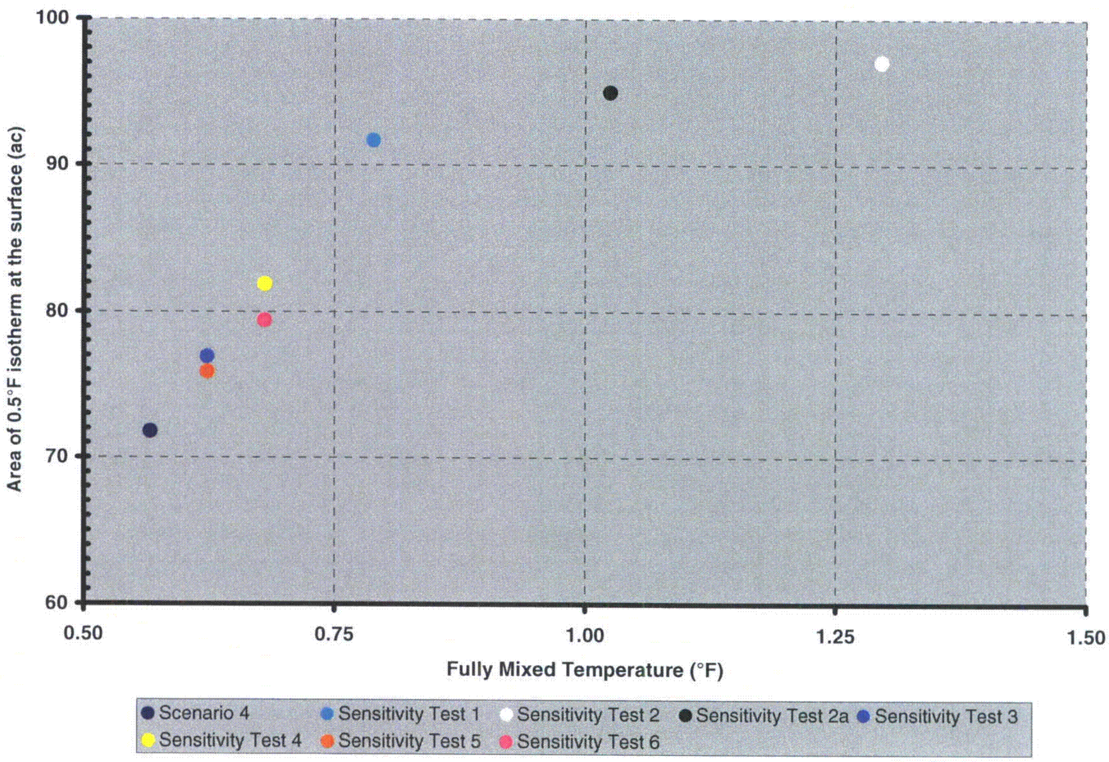
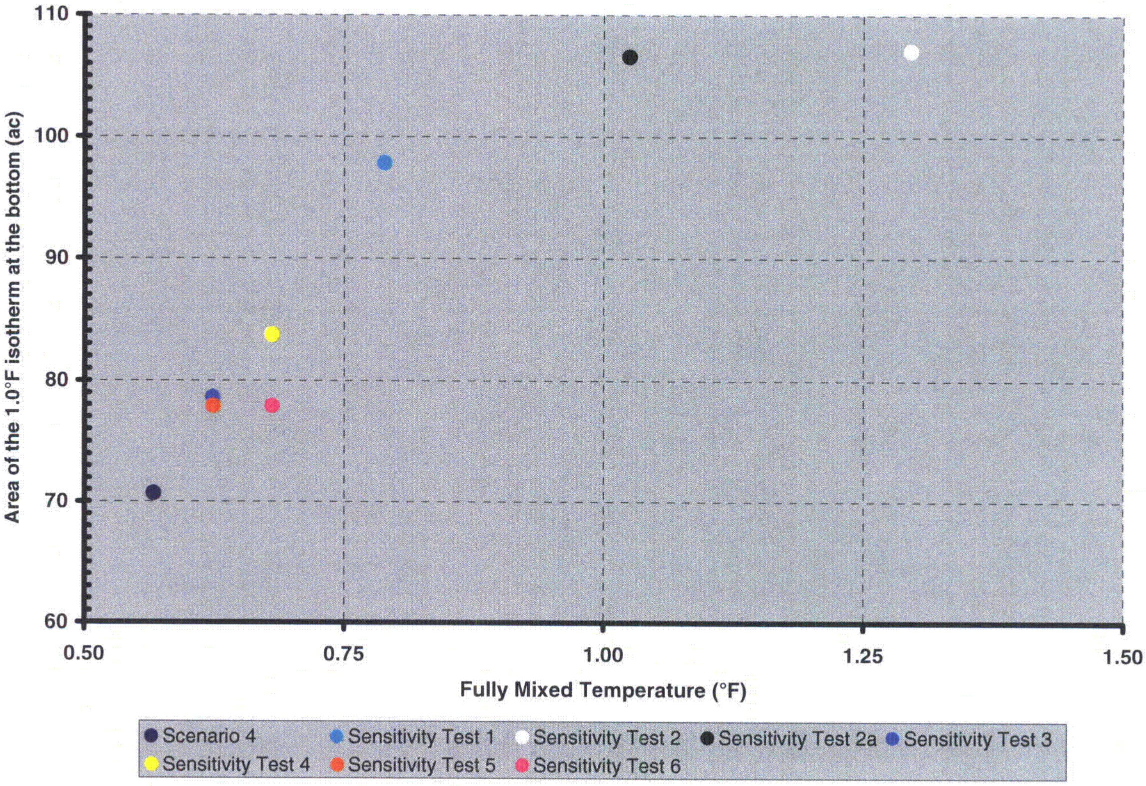


Figure 2: Fully-mixed temperature rise vs. bottom area



The computed plume areas increase with increasing fully-mixed temperature rise as expected, with the rate of increase decreasing at higher values of the fully-mixed temperature rise, likely reflecting the impact of additional factors (e.g. surface heat exchange, lateral and longitudinal dispersion). Furthermore, the plot shows that the amount of heat discharged (the product of the ΔT's and discharge rates) is more important than the value of the individual ΔT and discharge rate. This is shown by the near identical areas for Sensitivity Tests 3 and 5 (see Table 3). This pair represents increases in the heat rejected by 10% but that value is arrived at by increasing either the individual ΔT or the discharge rate by 10%. The same effect can be seen by comparing Sensitivity Tests 4 and 6 (see Table 3).

Enclosure 7 contains the thermal plume GEMSS input files used in the sensitivity analysis discussed above. The GEMSS files on the compact disc (CD) are as follows:

Date/Time	File Name	File Description
8/12/09 2:49p.m.	Verification May 1987_01.txt	GEMSS Input, May 1987 verif. Run
8/12/09 2:49p.m	Verification Sep 2008_01.txt	GEMSS Input, Sept. 2008 verif. Run
8/12/09 2:49p.m	Scenario 04_SR_RQ_01.txt	GEMSS Input, Sensitivity Test 1
8/12/09 2:49p.m	Scenario 04_SR_RQ_02.txt	GEMSS Input, Sensitivity Test 2
8/12/09 2:49p.m	Scenario 04_SR_DQ_01.txt	GEMSS Input, Sensitivity Test 2a
8/12/09 2:49p.m	Scenario 04_SR_DQ_02.txt	GEMSS Input, Sensitivity Test 3
8/12/09 2:49p.m	Scenario 04_SR_DE_01.txt	GEMSS Input, Sensitivity Test 4
8/12/09 2:49p.m	Scenario 04_SR_DE_02.txt	GEMSS Input, Sensitivity Test 5
8/12/09 2:49p.m	Scenario 04_SR_All_01.txt	GEMSS Input, Sensitivity Test 6

Bathymetric differences

The models presented in the ER Section 5.3 relied on two sets of bathymetric data: (1) the US Army Corps of Engineers (USACE) digital terrain maps – transects spaced approximately 500 ft apart and (2) more spatially-detailed bathymetric contours in the immediate vicinity of the SSES intake and discharge (see attached Figure 3, (PPL, 1978)).

The USACE digital terrain bathymetric mapping information for the Susquehanna River is found in Enclosure 8 and a copy of the transmittal letter accompanying the USACE data has been included as Enclosure 9.

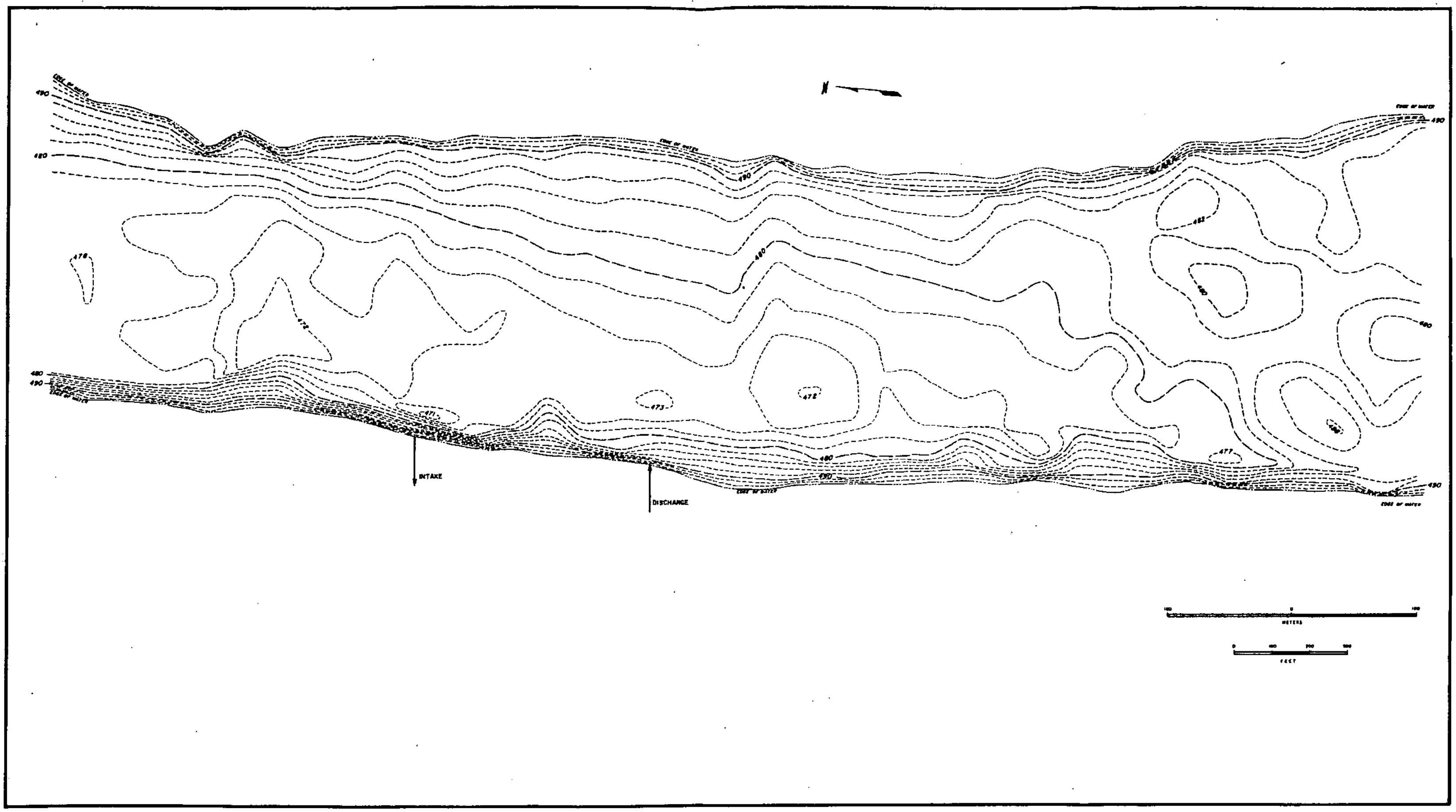
The bathymetric files in Enclosure 8 are as follows:

Date/Time	File Name	File Description
8/12/09 2:50p.m.	XYSusquehanna.dbf	US Army Corps of Engineers bathymetric dataset
8/12/09 2:50p.m.	XYSusquehanna.prj	
8/12/09 2:50p.m.	XYSusquehanna.sbn	
8/12/09 2:50p.m.	XYSusquehanna.sbx	
8/12/09 2:50p.m.	XYSusquehanna.shp	
8/12/09 2:50p.m.	XYSusquehanna.shx	

A third bathymetric dataset available in a report prepared by Ichthyological Associates, contains applicable pages which are included as Enclosure 10 to this RAI response.

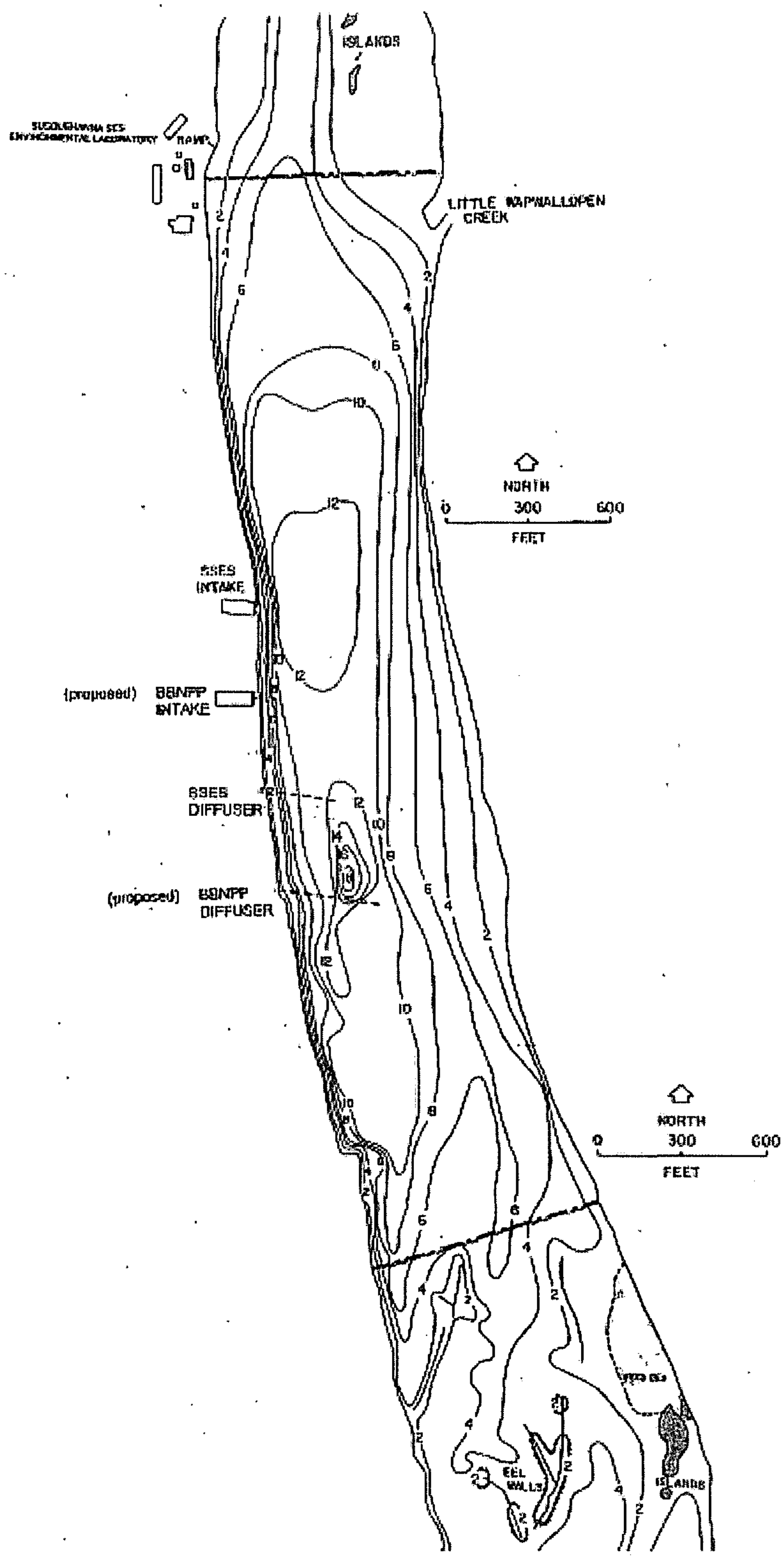
The availability of this dataset allows for comparison of the 1978 and 1983 datasets, shown in Figures 3 and 4.

Figure 3: 1978 bathymetric data from Pennsylvania Power and Light Company (1978)



SUSQUEHANNA STEAM ELECTRIC STATION ER–OPERATING LICENSE STAGE UNITS 1 AND 2
SUSQUEHANNA RIVER BATHYMETRY. FIGURE 2.4–3

Figure 4: 1983 depth data (from Fig. 1, Ecology III (1984)). The water surface elevation on the survey date was 486.2 ft MSL.



Note that Figures 3 and 4 are similar qualitatively, but that there is additional detail in the 1983 survey – depth was measured at 607 locations. Each survey shows a deeper area adjacent to the SSES intake and a deeper, but smaller area downstream of the SSES diffuser. These features existed prior to the operation of SSES Units 1 and 2. Based on a comparison of these figures, there was little change over the 5-year period between surveys.

To compare the two surveys, the contours are overlaid in Figures 5 and 6. The contours from each survey are so close to one another (e.g., the 1983 survey shows a depth about 8 in shallower at the BBNPP discharge) that at the level of detail incorporated into the near- and far-field models (overall depth in the former, and depths on a 30 ft by 50 ft grid in the latter), there would be no significant difference in the model results by using the 1983 dataset.

Figure 5: 1978 and 1983 bathymetric data overlain; green is the 1978 data, red the 1983 data.

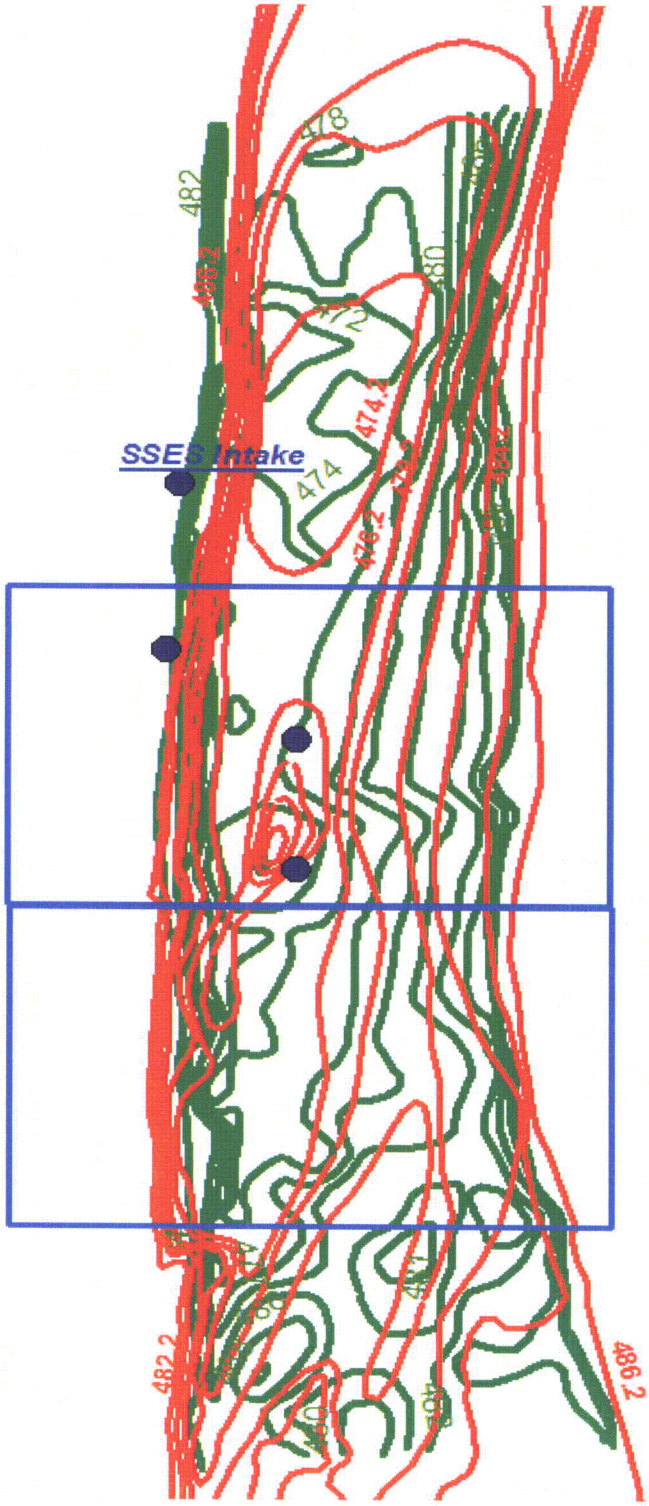
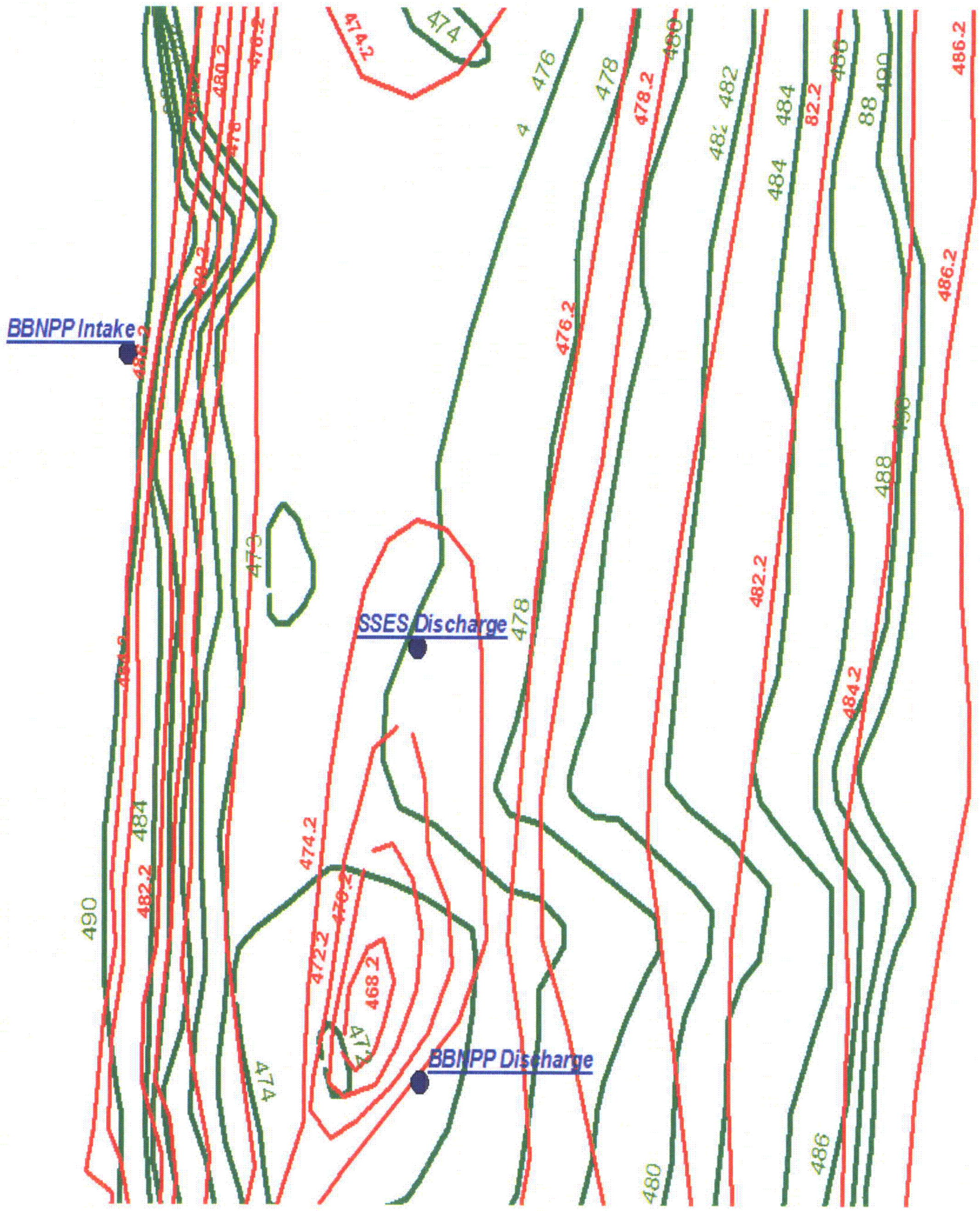


Figure 6: Detail near the BBNPP intake and discharge structures of the 1978 and 1983 bathymetric data; green is the 1978 data, red the 1983 data.



3. BBNPP plume calculations run in isolation as well as in combination with the SSES plume.

CORMIX was used to model the near-field thermal discharge plume from BBNPP in isolation, and GEMMS was used to model the far-field thermal discharge plume from BBNPP both in isolation and in combination with the discharge from SSES. Modeling results are discussed in ER Section 5.3.2.1 (see ER Figures 5.3-1 to 5.3-4). Because of the limitations of the model, CORMIX was used only to calculate the BBNPP plume in isolation. Modeling inputs and assumptions along with a description of the methodology employed to perform the CORMIX and GEMSS modeling are detailed in the June 2008 Susquehanna River Thermal Plume and Dilution Modeling report. The modeling report, along with accompanying CORMIX and GEMSS input files, were previously submitted to the NRC by PPL on June 29, 2009, in response to an information need request associated with the NRC's April 2009 BBNPP Environmental Audit (PPL, 2009). Input data used to calculate both the BBNPP and the combined BBNPP/SSES discharge plumes are provided in the CORMIX and GEMSS input files.

4. Sargent and Lundy Report 2008-06824, "Engineering and economic evaluation of integrated heat rejection cycle, Bell Bend Nuclear Power Plant," UniStar Nuclear Energy, April 2008.

A heat rejection system optimization study was performed for the Bell Bend Nuclear Power Plant. The evaluation determined the projected performance of the integrated heat removal systems (condenser, circulating water, and cooling tower). The Sargent and Lundy Report 2008-06824 determines whether there are compelling differences in net lifecycle economic benefits between various cooling tower options; whether these benefits and the ordering of options are dependent on external variables such as annual weather (average or extreme year); and whether these benefits are dependent on assumed circulating water flow. This report is included as Enclosure 11.

References Cited in Response:

PPL, 1978. Pennsylvania Power and Light Company. 1978. Susquehanna Steam Electric Station, Units 1 & 2 Environmental Report Operating License Stage (Volumes 1, 2, and 3), May 1978.

PPL, 2009. Letter from RR Sgarro (PPL) to U.S. NRC Document Control Desk, "BBNPP April 2009 NRC Environmental Audit Final Response Items," BNP-2009-131, dated June 29, 2009.

COLA Impact:

No changes to the BBNPP COLA ER are required as a result of this RAI response.

H 9.3-1

ESRP 9.3

Summary: *Provide a description of all surface water and groundwater users who could be affected by site construction and operation at all candidate alternative sites.*

Full Text: The applicant provided figures and tables at the site audit that gave additional details regarding water users that potentially could be impacted by construction and operation of the alternative sites.

Response: Data on surface water users provided at the BBNPP site audit were only fragmentary since they included only registered agricultural and industrial withdrawals. Withdrawals by public water supplies are not published by the Commonwealth of Pennsylvania.

The avoidance of impacts on users of groundwater for construction purposes at all alternative sites will be affected by the limitations on withdrawals through the permitting process of the Commonwealth. In the event that groundwater would be used at any of the alternative sites for plant operation the quantities will be small and they will also be regulated through the permitting process.

The use of surface water, principally for cooling at all candidate alternative sites is unlikely to have any impact on other users. Neither chemical nor thermal discharges will have significant impact on other potential users since all discharges will comply with the provisions of the Clean Water Act. Surface water withdrawals from the Susquehanna River for the BBNPP would amount to only one tenth of the 7 day 10 year low flow (7Q10) at this location. Similarly, the estimated withdrawals from the West Branch Susquehanna River for the Montour site would amount to only one tenth of the 7Q10. The Humboldt Industrial Park site would withdraw water from the main branch of the Susquehanna River also at a rate of one tenth of the 7Q10. The Seedco Industrial Park site would also use Susquehanna River water at a rate of one twenty-eighth of the 7Q10.

COLA Impact:

No changes to the BBNPP COLA ER are required as a result of this RAI response.

SE 2.5-2

ESRP 2.5.1

Summary: *Extend the transient population analysis out from 10 to 50 miles.*

Full Text: None.

Response: Quantitative estimates of transient populations within the 10-50 mi (16-80 km) radius of Bell Bend Nuclear Power Plant (BBNPP) are provided in Table 1. Transients considered for this analysis included populations using:

- Recreational, seasonal and occasional housing
- Motels/hotels and Bed & Breakfasts (B&Bs), and
- Campgrounds and Recreational Vehicle (RV) Parks

In order to avoid double counting populations that are most likely to be "resident" due to either their inclusion in census counts of the resident population or the large geographic area under consideration (where individuals traveling to various destinations may also live within the same area), the transient analysis does not include populations at primary and secondary schools; hospitals, nursing homes, prisons and other institutions; workplaces and colleges; or recreational areas and local attractions. In contrast, it is assumed that populations associated with recreational/seasonal/occasional housing, motels/hotels/B&Bs and campgrounds/RV parks are transient and come from outside the 50 mi (80 km) area. Additionally, agricultural workers have been excluded from the analysis, as the Commonwealth of Pennsylvania does not collect data on migrant or seasonal agricultural workers.

A qualitative discussion of special events that attract a large number of transients from outside the area for a short period of time is presented below.

Data for the population categories considered transient for the purpose of the analysis are shown in Tables 2 through 4. The transient analysis indicates that there are an estimated 49,896 transients within the 10-50 mi (16-80 km) radii of the BBNPP site (Table 1). Of these, there are approximately 17,225 transients occupying seasonal housing, 22,658 staying at campgrounds, and 10,013 lodging at motels, hotels and bed & breakfast establishments.

Recreational, Seasonal and Occasional Housing

Table 2 provides information on recreational, seasonal, and occasional housing. LandView©6 software has been used to estimate the transient population from the 2000 US Census (USCB, 2009a; USCB, 2009b). LandView©6 determines the number of housing units for each 10 mi (16 km) concentric circle segment within the 10 mi (16 km) to 50 mi (80 km) radii based on census block point data. For each segment, the number of housing units is multiplied by the percentage of total housing units in the corresponding census block group classified as "for recreational, seasonal, or occasional use." The number of seasonal housing units was then multiplied by the Pennsylvania State average household size (2.48 persons) to arrive at a maximum population in recreational, seasonal, and occasional housing (USCB, 2000). In order to account for the fact that these units are occupied for only a portion of the year, the estimated seasonal population for each segment was calculated by assuming that three quarters of the housing units would be occupied for three months of the year (Fermi, 2008). It was also assumed that seasonal occupants typically reside outside the 50 mi (80 km) area. Thus, by multiplying the maximum population in recreational, seasonal, or occasional housing units by 0.1875 ($0.1875 = 0.75 \times 0.25$) an estimate of the equivalent transient housing population for recreational, seasonal, or occasional use was determined for each 10 mi (80 km) concentric circle segment.

Campgrounds and RV parks

An estimate of the transient population using campgrounds and RV parks within the 10-50 mi (16-80 km) radii area is shown in Table 3. For each 10 mi (16 km) concentric circle segment within the 10-50 mi (16-80 km) radii, the campgrounds and RV park transient population was estimated by compiling listings of campground and RV parks from PA counties within 50 mi (80 km) of the BBNPP site (PVN, 2009). Each site listing a website was reviewed for information on the maximum number of camping, cabin, and RV sites within each campground and RV park. To estimate the maximum transient population associated with campgrounds and RV sites, the average number of persons per site was assumed to be four based on a review of the listed campground sites, the occupancy for each site was assumed to be 47% based on a national survey (Woodall, 2004) of occupancy rates, and the campers were assumed to come from outside the 50 mi (80 km) area.

Lodging Establishments

The estimated transient population using motels and other lodging establishments within the 10-50 mi (16-80 km) radii is provided in Table 4. The number of rooms at hotels, motels and bed and breakfast establishments within each 10 mi (16 km) concentric circle segment was identified using the AAA Tourbook (AAA, 2009). The maximum transient population for each segment was then calculated by multiplying the 2007 average hotel occupancy for Pennsylvania (61.9%) (PTO, 2007) by the number of rooms and an estimate of the number of persons per room (1.57), which is derived from nationwide survey information (AHLA, 2009). It is assumed that lodging guests come from outside of the 50 mi (80 km) area.

Special Events

Significant special events that generate large transient populations in the BBNPP 50 mi (80 km) radius area for short periods of time include the Pocono Raceway (NASCAR) in Long Pond, PA, and the Little League World Series in Williamsport, PA. The Pocono Raceway, which is estimated to attract many visitors on race weekends, has a seating capacity of 76,812. Two NASCAR Sprint Cup races are held there; one in June and another in August (NASCAR, 2009). Williamsport also hosts the Little League World Series. Seating capacity for the Lamade Stadium, where the Series is held, is approximately 40,000; 10,000 seats with additional space for 30,000 spectators on the grass (Little League, 2009). The Little League World Series in Williamsport typically occurs in August.

The transient population associated with these special events has not been included with the other transient groups mentioned above in estimating cumulative total transient populations present in the 10-50 mi (16-80 km) radii area.

Table 1. Summary of Transient Populations within 10-50 mi (16-80 km) of the BBNPP Site, by 10 mi (16 km) radii

Distance from BBNPP Site	Estimated Seasonal Housing Population	Estimated Campground Population	Estimated Lodging Population	Total Estimated Transient Population[1]
10-20 mi (16–32 km)	1,200	1,609	1,104	3,913
20-30 mi (32–48 km)	2,967	5,317	1,350	9,634
30-40 mi (48–64 km)	6,276	3,807	2,608	12,691
40-50 mi (64–80 km)	6,782	11,925	4,951	23,658
10-50 mi (16–80 km)	17,225	22,658	10,013	49,896

Note:

1. Total estimated transient population = estimated seasonal housing population + estimated campground population + estimated lodging population

Table 2. Recreational, Seasonal, or Occasional Housing Transient Population within 10-50 mi (16-80 km) of the BBNPP Site, by 10 mi (16 km) radii

Distance from BBNPP Site	Total Housing Units	Seasonal Housing Units[1]	Estimated Seasonal Population[2]
10-20 mi (16–32 km)	120,804	2,580	1,200
20-30 mi (32–48 km)	136,717	6,381	2,967
30-40 mi (48–64 km)	188,758	13,497	6,276
40-50 mi (64–80 km)	268,463	14,584	6,782
10-50 mi (16–80 km)	714,742	37,042	17,225

Notes:

1. Seasonal Housing Units = (Total Housing Units) × (% Recreational, Seasonal or Occasional Housing from 2000 US Census Block Group Data) (USCB, 2009a; USCB, 2009b)
2. Estimated Seasonal Population = (Seasonal Housing Units) × (2.48 persons/household) × 0.1875 (Fermi, 2008; USCB, 2000)

Table 3. Transient Population in Campgrounds and RV Parks within 50 mi (80 km) of BBNPP Site, by 10 mi (16 km) radii

Distance from BBNPP Site	Campground Sites	Estimated Campground Population[1]
10-20 mi (16–32 km)	856	1,609
20-30 mi (32–48 km)	2,828	5,317
30-40 mi (48–64 km)	2,025	3,807
40-50 mi (64–80 km)	6,343	11,925
10-50 mi (16–80 km)	12,052	22,658

Notes:

1. Campground Population = (Number of Campground Sites) × (4 persons/site) × 47%. (PVN, 2009; Woodall, 2004)

Table 4. Hotel, Motel, and B & B Transient Population within 10-50 mi (16-80km) of the BBNPP Site, by 10 mi (16 km) radii

Distance from BBNPP Site	Number of Rooms	Estimated Lodging Population[1,2]
10-20 mi (16–32 km)	1,136	1,104
20-30 mi (32–48 km)	1,389	1,350
30-40 mi (48–64 km)	2,684	2,608
40-50 mi (64–80 km)	5,094	4,951
10-50 mi (16–80 km)	10,303	10,013

Notes:

1. Lodging Population = (Number of Rooms) × (1.57 persons/room) * 61.9% hotel occupancy rate. (AAA, AHLA, 2009; 2009; PTO, 2007)
2. Number of persons/room = 1.57 = (43% business travel × 1 person/room) + (57% leisure travel × 2 persons/room) based on D.K. Shifflet & Associates, Ltd survey data. (AHLA, 2009)

References cited in this response:

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USCB, 2009b. LandView 6: A viewer for the Environmental Protection Agency, U.S. Census Bureau, and U.S. Geological Survey Data and Maps. Website: http://www.census.gov/geo/landview/. Date accessed: September 9, 2009.

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COLA Impact:
The BBNPP COLA ER will be revised as follows in a future COLA revision.

2.5.1.1.3.2 Transient Population Levels

Table 2.5-6 presents population distributions, by residential population and transient population in 2000, within each of sixteen geographic directional sectors at radii of 0 to1 mi (0 to 2 km), 1 to 2 mi (2 to 3 km), 2 to 3 mi (3 to 5 km), 3 to 4 mi (5 to 6 km), 4 to 5 mi (6 to 8 km), and 5 to10 mi (8 to 16 km) from the BBNPP site. Table 2.5-6a illustrates that there are an estimated 49,896 transients within 10-50 mi (6-80 km) radii of the BBNPP site. Of these, there are approximately 17,225 transients occupying seasonal housing, 22,658 staying at campgrounds, and 10,013 lodging at motels, hotels and bed & breakfast establishments.

New **Table 2.5-6a Summary of Transient Populations within 10-50 mi (16-80 km) of the BBNPP Site, by 10 mi (16 km) radius**

Transient Analysis	Distance from BBNPP Site mi (km)				
	10-20 mi (16–32 km)	20-30 mi (32–48 km)	30-40 mi (48–64 km)	40-50 mi (64–80 km)	10-50 mi (16–80 km)
Estimated Seasonal Housing Population[1, 2]	1,200	2,967	6,276	6,782	17,225
Estimated Campground Population[3]	1,609	5,317	3,807	11,925	22,658
Estimated Lodging Population[4,5]	1,104	1,350	2,608	4,951	10,013
Total Estimated Transient Population	3,913	9,634	12,691	23,658	49,896

Notes:

1. Seasonal Housing Units = (Total Housing Units) × (% Recreational, Seasonal or Occasional Housing from 2000 US Census Block Group Data)
2. Estimated Seasonal Population = (Seasonal Housing Units) × (2.48 persons/household) × 0.1875
3. Campground Population = (Number of Campground Sites) × (4 persons/site) × 47%.
4. Lodging Population = (Number of Rooms) × (1.57 persons/room) * 61.9% hotel occupancy rate.
5. Number of persons/room = 1.57 = (43% business travel × 1 person/room) + (57% leisure travel × 2 persons/room) based on D.K. Shifflet & Associates, Ltd survey data.

SE 4.4-4

ESRP 4.4.2

Summary: *Provide month-by–month and quarter-by-quarter workforce data during the construction timeframe. Also, provide an estimate of the number of operations workers who would be employed during the construction period.*

Full Text: Late in the construction period, operations workers will be hired and begin training at the new power plant. Build these workers into the construction period employment calculations and all associated calculations, including those related to demand for public services.

Response: The estimated construction workforce population was forecast on a quarterly basis for the period of construction. This forecast did not consider monthly staffing changes. ER Table 4.4-3; Estimated Average FTE Construction Workers, by Construction Year/Quarter at the BBNPP, provides the data for the projected 68 month period of construction. Based on ER Table 4.4-3, Table 1 was developed.

ER Section 5.8.2 states that an estimated total of 363 employees would be added to operate BBNPP. Staffing studies for an EPR Nuclear Power Plant indicate that operations personnel would be added during the entire period of construction with full staffing achieved during the fifth year of construction. Although actual staff additions would vary year to year, an average of approximately 73 additions would be made per year. The peak operations workforce of 363 represents less than 10% addition to the 3950 construction workforce present during year five of construction. Given the ramp up and subsequent decline in construction workers and ramp up of a small number of operations personnel, the likely impact on the demand for public services would be minimal.

Table 1 Estimated Average FTE Construction Workers, by Construction Month, Based Upon Quarterly Estimate Provided in ER Table 4.4-3

Year 1:	Quarterly	Monthly by Quarter	Year 4:	Quarterly	Monthly by Quarter
1	350	117	1	3,683	1228
2	800	267	2	3,867	1289
3	1,250	417	3	3,950	1317
4	1,600	533	4	3,950	1317
Year 2:			Year 5:		
1	1,900	633	1	3,950	1317
2	2,200	733	2	3,917	1306
3	2,500	833	3	3,700	1233
4	2,800	933	4	3,400	1133
Year 3:			Year 6:		
1	3,050	1017	1	3,050	1017
2	3,200	1067	2	1,967	656
3	3,350	1117	3*	768	384
4	3,500	1167			

*Based on two months due to 68-month construction period.

COLA Impact:
No changes to the BBNPP COLA ER are required as a result of this RAI response.

USACE-2b

Summary: *Identify and explain the mitigation requirement(s) from the Susquehanna River Basin Commission (SRBC) and identify if any Department of the Army Section 10 and/or Section 404 permits will be required.*

Full Text: Pursuant to Section 10 of the Rivers and Harbors Act, a Department of the Army permit is required for work or structures in navigable waters of the United States and pursuant to Section 404 of the Clean Water Act, a Department of the Army permit is required for the discharge of dredged or fill material into waters of the United States, including jurisdictional wetlands. Any proposal to perform the above activities within the area of Federal jurisdiction will require the prior approval of this office. All proposed impacts must be evaluated concurrently under one application submittal.

Response: The duties of the Susquehanna River Basin Commission (SRBC) per the *Susquehanna River Basin Compact* (SRBC, 1972) include the duty to administer, manage, and control water resources of the Susquehanna River Basin in all matters determined by the Commission to be interstate in nature or to have a major effect on the water resources or water resources management. SRBC staff develops and implements the programs as directed by the commissioners and as found in SRBC's comprehensive plan, *Comprehensive Plan for the Water Resources of the Susquehanna River Basin* (SRBC, 2008). The SRBC has published guidelines and regulations for surface water and groundwater withdrawal and consumptive water use; SRBC's regulations are promulgated in *Code of Federal Regulations, Title 18, Chapter VIII.* Among these regulations are standards for consumptive uses of water (Section 806.22) including requirements to mitigate consumptive use (Section 806.22(b)). (Federal Register, 2006)

Consumptive Use of Water

The BBNPP requires water for cooling and operational use. The sources for water are the Susquehanna River and the Berwick District of Pennsylvania American Water Company (PAW). Water from the Susquehanna River will provide cooling and operational uses while PAW will provide water for potable, sanitary, and miscellaneous plant systems. Section 3, Table 3.3-1 of the Environmental Report (BBNPP, 2009) provides a quantitative description of the minimum and maximum water flows to and from plant operating systems. Additionally, the average consumptive use of the Susquehanna River water during normal operating conditions will be approximately 6.9E+08 gallons per month. Table 3.3-1 of the Environmental Report details the consumptive water uses expected for normal operation of the BBNPP.

Consumptive Use Mitigation

SRBC's current standards for consumptive uses of water (Federal Register, 2006) dictate that all project sponsors whose consumptive use of water is subject to review and approval under Section 806.4 shall mitigate such consumptive use during low flow periods if deemed necessary. Mitigation may be provided by one or a combination of actions as stated in Section 806.22(b). They are as follows:

(1) During low flow periods as may be designated by the Commission for consumptive use mitigation.

(i) Reduce withdrawal from the approved source(s), in an amount equal to the project's total consumptive use, and withdraw water from alternative surface water storage or aquifers or other underground storage chambers or facilities approved by the Commission.

(ii) Release water for flow augmentation, in an amount equal to the project's total consumptive use, from surface water storage or aquifers, or other underground storage chambers or facilities approved by the Commission.

(iii) Discontinue the project's consumptive use.

(2) Use, as a source of consumptive use water, surface storage that is subject to maintenance of a conservation release acceptable to the Commission.

(3) Provide monetary payment to the Commission, for annual consumptive use, in an amount and manner prescribed by the Commission.

(4) Implement other alternatives approved by the Commission. As stated in Section 806.22(c), the Commission will, in its sole discretion, determine the acceptable manner of mitigation to be provided by project sponsors whose consumptive use of water is subject to review and approval. Such a determination will be made after considering the project's location, source characteristics, anticipated amount of consumptive use, proposed method of mitigation and their effects on the purposes set forth in Section 806.2, and any other pertinent factors. The Commission may modify, as appropriate, the manner of mitigation, including the magnitude and timing of any mitigating releases, required in a project approval. (Federal Register, 2006)

Department of the Army Section 10 and/or Section 404 permits and Pennsylvania State Programmatic General Permit

Section 4.3.1.3 of the Environmental Report indicates that approximately 36 ac (14.5 ha) of wetlands and approximately 340 linear feet (104 m) of stream channel will be permanently impacted by the placement of earthen fill material. The project will likely require an Individual Permit (IP) from the Baltimore District of the United States Army Corps of Engineers (USACE) under Section 404 of the Clean Water Act (CWA) and Section 10 of the Rivers and Harbors Act of 1899. The BBNPP project will not qualify for approval under the USACE Pennsylvania State Programmatic General Permit-3 (PASPGP-3) (USACE, 2008) due to the proposed unavoidable impacts to federally regulated Waters of the U.S.

Rivers and Harbors Act of 1899, Section 10

The Rivers and Harbors Act of 1899 (33 USC 401, et seq.) is the legislative origin of the US Army Corps of Engineers (USACE) regulatory program. Various sections establish permit requirements to prevent unauthorized obstruction or alteration of any navigable water of the United States. Section 10 (33 USC 403) of the Rivers and Harbors Act regulates construction, excavation, or deposition of materials in, over, or under such waters, or any work which would affect the course, location, condition, or capacity of those waters. Activities requiring Section 10 permits include structures (e.g., piers, wharfs, breakwaters, bulkheads, jetties, weirs, transmission lines) and work such as dredging or disposal of dredged material, or excavation, filling, or other modifications to the navigable waters of the United States. Section 10 permits are administered by USACE under the Department of the Army Permit Program.

The geographic jurisdiction of the Rivers and Harbors Act includes all navigable waters of the United States which are defined (33 CFR Part 329) as, "those waters that are subject to the ebb and flow of the tide and/or are presently used, or have been used in the past, or may be susceptible to use to transport interstate or foreign commerce."

Department of Army permits are required to authorize certain structures or work in, or affecting, navigable waters of the United States pursuant to Section 10 of the Rivers and Harbors Act. Certain activities may fall under an authorized nationwide general permit or a regional general permit. If this is not the case, an individual Section 10 permit is required (USACE, 2009).

Based on the installation of a blowdown return line affecting the bed and banks of the Susquehanna River, it is likely that a Section 10 permit will be required. The Section 10 permit will be reviewed in conjunction with the IP application submitted on behalf of PPL Bell Bend, LLC in 2010.

Additional Federal, State, Luzerne County, and local authorizations or approvals are anticipated to be required and must be secured by the permit applicant, prior to initiating any discharge of dredged or fill material, and/or the placement of structures into Waters of the U.S., including jurisdictional wetlands. These approvals include, but are not limited to:

a. A 401 Water Quality Certification issued by PADEP pursuant to Section 401 of the CWA.
b. A Consistency Determination issued by PADEP pursuant to Section 307 of the Federal Coastal Zone Management Act for activities located within designated Coastal Zone Management Areas.
c. For activities resulting in permanent, above-grade fills in Waters of the U.S., including jurisdictional wetlands within 100-year floodplains mapped by the Federal Emergency Management Agency (FEMA) or State or local governments, the permittee must comply with the applicable FEMA, State, and local floodplain construction requirements.

Depending on the required permit process, a Public Notice will be issued with a 15-day to 30-day comment period, if necessary. The proposal is reviewed by the USACE, general public, special interest groups, and State, local and other related federal agencies. The typical IP permit review and approval process may be greater than 12 months.

For PASPGP, the USACE IP is usually issued along with the State's authorization (USACE, 2009).

Summary

Impacts to wetlands and other Waters of the U.S. will require Section 404 and Section 10 permits administered under the Department of the Army Permit Program. A proposed compensatory wetland mitigation plan will be submitted to the USACE for review and comment with the IP application package. BBNPP will coordinate with SRBC with respect to water withdrawals and use and to mitigating consumptive water use. In the event modifications to the proposed construction and operation of the facility are implemented, BBNPP will coordinate with the USACE and SRBC to comply with appropriate regulatory requirements.

References cited in response:

BBNPP, 2009. Bell Bend Nuclear Power Plant, Combined License Application, Part 3, Environmental Report.Website: http://adamswebsearch2.nrc.gov/idmws/ViewDocByAccession.asp?AccessionNumber=ML090710517, Date accessed: November 17, 2009.

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USGS, 2008. Low flow statistics for Pennsylvania streams, Website: http://pa.water.usgs.gov/pc38/flowstats/lowflow.ASP?WCI=stats&WCU;ID=2428, Date accessed: May 30, 2008.

COLA Impact:

No changes to the BBNPP COLA ER are required as a result of this RAI response.

