NUREG-0564

Final Environmental Statement

related to the operation of Susquehanna Steam Electric Station, Units 1 and 2

Docket Nos. 50-387 and 50-388

Pennsylvania Power and Light Company
Allegheny Electric Cooperative, Inc.

U.S. Nuclear Regulatory Commission

Office of Nuclear Reactor Regulation

June 1981

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SUMMARY AND CONCLUSIONS

This Final Environmental Statement was prepared by the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation (the staff).

1. The action is administrative.

2. The proposed action is the issuance of operating licenses to the Pennsylvania Power and Light Company (PP&L), Allentown, Pennsylvania, and Allegheny Electric Cooperative, Inc., for the startup and operation of the Susquehanna Steam Electric Station (SSES), Units 1 and 2, located on the Susquehanna River in Luzerne County, about 10 km northeast of Berwick, Pennsylvania (Docket Nos. 50-387 and 50-388).

   The facility will employ two boiling-water reactors and will produce up to 3293 megawatts thermal (MWt) per unit. Two steam turbine-generators will use this heat to provide up to 1085 megawatts electrical (MWe) of electrical power capacity per unit. The maximum design thermal output of each unit is 3439 MWt with a corresponding maximum calculated electrical output of 1135 MWe. The exhaust steam will be condensed by water cooled in natural-draft cooling towers; makeup and blowdown will be taken from and discharged to the Susquehanna River.

3. The information in this statement represents the second assessment of the environmental impact associated with the Susquehanna Steam Electric Station, pursuant to the guidelines of the National Environmental Policy Act of 1969 (NEPA) and 10 CFR Part 51 of the Commission's Regulations. After receipt of an application, on 1 April 1971, to construct this plant, the staff carried out a review of the impacts that would occur during the construction and operation of this plant. This evaluation was issued as a Final Environmental Statement in June 1973. As the result of this environmental review; a safety review; an evaluation by the Advisory Committee on Reactor Safeguards; and public hearings in Berwick, Pennsylvania, on 21 February 1973 and 24 July 1973, the Atomic Energy Commission [AEC (now NRC)] issued a permit on 2 November 1973 for the construction of Units 1 and 2 of the Susquehanna Steam Electric Station. As of February 1981 the construction of Unit 1 was 91% complete and Unit 2 was 70% complete. With a proposed fuel-loading date of March 1982 for Unit 1 and June 1983 for Unit 2, the applicant has petitioned for licenses to operate both units and has submitted (April 1978) the required safety and environmental reports to substantiate this petition. The staff has reviewed the activities associated with the proposed operation of this plant and the potential impact; both beneficial and adverse effects are summarized as follows:

   a. Total of approximately 435 ha will be used for the Susquehanna Steam Electric Station site and about 1140 ha for the transmission line corridors (Sec. 2.2).

   b. The heat dissipation system will require an average daily consumptive use (by evaporation from the natural-draft cooling towers) of 1.4 m^3/s and a maximum use of 1.8 m^3/s of makeup water to be supplied from the Susquehanna River. Due to restrictions placed on water use by the Susquehanna River Basin Commission, effective 1 July 1984, the plant will not be allowed to withdraw water from the river without compensation under specified low-flow conditions (Sec. A.4.4.2.1). Appendix A is an analysis of a proposed reservoir at Pond Hill to replace water consumptively used by SSES.

   c. Heat, chemicals, and sanitary wastes discharged into the Susquehanna River will be rapidly diluted so that no adverse impacts on downstream water users or aquatic biota are expected (Sec. 4.3).

   d. The visual effects of the plant's natural-draft cooling towers and their associated visible plumes will create an adverse esthetic impact. No surface fogging, icing, or drift impacts will result from operation of the cooling towers; some light snow may fall from the visible plumes (Sec. 4.4.3).

   e. The risk associated with accidental radiation exposures is very low (Sec. 6.2).

f. No significant environmental impacts are anticipated from normal operational releases of radioactive materials. The estimated maximum integrated dose to the U.S. population due to operation of the station is 600 person-rem/yr, which is less than the normal fluctuations in the 26.8 million person-rem/yr background dose received by the estimated U.S. population in the year 2000 (Sec. 4.5.2).

g. Withdrawal of river water during periods of low flow may result in entrainment and impingement losses that are higher than normal for the plant. In addition, the temporary loss of habitat may have adverse impacts on the aquatic community in the vicinity of the intake (Sec. 4.4.2).

h. The implementation of the applicant's post-construction landscaping plan will enhance the quality of the terrestrial environment in the vicinity of the plant (Sec. 4.4.1.1).

i. Adverse impacts on the terrestrial environment of the project area during station operation include the following: ice-loading of local vegetation resulting from steam and drift emissions from the emergency spray pond during cold weather, impingements of flying birds on station facilities (primarily cooling towers), and increased noise levels attributable to operational facilities (Sec. 4.4.1). Drift emissions from the cooling towers are not expected to measurably affect local soils and vegetation (Sec. 4.4.1.1).

j. The staff has also updated the need-for-power section based on information available in 1978 (Sec. 7). The staff concludes that operation of the plant will be cheaper than any other generation alternative and could also be used to reduce dependence on oil-fired generation.

4. The following federal, state, and local agencies were asked to comment on the Draft Environmental Statement:

Advisory Council on Historic Preservation
Department of Agriculture
Department of the Army, Corps of Engineers
Department of Commerce
Department of Health, Education and Welfare
Department of Housing and Urban Development
Department of the Interior
Department of Transportation
Department of Energy
Environmental Protection Agency
Federal Energy Regulatory Commission
Pennsylvania State Clearinghouse
Pennsylvania Department of Environmental Resources
Luzerne County Planning Commission
Economic Development Council of Northeastern Pennsylvania
Board of Supervisors, Berwick

Comments on the Draft Environmental Statement were received from the following:

Department of Agriculture, Forest Service
Department of Agriculture, Soil Conservation Service
Department of Commerce
Department of Health, Education, and Welfare
Department of Housing and Urban Development
Department of the Interior
Department of Transportation
Economic Development Council
T.R. Duck
Environmental Protection Agency
Federal Energy Regulatory Commission
T.J. Halligan
M.L. Hershey
M. Laughland
M.J. Huntington
H.C. Jeppsen
W.A. Lochstet
Luzerne County Planning Commission
M.M. Molesevich
L. Moses

D. Oberst
Pennsylvania Power and Light Company
Pennsylvania State Clearinghouse, Department of Environmental Resources
W.L. Prelesnik
SEDA-Council of Governments
F.L. Shelly
S. Shortz
Sierra Club, Pennsylvania Chapter
Susquehanna Alliance
Susquehanna River Basin Commission
F. Thompson
D.E. Watson

Copies of these comments are appended in this Final Environmental Statement as Appendix B. The staff has considered these comments; the responses are located in Section 10.

5. The Draft Environmental Statement was made available to the public June 1979.

6. The Draft Supplement to the Draft Environmental Statement relating to the construction of a water storage reservoir in the Pond Hill Creek drainage basin was made available to the public March 1980. Comments on the Draft Supplement were received from the following:

   Department of Commerce
   Department of Health, Education and Welfare
   Department of the Interior
   Department of Transportation
   Environmental Protection Agency
   Federal Energy Regulatory Commission
   Pennsylvania Power and Light Company
   Pennsylvania State Clearinghouse, Department of Environmental Resources
   Susquehanna Alliance
   Susquehanna River Basin Commission

   Copies of these comments are appended in this Final Environmental Statement as Appendix B. The staff has considered these comments; the responses are located in Section 10A.

7. On the basis of the analysis and evaluation set forth in this statement, and after weighing the environmental, economic, technical, and other benefits against environmental costs and after considering available alternatives at the operation stage, it is concluded that the action called for under NEPA and 10 CFR Part 51, is the issuance of operating licenses for Unit 1 and Unit 2 of the Susquehanna Steam Electric Station, subject to the following recommendations for the protection of the environment:

   a. Before engaging in additional construction or operational activities that may result in a significant adverse environmental impact that was not evaluated or that is significantly greater than that evaluated in this environmental statement, the applicant shall provide written notification to the Director, Division of Licensing, Office of Nuclear Reactor Regulation.

   b. The applicant will carry out the environmental (thermal, meteorological, acoustical, chemical, radiological, ecological) monitoring programs outlined in this statement as modified and approved by the staff and implemented in the environmental technical specifications incorporated in the operating licenses for the Susquehanna Steam Electric Station (Sec. 5).

   c. If, during the operating life of the station, effects or evidence of irreversible damage are detected, the applicant will provide the staff with an analysis of the problem and a proposed course of action to alleviate the problem.

   d. The applicant will be required to conduct noise surveys after startup of Unit 1 and again when two units are in operation at sensitive offsite locations.

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FOREWORD

This environmental statement was prepared by the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation (the staff), in accordance with the Commission's regulation, 10 CFR 51 which implements the requirements of the National Environmental Policy Act of 1969 (NEPA).

NEPA states, among other things, that it is the continuing responsibility of the federal government to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate federal plans, functions, programs, and resources to the end that the nation may:

- Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.
- Assure for all Americans safe, healthful, productive, and esthetically and culturally pleasing surroundings.
- Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences.
- Preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment that supports diversity and variety of individual choice.
- Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities.
- Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

Further, with respect to major federal actions significantly affecting the quality of the human environment, Section 102(2)(C) of NEPA calls for preparation of a detailed statement on:

(i) the environmental impact of the proposed action;

(ii) any adverse environmental effects that cannot be avoided should the proposal be implemented;

(iii) alternatives to the proposed action;

(iv) the relationship between local short-term uses of the human environment and the maintenance and enhancement of long-term productivity; and

(v) any irreversible and irretrievable commitments of resources that would be involved in the proposed action should it be implemented.

An environmental report accompanies each application for a construction permit or a full-power operating license. A public announcement of the availability of the report is made. Any comments by interested persons on the report are considered by the staff. In conducting the required NEPA review, the staff meets with the applicant to discuss items of information in the environmental report, to seek new information from the applicant that might be needed for an adequate assessment, and generally to ensure that the staff has a thorough understanding of the proposed project. In addition, the staff seeks information from other sources that will assist in the evaluation and visits and inspects the project site and surrounding vicinity. Members of the staff may meet with state and local officials who are charged with protecting state and local interests. On the basis of all the foregoing and other such activities or inquiries as are deemed useful and appropriate, the staff makes an independent assessment of the considerations specified in Section 102(2)(C) of NEPA and 10 CFR 51.

This evaluation leads to the publication of a draft environmental statement, prepared by the Office of Nuclear Reactor Regulation, which is then circulated to federal, state, and local government agencies for comment. A summary notice of the availability of the applicant's environmental report and the draft environmental statement is published in the Federal Register. Interested persons are also invited to comment on the proposed action and the draft statement. Comments should be addressed to the Director, Division of Licensing, at the address shown below.

