R. R. Sgarro
Director - Regulatory Affairs

PPL Bell Bend, LLC
Two North Ninth Street
Allentown, PA 18101-1179
Tel. 610.774.7552 Fax 610.774.2618
rrsgarro@pplweb.com

January 27, 2014

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

BELL BEND NUCLEAR POWER PLANT
INITIAL RESPONSE TO RAIs ENV-24 AND ENV-25
BNP-2014-009 Docket No. 52-039

References: 1) T. Terry (NRC) to R. R. Sgarro (PPL Bell Bend, LLC), Final RAI ENV-24, email dated January 10, 2014

2) T. Terry (NRC) to R. R. Sgarro (PPL Bell Bend, LLC), Final RAI ENV-25, email dated January 10, 2014

The purpose of this letter is to provide the PPL Bell Bend, LLC (PPL) initial responses to the Requests for Additional Information (RAI) Nos. ENV-24 (Reference 1) and ENV-25 (Reference 2). The RAIs address information contained in the Bell Bend Nuclear Power Plant (BBNPP) Combined License Application (COLA) Part 3, Environmental Report (ER).

Enclosure 1 provides PPL's responses to RAI ENV-24, Questions AE-7313; AE-7315; AE-7317; TE 7321; and GEN-7325. Enclosure 2 provides PPL's responses to RAI ENV-25, Questions: TE-7339; TE-7340; TE-7341; TE-7343; TE-7345; and TE-7350.

The responses include revised COLA content which will be included in a future COLA revision, and is the only regulatory commitment in this correspondence.

Should you have questions, please contact the undersigned at 610.774.7552.

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

Executed on January 27, 2014.

Respectfully,

Rocco R. Sgarro

RRS/kw

Enclosures: 1) Responses to RAI ENV-24, Questions: AE-7313; AE-7315; AE-7317; TE 7321; and GEN-7325
2) Responses to RAI ENV-25, Questions: TE-7339; TE-7340; TE-7341; TE-7343; TE-7345; and TE-7350

D102
NRD

cc: w/ Enclosures

Ms. Tomeka Terry
Project Manager
U.S. Nuclear Regulatory Commission
11545 Rockville Pike
Mailstop: T-6 C32
Rockville, MD 20852

Ms. Laura Quinn-Willingham
Project Manager
U.S. Nuclear Regulatory Commission
11545 Rockville Pike
Mailstop: T-6 C32
Rockville, MD 20852

w/o Enclosures

Mr. William Dean
Regional Administrator
U.S. Nuclear Regulatory Commission
Region I
2100 Renaissance Blvd., Suite 100
King of Prussia, PA 19406-2713

Enclosure 1

Responses to RAI ENV-24, Questions: AE-7313; AE-7315; AE-7317; TE 7321; and GEN-7325

RAI ENV-24
Question AE 7313:

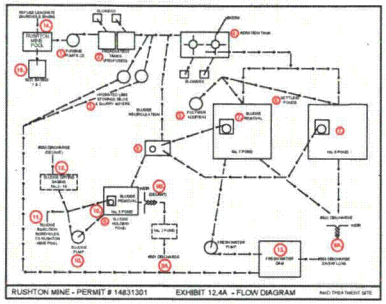
ESRP sections 2.3.1 and 5.3.1 direct the staff's description of the surface-water bodies that could be affected by the plant operation and of the impacts of the intake system during station operation. The Susquehanna River Basin Commission requires PPL to provide low-flow augmentation for consumptive water use by the Bell Bend Nuclear Power Plant. PPL's proposed mitigation measures for consumptive water use include alterations in operations of offsite water storage facilities and surface flows in natural stream courses (Consumptive Use Mitigation Plan, October 21, 2013, BNP-2013-142; RAI ENV-19 response, 12-4-12 ML123490007 PPL BNP-2012-281). In this plan, PPL describes the comprehensive plan for consumptive use mitigation, including plans to release water from Rushton Mine into Moshannon Creek to satisfy low-flow augmentation for the Montour Generating Station. To evaluate the potential effects of low-flow augmentation releases, the staff needs to identify the affected reach of Moshannon Creek. Identify the specific location at which water discharged from the Rushton Mine enters Moshannon Creek.

Response:

Please see the attached drawing titled "Flow Augmentation Project Rushton Mine Surface Area – 2009" for the specific locations where Rushton mine discharges water into Moshannon Creek. The discharges are labeled 6A (#005 Discharge) and 9A (#001 Discharge) on the attached map.

COLA Impact:

The BBNPP COLA will not be changed as a result of this response



LEGEND

PENNSYLVANIA MINES, LLC
FLOW AUGMENTATION PROJECT
RUSHTON MINE SURFACE AREA - 2009
DECATUR & RUSH TOWNSHIP
CLEARFIELD & CENTRE COUNTY, PENNSYLVANIA

DRAFT

CME
ENGINEERING
CME ENGINEERING LP
975 Georges Station Rd, Ste 100, Greensburg, PA 15601
724-830-4806 FAX: 724-833-4801

Drawn By	TAK
Checked By	JPM
Date	10-6-2011
Scale	1" = 300'
Project No.	0783-L310
File Name	Rushton - Flow Augmentation
Drawing	1 of 1

REVISIONS

No.	By	Date	Description

PAULINE HOLLOW SITE
NEAR DECATUR
CLEARFIELD & CENTRE COUNTIES, PENNSYLVANIA

RAI ENV-24
Question AE 7315:

ESRP section 5.3.1 directs the staff to describe the impacts of the intake system during station operation. Consumptive use mitigation is one of the possible impacts resulting from operation of the intake system. The Susquehanna River Basin Commission requires PPL to provide low-flow augmentation for consumptive water use by the Bell Bend Nuclear Power Plant (BBNPP). PPL's proposed mitigation measures for consumptive water use include alterations in operations of offsite water storage facilities and surface flows in natural stream courses (Consumptive Use Mitigation Plan, October 21, 2013, BNP-2013-142; RAI ENV-19 response, 12-4-12 ML123490007 PPL BNP-2012-281). In this plan, PPL describes using the water in Cowanesque Reservoir currently allocated to consumptive use mitigation for the Montour Generating Station (8.8 mgd) to satisfy part of the BBNPP consumptive use mitigation required by SRBC. PPL did not describe the circumstances under which low-flow augmentation releases currently are required for Montour by the Susquehanna River Basin Commission and whether the same requirements would apply to BBNPP consumptive use. Provide the current trigger information (gauge location, flow value) for releasing low-flow augmentation water for the Montour plant from the Cowanesque Lake. Provide additional information regarding the Rushton Mine option, including whether the same trigger would be applicable, the frequency of low-flow augmentation into Moshannon Creek required for the Montour plant assuming the same trigger that is in effect now, the rate of release for the low-flow augmentation water, and the length of time that the Rushton Mine could deliver the total water demand (~15 mgd) during low-flow augmentation.

Response:

PPL currently satisfies SRBC Consumptive use (CU) mitigation requirements for its Montour plant through the use of water releases from the 1) Cowanesque Reservoir; 2) PPL's Lake Chillisquaque; and, 3) in-lieu payment to the SRBC. As discussed in PPL's RAI ENV-19 response[1], PPL would propose to use the Rushton Mine to replace the 8.8 mgd currently provided by the Cowanesque Reservoir in order to use the Cowanesque Reservoir water for Bell Bend. This would be accomplished by the release of up to approximately 14 million gallons per day (mgd) from the Rushton Mine during drought periods which accounts for recharge into the mine plus up to 8.8 mgd to be drawn from mine storage.

Currently consumptive use mitigation for the Montour plant from the Cowanesque reservoir is triggered by Wilkes-Barre flows (USGS gage No. 01536500) receding to 900 cubic feet per second (cfs). This trigger is based on historical 7Q10 flows plus relevant consumptive use to be mitigated. The frequency (number of days) of river flow at Wilkes-Barre less than or equal to this trigger amount is as follows:

[1] BNP-2012-281, R. R. Sgarro, PPL Bell Bend, LLC to U.S. NRC Document Control Desk, "Bell Bend Nuclear Power Plant Response to RAI ENV-19," dated December 4, 2012.

Number of Days Wilkes-Barre Flow Less than or Equal to 900 cfs
(from USGS gage record)

Year	July	August	September	October	November	Annual Total
1899			1	1		2
1900			10	10		20
1908			21	9		30
1910		9	6	9	4	28
1911		3				3
1912		2				2
1913		14	21			35
1939		8	28			36
1941			9	16		25
1953		3	4	6		13
1954		2				2
1955	4	10				14
1959		3	13			16
1962	3	14	27			44
1963			6	22	6	34
1964		25	30	31	25	111
1965	3	2				5
1966		1	2			3
1985			1			1
1991			11			11
1995		4	9			13
1999		9	6			15
Total by Month	10	109	205	104	35	463

It should be noted that operational releases from Cowanesque are at the complete discretion of the SRBC. Recently, the SRBC and Army Corps of Engineers have proposed operational modifications for the Cowanesque Reservoir as outlined in a *"Draft Environmental Assessment Cowanesque Lake Water Supply Releases to Cowanesque, Tioga, Chemung and Susquehanna Rivers, Pennsylvania and New York, June 2013, US Army Corps of Engineers Baltimore District."* This report documents a proposed change to Cowanesque trigger flows at Wilkes-Barre corresponding to monthly P95 flows. The report is unclear as to the specific proposed trigger flows at Wilkes-Barre. SRBC should be consulted on this matter.

Flow triggers (gage and flow) for the use of Rushton Mine as a replacement for use of the Cowanesque reservoir for Montour would be at the discretion of the SRBC. Continued use of the Wilkes-Barre gage and a trigger flow at Wilkes-Barre of 900 cfs would maintain flow mitigation for Montour equivalent to existing operations; use of Wilkes-Barre monthly P95 flows as a Rushton trigger would maintain flow mitigation for Montour equivalent to proposed Cowanesque operations per the June 2013 Environmental Assessment. Regardless of which trigger flow is used by the SRBC for Rushton Mine operations, the mine has sufficient water in storage to satisfy SRBC operational requirements.

With respect to use of Cowanesque for Bell Bend, in a letter to PPL dated December 28, 2012[1] SRBC Staff recommended two mitigation requirements for BBNPP, namely that PPL:

> (a) maintain a specified "passby flow" in the river during the months June through October; and
> (b) mitigate BBNPP's CU by making compensating releases from upstream reservoir storage whenever river flows fall below specified amounts.

For purposes of potential flow modeling, PPL interprets this SRBC letter to require the following Bell Bend mitigation trigger flows at Wilkes-Barre. Note that these mitigation requirements for Bell Bend are considered by the SRBC to be preliminary and subject to change. It should also be noted that CU mitigation is limited to a 90-day period under SRBC regulations.

	BBNPP Preliminary "trigger" flows					
	Passby		Consumptive water use mitigation			
	At site[1] (cfs)	At Wilkes-Barre[2] (cfs)	[1]	P95 at Wilkes-Barre[3] (cfs)	BBNPP C (mgd)	P95 + C at Wilkes-Barre (cfs)
Jan	None	[redacted]	Monthly 95% exceedance flow (P95) at Wilkes-Barre plus consumptive use (C) - all months	2,400	17.82	2,428
Feb	None			2,800	17.93	2,828
Mar	None			5,280	19.23	5,310
Apr	None			8,900	20.90	8,932
May	1,750	1,702		4,330	22.46	4,365
Jun	1,750	1,702		2,220	23.29	2,256
Jul	1,750	1,702		1,280	23.86	1,317
Aug	1,200	1,167		970	23.57	1,006
Sep	890	866		860	22.79	895
Oct	1,010	982		970	21.41	1,003
Nov	None	[redacted]		1,390	19.95	1,421
Dec	None			2,100	18.48	2,129

[1] Ref. SRBC letter to PPL Bell Bend, LLC, December 28, 2012
[2] Adjusted by PPL based on drainage area
[3] Computed by PPL from USGS record at Wilkes-Barre gage

COLA Impact:
The BBNPP COLA will not be changed as a result of this response.

[1] Susquehanna River Basin Commission to Mr. Michael J. Caverly, PPL Bell Bend, LLC: "Re: Requirements for Consumptive Water Use Mitigation and Passby Flows for PPL Bell Bend, LLC-Bell Bend Nuclear Power Plant; Salem Township, Luzerne County, Pennsylvania; Commission Pending Nos. 2009-079 (SW) and 2009-080 (CU)" dated December 28, 2012.

RAI ENV-24
Question AE 7317:

ESRP Section 4.3.2 directs the staff's description, quantification, and assessment of the impacts of construction of the proposed facilities on the aquatic ecosystem. ESRP Section 5.3.1.2 directs the staff's description, quantification and assessment of the impacts of the operation of the proposed facilities on the aquatic ecosystem. ER Rev 4, Sections 4.2.1.1 and 4.3.2.1 list several aquatic resources that may be affected by the construction and operation of BBNPP even though they no longer exist (Beaver Pond) or appear to be outside the disturbance area shown in Figure 4.3-1 and others (Johnson Pond, Farm Pond, West Building Pond, and Unnamed Ponds 1 & 2). Clarify which, if any, ponds would be affected by the BBNPP construction activities and identify the potential impacts to the affected water bodies.

Response:

The Beaver Pond was drained and no longer exists and will be removed from the Environmental Report except for reference to past onsite fish sampling. The ponds located outside the Limit of Disturbance (LOD) should not appear in the referenced sections and will be removed.

COLA Impact:

The BBNPP COLA Part 3 (ER) will be revised as shown below:

2.4.2.1.1 Ponds

It is probable that these fish were washed into Farm Pond during flood events that caused Walker Run to overflow it's banks. None of the species collected in the three ponds are considered ecologically important. No rare, threatened, endangered, or species of special concern were collected. Several of the fishes have the potential to be recreationally important, but angler access to the on-site ponds is prohibited. Fish residing in the ponds may be ecologically important as prey for piscivorous birds and other predators. The Beaver Pond has since been drained and no longer exists as a pond.

4.2.1.1 Description of Surface Water Bodies and Groundwater Aquifers

Surface Water Bodies

The surface water bodies (Figure 2.3-3) within the hydrologic system that may be affected by the construction and operation of BBNPP are:
- East fork of Walker Run (labeled as Unnamed Tributary No. 1);
- Unnamed Tributary 2
- Main stem of Walker Run (labeled as Walker Run);
- Unnamed Tributary 5
- ~~Johnson's Pond;~~
- ~~Beaver Pond;~~
- ~~West Building Pond;~~
- ~~Unnamed Ponds 1 & 2~~
- ~~Farm Pond;~~
- North Branch of the Pennsylvania Canal (not shown in Figure 2.3-3); and
- Susquehanna River.

4.3.2 Aquatic Ecosystems

This section provides an assessment of the potential impact construction activities will have on aquatic ecosystems in the ~~onsite ponds,~~ Walker Run, Unnamed Tributary 5, North Branch Canal and adjacent waterbodies, and offsite in the Susquehanna River and Unnamed Tributaries 3 and 4, as shown on Figure 2.3-3. Any new transmission lines and access corridors associated with the project are limited to the BBNPP site.

4.3.2.1 Impacts to Impoundments and Streams

The following surface water bodies may be affected by construction activities:

- East fork of Walker Run (Unnamed Tributary 1);
- Unnamed Tributary 2,
- Main stem Walker Run (Walker Run);
- Unnamed Tributary 5, and
- ~~Johnson's Pond;~~
- ~~Beaver Pond;~~
- ~~West Building Pond;~~
- ~~Unnamed Pond;~~
- ~~Farm Pond; and~~
- North Branch of the Pennsylvania Canal and adjacent water bodies.

4.3.2.3 Impacts on the Transmission Corridor and Offsite Areas

There are no new offsite transmission corridors associated with the construction and operation of BBNPP. The new on-site transmission lines will cross over ~~Beaver Pond,~~ West Building Pond, Unnamed Tributary 1, and associated wetlands. No new transmission towers will be constructed in any on-site waterbodies. No important aquatic species or habitat will be impacted by the new on-site transmission corridors.

5.6.2.1 Aquatic Ecosystems

...Water bodies that are impacted by the project are identified in Section 2.3 and listed below:

- Unnamed tributary of and Walker Run,
- ~~Johnson's Pond,~~
- ~~Beaver Pond,~~
- ~~West Building Pond,~~
- ~~Unnamed Pond 1,~~
- ~~Unnamed Pond 2,~~
- ~~Farm Pond,~~
- North Branch Division of the Pennsylvania Canal System,
- Canal Outlet,
- Marshland, and
- Susquehanna River.

RAI ENV-24
Question TE 7321:

ESRP Section 9.3 states that the staff's environmental review of alternative sites should include all major aspects of environmental impacts of construction and operation, economic costs, and safety considerations. ER Rev 4 Sections 9.3.2.2 through 9.3.2.4 refer to a Pennsylvania American Water Company construction water pipeline for the Montour, Humboldt, and Seedco sites. However, no details are provided about the routes the pipeline would follow, installation construction activities, or habitat impacts to local species. Specifically, no forested and non-forested habitat or wetland or waterbody habitat information is provided for the construction water pipeline corridor at the Montour, Humboldt, and Seedco sites, as it is for the transmission line corridors and cooling water pipeline corridors (see response to RAI 5043 EIS 9.3-46 for affected forested and non-forested habitat, and ER Rev. 4 Table 9.3-13 for affected wetland and waterbody habitat). Provide details regarding the location of the dedicated Pennsylvania American Water Company pipeline; construction activities involved in its installation; and a table with the acreages of forested and non-forested upland habitat and wetland habitat, and acreages (or linear feet) and names of any water bodies and that would be affected at the Montour, Humboldt, and Seedco sites.

Response:

The subject of construction water supply has been revisited for each of the alternative sites with the following determination:

Montour Site: The best option for this site would be well water supply. A groundwater monitoring program will confirm availability of usable quantities of groundwater to satisfy the quantity described in ER Section 4.2.2. This monitoring program would be used to confirm no major offsite impacts.

Humboldt Site: This site is part of the Humboldt Industrial Park which has an existing water supply system that can be supplemented from the Hazleton Water Authority[1]. The Hazleton Water Authority has an ample capacity that can provide the quantities of water to satisfy the quantity described in ER Section 4.2.2. Connection to the existing system would be within the confines of the industrial park.

Seedco Site: This site is part of the Seedco Industrial Park which has an existing water supply system that includes a 600,000-gallon water storage tank[2]. This tank is supplied from Aqua Pennsylvania. Aqua Pennsylvania has an ample capacity that can provide the quantities of water to satisfy the quantity described in ER Section 4.2.2. Connection to the existing system would be within the confines of the industrial park.

COLA Impact:

The BBNPP COLA Part 3 (ER) will be revised as shown below:

9.3.2.2.3 Water

The best option for the Montour Site would be well water supply. A groundwater monitoring program will confirm availability of usable quantities of groundwater to satisfy the quantity described in ER Section 4.2.2. This monitoring program would be used to confirm no major

[1] http://www.hazletoncando.com/infrastructure-199, accessed 12/10/2013
[2] http://seedcoindustrialpark.com/, accessed 12/10/2013

offsite impacts. ~~A dedicated water line delivering water from the Pennsylvania American Water Company will be installed to support construction water needs. The required quantity of water is anticipated to be similar to the quantity described in ER Section 4.2.2.~~ Proper mitigation and management methods implemented during construction would limit the potential water quantity and quality impacts on surface water and groundwater.

9.3.2.3.3 Water

Hydrologic impacts associated with construction activities could include alteration of the existing watershed surface; disturbance of the ground surface for stockpiles, material storage, and construction of temporary access roads; construction of water intake and discharge structures; construction of cofferdams and storm sewers; construction of structures that might alter shoreline processes; dredging operations; temporary dewatering activities; construction activities contributing to sediment runoff; changes in surface water drainage characteristics; decreases in surface water infiltration (increases of impervious surfaces); increased erosion and sedimentation; changes in groundwater levels related to temporary dewatering activities; and possible subsidence resulting from groundwater withdrawals. ~~A dedicated water line delivering water from the Pennsylvania American Water Company will be installed to support construction water needs. The required quantity of water is anticipated to be similar to the quantity described in ER Section 4.2.2.~~ This Humboldt Site is part of the Humboldt Industrial Park which has an existing water supply system that can be supplemented from the Hazleton Water Authority. The Hazleton Water Authority has an ample capacity that can provide the quantities of water to satisfy the quantity described in ER Section 4.2.2. Connection to the existing system would be within the confines of the industrial park. Proper mitigation and management methods implemented during construction would limit the potential water quantity and quality impacts on surface water and groundwater.