USACE-2c

Summary: *Provide a narrative addressing public benefits of the proposed project which is separate from the project's proponents' benefit.*

Full Text: The proposed project must be evaluated to ensure that it is not contrary to the public interest (33 CFR 320.4). There are 20 public interest factors. The Corps must evaluate the project in light of these factors and the interests of the applicant to determine the overall balance of the project with respect to the public interest.

Response: Pursuant to 33 C.F.R. 323.6, a determination that the project is not contrary to the public interest must be achieved before permit issuance. Public interest considerations are listed in 33 C.F.R. 320.4 (a) (1) and, in the context of the BBNPP development project, are addressed below. It is shown below that the BBNPP project is not contrary to the public interest. Source material for the response herein was obtained from the Bell Bend Nuclear Power Plant Combined License Application, Part 3: Environmental Report, Revision 1 (UniStar, 2008).

1. **Conservation**

The BBNPP site is located in the southwestern quadrant of Luzerne County, Pennsylvania. This area is characterized by forests, open, undeveloped, agricultural, mined, and developed land. The developed portions of this area are located in and around the city of Hazleton and the eastern outskirts of Berwick Borough. The BBNPP development project has been designed to balance energy development and conservation values. Jurisdictional wetlands will remain on site in the post-development condition. Upland buffers of varying widths, along with additional upland preservation areas, will be located adjacent to the remaining wetlands on site. By preserving both wetland and upland areas within the project site, the majority of the natural resources provided by these on site wetland systems should be conserved.

The U.S. Environmental Protection Agency (USEPA), with authority through the Resource Conservation and Recovery Act (RCRA), regulates all types of solid wastes (hazardous and non-hazardous), including municipal wastes, industrial wastes, and hazardous waste (49 CFR 107 to 400). Under the guidance of the EPA, the Pennsylvania Department of Environmental Protection (PADEP) regulates waste management in the State of Pennsylvania. Waste management will be provided to ensure that no significant adverse impacts to conservation values will occur during the construction of the facility and after the facility is in full operation.

Implementation of the plant development would include construction of facilities, heavy equipment staging areas, construction laydown areas, haul roads, and the associated unavoidable increases of hazardous material use and hazardous waste generation. With any increase in handling or storage of hazardous material, there is an inherent increase in hazardous waste generation and general increase in risk to human health; however, PPL standard operating procedures, and other related regulatory guidance governing the storage, handling, and management of hazardous materials and hazardous wastes would continue to be enforced, thereby minimizing cumulative adverse impacts. It is anticipated that local disposal areas for these types of materials would continue to have the capacity to accept wastes generated in the construction of the facility.

The Joint Permit Application (JPA) for authorization of the U.S. Army Corps of Engineers (USACE) Individual Permit (IP) will include a detailed natural resource mitigation plan. This mitigation plan will include information regarding conservation of natural resources.

2. Economics

Information pertaining to the economic public interest is primarily provided in the context of socioeconomic development. In general, socioeconomic benefits accrue from capital expenditures as well as the increased number of jobs created during construction and long term operations and the additional spending that results. Section 5.8.1 of the Environmental Report (ER) provides general information on the adverse physical impacts of the proposed development such as the public perception of industry-specific stigmas (Blinder, 1979). Section 5.8.2 of the ER describes the potential positive impacts of the proposed action (demographic, housing, employment and income, tax revenue generation, land values, and public facilities and services). Section 5.8.2 also provides predictive estimates on the potential increases in direct and indirect workforce and associated secondary impacts such as increased property value.

The BBNPP development project would create some level of population growth, which would equate to additive economic gains for direct, indirect, and induced employment and income. Additional taxes would accrue to the federal, state, and local governments as a result of this cumulative economic activity. These gains would be additive and interactive with other economic activities in the local area and represent a positive gain for the economy.

3. Aesthetics

With construction of the BBNPP facility, some of the proposed buildings may be visible from a few neighboring properties, and the cooling tower plume observable from a larger area. Because of the minimal visual impacts of the proposed structures, access roads, water intake, outfall, transmission lines, and the water vapor plumes, impacts to area-wide and recreational aesthetics are considered minimal, and would not be expected to require mitigation. The two proposed cooling towers for the new facility are 90 feet less in height when compared to the existing Susquehanna Steam Electric Station cooling towers, but the final grade of the new towers will be higher than the existing towers. The net effect is the visibility of the new towers will be less than the existing towers.

Plume rise varies and is temporary, depending on the season, wind direction, and viewpoint location. Seasonal/Annual Cooling Tower Impacts (SACTI) modeling results show plumes occur in all directions, whose lengths and heights vary seasonally, but are judged to have small impact and not require mitigation. The visibility of the BBNPP site from north and east is limited due to topography. The existing visibility of the cooling tower from south and west is expected to remain the same. In order to reduce aesthetic impacts related to new transmission structures, the exteriors can be painted, where practicable, with a compatible color of the surrounding area. Adjacent community visual impacts could be affected by the proposed project development; however, it is anticipated that there would be only minor, cumulative impacts. This conclusion would be supported by ensuring that natural areas and forest cover are continued to be used for buffers on the plant site, thereby obscuring development. With these considerations, no significant adverse impact to area wide and recreational aesthetics should occur as a result of the proposed facility development.

4. General environmental concerns

As summarized in Section 9.2.3 of the ER, the general impacts (including environmental) that may be associated with facility development include, but are not limited to: 1) water use and quality, 2) terrestrial and aquatic ecology including wetlands, 3) threatened and endangered species, 4) safety, 6) environmental justice, 7) land use, 8) air quality, 9) waste management, and 10) human health. Based on these potential impacts, the coal, natural gas, or combination power generating facility (alternative sites) would not be environmentally preferable to the proposed BBNPP development site. The site selection process focuses on identifying and evaluating locations that represent a range of reasonable alternative sites for the proposed project. The primary objective of the site selection process is to determine if any alternative site is "obviously superior" to the preferred site for eventual construction and operation of the proposed reactor units. The preferred site is chosen from within the candidate sites, and then compared with the remaining candidate sites to demonstrate that none are "environmentally preferable." The basic constraints and limitations applicable to the site selection process are the currently implemented rules, regulations, and laws within the federal, state, and local agency levels. These provide a comprehensive basis and an objective rationale under which this selection process is performed. Overall, the alternative sites do not offer environmental advantages over the BBNPP site. Operational experience at the adjacent Susquehanna Steam Electric Station (SSES) has shown that the environmental impacts are minimal and operation of the new unit is expected to have essentially the same or less environmental impacts (Section 9.3.3 of ER).

Specific environmental concerns are detailed in the appropriate corresponding public interest considerations in this RAI response. Furthermore, as detailed in the ER, the narrative relating to Environmental Impacts of Construction and Station Operation (Chapters 4 and 5) attempts to thoroughly address general environmental concerns as they relate to: 1) land, 2) water (surface and ground), 3) ecology, and 4) radiological and non-radiological health impacts. Additionally, Section 5.10 of the ER (Measures and Controls to Limit Adverse Impacts during Operation) expands on: 1) erosion and sedimentation, 2) air quality (dust, air pollutants), 3) wastes (effluents, spills, material handling), 3) noise, 4) traffic, and 5) radiation exposure. Overall, no significant adverse impact to general environmental concerns should occur as a result of the proposed facility development.

5. Wetlands

The construction of the BBNPP facility will result in the loss of approximately 33 acres of jurisdictional wetlands (permanent fill impact). Significant efforts to avoid and minimize impacts to jurisdictional wetland areas on site are being made through the redesign of the facility footprint and other avoidance and minimization activities. As a result of these efforts, permanent impacts to jurisdictional wetlands are expected to be further reduced. To meet the project purpose and need, however, some limited wetland impacts will be unavoidable. A comprehensive compensatory mitigation plan will offset these wetland impacts through provision of targeted high quality restoration and creation of wetlands and riparian zone/floodplain habitat. A Joint Application detailing project impacts and mitigation requirements will be submitted to the US Army Corps of Engineers and the PA DEP in 2010.

6. Historic properties

On site/off site historic properties and those eligible for inclusion on the National Registry were identified during the Phase 1a and Phase 1b investigations (Section 2.5.3 of ER). These properties were also taken into consideration during the alternative energy source assessment and the site selection process for the BBNPP development project.

The proposed project development could potentially affect archaeological, cultural and historical resources where ground disturbance exposes any pre-historic or historic undocumented/unknown resources. However, should any additional resource evidence be revealed during construction having archaeological, cultural or historical value, the Pennsylvania State Historic Preservation Office will be notified in accordance with the Cultural Resources Protection Plan.

7. Fish and wildlife values

Fish and wildlife values are directly correlated to the overall terrestrial and aquatic ecological health. Field studies to characterize the terrestrial ecology of the BBNPP Owner Controlled Area (OCA) were initiated in July 2007 and continued through September 2008. The field studies included a flora survey (Summer 2008), a faunal survey (October 2007 through September 2008), and wetlands delineation and mapping efforts (July 2007 through August 2008). Additionally, characterization of the aquatic ecology related to BBNPP included both collection of new field data and acquisition of data collected by others for the waterbodies located within or adjacent to the OCA. Sections 2.4.1 and 2.4.2 of the ER summarize relevant information from each of these studies and provide other data on existing terrestrial and aquatic ecology in accordance with the guidance in NUREG-1555 (NRC, 1999).

Pennsylvania state agencies protect threatened and endangered plants and animals under 7 PA Code § 133, 17 PA Code Chapter 45, and 30 PA Code 2102 and 2305. Federally-listed (threatened and endangered) plants and animals are protected under the Endangered Species Act of 1973, as enforced by the U.S. Fish and Wildlife Service (USFWS). The BBNPP development project will be completed (construction and operation) in a manner such that no significant adverse impacts to the conservation of federal- and state-listed species will occur. Fish and wildlife values will be preserved though the preservation of on site wetlands, as well as upland preservation. Consequently, fish and wildlife values should not be adversely affected by the proposed construction of the facility.

8. Flood hazards

The PADEP (under 25 PA Code Chapters105 – 106) serves to manage floodplain permits for any activity that changes the course, current, or cross-section of a non-tidal stream or body of water, including the 100-year floodplain. This code adheres to floodplain management guidance as established by the Federal Emergency Management Agency (FEMA) under the Department of Homeland Security (DHS). With regard to the proposed construction at the BBNPP facility, stormwater discharges from impervious surfaces at the facility will be controlled and minimized by provisions of Pennsylvania's Stormwater Best Management Practices Manual. Three stormwater related plans, jointly administered by PADEP and Luzerne County under 25 PA Code 92, 93, ands 102, are required: 1) an Erosion and Sediment Control Plan is required to be implemented at a construction site in which best management practices (BMPs) are utilized to control erosion and sediment; 2) a Preparedness, Prevention, and Contingency Plan is required by Pennsylvania (PA Code Section 91.33 and 91.34); and 3) a Post-Construction Stormwater Management Plan must be prepared and implemented to identify the BMPs to be installed to manage and treat the stormwater discharge so that water quality is protected after construction activities are terminated (see Section 6.5.2.3 of ER). Elevations produced by routing a 100-year/24-hour storm event will be used to develop the proposed Storm Water Management System (SWMS). These elevations will also be used to establish the minimum finish floor elevation. With these considerations, the proposed construction of the BBNPP facility will not be expected to elevate flood hazards on site or adversely affect downstream areas.

9. Floodplain values

As stated above, the PADEP serves to manage floodplain permits for any activity that changes the course, current, or cross-section of a non-tidal stream or body of water, including the 100-year floodplain. This code adheres to floodplain management guidance as established by FEMA. The BBNPP plant grade elevation is 674 feet (205 meters) mean sea level, which is about 157 feet (48 meters) higher than the highest recorded water level. Therefore, it is anticipated that the Susquehanna River flooding does not affect the plant. The plant site is dry with respect to major flooding on the Susquehanna River (Section 3.4.1.3.3 of ER). With the exception of the new intake and discharge, most all of the proposed construction will occur outside of the 100-year floodplain. A small portion of the BBNPP site to the west along Walker Run may be within the 100-year and 500-year floodplain. With those exceptions, construction activities would be outside the 500-year floodplain in locations designated as areas of minimal flooding (Section 4.1.1.1 of ER). The implementation of the SWMS will provide assurance that water quality and quantity values will be maintained; and any floodplain issues addressed. No significant adverse impact to floodplain values should occur as a result of the proposed facility construction.

10. Land use

Most of the BBNPP OCA is zoned as an agricultural district with a much smaller portion zoned as a conservation district (see Figure 2.2-4 of the ER). Small areas of the site, occurring to the north and east of the SSES facility are zoned heavy industrial. Section 2.2 of the ER provides maps and figures detailing the existing land use: 1) on site; 2) within 50 miles and less; and 3) within Luzerne and Columbia Counties. Section 2.2.1 of the ER establishes the nature and extent of current and proposed land use within the vicinity and region of the BBNPP facility that might be impacted by station construction and operation. The review evaluates both on site and off site areas that will be modified for the sole purpose of supporting construction and maintenance of the proposed facility. Overall, the facility construction should not have a significant adverse impact to the surrounding land use. All permit requirements and mitigation measures (as needed) will be fulfilled and implemented per federal, state, and local regulations to minimize incremental adverse impacts to land use. Finally, the construction of the facility will not require a change in the existing zoned use of the BBNPP site.

11. Navigation

Several canals, dams, and levees were constructed during the early 1800's to improve transportation on the Susquehanna River. However, over time, bridges replaced ferries and railroads replaced canals, making commercial navigation on the Susquehanna River negligible (Section 2.3.2.1.3 of ER). With regard to waterway navigation and the proposed construction of the BBNPP facility, there is no work proposed along the adjacent navigable waterway (i.e., the Susquehanna River), and the estimated intake of the plant should not affect navigable flows. With regard to other transportation interests, Section 2.5.2.10 of the ER presented information on existing airports, public transit (bus), roads and highways, rail, and freight carriers. With the exception of minor increases in traffic consistent with normal population growth models, no additional exceptional changes in intensity, frequency, and duration of traffic is expected as a result of the BBNPP development.

12. Shore erosion and accretion

With the exception of the Susquehanna River and its tributaries, the proposed BBNPP development does not occur adjacent to or nearby any other shoreline (pond, lake, ocean or otherwise). Furthermore, the facility development should have minimal effects on erosion and runoff since the PADEP requires an Erosion and Sediment Control Plan as part of the construction plan for the project. During the construction process, BMPs, according to Pennsylvania's Stormwater Best Management Practices Manual, will be followed. These BMPs may include measures that will prevent sediment transport off the project site into off site waters. Use of devices such as silt screens, staked hay bales, temporary grassing, wind rowing of vegetation, or other mechanisms to prevent turbidity will be employed. The Post-Construction Stormwater Management Plan will implement the identified BMPs necessary to manage and treat stormwater discharge so that water quality is protected during operation of the facility.

13. Recreation

The BBNPP site, as including the proposed development area, does not directly, or indirectly, impact adjacent lands (forested, agricultural, or other managed natural areas) that are currently used for recreational purposes, such as hiking, birding, fishing, or hunting. Water-dependent recreation (i.e., fishing and limited swimming and boating along the Susquehanna River) represent non-consumptive surface water uses in the vicinity of the project site. Recreational opportunities are provided nearby at the Susquehanna Riverlands. There is no commercial fishing on the Susquehanna River in the vicinity of BBNPP (Section 4.2.1.6 of ER). The existing wetlands on the project site offer no recreational opportunities to the general public. Public access is restricted because of private ownership. In summary, no significant adverse impact to recreation should occur as a result of the proposed facility development.

14. Water supply and conservation

Managed by the Susquehanna River Basin Commission (SRBC), withdrawal and consumptive use of surface water and groundwater in the Susquehanna River Basin shall adhere to requirements of the SRBC regulations and the resulting docket for this project. In general, in-stream uses downstream of public water-supply intakes are protected by docket conditions requiring either conservation releases from large reservoirs or minimum passby flows (USGS, 2008). Susquehanna River water will be used to meet the cooling water demand requirements. No on site groundwater will be used for the actual operation of BBNPP. SRBC's current standards for consumptive uses of water (Federal Register, 2006b) dictate that all project sponsors, whose consumptive use of water is subject to review and approval under Section 806.4 of the SRBC Regulation of Projects (18 CFR Parts 801, 806, 807, and 809)(SRBC, 2009), shall mitigate such consumptive use during low flow periods. Registration and reporting requirements are also imposed by the PADEP. Potable water will be purchased from a public water supplier and will be a source for drinking water and water for other non-cooling purposes during plant operation. With these considerations, no significant adverse impact to the local or regional water supply is anticipated as a result of the proposed facility development.

15. Water quality

With regard to National Pollutant Discharge Elimination System (NPDES) permits, water diversions and withdrawals, and Clean Water Act (CWA) Section 401 water quality certification, the PADEP Bureau of Watershed Management and Bureau of Water Management assist with permitting, approving, and/or regulating water quantity/quality for new development projects. The Salem Township Zoning Ordinance under Section 1302 (SALEM, 2004) requires site development plan (SALEM, 2001b), erosion and sediment control plan, and related site access plan (SALEM, 2001a) approvals be obtained from Luzerne County, the Pennsylvania Department of Transportation (PADOT), and the PADEP prior to Salem Township approval (Section 1.3.3 of ER). Sanitary wastewater discharges from BBNPP will be sent to the Berwick Area Sewer Authority, under their approval and guidance. The aforementioned permitting approvals and guidance will be obtained prior to construction of the BBNPP facility. In summary, post-development water quality will be maintained as permitted and conditioned by the PADEP. No significant adverse impact to local or regional water quality is anticipated as a result of the proposed facility development.

16. Energy needs

The region of the BBNPP within Pennsylvania is known to contain Marcellus Shale, a source of naturally-occurring (geologic) natural gas. The potential existence, extent, and yield of this formation specific to the BBNPP site is unknown, however plant construction is not considered a potential impact to this resource. The BBNPP will ultimately increase the available energy supply in the region.

17. Safety

The proposed project will be designed with the maximum possible considerations for public safety. Specific safety considerations will be detailed in the extended Combined License Application (COLA). Section 9.2.3 of the ER summarized the potential project impacts, including potential impacts to safety and human health and these measures will ensure that this public interest factor is not adversely affected by BBNPP construction and operation.

18. Food and fiber production

Parts of the BBNPP site are leased to local farmers for production of feed corn, however no food for human consumption is produced at the site. Therefore, the proposed facility development will not adversely influence local, state, regional, or national food and fiber production.

19. Mineral needs

The BBNPP site does not fulfill any mineral needs, nor are any mineral products harvested at the present time. There are no known significant mineral deposits of notable value beneath the area covered by the project site. No mineral extraction activities will be undertaken in the proposed facility development.

20. Considerations of property ownership

PPL Susquehanna, LLC currently owns most of the BBNPP and SSES sites. Under the proposed facility development, the BBNPP site will be divided into a west parcel and an east parcel. PPL Susquehanna, LLC, which owns 90% of SSES Units 1 and 2, and Allegheny Electric Cooperative, Inc., which owns 10% of SSES Units 1 and 2, will retain ownership of the east parcel. PPL Bell Bend, LLC will be the owner of BBNPP and the owner of the west parcel. The operator of BBNPP will be PPL Bell Bend, LLC (see Section 2.2.1 of ER).

References cited in this response:

Blinder, C. 1979. The Effect of High Voltage Overhead Transmission Lines on Residential Property Values, presented to the Second Symposium on Environmental Concerns in Rights-of-Way, Ann Arbor, Michigan, October 1979.

Federal Register, 2006b. Part III, Susquehanna River. Basin Commission, 18 CFR Parts 803, 804, 805 et al, July, 2006. Website: http://edocket.access.gpo.gov/2006/06-5632.htm.

NRC, 1999. Standard Review Plans for Environmental Reviews for Nuclear Power Plants, NUREG-1555, Nuclear Regulatory Commission, October 1999.

Salem, 2001a. Salem Township Subdivision and Land Development Ordinance, Section 800, Application, 2001.

Salem, 2001b. Salem Township Subdivision and Land Development Ordinance, Section 501, Submission and Review Procedure, 2001.

Salem, 2004. Salem Township Zoning Ordinance, Section 1302, Zoning Permit, 2004.

SRBC, 2009. Susquehanna River Basin Commission. Website: http://www.srbc.net/programs/regulations.htm.

USGS, 2008. U.S. Geological Survey (USGS), Land Use and Land Cover Data, LULC Categories. Website: http://www.webgis.com/lulc_data/9_app.html.

Salem, 2004. Salem Township Zoning Ordinance, Section 1302, Zoning Permit, 2004.

SRBC, 2009. Susquehanna River Basin Commission. Website: http://www.srbc.net/programs/regulations.htm.

UniStar, 2008. Bell Bend Nuclear Power Plant Combined License Application, Part 3: Environmental Report (Revision 1).

USGS, 2008. U.S. Geological Survey (USGS), Land Use and Land Cover Data, LULC Categories. Website: http://www.webgis.com/lulc_data/9_app.html.

COLA Impact:

No changes to the BBNPP COLA ER are required as a result of this RAI response.

USACE-2d

Summary: *Provide a description of the relative extent of the public and private need for the proposed project.*

Full Text: Under 33 CFR 320.4(a)(2). The extent of the public and private need for a project is a general criteria of the public interest review that must be considered in the evaluation of every permit application.

Response: PPL Bell Bend, LLC proposes to construct and operate a new nuclear power plant to be designated as Bell Bend Nuclear Power Plant (BBNPP). BBNPP will be located west of the existing Susquehanna Steam Electric Station site. The purpose of the proposed new nuclear power plant is to generate electricity (baseload power) for sale. The BBNPP project will positively address the needs and welfare of the public by providing electricity for residents in the primary market area. Source material for the response herein was obtained from the Bell Bend Nuclear Power Plant Combined License Application (UniStar, 2008).

The geographic scope or primary market area for the BBNPP has been generally defined as the eastern part of the PJM Interconnection, LLC (PJM) "classic" market area. PJM is the Regional Transmission Organization (RTO) that serves to maintain the reliability of the bulk electricity power supply system for 13 states and the District of Columbia. PJM serves approximately 51 million people and includes the major U.S. load centers from the western border of Illinois to the Atlantic coast including the metropolitan areas in and around Baltimore, Chicago, Columbus, Dayton, Newark and northern New Jersey, Norfolk, Philadelphia, Pittsburgh, Richmond, and Washington, D.C. The eastern part of the PJM classic market area is a subset of the entire PJM area and is considered the Region of Interest (ROI) and primary market area for the BBNPP. The ROI/primary market area includes parts of the states of Pennsylvania, New Jersey, Delaware, Maryland, and Virginia. The task of evaluating the region's power supply resides with the PJM RTO and the regional electric reliability organization Reliability*First* Corporation (RFC). PJM has projected continuing load growth in the primary market area. The U.S. Department of Energy (DOE) has identified New Jersey, Delaware, eastern Pennsylvania, and eastern Maryland as a Critical Congestion Area. PJM expects expanded exports of power into New York, further exacerbating the situation. Limitations in the west-to-east transmission of energy across the Allegheny Mountains and the growing demand for baseload power at load centers along the east coast were factors in selecting the eastern part of PJM's primary market area as the ROI.

The need for power establishes a framework for analysis of project benefits and for the geographic boundaries over which benefits and costs are distributed. Because the BBNPP will be developed as a merchant facility, power generated could be distributed to PJM electricity distributor members or it could be sold outside the relevant primary market area boundary. While these distribution options are possible, market forces coupled with generation and transmission capabilities and load demands result in a strong partiality toward sales within the ROI/primary market area. Merchant facilities have the ability to sell energy to anyone, and they are only limited by the transmission system. PJM also imports and exports energy to and from other regions. As noted above, the BBNPP will be developed as a merchant plant with the ability to serve customers in the ROI/primary market area, the eastern part of the PJM classic market area. Historical and forecasted load information for the ROI/primary market area was taken from the PJM load forecasting model. As the RTO for the region, PJM calculates long term forecasts of peaks, net energy, and load management for zones and regions in the RTO. Data of the historical energy and demand since 1998 and the forecasted values through 2018 for the eastern part of the PJM classic market area clearly indicate a public need for more electrical power. The historical energy use trend has increased over the period of 1998 to 2007. This trend of increasing electricity consumption is expected to continue.

The purpose of the proposed BBNPP is to satisfy the aforementioned need for power identified by PJM. The result of No Action, or not constructing the new facility, would mean that the need for power has not been satisfied, and other electric generating sources would be needed to meet the forecasted electricity demands. The benefits of the proposed BBNPP include the following (ER Section 8.4.3):

- The proposed BBNPP would alleviate existing congestion in the west-to-east transmission of energy across the Allegheny Mountains;

- 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;

- 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;

- 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; and

- 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.

PPL has determined that neither a power generating facility fueled by coal, nor one fueled by natural gas, nor a combination of alternatives, including wind and/or solar power generating facilities, would provide an appreciable reduction in overall environmental impacts relative to the BBNPP (i.e., a nuclear power generating facility). The construction and operation of BBNPP will result in some limited short-term and unavoidable impacts to the environment. Mitigation measures have been proposed to limit both the short-term impacts of construction and those that may occur during the operational life of the power plant. Following site decommissioning, it is expected there will be no long-term impacts on productivity or the human environment that would preclude alternative uses of the site.

Pursuant to 33 CFR 323.6, a determination that the project is not contrary to the public interest must be achieved before permit issuance. The twenty public interest considerations are identified in 33 CFR 320.4 (a)(1) and include: conservation; economics; aesthetics; general environmental concerns; wetlands; historic properties; fish and wildlife values; flood hazards; floodplain values; land use; navigation; shore erosion and accretion; recreation; water supply and conservation; water quality; energy needs; safety; food and fiber production; mineral needs; and consideration of property ownership. A review of the twenty public interest factors indicated that the proposed BBNPP project should have no significant adverse impact on any one of these factors. The construction and operation of the new facility will require the disturbance of approximately 630 acres of land for construction, of which 365 acres will be permanently committed to power plant structures for the BBNPP. Protection of surface and subsurface water resources during construction will require limitations on the amount of groundwater withdrawn and the discharge of construction waste waters from dewatering activities. Best management practices will be implemented to limit construction related erosion and sedimentation of surface waters. Certain natural resources on site will be affected including limited impacts to surface waters and wetlands. Activities within these areas will conform to applicable state and federal regulations to ensure that impacts are limited and controlled, and that appropriate mitigation measures are incorporated into project design and planning to offset the short- or long-term loss of any functions and values provided by the impacted resources. Impacts to aquatic resources are expected to be minimal given the limited area to be committed to permanent use and the absence of threatened and/or endangered species. While a portion of the land utilized for construction will impact these resources, the fauna and flora found are typical of those that occur in comparable locations and are not otherwise unique to the BBNPP property. Where possible, sensitive onsite resources such as wetlands will be avoided or impacts minimized, and mitigated as necessary.

There are no significant mineral resources within the BBNPP site. Although 24 architectural resources were previously recorded within one mile of the BBNPP site, none are located within the BBNPP footprint. The impact of air emissions is expected to be minimal. Noise levels at the site boundary are predicted to conform to applicable U.S. Environmental Protection Agency (EPA) and Housing and Urban Development (HUD) criteria. Evaporative loss from the constructed cooling towers will create visible plumes which will vary seasonally; however, these plumes should have a minimal impact, visual or otherwise, to surrounding properties. Off site noise from tower operations is predicted to be within applicable EPA and HUD guidelines. Measures to promote public health and safety will be implemented during construction and operation. Finally, socioeconomic impacts of the BBNPP construction and operation are expected to be minimal.

Locating the proposed new nuclear facility at the existing BBNPP property will afford benefits to the local economy. The BBNPP owners will pay property taxes on the proposed new unit for the duration of the operating license. New jobs within approximately a 50 mile radius of the plant would be created by the construction and operation of the new facility. Many of these jobs would be in the service sector and could be filled by unemployed local residents, lessening demands on social service agencies in addition to strengthening the economy. It is anticipated that the new jobs would be maintained throughout the life of the plant. Construction and operation of the new nuclear facility at BBNPP would generate an economic multiplier effect in the area. The economic multiplier effect means that for every dollar spent an additional $0.60 of indirect economic revenue would be generated over the construction period within the ROI. The economic multiplier effect is one way of measuring direct and secondary effects. Direct effects reflect expenditures for goods, services, and labor, while secondary effects include subsequent spending in the community. The economic multiplier effect due to the increased spending by the direct and indirect labor force created as a result of the construction and operation of the new nuclear reactor unit would increase economic activity in the region, most noticeably in Luzerne and Columbia Counties. Given concerns in the ROI/primary market area about climate change and carbon emissions, BBNPP serves an important environmental benefit need by reducing carbon emissions in the Commonwealth. Upon operation, BBNPP would displace significant amounts of carbon compared to a coal-fired generating plant. The costs of climate change, which have been quantified, will have a significant impact on the global and national economies.

Finally, with regard to private need, the BBNPP will operate as a baseload, merchant independent power producer. The power produced will be sold on the wholesale market without specific consideration to supplying a traditional service area or satisfying a reserve margin objective. The ability to generate baseload power in a consistent, predictable manner meets the business objectives for the BBNPP.

In summary, the purpose of the proposed BBNPP is to satisfy the need for power. The BBNPP project will positively address the needs and welfare of the public by providing electricity for residents in the primary market area; i.e., the public need for the project will be satisfied. Specifically, the following criteria suggest the continuing benefits of and the need for a new merchant baseload generating facility:

- The relevant region's need to diversify sources of energy (e.g., using a mix of nuclear fuel and coal for baseload generation);
- The potential to reduce the average cost of electricity to consumers;
- The nationwide need to reduce reliance on petroleum; and
- The case of a significant benefit cost advantage being associated with plant operation before system demand for the plant capacity develops.

The result of No Action, or not constructing the new facility, would mean that the need for power has not been satisfied, and other electric generating sources would be needed to meet the forecasted electricity demands. Finally, the ability to generate baseload power in a consistent, predictable manner meets the business objectives for the BBNPP. The demand for additional power necessitates an increase in supply, which can be met through the creation of the BBNPP facility. The creation of the BBNPP facility is economically feasible; therefore, the private need for the project will be satisfied.

Reference cited in this response:

UniStar, 2008. Bell Bend Nuclear Power Plant Combined License Application, Part 3: Environmental Report (Revision 1).

COLA Impact:

No changes to the BBNPP COLA ER are required as a result of this RAI response.

Enclosure 5

RAI H 5.3-1
SSES Thermal Plume Study, 1987
Bell Bend Nuclear Power Plant
Luzerne County Pennsylvania

THERMAL PLUME STUDIES
IN THE SUSQUEHANNA RIVER AT THE
DISCHARGE DIFFUSER OF THE
SUSQUEHANNA STEAM ELECTRIC STATION
1986-87

Prepared by

Theodore V. Jacobsen, Project Director

For

Pennsylvania Power and Light Company

Ecology III, Inc.
Susquehanna SES Biological Laboratory
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19 November 1987

INTRODUCTION

The Susquehanna Steam Electric Station (Susquehanna SES) is a nuclear power station with two boiling water reactors that have a total generating capacity of 2,100 megawatts. The station is located along the Susquehanna River in northeastern Pennsylvania (Figure 1). Commercial production of electricity at the Unit 1 reactor began on 8 June 1983 and at Unit 2 on 12 February 1985. The Pennsylvania Power and Light Company (PP&L) owns 90% of the Susquehanna SES and the Allegheny Electric Cooperative, Inc. retains title to 10%.

Water from the Susquehanna River is used to cool the Susquehanna SES in an essentially closed circuit cooling system. When both reactors are generating at 100% capacity, approximately 38,000 gallons/minute of river water is used to replace about 30,000 gallons/minute that is lost to the atmosphere by evaporation from two natural draft cooling towers. The remaining 8,000 gallons/minute of cooling tower blowdown is discharged back into the Susquehanna River through a diffuser pipe located on the river bottom about 200 feet from the west bank. The diffuser is constructed from a 42-inch diameter pipe that is 115 feet long. Blowdown water is released into the river through a series of 72 ports which are 4 inches in diameter. These ports are spaced at 18-inch intervals along the upper edge of the downriver side of the diffuser. Over the past 15 years, records at the Susquehanna SES Biological Laboratory show that river flow has varied from about 900 to 250,000 cubic feet/second, and that ambient river temperature has ranged from 32.0 to 86.0 F.

An earlier environmental report, written before construction of the Susquehanna SES, theorized that a sizable thermal plume would be created by this blowdown water before it reached ambient river water temperature below the diffuser (PP&L 1972). Initial temperature measurements at the diffuser, after both units of the Susquehanna SES became operational, revealed that the thermal plume was much smaller than originally anticipated. The edge of the plume (0.5 F isotherm) rarely extended more than 300 feet downriver from the diffuser, and this occurred only during conditions of low river flow. More commonly, the plume edge was found within 150 feet of the diffuser and often it was located within 25 feet during average to high river flows. Therefore, a formal study of the thermal plume was never conducted because it was so limited in size.

In 1985, a review of the ecological monitoring programs for the Susquehanna SES was conducted by Drexel University (Allen et al. 1986). During this review, the water temperature of the river below the discharge diffuser was discussed at length. As a result, it was recommended that "a special study be made to determine by measurement exactly what the temperature change in the river is, even if it is measurable only within inches of the diffuser." In order to fulfill this recommendation, a study of the thermal plume was begun in November 1986, with the objective of defining its size.

METHODS

Three thermal plume studies were conducted at the discharge diffuser of the Susquehanna SES. Autumn, winter, and spring studies were done on 5 November 1986, 9 January 1987, and 14 May 1987, respectively. All studies were conducted when both reactors were at least 85% operational.

Temperatures were measured with a Hydrolab FT-3M Marine Thermometer (thermistor) which was calibrated immediately before each study with a NBS traceable thermometer. All temperatures were measured to the nearest 0.5 F. The temperature of the blowdown was measured in both cooling tower basins prior to the autumn and winter studies. In the spring study, blowdown temperature was measured at the discharge by a scuba diver who inserted the thermistor probe into several diffuser ports.

A plane-table mapping technique was used to draw a profile of the thermal plume in each study. The plane table, with drawing paper attached, was positioned along the west river bank about 150 feet downstream from the diffuser. It was oriented with various prominent structures, such as power poles and the intake building, using a Watts Microptic Alidade. The alidade was used to sight a stadia rod held at various points along the shoreline. Angles and distances to these points were measured and a base map of the shoreline and study area was drawn at a scale of 1 inch = 40 feet.

Two crews in boats, each equipped with a thermistor, measured ambient river temperature and located the diffuser. One of the boats was anchored about 100 feet upriver from the diffuser, and the ambient temperature was measured from surface to bottom at one-foot intervals. From shore, the boat was sighted with the alidade (stadia rod mounted on the boat) and its location was marked on the base map. In the meantime, the other boat was driven to one of two float-ropes that a scuba diver had previously attached to either end of the diffuser. By pulling the float-rope very tightly, it was possible to situate the boat directly above the end of the diffuser. This location was sighted from shore with the alidade and marked on the map.

The other end of the diffuser was marked in the same manner. The diffuser was then drawn on the map by connecting these two points with a line.

Both crews then proceeded to measure the temperature of the plume. In each study, vertical temperature series were determined at from 20 to 27 sites throughout the probable location of the plume downriver from the diffuser. The boats were anchored at each site and the thermistor was used to measure temperatures at one-foot intervals from surface to bottom. Air temperatures were also recorded. All sites were numbered and located on the base map using the alidade. Upon completion of temperature measurements within the plume area, ambient temperature was determined again at the original location. This was done to determine if a change had occurred during the time period in which the plume temperatures were recorded. When ambient changed, plume temperatures were adjusted accordingly.

In each study, the edge of the plume (0.5 F isotherm above ambient river temperature) was drawn on the base map by interpolating its location among the vertical series of temperature measurements at each site. Both planar and three-dimensional drawings were made of the plume.

RESULTS

Autumn Study

The autumn thermal plume study was conducted on 5 November 1986. On this date, the river level was stable at 487.8 feet above mean sea level (msl) which is equivalent to a flow of 4,840 cubic feet/second (2,173,000 gal/min). The water temperature of the cooling tower blowdown (approximately 8,000 gal/min) was 62.0 F. The weather was partly cloudy with a light breeze.

The location of each vertical temperature determination for ambient river temperature and for the 20 sites within the vicinity of the plume, are shown relative to the diffuser in Figure 2. The ambient temperature was 47.0 F and temperatures at the sites ranged from 47.0 to 47.5 F (Table 1). Air temperature decreased from 36.5 to 34.5 F throughout the 71-minute study.

The limits of the thermal plume are presented in Figure 3. The plume was within 5 feet of the diffuser along the inner half of the pipe. However, it extended downriver about 130 feet along the outer half of the diffuser. This portion of the plume remained near the bottom until about 75 feet downriver when it began to billow toward the surface.

Winter Study

The winter plume study was done on 9 January 1987 when the river level was 489.0 feet above msl. This level is equal to a flow of 9,250 cubic feet/second (4,152,000 gal/min). The approximately 8,000 gallons/minute of cooling tower blowdown was 61.0 F. The weather was partly cloudy and calm.

Determinations of ambient river temperature and the temperatures at the 21 plume sites are shown relative to the diffuser in Figure 4. The ambient river temperature was 33.5 F and temperatures within the vicinity of the plume ranged from 33.5 to 34.0 F (Table 2). Air temperature decreased from 39.0 to 35.5 F during the 1-hour and 53-minute study.

The thermal plume remained within 10 feet of the diffuser along the inner half of the pipe, and then extended downriver about 25 feet along the outer half (Figure 5). It tended to billow upward, but it was always less than 10 feet below the surface.

Spring Study

The spring thermal plume study was conducted on 14 May 1987. The river level on this date was stable at 487.9 feet above msl. This level is equivalent to a river flow of 5,120 cubic feet/second or 2,298,000 gallons/minute. The water temperature of the cooling tower blowdown (approximately 8,000 gal/min) was 75.0 F. The weather was cloudy during the first 30 minutes of the study and sunny throughout the remainder.

The locations of each temperature series recorded for ambient river temperature and for temperatures at the 27 sites near the plume are shown relative to the diffuser in Figure 6. Ambient river temperature increased from 65.5 to 66.0 F when the sunlight warmed the river throughout the 1-hour and 40-minute study (Table 3). This natural warming of the river necessitated the adjustment of the temperatures at the last 16 sites by subtracting 0.5 F from each measurement (Table 3). Temperatures within the plume ranged from 65.5 to 66.5 F.

The extent of the thermal plume is presented in Figure 7. Most of the plume was located downriver from the outer half of the diffuser where it extended about 80 feet in length. The plume tended to billow upward, but never reached closer than 7 feet of the surface.

DISCUSSION

The thermal plumes in all three studies were relatively small. This finding in itself is particularly interesting because the temperature of the cooling tower blowdown was 15.0, 27.5, and 9.5 degrees F above ambient river temperature in autumn, winter, and spring, respectively. In spite of these sizable delta t's, none of the plume temperature determinations were greater than 1 degree F above ambient, and most of the recordings were only 0.5 degree F above ambient. At some point in the river, within a few inches of the diffuser ports, the temperature of the blowdown water was reduced to within 1 degree F or less of ambient. The results of these studies did not detect the exact location of this gradient; however, even if it was found, it would be of only minor interest environmentally. The far more important finding is that, during these studies, the diffuser of the Susquehanna SES quickly mixed thermally-enriched water from the cooling tower blowdown with river water so that impact to the Susquehanna River was negligible.

The size of the plume seemed to be more a function of river flow than the difference in temperature between blowdown and ambient when results of the autumn and winter studies were evaluated. Of all the studies, plume size was largest in autumn when river flow was lowest and the delta t was 15.0 F. In the winter study, the delta t was nearly twice as large (27.5 F), but the plume was several fold smaller in a river-flow condition about twice as great as that measured in the autumn study. Results of the spring study were intermediate.

All three studies were conducted at river flows near the low end (9,250 cubic feet/second or 262 cubic meters/second) of the range of flows documented for this portion of the Susquehanna River over an 8-year period (Figure 8). It is doubtful that a plume of any consequence would be detected at river flows greater than those evaluated during the winter study. In the future, however, it may be of some value to conduct a fourth thermal plume study at low river flow in the summer. When this study is completed, the thermal plume will have been profiled once in each of the four seasons for a more complete evaluation.

REFERENCES CITED

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Pennsylvania Power and Light Company. 1972. Susquehanna Steam Electric Station, Applicant's Environmental Report, Vol. 1. Pa. Power & Light Co., Allentown, PA.

Table 1

Temperatures (F) recorded at 1-foot intervals from surface to bottom at 20 sites on the Susquehanna River near the discharge diffuser of the Susquehanna Steam Electric Station, 5 November 1986.

Site No.	Time	Temperature (F)		Depth in feet																Bottom	
		Air	Surface	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Depth	Temperature
Ambient	1249	36.5	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0					12.0	47.0
1	1250	36.5	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0			14.5	47.0
2	1255	36.5	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.5	47.5	47.5					12.0	47.5
3	1258	36.5	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.5	47.5	47.5	47.5	47.5	47.5		15.0	47.5
4	1300	36.5	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0			14.0	47.0
5	1305	36.5	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0					12.5	47.0
6	1306	36.5	47.0	47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.0	47.5	47.5	47.5	47.5	47.5	47.5			14.0	47.5
7	1314	36.5	47.0	47.0	47.0	47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.5			14.5	47.5
8	1320	36.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.5	47.5	47.5	47.5	47.5					12.5	47.5
9	1320	36.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0		15.0	47.0
10	1325	35.5	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0			14.5	47.0
11	1327	35.5	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0		15.0	47.0
12	1330	35.5	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0		15.0	47.0
13	1335	35.5	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	16.0	47.0
14	1335	35.5	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0							11.0	47.0
15	1340	34.5	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0			14.0	47.0
16	1342	34.5	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0						11.0	47.0
17	1345	34.5	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0									8.5	47.0
18	1346	34.5	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0						11.5	47.0
19	1351	34.5	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0					12.5	47.0
20	1355	34.5	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0						11.5	47.0
Ambient	1400	34.5	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0					12.0	47.0

Table 2

Temperatures (F) recorded at 1-foot intervals from surface to bottom at 21 sites on the Susquehanna River near the discharge diffuser of the Susquehanna Steam Electric Station, 9 January 1987.

Site No.	Time	Temperature (F)		Depth in feet																	Bottom	
		Air	Surface	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Depth	Temperature
Ambient	1517	39.0	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5				14.0	33.5
1	1526	39.0	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5			15.0	33.5
2	1531	37.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5		16.5	33.5
3	1537	37.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5		16.5	33.5
4	1542	39.0	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5		16.5	33.5
5	1547	39.0	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5		16.0	33.5
6	1552	37.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5					13.0	33.5
7	1556	37.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5		16.5	33.5
8	1600	37.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5		16.0	33.5
9	1604	37.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5			15.0	33.5
10	1609	38.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	34.0	33.5	17.0	33.5
11	1614	37.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5										9.0	33.5
12	1618	37.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5		16.5	33.5
13	1622	37.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5		16.0	33.5
14	1628	37.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	34.0	34.0	34.0	34.0	34.0		16.5	34.0
15	1633	38.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	34.0	34.0	34.0		16.5	34.0
16	1638	35.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	34.0	34.0	34.0	34.0	34.0		16.0	34.0
17	1641	35.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5			15.0	33.0
18	1645	35.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	34.0	34.0	34.0	34.0	34.0	34.0		16.5	34.0
19	1650	35.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	34.0	34.0	34.0	34.0		16.0	34.0
20	1653	35.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5			15.0	33.5
21	1659	35.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5				14.0	33.5
Ambient	1710	35.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5				14.0	33.5

Table 3

Temperatures (F) recorded at 1-foot intervals from surface to bottom at 27 sites on the Susquehanna River near the discharge diffuser of the Susquehanna Steam Electric Station, 14 May 1987.

Site No.	Time	Temperature (F) Air	Temperature (F) Surface	Depth in feet 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Bottom Depth	Bottom Temperature
Ambient	1355	—	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5						12.5	65.5
1	1358	69.0	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5			15.0	65.5
2	1409	—	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5					13.0	65.5
3	1409	—	65.5	65.5	65.5	65.5	65.5	65.5	65.5	66.0	66.0	66.0	66.0	66.0	66.5	66.5	65.5				14.0	66.0
4	1416	—	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5					13.0	65.5
5	1416	—	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5		16.0	65.5
6	1420	—	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5				14.0	65.5
7	1423	—	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5			15.0	65.5
8	1425	—	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5				14.0	65.5
9*	1430	—	66.0	66.0	66.0	66.0	66.0	66.0	66.0	65.5	65.5	65.5	65.5	65.5	65.5						12.0	65.5
10	1430	—	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	66.0	66.0	66.0	66.0				14.0	66.0
11	1435	—	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	66.0	66.5	66.5	66.5	66.5	66.5	66.5	66.5			15.0	65.5
12**	1439	—	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5					13.0	65.5
13	1448	—	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5					13.0	65.5
14	1452	—	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	66.0	66.0	66.0	66.0	66.0	66.0				14.0	66.0
15	1453	—	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5				14.0	65.5
16	1501	—	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	66.0	66.0	66.0	66.0	66.0	66.0	66.0		16.0	66.0
17	1503	77.0	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5						12.0	65.5
18	1504	—	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	66.0	66.0	65.5	65.5	66.0	66.0			15.0	66.0
19	1511	—	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5					13.0	65.5
20	1511	—	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5		16.0	65.5
21	1516	—	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0		16.0	65.0
22	1516	—	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	66.0	66.0	66.0	66.0	66.0	66.0	66.0	66.0	66.0		16.0	66.0
23	1520	—	65.5	65.5	65.5	65.5	65.5	65.5	66.0	66.0	66.0	66.0	66.0	66.0	66.0	66.0	66.0	66.0			15.0	66.0
24	1523	—	65.5	65.5	65.5	65.5	65.5	65.5													5.0	65.5
25	1524	—	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	66.0	66.5	66.5	66.5	66.5	66.0	66.0	66.0			15.0	66.0
26	1526	—	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5					13.0	65.5
27	1531	—	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	66.0	66.0	65.5	65.5	65.5	66.0	65.5			15.0	65.5
Ambient	1535	—	66.0	66.0	66.0	66.0	66.0	66.0	66.0	66.0	66.0	66.0	66.0	66.0	66.0	66.0					13.0	65.5

* River surface temperature increased from sunlight.

** All temperatures (except ambient) measured after 1439 hours were adjusted for an increase in ambient river temperature by subtracting 0.5 F.

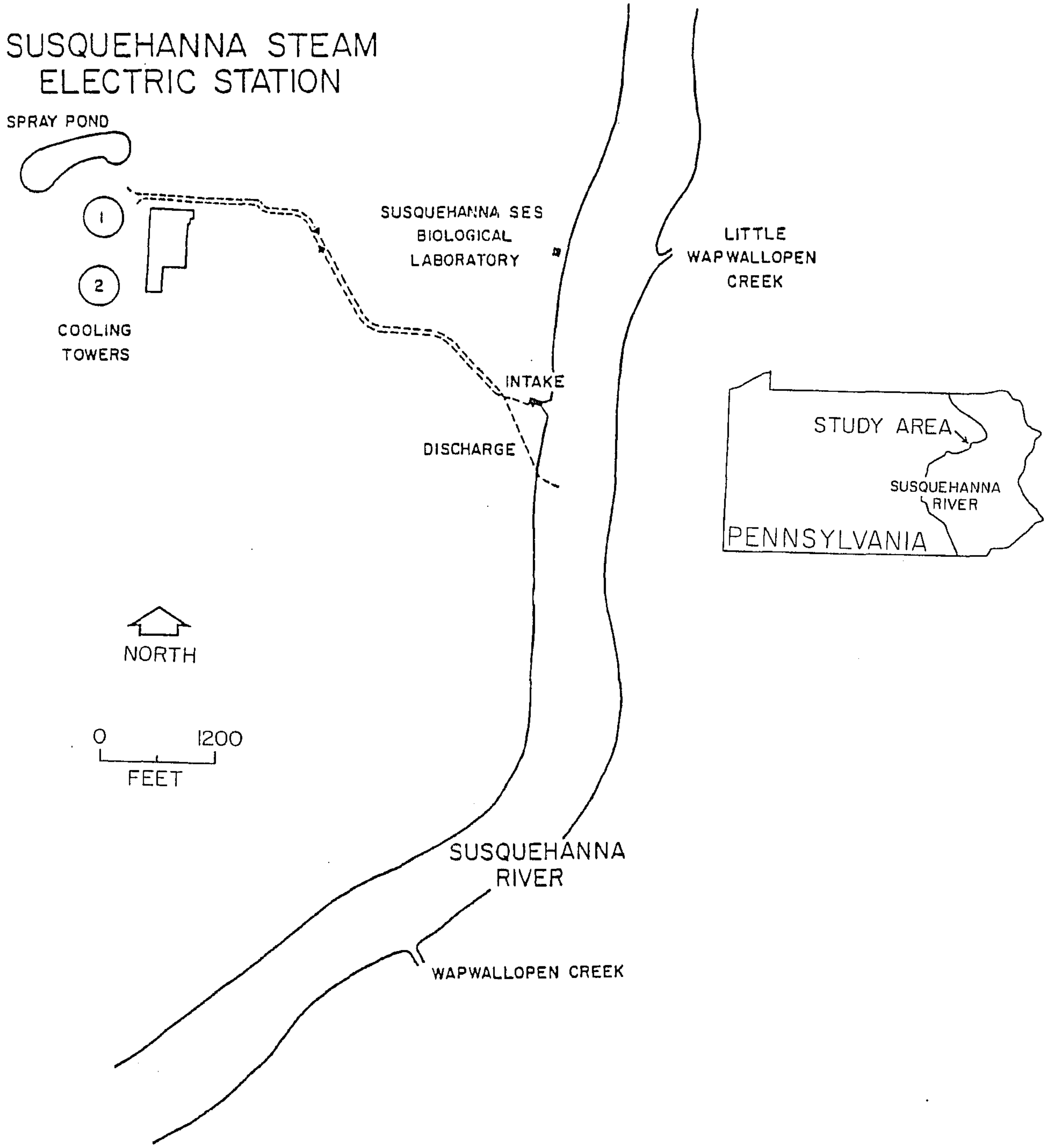

Figure 1

Location of the Susquehanna Steam Electric Station discharge in the Susquehanna River.