After receipt and consideration of comments on the draft statement, the staff prepares a final environmental statement, which includes a discussion of questions and objections raised by the comments and the disposition thereof; a final benefit-cost analysis, which considers and balances the environmental effects of the facility and the alternatives available for reducing or avoiding adverse environmental effects with the environmental, economic, technical, and other benefits of the facility; and a conclusion as to whether--after the environmental, economic, technical, and other benefits are weighed against environmental costs and after available alternatives have been considered--the action called for, with respect to environmental issues, is the issuance or denial of the proposed permit or license or its appropriate conditioning to protect environmental values.

This environmental review deals with the impact of operation of the Susquehanna Steam Electric Station, Units 1 and 2. Assessments found in this statement supplement those described in the Final Environmental Statement (FES-CP) that was issued in June 1973 and those described in the hearing-board decision of 29 October 1973 (LBP-73-38) and the Appeal Board decision of 11 December 1973 (ALAB-163) in support of issuance of construction permits for the units. The information to be found in the various sections of this statement updates the above assessments in four ways: (1) by identifying differences between environmental effects of operation (including those that would enhance as well as degrade the environment) currently projected and the impacts that were described in the preconstruction review; (2) by reporting the results of studies that had not been completed at the time of issuance of the FES-CP and that were requested by the staff to be completed before initiation of the operational review; (3) by evaluating the applicant's preoperational monitoring program and factoring the results of this program into the design of an operational surveillance program and into the development of environmental technical specifications; and (4) by identifying studies being performed by the applicant to yield additional information relevant to the environmental impacts of operating the Susquehanna Steam Electric Station.

The staff recognizes the difficulty a reader would encounter in trying to establish the conformance of this review with the requirements of the National Environmental Policy Act to provide "updating information." Introductory résumés in appropriate sections of this statement summarize the extent of "updating" and the degree to which the staff considers the subject to be adequately reviewed.

Copies of this statement are available for inspection at the Commission's Public Document Room, 1717 H. Street NW, Washington, DC, and the Ousterhout Free Library, Reference Department, 71 South Franklin Street, Wilkes Barre, Pennsylvania 18701. Single copies of this statement may be obtained by writing to:

Director, Division of Licensing
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Mr. Richard M. Stark is the NRC Project Manager for this project. Mr. Stark may be contacted at the above address or at 301/492-7238.

1. INTRODUCTION

1.1 HISTORY

In April 1971, the Pennsylvania Power & Light Company (applicant) filed an application with the AEC (now the NRC) for a permit to construct the Susquehanna Steam Electric Station. Construction Permits CPPR-101 and CPPR-102 were issued on 2 November 1973, following reviews by the AEC Regulatory Staff and its Advisory Committee on Reactor Safeguards and after public hearings before an Atomic Safety and Licensing Board in Berwick, Pennsylvania, on 21 February and 24 July 1973. The staff's Final Environmental Statement (FES-CP) was issued in June 1973.

As of February 1981, construction of Unit 1 was approximately 91% complete and the reactor is expected to be ready for loading of fuel in March 1982, and Unit 2 was approximately 70% complete with a tentative fuel-loading date of June 1983. Each unit has a boiling-water reactor which will produce up to 3293 MWt and a net electrical output of 1050 MWe.

In April 1978, Pennsylvania Power & Light Company and the Allegheny Electric Cooperative, Inc., submitted an application including a final safety analysis report (FSAR) and an environmental report (ER)* requesting issuance of operating licenses for Units 1 and 2. Those documents were docketed on 12 July 1978, and the operational safety and environmental reviews were initiated at that time.

1.2 PERMITS AND LICENSES

The applicant has provided a status listing of environmentally related permits, approvals, licenses, etc. required from federal, regional, state, and local agencies in connection with the proposed project. This information is provided in Chapter 12 of the ER-OL. The staff has reviewed that listing and is not aware of any potential non-NRC licensing difficulties that would significantly delay or preclude the proposed operation of the station. The issuance of 401 and 402 permits by the Pennsylvania State Environmental Protection Agency is a necessary prerequisite for the issuance of an operating license by the Nuclear Regulatory Agency.

The issuance of a National Pollution Discharge Elimination System (NPDES) permit is a necessary prerequisite for the issuance of an operating license by the Nuclear Regulatory Commission. The permit was issued by the Pennsylvania Department of Environmental Resources (PDER) on 31 July 1979 (Appendix F). This permit has been extended to January 1983.

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*Susquehanna Station Environmental Report, Operating License Stage, Vol. 1, 2, & 3, Pennsylvania Power & Light Company (hereinafter this will be cited as the ER-OL).

2. THE SITE

2.1 RÉSUMÉ

The staff revisited the Susquehanna Steam Electric Station in October 1978 to determine what changes had occurred at the site and in the surrounding environs since the preconstruction environmental review in 1973. Changes of interest were related to regional demography predictions and land use. Projections of population distribution have been updated and expanded to the year 2020 (Sec. 2.2). Land use in the area has changed as a result of construction of the station. Major land-use changes at the station site involve conversion of rural acreage to station use, e.g., permanent plant structures, construction facilities, warehouse, parking lot, roads, secondary cooling pond, railroad spur, and transmission rights-of-way (Sec. 2.2). Changes in the local economy due to construction are discussed in Section 2.2.7.

The water-use section has been updated (Sec. 2.3). Water quality data collected since the issuance of the FES-CP have been incorporated into Section 2.3 to provide a more complete picture of the water quality of the Susquehanna River and of the local groundwater resources.

The meteorological section (Sec. 2.4) has been updated to include new information for the region and the site.

Additional background information relating to the terrestrial and aquatic biota within the environs of the site and the Susquehanna River is provided in Section 2.5.

Section 2.6 contains new information on the cultural resources of the site. All pertinent geological and seismological data are provided in the applicant's final safety analysis report (FSAR). The results of the staff's evaluation of these data were presented in the safety evaluation report (SER), NUREG-0776.

2.2 SOCIOCULTURAL PROFILE

2.2.1 Introduction

The following sociocultural profile of the two-county area surrounding the plant site is designed to emphasize information that has become available since the FES-CP was issued. This profile has been subdivided into descriptive sections characterizing the major subsystems comprising local communities in Luzerne and Columbia counties.

2.2.2 Demography

2.2.2.1 General Characteristics

The demographic characteristics of the area within 16 km of the plant site are presented in Table 2.1; more specific information on the five counties located within or partially within this area are included in the ER-OL, Tables 2.1-1 through 2.1-6. All data prepared by the applicant are based on 1970 census information and, in combination with certain fertility and other demographic assumptions, have been utilized as the basis for a population projection for the years 1980 through 2020 (ER-OL, Tables 2.1-7 - 2.1-16 and Sec. 2.12.3). In 1970, the area within 16 km of the site was sparsely settled and described as having a declining rural-farm population with scattered communities (ER-OL, pg. 2.1-9).

Table 2.1. Communities within 16 km of the Site, 1970[a]

Communities	Population 1970	Population 1960	Directional Sector	Radial Distance[b]	% Change
Huntington Mills	6,987	7,234	NW	8-16	-3.4
Briar Creek	456	399	WSW	8-16	14.3
Berwick	12,274	13,353	WSW	8-16	-8.1
Nescopeck	1,897	1,934	SW	8-16	-1.9
Conyngham	1,850	1,163	SSE	8-16	59.1
Glen Lyon	3,408	4,173	NNE	8-16	-18.3
Shickshinny	1,685	1,843	N	6-8	-8.6
TOTAL	28,557	30,099			-5.1

[a]Source: Modified from U.S. Census of Population, 1970, and ER-OL, Table 2.1.4.
[b]In km.

2.2.2.2 Population Dynamics Within the Study Area

In 1970, the population of Luzerne and Columbia counties was 342,301 and 55,114, respectively (ER-OL, Table 2.1-1). Between 1940 and 1970, the total population of Luzerne County declined 22.5%; this trend continued through 1977[1] (see 1977 provisional census, Table 2.2). Columbia County experienced a steady increase in population during this period (see Table 2.2). The more recent population declines in Luzerne County appear to be due to an increase in the death to birth ratio and to out-migration, particularly of individuals in the 18 to 24 age group (Table 2.2).[1]

Although the population of Luzerne County is declining, the proportion of older residents (over 65 years) is strongly increasing when compared to national trends. In 1960, 1970, and 1977, the percentage of people over 65 years in the total county population were 11.1, 13.0, and 15.1, respectively.[1,2] Nationally, the 1960 and 1970 percentages of people over 65 years were 9.2 and 9.9.[1] The 1970 male/female sex ratio of 88.6/100 is also smaller than the state ratio of 92.4/100 reflecting a strong pattern of out-migration among males.[1]

Table 2.2. Population Change in Luzerne and Columbia Counties

	1970[a]	% Change 1940-1970[a]	% Change 1970-1977[b]	Number Change 1970-1977[b]	Components of Change[b] Births	Deaths	Migration
Luzerne	342,301	-22.5	-1.0	-3,200	29,600	32,100	-700
Columbia	55,114	+7.2	+7.7	+4,300	5,500	4,600	+3,400

[a]ER-OL, Table 2.1-1.
[b]Pennsylvania Projection Series, July 1977, "Estimates of County Population by Age, Sex, and Race," Office of State Planning and Development, October 1978.

2.2.3 Settlement Pattern

2.2.3.1 General Characteristics

The dispersed settlement pattern of Luzerne and Columbia counties has been historically structured by the local topography which is dominated by ridges and the long valleys of the Susquehanna and its branches.[3,4,5] The location of major communities within these counties and their position within the major river valley is presented in Figure 2.1. Luzerne County encompasses 4 cities, 35 boroughs, and a number of scattered rural homesteads;[6] Columbia County contains one major town and 9 boroughs.[7]

Communities, highways, and major communication networks also tend to parallel the river valley (see Figure 2.1). However, the smaller settlements in the Wilkes-Barre area and other fringe areas are now rapidly growing into one larger population center and problems of "sprawl" and linear-type developments are occurring, particularly along State Routes 309 and 11, and U.S. 29 (ER-OL Figures 2.1-4 - 2.1-5, ER).[3-8] Although these urbanized areas are growing, Luzerne County's 1970 population was still distributed among the many smaller municipalities rather than concentrated in the urban centers.[4] This trend appears to hold true for Columbia County as well.[7] In the 1970 census, about two thirds of the residents of both counties had resided in the same county for at least 5 years; it is expected that the 1972 flood dislocated many families.

The settlement pattern of both counties was substantially altered by tropical storm Agnes (1972); new patterns of land use are still emerging.[1] Currently, there is movement away from the floodplain, areas of mine subsidence, and highway construction.[1,4] The construction of I-80 and I-81 across both Luzerne and Columbia Counties may also strongly affect the future configuration of the region's settlement system.