9.3.2.4.3 Water

Hydrologic impacts associated with construction activities could include alteration of the existing watershed surface; disturbance of the ground surface for stockpiles, material storage, and construction of temporary access roads; construction of water intake and discharge structures; construction of cofferdams and storm sewers; construction of structures that might alter shoreline processes; dredging operations; temporary dewatering activities; construction activities contributing to sediment runoff; changes in surface water drainage characteristics; decreases in surface water infiltration (increases of impervious surfaces); increased erosion and sedimentation; changes in groundwater levels related to temporary dewatering activities; and possible subsidence resulting from groundwater withdrawals. ~~A dedicated water line delivering water from the Pennsylvania American Water Company will be installed to support construction water needs. The required quantity of water is anticipated to be similar to the quantity described in ER Section 4.2.2.~~ This Seedco Site is part of the Seedco Industrial Park which has an existing water supply system that includes a 600,000 water storage tank. This tank is supplied from Aqua Pennsylvania. Aqua Pennsylvania has an ample capacity that can provide the quantities of water to satisfy the quantity described in ER Section 4.2.2. Connection to the existing system would be within the confines of the industrial park. Proper mitigation and management methods implemented during construction would limit the potential water quantity and quality impacts on surface water and groundwater.

RAI ENV-24
Question GEN 7325:

ESPR Section 1.2 directs the staff to list the environmentally related authorizations required by Federal, State, regional, local, and affected Native American tribal agencies which should be developed as part of the review process. Revision 4 of the Environmental Report did provide an update, however the staff asks that PPL update Table 1.3-1 with each revision of the ER and ensure that all local and state permits are captured in Table 1.3-1, consistent with each revision. The staff did not find a permit listing for a "Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste" under the U.S. Department of Energy purview, nor a "Certificate of Registration" under the U.S. Department of Transportation purview listed in Table 1.3-1. Please provide a current listing of permits and authorizations.

Response:

PPL will update Table 1.3-1-Federal, State and Local Authorizations to include the current status of authorizations.

COLA Impact:

The BBNPP COLA Part 3 (ER) will be revised as shown below:

Table 1.3-1 Federal, State and Local Authorizations

Agency	Authority	Requirement	License/Permit No.	Expiration Date	Activity Covered	Anticipated Application Submittal Date
USNRC	10 CFR 50.54, 52.17	Emergency Response Plan	-(a)	-(a)	Construction Phase Emergency Response Plan	Included in the COL process
USNRC	10 CFR 50.47	Emergency Response Plan	-(a)	-(a)	Operation Phase Emergency Response Plan	Included in the COL process
USEPA	40 CFR 68	Risk Management Plan	-(a)	-(a)	Storage of Chemicals listed in Section 112(r) of the Clean Air Act in quantities above threshold	January 2015
Federal Emergency Management Agency (FEMA)	Title 44, Emergency Management and Assistance	Floodplain Development Conditional Letter of Map Revision	-(a)	-(a)	Verification from FEMA/FEMA-approved local authority that floodplain analyses are correct for constructed plant – North Branch Susquehanna River	March 2021
FEMA	Title 44, Emergency Management and Assistance	Floodplain Development Conditional Letter of Map Revision	-(a)	-(a)	Verification from FEMA/FEMA-approved local authority that floodplain analyses are correct for constructed plant – Walker Run	September 2017

Table 1.3-1 Federal, State and Local Authorizations (continued)

Agency	Authority	Requirement	License/Permit No.	Expiration Date	Activity Covered	Anticipated Application Submittal Date
PADEP	25 PA Code Article III Ch 121-145	Air Quality State Permit to Operate for Emission Sources	-(a)	-(a)	Operation-Phase Emission Sources for Diesel Generators	June 2016
U.S. Dept. of Energy (USDOE)	10 CFR 961.11	Standard Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste	DE-CR01-09RW09016	NA	Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste	Complete
U.S. Dept. of Transportation (USDOT)	49 CFR 107, Subpart G	Certification of Registration	-(b)	-(b)	Transportation of Hazardous Materials	-(b)

Notes:
(b) This activity will be performed by an established carrier in accordance with the carrier's Certificate of Registration

Enclosure 2

Responses to RAI ENV-25, Questions: TE-7339; TE-7340; TE-7341; TE-7343; TE-7345; and TE-7350

RAI ENV-25
Question TE 7339:

ESRP Section 4.3.1 directs the staff's description, quantification, and assessment of the impacts of construction of the proposed facilities on the terrestrial ecosystem, and directs staff to describe mitigative actions. The response to information need TE-19 provided May 15-17, 2012 states that "Compensatory wetland mitigation will be primarily in-kind, providing for the same types of habitats to be created as are lost." The response also states that, ".....emergent wetlands will be replaced in part by forested wetlands due to site-specific habitat creation goals." From these statements, it is unclear whether any permanently affected emergent wetlands would be mitigated in-kind or whether they all would be mitigated out-of-kind (i.e., replaced by forested wetlands). State the mitigation method(s) (including out-of-kind and in-kind replacement) by which all permanent impacts to emergent wetlands would be mitigated and the acreage(s) for each.

Response:

Response: There are a total of 0.88 acre of Department of Environmental Protection (DEP) jurisdictional palustrine emergent (PEM) wetland impacts and 0.74 acre of Army Corps of Engineers (ACOE) jurisdictional PEM impacts, as shown in Joint Permit Application (JPA) Rev 1 Environmental Assessment Impact Tables D3 and D4. The DEP and the ACOE calculate impacts differently, and have different extents of jurisdiction. All emergent wetland acreage will be replaced out-of-kind as palustrine forested (PFO) wetland. The prioritization and establishment of PFO wetlands has been identified by review agencies as an important aspect of mitigation projects on this site. Summary tables from the JPA Rev.1 Mitigation Narrative are provided below. As shown, there will be a net loss of PEM but a significant net gain in PFO.

JPA Table 2. Summary of Wetland Impacts and Mitigation Requirements for DEP

DEP Impacts and Mitigation Summary	PFO	PSS	PEM	Total Wetland	Total Stream
	(ac.)	(ac.)	(ac.)	(ac.)	(lf)
Project Impacts	1.58	0.00	0.88	2.57	997
Project Impacts Requiring Mitigation*	0.51	0.00	0.88	1.39	742
DEP Minimum Mitigation Requirement (1:1)	**0.51**	**0.00**	**0.88**	**1.39**	**742**
Wetland Creation and Stream Creation/Enhancement	8.56	0.00	0.00	8.56	5012
Mitigation Impacts	0.08	0.00	0.25	0.33	2799
Net Wetland Creation and Stream Creation/Enhancement**	**8.48**	**0.00**	**-0.25**	**8.23**	**2213**
Net Gain	**7.97**	**0.00**	**-1.13**	**6.85**	**1471**

*Although DEP considers the entire bridge span a permanent wetland and stream impact, mitigation is only required for the bridge piers.
**DEP does not count wetland enhancement towards mitigation acreage.

JPA Table 3. Summary of Wetland Impacts and Mitigation Requirements for ACOE

ACOE Impacts and Mitigation Summary	PFO	PSS	PEM	Total Wetland	Total Stream
	(ac.)	(ac.)	(ac.)	(ac.)	(lf)
Project Impacts	0.51	0.00	0.74	1.25	742
ACOE Minimum Mitigation Requirement (2:1 PFO, 1.5:1 PSS, 1:1 PEM)	**1.02**	**0.00**	**0.74**	**1.76**	**742**
Wetland and Stream Creation and Enhancement	15.36	0.00	0.00	15.36	5012
Mitigation Impacts	0.08	0.00	0.25	0.33	2799
Net Wetland Creation and Stream Creation/Enhancement	**15.28**	**0.00**	**-0.25**	**15.03**	**2213**
Net Gain	**14.26**	**0.00**	**-0.99**	**13.28**	**1471**

COLA Impact:

The BBNPP COLA will not be changed as a result of this response.

RAI ENV-25
Question TE 7340:

ESRP Section 4.3.1 directs the staff's description, quantification, and assessment of the impacts of construction of the proposed facilities on the terrestrial ecosystem, and directs staff to describe actions to mitigate those impacts. The Joint Permit Application Mitigation Narrative states that, "After installation all temporarily impacted wetlands will be restored to their original grade and will be seeded with a wetland mix." The JPA Mitigation Narrative also states that, "Temporarily impacted palustrine emergent wetlands will recover their functions and values post construction." It is unclear whether there will be any temporarily affected palustrine forested PFO wetlands and associated restorative mitigation. Identify any temporarily affected PFO wetlands and describe associated restorative mitigation. Describe also the difference in mitigation strategy and the expected time to functional recovery between temporarily affected forested wetlands versus emergent wetlands.

Response:

None of the Palustrine Forested (PFO) wetland impacts have been characterized as temporary. All PFO impacts are characterized as either "Permanent" or "Permanent PFO Wetland Conversion," as directed by the U.S. Army Corps of Engineers (Reference letter BNP-2012-145, dated December 21, 2012[1]). All PFO wetlands that will be cleared during construction, will not be permanently filled, but will be maintained in a scrub-scrub condition due to their proximity to transmission lines or bridges. The impacted Palustrine Emergent (PEM) (herbaceous) wetlands would functionally recover within two growing seasons (sometimes only one). If there were PFO wetlands, then the time to functionally recover would be more on the order of decades. Again, this is not applicable because there are no temporary impacted PFO wetlands.

COLA Impact:

The BBNPP COLA will not be changed as a result of this response.

[1] BNP-2012-145, M. J. Caverly, PPL Bell Bend, LLC to U.S. Army Corps of Engineers, "Response to ACOE Comments on BBNPP CWA Section 404 Application," dated December 21, 2012.

RAI ENV-25
Question TE 7341:

ESRP Section 2.4.1 directs the staff's description of the terrestrial and aquatic environments and biota at and in the vicinity of the site, as well as other areas likely to be impacted by the construction, operation or maintenance of the proposed project. ER Rev. 4 Tables 4.6-1 and 10.1-1 reference a historic survey database to identify important terrestrial species. Provide a copy of the historic survey database.

Response:

The historic survey database referenced in Bell Bend Environmental Report (ER) Tables 4.6-1 and 10.1-1 was included in the environmental studies report for 1994 prepared by Ecology III, Inc. Surveys were conducted in the vicinity of the Bell Bend site beginning in 1977.
This report, "Ecology III, 1995. Environmental Studies in the vicinity of the Susquehanna Steam Electric Station, 1994 Annual Report, Ecology III, Inc. June 1995" was referenced in ER Section 4.3.3.

Attached are the terrestrial ecology sections (Flora and Vegetation and Birds) of this 1994 annual report.

COLA Impact:

The BBNPP COLA will not be changed as a result of this response.

Attachment 1
RAI ENV-25
Question TE 7341

"Ecology III, 1995. Environmental Studies in the vicinity of the Susquehanna Steam Electric Station, 1994 Annual Report, Ecology III, Inc. June 1995"
"Flora and Vegetation" and "Birds"

ENVIRONMENTAL STUDIES
IN THE VICINITY OF THE
SUSQUEHANNA STEAM ELECTRIC STATION

1994 ANNUAL REPORT

Prepared By

Ecology III, Inc.
R R #1, Box 1795
Berwick, Pennsylvania 18603

For

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

June 1995

FLORA AND VEGETATION

PROCEDURES

Flora

Floristic studies were conducted from March through October 1994. Transects established in 1977 on both sides of the Susquehanna River in the vicinity of the Susquehanna SES (Fig. E-1) were used from 1977 through 1991 and 1993 (no floristic studies were conducted in 1992). In 1994, five transects were utilized for observing possible effects of moisture and salt drift from the Susquehanna SES cooling towers during operation and are referred to as salt drift transects. These transects were at varying distances and directions from the Susquehanna SES in mostly forested areas (Table E-1; Fig. E-1). For comparison with the five Susquehanna SES transects, an off-site control transect, established in 1982 at the Elimsport Substation near Elimsport, Lycoming County, Pennsylvania, was also surveyed in 1994.

On each salt drift transect, parasitic plant diseases were recorded according to host species. Frequency and relative effect of the disease on the host were noted and recorded as a coded value (Table E-2). Each transect was surveyed once a month from March through October. Parasitic plant diseases were identified using U. S. Department of Agriculture (1960), Sinclair et al. (1987), and Westcott (1990).

Vegetation

Quantitative vegetation studies at the Susquehanna SES were conducted in two upland forests, Council Cup Forest and Township Road 419 (TR419) Forest (Fig. E-1), and in a control upland forest at Elimsport Substation. Council Cup Forest is located on a moderate east-facing slope. TR419 Forest is located on a steep south-facing hillside. Both are located within 3 km of the Susquehanna SES in Luzerne County, Pennsylvania. The Elimsport Substation Forest (control plot) is located on a moderate south-facing slope, 5.4 km northeast of Elimsport, Lycoming County, Pennsylvania, 72 km northwest of the Susquehanna SES.

The forest plots were sampled in July for trees and saplings using 10x10-m quadrats, and for seedlings, shrubs, herbs, and ground cover using nested 1x1-m quadrats (Cain and Castro 1959). Details of this sampling procedure were discussed in Ichthyological Associates, Inc. (1985). Frequency, relative frequency, density, relative density, dominance, and relative dominance were calculated (Cain and Castro 1959). Importance value was found as the sum of relative frequency + relative density + relative dominance. Density was not used for shrubs, herbs, or ground cover since number of stems was not considered useful for these frequently colonial species.

Comparisons of data collected from 1977 through 1994 (vegetation data were not collected in 1992) were made using a repeated measures analysis of variance with a test for linear trends (Sokal and Rohlf 1969). Quadrat by quadrat tests were made using number of stems per quadrat for each tree, sapling, and seedling species, and percent

cover for shrubs, herbs, and ground cover. Significant changes ($P \leq 0.05$ or $P \leq 0.01$) were tested for linear trends to show increase (+), decrease (-), or no trend.

RESULTS AND DISCUSSION

Flora

Forty parasitic diseases were observed on 56 host species (Table E-2). As in 1977-93, leaf spots were the most frequent diseases encountered, accounting for 19 of the 40 diseases (48%) on 21 host species (38%). Powdery mildew occurred on 18 species (32%); 7 rust diseases occurred on 16 species (29%). Disease frequency ranged from rare to abundant (Table E-2). Disease effect ranged from discoloration only for powdery mildews, to minor leaf necrosis for most other diseases. Numbers of diseases were higher than previously recorded during preoperational and operational studies of forest transects for Council Cup and TR438 and near the upper end of ranges on other transects (Table E-3). Except on TR438, means for operational years are somewhat higher than preoperational means; this appears to be due to higher numbers of diseases on all transects in the last two years. There has been a gradual, irregular increase in the total number of diseases on all transects from 1977 through 1994 (Table E-3); the reason for this is unknown, although observer familiarity with the diseases may be a factor. The number and severity of diseases are also related to weather and host presence on the transect. No effects were observed in 1994 that could be attributed to the operation of the Susquehanna SES, and no evidence of salt drift damage was found.

Vegetation

In the Council Cup Forest in 1994, *Betula lenta* was the most important (highest importance value) tree (Table E-4), *Acer rubrum* was the most important sapling (Table E-5), and most important seedling (Table E-6). These two species have been the most important in these three classes since the study began in 1977, including preoperational (1977-82) and operational (1983-94) periods. Tree density was 640 trees/ha (Table E-4), about the same value as the last several years (Fig. E-2). Sapling density was 1,010/ha (Table E-5), about the same as 1993, but continuing a general decline in sapling density recorded since 1977; this is a successional change as saplings are crowded out or recruited into tree size class. Seedling density was 38,500/ha (Table E-6), near the average value over the last several years (Fig. E-2). *Kalmia latifolia* was the most important shrub in 1994 (Table E-7). *Lycopodium digitatum* was the most important herb and litter was the most important ground cover; each of these has also been the most important since 1977.

In the TR419 Forest, *Quercus velutina* was the most important tree (Table E-8), as in previous years. *Cornus florida* was the most important sapling (Table E-9); this species was the most important sapling before 1991, when it was replaced by *Acer rubrum*. *Cornus florida* has declined in importance due to leaf spot/dieback disease, but may be increasing since the disease has not been as damaging in the last two years. *Acer rubrum* was the most important tree seedling, as in 1993. Tree density was 467/ha (Table E-8), a slight decrease from 1993 (Fig. E-2). Sapling density was 629/ha (Table E-9); sapling density has exhibited an irregular decline from 1977 through 1994 (Fig. E-2). Seedling

density was 43,477/ha (Table E-10), a slight decrease from 1993 (Fig. E-2). *Rubus allegheniensis* was the most important shrub, *Dennstaedtia punctilobula* was the most important herb, and litter was the predominate ground cover (Table E-11). In general, there have been few changes among important species in this plot, and percent cover values are low (<10%) for all species of shrubs and herbs.

In the Elimsport Substation Forest, *Betula lenta* was the most important tree (Table E-12), and most important sapling (Table E-13), and *Acer rubrum* the most important seedling (Table E-14). The same species have been most important trees, saplings, and seedlings in most years since studies began at Elimsport in 1982. Tree density was 1,015/ha (Table E-12), continuing an increase observed each year since 1982 (Fig. E-2). Sapling density was 1,690/ha (Table E-13), continuing a decrease observed since 1982 (Fig. E-2). Seedling density was 90,500/ha (Table E-14), higher than the values reported in most previous years (Fig. E-2). *Smilax rotundifolia* was the most important shrub, *Dennstaedtia punctilobula* was the most important herb, and litter was the predominate ground cover (Table E-15). Each of these has been the most important in previous years.

A total of 82 significant changes was found for the three upland forest plots in trees, saplings, seedlings, shrubs, herbs, and ground cover (Tables E-16 through E-19). Few significant changes occurred among trees (Table E-16). There were more numerous changes among saplings (Table E-17); these were mostly decreases. At Council Cup Forest, the decreases in saplings are successional in nature (Ecology III, Inc. 1994). Sapling changes were less numerous and more variable in the TR419 Forest; however, several early successional species decreased significantly. At Elimsport Substation Forest

there were increases in five species of trees and decreases in nine species of saplings, including all five species that increased in tree class. These changes, first reported in 1989, indicate succession as many saplings are crowded out and some recruited into tree class.

Significant changes and trends were more variable among tree seedlings in the forest plots (Table E-18). Most of these changes have been reported previously, but a detailed analysis has not been made.

Changes in shrubs, herbs, and ground cover have not been analyzed in detail because of time constraints; however, the changes appear to be consistent with findings of previous years (Ecology III, Inc. 1994).

Changes in the forest plots are clearly successional in the case of trees and saplings. Changes in tree seedlings, shrubs, herbs, and ground cover are less clearly successional, although some changes may be related to succession. Details were discussed by Montgomery (Ecology III, Inc.1994). None of the significant changes found in 1994 showed a pattern that could be attributed to the operation of the Susquehanna SES. The Flora and Vegetation Program was discontinued for 1995.

Table E-1

Location of salt drift transects in the vicinity of the Susquehanna SES and at the Elimsport Substation, 1994.

TRANSECT (Abbrev.)	DIRECTION FROM SSES	DISTANCE FROM SSES (km)	HABITAT TYPE	LENGTH (km)	LOCATION
River Forest (RF)	ENE	1.5-2.0	Flood plain hardwood forest	1.2	Adjacent to the Susquehanna River north from Susquehanna SES Environmental Laboratory to southern tip of Gould Island
Twp. Road 419 (TR419)	N	0.5-1.2	Upland hardwood forest	1.5	Along Township Road 419, from U.S. 11 to T. R. 438
Twp. Road 438 (TR438)	WSW	0.4-1.9	Upland forest, open field, marsh	2.3	Along Township Road 438, from T. R. 419 to the entrance of abandoned race track
Quarry-Spring House Trail (QSH)	ENE	2.2-3.2	Upland forest	2.3	Trail from PA 239 to the transmission line along ridge top down the slope of Little Wapwallopen Valley to a trail past an abandoned spring house, ending at PA 239
Council Cup (CC)	ESE	2.8-3.3	Upland forest	1.4	Council Cup Nature Trail and Overlook
Elimsport Substation (ES)	WNW	72	Upland forest	0.8	Adjacent to and east of Elimsport Substation, 5.4 km NE of Elimsport, Lycoming County, PA

Table E–2

Parasitic plant diseases observed on salt drift transects in the vicinity of the Susquehanna SES and at Elimsport Substation, 1994. Transect names, abbreviations, and locations are given in Table E–1.