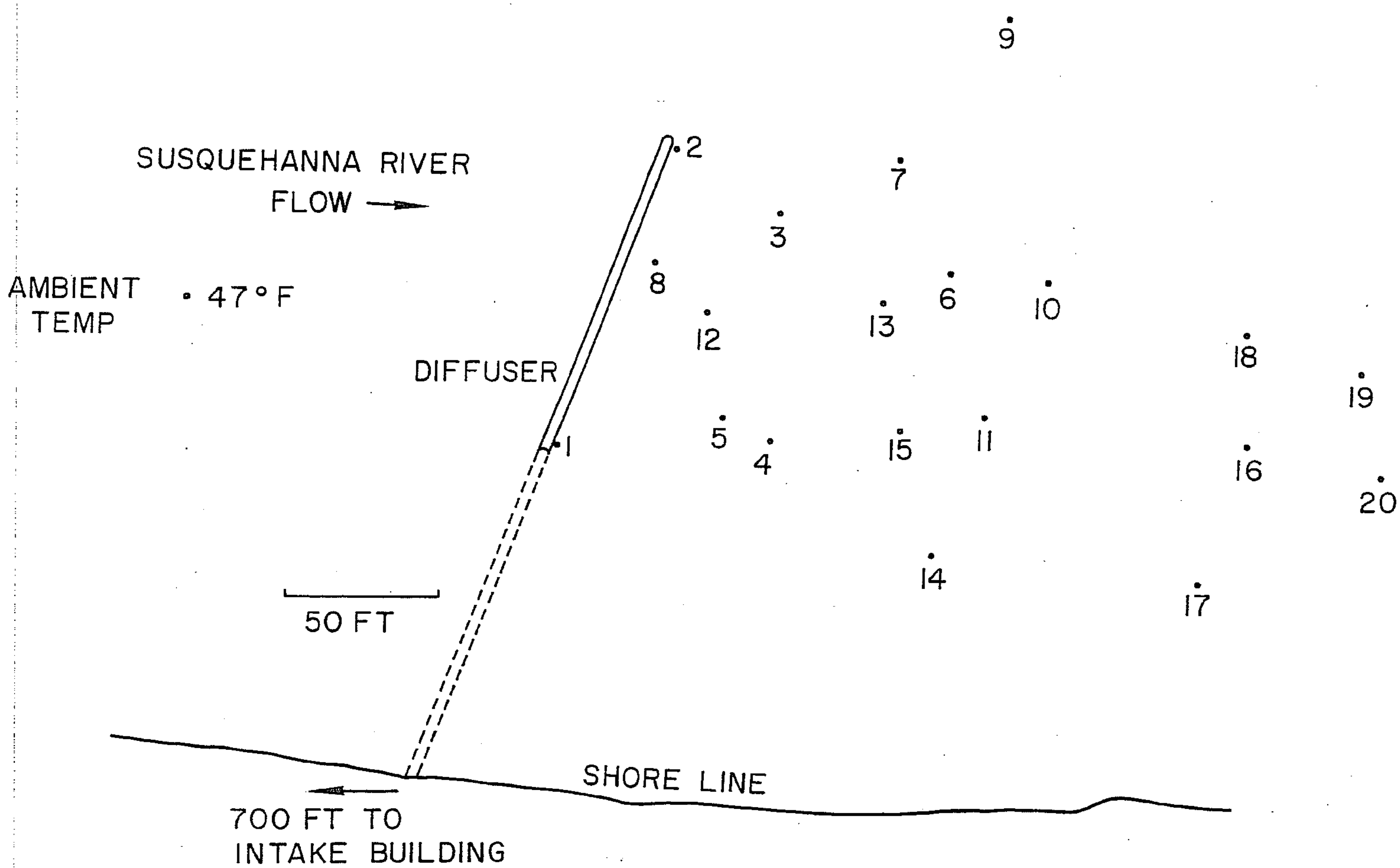

Figure 2

Sites at which water temperatures were recorded at 1-foot intervals from surface to bottom on the Susquehanna River near the discharge diffuser of the Susquehanna Steam Electric Station, 5 November 1986.

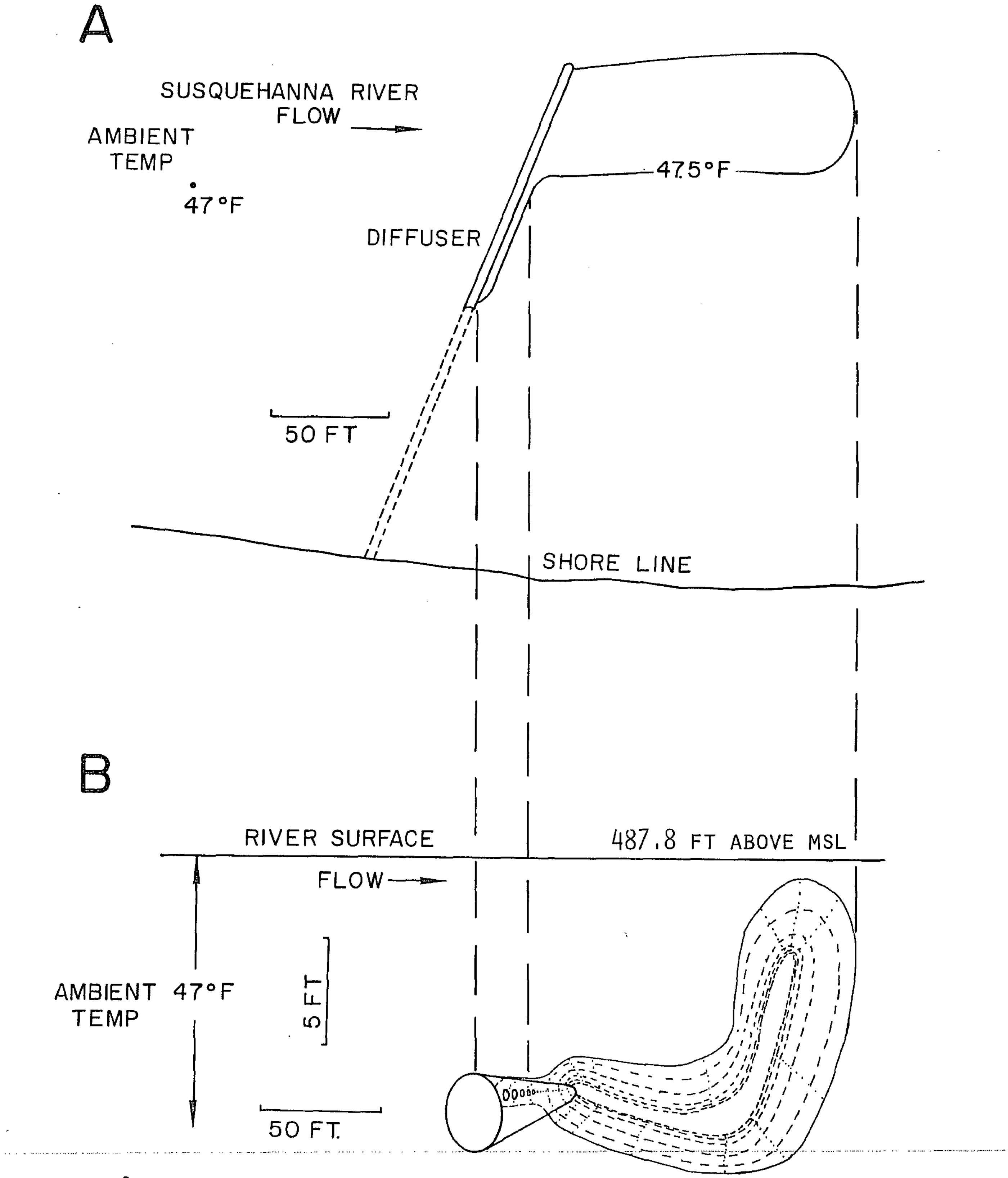

Figure 3

Limits of a thermal plume (0.5 F above ambient water temperature) in the Susquehanna River caused by the release of cooling tower blowdown from the discharge diffuser of the Susquehanna Steam Electric Station, 5 November 1986. (A = planar view, B = three-dimensional view)

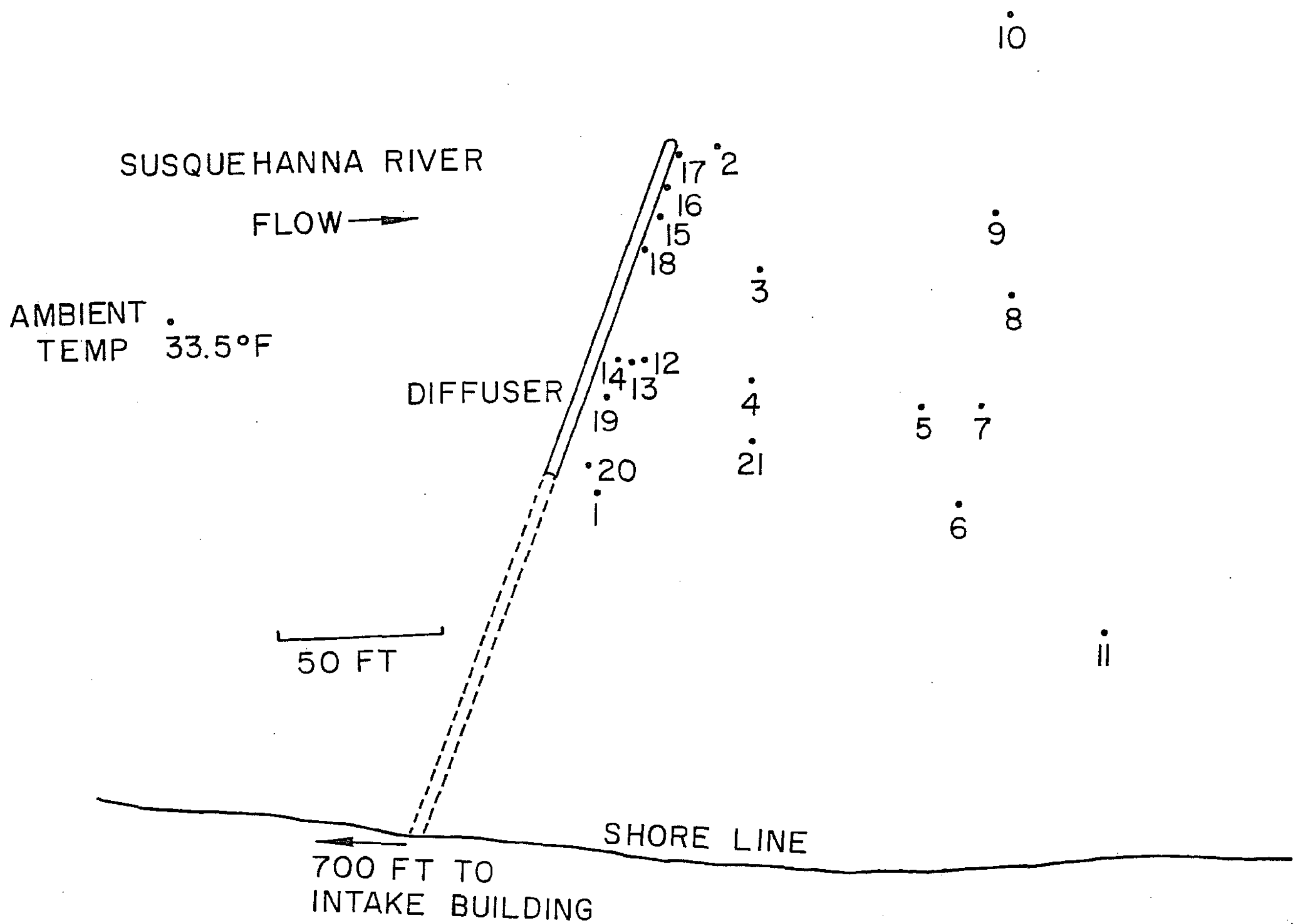

Figure 4

Sites at which water temperatures were recorded at 1-foot intervals from surface to bottom on the Susquehanna River near the discharge diffuser of the Susquehanna Steam Electric Station, 9 January 1987.

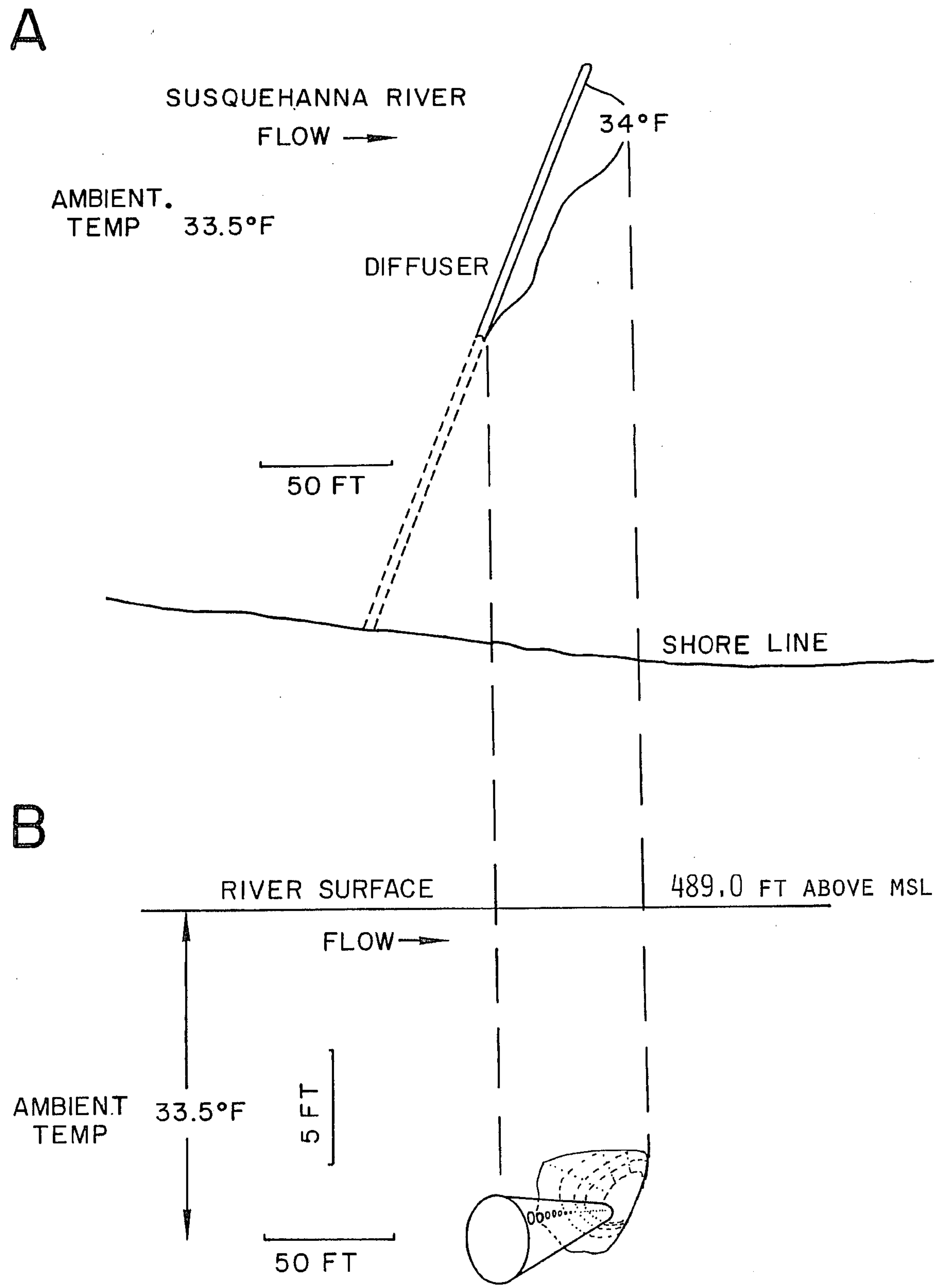

Figure 5

Limits of a thermal plume (0.5 F above ambient water temperature) in the Susquehanna River caused by the release of cooling tower blowdown from the discharge diffuser of the Susquehanna Steam Electric Station, 9 January 1987. (A = planar view, B = three-dimensional view)

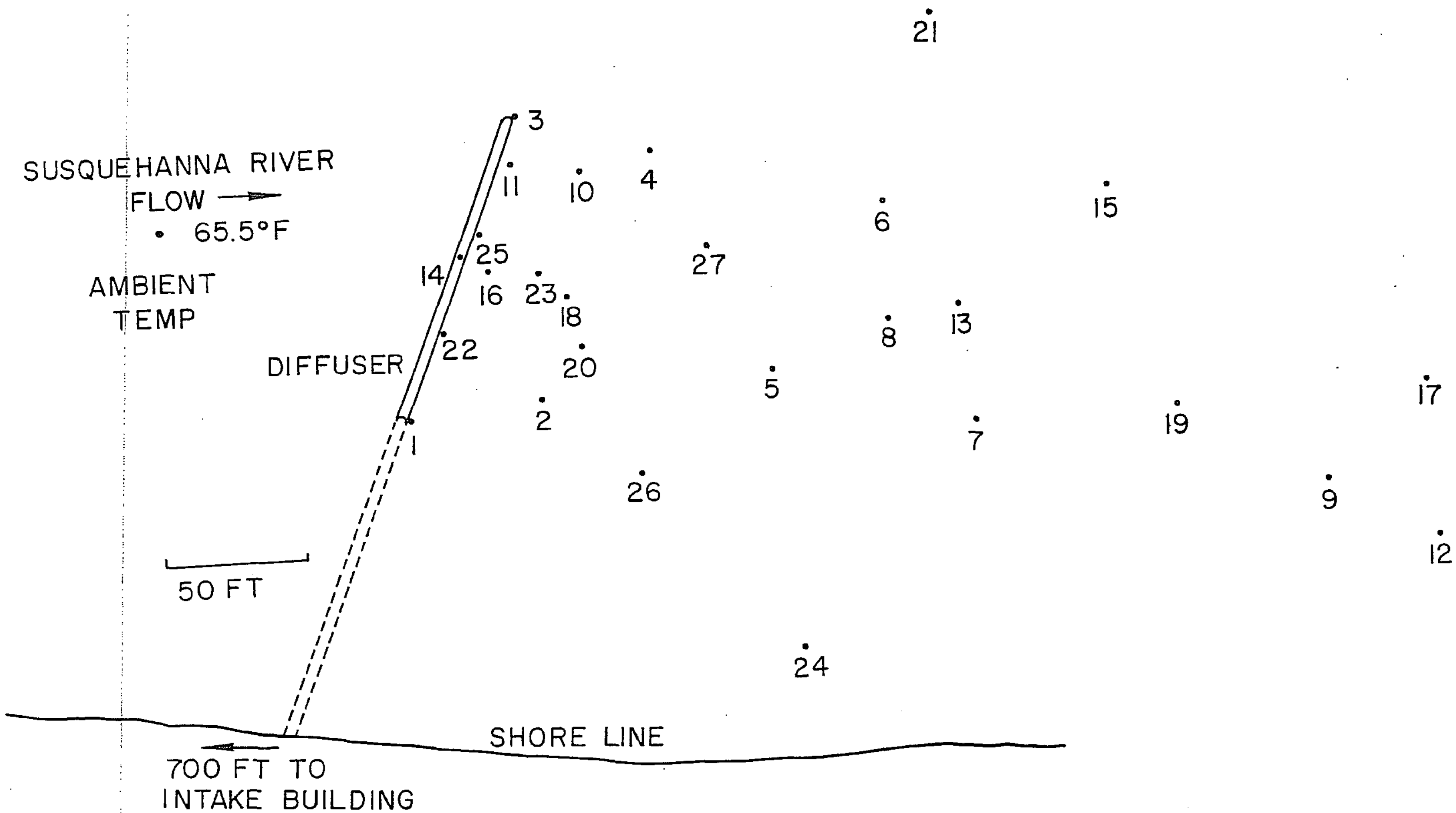

Figure 6

Sites at which water temperatures were recorded at 1-foot intervals from surface to bottom on the Susquehanna River near the discharge diffuser of the Susquehanna Steam Electric Station, 14 May 1987.

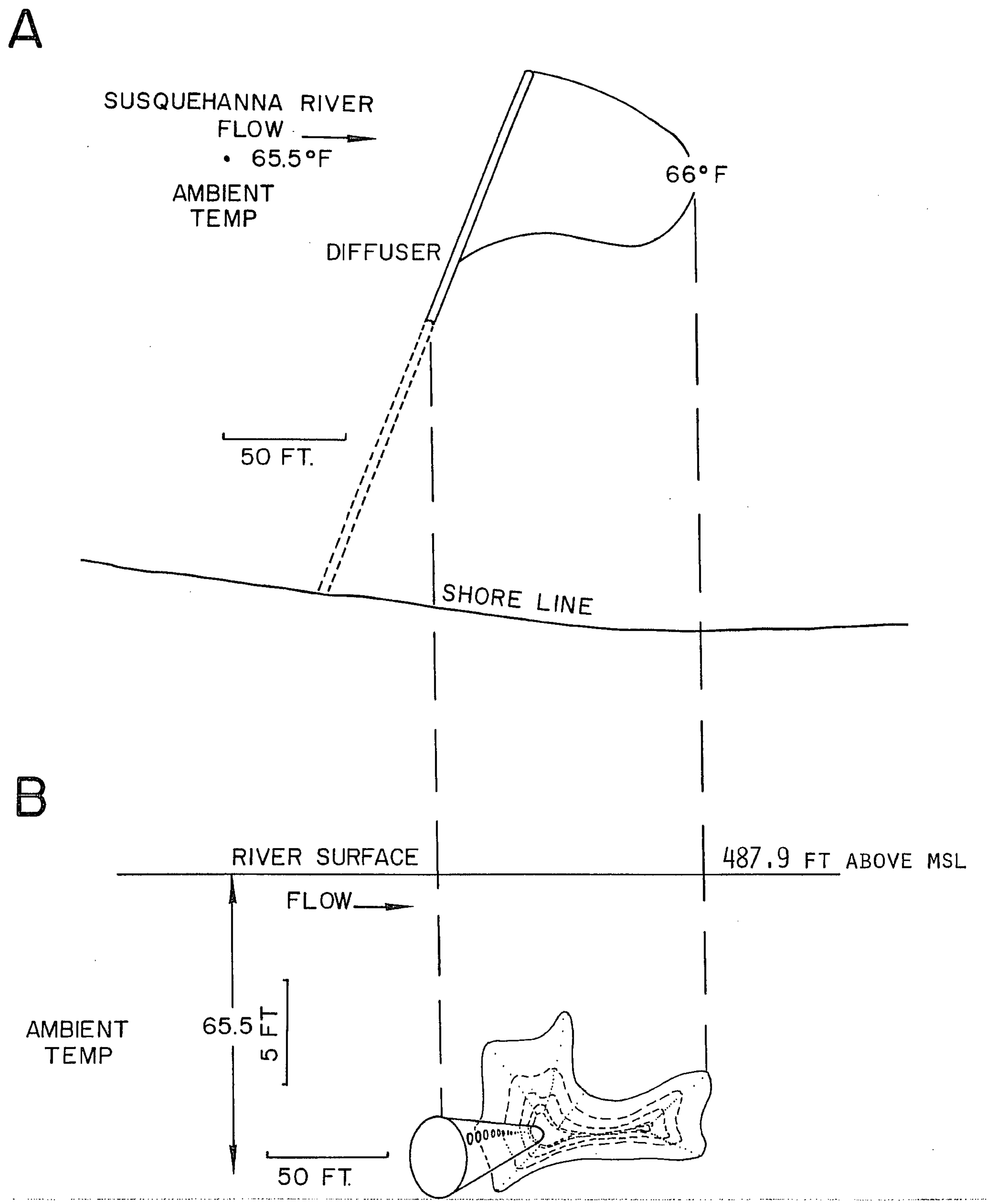

Figure 7

Limits of a thermal plume (0.5 F above ambient water temperature) in the Susquehanna River caused by the release of cooling tower blowdown from the discharge diffuser of the Susquehanna Steam Electric Station, 14 May 1987. (A = planar view, B = three-dimensional view)

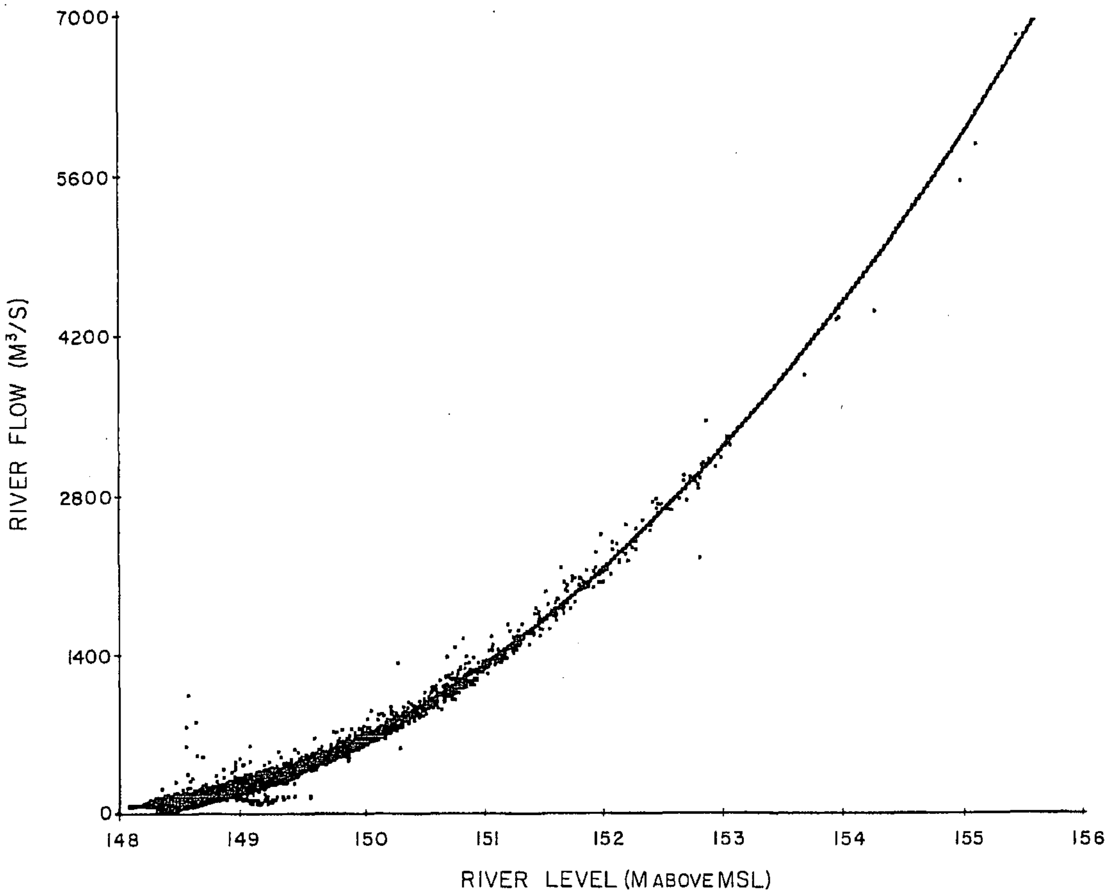

Figure 8

The relationship between flow (m^3/s) and level (m above msl) of the Susquehanna River at the Susquehanna SES Biological Laboratory from July 1973 through November 1980.

Enclosure 6

RAI H 5.3-1
SSES Thermal Plume Study, 2008
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17 February 2009

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SUSQUEHANNA STEAM ELECTRIC STATION
EIPL-1484
THERMAL PLUME SURVEYS – SUMMER 2008 – REV. 2

Attached are the final revised results of "Thermal Plume Surveys in the Susquehanna River at the Susquehanna Steam Electric Station Discharge Diffuser – Summer 2008." Many of the draft comments were incorporated into this final revision.

This report is a supplement to "Thermal Plume Studies in the Susquehanna River at the Discharge Diffuser of the Susquehanna Steam Electric Station, 1986-87".

If you have any questions, please contact me.

Theodore V. Jacobsen,
Project Director

/msh

Attachment

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THERMAL PLUME SURVEYS IN THE SUSQUEHANNA RIVER AT THE SUSQUEHANNA STEAM ELECTRIC STATION DISCHARGE DIFFUSER SUMMER 2008

REVISION 2

Prepared by

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17 February 2009

CONTENTS

INTRODUCTION

The Susquehanna Steam Electric Station (Susquehanna SES) is a nuclear power station located along the Susquehanna River in northeastern Pennsylvania. Surveys of the thermal plume from the river water discharge diffuser were conducted in the winter, autumn, and spring, 1986-87 (Ecology III, 1987). All three plumes were very limited and posed no environmental hazards to aquatic life in the river. With this documented, and, due to other time constraints, a summer survey was never done.

In 2008, PPL proposed construction of the Bell Bend Nuclear Power Plant (BBNPP) on a site adjacent to the Susquehanna SES. This power plant would construct its own intake 300 feet downriver from the Susquehanna SES intake (315 feet upriver from the SSES diffuser) and its own river discharge diffuser 380 feet downriver from the SSES diffuser (Fig. 1). With the close proximity of these proposed structures to the existing Susquehanna SES diffuser, it was deemed necessary to conduct a summer thermal plume survey(s) at the Susquehanna SES diffuser to complete baseline studies in all four seasons.

The Susquehanna SES diffuser is a 42-inch diameter, 115-feet long pipe located on the river bottom about 200 feet from the west riverbank. Blowdown water is released into the river through a series of 72, 4-inch diameter ports spaced at 18-inch intervals along the upper edge of the downriver side of the diffuser. The effluent pipe connected to the diffuser is also 42-inches in diameter and approximately ¾-mile long from the diffuser to the cooling tower basins at the power station.

PROCEDURES

Summer thermal plume surveys were conducted at the Susquehanna SES river water diffuser at mid-day on 21 August and 3 September 2008. During each survey both boiling water reactors were at full power (Unit 1 = 94.4% and Unit 2 = 100%), for a total generating capacity of about 2,400 megawatts. At this power level, the river water withdrawal at the intake on both days was approximately 39,000 gallons per minute (gpm) with a mean temperature of 74.4°F, and the blowdown, as it exited the cooling tower basins on site, was 12,000 gpm at an average of 82.7°F (Table 1).

During both surveys, river water temperatures were measured with a YSI 650 MDS Sonde that was calibrated prior to use. A vertical series of temperatures were determined to the nearest 0.1°F from the surface to the river bottom at one-foot depths at each site downriver from the diffuser. Ambient river temperatures were measured immediately upriver from the diffuser before and after each survey. The surveys were done within 1½ hours to avoid too much of a change in ambient river temperature.

A crew of three in a boat and a surveyor on shore used a plane table mapping technique to locate the diffuser and each site. The boat driver first anchored over either end of the diffuser and then moved to each site within the probable location of the plume and anchored, while two crewmembers measured a vertical temperature series. At each anchorage, the surveyor sighted a stadia rod mounted on the boat with a Watts microptic alidade on top of the plane table set up along the shoreline. These sightings were then transcribed onto a base map at a scale of 1 inch = 50 feet.

In the laboratory, these data were used to define the edge of the plume at 0.5°F and 1.0°F isotherms above ambient river temperature by interpolating its location among the vertical series of temperatures at each site. Planar views were then drawn for each survey to show the extent of the thermal plume.

RESULTS

During the first survey on 21 August 2008, the weather was overcast and ambient river temperature did not change throughout the survey. The average river flow on this date was 3,230 cubic feet per second (cfs) at a river level of 487.0 feet above mean sea level (msl) as recorded on the calibrated river level gage at the Susquehanna SES Environmental Laboratory (Water Quality Procedures 2004). The relationship of river level to river flow at the Lab was documented by Soya (1991). The plume was detected within 6 of the 28 sites (Table 2). The vertical temperature measurements show that it did not reach the surface before dissipating. The planar view in Fig. 2 defines the plume at the 0.5°F isotherm. It was less than 40 feet wide at the diffuser and narrowed as it extended 120 feet downriver.

In the second survey on 3 September 2008, bright sunlight warmed the river temperature nearly 1°F during the 1½-hour data collection period at 22 sites (Table 3). This warming necessitated the adjustment of the temperatures recorded midway through the period by subtracting 0.5°F from each temperature. The average river flow on this date was 2,140 cfs at a river level of 486.5 ft above msl. This river flow was one-third less than the flow during the first survey.

A thermal plume at 0.5°F was detected at most sites (Fig. 3); it was about 100 feet wide and extended downriver from the diffuser 300 feet. A smaller 1.0°F isotherm was found immediately downriver from the diffuser. Overall, the plume appeared to reach the surface of the river throughout the 0.5°F isotherm (Fig. 3), ranging from 0.1°F or less at Sites 12 and14 and to 0.8°F at Sites 21 and 22 (Table 3). However, surface temperatures at Sites 21 and 22 were probably more influenced by solar warming than by a thermal plume from the blowdown discharge. Furthermore, the adjusted 0.8°F temperatures at these two sites is perhaps quite conservative since they were the last to be measured during the survey and were within 0.1°F of the final ambient temperature recorded at 1252 hours (Table 3). They were actually 0.1°F cooler than the final ambient reading indicating that the surface heating at Sites 21 and 22 may possibly have been closer to zero than to 0.8°F. Additionally, subsurface temperatures from 1 to 3 feet at both sites were lower than the surface temperatures, and since any thermal heating reaching the river surface would first have to pass through these levels, the thermal plume may not have even reached the surface of the river at these sites.

Averaging the delta t surface temperatures of the 20 sites within the 0.5°F plume (less Sites 13 and 14) reveals that the surface temperature of the plume may have increased the ambient river temperature by 0.4°F only immediately above the plume, but that some of this increase was also caused by solar radiation despite an attempt to adjust for it.

SUMMARY

The water temperature in the cooling tower basins was a maximum of 7.4°F and 11.7°F above ambient river temperature during the surveys on 21 August and 3 September 2008, respectively (Table 1). With these delta t's, one might have expected a more extensive thermal plume in the river on both survey dates. However, the blowdown probably cools as it flows through the ¾-mile blowdown effluent pipe and, even more so, when it mixes with the water backed up into the effluent pipe and the diffuser before it exits out of the diffuser ports and into the river.

This cooling effect could be evaluated further with other surveys throughout the blowdown effluent pipe, but the fact remains that the thermal plume from the Susquehanna SES diffuser is very limited even during low river flow conditions. Thermal plumes of this size will pose no thermal environmental hazard to aquatic life in the Susquehanna River.

REFERENCES

Ecology III, Inc. 1987. Thermal plume studies in the Susquehanna River at the discharge diffuser of the Susquehanna Steam Electric Station, 1986-87. Prepared for Pennsylvania Power and Light Company. 8 pp.

Ecology III, Inc. 2004. Water quality procedures, 15 pp. *In* Procedures for Nonradiological Environmental Monitoring Program (Non-Quality) and Safety Programs at the Susquehanna SES Environmental Laboratory. Ecology III, Inc., Berwick, PA.

Soya, W. J. 1991. Depth – level – flow relationship of the Susquehanna River at the Susquehanna SES Environmental Laboratory. Ecology III, Inc., Berwick, PA. 10 pp.

Table 1
River water intake temperature and blowdown discharge temperature (as calculated from monitoring points in the cooling tower basins) at the Susquehanna Steam Electric Station during times of thermal plume surveys, 21 August and 3 September 2008. (Data provided by J. J. Kostyal, PPL Susquehanna)

Archived SSES Data (PI System)
Start: 8/21/2008 11:00
End 8/21/2008 13:00

	River Water Intake Temp (°F)	Unit 1 Blowdown* Temp (° F)	Delta t (° F)	Unit 2 Blowdown* Temp (° F)	Delta t (° F)
Min	74.5	79.6	5.1	81.0	6.5
Avg	74.5	80.6	6.1	81.6	7.0
Max	74.6	81.2	6.6	82.0	7.4

Archived SSES Data (PI System)
Start: 9/3/2008 11:00
End: 9/3/2008 13:00

	River Water Intake Temp (°F)	Unit 1 Blowdown* Temp (° F)	Delta t (° F)	Unit 2 Blowdown* Temp (° F)	Delta t (° F)
Min	74.2	82.1	7.9	83.6	9.4
Avg	74.3	83.7	9.4	84.8	10.6
Max	74.3	85.3	11.0	85.9	11.7

*Average CW/LP Inlet (Basin temperature, °F)

Table 2

Temperatures (°F) recorded at 1-foot intervals from surface to bottom at 28 sites on the Susquehanna River downriver from the Susquehanna Steam Electric Station discharge diffuser, 21 August 2008.

Site No.	Time	Temperature (F)		Depth in Feet																	Bottom	
		Air	Surface	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Depth	Temp
Ambient	1038	77.0	74.0	74.0	74.0	74.0	74.0	73.9	73.9	73.9	73.9	73.9	73.9	73.9	73.9						12	73.9
1	1045		74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.1	74.1	74.1	74.1	74.1	74.1					13	74.1
2	1049		74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.1	74.1	74.1	74.1	74.1	74.1					13	74.1
3	1050		74.0	74.0	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.0	74.0	74.0	74.0	74.0		16	74.0
4	1054		74.0	74.0	74.0	74.0	74.0	74.1	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0			15	74.0
5	1055		74.0	74.0	74.1	74.1	74.1	74.1	74.1	74.1	74.0	74.0	74.0	74.0	74.0	74.0	74.0				14	74.0
6	1056		74.1	74.1	74.1	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0				14	74.0
7	1058		74.0	74.0	74.0	74.1	74.1	74.1	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0				14	74.0
8	1100		73.9	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0				14	74.0
9	1102		74.0	74.0	74.0	74.1	74.1	74.1	74.5	74.5	74.5	74.5	74.6	74.4	74.4	74.4	74.3	74.2	74.2		16	74.2
10	1104		74.0	74.1	74.1	74.1	74.1	74.3	74.2	74.1	74.1	74.1	74.2	74.1	74.1						12	74.1
11	1106		74.0	74.0	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1					13	74.1
12	1108		74.0	74.0	74.0	74.0	74.1	74.1	74.2	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1				14	74.1
13	1111		74.0	74.0	74.1	74.1	74.1	74.1	74.2	74.2	74.4	74.3	74.4	74.5	74.6	74.7	74.5	74.5	74.5		16	74.5
14	1114		74.0	74.0	74.0	74.1	74.1	74.1	74.1	74.1	74.2	74.2	74.1	74.1	74.0	74.1	74.1	74.2	74.2		16	74.2
15	1116		74.0	74.0	74.0	74.1	74.1	74.1	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0		16	74.0
16	1118		74.0	74.0	74.0	74.0	74.1	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0						12	74.0
17	1119		74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0			15	74.0
18	1123		74.0	74.0	74.0	74.1	74.1	74.1	74.1	74.0	74.0	74.0	74.0	74.0	74.0	74.1	74.1	74.1	74.1		16	74.1
19	1126		74.0	74.0	74.1	74.0	74.1	74.0	74.0	74.0	74.0	74.0	74.1	74.0	74.0	74.0	74.0	74.0			15	74.0
20	1128		73.9	74.0	74.0	74.0	74.0	74.1	74.0	74.0	74.0	74.0	74.1	74.0	74.0	74.1					13	74.1
21	1138		74.0	74.0	74.0	74.0	74.0	74.5	74.5	74.5	75.0	75.0	75.0	74.5	74.5	74.5	74.5	75.0	75.0	75.0	17	75.0
22	1141		74.0	74.0	74.0	74.5	74.5	74.5	74.5	74.5	74.5	74.5	75.0	74.5	74.5	74.5	74.5				14	74.5
23	1145		74.0	74.0	74.0	74.0	74.5	74.5	74.5	74.5	74.5	74.5	74.5	74.5							11	74.5
24	1147		74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0			15	74.0
25	1150		74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0		16	74.0
26	1152		74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0								10	74.0
27	1155		74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0											7	74.0
28	1156		74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0						12	74.0
Ambient*	1200	78.0	74.0																			

*Only surface temperature recorded. Constant surface to bottom temperatures at sites 26-28 indicate that ambient temperature remained at 74°F throughout the survey.

Table 3:
Temperatures (°F) recorded at 1-foot intervals from surface to bottom at 22 sites on the Susquehanna River downriver from the Susquehanna Steam Electric Station discharge diffuser, 3 September 2008.

Site No.	Time	Temperature (F)		Depth In Feet															Bottom	
		Air	Surface	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Depth	Temp
Ambient	1126	77.6	74.6	74.5	74.5	74.5	74.4	74.4	74.3	74.3	74.3	74.3	74.3	74.3					11	74.3
1	1129		74.9	74.8	74.9	74.9	74.9	74.9	74.9	74.9	75.0	75.0	75.0	75.0	74.9	74.9	74.9		14	74.9
2	1134		75.0	75.1	75.0	75.1	75.0	75.0	75.0	75.0	75.0	75.1	75.0	75.0	75.0	75.0	75.0		14	75.0
3	1138		74.9	75.0	75.0	75.0	75.0	75.0	74.9	74.9	75.0	75.0	74.9	74.9	74.9	74.9			13	74.9
4	1141		75.1	75.0	75.0	74.9	74.9	74.9	75.0	75.0	74.9	74.9	74.9	74.8	74.8				12	74.8
5	1144		75.0	75.0	75.0	74.9	75.0	74.8	74.8	74.8	74.8	74.8	74.8	74.7	74.7				12	74.7
6	1147		74.9	75.0	75.1	74.8	74.8	74.9	74.7	74.8	74.9	74.7	74.9	74.9	74.9	75.0	74.9	74.9	15	74.9
7	1151		75.0	75.0	74.9	74.9	74.8	74.7	74.7	74.7	74.8	74.8	74.7	74.7	74.7	74.8	74.8	74.8	15	74.8
8	1154		75.1	75.1	74.8	74.7	75.1	74.9	74.8	74.7	74.7	74.7	74.7	74.7	74.7	74.7	74.7		14	74.7
9	1201		74.8	74.8	74.7	74.7	74.7	74.7	74.7	74.7	74.7	74.8	74.8	74.7	74.6	74.6	74.6		14	74.6
10	1204		74.9	74.8	74.8	74.8	74.8	74.8	74.9	75.0	74.9	74.8	74.8	74.8	74.7	74.7	74.7		14	74.7
11	1207		75.2	75.1	75.0	74.8	74.9	74.8	74.8	74.8	74.8	74.8	74.8	74.8	74.8				12	74.8
12*	1210		74.5	74.5	74.5	74.5	74.4	74.4	74.4	74.4	74.4	74.4	74.4	74.4					11	74.4
13	1213		74.8	74.7	74.6	74.4	74.3	74.3	74.4	74.3	74.3	74.4	74.4	74.3	74.3	74.3			13	74.3
14	1216		74.7	74.7	74.6	74.5	74.5	74.4	74.4	74.4	74.4	74.3	74.3	74.3					11	74.3
15	1226		75.1	75.1	75.0	75.1	75.0	75.1	75.0	74.8	75.1	75.2	75.0	74.9	74.8	74.7	74.7	74.7	15	74.7
16	1228		75.0	74.9	74.8	74.8	74.7	74.8	74.8	74.8	74.7	74.7	74.7	74.7	74.7	74.6			13	74.6
17	1230		75.1	75.0	75.0	75.0	74.9	74.9	74.9	74.8	74.8	74.8	74.9	74.9	74.9	74.9	74.7		14	74.7
18	1232		75.0	75.0	75.0	75.0	75.0	75.0	74.9	74.9	74.9	74.9	74.8	74.8	74.7	74.6			13	74.6
19	1234		75.0	75.0	75.0	74.9	74.9	74.8	74.9	74.8	74.8	74.8	74.8	74.8	74.8				12	74.8
20	1239		74.8	75.1	75.1	75.2	75.1	75.0	75.0	75.2	75.1	75.0	74.9	75.0	74.9	74.9	74.8		14	74.8
21	1244		75.4	75.0	74.8	74.7	74.5	74.5	74.5	74.4	74.5	74.4	74.5	74.5					11	74.5
22	1249		75.4	74.9	75.2	75.1	75.5	75.5	75.4	75.6	75.5	75.4	75.3	75.3	75.3	75.2	75.2		14	75.2
Ambient	1252	78.5	75.5	75.3	75.3	75.2	75.1	75.1	75.1	75.1	75.0	75.0	75.0	75.0	75.0				12	75.0

*All temperatures (except ambient) measured after 1210 hours were adjusted for an increase in ambient temperature by subtracting 0.5°F.

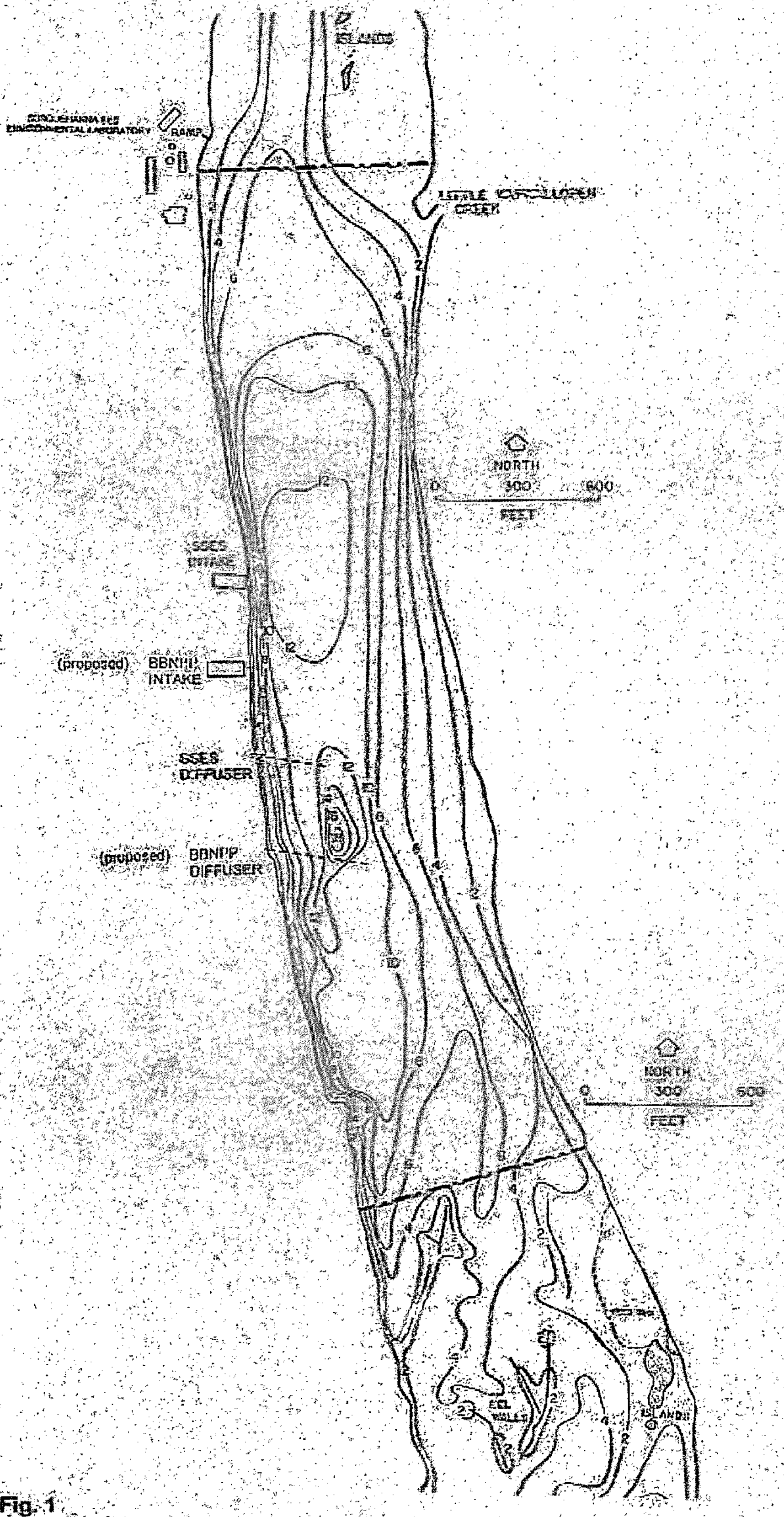

Fig. 1

Location of the Susquehanna Steam Electric Station (SSES) and the proposed Bell Bend Nuclear Power Plant (BBNPP) river water intakes and discharge diffusers along the west bank of a pool in the Susquehanna River, six miles upriver from Berwick, PA, 2008. Depth contours at 2-foot intervals based on a river level at 486.2 feet above mean sea level surveyed in 1983.