2.2.3.2 Housing

The Luzerne County Planning Commission has identified seven primary growth centers and has characterized housing conditions in those centers for 1960, 1970, and 1976; it also provided a 1980 projection of needs. This information has been summarized in Table 2.3. The information included in this table reflects an increasing trend in suburban development, particularly in the more mountainous areas where vacant land is plentiful and environmental amenities counterbalance a shorter trip to work.[8] The Planning Commission also developed a housing-need formula for these same seven areas in order to identify surpluses and deficits in housing units in 1976 for low, moderate, and high income needs (see Table 2.3). Housing deficits have been found in different degrees in all of the growth centers, particularly among low-income groups and among the elderly; this trend is expected to continue.[1,3]

Perhaps the single, most important factor affecting this deficit is the 1972 flood as a result of which the number of homes destroyed in Luzerne County equaled the total number of all new homes constructed in northeastern Pennsylvania in the three 1970 pre-census years.[3] The effects of the flood were complicated by the tight construction trade, including building-supply shortages, increased mortgage costs, and an aged housing supply where almost 80% of current structures are 40 years of age or older.[3,9]

Comparable information was not available for Columbia County, although complaints of housing shortages and high sale and rental costs have been expressed to the PP&L monitoring study team by local residents in this county, particularly in the Berwick area.[10] Like Luzerne County, Columbia County experienced an urban to rural movement and housing loss because of the 1972 flood; in addition, Columbia County absorbed approximately three fourths of the in-migrating construction work force for SSES.[10]

2.2.3.3 Recreational Patterns

A detailed study of the recreational, park, and open-space needs for Luzerne County has been prepared by the County Planning Commission. With the exception of the Wilkes-Barre area, regional recreational areas and large urban parks, as defined by the national standards used in this document, were found to be more than sufficient to take care of overall county needs.[11] However, deficiencies in small urban park lands were identified in various urban and semi-urban areas with at least one park needed for each community area, except for the Nanticoke and Mountaintop areas.[11] In Table 2.4 projected public and semi-public recreational land needs for local community areas are identified. Moreover, county-wide recreational programs, notably for residents in the 20 to 55 year-old age group, were found to be inadequate.[11] Attitudinal surveys of some residents confirmed that about 75% of those sampled were dissatisfied with existing recreational facilities and advocated an increase for additional county facilities.[11]

Luzerne County

Columbia County

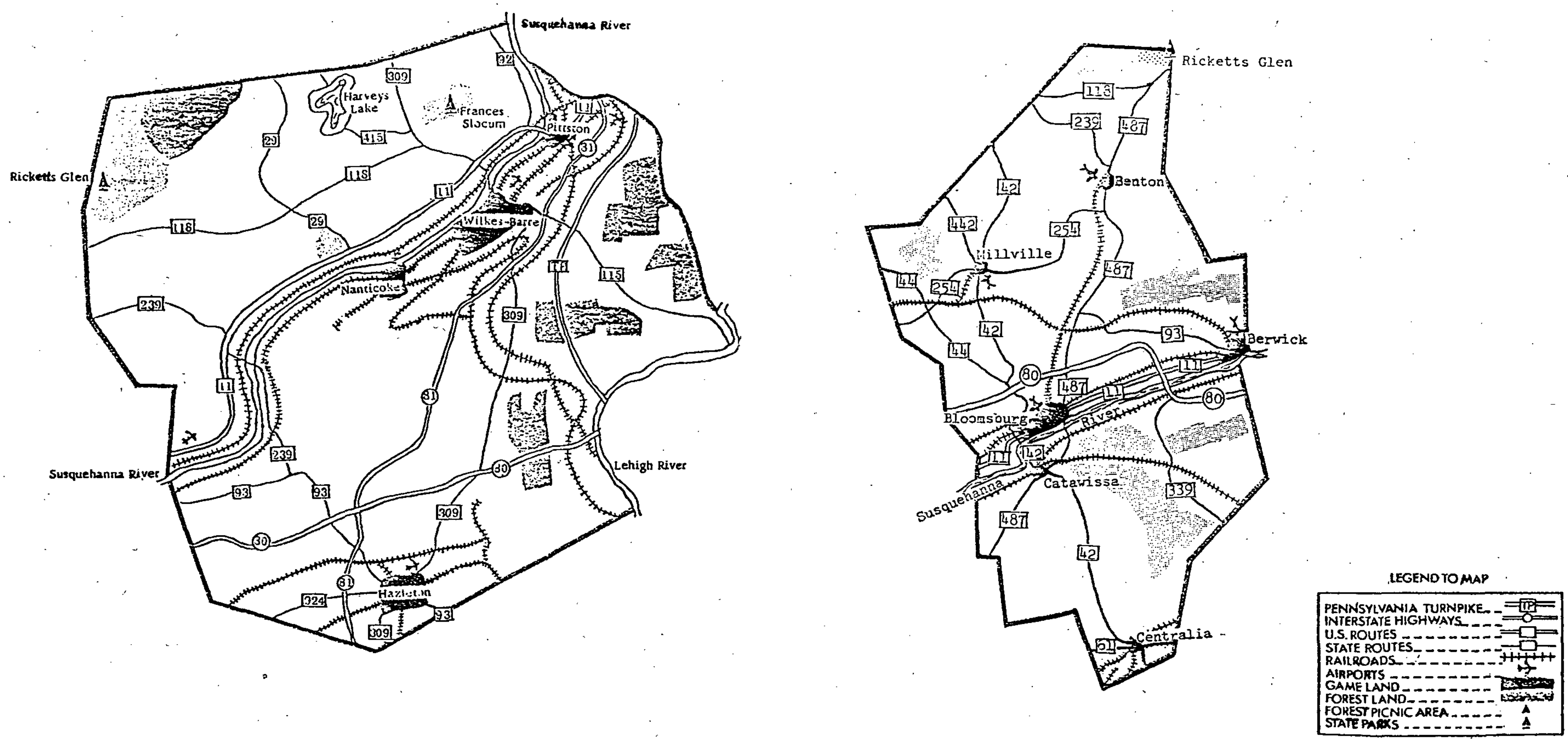

Fig. 2.1. Luzerne and Columbia Counties. Luzerne County, Pennsylvania Industrial Census. Series Release No. M-5-75, Department of Commerce, 1976. Columbia County, Pennsylvania Industrial Census. Series Release No. M-5-76, Department of Commerce, 1977.

Table 2.3. Luzerne County Housing Trends and Projections[a]

	Housing Unit Trends by Community Growth Areas							Projected Housing Deficits by Income Category 1976 and 1980 for Community Growth Areas							
		Change			Change			Low Income		Moderate Income		High Income		Total, All Incomes	
	1960	No.	%	1970	No.	%	1976	1976	1980	1976	1980	1976	1980	1976	1980
Wilkes-Barre area	52,821	281	0.53	53,102	100	0.19	53,202	-2,122	-1,304	-1,054	-983	-885	-870	-4,061	-3,157
Hazleton area	20,016	1,096	5.48	21,112	1,675	7.93	22,787	-656	-644	-400	-389	-224	-213	-1,280	-1,246
Pittston area	16,568	1,017	6.14	17,585	1,184	6.73	18,769	-765	-751	-429	-375	-282	278	-1,476	-1,404
Nanticoke area	8,796	-290	-3.30	8,506	-254	-2.99	8,252	-353	-350	-128	-125	-148	-146	-629	-621
Back Mountain area	6,847	1,320	19.28	8,167	1,442	17.66	9,609	-258	-249	-170	-163	-118	-117	-546	-529
Mountaintop area	3,079	780	25.33	3,859	1,124	29.13	4,983	-111	-101	-87	-81	-60	-58	-258	-240
Shickshinny area	5,562	551	9.91	6,113	1,580	25.85	7,693	-741	-680	50	58	119	120	-572	-502
TOTAL LUZERNE COUNTY	113,689	4,755	4.18 (avg)	118,444	6,851	5.78 (avg)	125,295	-5,006	-4,079	-2,218	-2,058	-1,598	1,562	-8,822	-7,699

[a]Source: Luzerne Planning Commission, "Housing Section of the Luzerne County Comprehensive Plan," 1978.

Table 2.4. Projected Public and Semi-Public Recreational/Open Land Needs in Luzerne County[a]

Location	Projected Area Needed (ha)
Mountaintop/Nescopec Creek State Park	1180
Hazleton area	607
Wilkes-Barre area (county and community parks)	355
Shickshinny area	198
Nanticoke area	100
Black Mountain area	34

[a]Data derived from the Luzerne County Planning Commission, "Land Use Plan for the Year 2000," June 1976.

2.2.4 Social Organization

2.2.4.1 Social Characteristics

In 1970, approximately 99% of the population in Columbia and Luzerne counties was Caucasian; the average household size was 3.0.[12-14] It is likely that an increasing number of households will contain retired or older couples whose children have left the area with their parents remaining in larger, older homes. The ratio of household to housing-unit size ranges are high compared to HUD standards and seem to support the above characterization.[3]

The foregoing, characterizing the pre-plant construction conditions that were not discussed in the FES, remains applicable to the current two-county study area. Sociocultural changes associated with plant construction have occurred in parts of Salem Township, Luzerne County, and in the community of Bell Bend, which is adjacent to the plant site. Because the lives of many members in the community of Bell Bend were unalterably changed, feelings and attitudes of local residents toward the plant and PP&L may be different from those during the pre-construction period. These changes may affect the manner in which local residents adjust to the operational period.

2.2.4.2 Social Services

In 1976, the applicant monitored construction impacts in parts of Luzerne and Columbia counties; this study included consideration of the following social services: education, hospital care, sewage and water services. Police and fire protection services were also considered in part.

Education

Since 1974/75, many of the local school systems have had decreasing enrollments and, in most cases, classroom space to absorb new students will be available without new construction or the hiring of additional teachers.[10]

Hospital Care

Facilities in the two-county area have 1978 occupancy rates within the desired 55-85% level recommended by the American Hospital Association for hospitals within the bed-size range indicated in Table 2.5.[15]

The Berwick Hospital is cooperating with PP&L in establishing a facility and staff training to provide for treatment of potential contamination cases,[10] should such needs arise.

Table 2.5. Hospital Care Services[a]

County	Hospital	Number of Available Beds	1978 Occupancy Rate (%)
Columbia	Berwick	172	65.1
	Bloomsburg	150	58.7
Luzerne	Hazleton State General	142	79.6
	Konal-Getter	8	35.5
	St. Joseph	210	60.0
	Retreat State	410	85.1
	Nesbitt Memorial	189	83.6
	Nanticoke State General	100	56.0
	Pittston Hospital	108	67.6
	Mercy	292	72.9
	Veterans Administration	500	81.8
	Wilkes-Barre General	360	93.0
	Wyoming Valley	106	70.8

[a]Data derived from American Hospital Association Guide to the Health Care Field, 1978 Edition, American Hospital Association, Chicago.

Sewage and Water Services

Public sewage and water services were strongly affected by the flood of 1972; specific details on 1973 capital improvements planned for Luzerne County through the year 2000 are discussed in a study prepared by Wilbur Smith and Associates.[1] In 1969, limitations in publicly available sewage and water capacity were observed in Columbia County;[16] however, more recent studies of service availability were not available. The construction monitoring program and statement by the applicant did not indicate severe stresses to these services as of 1976[9] (ER-OL, Amendment 4, Sec. 7.1).