HOST SPECIES	DISEASE	TRANSECTS	DISEASE FREQ. *	DISEASE EFFECT **
Acer rubrum	*Phyllosticta minima* leaf spot	TR419, TR438, QSH, CC, ES	2–4	1
Acer rubrum	*Rhytisma acerinum* tar spot	TR438, QSH	3	1
Acer pensylvanicum	*Rhytisma punctatum* tar spot	CC	3	1
Acer saccharinum	*Phyllosticta minima* leaf spot	RF, QSH	3	1
Acer saccharinum	*Rhytisma acerinum* tar spot	RF	3	1
Ambrosia artemisiifolia	*Erysiphe cichoracearum* powdery mildew	TR438, CC	3–4	0
Aster lateriflorus	*Coleosporium asterum* pine–needle rust	TR419	3	1
Aster puniceus	*Erysiphe cichoracearum* powdery mildew	TR438	2	0
Aster simplex	*Coleosporium asterum* pine–needle rust	RF, TR438	2	1
Aster simplex	*Erysiphe cichoracearum* powdery mildew	TR419	3	0
Betula lenta	*Gloeosporium betularum* leaf spot	QSH	3	1
Carya glabra	*Gnomonia caryae* anthracnose	QSH	2	1
Castanea dentata	*Endothia parasitica* chestnut blight	CC	3	4
Catalpa bignonioides	*Phyllosticta catalpae* leaf spot	TR419	4	1
Cornus amomum	*Septoria cornicola* leaf spot	TR438	4	1
Cornus florida	*Discula corni* leaf spot/dieback	TR419, QSH, CC	3	1
Crataegus sp.	*Gymnosporangium globosum* cedar–hawthorn rust	CC	3	1
Eupatorium fistulosum	*Erysiphe cichoracearum* powdery mildew	TR438	2	0
Eupatorium rugosum	*Erysiphe cichoracearum* powdery mildew	RF, TR419, CC	2	0
Fraxinus americana	*Gloeosporium aridum* anthracnose	CC	4	1
Fraxinus pensylvanica	*Gloeosporium aridum* anthracnose	RF	3	1
Helianthus tuberosus	*Coleosporium helianthae* leaf rust	RF	3	1

Table E-2 (cont.)

HOST SPECIES	DISEASE	TRANSECTS	DISEASE FREQ.	DISEASE EFFECT
Kalmia latifolia	*Mycosphaerella colorata* leaf spot	CC	4	1
Lindera benzoin	*Phyllosticta linderae* leaf spot	QSH	3	1
Liriodendron tulipifera	*Mycosphaerella tulipiferae* leaf spot	TR419, TR438, ES	3	1
Panicum lanuginosum	*Balansia strangulans* black ring	QSH	2	1
Parthenocissus quinquefolia	*Guignardia bidwellii* leaf spot	TR419, TR438	3	1
Platanus occidentalis	*Gnomonia platani* anthracnose	RF	3	3
Podophyllum peltatum	*Phyllosticta podophylli* leaf spot	CC	3	1
Podophyllum peltatum	*Puccinia podophylli* rust	RF, TR438, QSH, CC	4-5	1
Populus tremuloides	*Phyllosticta maculans* leaf spot	TR438	3	1
Potentilla simplex	*Phragmidium andersonii* rust	QSH, ES	1-2	1
Prunus serotina	*Coccomyces lutescens* leaf spot	TR438	2	1
Prunus serotina	*Dibotryon morbosum* black knot	CC	3	3
Pycnanthemum incanum	*Erysiphe cichoracearum* powdery mildew	CC	3	0
Pycnanthemum virginianum	*Erysiphe cichoracearum* powdery mildew	CC	3	0
Quercus alba	*Mycosphaera alni* powdery mildew	CC	1	0
Quercus borealis	*Gnomonia quercina* anthracnose	TR419	2	1
Quercus borealis	*Mycosphaera alni* powdery mildew	QSH	1	0
Quercus palustris	*Mycosphaera alni* powdery mildew	TR438	3	0
Quercus prinus	*Gnomonia quercina* anthracnose	CC	3	1
Quercus prinus	*Mycosphaera alni* powdery mildew	CC	1	0
Rhus radicans	*Cercospora rhoina* leaf spot	RF, TR419, TR438, QSH	2-3	1
Rubus allegheniensis	*Gymnoconia peckiana* rust	TR419, ES	2-3	1
Rubus flagellaris	*Elsinoe veneta* leaf spot	TR419, QSH, ES	2-4	1

Table E-2 (cont.)

HOST SPECIES	DISEASE	TRANSECTS	DISEASE FREQ.	DISEASE EFFECT
Rubus flagellaris	*Gymnoconia peckiana* rust	QSH	3	1
Rubus hispidus	*Elsinoe veneta* leaf spot	ES	4	1
Rubus occidentalis	*Gymnoconia peckiana* rust	CC, ES	3-4	1
Sassafras albidum	*Actinothyrium gloeosporioides* leaf spot	TR419, QSH, CC, ES	3	1
Smilax rotundifolia	*Cercospora smilacis* leaf spot	TR419, ES	3-4	1
Solidago arguta	*Coleosporium asterum* pine-needle rust	CC	3	1
Solidago arguta	*Erysiphe cichoracearum* powdery mildew	CC	3	0
Solidago caesia	*Coleosporium asterum* pine-needle rust	TR419, QSH, CC	2-4	1
Solidago caesia	*Erysiphe cichoracearum* powdery mildew	TR419, QSH, CC	2-3	0
Solidago canadensis	*Coleosporium asterum* pine-needle rust	RF, TR419, TR438, QSH, ES	3-4	1
Solidago canadensis	*Erysiphe cichoracearum* powdery mildew	TR419, ES	2-3	0
Solidago flexicaulis	*Coleosporium asterum* pine-needle rust	RF	4	1
Solidago gigantea	*Coleosporium asterum* pine-needle rust	RF, TR438	3-4	1
Solidago gigantea	*Erysiphe cichoracearum* powdery mildew	RF, TR438, QSH	2-3	0
Solidago graminifolia	*Coleosporium delicatulum* pine-needle rust	QSH, ES	2-3	1
Solidago graminifolia	*Placosphaeria haydeni* tar spot	TR438, QSH, ES	3	1
Solidago rugosa	*Coleosporium asterum* pine-needle rust	TR419, TR438, QSH, CC, ES	2-4	1
Solidago rugosa	*Erysiphe cichoracearum* powdery mildew	TR419, QSH	2-3	0
Tilia americana	*Gnomonia tiliae* anthracnose	RF, QSH	2-3	1
Ulmus americana	*Stegophora ulmea* black spot	QSH	3	1
Verbena urticifolia	*Erysiphe cichoracearum* powdery mildew	RF, TR419, QSH	3-4	0
Verbesina alternifolia	*Erysiphe cichoracearum* powdery mildew	RF	3	0
Viola blanda	*Septoria violae* leaf spot	ES	5	1
Vitis aestivalis	*Phyllosticta viticola* leaf spot	CC	3	1

Table E–2 (cont.)

HOST SPECIES	DISEASE	TRANSECTS	DISEASE FREQ.	DISEASE EFFECT
Vitis riparia	*Mycosphaerella personata* leaf spot	TR419	3	1

*Disease Frequency Code

1 = Rare – one or two plants only (estimated at less than 5% of population affected).
2 = Uncommon – a few plants, either scattered or clumped (estimated at less than 10% of population affected).
3 = Scattered – several plants at different localities (estimated at 10–25% of population affected).
4 = Common – many plants affected (estimated at 25–50% of population).
5 = Abundant – more than half affected (estimated at 50–100% of population).

**Disease Effect Code

0 = No effect except possibly discoloration.
1 = Local necrosis in small areas only.
2 = More important necrosis in larger area.
3 = Important necrosis and minor defoliation or twig death.
4 = Important necrosis and more important defoliation or twig death.
5 = Major necrosis and defoliation or host death.

Table E-3

Number of parasitic plant diseases on each salt drift transect, 1978-94. Transect names, abbreviations, and locations are given in Table E-1.

TRANSECT	PREOP.	OPERATION											
	Mean*	1983	1984	1985	1986	1987	1988	1989	1990	1991	1993	1994	Mean
CC	13.2	14	15	15	13	15	18	20	19	17	20	25	17.4
ES	6.0	8	12	8	11	13	7	7	12	12	15	15	10.9
QSH	21.6	23	22	25	22	20	27	22	21	23	27	26	23.5
RF	11.4	10	13	13	13	9	10	12	15	16	15	16	12.9
TR419	12.6	16	17	26	22	21	14	16	23	19	16	22	19.3
TR438	17.2	10	17	18	16	13	9	16	16	17	11	19	14.7
ALL	31.4	35	32	35	36	30	34	37	32	39	40	40	35.5

* Preoperational mean for 1977-82

Table E-4

Vegetation analysis for trees in the Council Cup Forest, 1994.

SPECIES	COMMON NAME	FREQ.	RELATIVE FREQ.	DENSITY (no./ha)	RELATIVE DENSITY	DOMINANCE (ba/ha)	RELATIVE DOMINANCE	IMPORT. VALUE
Betula lenta	sweet birch	0.75	24.2	205	32.0	61552	26.8	83.0
Pinus strobus	white pine	0.30	9.7	45	7.0	44724	19.5	36.2
Quercus borealis	red oak	0.35	11.3	75	11.7	20495	8.9	31.9
Quercus velutina	black oak	0.35	11.3	60	9.4	20122	8.8	29.5
Quercus prinus	chestnut oak	0.30	9.7	75	11.7	17196	7.5	28.9
Acer rubrum	red maple	0.35	11.3	50	7.8	8957	3.9	23.0
Quercus alba	white oak	0.15	4.8	20	3.1	26833	11.7	19.6
Pinus virginiana	virginia pine	0.10	3.2	35	5.5	17208	7.5	16.2
Tsuga canadensis	eastern hemlock	0.05	1.6	25	3.9	3966	1.7	7.2
Prunus pensylvanica	pin cherry	0.10	3.2	10	1.6	958	0.4	5.2
Carya glabra	pignut hickory	0.05	1.6	10	1.6	1748	0.8	4.0
Sassafras albidum	sassafras	0.05	1.6	10	1.6	1276	0.6	3.8
Fraxinus americana	white ash	0.05	1.6	5	0.8	1901	0.8	3.2
Pyrus malus	apple	0.05	1.6	5	0.8	1418	0.6	3.0
Populus tremuloides	quaking aspen	0.05	1.6	5	0.8	884	0.4	2.8
Betula populifolia	gray birch	0.05	1.6	5	0.8	393	0.2	2.6
TOTAL		-	100.0	640	100.0	229631	100.0	300.0

Table E-5

Vegetation analysis for saplings in the Council Cup Forest, 1994.

SPECIES	COMMON NAME	FREQ.	RELATIVE FREQ.	DENSITY (no./ha)	RELATIVE DENSITY	DOMINANCE (ba/ha)	RELATIVE DOMINANCE	IMPORT. VALUE
Acer rubrum	red maple	0.75	19.7	350	34.7	5180	34.3	88.7
Betula lenta	sweet birch	0.55	14.5	105	10.4	2796	18.5	43.4
Pinus strobus	white pine	0.55	14.5	120	11.9	2439	16.1	42.5
Quercus borealis	red oak	0.40	10.5	70	6.9	1237	8.2	25.6
Prunus serotina	black cherry	0.20	5.3	125	12.4	495	3.3	21.0
Quercus prinus	chestnut oak	0.20	5.3	65	6.4	715	4.7	16.4
Carya glabra	pignut hickory	0.20	5.3	30	3.0	306	2.0	10.3
Quercus velutina	black oak	0.15	3.9	20	2.0	353	2.3	8.2
Castanea dentata	american chestnut	0.10	2.6	30	3.0	228	1.5	7.1
Tsuga canadensis	eastern hemlock	0.10	2.6	20	2.0	334	2.2	6.8
Sassafras albidum	sassafras	0.10	2.6	10	1.0	283	1.9	5.5
Quercus alba	white oak	0.10	2.6	15	1.5	102	0.7	4.8
Fagus grandifolia	american beech	0.10	2.6	10	1.0	79	0.5	4.1
Fraxinus americana	white ash	0.10	2.6	10	1.0	71	0.5	4.1
Carya tomentosa	mockernut hickory	0.05	1.3	5	0.5	251	1.7	3.5
Amelanchier arborea	shad-bush	0.05	1.3	10	1.0	134	0.9	3.2
Acer pensylvanicum	striped maple	0.05	1.3	10	1.0	39	0.3	2.6
Betula populifolia	gray birch	0.05	1.3	5	0.5	63	0.4	2.2
TOTAL		-	100.0	1010	100.0	15105	100.0	300.0

Table E-6

Vegetation analysis for tree seedlings in the Council Cup Forest, 1994.

SPECIES	COMMON NAME	FREQ.	RELATIVE FREQ.	DENSITY (no./ha)	RELATIVE DENSITY	DOMINANCE (ba/ha)	RELATIVE DOMINANCE	IMPORT. VALUE
Acer rubrum	red maple	0.53	24.9	16750	43.5	1.73	18.5	86.9
Prunus serotina	black cherry	0.25	11.7	5250	13.6	1.45	15.5	40.8
Quercus borealis	red oak	0.28	13.1	3750	9.7	0.73	7.8	30.6
Acer pensylvanicum	striped maple	0.23	10.8	2750	7.1	0.53	5.7	23.6
Sassafras albidum	sassafras	0.13	6.1	2000	5.2	1.00	10.7	22.0
Quercus alba	white oak	0.08	3.8	2250	5.8	1.00	10.7	20.3
Quercus prinus	chestnut oak	0.18	8.5	2250	5.8	0.33	3.5	17.8
Quercus velutina	black oak	0.13	6.1	1000	2.6	0.55	5.9	14.6
Castanea dentata	american chestnut	0.05	2.3	250	0.6	1.00	10.7	13.6
Betula lenta	sweet birch	0.10	4.7	1000	2.6	0.33	3.5	10.8
Fraxinus americana	white ash	0.05	2.3	500	1.3	0.25	2.7	6.3
Carya glabra	pignut hickory	0.03	1.4	250	0.6	0.23	2.5	4.5
Crataegus sp.	hawthorne	0.03	1.4	250	0.6	0.10	1.1	3.1
Prunus avium	sweet cherry	0.03	1.4	250	0.6	0.08	0.9	2.9
Pinus strobus	white pine	0.03	1.4	0	0.0	0.03	0.3	1.7
TOTAL		-	100.0	38500	100.0	9.34	100.0	300.0

Table E-7

Vegetation analysis for shrubs, herbs, and ground cover in the Council Cup Forest, 1994.

SPECIES	COMMON NAME	FREQUENCY	RELATIVE FREQ.	DOMINANCE (% cover)	RELATIVE DOMINANCE	IMPORTANCE VALUE
SHRUBS						
Kalmia latifolia	mountain laurel	0.25	15.4	5.40	17.9	33.3
Vaccinium vacillans	low-bush blueberry	0.35	21.6	2.40	7.9	29.5
Gaylussacia baccata	black huckleberry	0.23	14.2	4.55	15.1	29.3
Rhus radicans	poison ivy	0.20	12.3	5.05	16.7	29.0
Vaccinium stamineum	deerberry	0.20	12.3	5.00	16.5	28.8
Rubus allegheniensis	blackberry	0.18	11.1	3.08	10.2	21.3
Rhododendron nudiflorum	pinxter-flower	0.10	6.2	3.28	10.9	17.1
Parthenocissus quinquefolia	virginia creeper	0.08	4.9	0.63	2.1	7.0
Viburnum acerifolium	maple-leaf viburnum	0.03	1.9	0.83	2.7	4.6
HERBS						
Lycopodium digitatum	ground pine	0.38	28.4	9.90	35.6	64.0
Maianthemum canadense	wild lily-of-the-valley	0.23	17.2	6.93	24.9	42.1
Dennstaedtia punctilobula	hay-scented fern	0.15	11.2	6.08	21.8	33.0
Aralia nudicaulis	wild sarsaparilla	0.18	13.4	1.93	6.9	20.3
Lysimachia quadrifolia	whorled loosestrife	0.08	6.0	0.33	1.2	7.2
Mitchella repens	partridge-berry	0.03	2.2	1.00	3.6	5.8
Medeola virginiana	indian cucumber	0.03	2.2	0.75	2.7	4.9
Polygala paucifolia	fringed polygala	0.05	3.7	0.18	0.6	4.3
Deschampsia flexuosa	hairgrass	0.03	2.2	0.45	1.6	3.8
Gaultheria procumbens	wintergreen	0.03	2.2	0.08	0.3	2.5
Phytolacca americana	pokeweed	0.03	2.2	0.08	0.3	2.5
Chimaphilia maculata	spotted wintergreen	0.03	2.2	0.03	0.1	2.3
Melampyrum lineare	cow-wheat	0.03	2.2	0.03	0.1	2.3
Prenanthes alba	tall white lettuce	0.03	2.2	0.03	0.1	2.3
Pyrola elliptica	shinleaf	0.03	2.2	0.03	0.1	2.3
GROUND COVER						
Litter	-	0.98	71.5	96.23	96.7	168.2
Moss	-	0.28	20.4	0.63	0.6	21.0
Rock	-	0.08	5.8	0.25	0.3	6.1
Bare soil	-	0.03	2.2	2.40	2.4	4.6

Table E-8

Vegetation analysis for trees in the TR419 Forest, 1994.

SPECIES	COMMON NAME	FREQ.	RELATIVE FREQ.	DENSITY (no./ha)	RELATIVE DENSITY	DOMINANCE (ba/ha)	RELATIVE DOMINANCE	IMPORT. VALUE
Quercus velutina	black oak	0.58	20.6	121	25.9	90694	38.1	84.6
Pinus virginiana	virginia pine	0.29	10.3	58	12.4	35539	14.9	37.6
Cornus florida	flowering dogwood	0.38	13.5	50	10.7	6872	2.9	27.1
Quercus prinus	chestnut oak	0.29	10.3	42	9.0	15220	6.4	25.7
Acer rubrum	red maple	0.29	10.3	38	8.1	12062	5.1	23.5
Pinus strobus	white pine	0.13	4.6	42	9.0	17135	7.2	20.8
Prunus serotina	black cherry	0.17	6.0	25	5.4	17541	7.4	18.8
Carya tomentosa	mockernut hickory	0.25	8.9	33	7.1	6404	2.7	18.7
Fraxinus americana	white ash	0.08	2.8	13	2.8	8394	3.5	9.1
Quercus alba	white oak	0.08	2.8	8	1.7	10724	4.5	9.0
Prunus avium	sweet cherry	0.08	2.8	8	1.7	4991	2.1	6.6
Carya glabra	pignut hickory	0.08	2.8	13	2.8	1119	0.5	6.1
Tsuga canadensis	eastern hemlock	0.04	1.4	8	1.7	5030	2.1	5.2
Liriodendron tulipifera	tulip-tree	0.04	1.4	4	0.9	5773	2.4	4.7
Amelanchier arborea	shad-bush	0.04	1.4	4	0.9	327	0.1	2.4
TOTAL		-	100.0	467	100.0	237825	100.0	300.0

Table E-9

Vegetation analysis for saplings in the TR419 Forest, 1994.

SPECIES	COMMON NAME	FREQ.	RELATIVE FREQ.	DENSITY (no./ha)	RELATIVE DENSITY	DOMINANCE (ba/ha)	RELATIVE DOMINANCE	IMPORT. VALUE
Cornus florida	flowering dogwood	0.50	18.2	142	22.6	3966	32.6	73.4
Acer rubrum	red maple	0.67	24.5	171	27.2	1600	13.2	64.9
Carya tomentosa	mockernut hickory	0.21	7.7	58	9.2	1685	13.9	30.8
Quercus velutina	black oak	0.17	6.2	63	10.0	1417	11.7	27.9
Betula lenta	sweet birch	0.25	9.1	54	8.6	658	5.4	23.1
Crataegus sp.	hawthorne	0.21	7.7	29	4.6	432	3.6	15.9
Carya glabra	pignut hickory	0.13	4.7	29	4.6	697	5.7	15.0
Quercus prinus	chestnut oak	0.08	2.9	13	2.1	213	1.8	6.8
Prunus serotina	black cherry	0.08	2.9	8	1.3	295	2.4	6.6
Quercus alba	white oak	0.08	2.9	8	1.3	295	2.4	6.6
Quercus borealis	red oak	0.08	2.9	8	1.3	190	1.6	5.8
Fraxinus americana	white ash	0.08	2.9	13	2.1	56	0.5	5.5
Fagus grandifolia	american beech	0.04	1.5	8	1.3	295	2.4	5.2
Amelanchier arborea	shad-bush	0.04	1.5	13	2.1	187	1.5	5.1
Pinus strobus	white pine	0.04	1.5	4	0.6	160	1.3	3.4
Prunus avium	sweet cherry	0.04	1.5	4	0.6	13	0.1	2.2
Sassafras albidum	sassafras	0.04	1.5	4	0.6	3	0.0	2.1
TOTAL		-	100.0	629	100.0	12162	100.0	300.0

Table E-10

Vegetation analysis for tree seedlings in the TR419 Forest, 1994.