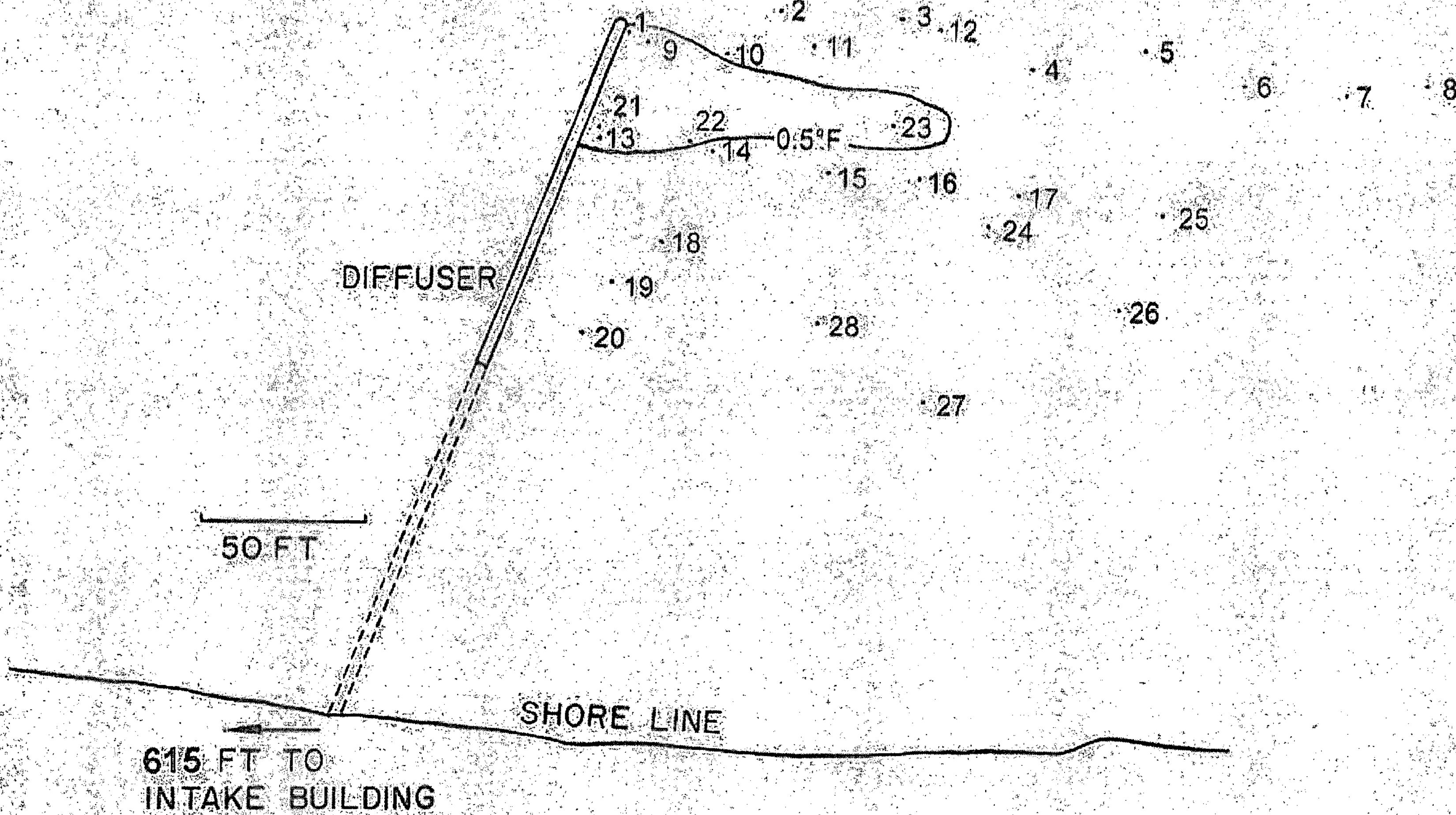

Fig. 2

Limits of a thermal plume (0.5° F above ambient water temperature) in the Susquehanna River caused by the release of cooling tower blowdown (12,000 gpm) from the Susquehanna Steam Electric Station discharge diffuser as measured at 28 sites, 21 August 2008. Average river flow on this date was 3,230 cubic feet/second.

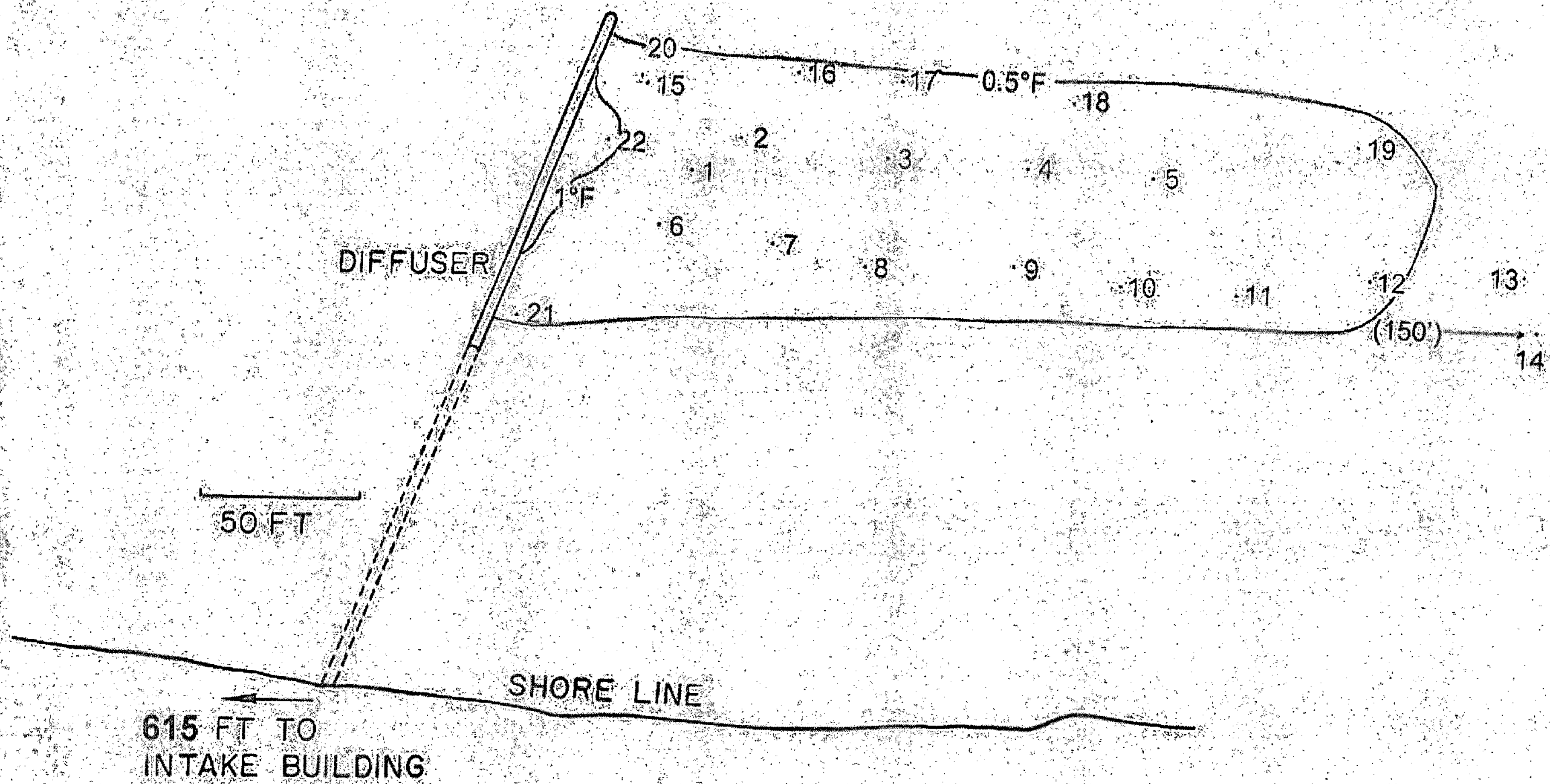

Fig. 3

Limits of a thermal plume (0.5° and 1° F above ambient water temperature) in the Susquehanna River caused by the release of cooling tower blowdown (12,000 gpm) from the Susquehanna Steam Electric Station discharge diffuser as measured at 22 sites, 3 September 2008. Average river flow on this date was 2,140 cubic feet/second.

Enclosure 7

RAI H 5.3-1
GEMSS Input Files
Bell Bend Nuclear Power Plant
Luzerne County Pennsylvania
(Compact Disc)

Enclosure 8

RAI H 5.3-1
USACE Bathymetry Files
Bell Bend Nuclear Power Plant
Luzerne County Pennsylvania
(Compact Disc)

Enclosure 9

RAI H 5.3-1
USACE Bathymetry Files Transmittal Letter
Bell Bend Nuclear Power Plant
Luzerne County Pennsylvania

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
WANAMAKER BUILDING, 100 PENN SQUARE EAST
PHILADELPHIA, PENNSYLVANIA 19107-3390

REPLY TO
ATTENTION OF

APR 0 1 2008

Planning Division

Edward M. Buchak
Partner, Surfacewater Modeling Group
Environmental Resources Management, Inc.
350 Eagleview Boulevard, Suite 200
Exton, PA 19341-1180

Mr. Buchak:
Attached is the information you requested for the Susquehanna River in Pennsylvania. Included is a DVD containing all of the digital GIS data you requested, namely; Digital Terrain Models (transmitted as TINs), hydrography coverages (which includes cross-section and stream bank locations), road centerlines and ortho-photography (transmitted in Mr SID format) for the entire study area. In addition, the HEC-RAS model as submitted to FEMA is on the DVD.

Please note the following about the data you are receiving. The hydraulic analysis was developed for use in a FEMA Flood Insurance Study and met FEMA accuracy requirements at the time. This data may not be suitable for other engineering design purposes. The data and supporting information contained in the analysis is over eight years old and may not reflect current conditions. In addition, the data and analysis is being transferred as it was submitted by the U.S. Army Corps of Engineers to FEMA and may not contain changes that might have been made during FEMA's final review. Also, the TINs do not contain geometric information about the river bottom. The HEC-RAS cross-section geometry contains river bottom elevation information derived by interpolation of depth of water survey data. The interpolated river bottom geometry was suitable for the FEMA study, but may not be suitable for other engineering design purposes. Please consider all of these limitations prior to using this data for any detailed engineering design.

Should you have any questions, please contact Jason Miller, P.E., Chief, Flood Plain Management Services Branch at 215 656-6549.

Sincerely,

C. MacIntosh
for Minas M. Arabatzis
Chief, Planning Division

Attachment D

"Ecological Studies of the Susquehanna River in the Vicinity of the Susquehanna Steam Electric Station, 1983 Annual Report". Prepared by Theodore V. Jacobsen, Ecology III, Ichthyological Associates, Inc., Ithaca, NY. August 1984.

Best copy available to AREVA is included.

ECOLOGICAL STUDIES OF THE SUSQUEHANNA RIVER IN THE VICINITY OF THE SUSQUEHANNA STEAM ELECTRIC STATION

1983 Annual Report

Theodore V. Jacobsen, Project Director and Editor
Susquehanna SES Biological Laboratory
R.D. 1, Berwick, Pennsylvania 18603

Prepared For

Pennsylvania Power and Light Company
Two North Ninth Street
Allentown, Pennsylvania 18101

Ichthyological Associates, Inc.
301 Forest Drive
Ithaca, New York 14850

August 1984

PHYSICOCHEMICAL ANALYSES

by

Walter J. Soya, Brian P. Mangan, and Theodore V. Jacobsen

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Statistical analyses of the physicochemical data from 1973 through 1983 showed significantly improved water quality. Much of this trend resulted from the termination of pumping coal mine water into the river and improved water quality of four major upriver mine drainages since 1972.

Water quality of the Susquehanna River was not adversely affected by the effluent of the Susquehanna SES during the first complete year of operation of the Unit 1 reactor. River temperature, dissolved oxygen, pH, total alkalinity, and filtrable residue data collected at Bell Bend were within limits established by the Pennsylvania Department of Environmental Resources (PDER). Total and dissolved iron concentrations at Bell Bend exceeded the PDER limit in a majority of samples, however, the concentrations were usually lower than those at the SSES control site. Historically, iron concentrations have exceeded PDER limits throughout preoperational studies.

INTRODUCTION

This report presents physicochemical data collected from the Susquehanna River near the Susquehanna SES in 1983. The objective from 1971 to 1 September 1982 was to establish a baseline of preoperational water quality data. These data are in annual reports from 1971 through 1982 (Ichthyological Associates 1972; Ichthyological Associates, Inc. 1973-74; Smith and Soya 1976; Jacobsen and Soya 1976-77; Soya and Jacobsen 1978-82; Soya et al. 1983). Operation and testing of the Unit 1 reactor of the Susquehanna SES began on 1 September 1982. The 1983 data were compared to water quality criteria established for the Susquehanna River.

PROCEDURES

Physicochemical data were collected from the river at the Susquehanna SES Biological Laboratory and the SSES and Bell Bend sampling sites (Fig. A-1). The laboratory is on the west bank, 495 m upriver from the center of the Susquehanna SES intake structure. The control site, SSES, is 230 m upriver from the intake structure and Bell Bend is 690 m downriver from the Susquehanna SES discharge diffuser; both are about 40 m from the west bank. The sites are 1.14 km apart.

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A depth contour map of a 4-km stretch of the Susquehanna River, from near the southern tip of Gould Island to the Berwick Boat Club, was drawn using a plane table survey (Figs. A-2 through A-5). Field work was done from 27 July through 27 October, a period of low river flow. Sitings were made with a Watts Microptic Alidade from the river bank to a stadia rod held in a boat; depths were taken at each of 607 sites using a chain gauge.

Physicochemical data were collected at the SSES and Bell Bend sites twice per week from April through September, and once per week from January through March and October through December. The order of sampling and analysis at the two sites was randomly determined. All samples were collected between 1200 and 1400 h. A grab sample and dissolved oxygen sample of surface water were taken while drifting over each site in a boat; air and surface water temperature, Secchi disc depth, and prevailing weather conditions were recorded (Table A-1). Ice cover prevented navigation on 29 December and samples were collected in ice-free areas along the west shore at both sites; Secchi disc depth was not recorded due to shallow water. River level and flow were tabulated with the SSES data.

Samples were immediately transported to the laboratory and analyzed for dissolved oxygen, pH, total alkalinity, specific conductance, sulfate, residues (total, fixed total, and nonfiltrable), and turbidity (Table A-1). Each laboratory analysis was performed at least twice and the mean was reported. All calculations were maintained in bound notebooks. Aliquots of each grab sample were fixed for analyses of total and dissolved iron (Table A-1) performed by personnel at the Pennsylvania Power and Light (PP&L) Water Laboratory, Hazleton, Pennsylvania. All analyses were conducted within the holding time recommended by the U.S. Environmental Protection Agency (EPA 1979).

Physicochemical data collected in 1983 were statistically analyzed. The nonparametric Wilcoxon signed rank test (Siegel 1956) was used to compare differences between data collected at SSES and Bell Bend. Data collected at the laboratory and SSES were compared to those obtained in previous years. Nonparametric statistics were used to determine if: 1) year-to-year changes had occurred in each parameter using Friedman's two-way analysis of variance test (S), and 2) a trend among years was present using Page's distribution-free test (L) for ordered alternatives (Hollander and Wolfe 1973). The tests were based on monthly mean values from the first complete year of sampling (1973 or 1974) through 1983. The 5% probability level was used to determine significance.

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RESULTS AND DISCUSSION

In 1983, the river temperature ranged from 0.0 C, recorded on numerous days in January, February, and December, to 30.0 C on 8 and 9 August (Table A-2). The lowest daily mean temperature, also 0.0 C, occurred on several days in January, February, and December, whereas the highest, 28.1 C, occurred on 9 August. The daily mean temperature varied least in January (Standard Error = 0.17) and most in September (SE = 0.62). The monthly mean temperature was lowest, 0.9 C, in January and highest, 26.0 C, in August. Daily water temperature fluctuations of 0.5 C or greater occurred in each month. These fluctuations were found in 96% of the days when the daily mean temperature was greater than 10.0 C and 58% of the days when the daily mean temperature was 10.0 C or less. The maximum fluctuation, 4.9 C, occurred on 8 August.

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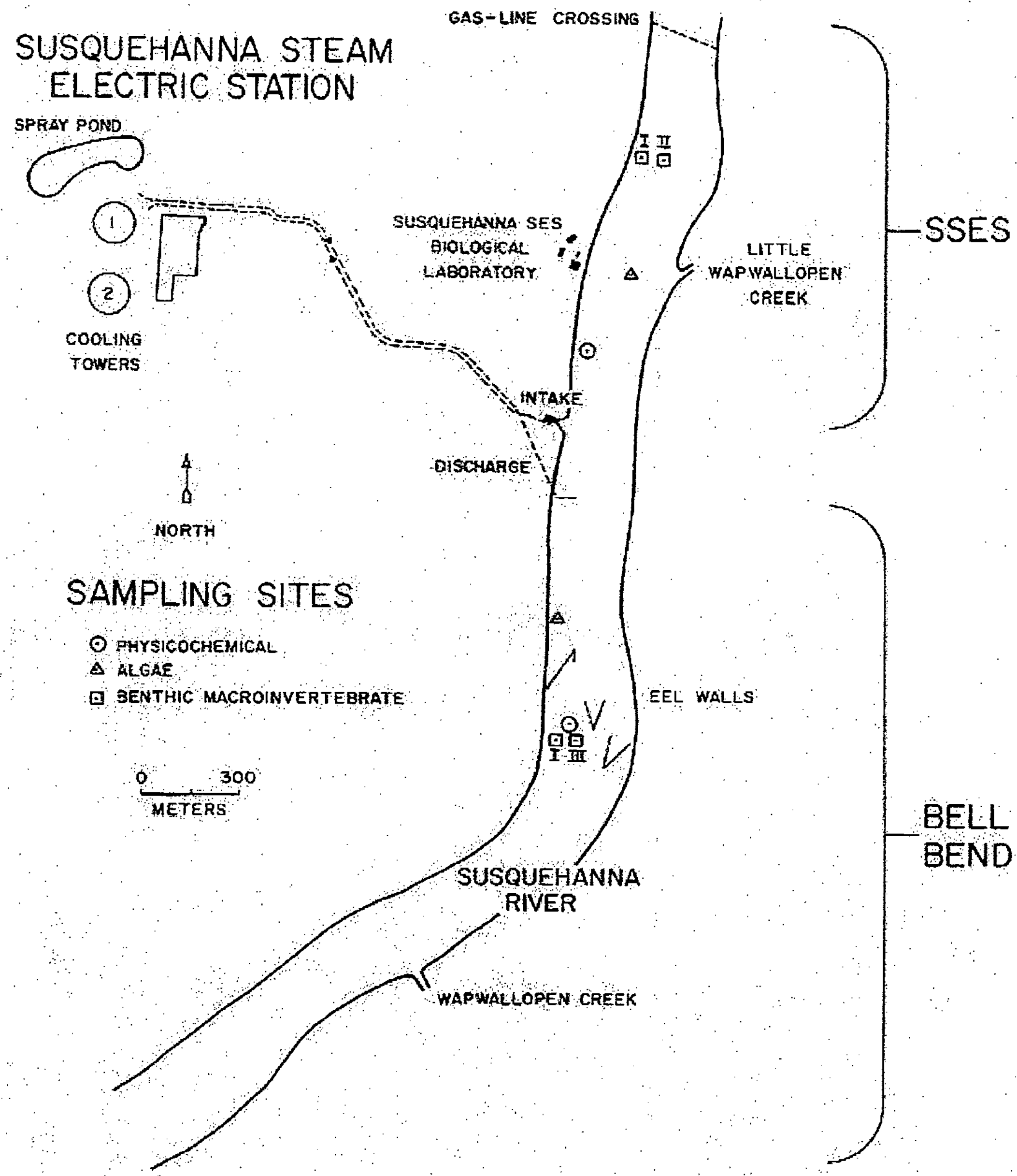

Fig. A-1

Physicochemical, algae, and benthic macroinvertebrate sampling sites at SSES and Bell Bend on the Susquehanna River, 1983.

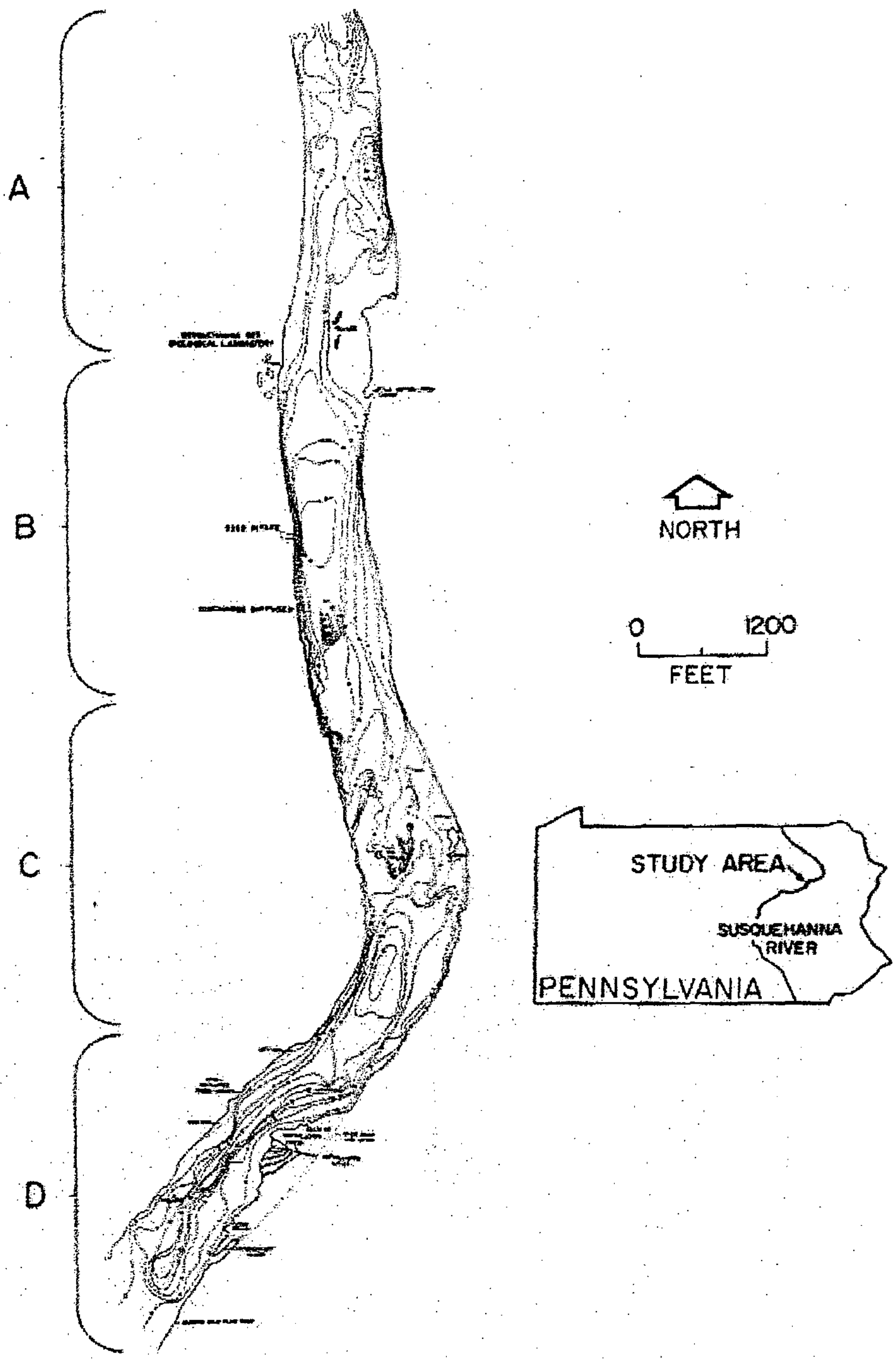

Fig. A-2

Depth contours (2-ft intervals) of the Susquehanna River (sections A through D) from near the southern tip of Gould Island to the Berwick Boat Club, 1983. Contours are based on a river level of 486.2 feet above msl at the Susquehanna SES Biological Laboratory.

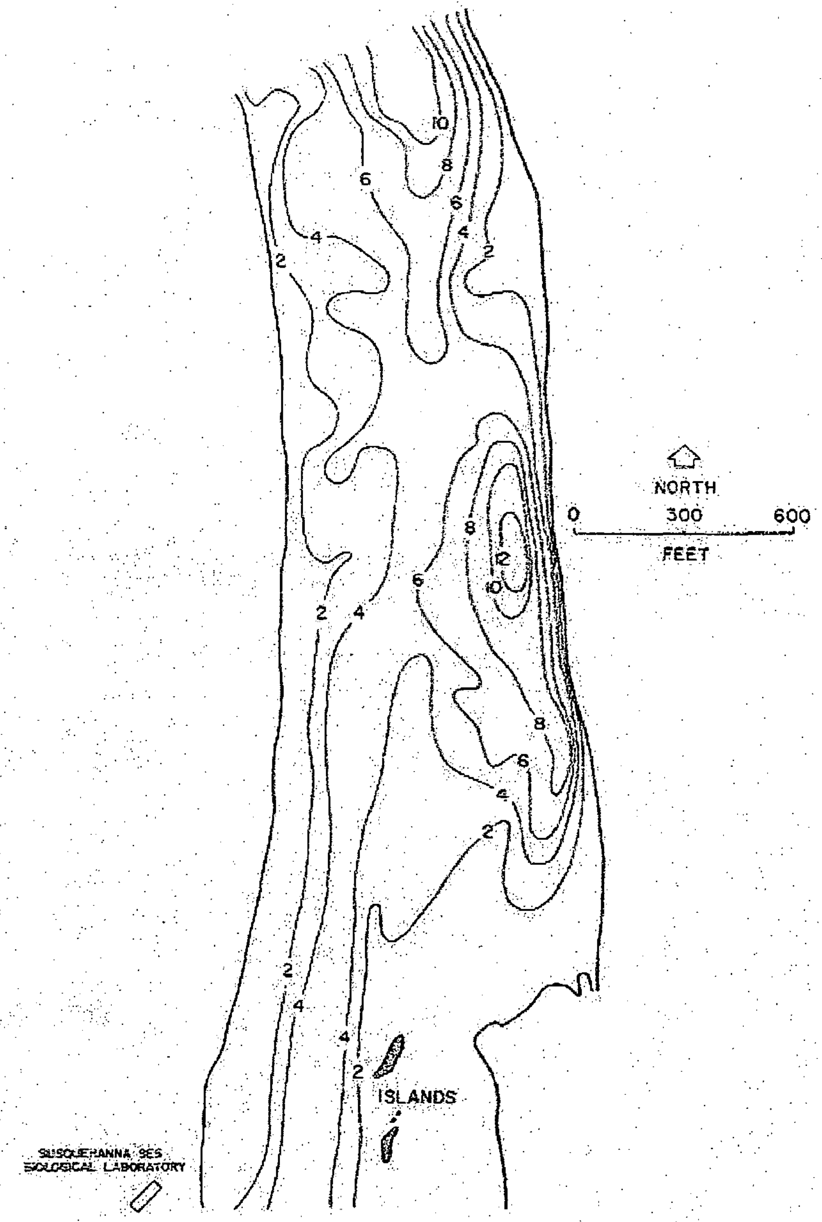

Fig. A-3

Section A (see Fig. A-2) depth contours (2-ft intervals) of the Susquehanna River, 1983.

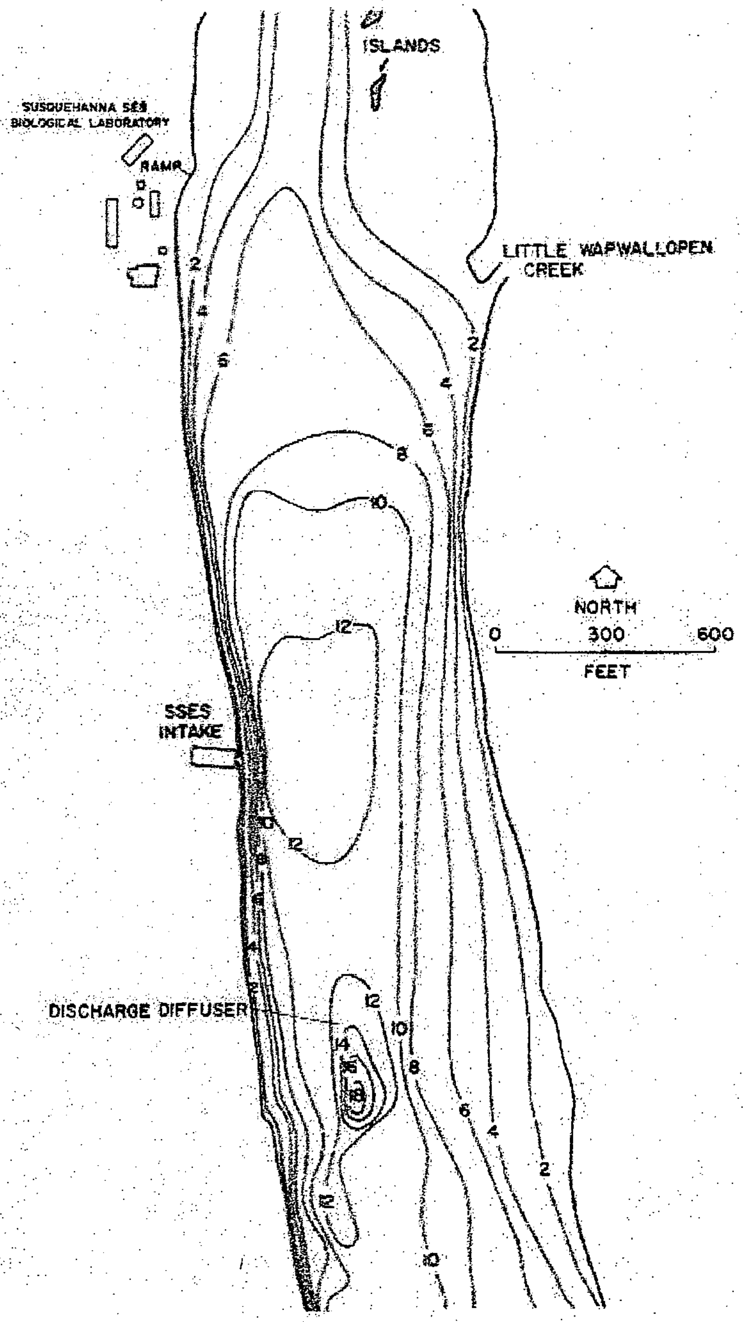

Fig. A-4

Section B (see Fig. A-2) depth contours (2-ft intervals) of the Susquehanna River, 1983.

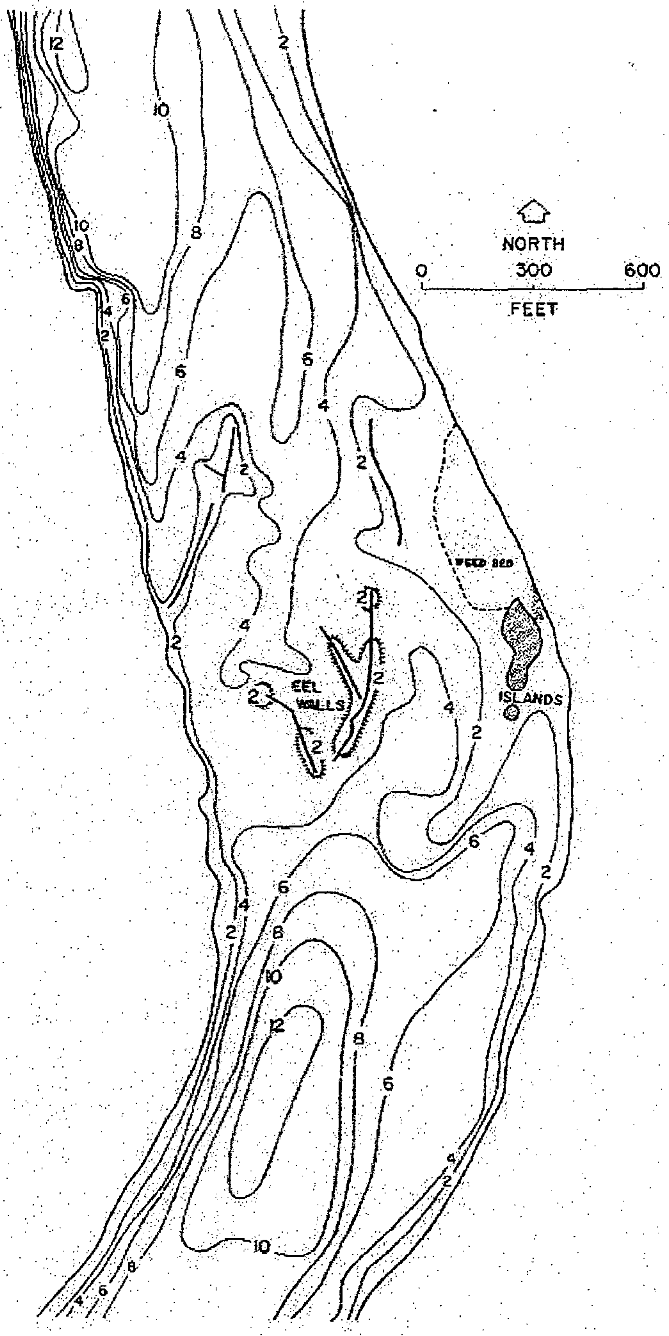

Fig. A-5

Section C (see Fig. A-2) depth contours (2-ft intervals) of the Susquehanna River, 1983.

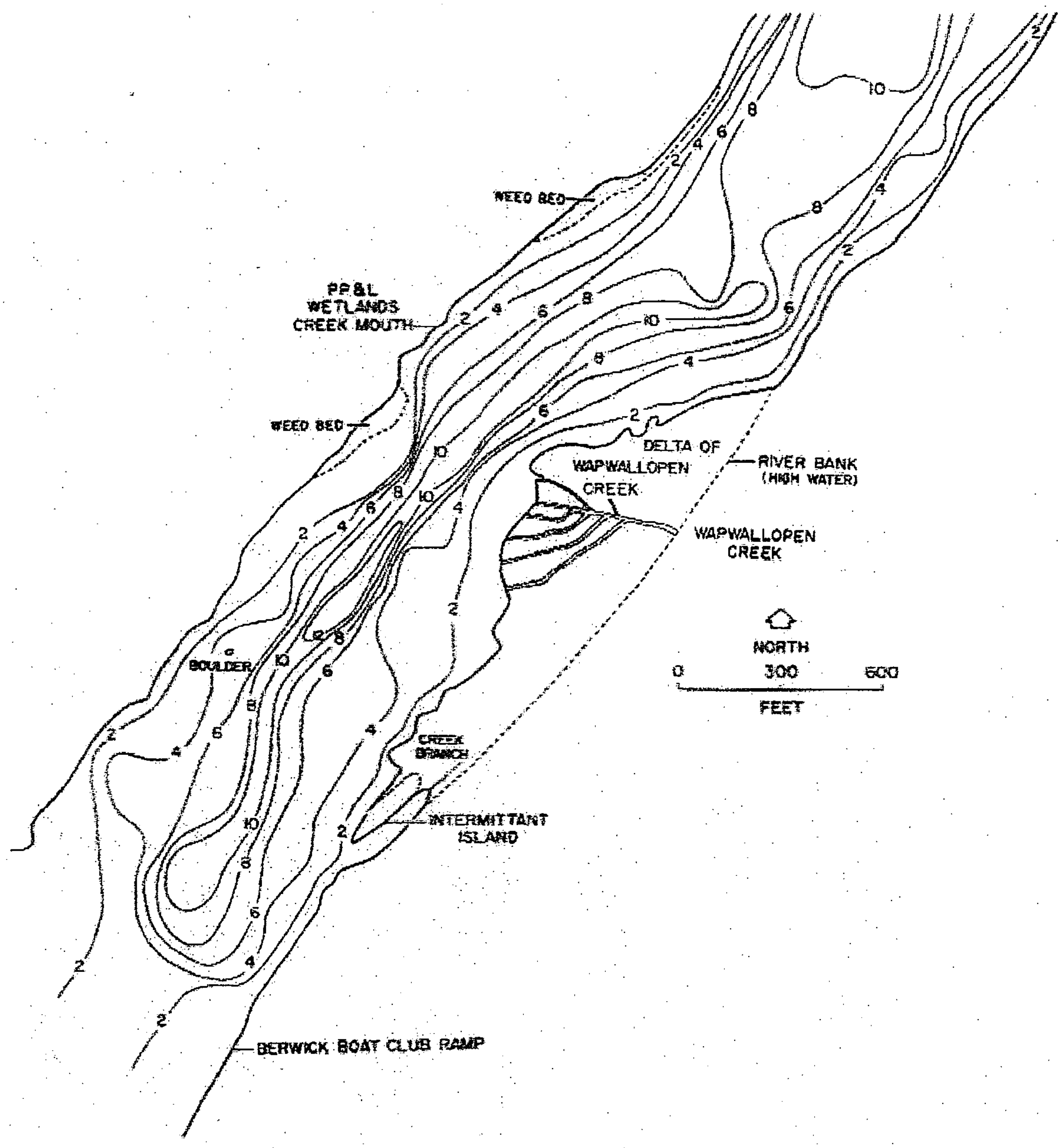

Fig. A-6

Section D (see Fig. A-2) depth contours (2-ft intervals) of the Susquehanna River, 1983.

Enclosure 10

RAI H 5.3-1
Ichthyological Associates Ecological Studies, 1984
Bell Bend Nuclear Power Plant
Luzerne County Pennsylvania

ECOLOGICAL STUDIES OF THE SUSQUEHANNA RIVER IN THE VICINITY OF THE SUSQUEHANNA STEAM ELECTRIC STATION

1983 Annual Report

Theodore V. Jacobsen, Project Director and Editor
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Prepared For

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August 1984

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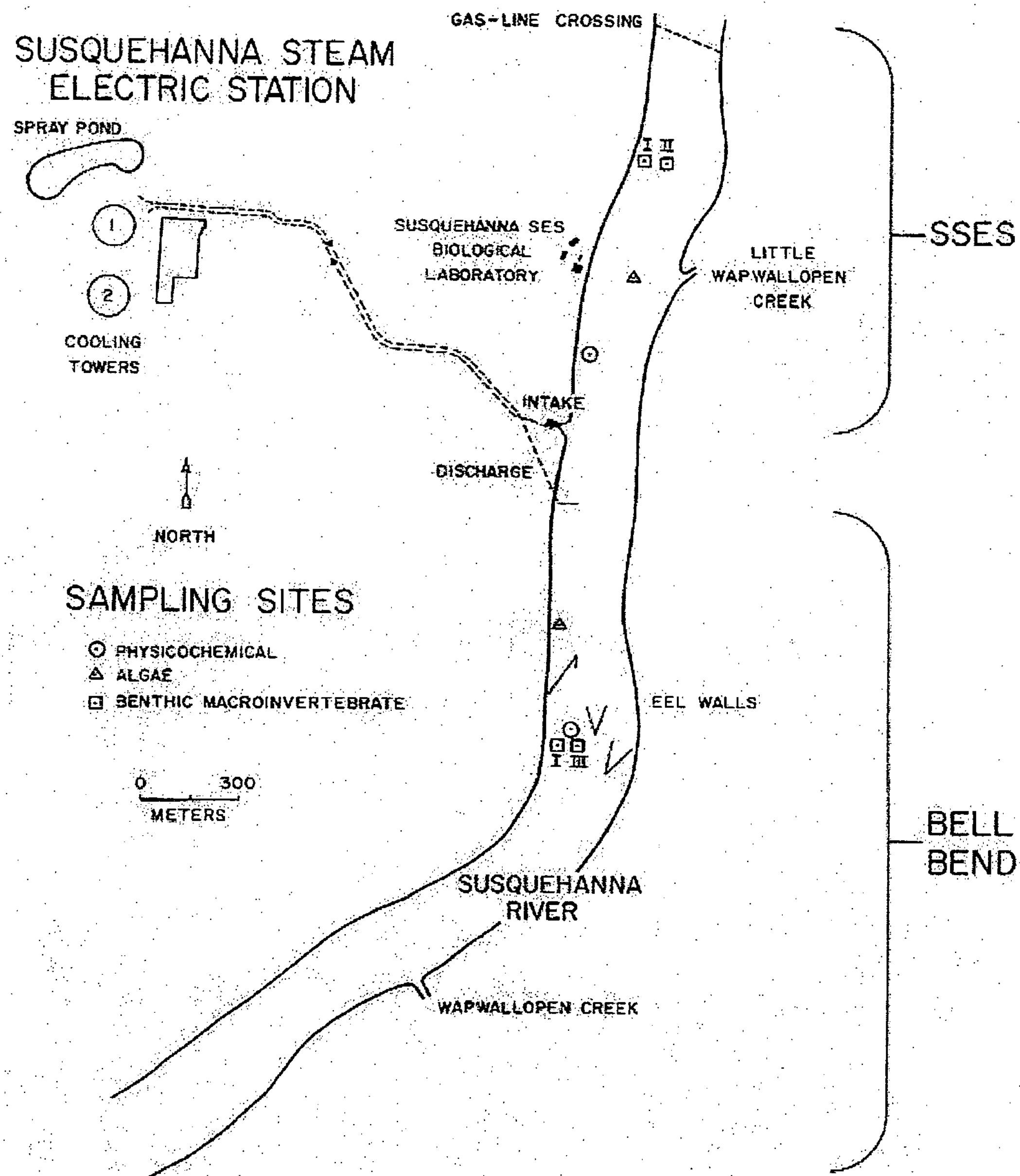

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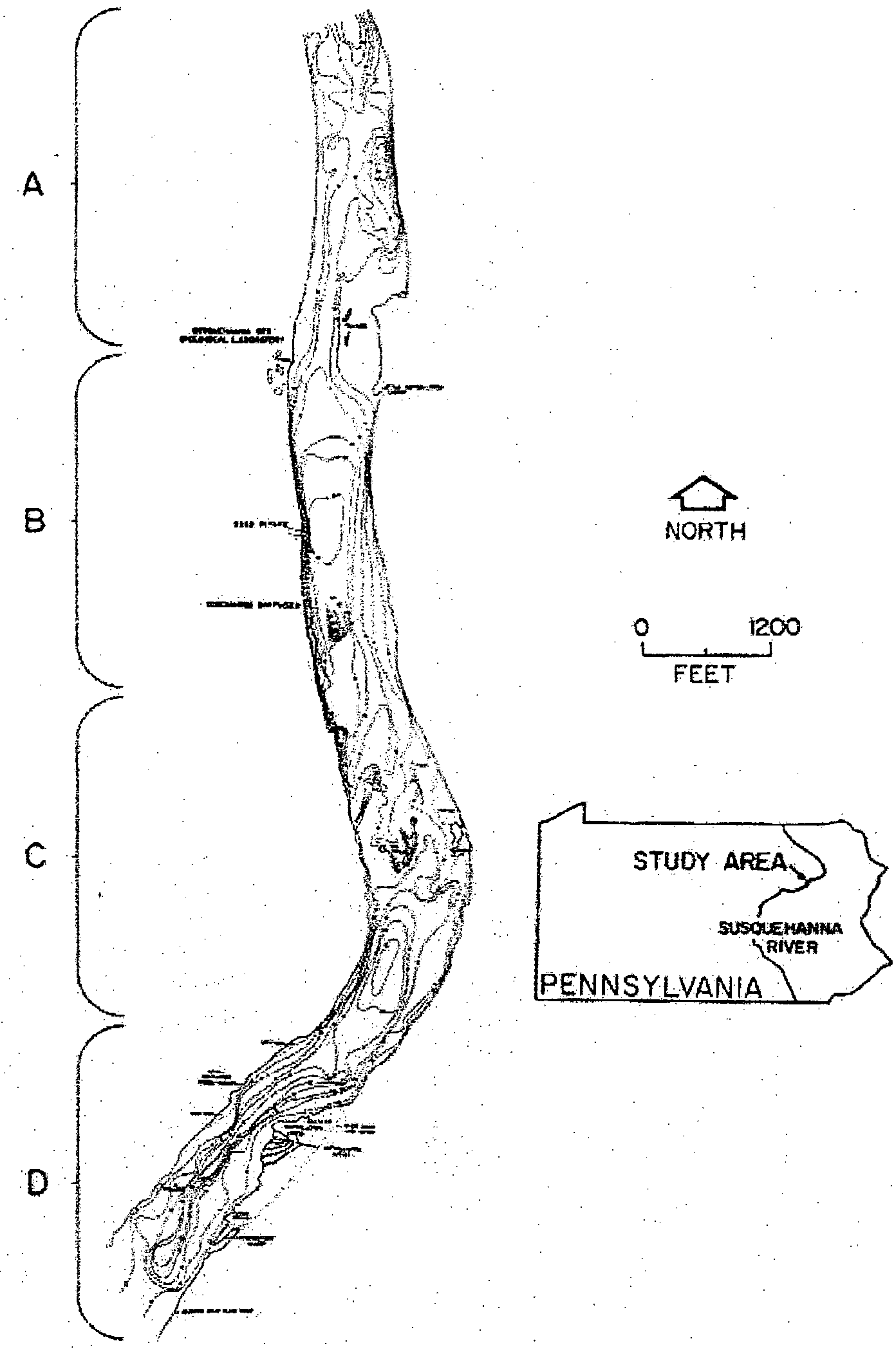

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Depth contours (2-ft intervals) of the Susquehanna River (sections A through D) from near the southern tip of Gould Island to the Berwick Boat Club, 1983. Contours are based on a river level of 486.2 feet above msl at the Susquehanna SES Biological Laboratory.

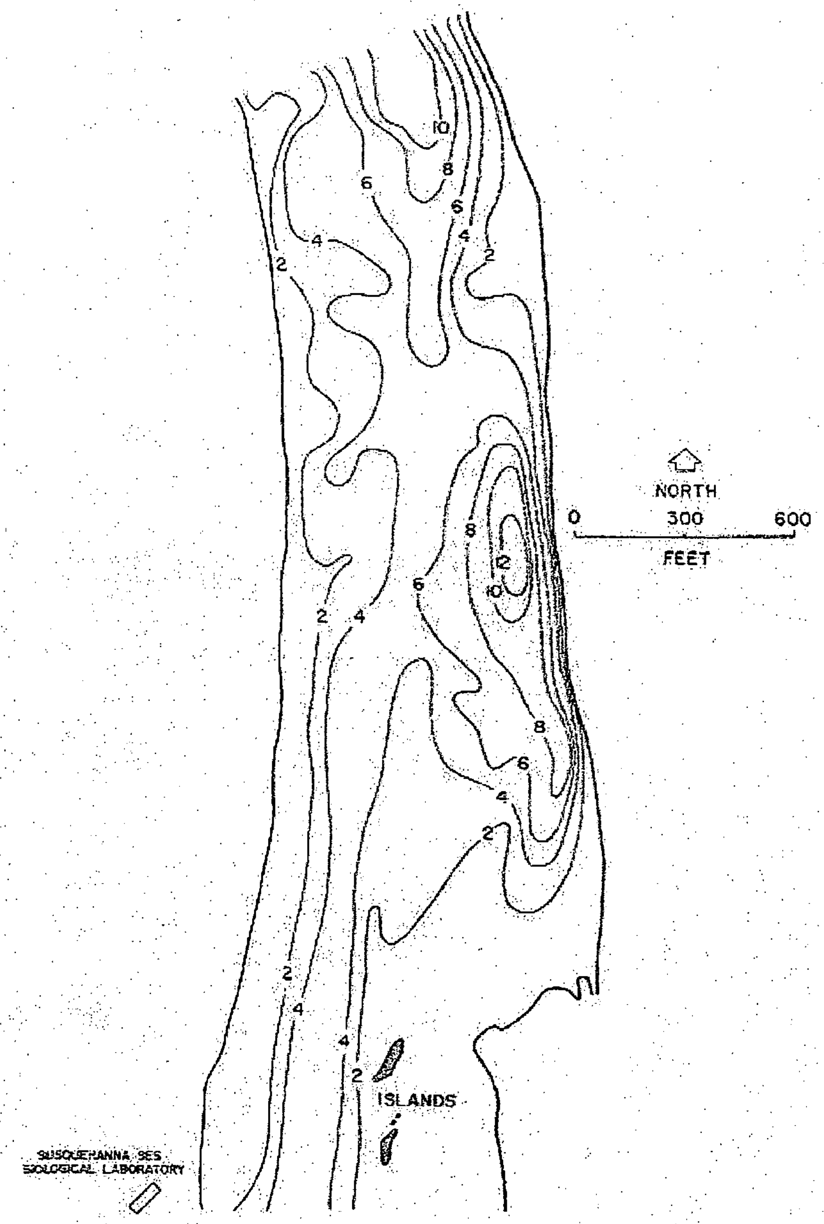


Fig. A-3

Section A (see Fig. A-2) depth contours (2-ft intervals) of the Susquehanna River, 1983.