Police and Fire Protection

Organization of police and fire protection varies throughout both counties, although volunteer groups predominate in the less urban areas. In Salem Township, fire protection facilities and locations are more than adequate according to the standards of the National Board of Underwriters.[17] There is, however, no police force serving this township; in order to meet the standards set by the National League of Cities, a six-person force would be required.[17] PP&L has stated that arrangements (letters of agreement) have been made with the local volunteer organizations for emergency services (ER-OL, Amendment 4, Soc. 7.1).

2.2.5 Political Organization

Columbia and Luzerne counties are both administered by elected, three-member boards that are responsible for the following: tax assessments for county, municipal, and school districts; maintaining facilities for county functions; inspections of scales and measuring devices; planning/zoning actions; and appointing various boards and individuals necessary for the administration of these duties.[16]

2.2.6 Land Use

2.2.6.1 Region

Luzerne County comprises 234,528 ha of land, of which 15% has been developed. Land-use categories for developed land are: 28% residential, 5% commercial, 14% industrial, 25% transportation, and 28% public and semi-public. Between 1975 and 2000, additional available land will be needed primarily for residential development and public/semi-public uses.[18] Columbia County has 124,765 ha of which about 7% has been developed. Columbia County land-use categories for developed land are: 78% residential/urban, 6% commercial, 3% industrial, 3% transportation, and 4% public or semi-public, and 6% recreational.[19]

2.2.6.2 Plant Site

Approximately 49 ha, or 11%, of the site's 435 ha will be needed for the station facilities. The station is located on a 244-ha plateau west of U.S. Route 11; a recreation area is located on a 170-ha floodplain between the river and U.S. 11. Gould Island, the remaining 21 ha of the site area, is left in its natural state as part of the recreational facility. Approximately 40% of this total area is to be kept in its natural state. In addition to the plant site, Pennsylvania Power and Light Co. has also purchased homes and private properties in the Bell Bend area.

2.2.7 <u>Changes in the Local Economy</u>

This economic profile considers such factors as economic conditions, economic base, commuter patterns, employment, and land use in relation to the plant.

2.2.7.1 Access to Markets

Prior to construction of I-81, U.S. 11 was a principal route between Harrisburg and Wilkes-Barre; the interstate route has, however, reduced the importance of U.S. 11. The construction of I-80 made the New York metropolitan region more easily accessible to the northeast Pennsylvania area. Due to interstate construction, the general economic access of the area to manufacturing and warehousing has improved over the years.

The site itself is located in Luzerne County, which is part of the northeast Pennsylvania labor market; the two principal centers for this labor market are the cities of Scranton and Wilkes-Barre. Scranton is located north of Luzerne, along U.S. 11, in Lackawanna County; Wilkes-Barre is in Luzerne County. Since the plant site is located in the westernmost portion of Luzerne County, the plant would be expected to attract operating personnel from Columbia County as well as Luzerne. Berwick, which is only 8 km away, is located to the southwest, in Columbia County.

The center of economic activity in Columbia County is the Berwick-Bloomsburg area. I-80 is that county's principal transportation link.

2.2.7.2 Export Base

The composition of industries in Luzerne and Columbia counties indicates that Luzerne County is oriented to the manufacture of nondurable goods. Location quotients,* which measure relative specialization of an area, show that the following industries make an important contribution to Luzerne's and Columbia's export bases: textile mill products (1.42), apparel and other textile products (5.56), printing and publishing (1.21), rubber and miscellaneous products (1.63), and leather and leather products (3.33). An examination of industries located near the site share the same features as other industries in Luzerne County, particularly apparel and textile industries.

Luzerne and Columbia counties are relatively low-wage areas and many unskilled manufacturing operations have transferred from the New York SMSA to take advantage of these prevailing low wages.

In 1970, the Wilkes-Barre/Hazelton and Columbia County areas had from 18 to 32% (depending on assumptions) employment in the low-wage[20] category compared to a national average of 8%. In 1978, the average hourly earnings in the northeast Pennsylvania SMSA were $4.93 per hour compared to $5.24 nationally. The apparel and textile industries, with wage scales of $4.04 and $4.08 per hour, respectively, are heavily represented in the region.

Based on its assessment, the staff has determined that the nuclear plant would pay competitive wages for almost all job categories. The demand for housing noted in Section 2.2.3.2 will be diminished to the extent that jobs at SSES are filled by local residents rather than by outsiders.

*A location quotient of 1.0 indicates that that economic sector produces goods and service at a level proportionate to the U.S. as a whole. Location quotients greater than 1.0 indicate a specialization in a particular sector of the economy relative to the U.S. as a whole.

2.2.7.3 Commuter Patterns

Based on access to the site and relative population density, the communities that would be likely choices for residence by plant workers are: Berwick-Bloomsburg, Wilkes-Barre, and Hazelton. Local workers finding jobs at the plant would probably be willing to commute a little farther than newcomers. Longer commuting patterns by existing residents would reflect the preference not to move their home.

2.2.7.4 Income and Employment

From 1970 to 1977 the civilian labor force grew by about 2% in northeast Pennsylvania and about 7% in the state as a whole. Employment declined about 3% in northeast Pennsylvania during that period; in the state, employment increased by about 3%.[21] It can be expected that such statistics would be reflected in high unemployment rates within the area and the concomitant migration of job seekers, particularly the young, from the area.

As noted, unemployment is high in both Luzerne (9.9%) and Columbia (11.1%) counties. The northeastern section of Pennsylvania has had consistently higher unemployment rates than either the state or the nation as a whole. In 1977 the unemployment rate for the respective areas were: northeast Pennsylvania, 9.7%; Pennsylvania, 7.7%; and U.S., 7.0%. The Pennsylvania Department of Labor and Industry classifies both Berwick-Bloomsburg and northeast Pennsylvania as labor surplus areas. Out of 44 areas ranked according to unemployment, the northeast was ranked 11th of all areas in Pennsylvania (but first in the rank of Pennsylvania SMSAs) and Berwick-Bloomburg was 18th.[22]

With respect to inflation, the northeast is doing no worse than the rest of the nation in keeping up with the consumer price index. Since the area is a "low wage manufacturing" area and average incomes tend to be lower, the actual effects of inflation are worse.

Problems that tend to arise in the area include: (1) increasing age of the work force without in-migration of younger workers, (2) mismatch of skills and job opportunities, and (3) need for training (few existing employers offering training programs appropriate to potential new industries in the area).

The problems of the area tend to be long-term and structural due to the makeup of its economic base; these problems cannot be easily attributed to any one specific cause. Although many of the problems existed prior to tropical storm Agnes (1972), the storm exacerbated the problem of providing an attractive region in which to live and work. Despite a difficult economic picture, the region made a successful transition from an economic coal-mining base after the 1930s.

2.3 WATER USE

2.3.1 Regional Water Use

There have been no major changes in water use in the region since the issuance of the FES-CP.

2.3.2 Hydrology

2.3.2.1 Surface Water

The discussion in Section 2.5.1 of the FES-CP is still considered valid. In addition, Figure 2.2 shows the floodplain, as defined in Executive Order 11988, Floodplain Management, in the vicinity of the site. Section 4.2 contains a discussion of the hydrologic effects of alterations in the floodplain.

2.3.2.2 Groundwater

The discussion in Section 2.5.2 of the FES-CP is still considered valid by the staff.

2.3.3 Water Sources

The applicant made a house-by-house survey of water wells and springs within 3.2 km of the plant. A total of 185 wells and 33 developed springs were identified. The total withdrawal rate from these wells and springs during 1976 was estimated by the applicant to average 212,000 L per day with the largest well withdrawing an average of 10,220 L per day. Most of the wells and springs are used for domestic or stock watering purposes. In addition, 213

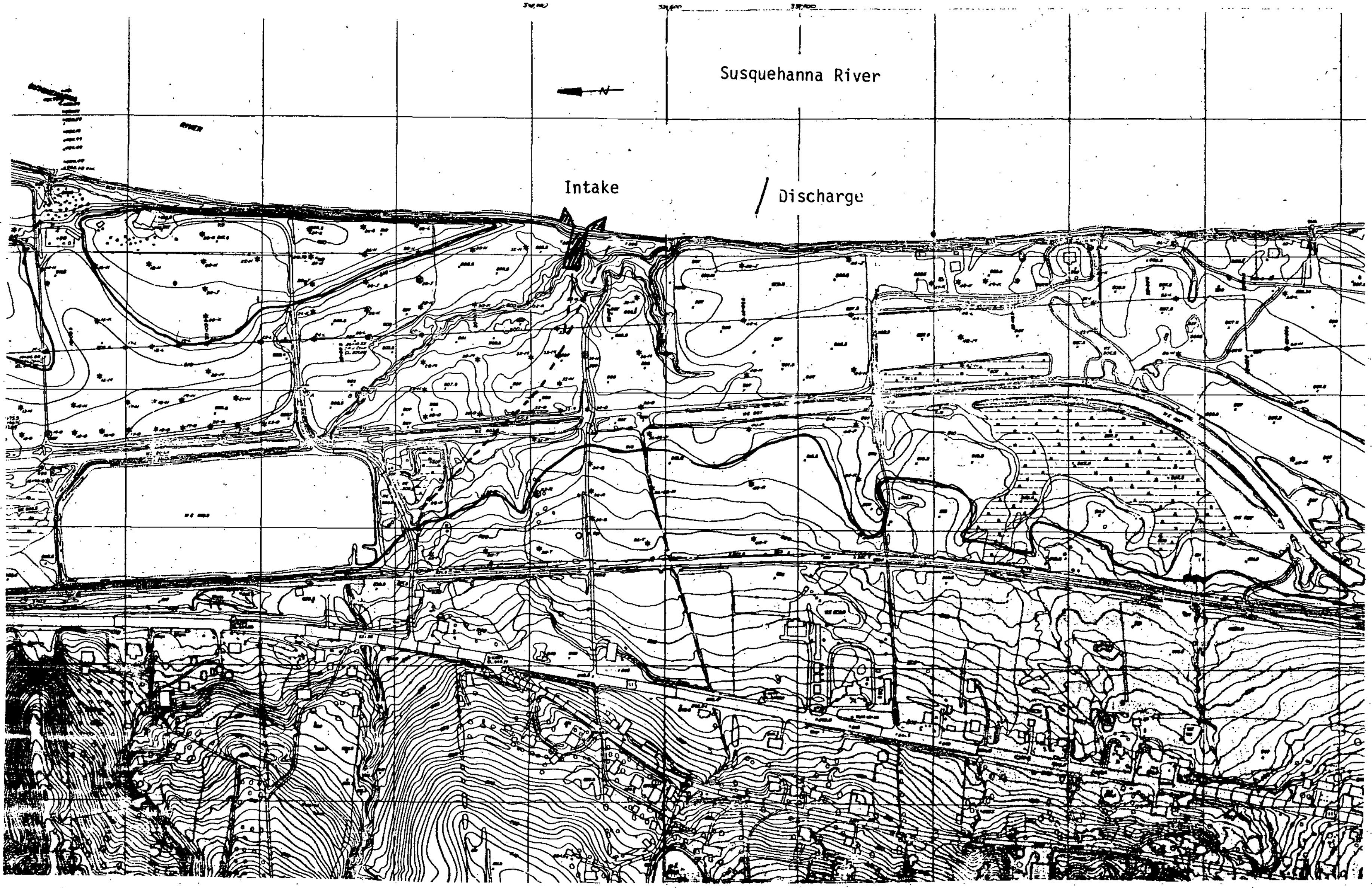

Fig. 2.2. Floodplain of the Susquehanna River in the Vicinity of the Site.

public-supply wells were identified within 32 km of the site. The applicant estimated that in 1975 the withdrawal rate of all groundwater users (public, industrial, and private) averaged 43.5 million L per day within this radius.