SPECIES	COMMON NAME	FREQ.	RELATIVE FREQ.	DENSITY (no./ha)	RELATIVE DENSITY	DOMINANCE (ba/ha)	RELATIVE DOMINANCE	IMPORT. VALUE
Acer rubrum	red maple	0.59	23.4	9565	22.0	1.67	12.7	58.1
Prunus serotina	black cherry	0.43	17.1	9565	22.0	1.70	12.9	52.0
Sassafras albidum	sassafras	0.41	16.3	8043	18.5	1.39	10.6	45.4
Fraxinus americana	white ash	0.24	9.5	3696	8.5	2.20	16.7	34.7
Betula lenta	sweet birch	0.11	4.4	3696	8.5	2.20	16.7	29.6
Quercus velutina	black oak	0.22	8.7	2391	5.5	1.41	10.7	24.9
Quercus prinus	chestnut oak	0.07	2.8	652	1.5	1.13	8.6	12.9
Cornus florida	flowering dogwood	0.15	6.0	1957	4.5	0.20	1.5	12.0
Prunus avium	sweet cherry	0.11	4.4	1739	4.0	0.22	1.7	10.1
Amelanchier arborea	shad-bush	0.07	2.8	652	1.5	0.57	4.3	8.6
Crataegus sp.	hawthorne	0.04	1.6	435	1.0	0.24	1.8	4.4
Quercus borealis	red oak	0.04	1.6	652	1.5	0.11	0.8	3.9
Quercus alba	white oak	0.02	0.8	217	0.5	0.09	0.7	2.0
Acer saccharum	sugar maple	0.02	0.8	217	0.5	0.04	0.3	1.6
TOTAL		-	100.0	43477	100.0	13.17	100.0	300.0

Table E-11

Vegetation analysis for shrubs, herbs, and ground cover in the TR419 Forest, 1994.

SPECIES	COMMON NAME	FREQUENCY	RELATIVE FREQ.	DOMINANCE (% cover)	RELATIVE DOMINANCE	IMPORTANCE VALUE
SHRUBS						
Rubus allegheniensis	blackberry	0.41	26.8	9.52	35.0	61.8
Lindera benzoin	spicebush	0.15	9.8	7.67	28.2	38.0
Parthenocissus quinquefolia	virginia creeper	0.33	21.6	2.33	8.6	30.2
Vaccinium stamineum	deerberry	0.11	7.2	2.17	8.0	15.2
Viburnum acerifolium	maple-leaf viburnum	0.07	4.6	2.22	8.2	12.8
Vaccinium vacillans	low-bush blueberry	0.11	7.2	1.04	3.8	11.0
Rubus flagellaris	dewberry	0.13	8.5	0.61	2.2	10.7
Vitis aestivalis	summer grape	0.11	7.2	0.30	1.1	8.3
Rhus radicans	poison ivy	0.07	4.6	0.52	1.9	6.5
Rubus occidentalis	black rasberry	0.02	1.3	0.54	2.0	3.3
Berberis thunbergii	japanese barberry	0.02	1.3	0.26	1.0	2.3
HERBS						
Dennstaedtia punctilobula	hay-scented fern	0.15	8.2	3.61	25.2	33.4
Alliaria officinalis	garlic mustard	0.07	3.8	2.43	17.0	20.8
Carex swannii	sedge	0.20	10.9	1.00	7.0	17.9
Solidago rugosa	rough goldenrod	0.09	4.9	0.65	4.5	9.4
Polygonum virginianum	virginia knotweed	0.09	4.9	0.59	4.1	9.0
Galium circaezans	bedstraw	0.09	4.9	0.48	3.3	8.2
Uvularia sessilifolia	sessile-leaved bellwort	0.11	6.0	0.28	2.0	8.0
Aster divaricatus	white wood aster	0.04	2.2	0.76	5.3	7.5
Geum canadense	avens	0.07	3.8	0.39	2.7	6.5
Maianthemum canadense	wild lily-of-the-valley	0.04	2.2	0.61	4.3	6.5
Circaea quadrisulcata	enchanter nightshade	0.07	3.8	0.35	2.4	6.2
Polystichum acrostichoides	christmas fern	0.04	2.2	0.54	3.8	6.0
Solidago caesia	blue-stemmed goldenrod	0.04	2.2	0.37	2.6	4.8
Panicum lanuginosum	panic-grass	0.07	3.8	0.13	0.9	4.7
Polygonum persicaria	smartweed	0.07	3.8	0.09	0.6	4.4
Arisaema triphyllum	jack-in-the-pulpit	0.04	2.2	0.24	1.7	3.9
Athyrium filix-femina	lady fern	0.04	2.2	0.17	1.2	3.4
Danthonia spicata	poverty oatgrass	0.02	1.1	0.28	2.0	3.1
Panicum boscii	panic-grass	0.04	2.2	0.11	0.8	3.0
Dryopteris carthusiana	spinulose wood fern	0.02	1.1	0.24	1.7	2.8
Phytolacca americana	pokeweed	0.02	1.1	0.13	0.9	2.0
Lysimachia quadrifolia	whorled loosestrife	0.02	1.1	0.11	0.8	1.9
Lysimachia terrestris	yellow loosestrife	0.02	1.1	0.09	0.6	1.7
Carex sp.	sedge	0.02	1.1	0.07	0.5	1.6
Polygonatum biflorum	soloman's seal	0.02	1.1	0.07	0.5	1.6
Smilacina racemosa	false soloman's seal	0.02	1.1	0.07	0.5	1.6
Thelypteris noveboracensis	new york fern	0.02	1.1	0.07	0.5	1.6
Desmodium nudiflorum	tick-trefoil	0.02	1.1	0.04	0.3	1.4
Impatiens biflora	jewelweed	0.02	1.1	0.04	0.3	1.4
Lycopodium digitatum	ground pine	0.02	1.1	0.04	0.3	1.4
Pilea pumila	clearweed	0.02	1.1	0.04	0.3	1.4
Viola papilionacea	common blue violet	0.02	1.1	0.04	0.3	1.4
Asplenium platyneuron	ebony spleenwort	0.02	1.1	0.02	0.1	1.2
Carex laxiflora	sedge	0.02	1.1	0.02	0.1	1.2
Convolvulus sepium	hedge bindweed	0.02	1.1	0.02	0.1	1.2
Deschampsia flexuosa	hairgrass	0.02	1.1	0.02	0.1	1.2
Lycopodium obscurum	tree clubmoss	0.02	1.1	0.02	0.1	1.2
Mitchella repens	partridge-berry	0.02	1.1	0.02	0.1	1.2
Polygonum convolvulus	black bindweed	0.02	1.1	0.02	0.1	1.2
Potentilla simplex	cinquefoil	0.02	1.1	0.02	0.1	1.2
Thalictrum polygamum	tall meadow rue	0.02	1.1	0.02	0.1	1.2
Uvularia perfoliata	perfoliate bellwort	0.02	1.1	0.02	0.1	1.2
GROUND COVER						
Litter	-	0.98	54.1	93.00	93.8	147.9
Moss	-	0.33	18.2	0.74	0.7	18.9
Bare soil	-	0.22	12.2	4.74	4.8	17.0
Rock	-	0.28	15.5	0.72	0.7	16.2

Table E-12

Vegetation analysis for trees in the Elimsport Substation Forest, 1994.

SPECIES	COMMON NAME	FREQ.	RELATIVE FREQ.	DENSITY (no./ha)	RELATIVE DENSITY	DOMINANCE (ba/ha)	RELATIVE DOMINANCE	IMPORT. VALUE
Betula lenta	sweet birch	0.90	22.2	295	29.1	48667	19.0	70.3
Acer rubrum	red maple	0.85	21.0	250	24.6	52107	20.3	65.9
Liriodendron tulipifera	tulip-tree	0.65	16.0	210	20.7	57153	22.3	59.0
Quercus prinus	chestnut oak	0.35	8.6	60	5.9	28588	11.1	25.6
Nyssa sylvatica	black gum	0.40	9.9	60	5.9	17204	6.7	22.5
Sassafras albidum	sassafras	0.35	8.6	75	7.4	12582	4.9	20.9
Quercus borealis	red oak	0.30	7.4	35	3.4	25408	9.9	20.7
Pinus strobus	white pine	0.10	2.5	10	1.0	9931	3.9	7.4
Acer pensylvanicum	striped maple	0.05	1.2	10	1.0	958	0.4	2.6
Tsuga canadensis	eastern hemlock	0.05	1.2	5	0.5	2077	0.8	2.5
Carya glabra	pignut hickory	0.05	1.2	5	0.5	1732	0.7	2.4
TOTAL		-	100.0	1015	100.0	256407	100.0	300.0

Table E-13

Vegetation analysis for saplings in the Elimsport Substation Forest, 1994.

SPECIES	COMMON NAME	FREQ.	RELATIVE FREQ.	DENSITY (no./ha)	RELATIVE DENSITY	DOMINANCE (ba/ha)	RELATIVE DOMINANCE	IMPORT. VALUE
Betula lenta	sweet birch	1.00	23.8	995	58.9	25537	55.2	137.9
Acer rubrum	red maple	0.90	21.4	315	18.6	8906	19.3	59.3
Sassafras albidum	sassafras	0.55	13.1	95	5.6	5030	10.9	29.6
Liriodendron tulipifera	tulip-tree	0.35	8.3	60	3.6	2234	4.8	16.7
Nyssa sylvatica	black gum	0.30	7.1	80	4.7	1641	3.5	15.3
Quercus prinus	chestnut oak	0.25	6.0	35	2.1	1166	2.5	10.6
Quercus borealis	red oak	0.15	3.6	30	1.8	456	1.0	6.4
Pinus strobus	white pine	0.15	3.6	15	0.9	86	0.2	4.7
Quercus velutina	black oak	0.10	2.4	15	0.9	389	0.8	4.1
Tsuga canadensis	eastern hemlock	0.10	2.4	10	0.6	102	0.2	3.2
Betula papyrifera	paper birch	0.05	1.2	5	0.3	251	0.5	2.0
Betula populifolia	gray birch	0.05	1.2	5	0.3	251	0.5	2.0
Fagus grandifolia	american beech	0.05	1.2	10	0.6	98	0.2	2.0
Fraxinus americana	white ash	0.05	1.2	5	0.3	35	0.1	1.6
Amelanchier arborea	shad-bush	0.05	1.2	5	0.3	16	0.0	1.5
Carya glabra	pignut hickory	0.05	1.2	5	0.3	16	0.0	1.5
Quercus alba	white oak	0.05	1.2	5	0.3	16	0.0	1.5
TOTAL		-	100.0	1690	100.0	46230	100.0	300.0

Table E-14

Vegetation analysis for tree seedlings in the Elimsport Substation Forest, 1994.

SPECIES	COMMON NAME	FREQ.	RELATIVE FREQ.	DENSITY (no./ha)	RELATIVE DENSITY	DOMINANCE (ba/ha)	RELATIVE DOMINANCE	IMPORT. VALUE
Acer rubrum	red maple	0.90	38.0	58750	64.9	1.43	35.6	138.5
Sassafras albidum	sassafras	0.43	18.1	6750	7.5	0.88	21.9	47.5
Acer pensylvanicum	striped maple	0.33	13.9	7750	8.6	0.38	9.5	32.0
Betula lenta	sweet birch	0.13	5.5	11750	13.0	0.20	5.0	23.5
Quercus prinus	chestnut oak	0.13	5.5	1500	1.7	0.43	10.7	17.9
Quercus borealis	red oak	0.10	4.2	1000	1.1	0.13	3.2	8.5
Liriodendron tulipifera	tulip-tree	0.10	4.2	1000	1.1	0.10	2.5	7.8
Prunus serotina	black cherry	0.05	2.1	500	0.6	0.10	2.5	5.2
Amelanchier arborea	shad-bush	0.03	1.3	0	0.0	0.13	3.2	4.5
Nyssa sylvatica	black gum	0.05	2.1	500	0.6	0.05	1.2	3.9
Pinus strobus	white pine	0.03	1.3	250	0.3	0.08	2.0	3.6
Carya glabra	pignut hickory	0.03	1.3	250	0.3	0.05	1.2	2.8
Crataegus sp.	hawthorne	0.03	1.3	250	0.3	0.03	0.7	2.3
Quercus velutina	black oak	0.03	1.3	250	0.3	0.03	0.7	2.3
TOTAL		-	100.0	90500	100.0	4.02	100.0	300.0

Table E-15

Vegetation analysis for shrubs, herbs, and ground cover in the Elimsport Substation Forest, 1994.

SPECIES	COMMON NAME	FREQUENCY	RELATIVE FREQ.	DOMINANCE (% cover)	RELATIVE DOMINANCE	IMPORTANCE VALUE
SHRUBS						
Smilax rotundifolia	greenbrier	0.45	50.0	6.93	47.1	97.1
Hamamelis virginiana	witch hazel	0.18	20.0	5.53	37.6	57.6
Lindera benzoin	spicebush	0.08	8.9	0.73	5.0	13.9
Vaccinium vacillans	low-bush blueberry	0.08	8.9	0.35	2.4	11.3
Rubus hispidus	dewberry	0.03	3.3	0.63	4.3	7.6
Vaccinium corymbosum	high-bush blueberry	0.03	3.3	0.45	3.1	6.4
Parthenocissus quinquefolia	virginia creeper	0.05	5.6	0.08	0.5	6.1
HERBS						
Dennstaedtia punctilobula	hay-scented fern	0.43	35.2	5.35	55.5	90.7
Thelypteris noveboracensis	new york fern	0.13	10.7	0.95	9.9	20.6
Osmunda cinnamomea	cinnamon fern	0.08	6.6	1.15	11.9	18.5
Carex swannii	sedge	0.13	10.7	0.25	2.6	13.3
Athyrium filix-femina	lady fern	0.05	4.1	0.50	5.2	9.3
Uvularia sessilifolia	sessile-leaved bellwort	0.08	6.6	0.15	1.6	8.2
Medeola virginiana	indian cucumber	0.05	4.1	0.20	2.1	6.2
Mitchella repens	partridge-berry	0.03	2.5	0.33	3.4	5.9
Osmunda claytoniana	interrupted fern	0.03	2.5	0.23	2.4	4.9
Polygonatum biflorum	soloman's seal	0.03	2.5	0.18	1.9	4.4
Aralia nudicaulis	wild sarsaparilla	0.03	2.5	0.15	1.6	4.1
Pteridium aquilinum	bracken	0.03	2.5	0.08	0.8	3.3
Carex sp.	sedge	0.03	2.5	0.03	0.3	2.8
Goodyera pubescens	rattlesnake plantain	0.03	2.5	0.03	0.3	2.8
Habenaria orbiculata	round-leaved orchid	0.03	2.5	0.03	0.3	2.8
Lysimachia quadrifolia	whorled loosestrife	0.03	2.5	0.03	0.3	2.8
GROUND COVER						
Litter	-	1.00	39.2	86.35	86.9	126.1
Rock	-	0.80	31.4	10.25	10.3	41.7
Moss	-	0.75	29.4	2.80	2.8	32.2

Table E-16

F values and trends for trees in the Council Cup Forest (1977-94), TR419 Forest (1978-94), and Elimsport Substation Forest (1982-94).

SPECIES	COUNCIL CUP		TR419		ELIMSPORT	
	F	Trend	F	Trend	F	Trend
Acer pensylvanicum	–		–		1.00	
Acer rubrum	1.44		1.38		4.84 **	+
Amelanchier arborea	–		1.00		–	
Betula lenta	0.76		–		13.70 **	+
Betula populifolia	0.28		1.28		–	
Carya glabra	1.00		1.56		1.00	
Carya tomentosa	–		0.80		–	
Cornus florida	1.47		1.92		1.00	
Crataegus sp.	–		1.00		–	
Fraxinus americana	1.00		1.06		–	
Liriodendron tulipifera	–		0.00		8.01 **	+
Nyssa sylvatica	–		–		1.57	
Pinus strobus	0.83		2.09 **	—	0.00	
Pinus virginiana	1.36		2.05 *	—	–	
Populus grandidentata	1.39		–		–	
Populus tremuloides	1.00		–		–	
Prunus avium	–		0.00		–	
Prunus pensylvanica	1.18		–		–	
Prunus serotina	–		0.51		–	
Pyrus malus	0.00		0.57		–	
Quercus alba	1.45		1.00		–	
Quercus borealis	2.19 **	+	0.86		0.47	
Quercus prinus	1.11		0.85		2.60 **	+
Quercus velutina	1.71		1.12		1.00	
Sassafras albidum	1.00		1.00		6.60 **	+
Tsuga canadensis	1.00		1.00		0.00	

*Significant at P≤0.05
**Significant at P≤0.01

Table E-17

F values and trends for saplings in the Council Cup Forest (1977-94), TR419 Forest (1978-94), and Elimsport Substation Forest (1982-94).

SPECIES	COUNCIL CUP		TR419		ELIMSPORT	
	F	Trend	F	Trend	F	Trend
Acer negundo	–		–		1.00	
Acer pensylvanicum	1.41		–		0.72	
Acer rubrum	1.69		2.38**	+	25.00**	—
Amelanchier arborea	0.63		1.24		1.40	
Betula lenta	9.80**	—	3.39**	+	109.44**	—
Betula papyrifera	–		–		1.00	
Betula populifolia	4.71**	—	3.39**	—	1.00	
Carya glabra	1.97		0.82		0.00	
Carya tomentosa	2.48**	—	2.38**	—	–	
Castanea dentata	1.67		–		1.00	
Cornus florida	3.02**	—	21.10**	—	5.27**	—
Crataegus sp.	–		1.49		–	
Fagus grandifolia	2.11**		0.92		1.16	
Fraxinus americana	2.01*		1.79		1.00	
Liriodendron tulipifera	–		–		11.24**	—
Nyssa sylvatica	–		–		3.69**	—
Pinus strobus	1.12		0.89		1.35	
Pinus virginiana	1.74		1.09		–	
Populus grandidentata	1.00		–		–	
Prunus avium	–		1.00		1.00	
Prunus pensylvanica	1.16		–		1.00	
Prunus serotina	1.65		0.91		1.70	
Pyrus malus	–		1.00		–	
Quercus alba	3.19**	—	1.65		3.37**	—
Quercus borealis	4.88**	—	1.36		3.68**	—
Quercus prinus	5.23**	—	0.87		11.22**	—
Quercus velutina	6.51**	—	4.52**	—	1.46	
Sassafras albidum	1.19		1.39		31.76**	—
Tsuga canadensis	0.58		–		1.00	
Ulmus americana	–		1.00		–	

*Significant at $P \leq 0.05$
**Significant at $P \leq 0.01$

Table E-18

F values and trends for tree seedlings (number of stems) in the Council Cup Forest (1978-94), TR419 Forest (1978-94), and Elimsport Substation Forest (1982-94).