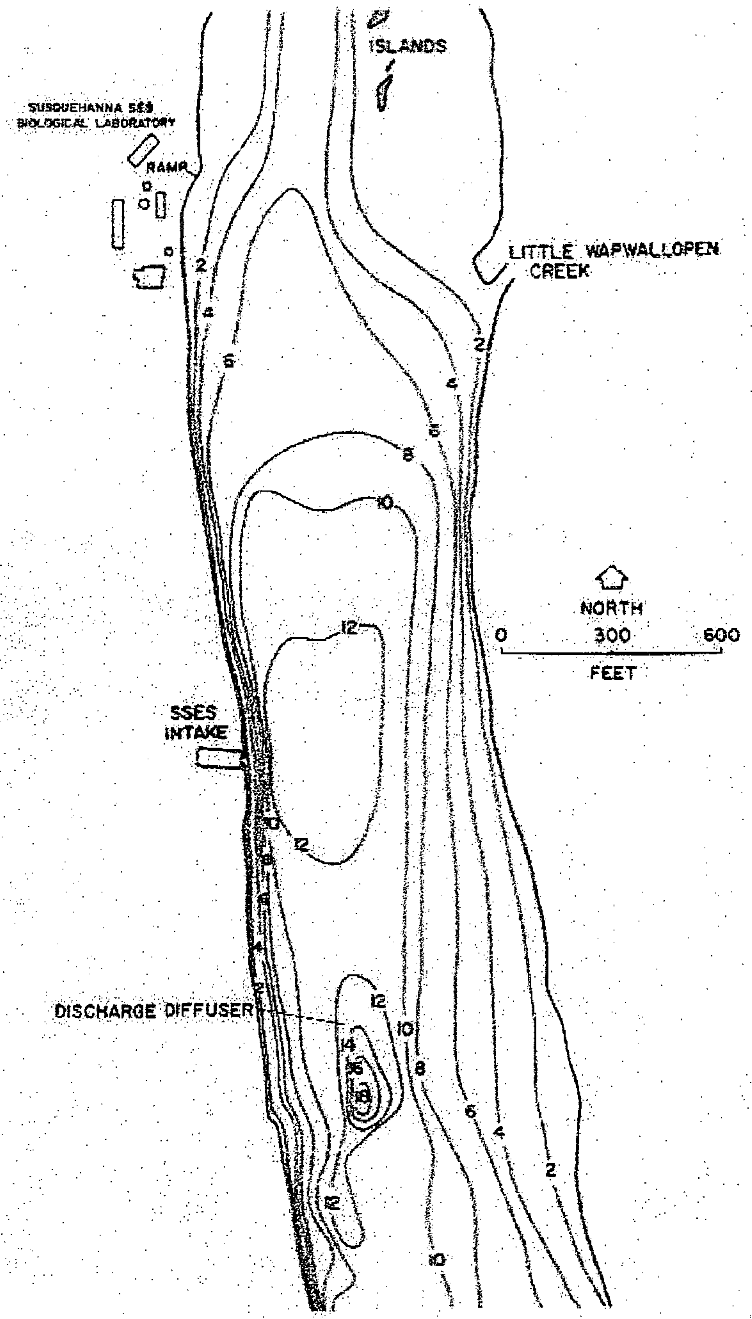


Fig. A-4

Section B (see Fig. A-2) depth contours (2-ft intervals) of the Susquehanna River, 1983.

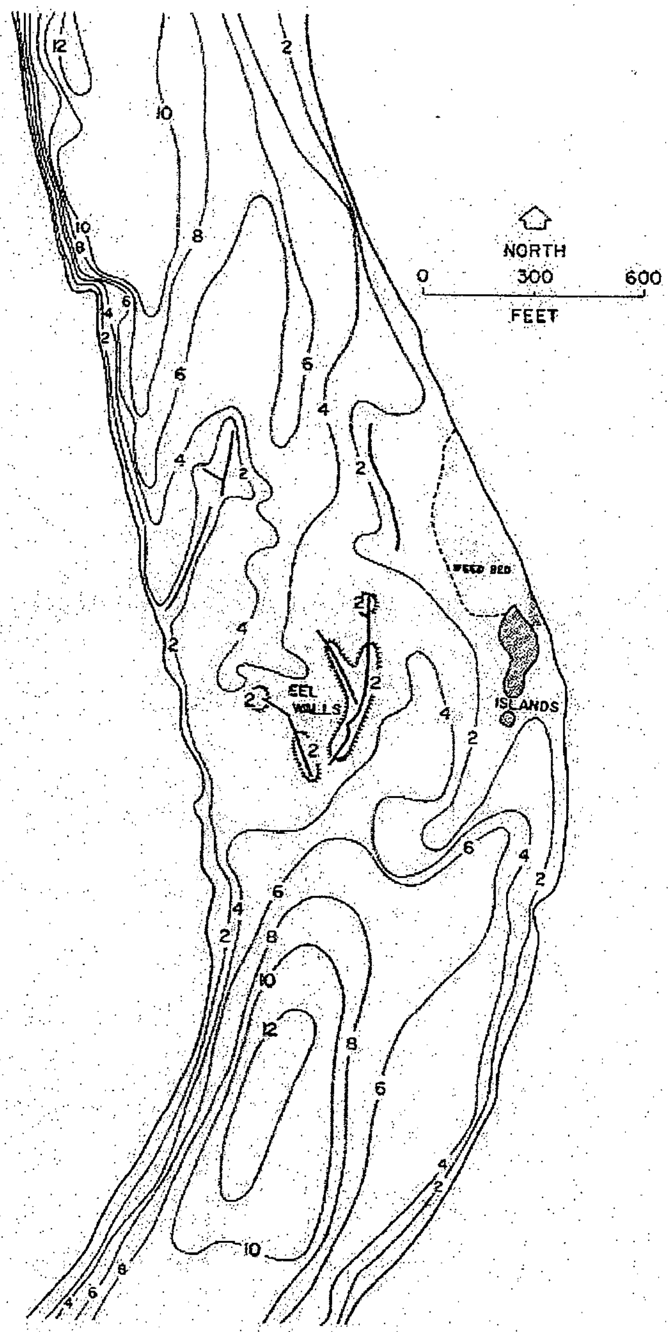


Fig. A-5

Section C (see Fig. A-2) depth contours (2-ft intervals) of the Susquehanna River, 1983.

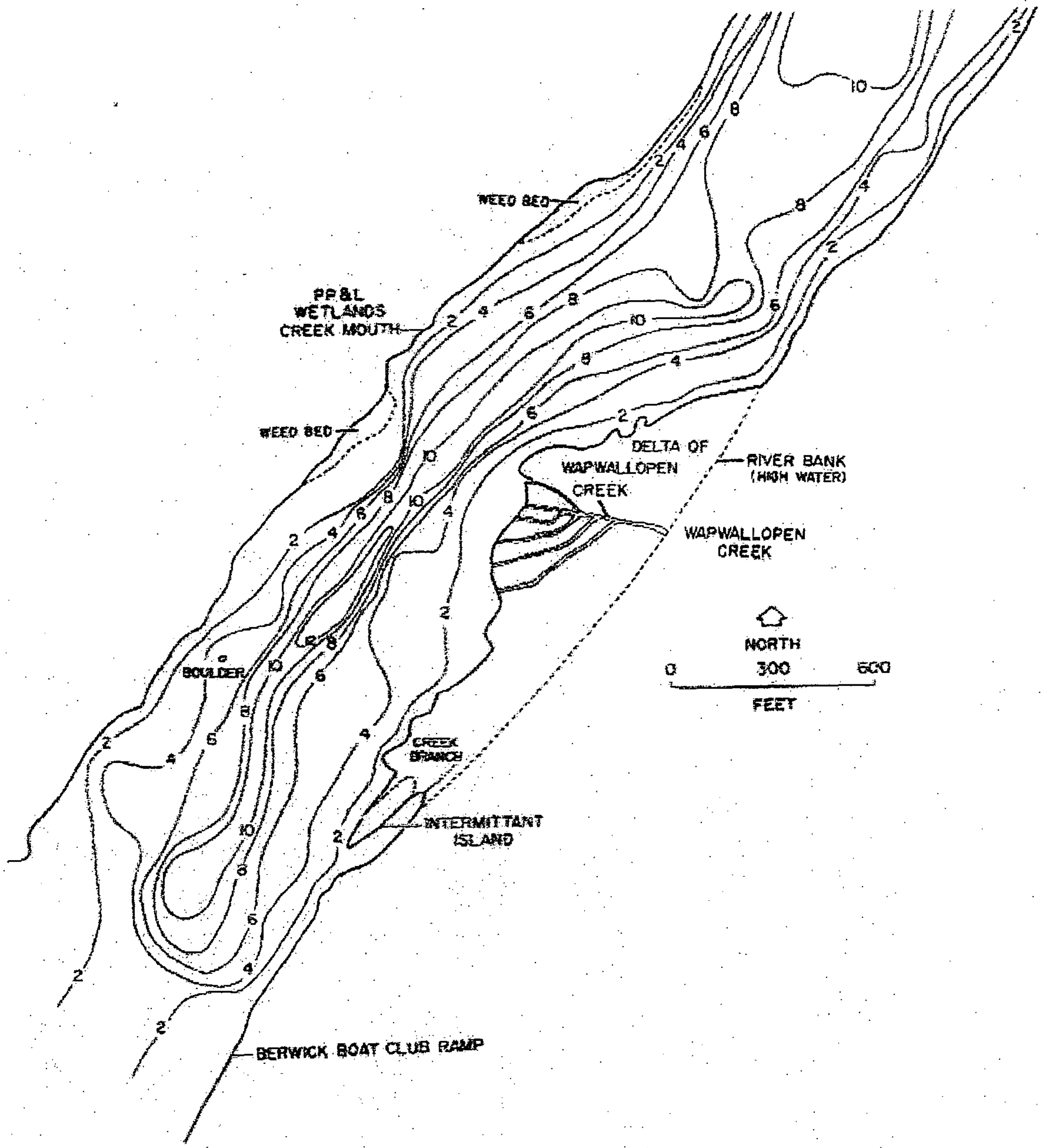


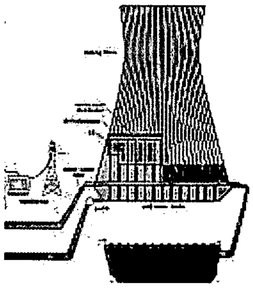
Fig. A-6

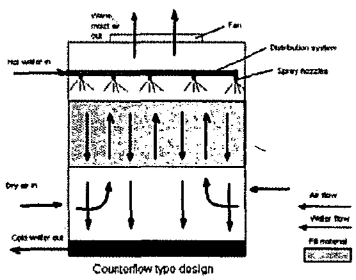
Section D (see Fig. A-2) depth contours (2-ft intervals) of the Susquehanna River, 1983.

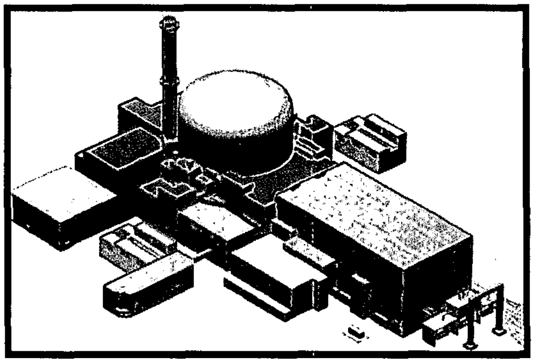
Enclosure 11

RAI H 5.3-1
Sargent and Lundy Report 2008-06824
Bell Bend Nuclear Power Plant
Luzerne County Pennsylvania

Engineering and Economic Evaluation of the Integrated Heat Rejection Cycle







Bell Bend Nuclear Power Plant 1– Proposed EPR Unit

Final Issue

PREPARED BY:	Daniel S. Elegant	DATE:	4/18/2008
REVIEWED BY:	Joshua M. Jasien	DATE:	4-18-2008
APPROVED BY:	Robert M. Field	DATE:	18 APRIL 2008

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Total Pages – Main Body (42), Attachment A (4), Attachment B (10), Attachment C (6), Attachment D (3), Attachment E (8), Attachment F (4) - Total - 77 pages

1.0 PURPOSE/OBJECTIVE

The purpose of this work is to perform a heat rejection system optimization study for the proposed AREVA EPR pressurized water reactor plant to be located at the Bell Bend site in Pennsylvania. This evaluation determines the projected performance of the integrated heat removal systems (condenser, circulating water, and cooling tower, net of associated auxiliary power requirements) for hourly intervals over one meteorological year. The goal of this evaluation is:

- Determine if there are compelling differences in net lifecycle economic benefits between various cooling tower options
- Determine whether these benefits and the ordering of options are dependent on external variables such as annual weather (average or extreme year)
- Determine whether these benefits are dependent on assumed CW flow
- Include the expected installation and maintenance costs in the evaluation.

If the predicted differences in net economic benefit are small, other considerations may be given higher consideration in the selection of cooling towers. These include:

- Site layout
- Aesthetics
- Corporate preference related to operations and maintenance issues
- First cost
- Risk associated with tower technology or vendor capability
- Associated site work for CW piping arrangement, and fit up to tower
- Expansion capabilities
- Standardization

In addition to the above evaluation, a review of cooling tower blowdown in hot months was performed.

1.1 Revision 1 Modifications

This report recommends that Bell Bend operate at 720 kgpm CW flow using two nominal 16°F approach natural draft cooling towers (Option 1b). Revision 0 did not provide a direct analysis of these towers using 720 kgpm of CW flow. Instead results were inferred from case analysis which varied CW flow for alternative tower options. Revision 1 directly illustrates the production differences for the recommended cooling towers operating at the nominal flow of 800 kgpm and the recommended flow of 720 kgpm. The life cycle economics between the two subcases are then analyzed to support the recommendation of the report.

2.0 METHODOLOGY AND ACCEPTANCE CRITERIA

2.1 Cooling Tower Options

There are eight different cooling tower options considered in this evaluation:

Option 1 - Natural Draft Tower(s)
- Option 1a: Two shells with an 84°F design approach temperature.
- Option 1b: Two shells with a 90°F design approach temperature.
- Option 1c: One shell with a 90°F design approach temperature.

Option 2: Rectangular mechanical draft cooling towers.
- Option 2a: Three towers with an 84°F design approach temperature.
- Option 2b: Two towers with a 90°F design approach temperature.

Option 3: Round mechanical draft cooling towers.
- Option 3a: Four shells with an 84°F design approach temperature.
- Option 3b: Three shells with a 90°F design approach temperature.

Option 4: One round mechanical draft cooling tower. Also called a fan-assisted natural draft tower.

Each of the considered cooling tower options will be evaluated with three different CW flow rates of 720,000 gpm, 800,000 gpm, and 880,000 gpm. Cooling tower performance curves for each option are presented in Attachment B. For comparison purposes, the Option 1a with a CW flow rate of 800,000 gpm is chosen as a baseline for the evaluation.

2.2 Modeling of the Main Condenser

The Main Condenser is modeled as a three shell, multi-pressure condenser. Circulating water from cooling tower/towers is passed in sequence through the condensing tube bundles in each condenser shell. This circulating water is used to remove the latent heat of condensation (vaporization) from the incoming turbine exhaust. The turbine exhaust enters the condenser as steam. This steam, passing around the condenser tubes, gives up heat to the circuiting water and becomes condensate. After passing through the condenser, CW flows back to the cooling tower/towers.

2.2.1 Condenser Thermal Performance

The condenser design was not finalized at the time of this report. However, a preliminary condenser design proposal was written and condenser performance data was obtained from this report [Ref. 5.11]. Since the evaluation will be performed for a range of CW flows, temperatures, and condenser heatloads, a separate evaluation is performed herein to determine the condenser backpressure at these operating conditions. Attachment A contains a sample spreadsheet with the condenser design specifications and resultant performance curves for design operating conditions.

The methodology allows condenser backpressure to be determined for a given steam loading, condenser surface area, circulating water temperature and flow rate, condenser cleanliness, tube material, and other plant specific parameters. The methodology computes the condensing temperature based on these inputs. The condenser backpressure is then the saturation pressure at the condensing temperature. Note that this methodology assumes a full waterbox and no air pocketing on the steam side of the tube bundles. The main equations used in the methodology presented below are based on the Westinghouse method [Ref. 5.2]:

$$\frac{T_o - T_i}{T_s - T_i} = \frac{T_r}{ITD} = 1 - e^{-x} = \alpha$$

$$x = \frac{J \cdot C_c \cdot C_m \cdot C_t \cdot K \cdot L}{500 \cdot \sqrt{V_{CW}}}$$

$$Q = W_c \cdot c_p \cdot (T_o - T_i)$$

where:

T_o	– CW outlet temperature (°F)
T_i	– CW inlet temperature (°F)
T_s	– condensing temperature (saturation) (°F)
T_r	– CW temperature rise (°F)
ITD	– initial temperature difference (°F)
α	– condenser effectiveness
x	– effectiveness calculation exponent
J	– tube size constant
C_c	– tube cleanliness correction factor
C_m	– tube material correction factor
C_t	– CW inlet temperature correction factor
K	– tube geometry constant
L	– active tube length times number of passes (ft)
V_{CW}	– CW velocity (ft/s)
W_c	– CW flow (lb_m/hr)
c_p	– specific heat of water (BTU/°F-lb_m)
Q	– heat transferred by condenser (BTU/hr)

2.3 Steam Turbine Generator Performance

The change in generator output versus the average condenser backpressure is obtained from Alstom correction curves [Ref. 5.9] as presented below:

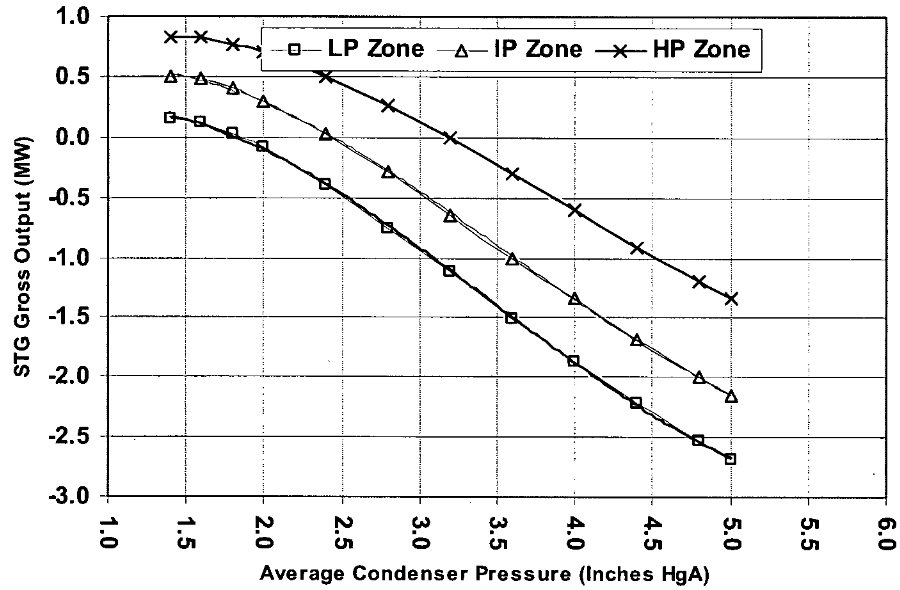


Fig. 2-1: Backpressure Correction Curve

This information is entered into an Excel spreadsheet from which the generator output versus average backpressure curve fit equation is created to be used in calculation of the overall gross generator output at any given condenser backpresure (Fig. 2-2, below).

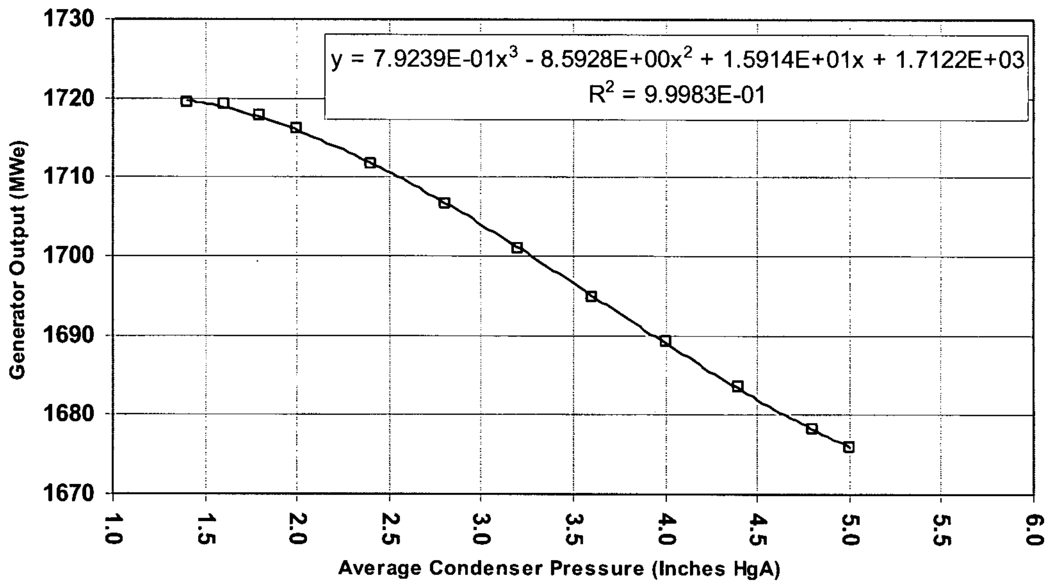


Fig. 2-2: Curvefit of Backpressure Correction Curve

2.4 Meteorological Data

Weather data from 1949–2006 were purchased in digital form from the climatological station at the Wilkes-Barre/Scranton, Pennsylvania airport, and is used to develop a hottest year and average year weather based on hourly wet bulb temperatures. Only wet bulb temperatures and relative humidity with imputed dry bulb are used in the cooling tower evaluation since they have the greatest impact on the cooling tower performance. Detailed methodology for generating meteorological data is presented in Attachment C.

2.4.1 The Hottest Year Weather Data

The hottest year weather data is developed from the 57 years of the meteorological data by comparing the warmest monthly wet bulb temperatures. The worst individual twelve calendar months are then combined to generate a single (synthetic) year of hot weather. Based on this methodology, the twelve hottest months are compiled into a single year of hot weather as presented below.

Table 2-1: Synthetic Compilation of 'Hottest' Weather Year

Month	Year	Highest Monthly Average WB (F)
January	1950	33.30
February	1984[a]	32.79
March	1973	37.23
April	1955	45.55
May	2004	57.74
June	2005	64.84
July	1949	67.87
August	2003	66.29
September	1961	62.67
October	1984	52.72
November	1975	42.68
December	2006	34.04

[a] Data from February 29, 1984 (leap year) were not included in the synthetic meteorological data set.

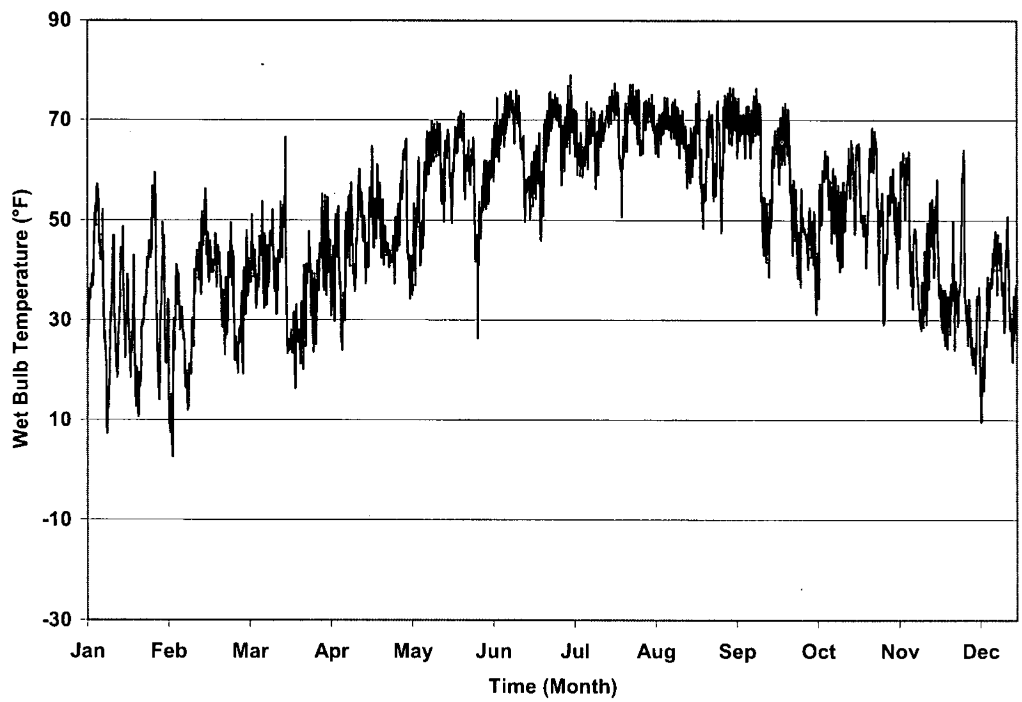


Fig. 2-3: 'Hottest' Year Wet Bulb Temperatures using Synthetic Weather Data Compilation

2.4.2 The Average Year Weather Data

The average year weather data is developed from the fifty-seven (57) years of the meteorological data by comparing the average monthly wet bulb temperatures. The average twelve months are then combined to generate a single (synthetic) year of average weather. Based on this methodology, the twelve average months are compiled into a single year of average weather as presented below.

Table 2-2: Synthetic Compilation of 'Average' Weather Year

Month	Year	Average Monthly WB Temperature (F)
January	1956	23.81
February	1982	25.31
March	1997	31.99
April	1949	41.83
May	2001	51.57
June	1951	60.17
July	1989	64.19
August	1974	63.28
September	1983	56.87
October	1996	46.54
November	1987	37.50
December	1993	27.69

For additional details see Attachment C.

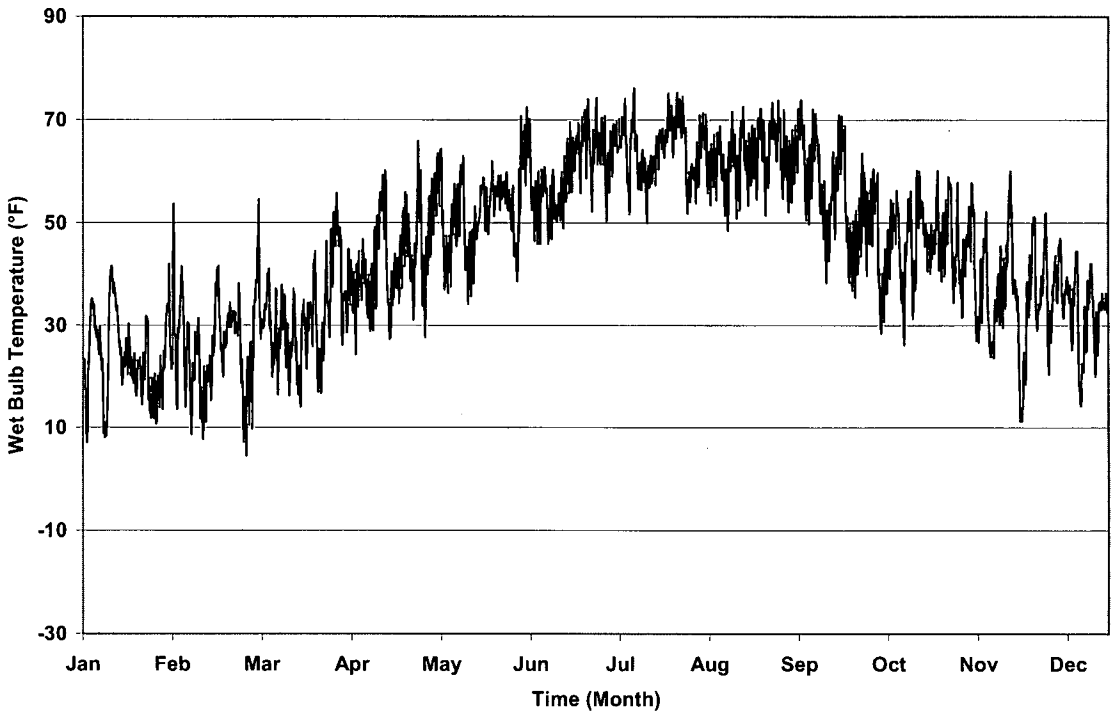


Fig. 2-4: 'Average' Year Wet Bulb Temperatures

Finally, for comparison purposes the single hot year wet bulb temperature is compared to the average year wet bulb temperature in Fig. 2-5 below.

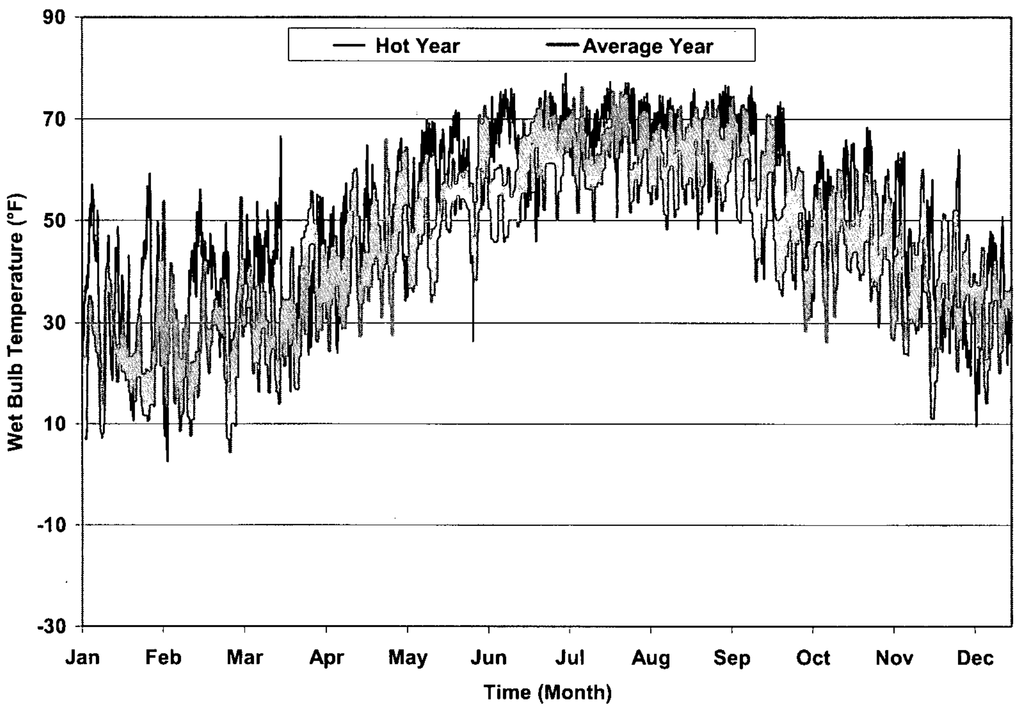


Fig. 2-5: Comparison of 'Hot' and 'Average' Year Wet Bulb Data

2.5 Circulating Water Pumping Power

The cooling tower selection is partly dependent on the overall energy consumption by the CW pumps. The CW pump energy consumption is dependent on the CW flow rate, tower option elevation difference between the cooling tower basin and distribution header, and the frictional pressure drop in the CW system. The following equation from Crane [Ref. 5.8] represents the total energy used by the CW pumps:

$$P_{CW} = \frac{Q \cdot (H_{static} + (H_{piping} + H_{condenser}) \cdot (Q/800{,}000)^2) \cdot \rho}{247{,}000 \cdot e_p \cdot e_m} \cdot \frac{745.7}{1000{,}000} \, (MWe)$$

where:

- Q - total CW flow rate (gpm)
- H_{static} - elevation difference between the cooling tower basin and distribution header (ft)
- H_{piping} - CW piping frictional head loss (ft) – see Assumption 3.3
- $H_{condenser}$ - condenser frictional head loss (ft)
- e_p - CW pump efficiency (fraction) – see Assumption 3.4

e_m - CW pump motor efficiency (fraction) – see Assumption 3.4
ρ - CW density (lb_m/ft^3)

2.6 Mechanical Draft Cooling Tower Fan Power

The three mechanical draft cooling tower options have an additional energy usage in the form of tower fans. Fan power requirements for each option are summarized below:

Table 2-3: Mechanical Draft Towers' Fan Power Requirements

Option (-)	CT Type (-)	Fan Power Use (MW_e)
2a	3 – Rect. MDT	11.19
2b	2 – Rect. MDT	8.21
3a	4 – Round MDT	8.95
3b	3 – Round MDT	6.71
4	1 – Round MDT	11.60

Note that for northern climates (such as Bell Bend), tower fans are often operated at reduced speed or in a feathered condition for cooler months. It has been determined that for southern climates, year round operation of fans at full speed is often cost effective. The Bell Bend site may have winter time wet bulb temperatures which make two-speed fan operation economical. Therefore for cold wetbulb operation fans could be turned off as needed when the average condenser backpressure reaches a low point of 1.4 in HgA. Reduced fan power in winter months was modeled in the analysis.

2.7 Hourly Electricity Pricing

To account for the significant differences in the spot power market, hourly selling prices for electricity are used in the model. The hourly selling prices for electricity for Susquehanna from 2006 [Ref. 5.4] were reviewed and selected. By utilizing the selected hourly selling prices, the differential net production between the considered options is translated into an annual difference in revenues.

2.8 Cooling Tower Maintenance Cost

In addition to the differences in the initial cost of construction for each of the cooling tower options, there are some differences in the expected maintenance cost that need to be included in the overall economic evaluation. The following four items specify typical expected cost variables associated with maintenance of cooling towers.

2.8.1 Cooling Tower Fill Inspection and Replacement

The typical cooling tower fill provided with a new cooling tower should last ~10 years without significant maintenance cost. Historically, for towers installed in the 1970's and 1980's, after about 15 to 20 years total fill replacement is typically needed. More recently towers with splash fill have shown good durability, and after 15 years of operation, no major fill replacement is planned.

Due to the anticipated short duration of nuclear plant outages (~ one month every 18 months), fill replacement is usually done in stages of 10 to 25% per outage. With either poor quality or durable fill, the overall fill replacement cost is similar between the four cooling tower options considered in this evaluation and is therefore not included in the comparative economic evaluation.

2.8.2 Distribution Piping/Nozzle Inspection and Replacement

The distribution piping/nozzle inspection is usually performed on an annual or biannual basis. The distribution nozzles are visually inspected and cleaned or replaced as required. The overall distribution piping/nozzle maintenance cost is similar between the three cooling tower options considered in this evaluation and is therefore not included in the economic evaluation.

2.8.3 Mechanical Components Inspection and Maintenance

Mechanical draft cooling towers (Options 2, 3, and 4) include a variety of mechanical components (such as motors, fans, speed reducers, etc.) that require periodic inspection and maintenance. According to one leading cooling tower manufacturer (SPX), the approximate cost of inspection and maintenance is ~\$5,000 per cell per year. Therefore, the total yearly cost is approximately ~\$300,000 (60 x \$5,000) for Option 2 and ~\$240,000 (48 x \$5,000) for Options 3 and 4 (Option 4 is assumed to have a similar maintenance cost as for Option 3) per one EPR unit in current dollars.

2.8.4 Mechanical Components Replacement

In addition to the inspection and maintenance cost as outlined in Section 2.8.3, the mechanical components will degrade over time and will need to be replaced. Again, according to one leading cooling tower manufacturer (SPX) most of the mechanical components will need to be replaced after ~10 to ~30 years of operation. The approximate cost of replacing major mechanical components (such as motors, fans, speed reducers, etc) is ~\$65,000 to ~\$70,000 per cell. With the total of 60 cells (Option 2) and 48 cells (Option 3) the total single time replacement cost is ~\$3,900,000 to ~\$4,200,000 (Option 2) and ~\$3,120,000 to ~\$3,360,000 (Option 3) in current dollars. With the expected nuclear plant life of 60 years and the average life of the cooling tower mechanical components of ~20 years it is expected that each of the major cooling tower mechanical components will need to be replaced twice over the 60 year life of the nuclear plant. Therefore, after conservatively taking the higher replacement value the total replacement cost would be approximately ~\$8,400,000 (Option 2) and ~\$6,720,000 (Option 3) in current dollars. However, since the equipment degradation is not uniform and it is predicted that the original mechanical components should last at least 10 years without replacement, the total will be equally distributed over the remaining 50 years of the plant life for ~$168,000 (Option 2) and ~ $134,400 (Options 3 and 4 which is assumed to have similar replacement cost as Option 3) in current dollars per year from year 10 to 60. Per discussions with SPX, cell replacement will be required for Option 4 despite the fans not being within the exhaust stream flow.

2.9 Economic Evaluation Method

The relative economics of the three tower options are examined as follows:

- Cash In – Annual cash in is based on the net production for the four options determined hourly as net generation difference (gross output, adjusted for corresponding condenser backpressure, minus CW and tower fan power) times the corresponding hourly selling price ($/MW-hr). (House load outside of CW and tower fans is assumed to be common to all four options). An inflation rate of 4% is used and the annual revenues over the sixty year plant life are set to a net present value using an assumed discount rate (see Assumption 3.7).
- Installed Cost – The installed cost for tower options is an overnight cost in 2007 dollars which does not include allowance for funds used during construction (AFUDC). The capital cost is the estimated installation cost for the four tower options, including support systems unique to each option. Costs which are common to all four options, such as CW pumps and motors, and makeup and blowdown systems were not estimated or included. Installed cost is based on vendor input for basic tower supply and erection, while support costs for civil and electrical works are based on recent S&L cost studies for similar installations.

  Design and overhead costs for owners, engineer, and construction management are taken as a fixed percentage of the cost for the option.
- Maintenance Cost – Maintenance cost differences are described in Section 2.8. These assume a 4% rate of inflation and are brought back to a net present value using the same discount rate as used for revenues (see Assumption 3.7). Note that the cost of fill replacement is considered to be uniform across all options.

2.10 Environmental Constraints on Blowdown

2.10.1 Blowdown Temperature – Blowdown from the towers, whether of natural or mechanical draft design, is required to maintain tower water chemistry within design limits. It is expected that blowdown will be regulated by environmental permit and that a maximum blowdown temperature will be established. These limits are often based on a 24-hour average.

For this evaluation it is assumed that the blowdown will be limited to a maximum temperature of 87°F. This is based on having to meet water quality requirements for the stretch of the Susquehanna River where the station is located. The Susquehanna River in Luzerne County, PA is protected for Warm Water Fishes (WWF) and therefore, the maximum temperature in the receiving water cannot exceed 87°F or increase by more than 2°F in one hour [Ref. 5.7].

2.10.2 Blowdown and Makeup Flow Computation – The blowdown is defined as the amount of water discharged from the system to control the concentration of salts or other impurities in the circulating water. Varying the blowdown controls the degree of concentration in the cooling tower which is measured in terms of cycles of concentration as defined in the literature [Ref. 5.12]:

$$\pi_C = \frac{M}{B+W}$$

where: π_c - Cycles of concentration (-)
M - Total makeup flow (gpm)
B - Total blowdown flow (gpm)
W - Total windage and drift losses (gpm)

Additionally the total makeup flow can be defined as follows:

$$M = E + W + B$$

where: E - Evaporation losses (gpm) = 0.08% of CW flow per each degree of cooling.

Solving for the blowdown in terms of the known inputs results in the following equation:

$$B = \frac{E - [(\pi_C - 1) * W]}{\pi_C - 1}$$

3.0 ASSUMPTIONS

3.1 Pump Heat - The total temperature increase due to the pump heat addition is estimated to be very small and is therefore ignored for simplicity of the evaluation.

3.2 Makeup and Blowdown Streams Energy Contribution - Makeup to the CW is provided through fresh water from Susquehanna River. Since the makeup is only a small fraction of the CW flow, the net energy flow by makeup and blowdown will not be considered when establishing the required CT outlet temperature or in the tower energy balance.

3.3 CW Piping Friction Pressure Drop - CW piping frictional head loss is assumed to be 20-ft for all cases. This assumption is reasonable since most of the pressure drop will be through the condenser and in the static elevation differences, which are accurately modeled.

This is an important consideration in layout and sizing for CW piping in the detailed design stage. However, for this evaluation, differences between tower options associated with this effect are considered to be small.

3.4 CW Pump and Motor Efficiency - CW pump and motor efficiency is assumed 85% and 95% respectively for all cases. The assumed efficiency values are typical for this type of application. Pump efficiencies are not expected to vary significantly for the different tower options.

Again, this is an important design consideration in the detailed design phase. These considerations are not, however, expected to change the overall ranking of options.

3.5 Mechanical Tower Fan Power – Auxiliary power for mechanical draft fan towers is assumed at 250 hp per fan for Options 2 and 3. For Option 4 SPX has provided the total auxiliary power of 11.6 MWe for 48 fans.

3.6 Economic Analysis – Economic analysis is based on a unit capacity factor of 1. Accounting for forced and planned outages is not expected to change the economic ranking of options.

3.7 Discount Rate and Inflation – A discount rate of 8% per annum is used to bring future electricity revenues and maintenance costs into present value calculations. An inflation rate of 4% per annum is used to account for the growing prices for electricity and costs of maintenance and replacement parts. These rates were determined per discussions with the client.

3.8 Expected Plant Life – Economic analysis is based on an assumed expected nuclear plant life of 60 years. This is a reasonable assumption based on the current predictions of future nuclear power plant operation. Additionally, the salvage value of the nuclear plant is assumed to be zero at the end of the economic life.

3.9 NPDES Thermal Discharge Temperature Limit - For this evaluation it is assumed that the blowdown will be limited to a maximum temperature of 87°F. This is based having to meet water quality requirements for the stretch of the Susquehanna River where the station is located. The Susquehanna River in Luzerne County, PA is protected for Warm Water Fishes (WWF) and therefore, the maximum temperature in the receiving water cannot exceed 87°F or increase by more than 2°F in one hour [Ref. 5.7].

3.10 Condenser Design Parameters – Based on preliminary discussions with Unistar, condenser tubes are assumed to be constructed of titanium with a tube bundle pressure drop of 46.6 ft H_2O with 800,000 gpm of circulating water. Stainless steel was later chosen as the material, however, based on experience with condenser backpressure data from Nine Mile Point Unit 3, the change in material will not significantly affect the condenser performance.

3.11 Cooling Tower Recirculation – The inlet wetbulb temperature is assumed with no adjustment for recirculation of cooling tower plumes. The cooling towers under evaluation are assumed to be designed and arranged to eliminate recirculation.

3.12 Cooling Tower Cycles of Concentration – The number of cycles of concentration allowable for circulating water is assumed to be between 3 and 5. This is typical for cooling towers with freshwater makeup sources.

3.13 Cooling Tower Initial Cost Accuracy – Uncertainty associated with the cooling tower preliminary budgetary price is listed below based on input from SPX.

Option 1, Natural Draft Towers: ±30%

Option 2, Rectangular Mechanical Draft Towers: ±15%

Option 3, Round Mechanical Draft Towers: ±20%

Option 4, Single Round Mechanical Draft Tower: ±30%

3.14 Cooling Tower Drift Rate – Circulating water will be lost at a rate of 0.0010% of CW flow due to drift. This is a typical value for modern tower design.

4.0 DESIGN INPUTS

4.1 Option 1a, Natural Draft Tower – Two Shells - Two shells natural draft hyperbolic cooling tower data is assumed as follows [Ref.'s 5.6 & 5.10]:

Design Range = 24.8°F

Design Wet Bulb Temperature = 73°F

Design Relative Humidity = 70%

Design CW Flow = 800,000 gpm

Design Approach = 8.8°F

Preliminary Budgetary Price = $100,000,000

Base Diameter = ~475 feet (per tower)

Height = ~600 feet (per tower)

Pump Head = 60 feet (assumed)

Tower Footprint = ~1425 x 475 ft (see Fig. 7-5)

Performance curves were also provided as illustrated in Appendix B. These curves account for effect of wet bulb and relative humidity (dry bulb) on tower performance.

4.2 Option 2a, Mechanical Draft – Three Rectangular Towers, 60 Cells - Three rectangular mechanical draft cooling tower data is assumed as follows [Ref.'s 5.6 & 5.10]:

Design Range = 24.8°F

Design Wet Bulb Temperature = 73°F

Design Relative Humidity = 70%

Design CW Flow = 800,000 gpm

Design Approach = 10.5°F

Fan Power = 250 hp per cell (total of 20 cells per tower)

Preliminary Budgetary Price = $45,000,000

Dimensions = ~100 feet x 500 feet (per tower)

Height = ~60 feet (per tower)

Pump Head = 36 feet

Tower Footprint = 1000 x 1050 ft (see Fig. 7-5)

Performance curves were also provided as illustrated in Appendix B. These curves account for effect of wet bulb and range on tower performance.

4.3 Option 3a, Mechanical Draft - Four Round Towers, 48 Cells - Four round mechanical draft cooling tower data is assumed as follows [Ref.'s 5.6 & 5.10]:

Design Range = 24.8°F

Design Wet Bulb Temperature = 73°F

Design Relative Humidity = 70%

Design CW Flow = 800,000 gpm

Design Approach = 10.5°F

Fan Power = 250 hp per cell (total of 12 cells per tower)

Preliminary Budgetary Price = $60,000,000

Base Diameter = ~250 feet (per tower)

Height = ~60 feet (per tower)

Pump Head = 36 feet

Tower Footprint = ~1000 x 683 ft (see Fig. 7-5)

Performance curves were also provided as illustrated in Appendix B. These curves account for effect of wet bulb and range on tower performance.

4.4 Option 4, Mechanical Draft - Single Round Tower - One round mechanical draft cooling tower data is assumed as follows [Ref. 5.12]:

Design Range = 24.8°F

Design Wet Bulb Temperature = 73°F

Design Relative Humidity = 70%

Design CW Flow = 800,000 gpm

Design Approach = 12.4°F

Fan Power = Total of 11.6 MWe

Preliminary Budgetary Price = $60,000,000

Height = ~164 feet

Pump Head = 44 feet

Tower Footprint = ~600 x 600 ft (see Fig. 7-5)

Performance curves were also provided as illustrated in Appendix B. These curves account for effect of wet bulb and range on tower performance.

4.5 Weather Data - Weather information used for this study is based on meteorological data from Wilkes-Barre/Scranton, Pennsylvania airport from 1949 - 2006 [Ref. 5.3].

4.6 Condenser Data - Condenser design backpressure is taken from the Alstom conceptual design report [Ref. 5.11].

4.7 Time of Day Electricity Pricing - Time of the day energy pricing used for this study is obtained directly from PJM Interconnection [Ref. 5.4].

4.8 Heat Rate Correction – The nominal heat rate backpressure correction curve is obtained from the Alstom correction curve [Ref. 5.9].

4.9 NSSS Power – The total NSSS thermal power is taken as 4614 MWt from the Alstom guaranteed heat balance [Ref. 5.1].

4.10 Condenser Design Parameters – The following preliminary design parameters are used for the analyses in this calculation [Ref. 5.11]:

Table 4-1: Condenser Design Parameters

Condenser size (surface area) and type	Three shell, multi pressure condenser, total surface area of 16.78 x10^5 ft^2
Condenser tube diameter	25 BWG, 1" diameter condenser tubes (42,690 tubes per shell)
Design inlet temperatures	Low pressure shell – 1.85 in-Hg at 790,000 gpm, 85°F Intermediate pressure shell – 2.44 in-Hg at 790,000 gpm, 93.4°F High pressure shell – 3.20 in-Hg at 790,000 gpm, 101.79°F

4.11 Weather Conditions – The weather conditions at Wilkes-Barre/Scranton, PA used to determine the expected performance of the cooling towers are 1% wet bulb, 73°F, and mean coincident humidity ratio: 111 grains/lb (~70% Relative Humidity) [Ref. 5.13].

4.12 Cooling Tower Evaporation – Circulating water evaporation is estimated as 0.08% of CW flow for each degree of cooling [Ref. 5.14]. This is used to determine makeup requirements. Tower energy balance is based on performance curves per Attachment B.

4.14 Smaller Cooling Tower Design Parameters – Table 4-2 contains the design parameters of cooling towers designed for an outlet temperature of 90°F [Ref.'s 5.16 and 5.17].

Table 4-2: Smaller Cooling Tower Design Parameters

Option (-)	Tower Type (-)	Cooling Tower Outlet (°F)	# of Towers (-)	# of Cells per Tower (-)	Construction Cost (10^3 $)
2b	Rectangular Mechanical Draft	90	2	22	$32,000
3b	Round Mechanical Draft	90	3	12	$48,000
1b	Natural Draft	90	2	N/A	$70,000
1c	Large Natural Draft	90	1	N/A	$55,000

5.0 REFERENCES

5.1 Alstom Guaranteed Heat Balance (75V1950-100a), Dated Jan 29, 2007.

5.2 "General Information on Surface Condensers," Westinghouse Electric Co, 1310-70-E.

5.3 Meteorological Data for Wilkes-Barre/Scranton, Pennsylvania Airport from 1949-2006 (Used to develop a warmest and an average year weather). (Attachment C)

5.4 Email. From: Robert A. Hameetman, S&L, To: Pawel Kut, S&L, Subject: Fw: Locational Marginal Pricing for SSES Unit 2 (500 kv node) 2006 and 2007 to present, Date: 11/07/2007 02:27 PM.

5.5 Cooling Tower Performance Curves, SPX Cooling Technologies.

(a) Natural Draft (2 Towers) Model # 8550 252-6.6-417, Performance Curve at Waterflow = 720,000 gpm, 800,000 gpm, and 880,000 gpm, 11-20-2007.

(b) Rectangular Mechanical Draft (3 Towers) Model # F488A-6.6-20B, Performance Curve at Waterflow = 720,000 gpm, 800,000 gpm, and 880,000 gpm, 11-26-2007.

(c) Round Mechanical Draft (4 Towers) Model # F41010A-5.3-12, Performance Curve at Waterflow = 720,000 gpm, 800,000 gpm, and 880,000 gpm, 11-20-2007.