The only significant source of surface water in the vicinity of the plant is the Susquehanna River which is used for municipal water supply, industrial use, and recreation (see Figure 2.3 for water-use diagram). The nearest downstream municipal water supply using river water is that of the Borough of Danville, 50 river kilometers downstream, although both Berwick (11 km downstream) and Bloomsburg (30.5 km downstream) maintain river intakes for use as standby water supplies. Five industrial users and one recreational-area user have also been identified in this river reach.

2.3.4 Water Quality

2.3.4.1 Surface Water

Water quality of the Susquehanna River adjacent to the SSES site has been monitored monthly since 1968 by the applicant and daily since 1971 by Ichthyological Associates;[23] these data are summarized in Tables 2.6 and 2.7 and Figure 2.4. Sampling locations are identified in Figure 2.5. During 1974, Ichthyological Associates also measured the flow, pH, total alkalinity, specific conductance, sulfate, iron, residue, and turbidity at each of the sites identified in Figure 2.6 to establish patterns over a greater length of the river. The data collected since issuance of the FES-CP support those collected earlier and provide a broader information base.

With the exception of total iron, the water in this portion of the Susquehanna River normally meets all the water-quality criteria established for it in Chapter 93, Water Quality Criteria, Rules and Regulations, Pennsylvania Department of Environmental Resources. These are listed in Table 2.8 along with the 1962 Drinking Water Standards of the U.S. Public Health Service.

2.3.4.2 Groundwater Quality

The quality of the groundwater on the SSES site has been measured on three different dates in a total of 14 wells. The location of these wells can be identified in Figure 2.4-14 of the ER-OL. In general, the groundwater has a low dissolved-solids content, 44 to 393 mg/L; total hardness, as $CaCO_3$, ranged from 12 to 255 mg/L. Dissolved iron ranged from 0 to 9.5 mg/L and pH ranged from 6.0 to 11.0. Table 2.9 contains information on the radioactivity of groundwater samples. Tritium levels in onsite wells ranged between 80 and 430 pCi/L in these 1977 measurements.

2.4 METEOROLOGY

2.4.1 Regional Climatology

The eastern Pennsylvania area experiences warm, humid summers and cold winters with considerable amounts of snow. Precipitation is fairly uniformly distributed throughout the year. Maritime tropical air masses dominate in the summer and cold, dry continental polar air masses predominate in the winter. The average yearly temperature is 9°C. Average monthly temperatures range from -3°C in January to 22°C in July. On an average, temperatures fall below freezing on 133 days per year; temperatures below -18°C occur an average of four times yearly. Temperatures of 32°C or above occur on an average of seven days per year.[24] The average annual precipitation equals about 880 mm per year.[24] Storm systems moving across the continental United States are the primary source of summer precipitation. In winter, coastal lows originating over the Gulf of Mexico or Cape Hatteras are occasionally responsible for heavy snowfalls. Decaying tropical storm systems have caused maximum recorded rainfalls; Hurricane Agnes dropped 460 mm of rain during one three-day period in 1972.[25]

2.4.2 Local Meteorology

Onsite wind data collected between January 1973 and December 1976 at the 9.6-m and 91.5-m levels were submitted by the applicant.

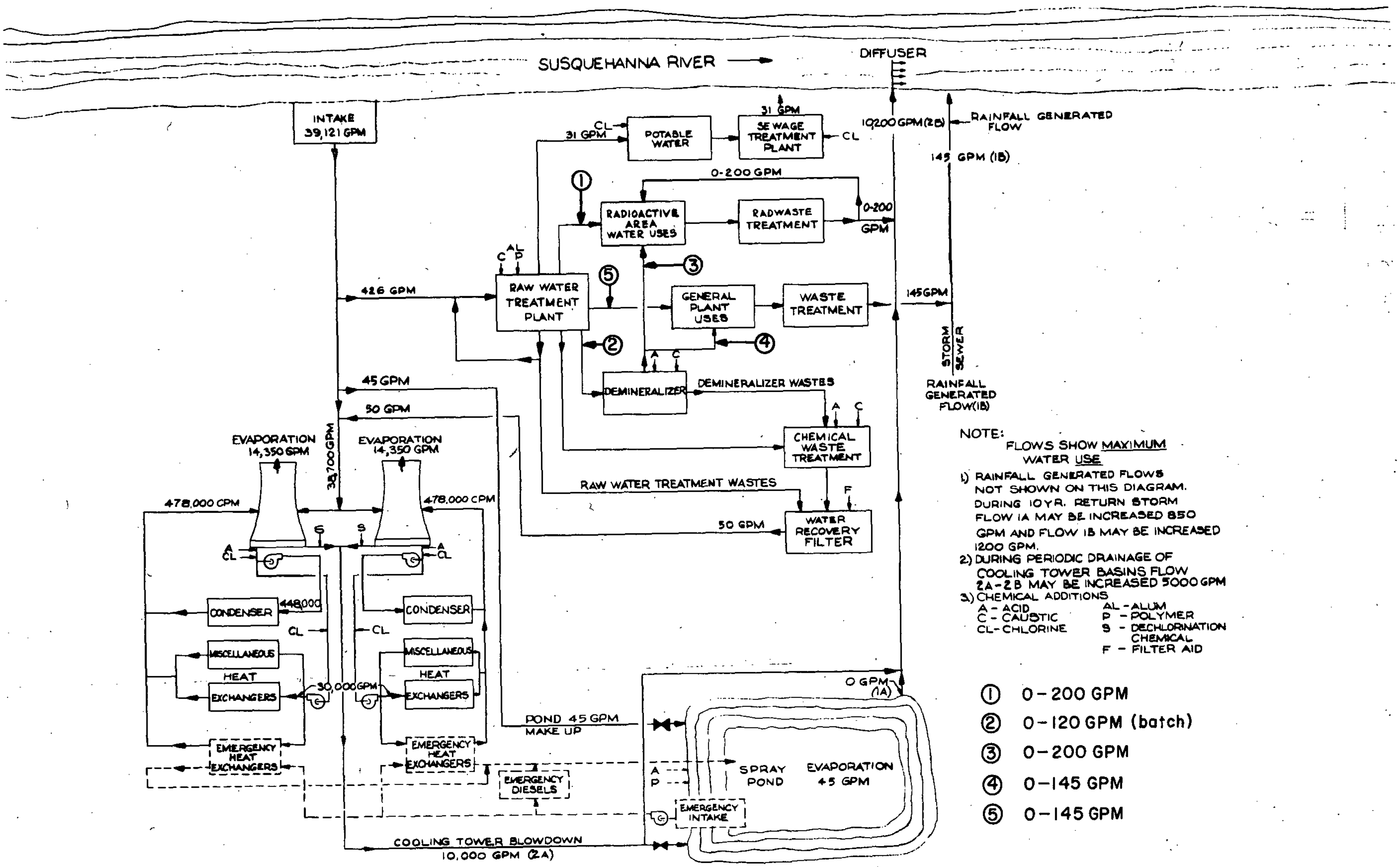

Fig. 2.3. Water Use Diagram for Susquehanna Units 1 and 2. From ER-OL, Fig. 3.3-1.

Table 2.6. Summary of Chemical Analysis of Susquehanna River Study Area, 1968-1977[a]

	Number of Samples	Maximum	Minimum	Average
Total suspended solids	174	912.6	1.6	54.8
Total dissolved solids	174	467.4	66.8	192.2
Total mineral solids	174	400.6	66.3	190.3
Specific conductance (mmhos/cm)	174	635.0	98.0	297.1
Total alkalinity	163	78.0	21.0	43.0
Total hardness	174	279.0	34.5	116.1
Chloride (Cl)	174	32.9	3.6	13.0
Sulfate (SO_4)	174	222.5	12.8	69.1
Nitrate (N)	173	1.67	0.09	0.59
Ammonia (N)	173	0.84	0.00	0.27
Phosphate (PO_4)	125	0.48	0.00	0.08
Total soluble	125	0.48	0.00	0.08
Phosphate (PO_4)				
Total	20	1.54	0.04	0.28
Carbon dioxide (CO_2)	54	13.5	3.0	7.3
Bicarbonate (HCO_3)	174	90.3	25.6	52.9
pH (units)	174	8.65	6.6	7.18
Water Temperature (°C)	170	29.4	0.0	12.2
Dissolved oxygen (O_2)	164	15.0+	5.8	10.1
Color (Pt Co. Units)[2]	173	116.0	0.0	27.4
Turbidity (JTU)	53	170.0	5.2	28.1
Chemical oxygen demand	135	70.8	3.5	15.2
Biochemical oxygen demand	138	6.6	0.10	1.74
Soluble (SiO_2)	174	6.25	0.005	3.16
Chlorine demand (1 hr)	101	3.80	0.27	2.07
Chlorine demand to given 0.1 mg/L Cl_2 after 10 min.	101	1.04	0.15	0.37
Chlorine demand to give 1.0 mg/L Cl_2 after 5 min.	101	3.48	1.10	1.85
Coloforms (fecal)				

[a]Test results in mg/L unless otherwise noted.

Table 2.7. Trace Metal Analysis of the Susquehanna River Study Area[a]

	No. of Samples	Maximum	Minimum	Average
Sodium (Na)	75	16.7	3.6	8.5
Magnesium (Mg)	174	42.0	1.6	9.3
Calcium	174	65.2	11.2	31.3
Sodium and potassium (as Na), by Diff.	99	32.4	0.0	8.7
Potassium (K)	75	2.8	0.39	1.5
Iron (Fe), dissolved	169	2.29	0.00	0.42
Copper (Cu), dissolved	74	0.03	0.00	0.01
Manganese (Mn), dissolved	169	3.45	0.00	0.26
Zinc (Zn), dissolved	74	0.04	0.00	0.23
Aluminum (Al), dissolved	169	0.35	0.00	0.03
Iron (Fe), total	86	17.30	0.15	3.20
Copper (Cu), total	73	0.10	0.00	0.02
Manganese (Mn), total	73	1.37	0.01	0.41
Zinc (Zn), total	73	0.10	0.00	0.03
Aluminum (Al), total	72	9.40	0.08	1.13
Nickel (Ni), total	8	0.04	0.01	0.02
Arsenic (As), total	2	F0.010	F0.010	F0.010
Mercury (Mg), total	2	F0.0002	F0.0002	F0.0002
Lead (Pb), total	2	F0.001	0.000	F0.0001
Nickel (Ni), dissolved	6	0.04	0.000	0.015

[a]Compiled from ER-OL; Soya and Jacobsen, 1978. Test results in mg/L unless otherwise noted.