SPECIES	COUNCIL CUP		TR419		ELIMSPORT	
	F	Trend	F	Trend	F	Trend
Acer pensylvanicum	4.11 **	+	–		6.62 **	+
Acer rubrum	5.51 **	—	3.03 **		10.78 **	
Acer saccharum	–		1.00		–	
Amelanchier arborea	0.91		1.30		0.00	
Betula lenta	2.82 **	+	3.70 **	+	4.47 **	
Betula populifolia	1.00		1.18		–	
Carya glabra	0.77		1.86		1.69	
Carya tomentosa	0.85		1.11		–	
Castanea dentata	1.96		–		–	
Celtis occidentalis	–		1.96		–	
Cornus florida	–		12.42 **	—	1.37	
Crataegus sp.	1.00		0.79		0.97	
Fagus grandifolia	–		–		1.00	
Fraxinus americana	0.22		8.44 **	—	0.92	
Liriodendron tulipifera	–		–		2.12 *	
Nyssa sylvatica	–		–		5.61 **	—
Pinus strobus	9.60 **	+	2.09 **		0.90	
Pinus virginiana	1.00		2.00 *		–	
Populus grandidentata	0.93		1.46		–	
Populus tremuloides	1.84		0.87		–	
Prunus avium	1.13		1.65		–	
Prunus pensylvanica	1.00		–		–	
Prunus serotina	2.53 **	—	2.27 **	—	2.74 **	—
Prunus virginiana	1.00		–		–	
Pyrus malus	–		1.28		–	
Quercus alba	2.06 *	+	1.00		0.57	
Quercus borealis	2.01 *		1.09		1.45	
Quercus prinus	0.66		0.55		2.53 **	+
Quercus velutina	1.36		2.16 **		0.70	
Sassafras albidum	1.49		1.58		2.09 *	—
Tsuga canadensis	1.46		1.00		0.75	

*Significant at P≤0.05
**Significant at P≤0.01

Table E-19

F values and trends for shrubs, herbs, and ground cover (% cover) in the Council Cup Forest (1977-94), TR419 Forest (1978-94), and Elimsport Substation Forest (1982-94).

SPECIES	COUNCIL CUP		TR419		ELIMSPORT	
	F	Trend	F	Trend	F	Trend
Gaylussacia baccata	3.88 **	+	–		–	
Hamamelis virginiana	–		–		0.97	
Kalmia latifolia	1.32		–		–	
Lindera benzoin	–		3.01 **	+	1.11	
Parthenocissus quinquefolia	1.16		1.32		2.10 *	—
Rhododendron nudiflorum	1.94		–		–	
Rhus radicans	2.38 **	+	1.67		–	
Rubus allegheniensis	3.12 **	+	2.14 **	+	2.60 **	—
Rubus flagellaris	–		1.56		–	
Rubus occidentalis	–		0.81		–	
Smilax rotundifolia	–		–		0.48	
Vaccinium stamineum	3.90 **	+	0.77		–	
Vaccinium vacillans	3.59 **	—	1.39		1.38	
Viburnum acerifolium	–		0.52		–	
Vitis aestivalis	–		1.67		0.51	
Alliaria officinalis	–		1.24		–	
Aralia nudicaulis	1.23		–		1.38	
Arisaema triphyllum	–		0.99		–	
Asplenium platyneuron	–		1.01		–	
Aster divaricatus	–		0.70		–	
Carex laxiflora	–		2.20 **		–	
Carex pensylvanica	–		1.12		–	
Carex rosea	–		1.62		–	
Carex swannii	–		5.53 **		2.59 **	+
Carex sp.	–		1.83		1.78	
Chimaphilia maculata	1.31		–		–	
Circaea quadrisulcata	–		0.43		–	
Danthonia spicata	–		1.25		–	
Dennstaedtia punctilobula	2.85 **	+	0.48		0.30	
Desmodium nudiflorum	–		2.17 **	—	–	
Erechtites hieracifolia	–		14.72 **	+	–	
Eupatorium rugosum	–		1.38		–	
Galium aparine	–		0.92		–	
Galium circaezans	–		2.27 **		–	
Geum canadense	–		0.80		–	
Lycopodium digitatum	1.64		1.44		–	
Lysimachia quadrifolia	3.36 **		–		1.16	
Maianthemum canadense	3.82 **	+	1.00		–	
Medeola virginiana	–		–		0.93	
Melampyrum lineare	1.39		–		–	
Monotropa uniflora	1.34		1.97		–	
Osmunda cinnamomea	–		–		1.33	
Panicum boscii	–		2.94 **	+	–	
Panicum lanuginosum	–		2.24 **	+	–	
Panicum spp.	–		1.98		–	
Phytolacca americana	–		1.72		–	
Pilea pumila	–		1.52		–	
Polygala paucifolia	1.10		–		–	
Polygonatum biflorum	–		–		1.58	
Polygonum persicaria	–		1.01		–	
Polygonum virginianum	–		1.93		–	
Potentilla simplex	–		1.33		–	
Solidago caesia	–		0.99		–	
Solidago rugosa	–		0.60		–	
Thelypteris noveboracensis	–		–		0.70	
Uvularia perfoliata	–		2.75 **		–	
Uvularia sessilifolia	–		1.93		2.14 *	
Veronica officinalis	1.73		–		–	
Viola papilionacea	–		1.29		–	
Litter	0.86		0.87		1.46	
Moss	1.44		3.58 **	—	2.21 *	
Rock	3.49 **	—	1.48		2.89 **	+
Bare soil	1.01		1.28		–	

*Significant at P≤0.05
**Significant at P≤0.01

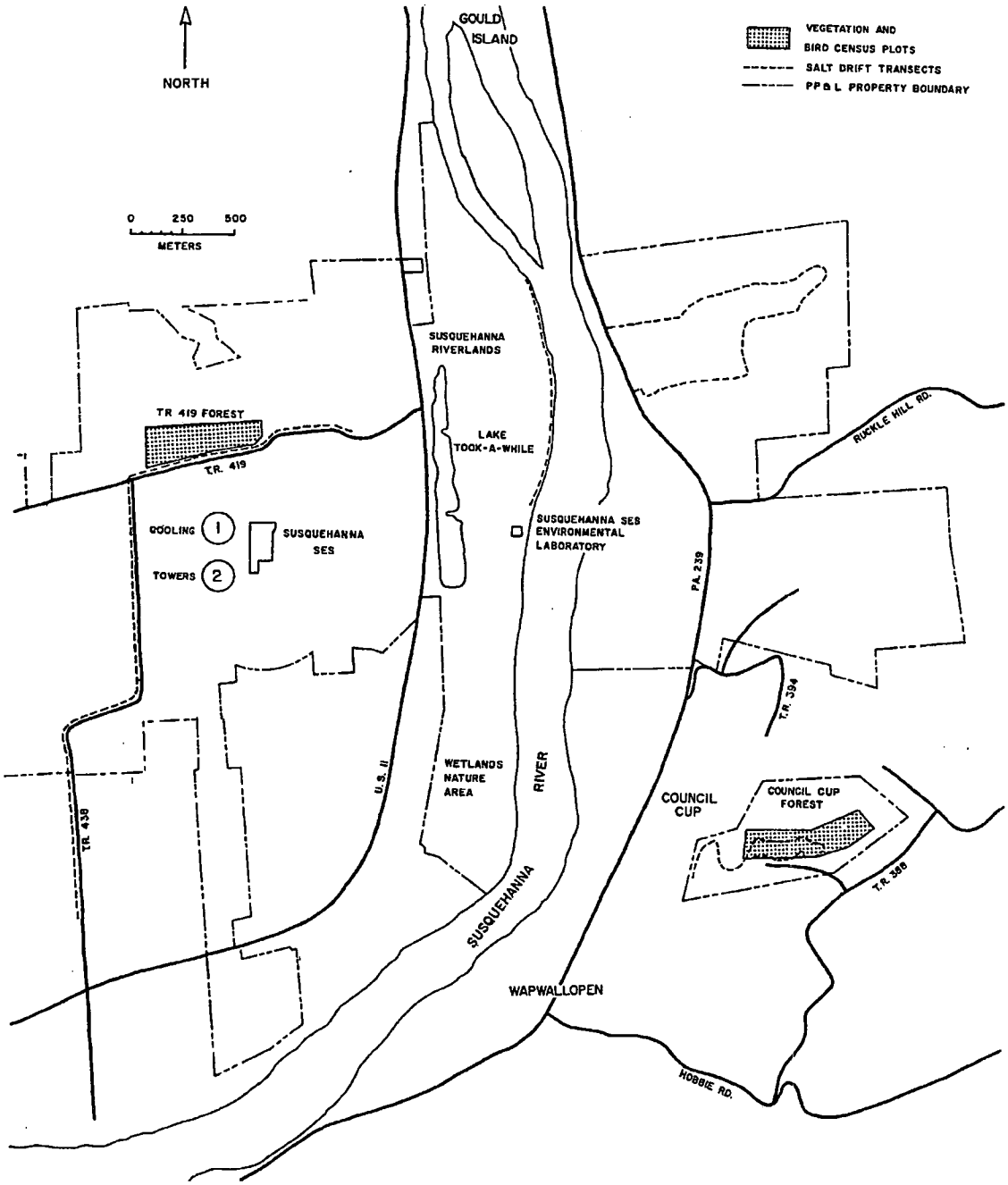


Fig. E-1

Location of vegetation and bird census plots and salt drift transects in the vicinity of the Susquehanna SES site, 1994.

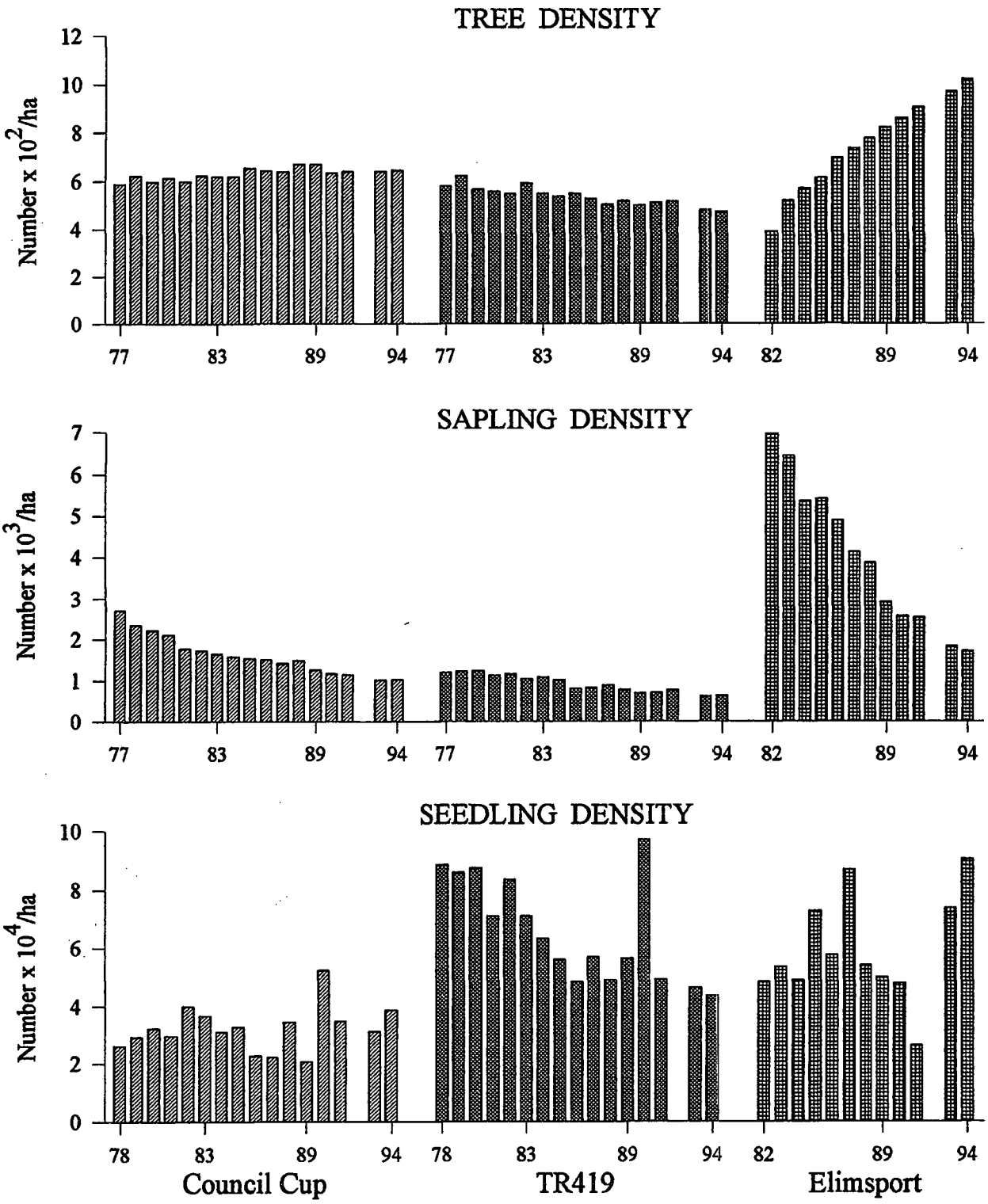


Fig. E-2

Tree, sapling, and seedling density for forest plots during preoperation (1977-82) and operation (1983-94) of the Susquehanna SES. Data were not collected in 1992.

BIRDS

PROCEDURES

Species of Special Concern

The Pennsylvania Species of Special Concern List is divided into the following categories: endangered, threatened, candidate (at risk, rare, and undetermined), and extirpated. It includes birds that are listed as endangered or threatened in the 1988 Endangered Species Act Amendments (U. S. Department of the Interior 1994). The extirpated category is treated by the Pennsylvania Game Commission as a subcategory of endangered (Brauning et al. 1994). The Susquehanna SES program emphasizes endangered and threatened species and candidate species with a history of nesting nearby.

Species of Special Concern surveys were conducted throughout the year. Most surveys occurred on PP&L property within 8 km of the Susquehanna SES, but some observations were made as far away as 15 km. Efforts were concentrated on wetlands, especially the Wetlands Nature Area in the southern part of the Susquehanna Riverlands, riverbank lookouts along the Susquehanna River, and Council Cup Overlook. Advocational birdwatchers and naturalists reported rare bird sightings to the Susquehanna SES Environmental Laboratory and the Susquehanna Energy Information Center. Local birdwatchers conducted a hawkwatch from Council Cup Overlook during autumn migration (Gregory 1995). Hawkwatch data were used to judge the status of some raptors listed as

Species of Special Concern. These sightings were checked for accuracy by assessing observer expertise and by obtaining details of the sighting. Birds were identified in the field using field marks learned from personal experience or these identification guides: Robbins et al. (1966), Peterson (1980), Farrand (1983), Scott (1983), Clark and Wheeler (1987), Dunn et al. (1988), and Kaufman (1990).

Bird Population Studies

The 1994 breeding bird studies were conducted in TR419 Forest (11.05 ha) and Council Cup Forest (6.00 ha) plots (Fig. E-1). Both forest plots are part of large wooded tracts fragmented by roads, farms, and transmission corridors. All birds were identified to species. Time and weather conditions were recorded during each count. Counts and surveys were not conducted during periods of inclement weather, such as heavy rains or high winds, when birds are more difficult to detect. Nomenclature follows the American Ornithologists' Union Check-list (1983, 1987, 1989, 1991, and 1993).

Nine breeding bird counts were conducted from 4 May through 29 July in each plot. Birds were counted by the spot-mapping method, in which each contact with a bird was located and registered on a daily count map (Hall 1964, Robbins 1970). The species, sex, and behavior (e.g., singing, aggression, nest building) of each bird were noted when applicable. Counts were begun within one hour of sunrise and conducted in early morning when bird activity is greatest.

Daily count map data were transferred to species maps and then analyzed. The number of breeding pairs was usually determined by counting the clusters formed by

registrations of conspicuous territorial males. Consideration was also given to locations of nests and females, and especially to simultaneous observations of territorial birds. The number of breeding pairs was rounded to the nearest half number according to convention (Robbins 1970). When a species was represented by less than 0.5 pair (territory), it was assigned a value of 0.1 for the sake of analysis. For each species, the following were calculated:

$$\textit{Density} = \frac{\textit{number of breeding pairs}}{\textit{km}^2}$$

$$\textit{Relative density (\% total)} = \frac{\textit{number of breeding pairs of a species}}{\textit{number of breeding pairs of all species}} \times 100$$

Breeding bird densities were tested for change over time with Daniels test for trend (Conover 1971). Densities were paired with years using Spearman's rank correlation coefficient (rho) to test trend over time. Critical values were found in Zar (1974). This approach to trend analysis does not assume normal distribution or linearity of trend (Forbes 1990). Its ranking procedure lessens the influence of unusual values. The null hypothesis is that year and bird densities are independent and the alternative is that bird densities change with time. Trend analysis was performed only on species with at least 0.5 territories for at least five years. Spearman's rank correlations were also conducted between appropriate bird densities in the two plots to evaluate similarities between TR419 and Council Cup Forests.

RESULTS AND DISCUSSION

From 1977 through 1994, 248 species of birds and 2 hybrids were observed within 8 km of Susquehanna SES. No species were added to the site list in 1994.

Species of Special Concern

Thirty-seven species of birds observed near the Susquehanna SES since 1977 are currently listed as Pennsylvania Species of Special Concern (Brauning et al. 1994). A summary of their history and status near the Susquehanna SES is presented in Table F-1. None of the species listed as endangered or threatened were found nesting near the Susquehanna SES, but some listed species were seen more frequently than in past years.

In 1994, four Pennsylvania endangered species were observed near Susquehanna SES: Osprey, Bald Eagle, Peregrine Falcon, and Black Tern. The U. S. Fish and Wildlife Service categorizes the Bald Eagle and Peregrine Falcon as Endangered (U. S. Department of the Interior 1994). The first three endangered species are recovering in northeastern United States, but none of them nest within 15 km of the power station.

Ospreys have become fairly common near the power station, especially near the river. There are no known nesting Ospreys in the immediate vicinity, but pairs nest along the lower Susquehanna River near Harrisburg and in the Poconos. The closest known nest is near Bear Creek in eastern Luzerne County.

Peregrine Falcons have been seen migrating through the area almost every year. There were two Peregrine Falcon sightings at Council Cup despite lower hawk-watch

coverage in October 1994. A state program has helped Peregrines in five Pennsylvania cities and raised public interest in this appealing bird (Brauning 1994a). Peregrine Falcons once nested on Council Cup bluff and several other cliffs along the Susquehanna River (Rice 1969).

There were more reports of Bald Eagles near Susquehanna SES in 1994 than in any previous year. At least two Bald Eagles apparently stayed in the Shickshinny - Berwick area during the winter of 1993-94. One was an adult and at least one immature bird with plumage characteristics of a third-year bird (McCollough 1989). Mid-air fights observed between two eagles near Shickshinny indicated either courtship or territoriality. Bald Eagles have been reestablishing themselves along Pennsylvania rivers and lakes (Leberman 1992). Since the Susquehanna River provides the necessary foraging and nesting locations, Bald Eagles might eventually nest in the area as part of its regional expansion.

Three species listed as Pennsylvania threatened were observed migrating near the Susquehanna SES in 1994, but none of them were observed breeding. Great Egrets were observed on several occasions along the Susquehanna River in late summer. Common Snipes were found in wet areas of the Susquehanna Riverlands during spring and autumn migrations. Two migrating Yellow-bellied Flycatchers were found in the Quarry-Hillside Forest on 13 May.

Few species listed as Pennsylvania candidates regularly nest near Susquehanna SES, so they have not been studied extensively (Table F-1). These species have not been studied thoroughly enough to detect population trends.

The presence, and sometimes increase, of several endangered and threatened species near Susquehanna SES indicate that habitats on PP&L lands near the power station are important to local wildlife. The wetlands, fields, and forests associated with the Susquehanna River provide important feeding and resting areas for several birds listed as Pennsylvania Species of Special Concern.

Bird Population Studies

Forty-eight species demonstrated some evidence of breeding in the 1994 study plots (Table F-2). There were 42 breeding species in TR419 Forest and 34 in Council Cup Forest. Red-eyed Vireo was the most common breeding species (highest density) in TR419 Forest and Ovenbird was the most common species in Council Cup Forest. The Kentucky Warbler was a new breeding species in TR419 Forest and Black-throated Green Warbler was new in Council Cup Forest.

Most birds that nest in these plots travel great distances to Latin America for the winter. These are the long-distance migrants. Residents are the next largest group, followed by the short-distance migrants. Resident species are important monitoring subjects because they nest and overwinter in the same area and thus experience local environmental stresses throughout the year. Many long-distance migrants are forest-obligate or forest interior species, while most residents and short-distance migrants are less sensitive to vegetational disturbances (Brittingham 1989, Freemark and Collins 1992). Forest-obligate species are important monitoring subjects because changes in their populations have the potential to reflect stresses on the forest food web.

Since the start of power station operation, the breeding populations of most species have been as high or higher than during preoperational years (Tables F-3 and F-4). Since the preoperation data set is relatively small and both forests were stressed by gypsy moth infestation in the early 1980's, emphasis is placed on long-term trends rather than before-after comparisons.