5.6 Cooling Tower Options and Budgetary Pricing, SPX Cooling Technologies 11-26-2007.

5.7 RFI #08-045, Dated Feb 7, 2008. (Provides thermal discharge limits for blowdown, see Attachment D).

5.8 Crane Technical Paper 410, "Flow of Fluids Through Valves, Fittings, and Pipe," Twenty Fifth printing –1991.

5.9 Alstom Backpressure Correction Curve (75V1950-103a), dated Jul 3, 2006.

5.10 Cooling Tower Options and Budgetary Pricing, GEA Power Cooling, Inc 10-31-2007.

5.11 RFI # 08-008, Dated Jan 9, 2008. (Provides condenser performance specifications).

5.12 Cooling Tower and Circulating Water System Study, Study No. 25237-000-G65-GGG-00002, Rev. 001.

5.13 "Engineering Weather, 2000 Edition." National Climatic Data Center, Asheville, NC.

5.14 Cooling Tower Fundamentals, SPX Cooling Technologies, Second Edition, 2006.

5.15 Wilkes-Barre - Wind data collected at the Wilkes-Barre/Scranton, PA airport. Data compiled in digital format by the National Climatic Data Center, Asheville, NC.

5.16 Cooling Tower Options and Budgetary Pricing, SPX Cooling Technologies 04/07/2008.

5.17 Cooling Tower Options and Budgetary Pricing, GEA Power Cooling, Inc 03/30/2008.

6.0 EVALUATIONS

6.1 Cooling Tower Performance

Cooling tower design typically includes a single design point, which in this case is:

Design Range = 24.8°F
Design Wet Bulb Temperature = 73°F
Design Relative Humidity = 70%
Design CW Flow = 800,000 gpm

This single design point does not indicate the performance of the tower during typical operation which spans a range of conditions. The following figures present cooling tower approach temperatures for the different tower options as a function of the wet bulb temperature. An average relative humidity of 70% (see Design Input 4.11) is used for the curves. Fig. 6-1 illustrates expected performance for the four 84°F design approach temperature options at a CW flow rate of 800,000 gpm. The 90°F approach temperature curves are shifted up by 6°F at all points.

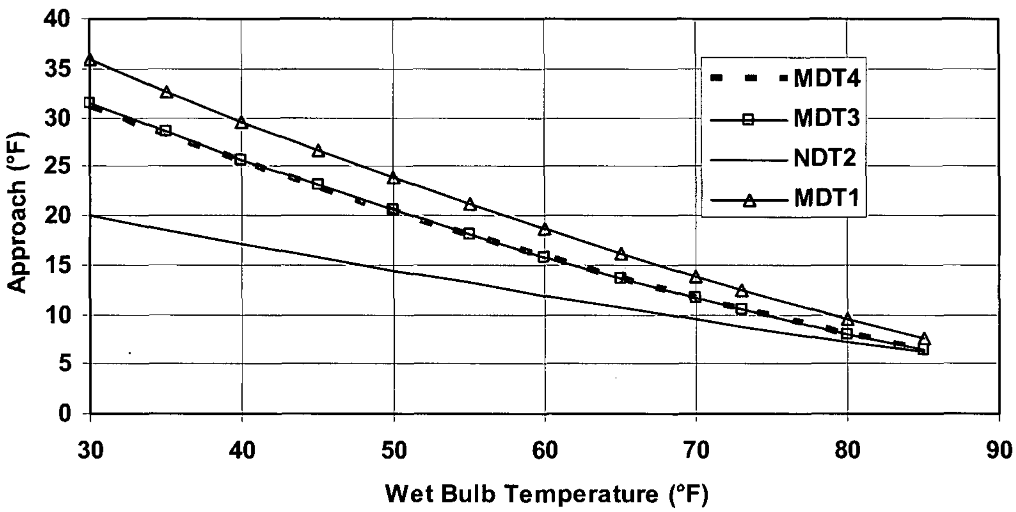


Fig. 6-1: Tower Performance for Four Tower Options vs. Wet Bulb Temperature

In addition, Fig. 6-2 presents performance for three different CW flow rates for the average annual wet bulb and relative humidity.

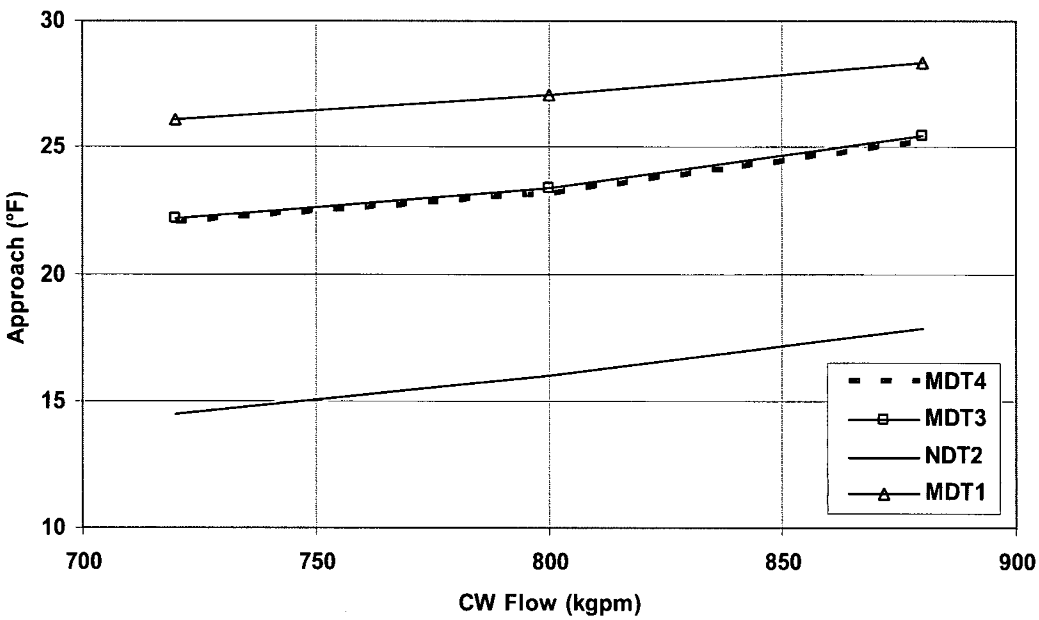


Fig. 6-2: Tower Performance for Four Tower Options vs. CW Flow

6.2 Production Analysis

Each of the base cooling tower options (1a, 2a, 3a and 4) was evaluated at three different CW flowrates (720,000 gpm, 800,000 gpm, and 880,000 gpm) using two different weather profiles (the representative 'hot' year and the 'average' year). The towers with reduced cooling capacity (1b, 1c, 2b and 3b) were evaluated with 800,000 gpm CW flowrate and 'hot' year weather. In addition, hourly electricity pricing schedules were applied to the net production differences between the base case and each option. (Note that 'net' power refers to gross production less the CW pump and tower fan power consumed for each option. Auxiliary power serving the power block is common to all options and not considered here). For the base case, Option 1a with 800,000 gpm CW flow is used. Table 6-1 presents the cases analyzed. The results are summarized in Table 6-2.

Table 6-1: Description of Case Analysis

Case No.	CW Flow (gpm)	Cooling Tower Type	Design CT Outlet Temperature (°F)	Weather Data
A1	800,000	Two Towers – Natural Draft	84	Hot/Average Year
A2	800,000	Three Rectangular Towers – Mechanical Draft	84	Hot/Average Year
A3	800,000	Four Round Towers – Mechanical Draft	84	Hot/Average Year
A4	800,000	One Round Tower – Mechanical Draft	84	Hot/Average Year
B1	720,000	Two Towers – Natural Draft	84	Hot Year
B2	720,000	Three Rectangular Towers – Mechanical Draft	84	Hot Year
B3	720,000	Four Round Towers – Mechanical Draft	84	Hot Year
B4	720,000	One Round Tower – Mechanical Draft	84	Hot Year
C1	880,000	Two Towers – Natural Draft	84	Hot Year
C2	880,000	Three Rectangular Towers – Mechanical Draft	84	Hot Year
C3	880,000	Four Round Towers – Mechanical Draft	84	Hot Year
C4	880,000	One Round Tower – Mechanical Draft	84	Hot Year
D1	800,000	Two Towers – Natural Draft	90	Hot Year
D2	800,000	Three Rectangular Towers – Mechanical Draft	90	Hot Year
D3	800,000	Four Round Towers – Mechanical Draft	90	Hot Year
D4	800,000	One Tower – Natural Draft	90	Hot Year

Table 6-2: Net Annual Production Revenue of Tower Options

Case No.	Weather Profile	Option	CT Type	CW Flow	CW Design Outlet Temperaure	Average Gross Output	Average Fan Power	Average CW Pump Power	Average Gross Output Less Fan&CW	Maximum CW Inlet Temperature	Yearly Generation Revenue Difference from 800 kgpm base (2006 Energy Pricing)
				(gpm)	(°F)	(MWe)	(MWe)	(MWe)	(MWe)	(°F)	($)
A1	Hot Year	1a	ND-2 shells	800,000	84	1718.43	0	23.59	1694.83	87.60	Base
A2	Hot Year	2a	MD-3 twrs	800,000	84	1717.64	10.70	19.11	1687.83	87.32	($3,095,243)
A3	Hot Year	3a	MD-4 shells	800,000	84	1717.67	8.53	19.11	1690.03	87.31	($2,122,404)
A4	Hot Year	4	MD-1 shell	800,000	84	1716.69	11.48	20.60	1684.62	88.84	($4,525,692)
A1*	Average Year	1a	ND-2 shells	800,000	84	1719.02	0	23.60	1695.43	84.64	$269,045
A2*	Average Year	2a	MD-3 twrs	800,000	84	1718.39	10.36	19.12	1688.91	85.49	($2,632,524)
A3*	Average Year	3a	MD-4 shells	800,000	84	1718.41	8.25	19.12	1691.05	85.46	($1,686,018)
A4*	Average Year	4	MD-1 shell	800,000	84	1717.63	11.32	20.60	1685.71	87.19	($4,067,099)
B1	Hot Year	1a	ND-2 shells	720,000	84	1718.20	0	19.75	1698.45	86.58	$1,597,277
B2	Hot Year	2a	MD-3 twrs	720,000	84	1717.28	10.82	15.72	1690.74	86.48	($1,811,522)
B3	Hot Year	3a	MD-4 shells	720,000	84	1717.29	8.64	15.72	1692.93	86.50	($841,249)
B4	Hot Year	4	MD-1 shell	720,000	84	1717.00	11.41	17.06	1688.54	88.45	($2,786,450)
C1	Hot Year	1a	ND-2 shells	880,000	84	1718.48	0	27.95	1690.52	88.91	($1,911,675)
C2	Hot Year	2a	MD-3 twrs	880,000	84	1717.66	10.70	23.02	1683.94	88.65	($4,821,373)
C3	Hot Year	3a	MD-4 shells	880,000	84	1717.71	8.53	23.02	1686.15	88.60	($3,839,875)
C4	Hot Year	4	MD-1 shell	880,000	84	1716.11	11.53	24.66	1679.92	90.14	($6,620,046)
D1	Hot Year	1b	ND-2 sm. shells	800,000	90	1715.87	0	23.58	1692.29	95.80	(1,188,894)[1]
D1a	Hot Year	1b	ND-2 sm. Shells	720,000	90	1715.43	0	19.74	1695.70	94.78	$313,298[1]
D2	Hot Year	2b	MD-2 twrs	800,000	90	1714.83	8.16	19.10	1687.57	93.83	(3,246,525)[1]
D3	Hot Year	3b	MD-3 shells	800,000	90	1714.90	6.67	19.10	1689.13	93.82	(2,556,231)[1]
D4	Hot Year	1c	ND-1 shell	800,000	90	1715.87	0	23.58	1692.29	95.80	(1,188,894)[1]

(1) Initial cost of towers may be less than 84°F design outlet options due to lower efficiency requirements.

Results indicate that the performance of the two-shell natural draft towers generates the most electricity revenue for all cases. This option however has the highest initial cost, which needs to be accounted for in the tower selection. In Section 7.3, the generation differences are compared against the initial tower cost and maintenance cost differences over the assumed 60 years of the plant life (i.e., for a base flow of 800,000 gpm).

Note that the net generation is increased for the low flow, 720,000 gpm cases. These cases would also have the lowest initial capital costs since CW pumps, CW pump motors, CW piping, CW valves, and civil structures associated with these components are smaller and lower cost for this target flow rate. Note that annual revenues are relatively insensitive to the assumed CW flow within the range of 720,000 to 880,000 gpm.

6.3 Economic Evaluation

In considering the comparison of the various cooling tower options, three main costs/ benefits should be considered:

(a) Production - This evaluation calculated the detailed net present value for production benefits for an average and the hot single year of plant operation for the various cooling tower options (summation of 8760-hourly computations).

(b) Initial Cost - Additionally, the initial 'overnight' cooling tower cost was based on vendor input and expected cost differences associated with procurement, support systems, and general contractor items to integrate the towers into the site.

(c) Maintenance - Finally, inspection and maintenance (replacement parts) cost differences were considered over the anticipated 60 years of the plant life.

The simplified economic analyses are prepared with an assumed discount rate of 8% with 4% inflation in energy prices and maintenance cost differences. A detailed life-cycle cost analysis is performed in Attachment E including a cost-sensitivity analysis.

6.4 Blowdown and Makeup Flow Calculation

It is expected that the cooling towers will operate between 3-5 cycles of concentration given their freshwater makeup source. Using tower data, the range of blowdown and makeup required for the towers is calculated and is summarized below:

Table 6-3: Makeup and Blowdown Required for Cooling Tower Operation

Cycles of Concentration (-)	Windage and Drift (gpm)	Evaporation Losses (gpm)	Total Estimated Blowdown (gpm)	Total Estimated Makeup (gpm)
3	8	15,872	7,928	23,808
5	8	15,872	3,960	19,840

6.5 Environmental Constraints on Blowdown

Blowdown from the towers, whether of natural or mechanical draft design, is required to maintain tower water chemistry within design limits. It is expected that blowdown will be regulated by environmental permit and that a maximum blowdown temperature will be established. Often these limits are based on a 24-hour average.

For this evaluation it is assumed that the blowdown will be limited to a maximum temperature of 87°F based on protection of warm water fishes in Susquehanna River [Ref. 5.7]. (Whether this is an hourly or 24-hour average does not impact the following evaluation).

With expected extreme wet bulb temperatures in the range of 70 to 75°F, and expected approach temperatures for aged towers to be in the range of 10 to 15°F, it is not prudent to expect that blowdown temperatures will remain below 87°F for critical production times in the hottest weather (e.g., see Cases C1 to C4, and D1 to D4 per Table 6-2). A forced downpower to address blowdown temperatures is not economical. Therefore, the options below are considered.

6.5.1 Alternative 1 – Blowdown Tower – A dedicated (small) cooling tower for blowdown could be included in the design. However, in addition to operating and maintenance expense, such a tower would have the same difficulty in achieving the close approach temperature needed to meet the environmental limit (as would the main tower). With the complexity and cost of a separate tower, to be used only a small fraction of operating hours, this option is not practical or cost effective.

6.5.2 Alternative 2 – Cooling Blowdown using Makeup – For this option, blowdown is cooled, as necessary, by tower makeup from the river using a plate and frame heat exchanger. An illustration of such a unit is shown below in Fig. 6-3.

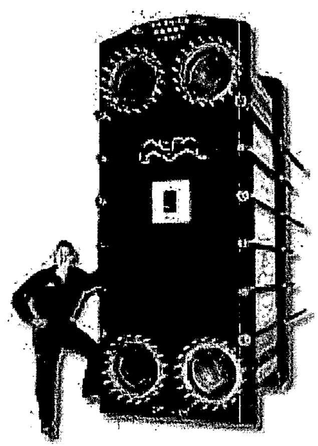


Fig. 6-3: Large Plate and Frame Heat Exchanger (Courtesy Alpha Laval)

These large units are capable of very close approach temperatures (approaches in the range of 3.5 to 5°F are economically achievable). A single unit is capable of flow in excess of 15,000 gpm and could likely accomplish the total blowdown cooling duty for one EPR unit. The design cycle for blowdown cooling is illustrated below (Fig. 6-4).

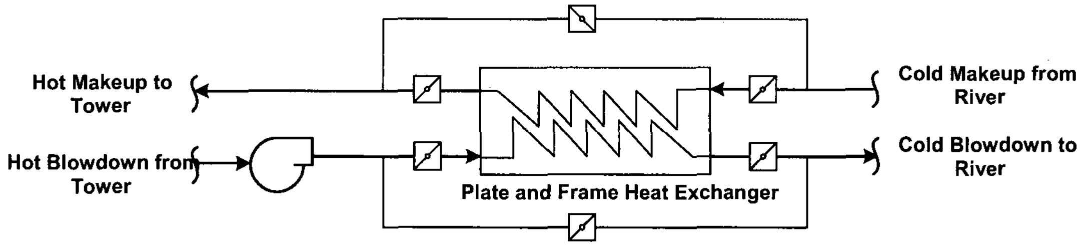


Fig. 6-4: Cooling Cycle for Blowdown using Makeup

Since blowdown and makeup are operated simultaneously, the design will essentially always have a cooling medium. Further, the design is passive without requirements for power actuated valves or devices. Blowdown is either gravity fed or pump driven, depending on plant layout. The plate and frame heat exchanger will not impact this aspect of the blowdown system design.

Since heating of the makeup adds to the tower heat load and costs some plant efficiency, a bypass is included in the design such that cooling will only be effected when required by permit. It is likely that this flow balancing through and around the heat exchanger could be performed as a seasonal activity (without the need for automated valves and associated instrumentation). This would assist in heat rate improvement without the associated capital, operating, and maintenance costs of automated equipment.

Since the heat exchanger is passive and has high anticipated reliability, it is expected that it will only occasionally require cleaning, and therefore there is no required redundancy for this equipment. The unit can simply be bypassed during the short time frame associated with disassembly for cleaning.

6.5.3 Summary – In summary, a makeup / blowdown system designed to cool blowdown (as necessary) using makeup in a plate and frame heat exchanger is considered to be a cost effective option to reliably maintain blowdown temperatures within environmental limits. This approach would eliminate constraints on main tower performance and avoid unit downpowers for this issue. Since a cost effective option to address the environmental permitting issue associated with blowdown heat load is available, and common to all tower options, the need for and cost of this supplemental cooling alternative is not studied further here.

The need for such a system will depend on final permitting. It is recommended that the layout of makeup and blowdown include provisions (e.g., location for heat exchanger pad) to add this alternative at a future date.

6.6 Monthly Production

The various tower options will result in differences in production. The breakdown in net monthly production relative to the baseline option of the natural draft towers at 800,000 gpm flowrate is summarized in Tables 6-4 and 6-5 below:

Table 6-4: Projected Monthly Production Differences for 'Hot' Weather Year

Month	Baseline[1] (MW-hr Net)[5]	3xMDT[2] (ΔMW-hr)[5]	4xMDT[3] (ΔMW-hr)[5]	1xMDT[4] (ΔMW-hr)[5]
January	1,215,686	-4,118	-2,599	-6,447
February	1,099,528	-3,713	-2,334	-5,801
March	1,217,325	-4,451	-2,875	-6,736
April	1,177,967	-5,016	-3,399	-7,148
May	1,216,150	-5,834	-4,141	-8,231
June	1,175,651	-5,724	-4,084	-8,153
July	1,214,213	-5,956	-4,263	-8,518
August	1,214,831	-6,181	-4,488	-8,721
September	1,175,996	-5,799	-4,162	-8,185
October	1,216,918	-5,720	-4,029	-8,020
November	1,177,935	-4,711	-3,148	-6,969
December	1,217,306	-4,117	-2,584	-6,514

1) Baseline is for production using two natural draft towers per one EPR.
2) 3 x MDT – three rectangular mechanical draft towers per one EPR unit, twenty cells each, one 250 hp fan per cell.
3) 4 x MDT – circular mechanical draft towers per one EPR unit, twelve cells each, one 250 hp fan per cell.
4) 1 x MDT – one circular mechanical draft tower per one EPR unit, 11.6 MWe of fan power.
5) Monthly production, in net MW-hr accounts for auxiliary power loads and main power transformer losses of 60 MWe (excluding CW pumps and tower fans), and CW pump and tower fan power per Table 6-2.

Table 6-5: Projected Monthly Production Differences for 'Average' Weather Year

Month	Baseline[1] (MW-hr Net)[5]	3xMDT[2] (ΔMW-hr)[5]	4xMDT[3] (ΔMW-hr)[5]	1xMDT[4] (ΔMW-hr)[5]
January	1,215,700	-3,229	-1,859	-5,675
February	1,099,529	-3,001	-1,754	-5,237
March	1,217,331	-3,928	-2,437	-6,346
April	1,177,987	-4,669	-3,094	-6,859
May	1,216,973	-5,579	-3,880	-7,844
June	1,176,723	-5,730	-4,087	-8,085
July	1,215,283	-6,074	-4,378	-8,584
August	1,215,628	-6,169	-4,472	-8,667
September	1,176,922	-5,472	-3,834	-7,765
October	1,217,241	-5,276	-3,604	-7,498
November	1,178,045	-4,309	-2,791	-6,561
December	1,217,336	-3,630	-2,182	-6,020

1) Baseline is for production using two natural draft towers per one EPR.
2) 3 x MDT – three rectangular mechanical draft towers per one EPR unit, twenty cells each, one 250 hp fan per cell.
3) 4 x MDT – circular mechanical draft towers per one EPR unit, twelve cells each, one 250 hp fan per cell.
4) 1 x MDT – one circular mechanical draft tower per one EPR unit, 11.6 MWe of fan power.
5) Monthly production, in net MW-hr accounts for auxiliary power loads and main power transformer losses of 60 MWe (excluding CW pumps and tower fans), and CW pump and tower fan power per Table 6-2.

For Option 1b, the effect of reducing flow from 800 kgpm to 720 kgpm is documented in Table 6-6. The table displays the monthly production for each flow rate and the difference between the two.

Table 6-6: Monthly Production for Varying Flow (Option 1b 'Hot' Year)

Month	Case D1 800 kgpm (MWe-hr)	Case D1a 720 kgpm (MWe-hr)	Δ Production Case D1a Minus D1 (MWe-hr)
January	1,215,479	1,218,280	2,801
February	1,099,434	1,101,982	2,547
March	1,217,122	1,219,919	2,798
April	1,177,175	1,179,787	2,612
May	1,213,523	1,215,944	2,421
June	1,171,814	1,173,948	2,133
July	1,209,676	1,211,782	2,107
August	1,210,769	1,212,953	2,183
September	1,172,622	1,174,821	2,199
October	1,215,223	1,217,791	2,568
November	1,177,228	1,179,863	2,635
December	1,217,168	1,219,986	2,818

6.7 Comparison to Historical Projects

Fig. 6-5 below provides an indication of the sizing of the UniStar Nuclear EPR condenser and CW flow relative to historical nuclear projects. Overall, the condenser surface is larger than previous projects while the CW flow rate is on the low end of flows which were determined to be economical for those projects. These two items are related.

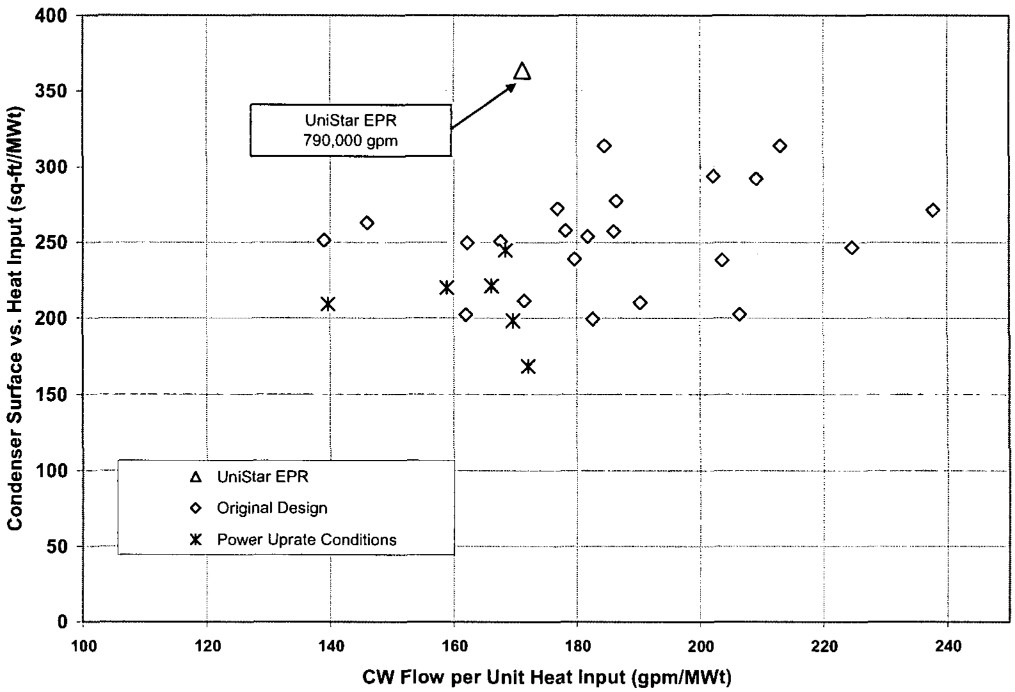


Fig. 6-5: Comparison of Heat Rejection Capability

7.0 SUMMARY AND CONCLUSIONS

7.1 Economic Comparison

7.1.1 Life Cycle Cost Comparison – One measure for cost comparison is the net present value of the life cycle cost for each option considering (a) procurement plus construction costs, (b) maintenance cost, and (c) accounting for differential production credits. The cooling tower performance evaluation in Section 6.2 demonstrated that the two-shell natural draft cooling tower (Option 1a) resulted in the largest yearly gross generation revenue for all options considered. However this is also the cooling tower option with the highest initial cost. A life cycle cost analysis is performed in Attachment E including a cost sensitivity analysis. The evaluation incorporates the initial tower cost and maintenance differences along with the generation revenue differences for the expected 60-year life of the plant for the options with an assumed 800,000 gpm of CW flow.

Results demonstrate that the option with the lowest life cycle cost is Option 1c, a single 16°F approach natural draft tower. The second most cost effective option is Option 1b, two 16°F approach natural draft towers. These results are fairly insensitive to the uncertainty in construction costs provided by the vendors. As discussed later, Option 1c is discounted due to risk factors and Option 1b is recommended.

7.1.2 Incremental Production Cost – Another measure for cost comparison is the cost of incremental KW_e output for the more costly options. Factoring in construction and maintenance costs, the total cost of each cooling tower option was determined in Attachment E. Comparing the difference in costs for each tower and the change in net plant output, the cost of effectively increasing net output was calculated. The cost per additional kilowatt is tabulated below compared to the lowest cost option. Option 1c is excluded from this analysis (see Section 7.5.4).

Table 7-1: Life-Cycle Cost per Installed (Net) KW_e

Option (-)	CT Type (-)	Life-Cycle Cost (NPV)† ($)	Difference from Lowest Cost Option ($)	Change in Net Plant Output (KW)	Cost per Incremental KW_e ($/KW)
2b	Rect. 2-MDT	$100,712,677	$0	0	N/A
3b	Round 3-MDT	$120,443,420	$19,730,743	1,556	$12,677
1b	Small 2-NDT	$125,876,890	$25,164,213	4,717	$5,335
2a	Rect. 3-MDT	$140,607,681	$39,895,004	256	$155,836
4	Lg. Round 1-MDT	$143,346,958	$42,634,281	-2,952	Negative
3a	Round 4-MDT	$151,020,366	$50,307,689	2,452	$20,516
1a	2-NDT	$173,726,890	$73,014,213	7,259	$10,058

(†) Installed cost plus net present value of lifetime maintenance.

The option with the lowest construction and maintenance cost is Option 2b. The option with the lowest incremental cost per KW_e produced is Option 1b. The cost of $5,335 per KW_e is of moderate value. None of the other options have reasonable incremental production costs, and therefore, by this measure are not optimal.

7.2 Optimal CW Flow

The effect of varying CW flow is illustrated in the following figures. Fig. 7-1 compares gross output for varying CW flow and temperatures. Fig. 7-2 compares net output (defined as gross less CW pumping power) for the same parameters.

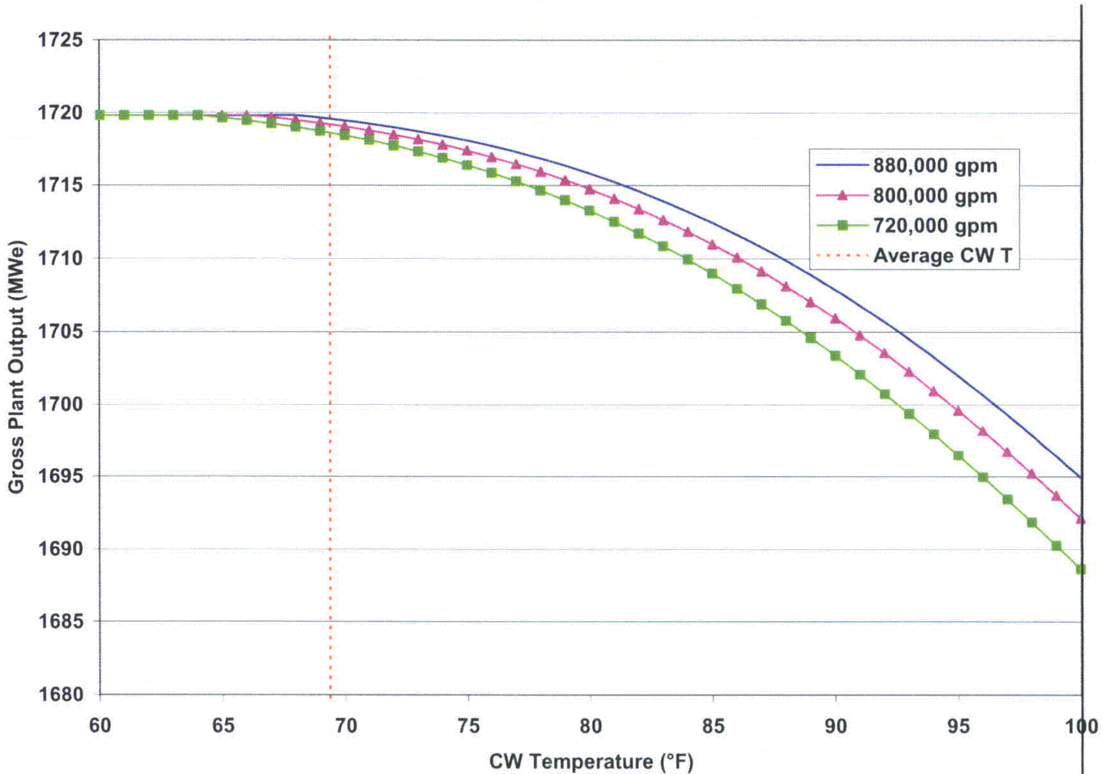


Fig. 7-1: Change in Gross Output for Varying CW Flow and Temperature.

At the hot year average CW temperature, 69.4°F, the change in gross output for variations in CW flow is minimal. This is reflected in the yearly average results from Table 6-2.

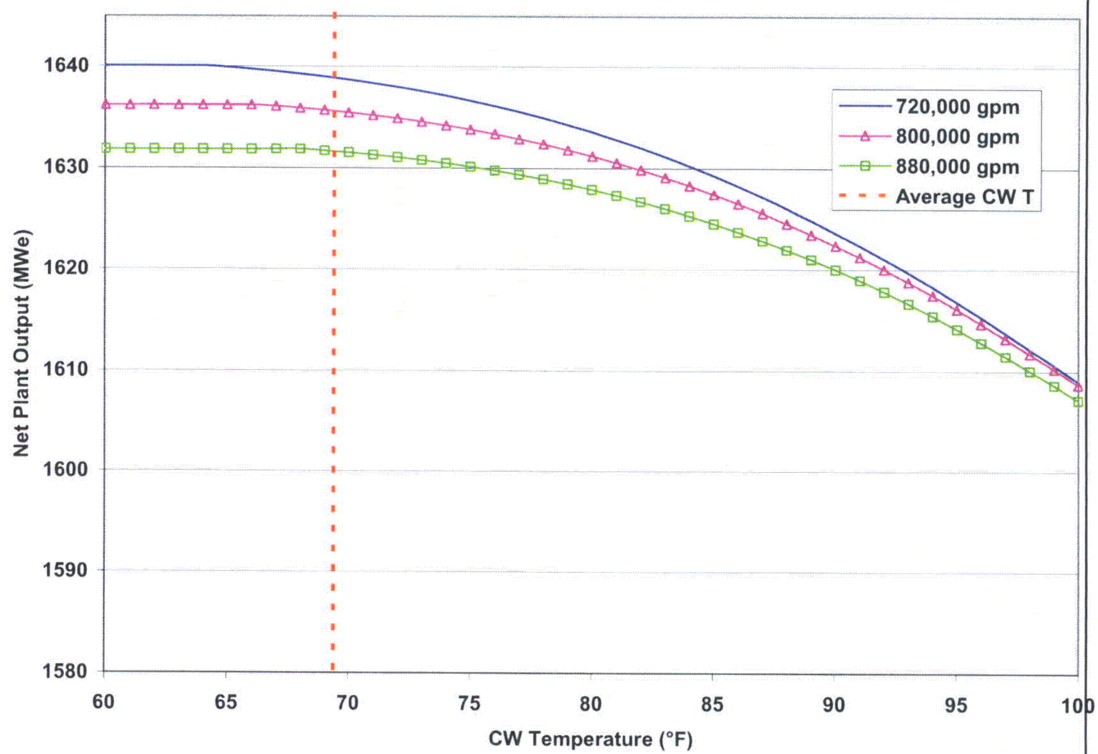


Fig. 7-2: Change in Net Output for Varying CW Flow and Temperature.

Changes in CW flow have a more significant impact on net plant output. The reduced pumping power from lower flows result in a gain of ~4 MWe at the hot year average temperature for a reduction of 10% flow. The reduction in gross output with reduced flow is overcome by the reduced pumping power requirements. This effect is also reflected in the results of Table 6-2.

In order to support a recommendation on CW flow rate, a direct comparison for the recommended cooling tower option of two 16°F approach natural draft cooling towers with varying flow rate is performed. Monthly production results in Table 6-6 demonstrate that year-round, the towers operating with 720 kgpm CW flow outperform the towers with the nominal CW flow rate. Table 7-2 presents a performance comparison between the two flow rates for Option 1b including the results from the life cycle cost analysis in Attachment E.

Table 7-2: Option 1b (2 Small NDT) 'Hot' Year Flow Comparison

Case	D1	D1a
CW Flow (gpm)	800,000	720,000
Average Gross Output (MWe)	1715.87	1715.43
Average Fan Power (MWe)	0	0
Average CW Pump Power (MWe)	23.58	19.74
Average Gross Output Less CW Pumping Power (MWe)(1)	1692.29	1695.70
Maximum CW Inlet Temperature (°F)	95.80	94.78
Max Condenser Backpressure – Average of Zones (in-Hg)	3.38	3.49
Estimated Max Condenser Backpressure – High Pressure Zone (in-Hg)	4.14	4.26
Generation Revenue (Δ$/yr)	Base	+$1,502,192
Life Cycle Cost (Case 1a as Base)(2) ($$10^3$)	$154,642	$118,297

(1) Note that the analysis accounts for tower performance as a function of CW flow.
(2) Includes accounting for engineering, procurement and construction, maintenance and revenue.

Based on the results of this comparison, it is recommended that Bell Bend operate using a flow rate of 720 kgpm of CW through two 16°F approach natural draft cooling towers.

7.3 Cooling Tower Footprint

The land usage of each tower arrangement, described below, accounts for the tower size and spacing requirements. Additional space may be needed to install pumps, controls and other secondary components. Fig. 7-3 shows the tower space requirements for each arrangement.

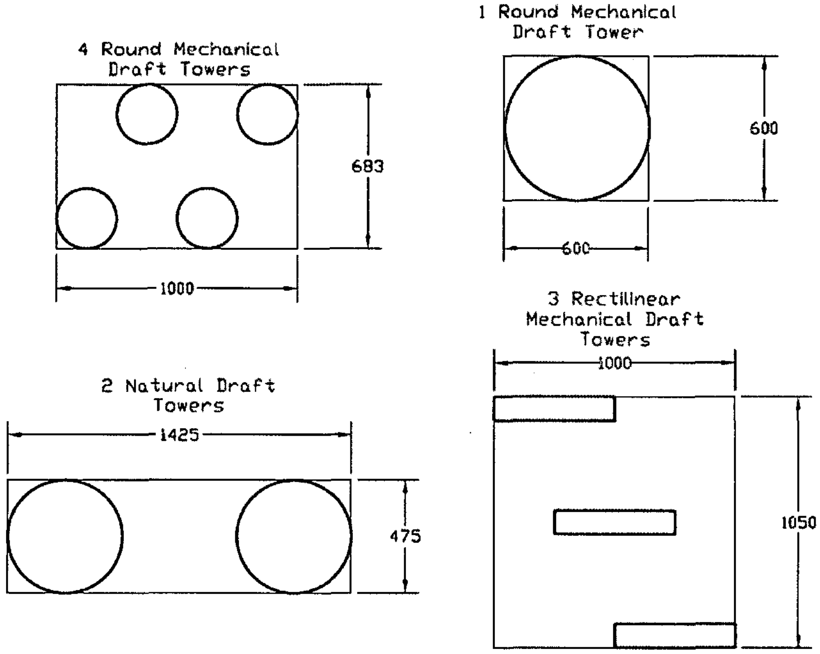


Fig. 7-3: Footprints of cooling tower arrangement options (lengths listed in feet).

Appendix F shows the placement of each cooling tower arrangement at the Bell Bend site. From this review, the three rectangular mechanical draft towers cannot be placed at the site with the correct orientation without encroaching on other areas not designated for cooling towers.

7.3.1 Expansion Capabilities – Expansion capabilities are mostly driven by the available space at a given site. Based on space requirements for the cooling towers, the smallest area would be required by Option 4 (8.3 acres), followed by Options 1a and 3a (15.5 and 15.7 acres) and finally Option 2a (24.1 acres). The 90°F approach temperature towers (Options 1b, 1c, 2b and 3b) have smaller footprints than their counterparts since less/smaller towers are used.

7.3.2 Standardization Considerations – Standardization of cooling tower design at different locations could show benefits in terms of possible cost savings based on multiple orders from the same cooling tower vendor. Additional benefits could come from having similar operating and maintenance procedures for all new EPR sites. Operator training could also be centralized and not be site specific. On the other hand, the construction time could be delayed if the similar tower orders are placed at the same time and if the construction schedule is dictated by the availability of materials and trained crew.

Natural Draft Towers - There may be significant benefits to standardization of natural draft towers across more than one site. These towers require large concrete forms which are custom built. Construction of more than one EPR unit of natural draft towers could accrue savings from standardization and lessons learned from sequential erection. Maintenance costs are a relatively small part of the total life cycle costs for this option and maintenance savings from standardization are considered to be a very minor consideration.

Mechanical Draft Towers - As for mechanical draft towers, based on recent S&L observations of erection and maintenance practices, it is believed that there is little benefit to standardization for this type of tower. In terms of tower procurement, the industry is considered to be highly competitive without substantial savings in terms of scale. Any specific EPR site will be a substantial order for any vendor without any real potential for savings in terms of standardization. Most tower components are supplied by subsuppliers (fans, fan stacks, fasteners, switchgear, motor control centers, fan motors, fill, etc.) and there are no particular benefits associated with scale when it comes to erection. Erection crews are rotated from job to job within the industry and erection is simple and straightforward.

Mechanical draft tower maintenance is relatively straightforward (e.g., nozzle inspection and cleaning, fan leading edge inspection and repair, epoxy-coal tar re-coating, fiberglass pipe inspection and repair, fan motor oil check). It is unlikely that rotation of a single maintenance crew across widespread facilities will accrue cost savings in maintenance. While there are only a few what may be considered 'major' tower vendors, there are many suppliers of tower components within the industry (fans, stacks, fill, fan motors, gear boxes, nozzles, etc.). In ten to twenty years, when equipment requires replacement, it is unlikely that having tower standardization will be of any great benefit in terms of tower rebuilds.

7.4 Cooling Tower Makeup and Blowdown

7.4.1 Blowdown Temperature – As described in Section 6.5, a makeup / blowdown system designed to cool blowdown as necessary using makeup in a plate and frame heat exchanger is considered to be a cost effective option to reliably maintain blowdown temperatures within environmental limits. This approach would eliminate constraints on main tower performance and avoid unit downpowers for this issue. Since a cost effective option to address the environmental permitting issue associated with blowdown heat load is available and common to all options, the need for and cost of this supplemental cooling option is not studied further here.

The need for such a system will depend on tower sizing and final permitting. It is recommended that the layout of makeup and blowdown include provisions (e.g., location for heat exchanger pad) to add this option at a future date.

7.4.2 Makeup and Blowdown Flow – The range of makeup and blowdown required are summarized in Table 7-3 below. The cycles of concentration required is expected to fall within this range which will dictate the exact makeup and blowdown requirements. Since all towers provide the same amount of cooling, the same evaporation to provide the cooling is required. The drift losses for the different options is also expected to be the same. Therefore, the makeup and blowdown requirements are the same for all cooling tower options.

Table 7-3: Makeup and Blowdown Required for Cooling Tower Operation

Cycles of Concentration (-)	Total Estimated Drift (gpm)	Total Estimated Evaporation (gpm)	Total Estimated Blowdown (gpm)	Total Estimated Makeup (gpm)
3	8	15,872	7,928	23,808
5	8	15,872	3,960	19,840

7.5 Summary and Recommendations

7.5.1 Cooling Tower Recommendation – Based on an evaluation of economics, siting and risk, it is recommended that Bell Bend install two natural draft towers with a 16°F approach temperature (Option 1b). The life-cycle cost analysis determined that the increased capital costs involved in installing natural draft towers were offset by the increased net electricity generated.

Although it has been many years since natural draft towers have been constructed in the United States, construction has been ongoing in Europe. Therefore, vendor experience in natural draft tower erection is current and performance predictions are expected to be accurate. Cost estimation, however, is laden with uncertainty due to the non-linear translation of costs from Europe to the US. The cost sensitivity analysis determined that the uncertainty did not significantly impact life cycle cost analysis.

7.5.2 Optimal CW Flow – The CW flow at the lower end of the assumed range, or 720,000 gpm resulted in the highest net generation with 800,000 gpm close behind. The 720,000 gpm target flow also has the lowest initial capital cost since CW pumps, CW pump motors, CW piping, CW valves, auxiliary electrical power infrastructure, and civil structures associated with these components are smaller and lower cost for this flow. It is recommended that Bell Bend specify a design CW flow of 720,000 gpm for optimal performance.

7.5.3 Cooling Tower Specifications – Per preliminary design information, the recommended tower design will consist of two natural draft towers with basin diameters of 350 ft, tower diameters of 222 ft and heights of 475 ft. The towers will be sited per Attachment F with spacing of 350 ft or 1 diameter.

7.5.4 Option 1c: Single Natural Draft Tower – Cost analyses determined that Option 1c is the most cost effective option. GEA has provided an estimate for a single natural draft tower capable with an approach of 16°F at 800,000 gpm. Although on paper, this seems like the best option, the risks involved would be greater than for two nominally sized towers. The GEA tower is significantly larger than typical natural draft towers in both height and diameter. Because of the unusual size of this tower, the performance is not as proven, and there is greater risk involved in its construction. A more detailed inquiry into this option should be performed if it is pursued as a cooling solution for Bell Bend.

7.5.5 Blowdown Cooling – A makeup / blowdown system designed to cool blowdown using makeup in a plate and frame heat exchanger is considered to be a cost effective option to reliably maintain blowdown temperatures within environmental limits. Using the recommended towers with a 16°F approach, downpowers could easily become an issue on hot summer days. The addition of this heat exchanger would help avoid costly downpowers during times when electricity prices are highest.

7.6 Disclaimers and Cautions

In using this study for future work and design decisions, the following cautions are offered:

(1)	Economic Evaluation - Economic analysis is based on a simple approach to discounting future electricity revenues and maintenance and refurbishment cost differences. This analysis does not consider AFUDC, construction schedules, overall project budgets, corporate capital requirements, and many other items found in a more sophisticated analysis.
(2)	Installed Tower Cost Differences - Estimates for installed tower costs are not based on site specific layouts and piping runs.
(3)	Tower Performance Degradation - Degradation of tower performance is not accounted for in the projected production figures. Based on discussions with leading industry cooling tower experts, modern low fouling film fill is expected to retain performance over many years.
(4)	Extreme Pricing on Hot Summer Days - Net production benefit may not reflect extreme pricing (beyond that for the year 2006) on hot summer days. The economic analysis is not as sensitive for electricity pricing for high demand winter periods since the backpressure penalty on production is not as severe for the associated winter weather.
(5)	Design CW Flow - The design point for the condenser and towers is 800,000 gpm (nominal flow). The indicated optimal flow is at the low end of the range (i.e., 720,000 gpm). However, the study did not examine decreased condenser surface area.