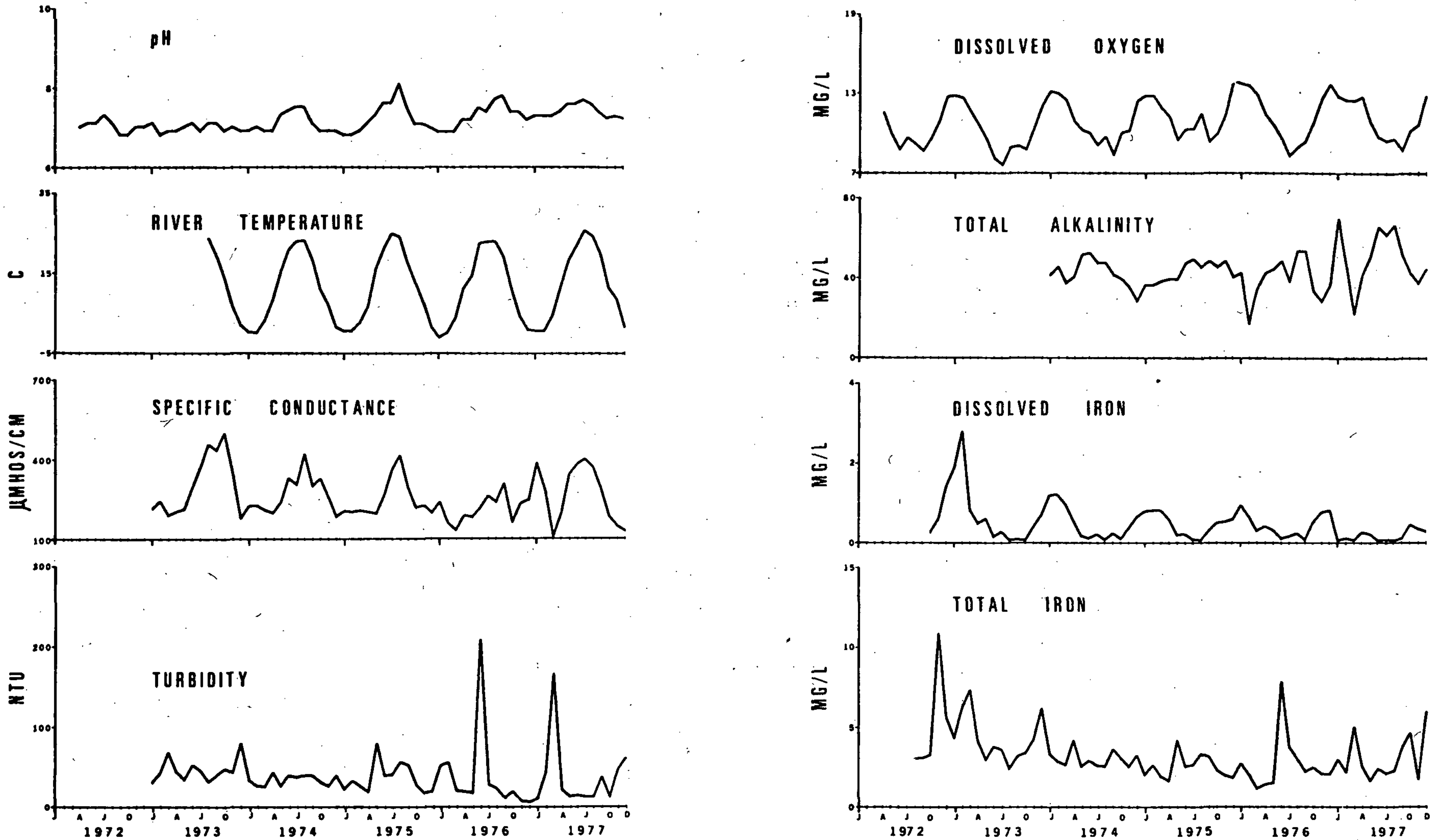

Fig. 2.4. Trends in Monthly Mean Values of pH, River Temperature, Specific Conductance, Turbidity, Dissolved Oxygen, Total Alkalinity, Dissolved Iron, and Total Iron in the Susquehanna River near SSES, 1972-1977.

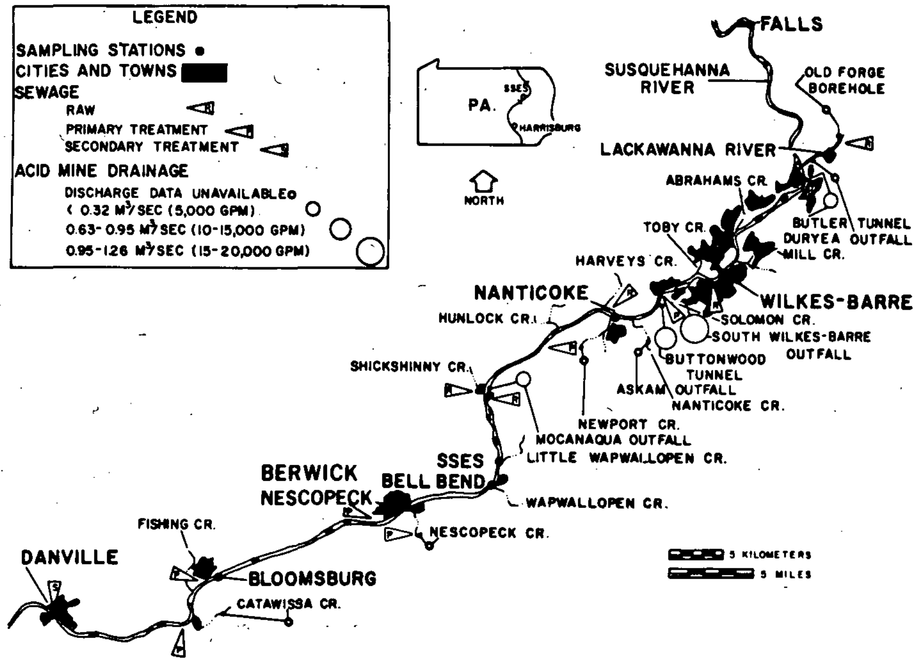

Fig. 2.5. Map of the Study Area with Sampling Stations and Sewage and Acid-Mine Drainage Effluents. The raw sewage effluents of the lower Lackawanna River and Wilkes-Barre were changed to primary treatment in December 1975. From ER-OL, Fig. 2.2-6.

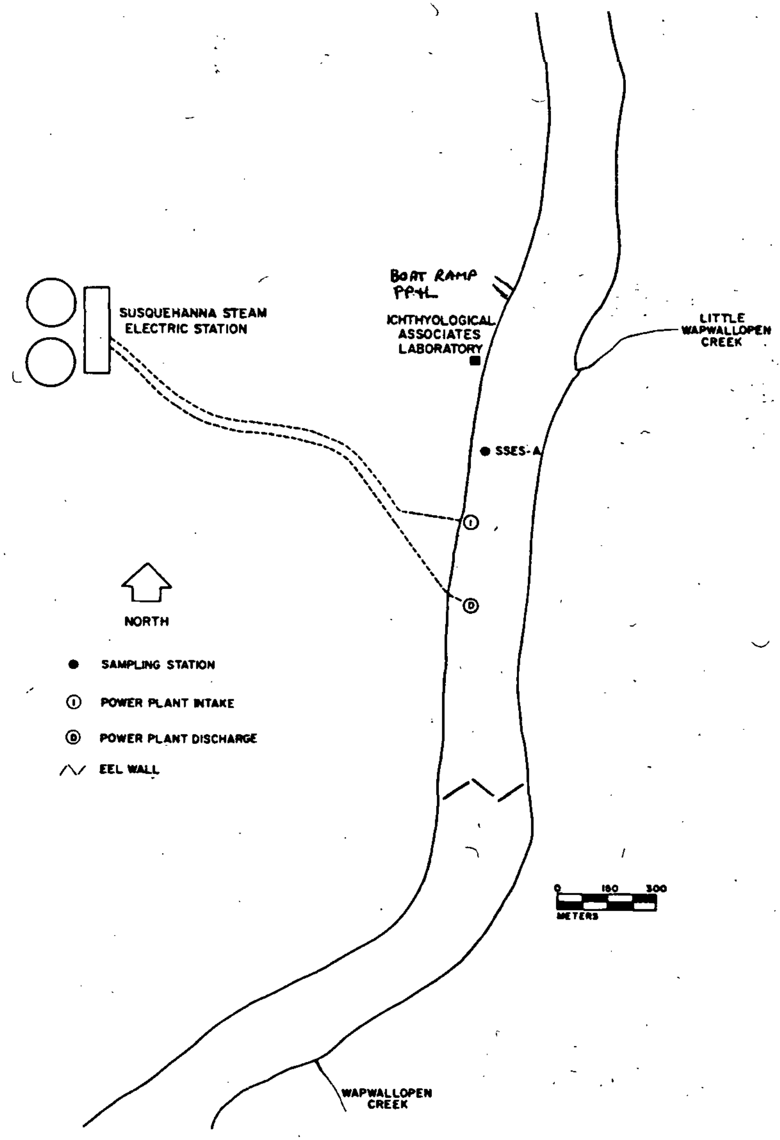

Fig. 2.6. Physicochemical Sampling Stations on the North Branch of the Susquehanna River, 1975.

Table 2.8. Water Quality Criteria Applicable to the North Branch of the Susquehanna River in the Vicinity of SSES

Parameter[a]	1962 U.S.P.H.S Drinking Water Standards[b]	1979 PA Dept. of Environmental Resources Rules and Regulations, Chapter 93, Water Quality Criteria
Alkalinity (as $CaCO_3$)		>20
Aluminum (Al)		<0.1 of LCD 50 (96 hr)
Arsenic (As)	<0.05	<0.05
Barium (Ba)	<1	
Carbon Tetrachloride Extract (C.C.E.)	<0.2[c]	
Cadmium (Cd)	<0.01	
Chloride (Cl)	<250[c]	
Chromium (Cr)	<0.05	<0.05
Coliforms, total	≤1	
Coliforms, fecal		<200/100 mL over 5 samples (during swimming season, May-September 30)
Color (color units)	<15[c]	
Copper (Cu)	<1[c]	<0.1
Cyanide (CN)	<0.2	<0.005
Fluoride (F)	1.4-2.4	<2.0
Iron (Fe), total	<0.3[c]	<1.5 (0.3 dissolved)
Lead (Pb)	<0.05	<0.05
MBAS	<0.5[c]	
Manganese (Mn)	<0.05[c]	<1.0
Nitrate (as N)	<10[c]	<10 (nitrate plus nitrite)
Odor (odor number)	<3[c]	
Oxygen (O), dissolved		>5.0 (daily average; no value <0.4)
pH (pH units)		6.0-9.0
Phenolics		<0.005
Selenium (Se)	<0.1	
Silver (Ag)	<0.5	
Sulfate (SO_4)	<250[c]	
Total dissolved solids (TDS)	<500[c]	<500 monthly average; <750 anytime
Turbidity (JTU)	<5	
Zinc (Zn)	<5	<0.01 of LC 50 (96 hr)
Gross β (pCi/L)	<1000	
Radium-226 (pCi/L)	<3	
Strontium-90 (pCi/L)	<10	
Temperature		<5°F[d] rise or <87°F[e], whichever is less; not to be changed by more than 2°F in any 1 hr. period.