Many 1994 breeding bird densities are similar to previous years (Tables F-3 and F-4). It is evident that total bird densities (Fig. F-1) and densities of 20 common species (Figs. F-2 through F-4) have changed since the beginning of this study. Some changes are without an obvious pattern, but 27 species had significant or marginally significant trends in at least one of the study plots (Table F-5).

The TR419 Forest total breeding bird density was 37% higher than the average of 1980-93 and the third highest observed during the study (Table F-3; Fig. F-1). Twenty-seven species had densities that were above the average of previous years, while 28 species were below average or did not occur (Table F-3). Fifteen species had positive significant or marginally significant trends from 1980 to 1994, while five species had negative trends (Table F-5).

In Council Cup Forest, the 1994 total breeding bird density was the highest ever observed in the plot (Fig. F-1). Of the fifty species, half had higher than average breeding densities, while the other 25 were below average or did not occur (Table F-4). From 1980 to 1994, there were 11 species with positive trends that were significant or marginally significant and there was only one species with a significant negative trend (Table F-5).

Residents had fairly similar trends in both plots (Fig. F-1). Tufted Titmouse significantly increased in both forests while other residents seemed to vary without obvious trend. Most Pennsylvania resident species have increased or changed without trend in recent years (Brauning 1992, 1994b). Trends in these plots roughly reflect state-wide patterns.

Most decreases have been experienced by short-distance migrants which are generally considered edge or shrub species (Table F-5; Fig. F-3). The decline of the Rufous-sided Towhee in TR419 Forest is typical of a decline observed throughout the northeastern United States, including Pennsylvania (Gross 1992, Hagan 1993, Brauning 1994b). Forest maturization may be the main contributor to towhee decreases. Blue Jay declined significantly in TR419 Forest, but it seems to have recovered from a 1988 low in Council Cup (Table F-5; Fig. F-3). Cedar Waxwing provides an exception in this group by increasing significantly in both plots. Waxwings eat fruit produced by various shrubs and trees, including cherries (*Prunus* spp.) in and near the plots. In TR419 Forest, cherry trees increased in dominance by 34% from 1980 to 1994 ("Flora and Vegetation" in Ichthyological Associates 1981).

Several long-distance migrant forest birds have significantly increased in at least one of the plots during the study (Table F-5; Fig. F-4). Many long-distance migrants are forest interior birds that forage or nest in the canopy (DeGraff and Rudis 1986, Ehrlich et al. 1988, Brittingham 1989). This includes the Blue-gray Gnatcatcher, Yellow-throated Vireo, Red-eyed Vireo, American Redstart, and Scarlet Tanager. Increases in canopy volume as measured by tree dominance may account for the increases in many canopy-

dwelling birds (see "Flora and Vegetation"). Breeding bird densities can increase with canopy volume because larger trees provide more feeding substrate, nesting locations, and camoflage from nest predators.

Gypsy moth defoliation and subsequent tree mortality may have also influenced forest bird populations. The canopy gaps due to tree mortality create patches of herbaceous plants and woody shrubs including blackberries (*Rubus* spp.) used by several bird species in these plots. Several woody shrubs and herbs have significantly increased in both plots (see "Flora and Vegetation"). Eastern Wood-Pewee, Wood Thrush, Chestnut-sided Warbler, Hooded Warbler, and Indigo Bunting may benefit from the micro-habitat changes due to tree-fall gaps (Blake and Hoppes 1986, Yahner and Smith 1990). The increase in downed woody debris caused by tree mortality is also associated with higher populations of some forest birds, particularly Eastern Wood-Pewee, Worm-eating Warbler, and Ovenbird.

There were mixed results with long-distance migrant significant trends. There were increases in some area-sensitive species such as Ovenbird (both plots) and Worm-eating Warbler (TR419 Forest), but there were also some decreases. Great Crested Flycatcher declined in Council Cup Forest, while Black-and-white Warbler and Rose-breasted Grosbeak declined in TR419 Forest. It is difficult to determine the reasons for these trends, but some might be explained by changes in vegetation and associated food resources. Black-and-white Warbler is associated with higher densities of oaks, but declines as canopy cover increases, a consequence of forest maturization (Yahner and Smith 1990). The decrease of Rose-breasted Grosbeak, a forest edge and mid-story

species (Leberman 1992), might be related to declines in flowering dogwood and sapling density (see "Flora and Vegetation"). Since Ovenbirds and Worm-eating Warblers are area-sensitive forest-obligate species, their populations bear watching (Robbins et al. 1989). The reproductive success and breeding density of Ovenbirds is greater in large forest fragments (Porneluzi et al. 1993, Villard et al. 1993).

There is a widespread concern about declines in migratory forest birds (Terborgh 1989, Hagan and Johnston 1992). Some investigators have found evidence that many long-distance migrants may be declining because of problems on their breeding grounds (Böhning-Gause et al. 1993, Martin 1992). Forest fragmentation may be the chief culprit, indirectly causing nest depredation and a decrease in productivity (Robbins 1979, Temple and Cary 1988, Hoover 1992, Porneluzi et al.1993). Transmission corridor maintenance may be a confounding factor since some intense vegetation control methods have negative effects on many bird species (Chasko and Gates 1982). Except for some maintenance cutting at forest edges, both plots have not been noticeably disturbed by humans during the study period and have been allowed to mature naturally. For this reason, the trends observed in migratory forest birds in these forests run counter to the pattern of decline in similar breeding bird plot data sets in eastern United States, but are similar to trends observed in Pennsylvania generally (Holmes and Sherry 1988, Johnston and Hagan 1992, Brauning 1994b). Like many forests in rural Pennsylvania, TR419 and Council Cup are relatively mature and are not suffering from the severe fragmentation experienced in more heavily developed parts of the Northeast where many similar studies have taken place.

Many patterns of population change in TR419 Forest (within 0.3 km of the Unit 1 Cooling Tower) have been similar to the patterns in Council Cup Forest, which is 3 km from the cooling towers (Figs. F-2 through F-4). The total breeding bird densities of the two plots were significantly correlated through time and several species significantly increased during the study period in both forests (Table F-5). Many of the trends observed in these plots are similar to ones recently observed in Pennsylvania generally (Brauning 1992, 1994b). Since many resident and forest-obligate species have increased in TR419 Forest, the power station probably has not put significant stress on the forest food web.

The patterns and trends found in these bird population data sets suggest that many, but perhaps not all, changes in bird populations are due to factors other than power station operation that are common to both plots. These may include, but are not limited to general forest maturization, gypsy moth infestations, the effects of plant diseases on vegetation (dogwood leaf anthracnose), and weather (droughts). Many species that have declined at other locations in eastern United States have increased or been stable in the two forest plots studied here. Most breeding bird densities during operational years were similar to or higher than preoperational years. This suggests that Susquehanna SES operation has not been a negative factor to most bird species living nearby. There is, however, a lack of data about nesting productivity and survivalship of birds in these forests due to the large amount of resources this kind of research would require. The Bird Program was discontinued for 1995.

Table F-1

Pennsylvania bird Species of Special Concern observed near Susquehanna SES, 1977-94. The following were used to review local and historical status: Warren (1890), Poole (1964), Gill (1985), and Brauning et al. (1994).

CATEGORY* Species	1994 STATUS NEAR SUSQUEHANNA SES
ENDANGERED	
Osprey	A regular and relatively common migrant along the Susquehanna River and along ridges near the power station. Ospreys were observed fishing or resting several times on PP&L property, especially the Susquehanna Riverlands. Over 30 were counted as they flew by Council Cup Overlook and the Susquehanna Riverlands in autumn migration. At least 20 pairs nested in Pennsylvania, primarily in the Poconos. Ospreys nest in eastern Luzerne County and along the Susquehanna River near Harrisburg, but no nests were found within 15 km of the power station.
** Bald Eagle	There were more eagle sightings near the power station than in any previous year. Most eagles were seen along the river or near Council Cup Overlook (7 sightings). At least two Bald Eagles, an adult and an immature, apparently stayed in the Shickshinny-Berwick area during the winter of 1993-94. The Bald Eagle is recovering in Pennsylvania from a status of near extirpation to a breeding population of 18 pairs. Earlier this century, Bald Eagles nested locally along the Susquehanna River, possibly near Wapwallopen.
** Peregrine Falcon	A rare but regular migrant in all seasons, mostly in autumn. Three Peregrines were observed at Council Cup Overlook in 1994. Peregrine Falcons nested on Council Cup bluff as late as 1960, producing fledglings that year.
King Rail	Never observed near Susquehanna SES. No history of nesting nearby.
Black Tern	A juvenile bird was observed flying over the Susquehanna River on 13 June 1994. Black Tern is a rare migrant in Luzerne County. There is no history of nesting nearby. The closest nesting populations are in northwestern Pennsylvania and the Lake Ontario region of New York. A species in decline in northeastern states.
Short-eared Owl	A rare migrant at Susquehanna SES with no history of nesting nearby. None observed in 1994; last observed 30 December 1985.
THREATENED	
American Bittern	A rare but regular migrant in wetlands. None observed in 1994; last observed in the Wetlands Nature Area on 23 April 1992. Historically, American Bittern may have nested in the area, but no nestings have been documented since these studies began.
Least Bittern	A rare but regular migrant in the Wetlands Nature Area. No known local nesting. None observed in 1994; last observed 13 May 1989.
Great Egret	An uncommon but fairly regular migrant. Some were observed along the river in post-breeding dispersal in August and September. Never known to nest locally, but does nest along the lower Susquehanna River.
Yellow-crowned Night-Heron	Never observed near Susquehanna SES, but nests along the lower Susquehanna River.
Upland Sandpiper	None observed in 1994. The only recent record was a single bird seen over the Susquehanna Riverlands, 7 April 1993. Historically, the Upland Sandpiper nested in grasslands of the Susquehanna River valleys, including sites near Montour SES.

Table F-1 (cont.)

CATEGORY* Species	1994 STATUS NEAR SUSQUEHANNA SES
THREATENED (cont.)	
Common Snipe	An uncommon but regular migrant in wetlands near Susquehanna SES. A few were seen in the Susquehanna Riverlands and Wetlands Nature Area in 1994. Small numbers nest in northern Pennsylvania; population is declining in state.
Yellow-bellied Flycatcher	A rare migrant near Susquehanna SES. Two were observed in Quarry-Hillside Forest on 13 May 1994. A rare local nester in some forested wetlands about 80 km north of Susquehanna SES.
Sedge Wren	No observations in 1994. Only observation was in the Wetlands Nature Area, 6 May 1992. No records of nesting nearby.
EXTIRPATED	
Greater Prairie-Chicken	No records for immediate area, but the Heath Hen (Pennsylvania's subspecies) nested in northeastern Pennsylvania, including Luzerne County.
Piping Plover	Never observed in area. Not believed to have nested nearby.
Common Tern	An uncommon migrant along the Susquehanna River. No records of local nesting. Last sighting in spring 1991.
Olive-sided Flycatcher	A rare but regular migrant in wetlands, woods, and fence rows. None observed in 1994, but one visited the Wetlands Nature Area, 23-27 September 1992. This species once nested within 25 km of Berwick.
Bewick's Wren	Never observed near Susquehanna SES. No historical records.
Loggerhead Shrike	A rare migrant. No known local nesting. None observed in 1994; last sighting, 23 April 1983.
Bachman's Sparrow	Never observed near Susquehanna SES. No historical records.
CANDIDATE – AT RISK	
Snowy Egret	None observed in 1994. A rare migrant in wetlands, especially along the Susquehanna River. No records of nesting nearby.
Northern Harrier	An uncommon migrant throughout the area. Not known to nest in study area, but probably nests within 20 km of Susquehanna SES.
Barn Owl	A rare local nesting species which is reported to nest on farms within 8 km of Susquehanna SES. It has nested in large trees in Beach Haven.
Prothonotary Warbler	None observed in 1994. A rare migrant with no history of nesting near Susquehanna SES. It has been increasing in parts of the state.
CANDIDATE – RARE	
Green-winged Teal	An uncommon but regular migrant. Regularly seen in the Wetlands Nature Area. This species nests in wetlands 55 km north of Susquehanna SES.
Northern Goshawk	A rare but regular migrant. This species nests in extensive mature forests throughout northern Pennsylvania.
American Coot	An uncommon migrant for which there are no local records of nesting. Regularly seen in the Wetlands Nature Area in spring and autumn.

Table F-1 (cont.)

CATEGORY* Species	1994 STATUS NEAR SUSQUEHANNA SES
CANDIDATE -- RARE (cont.)	
Marsh Wren	A rare migrant for which there are no local records of nesting. There were no 1994 records, but two birds were observed in the Wetlands Nature Area, 28 April 1993. Although it has never been documented nesting here, this wren nests in some northeastern Pennsylvania marshes.
Swainson's Thrush	An uncommon but regular migrant in forests near Susquehanna SES. In recent years, some breeding has been documented on the plateau approximately 50 km north of Susquehanna SES.
Summer Tanager	An occasional migrant with only one local observation in 1979. No history of nesting in area.
CANDIDATE -- UNDETERMINED	
Cattle Egret	An uncommon migrant with no history of nesting nearby.
Northern Pintail	An uncommon but regular migrant with no history of nesting nearby.
Northern Shoveler	A rare migrant with no history of nesting nearby.
American Wigeon	An uncommon but regular migrant with no history of nesting nearby.
Ruddy Duck	A rare migrant with no record of nesting nearby.
Northern Bobwhite	An uncommon resident which is regularly stocked throughout the area. Local history and status is obscured by these stocking attempts.
Long-eared Owl	A rare migrant and possible nesting species in the area. None were observed in 1994, but a pair nested near Benton, Columbia County, within 32 km of Susquehanna SES.
Northern Saw-whet Owl	A rare migrant which nests in high elevations within 50 km of Susquehanna SES. None observed in 1994.
Common Nighthawk	Common, but perhaps declining, nesting bird in Berwick area. Many migrated through area in August.
Whip-poor-will	Rare nesting species which was once much more common in local woods and farms. None observed in 1994.
Henslow's Sparrow	Never observed at Susquehanna SES. This species has a history of nesting in various northern Luzerne County locations.
Dickcissel	An occasional migrant with no record of nesting nearby. One impacted on a cooling tower in 1979.
Red Crossbill	An erratic and rare migrant, primarily in autumn and winter. None observed in 1994. Historically, this conifer specialist once nested in Luzerne County, but is poorly documented.
EXTINCT	
Passenger Pigeon	An abundant bird in this area in the nineteenth century.

* Breeding status within the state. Extirpated is treated by the Pennsylvania Game Commission as a subcategory of endangered.
** Federal endangered species list.

Table F-2

Number of breeding pairs, density (no./sq km), and relative density (% total) of bird species in TR419 and Council Cup Forests, 1994.

MIGRATORY STATUS	TR419 FOREST			COUNCIL CUP FOREST		
Species	Pairs	Density	% Total	Pairs	Density	% Total
RESIDENTS	**16.4**	**148.2**	**15.3**	**18.5**	**308.4**	**26.5**
Red-tailed Hawk	1.0	9.0	0.9	0.0	0.0	0.0
Ruffed Grouse	0.1	0.9	0.1	0.5	8.3	0.7
Downy Woodpecker	3.0	27.1	2.8	1.5	25.0	2.1
Hairy Woodpecker	0.1	0.9	0.1	1.0	16.7	1.4
Pileated Woodpecker	0.1	0.9	0.1	0.5	8.3	0.7
American Crow	1.0	9.0	0.9	1.0	16.7	1.4
Black-capped Chickadee	4.0	36.2	3.7	7.0	116.7	10.0
Tufted Titmouse	6.0	54.3	5.6	3.0	50.0	4.3
White-breasted Nuthatch	0.1	0.9	0.1	3.0	50.0	4.3
Northern Cardinal	1.0	9.0	0.9	1.0	16.7	1.4
SHORT-DISTANCE MIGRANTS	**10.7**	**96.7**	**10.0**	**12.1**	**201.8**	**17.3**
Northern Flicker	0.5	4.5	0.5	0.1	1.7	0.1
Blue Jay	1.0	9.0	0.9	1.5	25.0	2.1
Fish Crow	0.1	0.9	0.1	0.0	0.0	0.0
Red-breasted Nuthatch	0.0	0.0	0.0	1.0	16.7	1.4
Brown Creeper	0.0	0.0	0.0	0.5	8.3	0.7
American Robin	2.0	18.1	1.9	3.0	50.0	4.3
Cedar Waxwing	2.0	18.1	1.9	1.0	16.7	1.4
Rufous-sided Towhee	0.1	0.9	0.1	0.0	0.0	0.0
Brown-headed Cowbird	4.0	36.2	3.7	4.0	66.7	5.7
American Goldfinch	1.0	9.0	0.9	1.0	16.7	1.4
LONG-DISTANCE MIGRANTS	**80.4**	**727.1**	**74.8**	**39.3**	**655.4**	**56.2**
Yellow-billed Cuckoo	0.0	0.0	0.0	1.0	16.7	1.4
Ruby-throated Hummingbird	1.0	9.0	0.9	0.0	0.0	0.0
Eastern Wood-Pewee	6.5	58.8	6.0	3.0	50.0	4.3
Great Crested Flycatcher	0.1	0.9	0.1	1.0	16.7	1.4
Eastern Kingbird	0.0	0.0	0.0	0.1	1.7	0.1
House Wren	0.1	0.9	0.1	0.0	0.0	0.0
Blue-gray Gnatcatcher	5.0	45.2	4.7	2.0	33.3	2.9
Wood Thrush	8.0	72.4	7.4	2.5	41.7	3.6
Gray Catbird	3.5	31.7	3.3	0.0	0.0	0.0
Solitary Vireo	0.0	0.0	0.0	2.5	41.7	3.6
Yellow-throated Vireo	1.5	13.6	1.4	0.0	0.0	0.0
Red-eyed Vireo	15.0	135.7	14.0	5.5	91.7	7.9
Yellow Warbler	0.1	0.9	0.1	0.0	0.0	0.0
Chestnut-sided Warbler	0.5	4.5	0.5	0.0	0.0	0.0
Black-throated Green Warbler	0.0	0.0	0.0	1.0	16.7	1.4
Blackburnian Warbler	1.0	9.0	0.9	0.0	0.0	0.0
Pine Warbler	1.0	9.0	0.9	0.1	1.7	0.1
Black-and-white Warbler	1.0	9.0	0.9	1.0	16.7	1.4
American Redstart	9.0	81.4	8.4	1.0	16.7	1.4
Worm-eating Warbler	3.0	27.1	2.8	0.0	0.0	0.0
Ovenbird	7.5	67.9	7.0	10.0	166.7	14.3
Kentucky Warbler	0.1	0.9	0.1	0.0	0.0	0.0
Common Yellowthroat	0.5	4.5	0.5	0.0	0.0	0.0
Hooded Warbler	2.5	22.6	2.3	0.0	0.0	0.0
Scarlet Tanager	9.0	81.4	8.4	7.0	116.7	10.0
Rose-breasted Grosbeak	1.5	13.6	1.4	0.5	8.3	0.7
Indigo Bunting	2.0	18.1	1.9	0.1	1.7	0.1
Northern Oriole	1.0	9.0	0.9	1.0	16.7	1.4
TOTAL	**107.5**	**972.0**		**69.9**	**1165.6**	

Table F-3

Comparison of breeding bird densities observed in TR419 Forest in 1994 with prior study years (1980-93) and during preoperation (1980-82) and operation (1983-94) of the Susquehanna SES.