FINAL PAGE OF SECTION

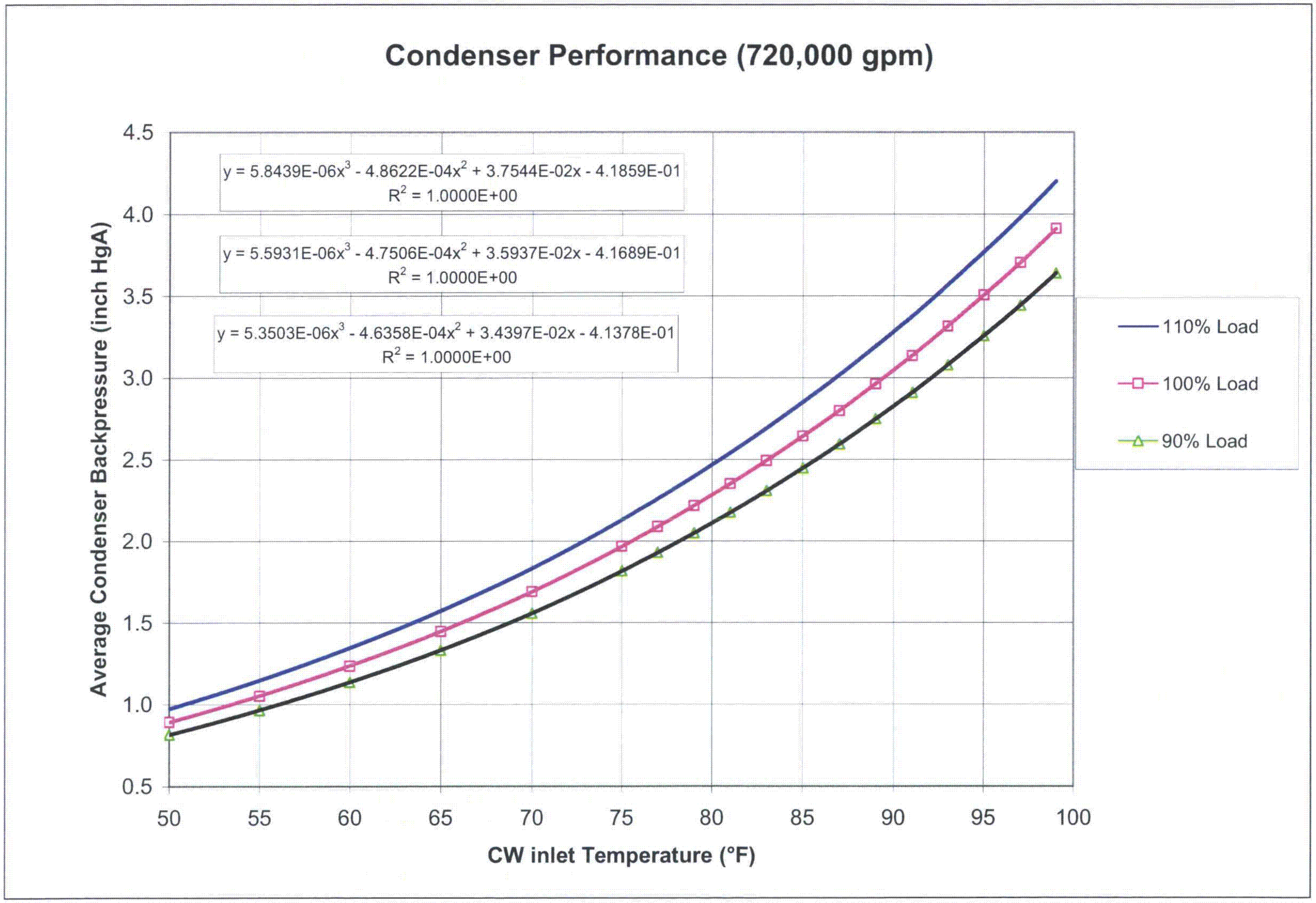
ATTACHMENT A

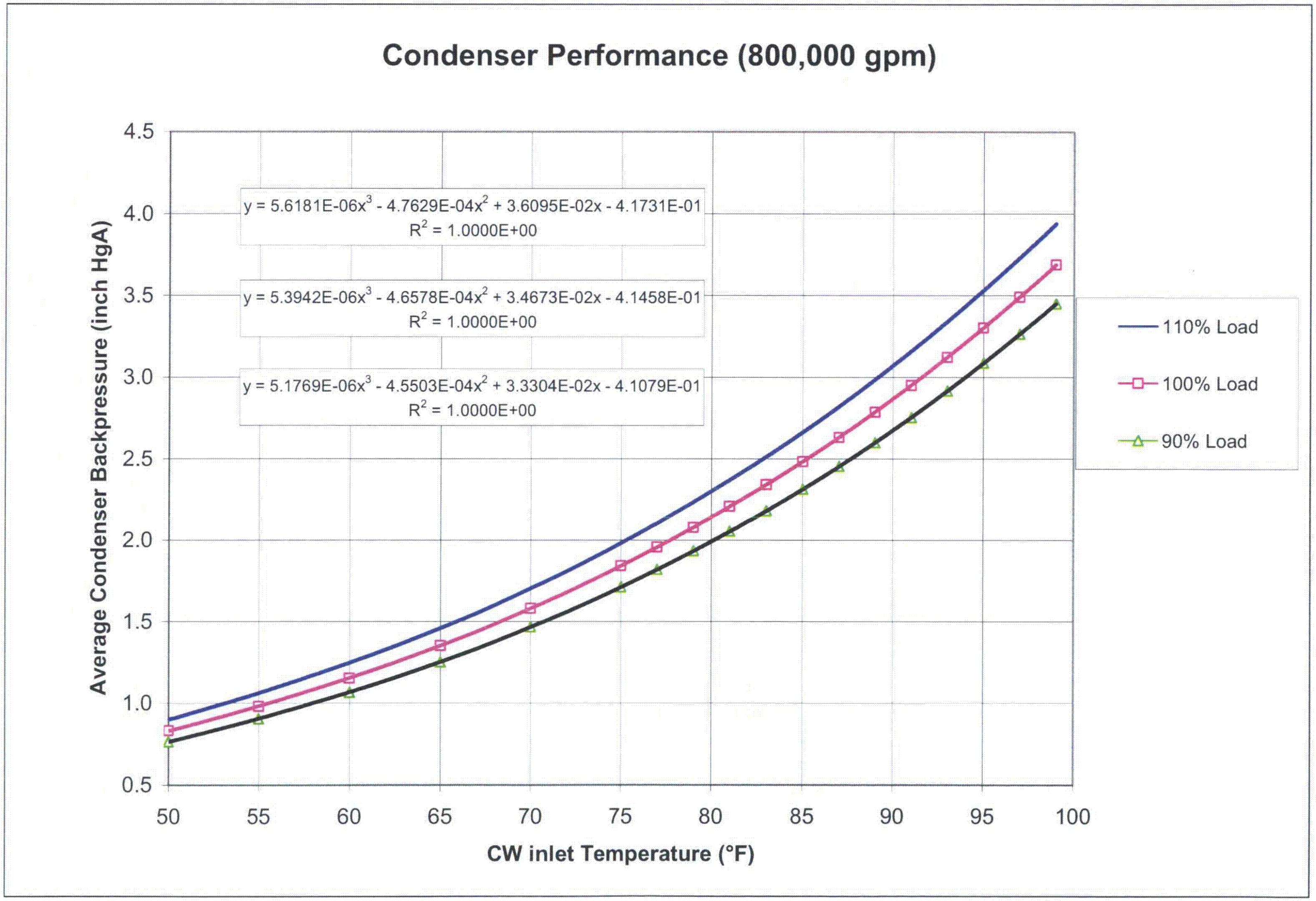
CONDENSER DATA	**LP Zone**	**IP Zone**	**HP Zone**	
Tube material	**Titanium**	**Titanium**	**Titanium**	
Tube outside diameter (Dt)	**1.000**	**1.000**	**1.000**	in
Tube gage	**25**	**25**	**25**	BWG
Tube wall thickness (Tt)	**0.020**	**0.020**	**0.020**	in
Number of waterboxes (Nb)	**2**	**2**	**2**	
Number of passes per waterbox (Np)	**1**	**1**	**1**	
Total Number of tubes (Ntt)	**42,690**	**42,690**	**42,690**	
Number of tubes per pass in each waterbox (Nt)	21345	21345	21345	
Active tube length per pass (L)	50.67	50.11	49.41	ft
Design flow rate to the condenser (Qp)	**790,000**	**790,000**	**790,000**	gpm
Cooling water inlet temp (T1)	**85**	**93.40**	**101.79**	F
Heat transfered by condenser (Q) - Design	**3,312,171,440**	**3,302,195,020**	**3,362,053,540**	Btu/hr
Heat transfered by shell (%) of total	**33.2%**	**33.1%**	**33.7%**	

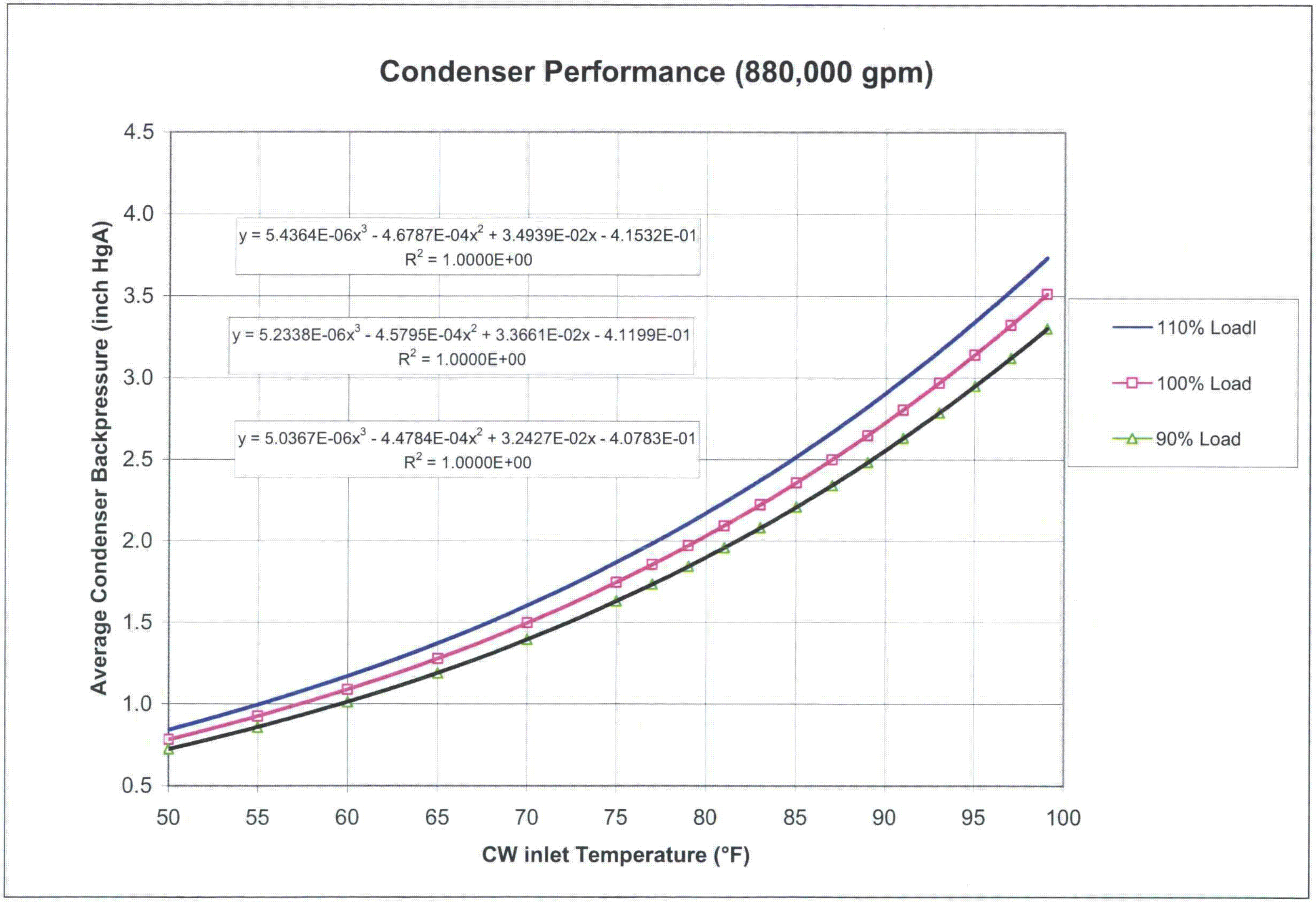
Condenser Design Parameters				
Tube size factor - Page 4 (J)	**263**	**263**	**263**	
Tube cleanliness correction factor - Ref. 8.5 (Cc)	1.000	0.890	0.815	
CW inlet temp correction factor - Curve 2 (Ct)	**1.062**	**1.083**	**1.106**	
Tube material correction factor - Table 2 (Cm)	**0.880**	**0.880**	**0.880**	
Tube geometry constant - Table 1 (K)	**0.1109**	**0.1109**	**0.1109**	

Other Parameters				
Water density (d)	**62.17**	**62.08**	**61.97**	lbm/ft^3

Calculations				
Tube velocity (Vt)	8.2099	8.2099	8.2099	ft/sec
Effectiveness exponent (X)	0.9640	0.8653	0.7976	
Effectiveness (a)	0.6186	0.5791	0.5496	
Cooling water mass flow (Wc)	109526	109362	109178	lbm/sec
CW Temperature rise (Tr)	8.40	8.39	8.55	F
Cooling water outlet temp	93.40	101.79	110.34	F
Initial Temperature Difference (ITD)	13.58	14.48	15.56	F
Saturation temperature (Ts)	98.58	107.88	117.35	F
Condenser Pressure at Ts	***1.85***	***2.44***	***3.20***	***in Hg***

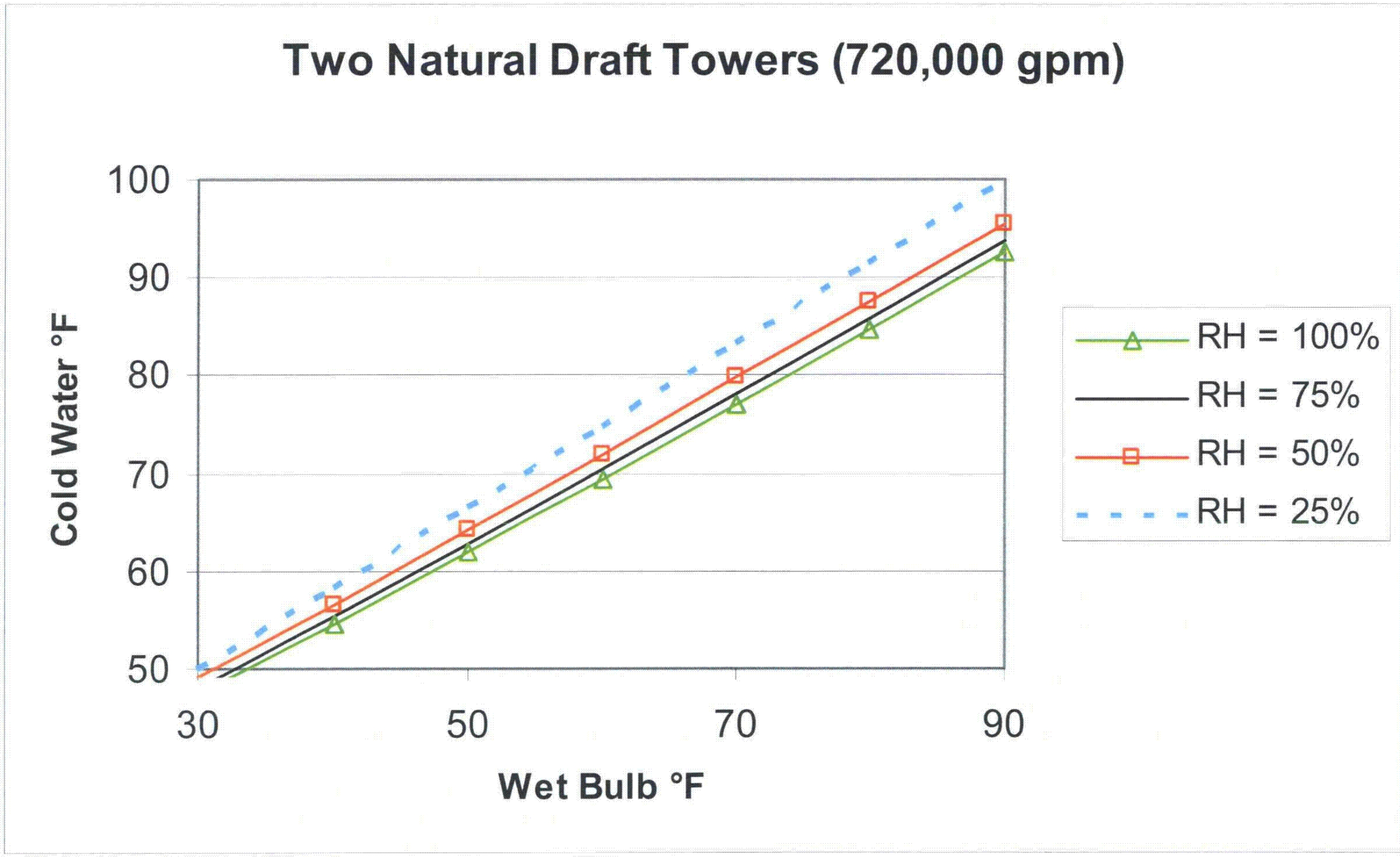

Condenser Performance (720,000 gpm)
y = 5.8439E-06x^3 - 4.8622E-04x^2 + 3.7544E-02x - 4.1859E-01
R^2 = 1.0000E+00
y = 5.5931E-06x^3 - 4.7506E-04x^2 + 3.5937E-02x - 4.1689E-01
R^2 = 1.0000E+00
y = 5.3503E-06x^3 - 4.6358E-04x^2 + 3.4397E-02x - 4.1378E-01
R^2 = 1.0000E+00
Average Condenser Backpressure (inch HgA)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
50
55
60
65
70
75
80
85
90
95
100
CW inlet Temperature (°F)
110% Load
100% Load
90% Load

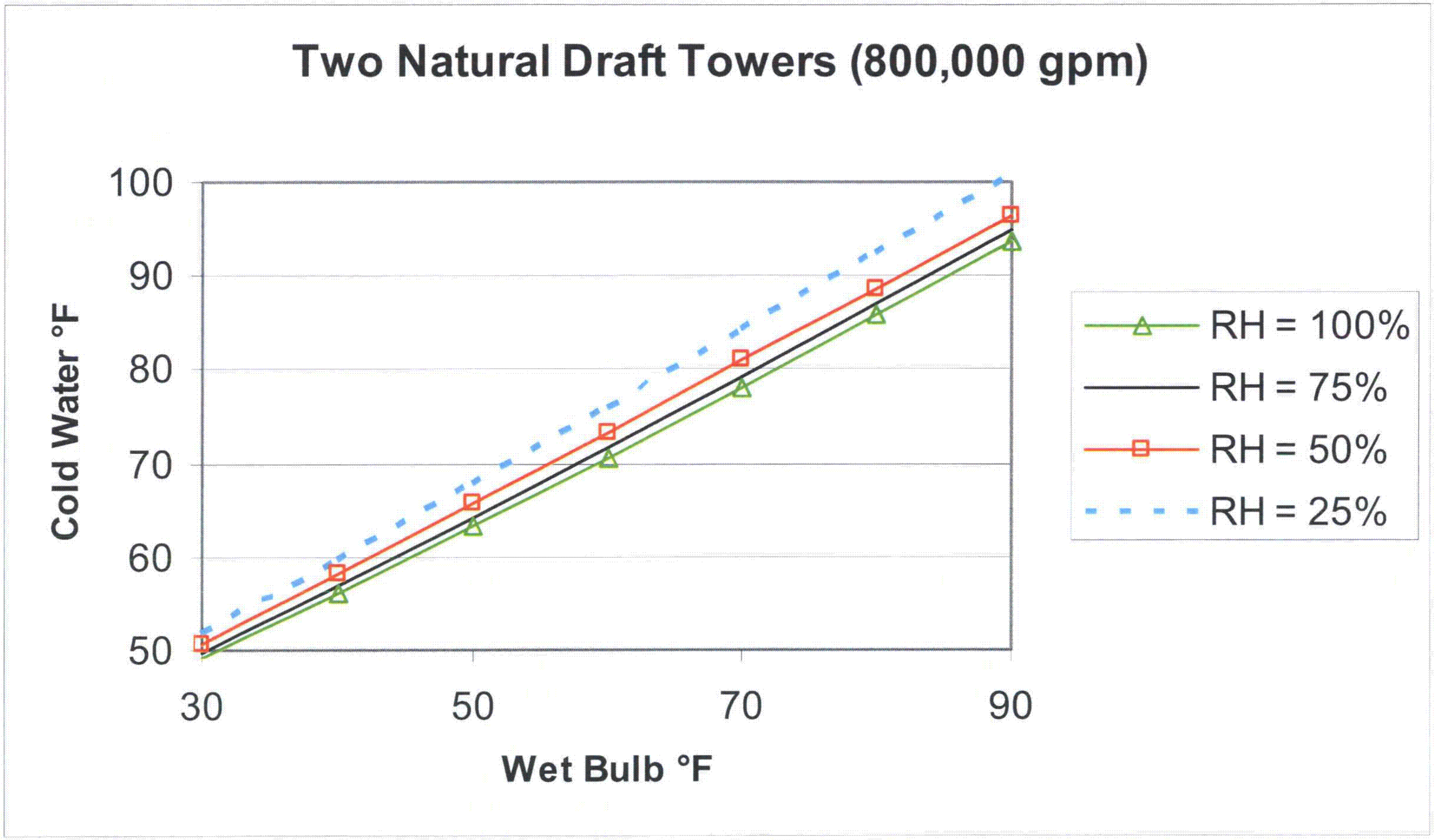

Condenser Performance (800,000 gpm)
y = 5.6181E-06x3 - 4.7629E-04x2 + 3.6095E-02x - 4.1731E-01
R2 = 1.0000E+00
y = 5.3942E-06x3 - 4.6578E-04x2 + 3.4673E-02x - 4.1458E-01
R2 = 1.0000E+00
y = 5.1769E-06x3 - 4.5503E-04x2 + 3.3304E-02x - 4.1079E-01
R2 = 1.0000E+00
110% Load
100% Load
90% Load
Average Condenser Backpressure (inch HgA)
CW inlet Temperature (°F)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
50
55
60
65
70
75
80
85
90
95
100

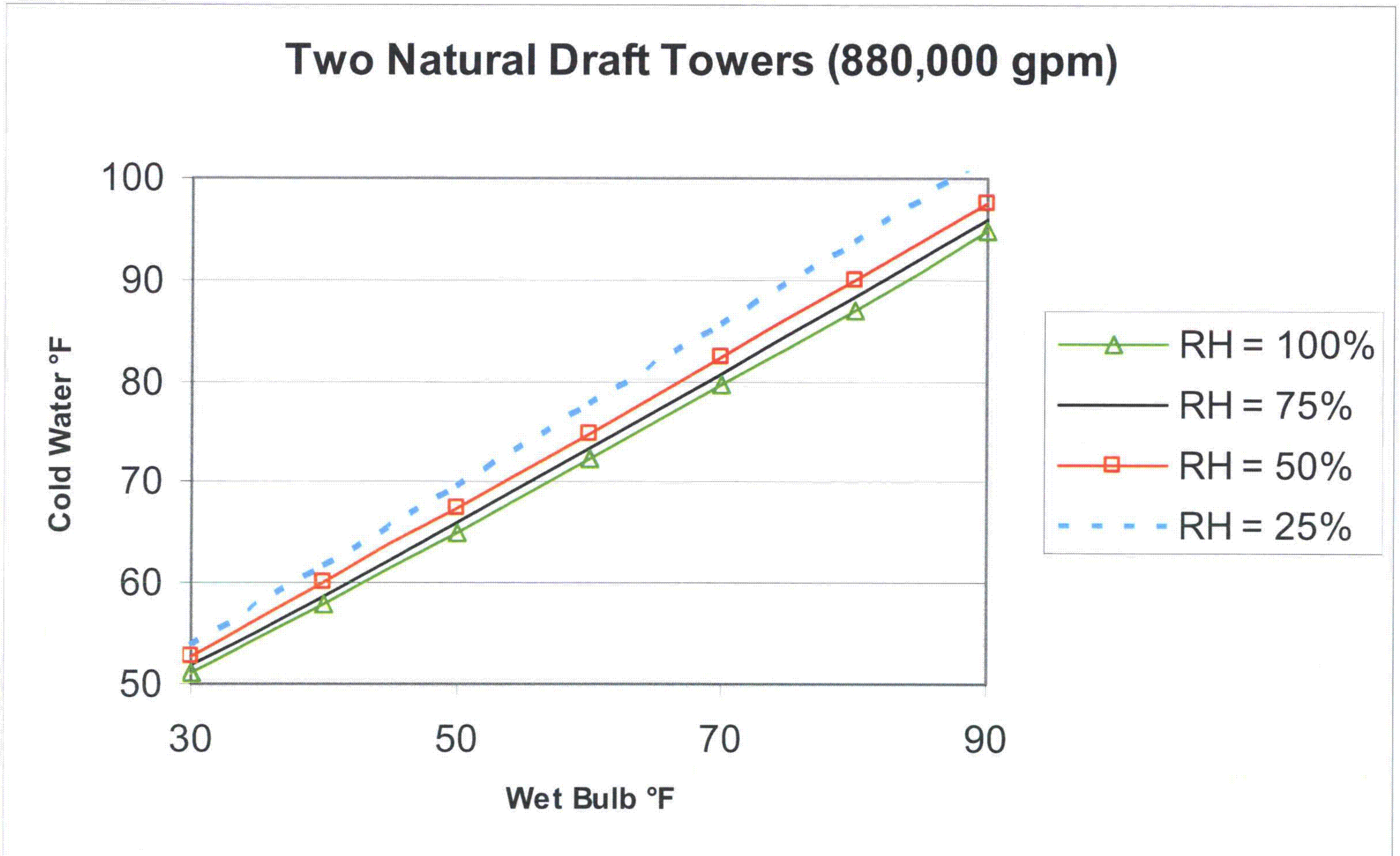


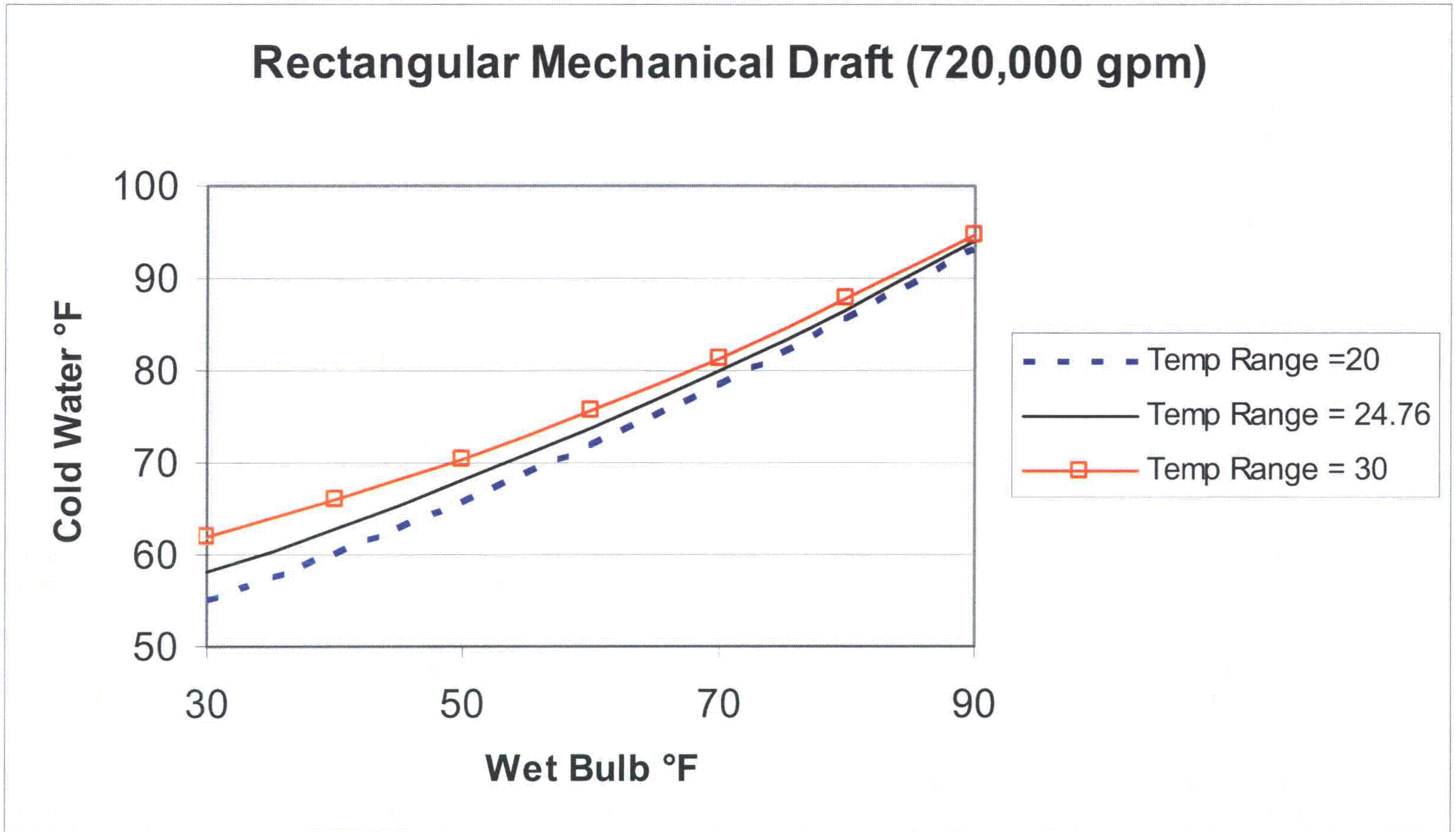
FINAL PAGE OF SECTION

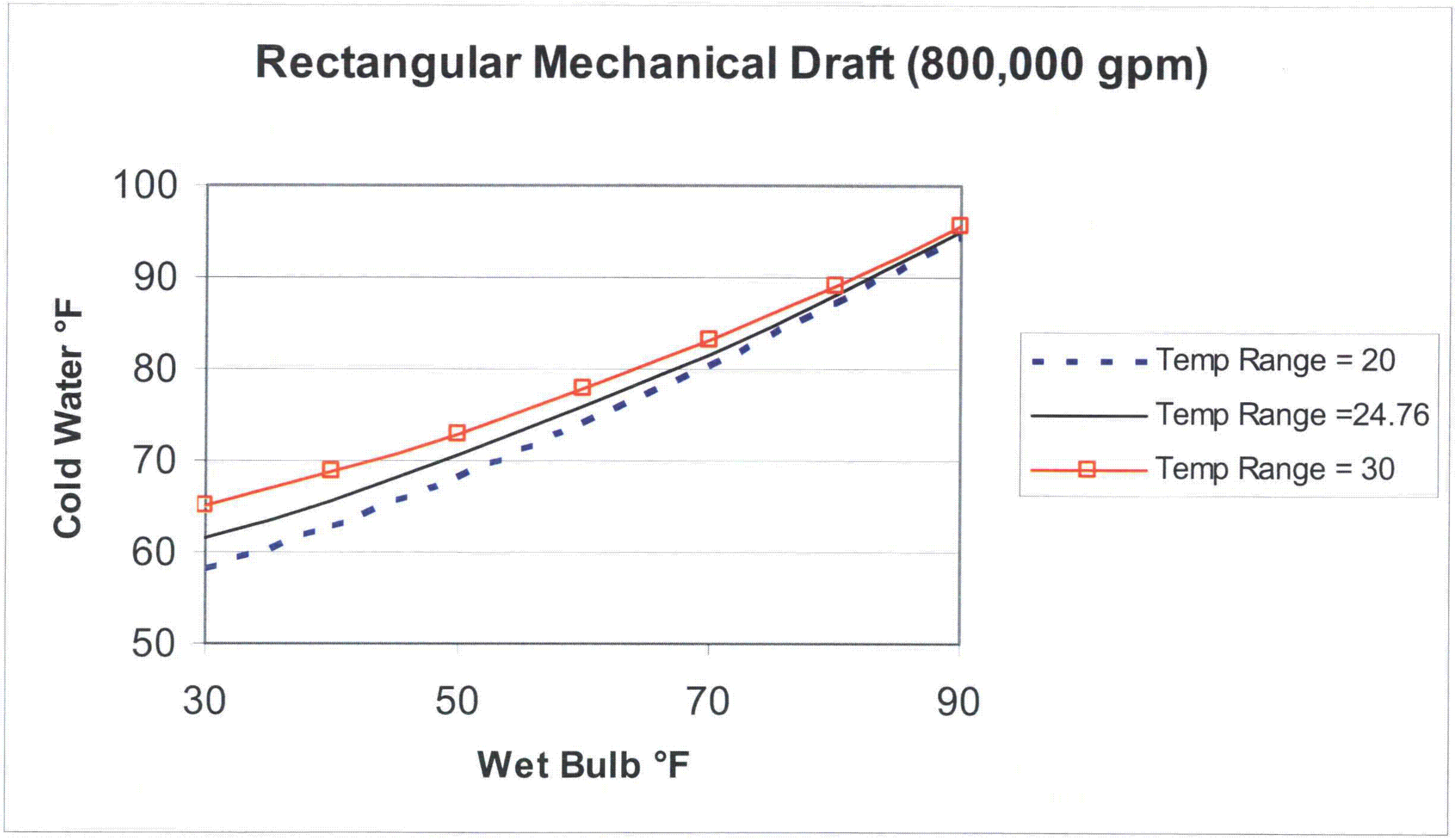
ATTACHMENT B

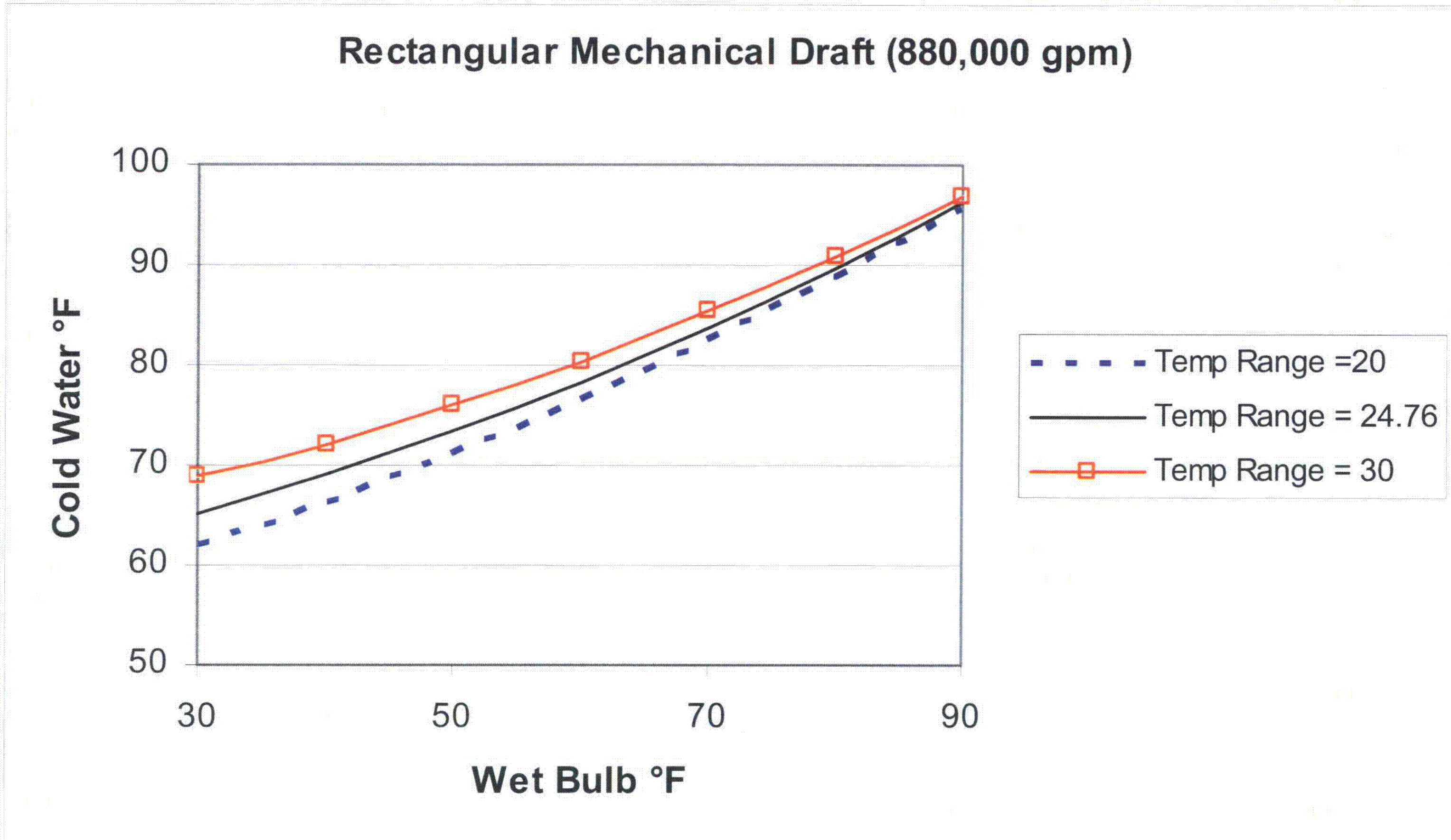


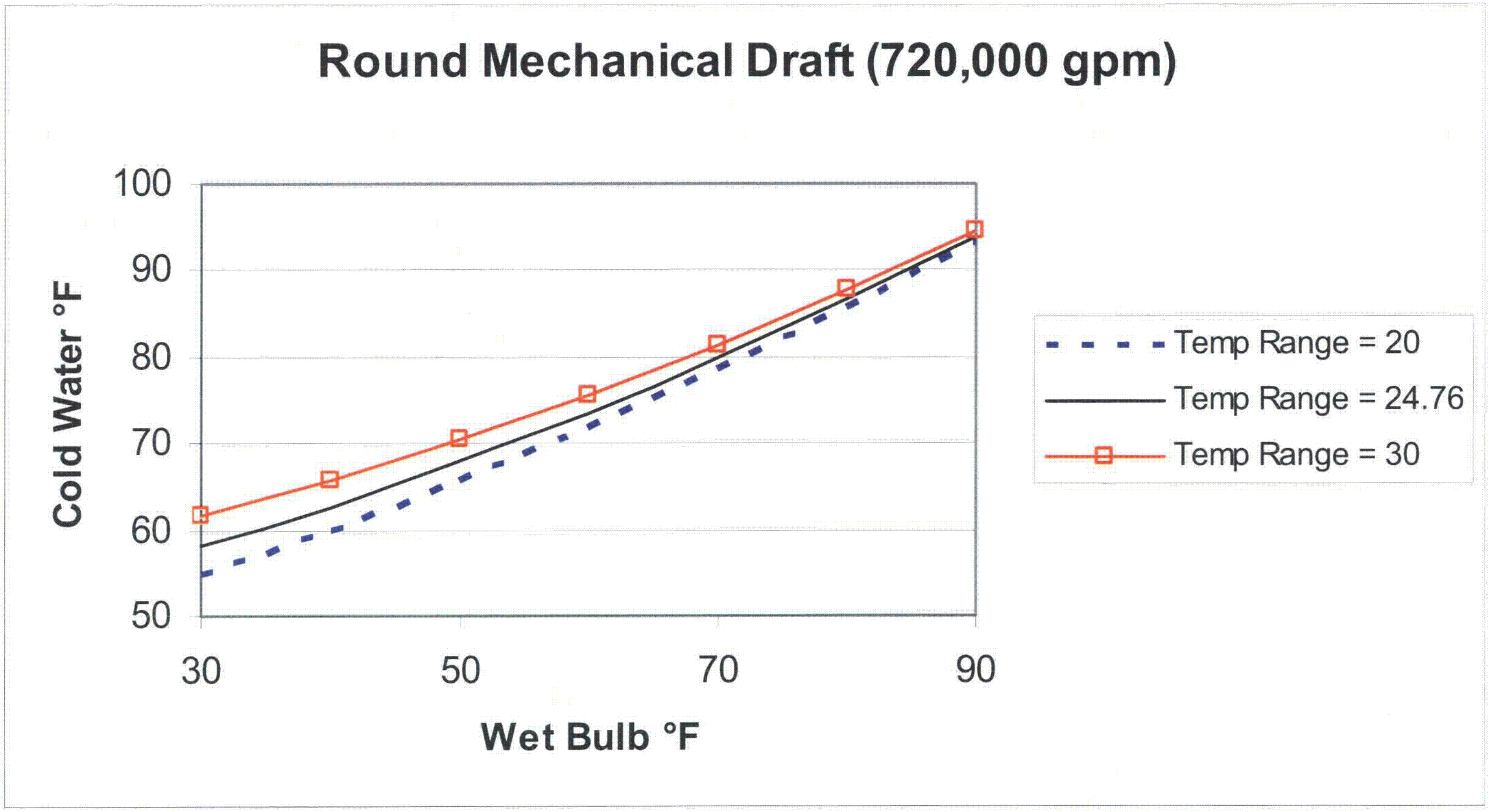

Two Natural Draft Towers (800,000 gpm)
Cold Water °F
100
90
80
70
60
50
30
50
70
90
Wet Bulb °F
RH = 100%
RH = 75%
RH = 50%
RH = 25%

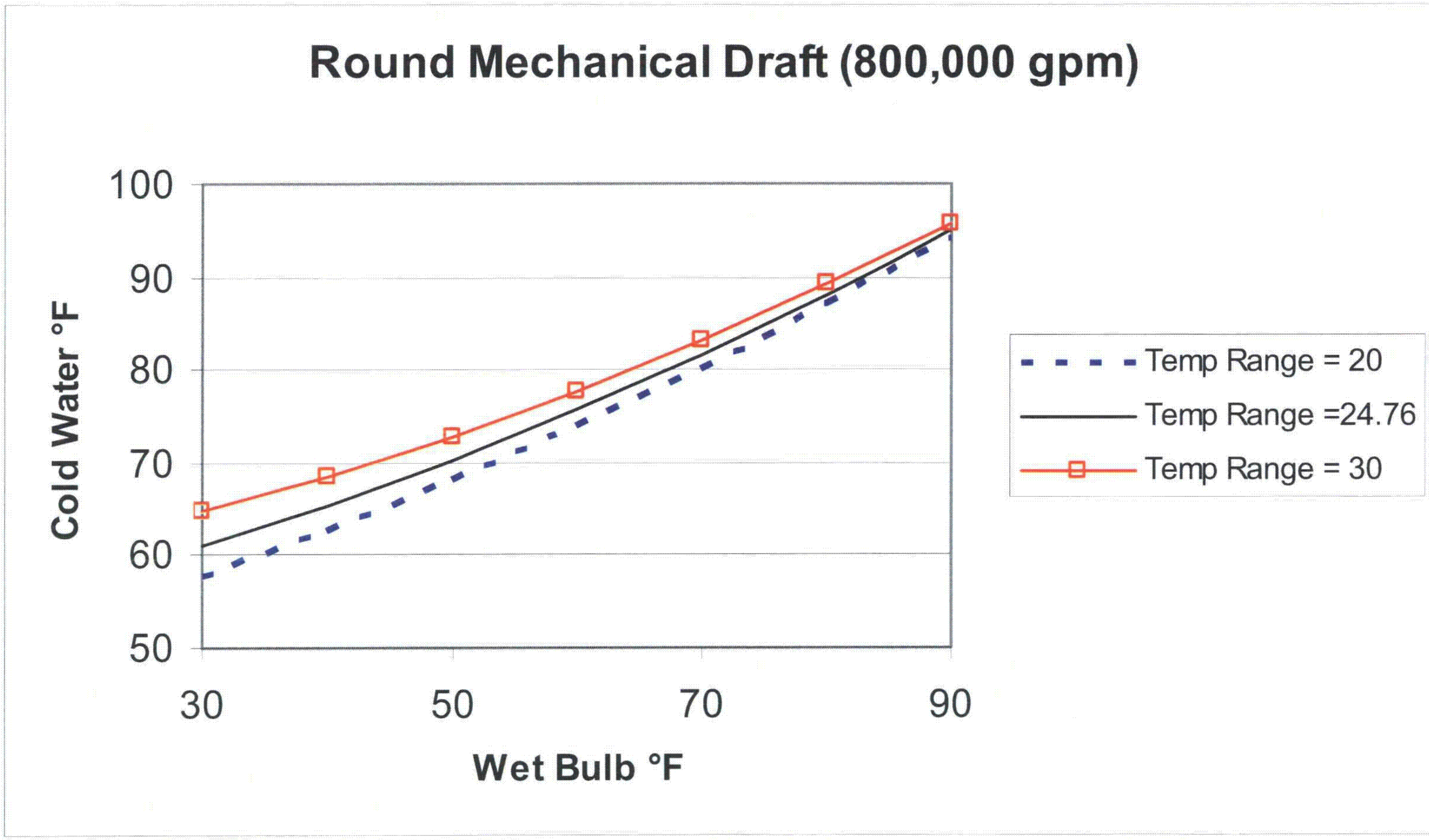

Two Natural Draft Towers (880,000 gpm)
100
90
80
70
60
50
Cold Water °F
30
50
70
90
Wet Bulb °F
RH = 100%
RH = 75%
RH = 50%
RH = 25%

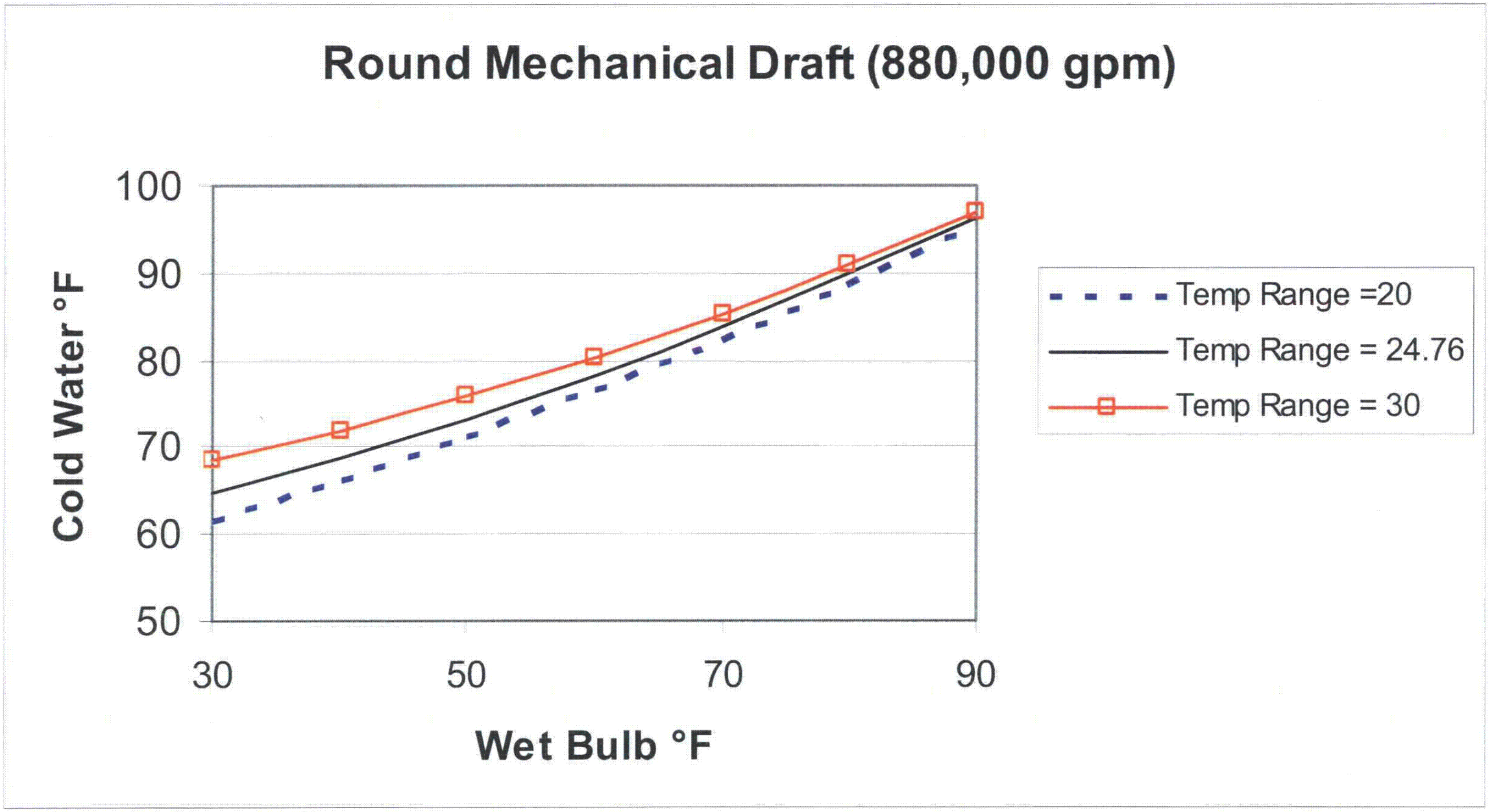

Rectangular Mechanical Draft (720,000 gpm)
100
90
80
70
60
50
Cold Water °F
30
50
70
90
Wet Bulb °F
Temp Range =20
Temp Range = 24.76
Temp Range = 30

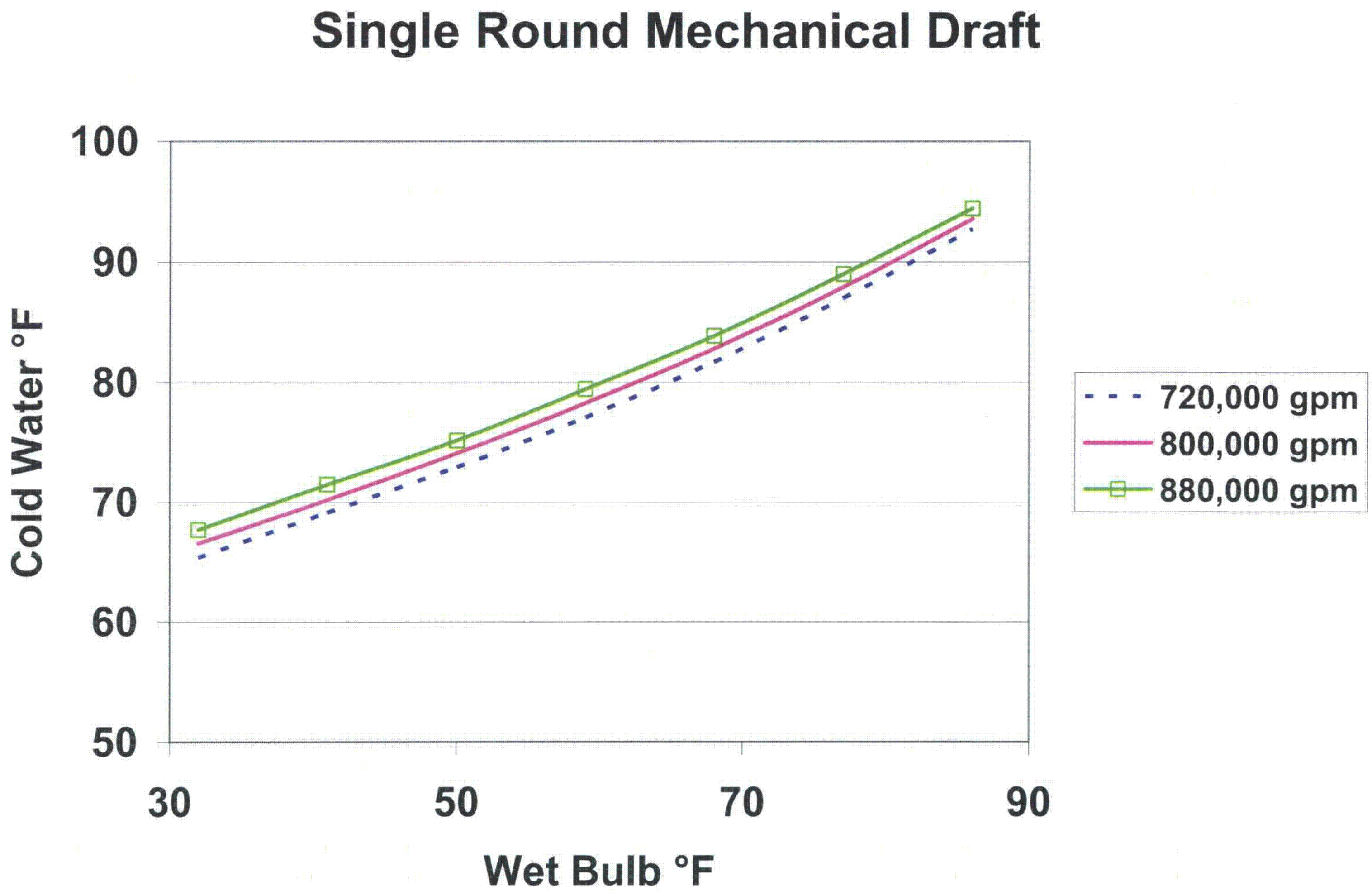

Rectangular Mechanical Draft (800,000 gpm)
Cold Water °F
100
90
80
70
60
50
30
50
70
90
Wet Bulb °F
Temp Range = 20
Temp Range =24.76
Temp Range = 30


Rectangular Mechanical Draft (880,000 gpm)
Cold Water °F
100
90
80
70
60
50
30
50
70
90
Wet Bulb °F
Temp Range =20
Temp Range = 24.76
Temp Range = 30


Round Mechanical Draft (720,000 gpm)
Cold Water °F
100
90
80
70
60
50
30
50
70
90
Wet Bulb °F
Temp Range = 20
Temp Range = 24.76
Temp Range = 30


Round Mechanical Draft (800,000 gpm)
100
90
80
70
60
50
Cold Water °F
30
50
70
90
Wet Bulb °F
Temp Range = 20
Temp Range =24.76
Temp Range = 30


Round Mechanical Draft (880,000 gpm)
Cold Water °F
Wet Bulb °F
100
90
80
70
60
50
30
50
70
90
Temp Range =20
Temp Range = 24.76
Temp Range = 30



FINAL PAGE OF SECTION

ATTACHMENT C

Task description

Two sequential hourly meteorological data sets were required for input to the project cooling system performance analysis for the Susquehanna Steam Electric Station ("Station"), near Berwick, Pennsylvania. This document describes those data sets and methods used for their creation.