[a]Measurements in mg/L unless otherwise noted.

[b]After treatment including disinfection and/or fluoridation.

[c]Recommended.

[d]To convert Δ°F to Δ°C, multiply by 5/9.

[e]To convert °F to °C, multiply (°F-32) by 5/9.

Table 2.9. Results of Radiological Analysis of Groundwater Samples from Observation Wells on SSES[a]

Observation Well	Date of Sampling	Depth of Sampling below S.W.L. (Ft)[b]	Gross Alpha (pCi/L)	Gross Beta (pCi/L)	Tritium $-H^3$ (pCi/L)	Sr^{89} (pCi/L)	Sr^{90} (pCi/L)
8	8-16-77	13	1.69±1.12	4.69±2.53	106±73	<2.23	<0.663
19	8-16-77	8	<1.50	<3.00	235±74	<1.40	<0.423
109	1-4-77	10	<2.15	<3.34	193±74	<1.00	<0.65
	8-16-77	35	<1.50	<3.00	101±72	<2.42	<0.689
1201	8-16-77	10	<1.86	4.71±2.10	104±73	<2.49	<0.739
1209A	8-16-77	12	<1.50	14.2±3.29	250±75	<3.26	<0.937
1210	8-15-77	4	2.20±2.06	2.35±2.30	211±74	<2.35	<0.721
B-1	1-5-77	5	<1.65	<3.34	169±74	<1.21	1.99±0.55
CPW	1-5-77	5	<1.96	<3.34	194±67	<1.09	<0.76

[a]Source: ER-OL,

[b]S.W.L. = static water level. To convert ft to m, multiply by 0.3048.

Due to problems with data recovery and to questionable data collected during the years 1973-1975, wind direction for only the one-year period of 1976 is summarized in Figure 2.7 to provide an estimate of expected long-term wind direction conditions at the Susquehanna site. During this one-year period, the predominant wind flow was from the west-southwest with a 13.5% frequency of occurrence. Secondary flow occurred from the west with a 12.0% frequency. The preference for the west-southwest/east-northeast wind-flow axis indicates that the terrain has a major influence on the local airflow.

2.4.3 Severe Weather

Eastern Pennsylvania is subjected to thunderstorm activity and the effects of tropical storms. Freezing rain and glaze are not uncommon in winter.

Between 1953 and 1974, 35 tornadoes were reported in a 160-km square containing the Susquehanna site. The calculated resultant tornado frequency and recurrency interval for a point in the site area is 4.6×10^{-4} tornadoes per year and 2200 years, respectively.[26,27] Hail measuring 20 mm in diameter or larger was recorded on five days and winds of 26 m/s were reported on eight days during the period from 1955 through 1967 within the one-degree latitude-longitude rectangle containing the Susquehanna site.[28] The maximum "fastest mile" of wind reported in Avoca was 27 m/s in February 1956. On an annual average, thunderstorms may be expected to occur about 31 days per year.[24] Between 1871 and 1977, 10 hurricanes passed within 80 km of the Susquehanna site.[29,30]

Freezing precipitation (ice storms) may be expected to occur about once a year, and ice storms resulting in an accumulation of 13 mm or more may be expected slightly more frequently than one year in two.[31] Twenty-five cases of air stagnation within the site area lasting four or more days occurred during the period from 1936 through 1970.[32]

2.4.4 Dispersion

Pennsylvania Power and Light Company has submitted a joint frequency distribution of onsite 9.6-m level wind speed and direction data, and atmospheric stability data (based on temperature differences between 91.4 and 9.6 m) measured during calendar year 1976 which the staff used to make estimates of average atmospheric dispersion conditions for the Susquehanna site. A straight-line diffusion model as described in Regulatory Guide 1.111, "Methods of Estimating Atmospheric Transport and Dispersion of Gaseous Effluents from Light-Water-Cooled Reactors," was used. Because of the complex terrain in the site vicinity, recirculation factors are incorporated. The model assumes a mixture of elevated and ground-level releases, based on the criteria established in Regulatory Guide 1.111. Intermittent gaseous releases were evaluated separately from continuous releases. Table 4.6 lists relative concentration and deposition values used in the dose estimates.

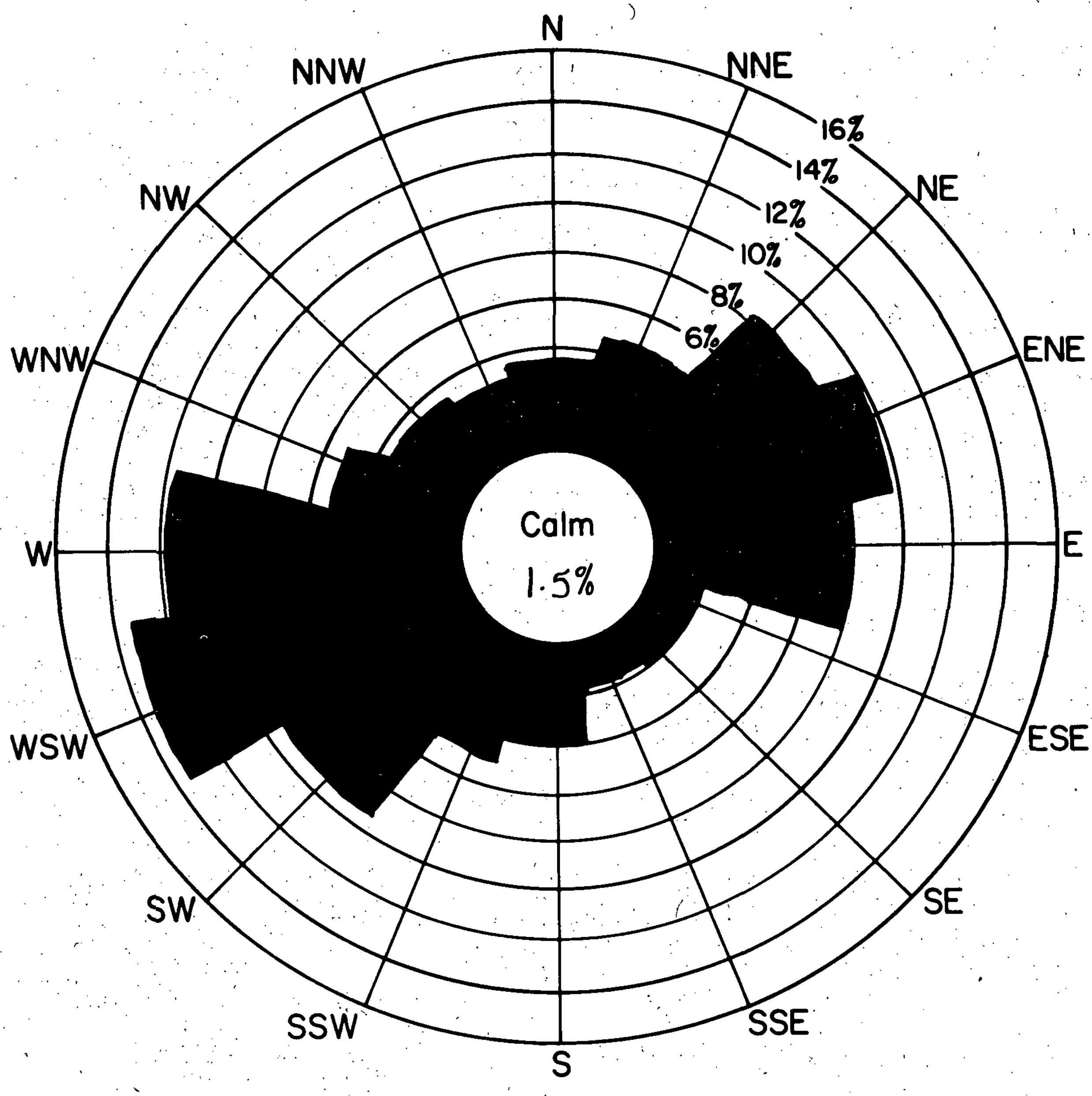

Fig. 2.7. Percent Occurrence of Wind by Direction at Susquehanna Nuclear Power Station. The figure is of onsite data measured 9.6 m above ground January 1976 through December 1976. (Calms are those winds with hourly average speeds of less than 0.3 m/s.)

2.5 SITE ECOLOGY

2.5.1 Terrestrial Ecology

Information concerning the terrestrial environment of the SSES site was briefly summarized in the FES-CP. The area of the site was, however, subsequently increased by the purchase of 49 ha of land in 1974 and 1975 (ER-OL, Supp. Response to Q.TER-2.1). The applicant has also collected considerable additional information regarding the local environment. The updated information base is summarized in the following sections.

2.5.1.1 Vegetation

The vegetation of the additional project lands purchased in 1974-1975 consisted primarily of open field and upland forest communities. Within present boundaries of the project site, these two community types thus occupied a greater area than reported in the FES-CP. However, the distribution of both community types has been altered during site development.