MIGRATORY STATUS	1994	1980-93		PREOPERATION		OPERATION	
Species		Mean	SD	Mean	SD	Mean	SD
RESIDENTS	**148.2**	**163.3**	**73.9**	**132.4**	**15.8**	**169.8**	**34.0**
Red-tailed Hawk	9.0	2.6	3.5	3.0	4.3	3.1	3.6
Ruffed Grouse	0.9	1.1	2.2	0.3	0.4	1.3	2.4
Wild Turkey	0.0	0.1	0.2	0.0	0.0	0.1	0.2
Eastern Screech-Owl	0.0	0.7	2.3	0.0	0.0	0.8	2.5
Great Horned Owl	0.0	0.8	2.3	0.0	0.0	1.0	2.4
Downy Woodpecker	27.1	22.9	9.1	18.1	0.0	24.5	9.5
Hairy Woodpecker	0.9	6.3	6.8	3.6	3.8	6.5	7.1
Pileated Woodpecker	0.9	1.2	1.4	0.3	0.4	1.4	1.4
American Crow	9.0	2.0	2.6	0.0	0.0	3.1	3.1
Black-capped Chickadee	36.2	44.3	7.7	40.7	9.8	44.5	6.9
Tufted Titmouse	54.3	46.5	15.0	31.7	9.8	50.9	12.9
White-breasted Nuthatch	0.9	8.3	5.2	10.6	5.6	7.1	5.0
Carolina Wren	0.0	3.6	6.4	0.0	0.0	4.2	6.7
Northern Cardinal	9.0	22.9	9.3	24.1	4.2	21.5	10.5
SHORT-DISTANCE MIGRANTS	**96.7**	**121.7**	**23.5**	**137.3**	**10.7**	**115.7**	**23.9**
Sharp-shinned Hawk	0.0	0.1	0.2	0.0	0.0	0.1	0.2
Northern Flicker	4.5	8.9	6.9	13.6	6.4	7.4	6.3
Blue Jay	9.0	25.2	9.5	36.2	3.7	21.1	8.7
Fish Crow	0.9	0.6	2.3	0.0	0.0	0.8	2.5
Brown Creeper	0.0	3.3	4.3	6.0	4.3	2.3	3.9
American Robin	18.1	6.0	6.1	15.1	2.1	4.7	5.7
Cedar Waxwing	18.1	26.2	17.1	6.0	4.3	30.5	14.9
Rufous-sided Towhee	0.9	6.1	8.1	18.1	3.7	2.6	5.2
Chipping Sparrow	0.0	5.8	8.3	0.0	0.0	6.8	8.6
Brown-headed Cowbird	36.2	37.2	7.7	42.2	4.3	35.8	7.5
American Goldfinch	9.0	2.3	5.0	0.0	0.0	3.5	5.5
LONG-DISTANCE MIGRANTS	**727.1**	**426.0**	**117.8**	**292.8**	**25.2**	**501.1**	**125.3**
Broad-winged Hawk	0.0	0.1	0.2	0.0	0.0	0.1	0.2
Yellow-billed Cuckoo	0.0	2.2	4.2	4.8	6.2	1.1	2.7
Ruby-throated Hummingbird	9.0	0.8	2.4	0.0	0.0	1.6	3.3
Eastern Wood-Pewee	58.8	35.1	16.2	19.6	9.3	42.6	14.9
Great Crested Flycatcher	0.9	4.5	3.8	6.3	3.8	4.1	3.7
Eastern Kingbird	0.0	0.5	1.2	0.0	0.0	0.5	1.2
House Wren	0.9	5.5	5.3	0.6	0.4	6.3	5.1
Blue-gray Gnatcatcher	45.2	20.3	17.6	4.8	6.2	29.8	19.6
Veery	0.0	0.8	2.4	3.3	4.1	0.1	0.3
Wood Thrush	72.4	47.3	11.0	42.2	8.5	51.3	12.2
Gray Catbird	31.7	10.9	8.1	16.6	7.7	11.4	9.2
Solitary Vireo	0.0	0.7	2.4	0.0	0.0	0.8	2.5
Yellow-throated Vireo	13.6	5.9	7.0	0.0	0.0	8.3	6.6
Red-eyed Vireo	135.7	73.8	36.2	33.2	2.1	91.2	32.8
Yellow Warbler	0.9	0.1	0.3	0.0	0.0	0.2	0.4
Chestnut-sided Warbler	4.5	1.6	2.7	4.5	3.7	1.7	2.7
Blackburnian Warbler	9.0	2.4	3.8	0.0	0.0	3.5	4.1
Pine Warbler	9.0	4.2	4.5	3.0	4.3	4.5	4.5
Black-and-white Warbler	9.0	12.4	11.2	10.9	7.3	11.4	11.6
American Redstart	81.4	28.7	26.7	6.3	5.3	41.2	28.2
Worm-eating Warbler	27.1	12.5	8.3	3.0	4.3	16.6	7.2
Ovenbird	67.9	34.1	14.8	19.6	4.3	42.6	15.9
Kentucky Warbler	0.9	0.0	0.0	0.0	0.0	0.1	0.2
Mourning Warbler	0.0	0.1	0.2	0.0	0.0	0.1	0.2
Common Yellowthroat	4.5	1.2	2.3	3.3	4.1	0.9	1.2
Hooded Warbler	22.6	17.4	7.7	13.6	3.7	21.1	10.5
Scarlet Tanager	81.4	62.3	13.3	42.2	9.3	69.4	7.2
Rose-breasted Grosbeak	13.6	27.1	10.2	39.2	2.1	23.0	8.5
Indigo Bunting	18.1	7.3	10.1	3.6	3.8	10.4	11.1
Northern Oriole	9.0	6.3	6.0	12.0	7.7	5.3	4.0
TOTAL	**972.0**	**711.0**	**155.2**	**562.5**	**21.5**	**786.5**	**150.6**

Table F-4

Comparison of breeding bird densities observed in Council Cup Forest in 1994 with prior study years (1980-93) and during preoperation (1980-82) and operation (1983-94) of the Susquehanna SES.

MIGRATORY STATUS	1994	1980-93		PREOPERATION		OPERATION	
Species		Mean	SD	Mean	SD	Mean	SD
RESIDENTS	**308.4**	**211.5**	**58.2**	**145.6**	**20.1**	**236.0**	**54.3**
Red-tailed Hawk	0.0	0.4	0.7	0.0	0.0	0.4	0.7
Ruffed Grouse	8.3	4.3	8.5	1.7	0.0	5.3	9.1
Wild Turkey	0.0	0.1	0.4	0.0	0.0	0.1	0.5
Eastern Screech-Owl	0.0	0.7	2.2	0.0	0.0	0.8	2.3
Great Horned Owl	0.0	1.8	4.2	0.6	0.8	1.9	4.5
Downy Woodpecker	25.0	23.8	9.9	13.9	3.9	26.4	8.9
Hairy Woodpecker	16.7	13.8	9.6	13.9	0.0	14.0	10.2
Pileated Woodpecker	8.3	3.6	3.0	3.9	3.1	3.9	3.1
American Crow	16.7	3.0	3.4	2.8	3.9	4.2	4.9
Black-capped Chickadee	116.7	87.5	19.6	69.4	14.2	94.5	18.4
Tufted Titmouse	50.0	45.8	18.6	25.0	11.8	51.4	15.2
White-breasted Nuthatch	50.0	21.6	14.2	11.7	7.1	26.4	15.5
Northern Cardinal	16.7	5.1	6.6	2.8	3.9	6.7	7.4
SHORT-DISTANCE MIGRANTS	**201.8**	**179.7**	**41.2**	**156.7**	**19.6**	**187.2**	**41.6**
Cooper's Hawk	0.0	0.1	0.4	0.0	0.0	0.1	0.5
Northern Flicker	1.7	8.7	9.2	17.2	12.9	6.0	5.9
Blue Jay	25.0	35.1	10.5	38.9	3.9	33.3	11.3
Red-breasted Nuthatch	16.7	1.2	2.9	2.8	3.9	2.1	5.0
Brown Creeper	8.3	8.6	10.3	0.0	0.0	10.7	10.0
Hermit Thrush	0.0	1.1	2.1	0.6	0.8	1.1	2.3
American Robin	50.0	16.4	11.1	22.2	7.9	17.8	14.5
Cedar Waxwing	16.7	39.9	17.9	19.4	14.2	43.1	15.9
Rufous-sided Towhee	0.0	3.2	4.6	1.7	0.0	3.3	5.0
Chipping Sparrow	0.0	11.7	11.3	3.3	3.6	12.8	11.7
Brown-headed Cowbird	66.7	53.6	15.3	50.0	13.6	55.6	15.3
American Goldfinch	16.7	0.1	0.4	0.6	0.8	1.4	4.6
LONG-DISTANCE MIGRANTS	**655.4**	**448.2**	**62.5**	**405.0**	**73.6**	**476.3**	**74.3**
Broad-winged Hawk	0.0	2.6	5.8	11.7	7.1	0.1	0.5
Black-billed Cuckoo	0.0	0.7	2.1	0.6	0.8	0.7	2.3
Yellow-billed Cuckoo	16.7	6.8	8.9	19.4	3.9	4.5	7.1
Ruby-throated Hummingbird	0.0	0.8	2.2	2.8	3.9	0.3	0.6
Eastern Wood-Pewee	50.0	49.4	20.0	27.8	10.4	54.9	17.2
Great Crested Flycatcher	16.7	28.0	8.7	33.3	0.0	25.7	9.3
Eastern Kingbird	1.7	0.1	0.4	0.0	0.0	0.3	0.6
Blue-gray Gnatcatcher	33.3	10.0	10.9	20.0	13.4	9.4	10.7
Veery	0.0	0.1	0.4	0.0	0.0	0.1	0.5
Wood Thrush	41.7	44.1	15.9	44.4	15.7	43.8	15.3
Solitary Vireo	41.7	4.3	6.8	2.8	3.9	7.8	12.4
Red-eyed Vireo	91.7	86.3	18.5	61.1	7.9	93.1	13.5
Black-throated Blue Warbler	0.0	0.1	0.4	0.0	0.0	0.1	0.5
Black-throated Green Warbler	16.7	0.0	0.0	0.0	0.0	1.4	4.6
Blackburnian Warbler	0.0	2.5	5.8	0.0	0.0	2.9	6.2
Pine Warbler	1.7	0.0	0.0	0.0	0.0	0.1	0.5
Black-and-white Warbler	16.7	22.4	13.4	30.6	10.4	19.9	12.7
American Redstart	16.7	0.6	2.1	0.0	0.0	2.1	5.0
Worm-eating Warbler	0.0	3.3	4.9	8.3	6.8	1.8	3.0
Ovenbird	166.7	92.9	29.7	61.1	21.9	106.9	30.2
Canada Warbler	0.0	0.1	0.4	0.0	0.0	0.1	0.5
Scarlet Tanager	116.7	60.7	14.6	61.1	7.9	65.3	21.7
Rose-breasted Grosbeak	8.3	25.1	13.5	17.2	17.5	25.7	12.0
Indigo Bunting	1.7	2.4	2.5	1.7	0.0	2.5	2.7
Northern Oriole	16.7	4.9	4.7	1.1	0.8	6.8	5.5
TOTAL	**1165.6**	**839.4**	**116.6**	**707.2**	**107.2**	**899.6**	**117.7**

Table F-5

Daniels' test for trend over time (1980-94) in breeding bird densities of common species and correlations between these densities in TR419 and Council Cup Forest plots. Trend test was Spearman's rank correlation coefficient (rho). Analysis was limited to species with at least 0.5 territory in at least five years of the study period.

MIGRATORY STATUS Species	TR419 FOREST rho	 P	COUNCIL CUP FOREST rho	 P	CORRELATION BETWEEN PLOTS rho	 P
RESIDENTS	**0.589**	**0.020 ****	**0.780**	**0.000 ****	**0.604**	**0.017 ****
Red-tailed Hawk	0.291	0.281				
Downy Woodpecker	0.342	0.204	0.586	0.021 **	0.242	0.374
Hairy Woodpecker	-0.006	0.974	0.117	0.667	0.340	0.209
Pileated Woodpecker			0.262	0.339		
American Crow	0.800	0.000 **	0.711	0.003 **	0.601	0.018 **
Black-capped Chickadee	-0.396	0.138	0.476	0.071 *	0.209	0.441
Tufted Titmouse	0.800	0.000 **	0.595	0.018 **	0.743	0.001 **
White-breasted Nuthatch	-0.188	0.489	0.492	0.060 *	-0.071	0.792
Northern Cardinal	-0.029	0.913	0.720	0.002 **	0.346	0.199
SHORT-DISTANCE MIGRANTS	**-0.345**	**0.199**	**0.497**	**0.058 ***	**-0.072**	**0.792**
Northern Flicker	-0.268	0.325	-0.092	0.734	-0.262	0.339
Blue Jay	-0.705	0.003 **	-0.317	0.240	0.540	0.037 **
Brown Creeper	-0.359	0.185	0.520	0.046 **	0.256	0.346
American Robin	-0.382	0.154	0.267	0.325	0.291	0.281
Cedar Waxwing	0.705	0.003 **	0.334	0.214	0.527	0.043 **
Rufous-sided Towhee	-0.736	0.001 **				
Chipping Sparrow	0.401	0.134	-0.167	0.540	0.303	0.263
Brown-headed Cowbird	-0.442	0.095 *	0.344	0.204	-0.132	0.629
LONG-DISTANCE MIGRANTS	**0.940**	**0.000 ****	**0.509**	**0.050 ****	**0.416**	**0.117**
Yellow-billed Cuckoo			-0.290	0.287		
Eastern Wood-Pewee	0.780	0.000 **	0.623	0.012 **	0.619	0.014 **
Great Crested Flycatcher	0.096	0.724	-0.661	0.007 **	0.277	0.306
House Wren	0.281	0.300				
Blue-gray Gnatcatcher	0.780	0.000 **	-0.354	0.189	-0.448	0.089 *
Wood Thrush	0.535	0.038 **	-0.261	0.339	-0.400	0.134
Gray Catbird	-0.029	0.913				
Solitary Vireo			0.397	0.138		
Yellow-throated Vireo	0.760	0.000 **				
Red-eyed Vireo	0.910	0.000 **	0.553	0.031 **	0.721	0.002 **
Chestnut-sided Warbler	0.196	0.473				
Blackburnian Warbler	0.830	0.000 **				
Pine Warbler	0.217	0.426				
Black-and-white Warbler	-0.579	0.023 **	-0.295	0.275	0.238	0.381
American Redstart	0.860	0.000 **				
Worm-eating Warbler	0.840	0.000 **				
Ovenbird	0.750	0.000 **	0.681	0.005 **	0.780	0.000 **
Hooded Warbler	0.820	0.000 **				
Scarlet Tanager	0.647	0.009 **	0.429	0.107	0.364	0.176
Rose-breasted Grosbeak	-0.656	0.007 **	0.305	0.257	-0.188	0.489
Indigo Bunting	0.662	0.007 **				
Northern Oriole	-0.190	0.489	0.720	0.002 **	0.024	0.923
TOTAL	**0.900**	**0.000 ****	**0.870**	**0.000 ****	**0.800**	**0.000 ****

* Marginally significant at $P \leq 0.10$
** Significant at $P \leq 0.05$

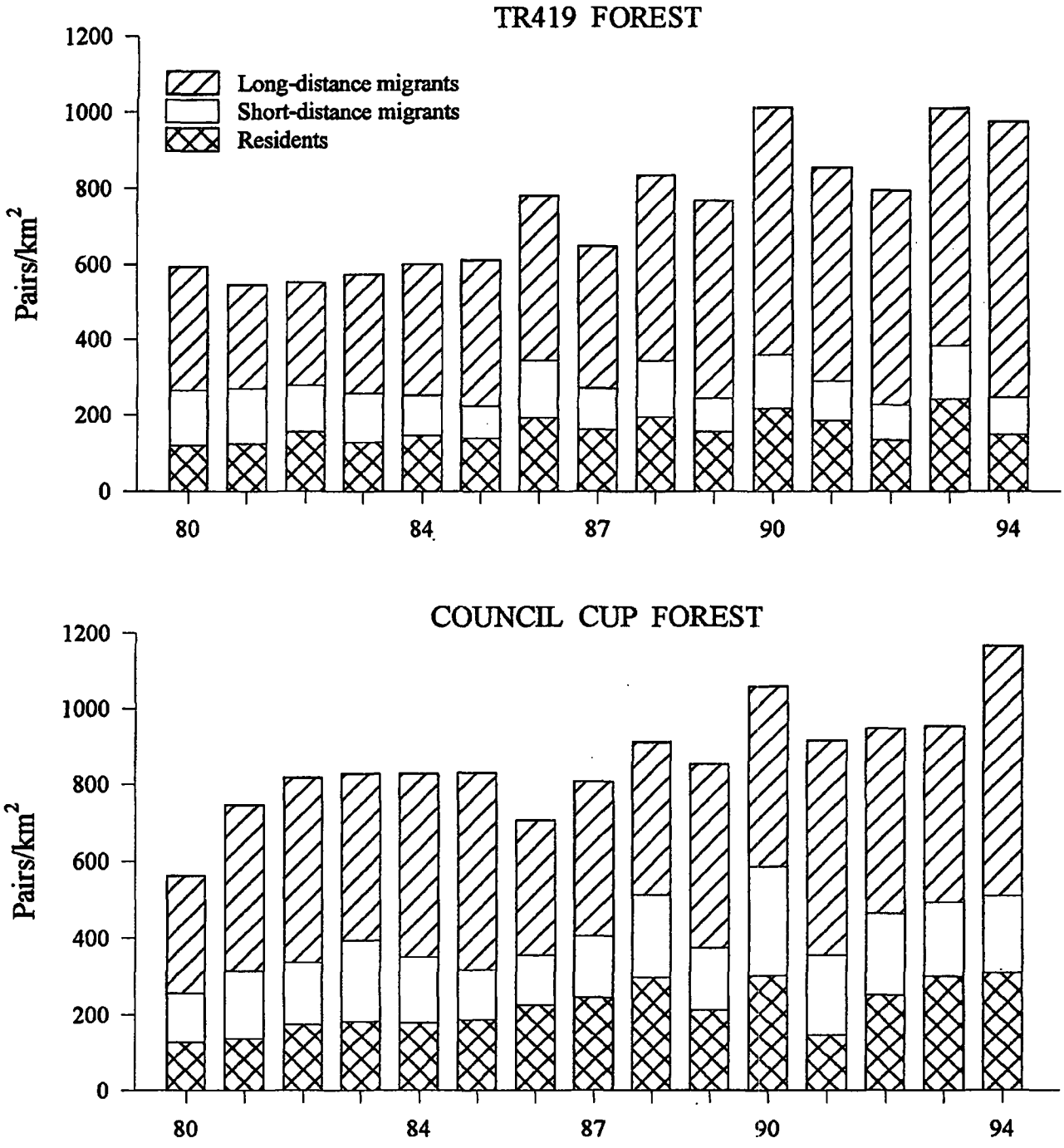


Fig. F-1

Total breeding bird densities in TR419 and Council Cup Forests during preoperation (1980-82) and operation (1983-94) of the Susquehanna SES .

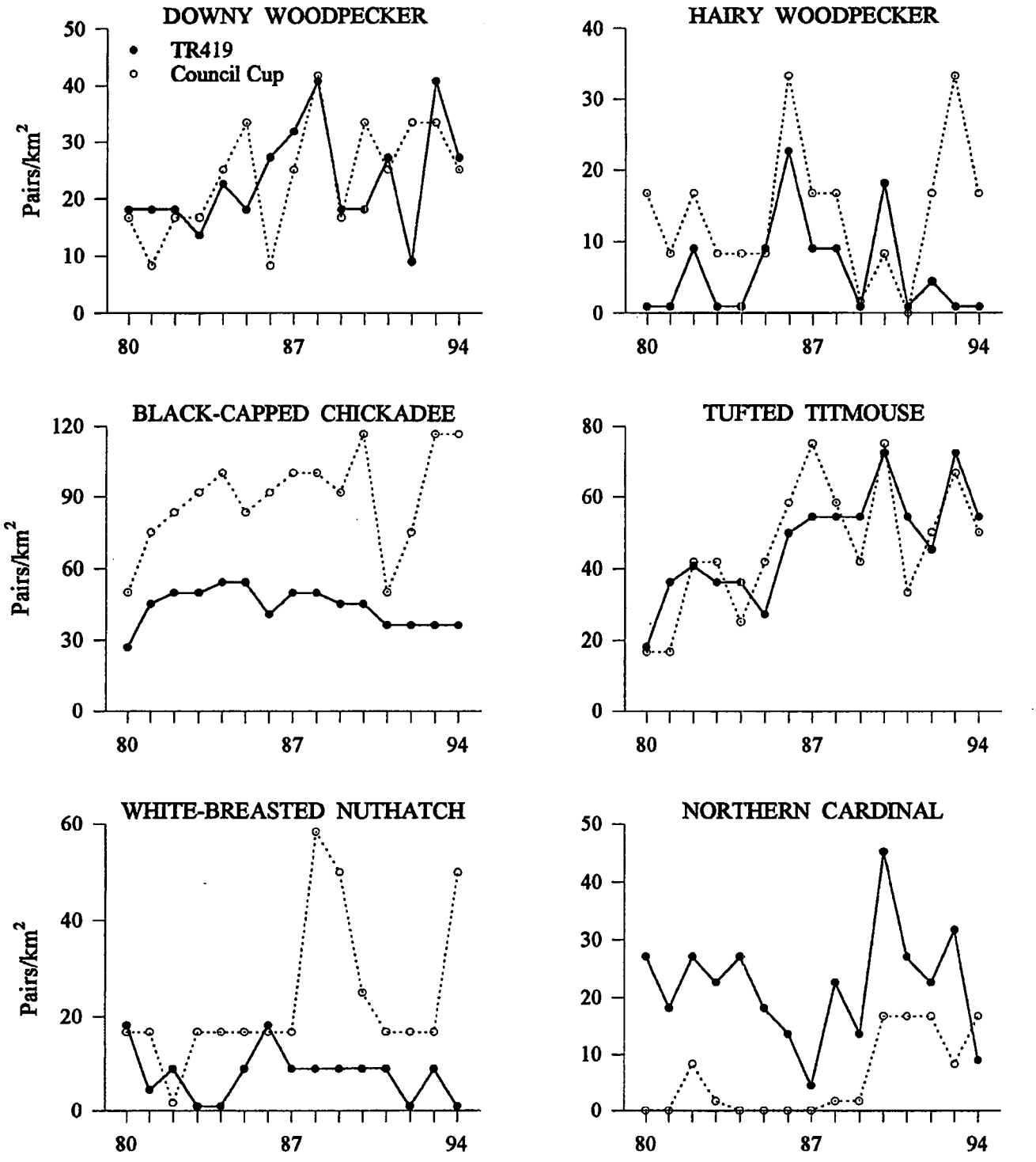


Fig. F-2

Breeding densities of six common resident species in TR419 and Council Cup Forests during preoperation (1980-82) and operation (1983-94) of the Susquehanna SES.