Step 1: Identify representative meteorological station

The first step was to identify a representative meteorological station. Figure 1 shows the region around the Station. The site is located approximately seven miles northeast of Berwick, PA at an elevation of approximately 700 ft MSL along the Susquehanna River. The Susquehanna cuts a roughly northeast-southwest course in the region, following the general orientation of the Appalachians. The climate of the region is continental with warm summers (Trewartha 1961). The closest National Weather Service (NWS) climatological station with a long-term and sufficiently detailed monitoring record for this analysis is located at the Wilkes-Barre/Scranton, Pennsylvania airport (station KAVP, station ID #725130). The airport is located approximately 17 miles northeast of the Station near the Susquehanna River at an elevation of 953 ft. We expect temperature and humidity climate statistics from Wilkes-Barre/Scranton to be representative of those at the Station, due to their close proximity, location near the Susquehanna River, and co-location within the same climate zone.

Step 2: Create a "warmest year" meteorological data set based on historical wet-bulb temperatures.

The hourly meteorological data for Wilkes-Barre/Scranton were purchased in digital form from the National Climatological Data Center (NCDC 2007). Meteorological data were available from 1949-2006. Those data were first checked for missing and out-of-range values before being processed. Hourly data with missing dry-bulb temperature and/or dew point readings were excluded from subsequent analysis. Approximately 0.5% of the available hourly readings had missing or out-of-range values[1].

The next step was to create a data set containing a "warmest year" of wet-bulb temperatures[2]. The approach we selected was to create a synthetic warmest year by integrating a set of 12

[1] 475,424 weather records were available for the period. 472,869 records had valid data, producing an initial missing data percentage of approximately 0.5%.

[2] The hourly Wilkes-Barre digital meteorological data archive did not include complete hourly station pressure data. However, per the mathematical properties of the wet-bulb temperature equations (Iribarne and Godson, 1981; pgs. 75, 125), the wet-bulb temperature is insensitive to variations in station pressure at typical values of surface atmospheric pressure. Therefore, in lieu

whole, intact months from the weather observation database. The process developed to produce the warmest year is described below.

Step 2a: Compute the wet-bulb temperature from recorded temperature and dew point for each complete hourly weather observation.

Step 2b: Using the hourly wet-bulb temperature data from (2a), compute an average wet-bulb temperature for each available month from January 1949 to December 2006. Steps 2a and 2b were performed with a short FORTRAN program developed specifically for this purpose.

Step 2c: To ensure that monthly average wet-bulb temperatures in Step 2a were not unintentionally skewed by insufficient sample size, months in which 10% or more of the data were missing were excluded from further analysis. This is consistent with standard meteorological practice when evaluating meteorological data sets (USEPA 2000) and relatively few months were affected. The resulting data record contained 591 months (approximately 49 years) of meteorological data, which was a sufficiently long period of record to represent climatic conditions.

Step 2d: Using the monthly average wet-bulb temperatures remaining from (2c), identify the month with the highest monthly average wet-bulb temperature for each month in the calendar year. An Excel spreadsheet was developed for this purpose. For example January 1950 had the highest average monthly wet-bulb temperature (33.30 F) of all of the available January monthly average wet bulb temperatures. Similarly, February 1984 had the highest average monthly wet-bulb temperature (32.79 F) of all of the available February monthly averages. The result of this step was a list of 12 months with the highest average wet-bulb temperatures (Table 1).

Step 2e: The hourly meteorological data for the 12 months in Table 1 were composited into a single spreadsheet representing the "warmest year"[3].

Step 2f: The hourly meteorological data in step 2e were checked for missing data. Gaps in the data were scattered throughout the files and were generally 1-2 hours long. Missing data were linearly interpolated in an Excel spreadsheet. The resulting spreadsheet contained hourly dry-bulb temperature, wet-bulb temperature, dew point and humidity values. The specifications of the spreadsheet are listed in Table 2.

of hourly station pressure data, the published long-term average station pressure from Wilkes-Barre (29.01 in. Hg., from NCDC 2006) was used in the wet-bulb temperature computations. (Iribarne and Godson, 1981; pg. 75). The use of average station pressure had a negligible impact on the computed historical wet-bulb temperatures.

[3]Some programs that use meteorological data are unable to process data unless each data record has the same year stamp. Anticipating this situation, the year stamp was set to the same year as the original January data in each file. Therefore, the year stamp was set to 1956 in the synthetic data set representing the average year and 1950 in the data set representing the warmest year.

Step 3: Create an "average year" meteorological data set based on historical wet-bulb temperatures.

The last step was to create a data set containing an "average year" of wet-bulb temperatures. The approach we selected was to create a synthetic average year by integrating a set of 12 whole, intact months from the weather observation database. The process developed to produce this data set is described below.

Step 3a. Compute an average monthly mean wet-bulb temperature for each calendar month from the individual monthly averages in steps 2b and 2c. For example the average January wet-bulb temperature produced from all the individual January monthly averages was 23.81 F. Similarly, the average February wet-bulb temperature computed from the individual February monthly averages was 25.31 F. The result was 12 average monthly wet-bulb temperature values that are listed in the second column of Table 3.

Step 3b. Using the average monthly mean wet-bulb temperature from (3a), identify the month with the individual average wet-bulb temperature that was closest to the average monthly mean wet-bulb for that month. For example January 1956 had an average wet bulb temperature that was closest to the monthly average wet-bulb temperature for all of the January values (23.81 F). The absolute difference between the average monthly wet-bulb temperature for January 1956 and the monthly average wet-bulb temperature for all of the January values (23.81 F) was 0.19 F. Similarly, February 1979 had an average monthly wet bulb that was closest to the monthly average wet-bulb temperature for all of the February values (25.31 F). The absolute difference between the average monthly wet-bulb temperature for February 1979 and the monthly average wet-bulb temperature for all of the February values (25.31 F) was 0.33 F. The result of this step was a list of 12 months with individual average wet-bulb temperatures that were closest to the average wet-bulb for each month of the calendar year. This list is shown in the 4th column of Table 3. Hourly meteorological data for the 12 months listed in Table 3 were composited into a single spreadsheet representing the "average year". The resulting spreadsheet contained hourly dry-bulb temperature, wet-bulb temperature, dew point and humidity records for the "average year". The specifications of this spreadsheet are listed in Table 2.

References:

Iribarne, J.V. and W.L. Godson. 'Atmospheric Thermodynamics". D. Reidel Publishers. 1981.

National Climatic Data Center (NCDC) 2006. "Local Climatological Data Annual Summary with Comparative Data." Wilkes-Barre, NY. Published by NCDC, Asheville, NC.

NCDC 2007, "Integrated Surface Hourly (ISH) archived digital hourly surface meteorological database for Wilkes-Barre, PA. Period of record, 1 January 1949 through 31 December 2006. Purchased and downloaded from the NCDC Internet site at: http://www.ncdc.noaa.gov/oa/ncdc.html, NCDC Asheville, NC. December, 2007.

Trewartha, G. T., "The Earth's Problem Climates." Published by the University of Wisconsin Press, Madison, WI, 1961.

US Environmental Protection Agency (USEPA) 2000. "Meteorological Monitoring Guidance for Regulatory Modeling Applications." USEPA report EPA-454/R-99-005. February 2000. Section 5.3.2.

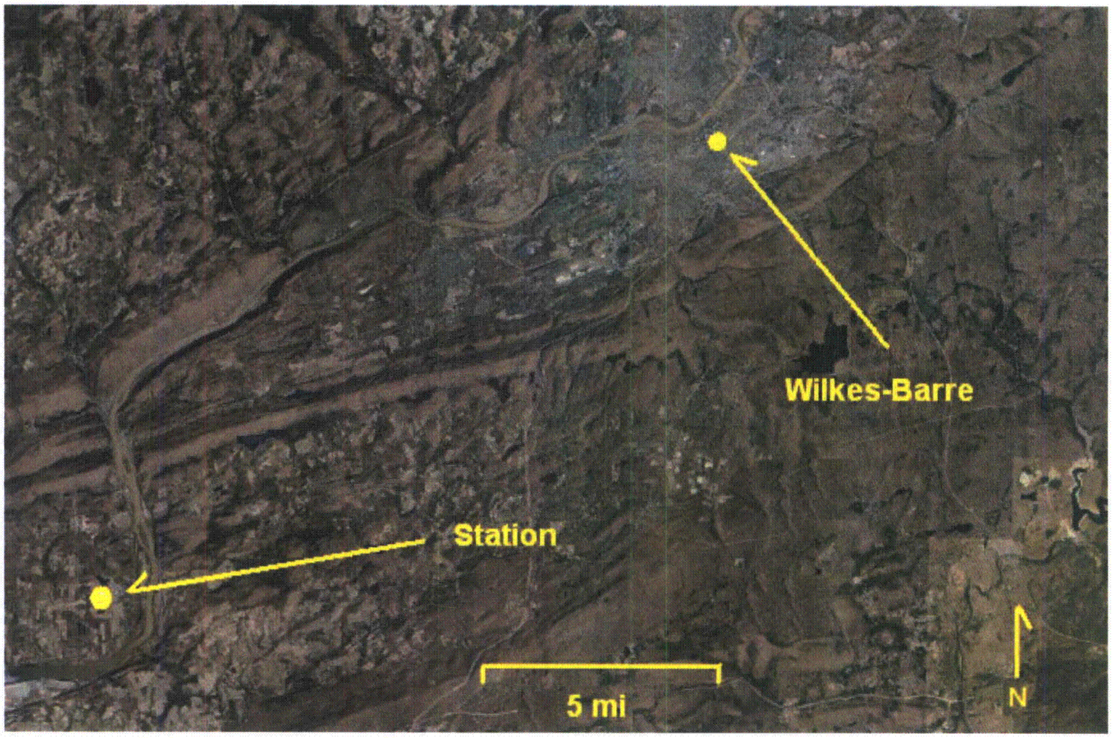


Figure 1. The Susquehanna Steam Electric Station (Station) and surrounding region.

Table 1. Highest monthly average wet-bulb (WB) temperature and corresponding month used in the "warmest year" meteorological data set.		
Month	**Highest monthly average WB (F)**	**Year with the highest monthly average WB temperature**
January	33.30	1950
February	32.79	1984[a]
March	37.23	1973
April	45.55	1955
May	57.74	2004
June	64.84	2005
July	67.87	1949
August	66.29	2003
September	62.67	1961
October	52.72	1984
November	42.68	1975
December	34.04	2006

[a] Data From February 29, 1984 (leap year) were not included in the synthetic meteorological data set.

Table 2. Synthetic meteorological data file specifications			
Filename	**Description of contents**	**File creation date/time**	**File size (kb)**
warmest.xls	Synthetic hourly meteorological data for warmest month/year on a wet-bulb temperature basis	12/21/2007 4:07 PM	1058
average.xls	Synthetic hourly meteorological data for month/year closest to average on a wet-bulb temperature basis	12/21/2007 4:07 PM	1057

Table 3. Average monthly average wet-bulb (WB) temperature and corresponding month used in the "average year" meteorological data set.			
Month	**Average monthly WB temperature (F)**	**Smallest deviation of individual monthly mean from average monthly WB temperature (F)**	**Year with the smallest deviation from the average monthly WB temperature**
January	23.81	0.19	1956
February	25.31	0.33	1982
March	31.99	0.09	1997
April	41.83	0.00	1949
May	51.57	0.00	2001
June	60.17	0.04	1951
July	64.19	0.03	1989
August	63.28	0.04	1974
September	56.87	0.16	1983
October	46.54	0.17	1996
November	37.50	0.02	1987
December	27.69	0.08	1993

FINAL PAGE OF SECTION

ATTACHMENT D

George Wrobel
Licensing Director

UniStar NUCLEAR

February 7, 2008

Fehmida Mesania
Project Engineer
Paul C. Rizzo Associates, Inc.
105 Mall Blvd, Suite #270
Monroeville, PA 15146

RFI #08-045

Subject: Response to RFI PCR-BER-004, transmitted from Fehmida Mesania to George Wrobel, dated December 4, 2007.

Attached is the subject RFI, as well as the UniStar Nuclear response. Attachments include the 1) Supplemental Laboratory Accreditation Form, 2) Susquehanna River Basin Data, and 3) the Susquehanna River Water Quality and Fishes Report.

Sincerely,

George Wrobel

xc: R. Krich, w/o
D. Green, w/o
B. Perdue
M. Hunter, w/o
S. Strout, w/o
K. Scopelliti, PPL
F. Eisenhuth, PPL
J. Fields, PPL, w/o
M. Cain, w/o
J. Morris, AREVA
G. van Noordennen, w/o
R. Hameetman, S&L, w/o

NUCLEAR

REQUEST FOR INFORMATION (RFI)

RFI NUMBER: PCR-BER-004

DATE: 12/4/07

PROJECT NUMBER: 073891

PROJECT NAME: Berwick Unit 1

ORIGINATOR: Fehmida Mesania

PHONE/FAX: 412-856-9700 x 1096/412-856-9749

PROJECT MANAGER APPROVAL: Antonio Fernandez

SUPERVISOR APPROVAL: George Wrobel

TO: UniStar

REFERENCE SECTION(S): ER 2.3

REV.: N/A

SPECIFICATION(S): N/A

REV.: N/A

INFORMATION REQUESTED:

Describe existing Water Quality Monitoring Program for Susquehanna Unit 1 & 2. What parameters are being monitored? At what frequency? If data and maps are available please provide those.

RESPONSE REQUIRED BY: February 01, 08

IMPACTS:
ER 2.3.1

RESPONSE INFORMATION

TO: FEHMIDA MESANIA

FROM: GEORGE WROBEL

OF: RIZZO

OF: UniStar NUCLEAR

RESPONSE INFORMATION: See attached: Supplemental Laboratory Accreditation Form
: Susquehanna River Basin Data
: Susquehanna River Water Quality + Fishes Report

Prepared by: Mark Hunter, by telecon 1/24/08

Approved by: George Wrobel [signature], UniStar Nuclear 2/6/08

APPROVED FOR USE: N/A GW

DATE: 2/6/08

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Attachments: DOC001.PDF; DOC001.PDF

DOC001.PDF (152 KB) DOC001.PDF (88 KB)

Doesn't this answer PCR-BER-004

Mark T. Hunter
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-----Original Message-----
From: Fields, Jerome S [mailto:jsfields@pplweb.com]
Sent: Wednesday, January 09, 2008 9:09 AM
To: Hunter, Mark T
Cc: Harpster, Terry L; Eisenhuth, Frederick T
Subject: RE: Susquehanna NPP NPDES Discharge Permit, Monitoring Parameters, and Analytical Data

Mark,

Yes, the existing discharge limits are contained in the NPDES permit - Part A pages 2 - 17. Some outfalls have limits while others just have monitoring requirements bimonthly or annually. For example stormwater outfalls, 070, 075, and 080 have annual sampling requirements, however, since the discharges are essentially the same only one outfall is sampled. Outfall 079, Sewage Treatment Plant (STP) requires only bimonthly sampling for ammonia, nitrogen (nitrites & nitrates) and phosphorus. There are STP limits for CBOD, Total Suspended Solids, etc.
Other outfalls also have limits for various parameters. I am attaching a list of procedures used to analyze NPDES discharges for your information.

One parameter that we do not have any NPDES discharge limits for is temperature. We need to meet PaDEP water quality requirements for the stretch of the Susquehanna River where the station is located. The Susquehanna River in Luzerne County Pa is protected for Warm Water Fishes (WWF) and therefore, the max temperature in the receiving water can not exceed 87 degrees F or increase by more than 2 degrees F in an hour. (Regulatory references are attached).

Also, it is important to know that the NRC in the COL ER wants to know what the impacts of the new and existing discharges are on the receiving body of water, Susquehanna River. Once the Extended Power Uprate project is completed in the next couple of years the max water body temperature will approach the 87 degree F limit. Therefore, discharge from the Berwick plant to the river needs to be well thought out to avoid future NPDES noncompliances.

If you or Rizzo have any additional questions please let me know.

Thanks,

FINAL PAGE OF SECTION

ATTACHMENT E

Life Cycle Cost Analysis for Cooling Tower Options

E1.0 Life Cycle Cost Analysis at Nominal Pricing

Table E1-1 contains the life cycle cost analysis for the base cooling tower options (Options 1a, 2a, 3a and 4) in the 'hot' year and 'average' year. The results show that the variation in weather does not significantly affect the life-cycle costs of the cooling tower options.

Therefore, the 'hot' year data was used to compare all cooling tower options. Table E2-1 contains the life cycle cost analysis for all cooling tower options for 'hot' year production.

Table E1-1: Life Cycle Cost-Benefit for 84°F Approach Tower Options (800,000 gpm)

	Hot Year				Average Year			
Type of Cooling Tower	Natural Draft - 2 Towers	Rectilinear Mech. Draft - 3 Towers	Round Mech. Draft - 4 Shells	Round Mech. Draft - 1 Shell	Natural Draft - 2 Towers	Rectilinear Mech. Draft - 3 Towers	Round Mech. Draft - 4 Shells	Round Mech. Draft - 1 Shell
Option	1a	2a	3a	4	1a	2a	3a	4
CW flowrate (gpm)	800000	800000	800000	800000	800000	800000	800000	800000
Initial Tower Cost ($ 10^3)	$ (100,000)	$ (45,000)	$ (60,000)	$ (60,000)	$ (100,000)	$ (45,000)	$ (60,000)	$ (60,000)
Piping Connection Cost Differences ($ 10^3)	$ (6,120)	$ (15,122)	$ (8,292)	$ (4,877)	$ (6,120)	$ (15,122)	$ (8,292)	$ (4,877)
Electrical Connection Cost Differences ($ 10^3)	$ (300)	$ (13,644)	$ (10,915)	$ (8,186)	$ (300)	$ (13,644)	$ (10,915)	$ (8,186)
Tower Basin Cost Differences ($ 10^3)	$ -	$ (7,184)	$ (9,388)	$ (10,345)	$ -	$ (7,184)	$ (9,388)	$ (10,345)
Auger Cast Pilings Differences ($ 10^3)	$ (2,500)	$ (1,000)	$ (1,125)	$ (1,500)	$ (2,500)	$ (1,000)	$ (1,125)	$ (1,500)
CT Initial Cost ($ 10^3)*	**$ (108,920)**	**$ (81,950)**	**$ (89,719)**	**$ (84,909)**	**$ (108,920)**	**$ (81,950)**	**$ (89,719)**	**$ (84,909)**
Contractor+Eng.+Manag.+Owner+Cont. ($ 10^3)	(64,807)	(48,760)	(53,383)	(50,521)	(64,807)	(48,760)	(53,383)	(50,521)
Construction Cost ($ 10^3)*	**(173,727)**	**(130,710)**	**(143,103)**	**(135,429)**	**(173,727)**	**(130,710)**	**(143,103)**	**(135,429)**
Yearly Production Difference ($ 10^3)	$ -	(3,095.2)	(2,122.4)	(4,525.7)	$ -	(2,904.7)	(1,955.1)	(4,336.1)
Yearly Maintenance Difference ($ 10^3)	$ -	$ (300.0)	$ (240.0)	$ (240.0)	$ -	$ (300.0)	$ (240.0)	$ (240.0)
Yearly Replacement Parts Cost Difference - After Year 10 ($ 10^3)	$ -	$ (168.0)	$ (134.4)	$ (134.4)	$ -	$ (168.0)	$ (134.4)	$ (134.4)
Rate of Return (%)	8%	8%	8%	8%	8%	8%	8%	8%
Inlation (%)	4%	4%	4%	4%	4%	4%	4%	4%
Present Value of Maint. Cost Difference ($ 10^3)	$ -	($7,258.49)	$ (5,806.8)	$ (5,806.8)	$ -	($7,258.49)	($5,806.79)	($5,806.79)
Present Value of Repl. Parts Cost Difference ($ 10^3)	$ -	($2,638.81)	$ (2,111.1)	$ (2,111.1)	$ -	($2,638.81)	($2,111.05)	($2,111.05)
Total Present Value of CT Cost Including Maintenance Differences ($ 10^3)	**(173,727)**	**(140,608)**	**(151,020)**	**(143,347)**	**(173,727)**	**(140,608)**	**(151,020)**	**(143,347)**
Present Value of Production Difference ($ 10^3)	$0	($74,889)	($51,351)	($109,499)	$0	($70,278)	($47,303)	($104,913)
Total Present Value of CT Cost Including Production Difference Benefits ($ 10^3)	**($173,727)**	**($215,497)**	**($202,372)**	**($252,846)**	**($173,727)**	**($210,886)**	**($198,323)**	**($248,260)**

* The presented cost exludes common items such as CW pumps, makeup and blowdown systems, tower fill replacement, etc.

Table E1-2: Life Cycle Cost-Benefit for All Tower Options ('Hot' Year)

	Hot Year								
Type of Cooling Tower	Natural Draft - 2 Towers	Rectilinear Mech. Draft - 3 Towers	Round Mech. Draft - 4 Shells	Round Mech. Draft - 1 Shell	Natural Draft - 2 Small Towers	Natural Draft - 2 Small Towers	Rectilinear Mech. Draft - 2 Towers	Round Mech. Draft - 3 Shells	Natural Draft - 1 Large Tower
Option	1a	2a	3a	4	1b	1b	2b	3b	1c
CW flowrate (gpm)	800000	800000	800000	800000	800000	720000	800000	800000	800000
Initial Tower Cost ($\$ 10^3$)	$ (100,000)	$ (45,000)	$ (60,000)	$ (60,000)	$ (70,000)	$ (70,000)	$ (32,000)	$ (48,000)	$ (55,000)
Piping Connection Cost Differences ($\$ 10^3$)	$ (6,120)	$ (15,122)	$ (8,292)	$ (4,877)	$ (6,120)	$ (6,120)	$ (11,707)	$ (7,438)	$ (4,877)
Electrical Connection Cost Differences ($\$ 10^3$)	$ (300)	$ (13,644)	$ (10,915)	$ (8,186)	$ (300)	$ (300)	$ (9,096)	$ (8,186)	$ (300)
Tower Basin Cost Differences ($\$ 10^3$)	$ -	$ (7,184)	$ (9,388)	$ (10,345)	$ -	$ -	$ (4,790)	$ (7,041)	$ -
Auger Cast Pilings Differences ($\$ 10^3$)	$ (2,500)	$ (1,000)	$ (1,125)	$ (1,500)	$ (2,500)	$ (2,500)	$ (1,000)	$ (1,125)	$ (1,500)
CT Initial Cost ($\$ 10^3$)*	**$ (108,920)**	**$ (81,950)**	**$ (89,719)**	**$ (84,909)**	**$ (78,920)**	**$ (78,920)**	**$ (58,592)**	**$ (71,790)**	**$ (61,677)**
Contractor+Eng.+Manag.+Owner+Cont. ($\$ 10^3$)	**(64,807)**	**(48,760)**	**(53,383)**	**(50,521)**	(46,957)	(46,957)	(34,862)	(42,715)	(36,698)
Construction Cost ($\$ 10^3$)*	**(173,727)**	**(130,710)**	**(143,103)**	**(135,429)**	**(125,877)**	**(125,877)**	**(93,455)**	**(114,505)**	**(98,374)**
Yearly Production Difference ($\$ 10^3$)	$ -	$ (3,095.2)	$ (2,122.4)	$ (4,525.7)	$ (1,188.9)	$ 313.3	(3,246.5)	(2,556.2)	$ (1,188.9)
Yearly Maintenance Difference ($\$ 10^3$)	$ -	$ (300.00)	$ (240.00)	$ (240.00)	$ -	$ -	$ (220.0)	$ (180.0)	$ -
Yearly Replacement Parts Cost Difference - After Year 10 ($\$ 10^3$)	$ -	$ (168.00)	$ (134.40)	$ (134.40)	$ -	$ -	$ (123.2)	$ (100.8)	$ -
Rate of Return (%)	8%	8%	8%	8%	8%	8%	8%	8%	8%
Inlation (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%
Present Value of Maint. Cost Difference ($\$ 10^3$)	$ -	$ (7,258.49)	$ (5,806.79)	$ (5,806.79)	$ -	$ -	($5,322.89)	$ (4,355.1)	$ -
Present Value of Repl. Parts Cost Difference ($\$ 10^3$)	$ -	$ (2,638.81)	$ (2,111.05)	$ (2,111.05)	$ -	$ -	($1,935.13)	$ (1,583.3)	$ -
Total Present Value of CT Cost Including Maintenance Differences ($\$ 10^3$)	**(173,727)**	**(140,608)**	**(151,020)**	**(143,347)**	**(125,877)**	**(125,877)**	**(100,713)**	**(120,443)**	**(98,374)**
Present Value of Production Difference ($\$ 10^3$)	$0	($74,889)	($51,351)	($109,499)	($28,765)	$7,580	($78,550)	($61,848)	($28,765)
Total Present Value of CT Cost Including Production Difference Benefits ($\$ 10^3$)	**($173,727)**	**($215,497)**	**($202,372)**	**($252,846)**	**($154,642)**	**($118,297)**	**($179,262)**	**($182,291)**	**($127,139)**

* The presented cost exludes common items such as CW pumps, makeup and blowdown systems, tower fill replacement, etc.

Analysis results are summarized in the table below:

Table E1-3: Life Cycle Cost-Benefit Summary for All Tower Options (800,000 gpm)

Cooling Tower Type	Design Cold Water Temperature (°F)	Overall Net Cost Difference (Net Present Value) From The Lowest Cost Option (10^3 $ per one EPR unit)
Option 1c (One Large Natural Draft Tower)	90	Lowest Cost
Option 1b (Two Small Natural Draft Towers)	90	$27,503
Option 1a (Two Natural Draft Towers)	84	$46,587
Option 2b (2 Rectangular Mechanical Draft Towers)	90	$52,123
Option 3b (3 Round Mechanical Draft Towers)	90	$55,152
Option 3a (4 Round Mechanical Draft Towers)	84	$75,232
Option 2a (3 Rectangular Mechanical Draft Towers)	84	$88,358
Option 4 (1 Large Mechanical Draft Tower)	84	$125,706

For nominal tower pricing, the most cost effective option is Option 1c, one large natural draft tower, followed by Option 1b, two small natural draft towers. The worst option is Option 4, one large fan-assisted natural draft tower.

E2.0 Life Cycle Cost Sensitivity Analysis

Per discussion with cooling tower vendors, each option's initial cost estimate has inherent uncertainty. This is a function of both changing materials/construction costs and how recently similar projects have been completed. Specifically, information regarding the costs of natural draft towers must be interpreted from construction costs in Europe due to a lack of projects in the United States. Uncertainties in initial costs are summarized for each tower option below:

- Option 1 - Natural draft cooling towers: ±30%
- Option 2 - Rectilinear mechanical draft cooling towers: ±15%
- Option 3 - Round mechanical draft cooling towers: ±20%
- Option 4 - Single round mechanical draft cooling tower: ±30%

Table E2-1 contains the cost sensitivity analysis of all towers using the high end of the pricing range. Table E2-2 does the same for the low end of the pricing range.

Table E2-1: Life Cycle Cost-Benefit for All Tower Options (800,000 gpm, High Initial Cost Estimate)

	Hot Year							
Type of Cooling Tower	Natural Draft - 2 Towers	Rectilinear Mech. Draft - 3 Towers	Round Mech. Draft 4 Shells	Round Mech. Draft - 1 Shell	Natural Draft - 2 Small Towers	Rectilinear Mech. Draft - 2 Towers	Round Mech. Draft - 3 Shells	Natural Draft - 1 Large Tower
Option	1a	2a	3a	4	1b	2b	3b	1c
CW flowrate (gpm)	800000	800000	800000	800000	800000	800000	800000	800000
Initial Tower Cost ($ 10^3)	$ (130,000)	$ (51,750)	$ (72,000)	$ (78,000)	$ (91,000)	$ (36,800)	$ (57,600)	$ (71,500)
Piping Connection Cost Differences ($ 10^3)	$ (6,120)	$ (15,122)	$ (8,292)	$ (4,877)	$ (6,120)	$ (11,707)	$ (7,438)	$ (4,877)
Electrical Connection Cost Differences ($ 10^3)	$ (300)	$ (13,644)	$ (10,915)	$ (8,186)	$ (300)	$ (9,096)	$ (8,186)	$ (300)
Tower Basin Cost Differences ($ 10^3)	$ -	$ (7,184)	$ (9,388)	$ (10,345)	$ -	$ (4,790)	$ (7,041)	$ -
Auger Cast Pilings Differences ($ 10^3)	$ (2,500)	$ (1,000)	$ (1,125)	$ (1,500)	$ (2,500)	$ (1,000)	$ (1,125)	$ (1,500)
CT Initial Cost ($ 10^3)*	**$ (138,920)**	**$ (88,700)**	**$ (101,719)**	**$ (102,909)**	**$ (99,920)**	**$ (63,392)**	**$ (81,390)**	**$ (78,177)**
Contractor+Eng.+Manag.+Owner+Cont. ($ 10^3)	(82,657)	(52,777)	(60,523)	(61,231)	(59,452)	(37,718)	(48,427)	(46,515)
Construction Cost ($ 10^3)*	**(221,577)**	**(141,477)**	**(162,243)**	**(164,139)**	**(159,372)**	**(101,111)**	**(129,817)**	**(124,692)**
Yearly Production Difference ($ 10^3)	$ -	(3,095.2)	(2,122.4)	(4,525.7)	$ (1,188.9)	(3,246.5)	(2,556.2)	$ (1,188.9)
Yearly Maintenance Difference ($ 10^3)	$ -	$ (300.0)	$ (240.0)	$ (240.0)	$ -	$ (220.0)	$ (180.0)	$ -
Yearly Replacement Parts Cost Difference - After Year 10 ($ 10^3)	$ -	$ (168.0)	$ (134.4)	$ (134.4)	$ -	$ (123.2)	$ (100.8)	$ -
Rate of Return (%)	8%	8%	8%	8%	8%	8%	8%	8%
Inlation (%)	4%	4%	4%	4%	4%	4%	4%	4%
Present Value of Maint. Cost Difference ($ 10^3)	$ -	($7,258.49)	$ (5,806.8)	$ (5,806.8)	$ -	($5,322.89)	$ (4,355.1)	$ -
Present Value of Repl. Parts Cost Difference ($ 10^3)	$ -	($2,638.81)	$ (2,111.1)	$ (2,111.1)	$ -	($1,935.13)	$ (1,583.3)	$ -
Total Present Value of CT Cost Including Maintenance Differences ($ 10^3)	**(221,577)**	**(151,374)**	**(170,160)**	**(172,057)**	**(159,372)**	**(108,369)**	**(135,755)**	**(124,692)**
Present Value of Production Difference ($ 10^3)	$0	($74,889)	($51,351)	($109,499)	($28,765)	($78,550)	($61,848)	($28,765)
Total Present Value of CT Cost Including Production Difference Benefits ($ 10^3)	**(221,577)**	**($226,263)**	**($221,512)**	**($281,556)**	**($188,137)**	**($186,918)**	**($197,603)**	**($153,457)**

* The presented cost exludes common items such as CW pumps, makeup and blowdown systems, tower fill replacement, etc.

Table E2-2: Life Cycle Cost-Benefit for All Tower Options (800,000 gpm, Low Initial Cost Estimate)

	Hot Year							
Type of Cooling Tower	Natural Draft - 2 Towers	Rectilinear Mech. Draft - 3 Towers	Round Mech. Draft - 4 Shells	Round Mech. Draft - 1 Shell	Natural Draft - 2 Small Towers	Rectilinear Mech. Draft - 2 Towers	Round Mech. Draft - 3 Shells	Natural Draft - 1 Large Tower
Option	1a	2a	3a	4	1b	2b	3b	1c
CW flowrate (gpm)	800000	800000	800000	800000	800000	800000	800000	800000
Initial Tower Cost ($ 10^3)	$ (70,000)	$ (38,250)	$ (48,000)	$ (42,000)	$ (49,000)	$ (27,200)	$ (38,400)	$ (38,500)
Piping Connection Cost Differences ($ 10^3)	$ (6,120)	$ (15,122)	$ (8,292)	$ (4,877)	$ (6,120)	$ (11,707)	$ (7,438)	$ (4,877)
Electrical Connection Cost Differences ($ 10^3)	$ (300)	$ (13,644)	$ (10,915)	$ (8,186)	$ (300)	$ (9,096)	$ (8,186)	$ (300)
Tower Basin Cost Differences ($ 10^3)	$ -	$ (7,184)	$ (9,388)	$ (10,345)	$ -	$ (4,790)	$ (7,041)	$ -
Auger Cast Pilings Differences ($ 10^3)	$ (2,500)	$ (1,000)	$ (1,125)	$ (1,500)	$ (2,500)	$ (1,000)	$ (1,125)	$ (1,500)
CT Initial Cost ($ 10^3)*	**$ (78,920)**	**$ (75,200)**	**$ (77,719)**	**$ (66,909)**	**$ (57,920)**	**$ (53,792)**	**$ (62,190)**	**$ (45,177)**
Contractor+Eng.+Manag.+Owner+Cont. ($ 10^3)	(46,957)	(44,744)	(46,243)	(39,811)	(34,462)	(32,006)	(37,003)	(26,880)
Construction Cost ($ 10^3)*	**(125,877)**	**(119,944)**	**(123,963)**	**(106,719)**	**(92,382)**	**(85,799)**	**(99,193)**	**(72,057)**
Yearly Production Difference ($ 10^3)	$ -	(3,095.2)	(2,122.4)	(4,525.7)	$ (1,188.9)	(3,246.5)	(2,556.2)	$ (1,188.9)
Yearly Maintenance Difference ($ 10^3)	$ -	$ (300.0)	$ (240.0)	$ (240.0)	$ -	$ (220.0)	$ (180.0)	$ -
Yearly Replacement Parts Cost Difference - After Year 10 ($ 10^3)	$ -	$ (168.0)	$ (134.4)	$ (134.4)	$ -	$ (123.2)	$ (100.8)	$ -
Rate of Return (%)	8%	8%	8%	8%	8%	8%	8%	8%
Inlation (%)	4%	4%	4%	4%	4%	4%	4%	4%
Present Value of Maint. Cost Difference ($ 10^3)	$ -	($7,258.49)	$ (5,806.8)	$ (5,806.8)	$ -	($5,322.89)	$ (4,355.1)	$ -
Present Value of Repl. Parts Cost Difference ($ 10^3)	$ -	($2,638.81)	$ (2,111.1)	$ (2,111.1)	$ -	($1,935.13)	$ (1,583.3)	$ -
Total Present Value of CT Cost Including Maintenance Differences ($ 10^3)	**(125,877)**	**(129,841)**	**(131,880)**	**(114,637)**	**(92,382)**	**(93,057)**	**(105,131)**	**(72,057)**
Present Value of Production Difference ($ 10^3)	$0	($74,889)	($51,351)	($109,499)	($28,765)	($78,550)	($61,848)	($28,765)
Total Present Value of CT Cost Including Production Difference Benefits ($ 10^3)	**(125,877)**	**($204,731)**	**($183,232)**	**($224,136)**	**($121,147)**	**($171,606)**	**($166,979)**	**($100,822)**

* The presented cost exludes common items such as CW pumps, makeup and blowdown systems, tower fill replacement, etc.

The results of the cost sensitivity analysis are summarized in the tables below. Table E2-3 contains the tower options ranked from lowest highest life cycle cost for a high initial cost estimate. Table E2-4 does the same for a low initial cost estimate.

Table E2-3: Life Cycle Cost-Benefit Summary (800,000 gpm, High Initial Cost Estimate)

Cooling Tower Type	Design Cold Water Temperature (°F)	Overall Net Cost Difference (Net Present Value) From The Lowest Cost Option (10^3 $ per one EPR unit)
Option 1c (One Large Natural Draft Tower)	90	Lowest Cost
Option 2b (2 Rectangular Mechanical Draft Towers)	90	$33,461
Option 1b (Two Small Natural Draft Towers)	90	$34,680
Option 3b (3 Round Mechanical Draft Towers)	90	$44,146
Option 3a (4 Round Mechanical Draft Towers)	84	$68,055
Option 1a (Two Natural Draft Towers)	84	$68,120
Option 2a (3 Rectangular Mechanical Draft Towers)	84	$72,806
Option 4 (1 Large Mechanical Draft Tower)	84	$128,099

Table E2-4: Life Cycle Cost-Benefit Summary (800,000 gpm, Low Initial Cost Estimate)

Cooling Tower Type	Design Cold Water Temperature (°F)	Overall Net Cost Difference (Net Present Value) From The Lowest Cost Option (10^3 $ per one EPR unit)
Option 1c (One Large Natural Draft Tower)	90	Lowest Cost
Option 1b (Two Small Natural Draft Towers)	90	$20,325
Option 1a (Two Natural Draft Towers)	84	$25,055
Option 3b (3 Round Mechanical Draft Towers)	90	$66,157
Option 2b (2 Rectangular Mechanical Draft Towers)	90	$70,784
Option 3a (4 Round Mechanical Draft Towers)	84	$82,410
Option 2a (3 Rectangular Mechanical Draft Towers)	84	$103,909
Option 4 (1 Large Mechanical Draft Tower)	84	$123,314

For both the high-end and low-end cost estimate, the most cost-effective option remains Option 1c, the single large natural draft tower. The risk involved in this option warrants evaluating the next leading candidate. For high-end cost, the next best choice is Option 2b followed closely by Option 1b. For the low-end cost estimate, the next best choice is Option 1b. Option 1b is the next leading option throughout most of the initial cost range, being edged out by Option 2b only at the highest cost estimate. Therefore, the recommendation of Option 1b is mostly insensitive to cost variation.

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ATTACHMENT F

Bell Bend Cooling Tower Plant Siting

Each cooling tower option was placed at the Bell Bend site to determine if the tower footprint could fit in the desired location. The options are reviewed below for their siting.

F1.0 Option 1, Two Natural Draft Towers

Figure F1-1 shows the layout of two natural draft towers at Bell Bend.

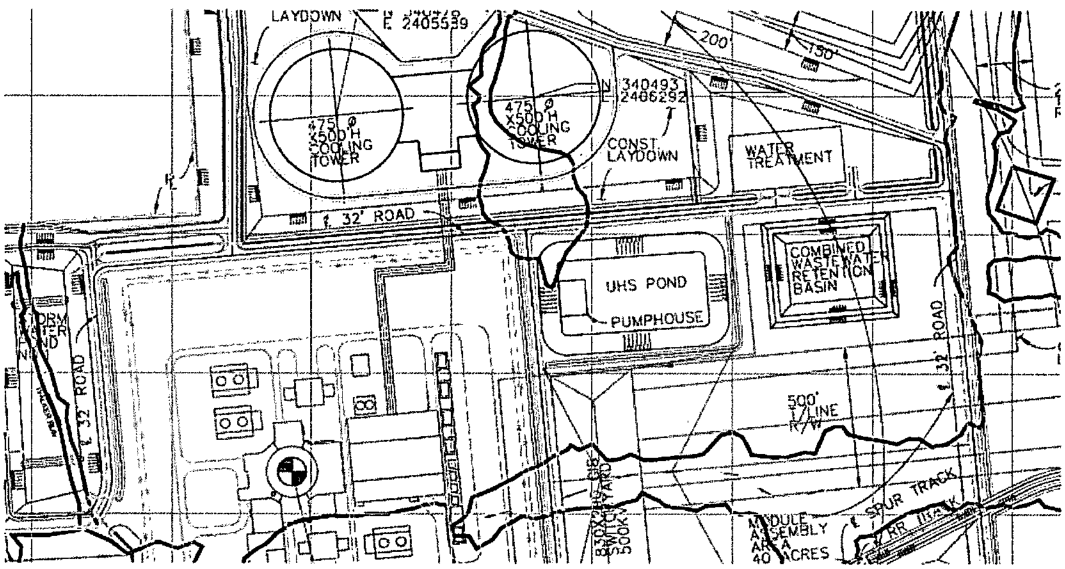

Fig. F1-1: Placement of two natural draft cooling towers at Bell Bend.

As shown in Fig. F1-1, two natural draft towers, described in Option 1, are expected to have no difficulties being constructed in the space available for cooling towers at the Bell Bend site. No changes to the site layout are required to place the two towers.

F2.0 Option 2, Three Rectangular Mechanical Draft Towers

The placement of the towers for Option 2 is highly dependant on the prevailing wind direction. The rectangular towers must sit such that the wind blows along the long side of the towers. This will minimize the effects of recirculation. The prevailing winds, determined from historical data [Ref. 5.15], blow from the south west.

Figure F2-1 shows the layout of three mechanical draft towers at Bell Bend.

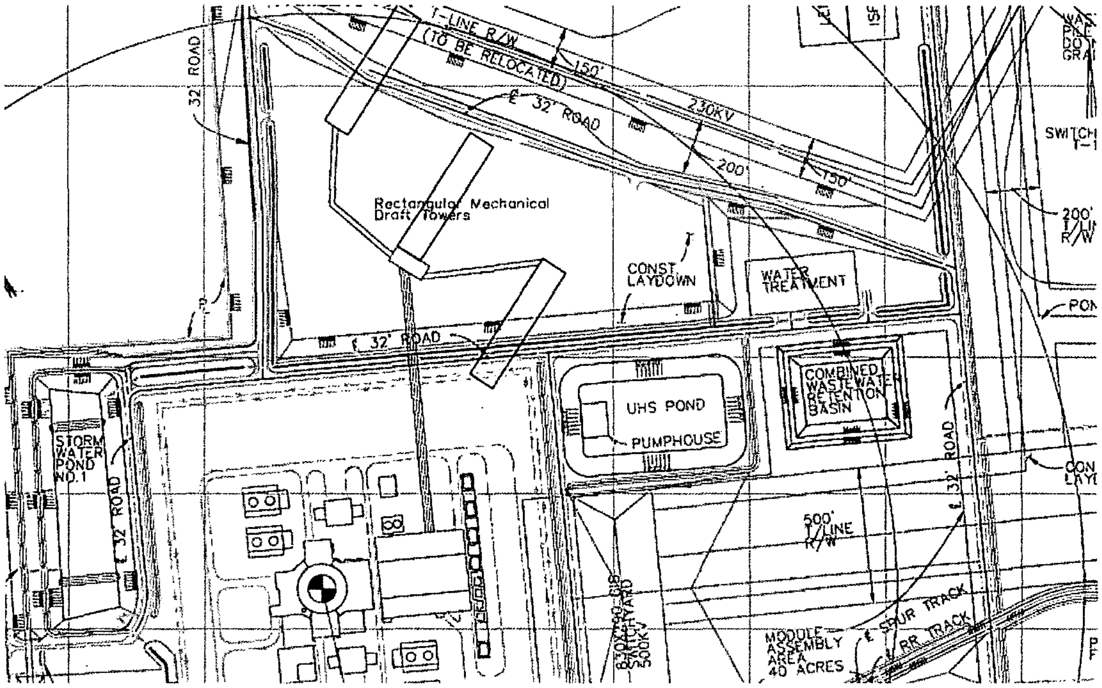

Fig. F2-1: Placement of three rectangular mechanical draft cooling towers at Bell Bend.

As shown in Fig. F2-1, three rectangular mechanical draft towers cannot be placed with the correct orientation at the Bell Bend site in the designated area. This eliminates Option 2 as a viable choice for cooling towers at Bell Bend.

F3.0 Option 3, Four Round Mechanical Draft Towers

Figure F3-1 shows the layout of four mechanical draft towers at Bell Bend.

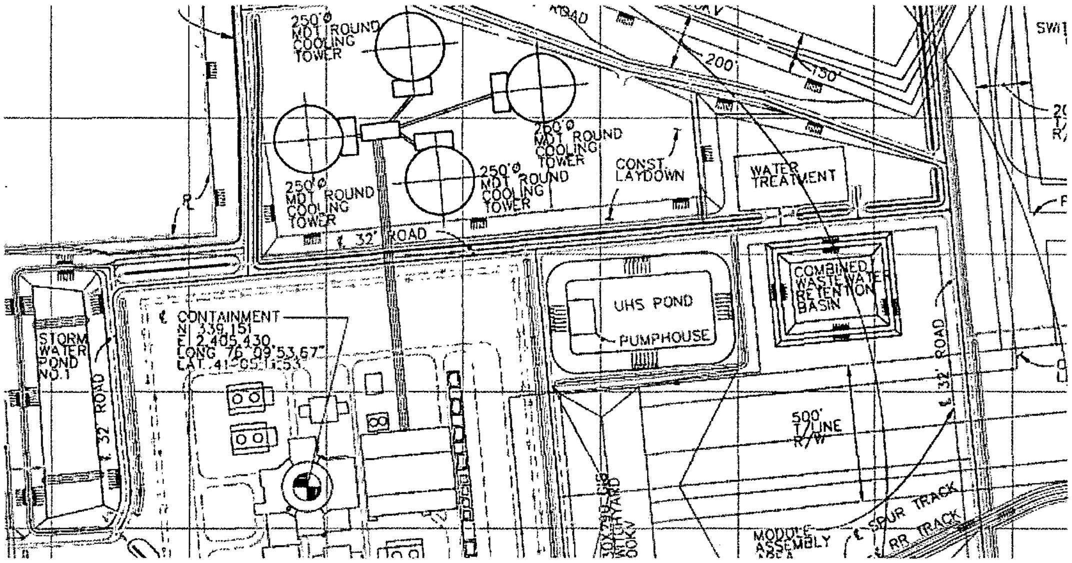

Fig. F3-1: Placement of four round mechanical draft cooling towers at Bell Bend.

As shown in Fig. F3-1, four round mechanical draft towers, described in Option 3, are expected to have no difficulties being constructed in the space available for cooling towers at the Bell Bend site. No changes to the site layout are required to place the two towers.

F4.0 Option 4, One Round Mechanical Draft Tower

Figure F4-1 shows the layout of one round mechanical draft towers at Bell Bend.

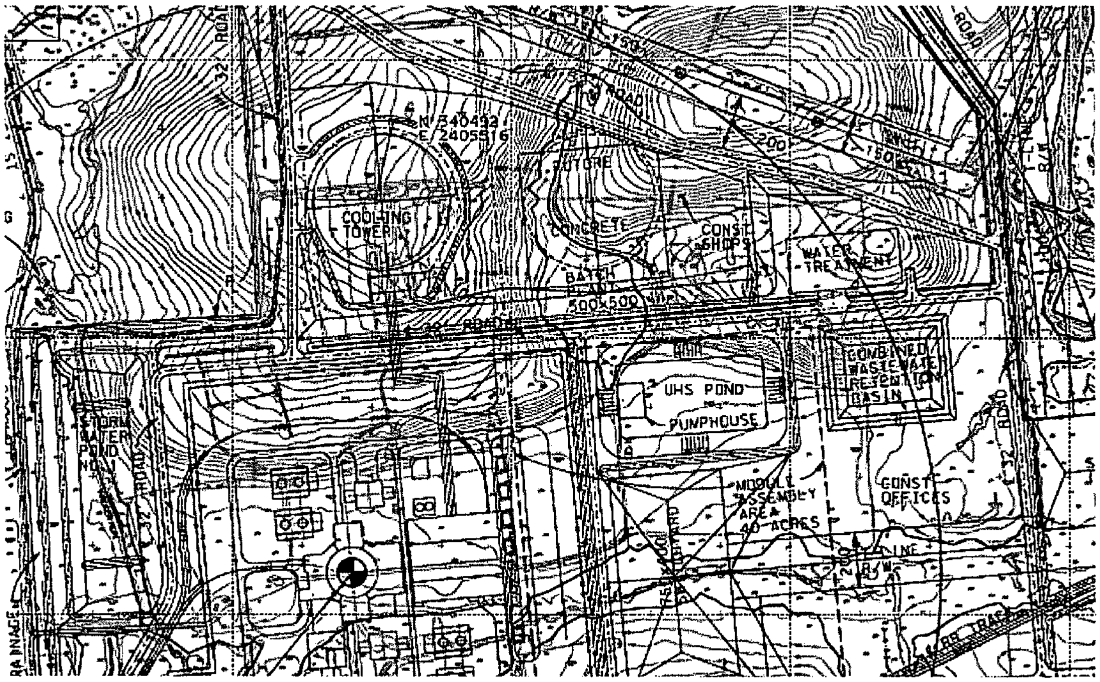

Fig. F4-1: Placement of one round mechanical draft cooling towers at Bell Bend.

As shown in Fig. F4-1, one round mechanical draft towers, described in Option 3, are expected to have no difficulties being constructed in the space available for cooling towers at the Bell Bend site. No changes to the site layout are required to place the two towers.

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