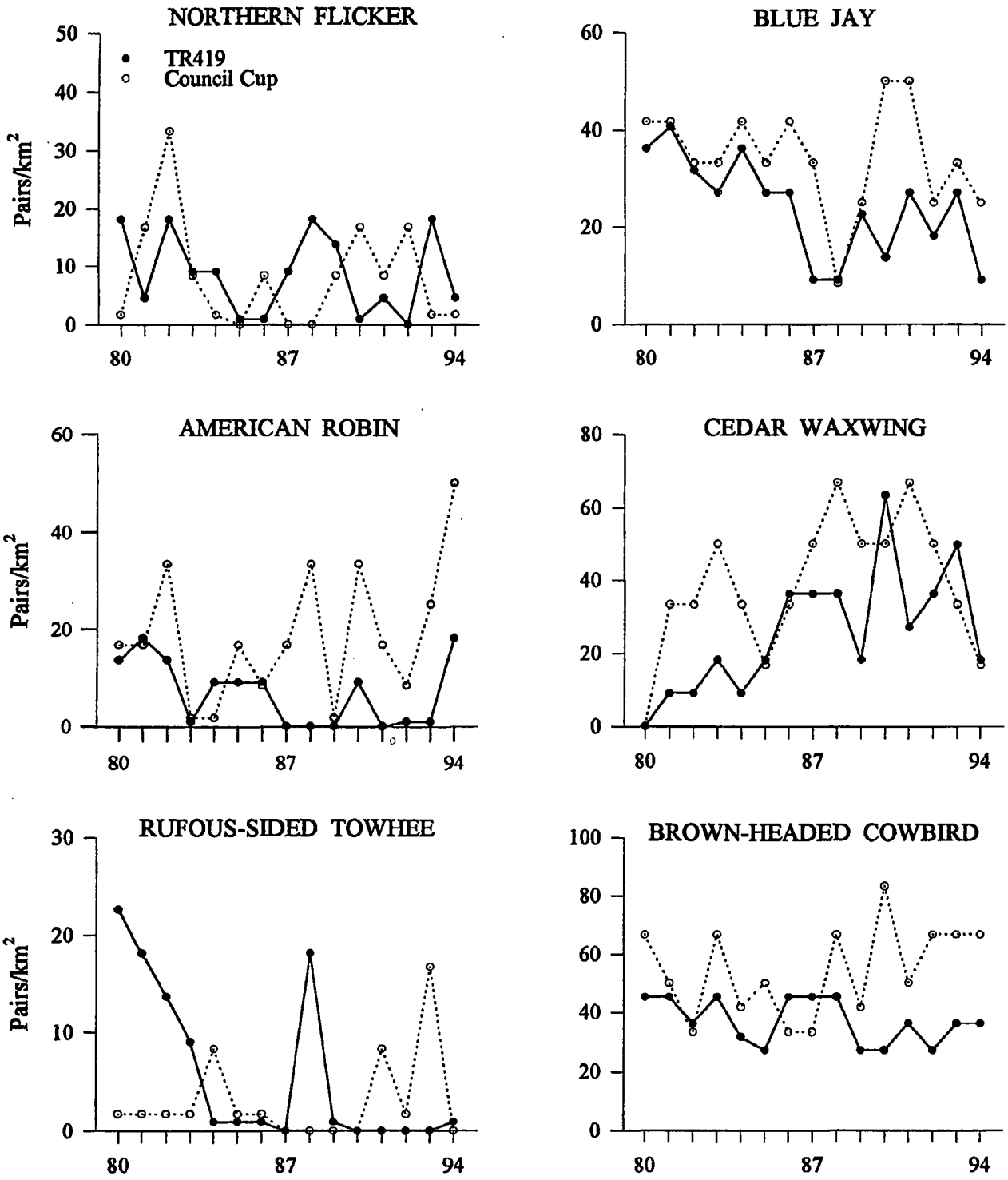


Fig. F-3

Breeding densities of six common short-distance migrant species in TR419 and Council Cup Forests during preoperation (1980-82) and operation (1983-94) of the Susquehanna SES.

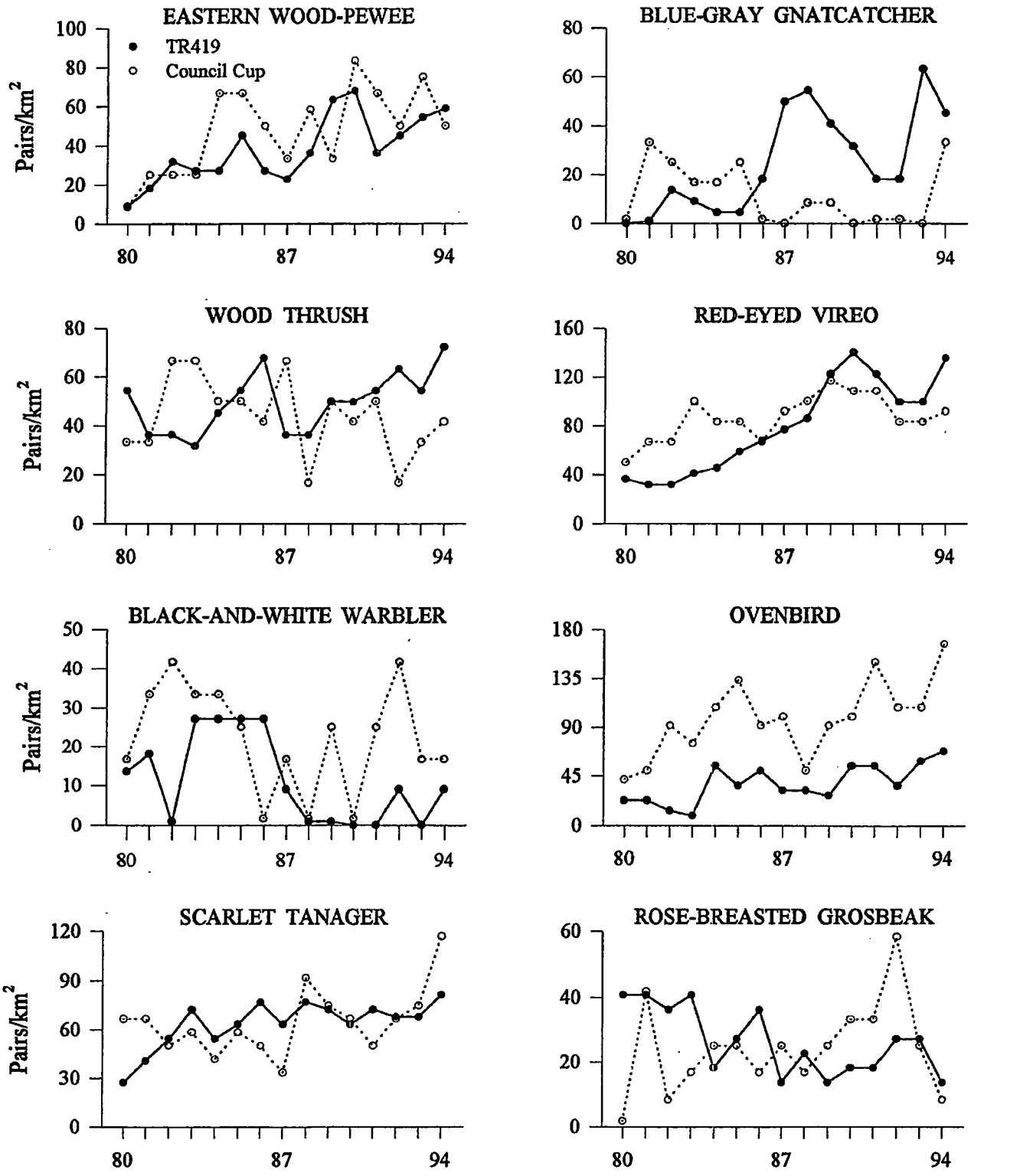


Fig. F-4

Breeding densities of eight common long-distance migrant species in TR419 and Council Cup Forests during preoperation (1980-82) and operation (1983-94) of the Susquehanna SES.

RAI ENV-25
Question TE 7343:

ESRP Section 4.3.1 directs the staff's description, quantification, and assessment of the impacts of construction of the proposed facilities on the terrestrial ecosystem. ER Rev. 4 Table 10.1-1 references management of forest habitat removal specific to key bird species to limit habitat fragmentation. Describe how removal of forest habitat would be managed for key bird species to limit habitat fragmentation. Identify the key bird species.

Response:

Included in ER Table 10.1-1, "Construction-Related Unavoidable Adverse Environmental Impacts," under "Mitigation Measures" in Impact Category "Terrestrial Ecology (continued)" BBNPP proposes to manage forest habitat removal specific to key bird species and limit fragmentation. Some of these measures include:

1. Reclaiming old fields;
2. Consulting with appropriate agencies regarding avoidance and appropriate mitigation measures;
3. Designing the construction footprint to account for important habitat; and
4. Using strobe lights on towers and removing habitat around the tower base.

The Terrestrial Ecosystems discussion (Section 4.3.1) of ER Table 4.6-1, "A summary of Measures and Controls to Limit Adverse Impacts During Construction," lists several additional items including implementing the Post-Construction Stormwater Management Plan and limiting tree cutting if needed to help minimize habitat fragmentation. The BBNPP Joint Permit Application also provides plans to minimize impacts to aquatic and terrestrial species at the site.

Key bird species at the BBNPP site and in the vicinity include the scarlet tanager (*Piranga olivacea*), bald eagle (*Haliaeetus leucocephalus*), peregrine falcon (*Falco peregrinus*), osprey (*Pandion haliaetus*), and wild turkey (*Meleagris gallopovo*) (ER Table 2.4-1, "Important Terrestrial Species and Habitats at the BBNPP Site"). They are considered key or important species because:

1. The scarlet tanager is an important species because it is considered ecologically important since it can serve as a biological indicator related to forest fragmentation. It is one of the most frequently observed forest interior bird species at the BBNPP site area (ER Section 2.4.1.2.2.3, "Ecologically Important Birds").
2. The bald eagle (state threatened), peregrine falcon (state endangered), and osprey (state threatened) are considered key species because of their regulatory status. They have been observed along the Susquehanna River in recent years but no nesting or intensive use has been documented on the BBNPP site. A possible mitigating measure could be to erect nesting structures near or at the BBNPP site (ER Section 4.3.1.2, "Fauna").
3. Finally, the wild turkey is considered a key or important species at the BBNPP site because it is commercially and recreationally important.

COLA Impact:

The BBNPP COLA Part 3 (ER) will be revised as shown below:

4.3.1.2 Fauna

Rare Important Species:

~~The bald eagle, peregrine falcon, and osprey (all state threatened)~~ The bald eagle and osprey (state threatened species), and the peregrine falcon, (a state endangered species) have been observed with increasing frequency during migration along the Susquehanna River in recent years but no nesting or intensive use have ever been documented on the BBNPP site, so it is unlikely that construction will have any significant impact on any of these bird species.

RAI ENV-25
Question TE 7345:

ESRP Section 4.3.1 directs the staff's description, quantification, and assessment of the impacts of construction of the proposed facilities on the terrestrial ecosystem. ER Rev. 4 Table 10.1-1 references restoration of available old field habitat not affected by the project. Identify the old field habitat that would be restored, restoration methods that would be employed, restoration goals, and the methods that would be used to maintain the restored old fields.

Response:

A majority of old field acreage within the Bell Bend Nuclear Power Plant (BBNPP) Project Boundary will be impacted from either permanent or temporary construction. COLA ER Figure 4.3-2, "Vegetation Impacts," shows only a small area of old fields that would not be affected by the project and are located adjacent to Walker Run within the project boundary. There will be plantings in these old fields along Walker Run as part of the stream's mitigation program, where possible, available trees and tree clusters will be preserved.

The Walker Run mitigation program will improve channel stability, water quality, aquatic habitat along the project reach, and restore the functionality of the floodplain. Mitigation includes restoration of wetlands, old fields, and other areas within this floodplain.

Planned plantings of herbaceous plants, trees, and shrubs should help restore these old fields and other areas adjacent to Walker Run. Some of these plants include:

Herbaceous
Boltonia asteroides – Thousand-flowered Aster
Carex crinita – Fringed Sedge
Pontederia cordata – Pickerelweed
Chelone glabra – White Turtlehead
Carex stricta –Tussock Sedge

Trees
Acer rubrum – Red Maple
Carya ovata – Shagbark Hickory
Quercus bicolor – Swamp White Oak

Shrubs
Alnus rugosa – Speckled Alder
Cephalanthus occidentalis – Buttonbush
Lindera benzoin – Spicebush
Viburnum dentatum – Arrowwood

COLA Impact:

The BBNPP COLA will not be changed as a result of this response.

RAI ENV-25
Question TE 7350:

ESRP Section 4.3.1 directs the staff's description, quantification, and assessment of the impacts of construction of the proposed facilities on the terrestrial ecosystem. PADEP Water Obstruction and Encroachment Permit, E40-720 (ML13161A023) identifies bridge removal as an impact associated with Joint Permit Application (JPA) Impact B (Wetlands 10 and 12). The JPA (environmental assessment Part 2 – Project Description, Part D – Project Impacts) describes wetland impacts associated with bridge construction under Impact B; however, the JPA does not describe wetland impacts from bridge removal. Provide information on potential wetland impacts associated with bridge removal under JPA Impact B. Indicate if, how, and to what extent these wetland impacts, if any, would differ from those associated with bridge construction under JPA Impact B (see Enclosures D3 and D4 in the JPA).

Response:

The bridge over Walker Run consists of three sections (refer to attached Figures 1 through 3). The lower section is a 10-foot long, 12-foot wide concrete arch spanning Walker Run. The top flat part of the arch is covered by a middle section consisting of 15 railroad ties laying side-by-side. Each tie is 13 feet long, 9 inches wide, and 7 inches in height. The two end sections of each tie are embedded in the top part of the stream bank. The railroad ties are covered by two 1/2-inch steel plates tack welded together at the center seam. Each plate measures 10 feet long and 6 feet wide. The top of the bridge measures approximately 10 feet long and 12 feet wide. There are three vertical straps welded to each plate's side to prevent the top plate from shifting from side-to-side. The top of the bridge is about 5 feet from the bottom of the stream at low level. The bridge will be removed by a machine such as a back hoe.

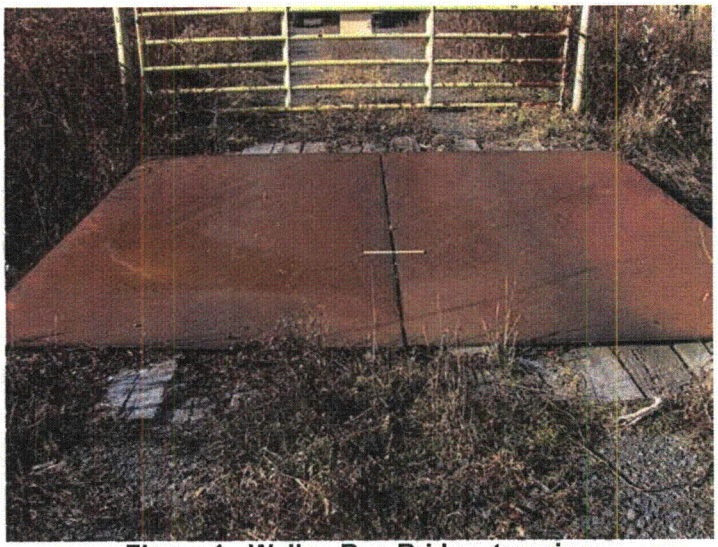


Figure 1 - Walker Run Bridge, top view

Figure 2 - Walker Run Bridge, looking downstream

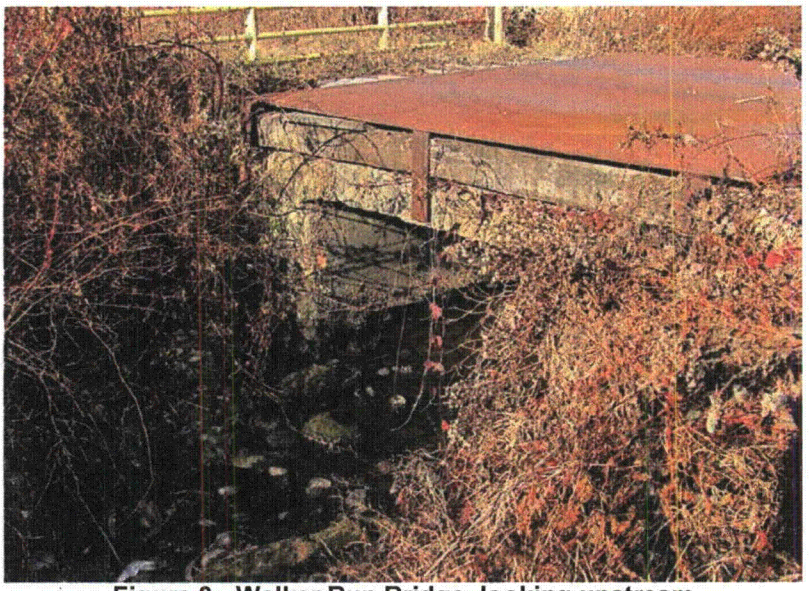


Figure 3 - Walker Run Bridge, looking upstream

The removal of the Walker Run Bridge will occur during construction of the Walker Run mitigation project. Walker Run will remain in the existing stream channel while the restored channel is being constructed under dry conditions. The bridge will be removed following new channel construction and the installation of appropriate stabilization measures, as described in the Walker Run Mitigation Plans dated August 12, 2011 included in the Walker Run Design Report Rev 0 (JPA Rev.1 Mitigation Section). The flow will be directed from the existing channel into the new, restored channel. Since the channel will already be abandoned at the time of the bridge removal, there will not be any impacts to the watercourse resulting from bridge removal.

The bridge over the Walker Run Unnamed Tributary is actually a 24-inch diameter concrete pipe (culvert) that goes under the road (refer to attached Figures 4 through 7). The pipe is buried under several inches of dirt and gravel and runs approximately 19 feet from end-to-end. The pipe will be removed by a machine such as a back hoe.

Figure 4 - Walker Run Unnamed Tributary Bridge, downstream outlet

Figure 5 - Walker Run Unnamed Tributary Bridge, Road Surface-Downstream
(Tape measure is over the centerline of the pipe)

Figure 6 - Walker Run Unnamed Tributary Bridge, Road Surface-Upstream
(Tape measure is over the centerline of the pipe)

Figure 7 - Walker Run Unnamed Tributary Bridge, upstream inlet

The construction of Bridge #3 over the Unnamed Tributary will require removing the culvert that was used to allow farm equipment to cross the stream. According to the Construction Sequence in the E&S Control Plan Narrative, dated September 15, 2011, stream flow will be diverted. This diversion of flow will maintain a dry work area for bridge construction, including the removal of the existing pipe, and will prevent impacts to downstream terrestrial ecology.

COLA Impact:

The BBNPP COLA will not be changed as a result of this response.