The applicant conducted floristic and/or vegetational studies (including phenology) within or immediately adjacent to the project site during the 1972-1974 and 1977 growing seasons.[33] A total of 568 plant species were identified, including 112 woody plants, 36 species of ferns and other cryptogams, and an additional 420 species of flowering plants. The family Asteraceae was best represented (66 species), followed by Gramineae (49), Rosaceae (29), Cyperaceae (27), and Leguminosae (23). Nineteen species of *Carex* were identified; other well represented genera included *Aster* (asters), *Polygonum* (knotweeds), *Solidago* (goldenrods), and *Viola* (violets) with 12, 12, 10, and 10 species, respectively. The local vegetation was differentiated into five general community types; the principal species of the five community types are presented in Table 2.10.[33]

Table 2.10. Principal Plant Species of Major Plant Communities in the Vicinity of SSES

Plant Community Types	Principal Species
River floodplain forest	
Woody species:	*Acer saccharinum, Betula nigra, Quercus borealis*
Non-woody species:	*Matteuccia struthiopteris, Podophyllum peltatum, Alliaria officinalis, Hesperia matronalis, Floerkia proserpinacoides, Dicentra cucullaria, Polygonum virginianum, Viola papilionacea, Erythronium americanum*
Upland forest	
Woody species:	*Pinus virginiana, Betula lenta, Cornus florida, Quercus alba, Quercus borealis, Quercus velutina, Liriodendron tulipifera*
Non-woody species:	*Lycopodium flabelliforme, Dronyopteris intermedia, Glecoma hederacea, Geum canadense, Potentilla simplex, Viola papilionacea, Carex Swannii*
Abandoned field	
Woody species:	*Betula populifolia, Rubus allegheniensis, Rubus flagellaris*
Non-woody species:	*Aster ericoides, Aster simplex, Solidago rugosa, Rumex acetosella, Potentilla simplex, Carex annectans, Agrostis stolonifera; Andropogon scoparius, Danthonia spicata, Phleum pratense*
Open marsh and pond	
Woody species:	--
Non-woody species:	*Polygonum sagittatum, Sagittaria latifolia, Carex crinata, Carex scoparia, Scripus cyperinus, Leersia oryzoides, Juncus effusus, Typha latifolia*
Agricultural field	
Woody species:	--
Non-woody species:	Agricultural crops, primarily corn, *Panicum capillare*; numerous associated weedy species, primarily annuals

2.5.1.2 Wildlife Species

Mammals

Detailed site-specific information concerning the mammals occurring in the vicinity of SSES was not available for incorporation in the FES-CP. The applicant, however, did conduct local mammal surveys and studies from October 1972 to December 1974. The presence of 26 mammal species, as listed in Table 2.2-55 of the ER-OL, was documented.

Based on trapping results, an unidentified species of *Peromyscus* was the most abundant of the small rodents, followed by eastern chipmunk, short-tailed shrew, and woodland jumping mouse, respectively. *Peromyscus* was "found in all the habitats on the site" (ER-OL, Sec. 2.2.2.4). The chipmunk and woodland jumping mouse occurred primarily in forest areas, the shrew primarily in open fields. The star-nosed mole and meadow vole were occasionally observed in fields and marshland.

Collected specimens of game and fur-bearing mammals included opossum, eastern cottontail, eastern woodchuck, raccoon, muskrat, and eastern gray squirrel. Red and gray foxes were occasionally observed but none were collected. During the study period, muskrats were taken extensively by local trappers, who also caught four beaver on nearby Gould Island in 1974. The three most important game species were, in decreasing order of importance, white-tailed deer, eastern cottontail, and eastern gray squirrel.

Birds

Species lists presented in the applicant's ER-OL (Tables 2.2-46, 53) indicate that a total of 154 bird species, including 26 species of waterfowl, were observed at or near the Susquehanna project during surveys conducted during and prior to 1974. In addition, the applicant's consultants observed an additional 42 species not reported in the previous surveys upon completion of a 1977 study.[33] The total species observed (196) in the 1973-1974 and 1977 surveys included representatives of more than 40 families, but about 57 percent of the total inventory was comprised of only seven families. The family Parulidae (wood warblers) was represented by 28 species, Anatidae (waterfowl) by 26 species; Fringillidae (sparrows, grosbeaks, etc.) by 24 species; Ardeidae (herons, egrets, and bitterns) by 9 species; and the families Accipitridae (hawks, eagles), Tyrannidae (flycatchers, phoebes, etc.), and Icteridae (blackbirds, orioles, etc.) by 8 species each.

The results of nonsystematic surveys (walks through representative habitat types) conducted in 1977 provide some insight with respect to seasonal variation in species composition of local bird populations. A total of 45 species was observed during the winter, 81 during the spring, 76 during the summer, and 81 during the fall.[33] Information concerning seasonal variation in the total bird population of the area was collected in 1974.[34] An average of 171 birds per observation period was observed along an established survey route during January and February. The comparable average for March, April, and May was 450; that for June, July, and August was 282. The number of birds recorded for September 30, October 31, and December 20 was 426, 157, and 115, respectively.

Analysis of the 1977 nonsystematic surveys indicate that the common crow, blue jay, cardinal, and song sparrow were among the more frequently observed species in the course of all four seasons.[33] Other relatively abundant species observed during winter censuses included the downy woodpecker, brown creeper, tree sparrow, white-breasted nuthatch, and common merganser.

Waterfowl were relatively abundant during the spring season; mallard, American widgeon, and the wood and black duck were the most frequently observed species. Other predominant species included the downy woodpecker, black-capped chickadee, mourning dove, robin, redwinged blackbird, and common grackle; the last four of these species were also relatively abundant during the summer season. Additional species frequently recorded in summer censuses included the barn swallow, catbird, yellowthroat, Indigo bunting, American goldfinch, and chipping and field sparrows.

The most frequently recorded species during fall surveys included the downy woodpecker, black-capped chickadee, white-breasted nuthatch, American goldfinch, and yellowthroat, as well as the previously mentioned four species that are predominant in all seasonal populations.

Reptiles and Amphibians

Site-specific information concerning local reptiles and amphibians was not available for incorporation in the FES-CP. However, local surveys were conducted by the applicant's consultants in 1972-1973 (ER-OL, Sec. 2.2.2.2).

A total of 38 amphibian and 48 reptilian species are reported to occur in Pennsylvania.[35] Based on published species-distribution maps, only 20 amphibians and 19 reptiles are likely to occur in the area surrounding the station.[36] The applicant's consultant collected or observed 13 amphibian species and 10 reptile species during the surveys. Seven species of the order Caudata were identified. The red-backed salamander was the most frequently observed species in terrestrial habitats and the northern dusky salamander was the most abundant species in aquatic habitats. The other identified species included the hellbender; red-spotted newt; and the spotted, two-lined, and spring salamanders. Toads and frogs (6 species) were abundant in the marshes and ponds in the eastern portion of the study area. Voice emissions of the American toad and spring peeper were predominant during the spring season; those of the green, bull, and leopard frogs were more pronounced during the warmer summer months. Tree frogs were observed in upland pine stands in northern portions of the site.

The most frequently observed of the seven species of turtles that were identified was the eastern painted turtle; the largest individual captured was a snapping turtle. Other species observed included the eastern box and wood turtles, which frequently inhabitat terrestrial environments, and the stinkpot and spotted and map turtles, which are primarily inhabitants of aquatic habitats.[36] The most abundant and widely distributed snake occurring on the site was the common garter snake. The only other observed snakes were the common water snake and the northern black racer, although other nonpoisonous and venomous species are expected to occur in the area (ER-OL, Sec. 2.2.2.2).

2.5.1.3 Endangered and Threatened Biotic Species

None of the current federally designated plant species (including varieties) of endangered or threatened status occur in Pennsylvania.[37] Five plants reported to occur within the state were included in a 1976 federal listing of proposed threatened or endangered species; none of the listed species were included in the 568 species identified in vegetation surveys conducted in the vicinity of the station.[38]

SSES is within the distributional range of five animals, two mammals and three birds, included in the federal list of threatened and endangered species.[37,39] Neither of the mammals, the eastern cougar (*Felis concolor cougar*) and Indiana bat (*Myotis sodalis*), were observed during mammal surveys conducted in the project area (ER-OL, Sec. 2.2.2.4). None of the critical habitats designated for the Indiana bat occur in Pennsylvania.[40] The endangered bird species include the American and arctic peregrine falcons (*Falco peregrinus anatum* and *Falco peregrinus tundrius*) and the bald eagle (*Haliaeetus Luecocephalus*). Neither of the peregrine falcons are included in the list of 196 species identified during the 1973-1974 and 1977 surveys.[33] Bald eagles, however, were sighted twice during the 1977 survey when an immature and an adult eagle were observed flying over the project area on separate occasions. In view of the extensive surveys conducted in the project area, the staff concludes that bald eagles are only occasional transients with respect to the site. An American peregrine falcon was observed in 1973.

Certain reptiles and amphibians have been designated as endangered species by the Pennsylvania Fish Commission;[41] none of these species was observed in surveys of the project area. There is no state listing of endangered birds and mammals at this time (ER-OL, Supp., Response to Q.TER-6.1.).

2.5.2 Aquatic Ecology

Since the issuance of the FES-CP, extensive data on the aquatic ecology have been collected both 6.5 km upstream and downstream of the SSES intake structure. These data are summarized here; detailed information can be found in the ER-OL and in References 33 and 42-44.

In the vicinity of the site, the grade of the river is about 0.3 m/km. River depth ranges from 1 to 8 m, the width varies from 100 to 480 m, and the bed is mostly rock and gravel. During the periods of low flow in late summer and early autumn, abandoned eel walls help maintain river pools, some of which are several kilometers long. Eel walls closest to the Susquehanna intake structure are located approximately 300 m downriver and 1400 m upriver. In times of moderate to high flow, the river level increases by as much as 1 to 3 m and its flow characteristics resemble those of an open channel.

From 1972 to 1975, the minimum daily flow past the site was 50 m^3/s. In the past 75 years, the lowest daily flow at the site was 15.3 m^3/s. During periods of normal flow, the river's velocity at the site ranged from 0.1 to 1.69 m/s.

2.5.2.1 Physicochemical Analyses

Beginning as early as July 1971, various water quality parameters have been monitored on a continuous basis. The parameters measured for the longest periods are listed in Table 2.11.

Table 2.11. Main Physicochemical Parameters Monitored at SSES

River level
River velocity
River flow
Water temperature
Dissolved oxygen
pH
Total alkalinity
Specific conductance
Sulfate
Total iron
Dissolved iron
Total residue
Fixed total residue
Nonfilterable residue
Total phosphate
Nitrate
Turbidity
Secchi disc depth
Bacteria

Statistical analyses of the physicochemical data from 1973 through 1977 showed improved water quality of the river. Dissolved oxygen, pH, and alkalinity increased; dissolved iron, total iron, turbidity, and specific conductance decreased (see Fig. 2.4).[33] These improved water quality trends are associated with the termination of pumping of mine water from flooded mines into the river following tropical storm Agnes in 1972. The amounts of acid, dissolved solids, iron, and sulfate in the river diminished as the volume of mine water decreased. However, mine pollution has not completely ceased, since some effluents continue to enter by gravity flow.[33]

The pH and alkalinity of the river increased as the drainage of acid from the mines decreased. Dissolved oxygen also increased. The specific conductance of the river decreased with the occurrence of fewer dissolved solids, and turbidity decreased due to the smaller amounts of suspended ferric precipitates.[33]

2.5.2.2 Phytoplankton

Phytoplankton was sampled monthly from August 1971 through September 1973. Genera of Bacillariophyta, Chlorophyta, and Cyanophyta collected during 1972 and 1973 are listed in Table 2.2-20 of the ER-OL. Major phytoplankton and periphyton species collected in 1974 and 1977 are listed in Table 2.2-21 of the ER-OL. Both phytoplankton density and standing crop were determined. The mean phytoplankton density for all stations increased from 3,400,000 units/L in August to a maximum of 7,100,000 units/L in October and then declined to about 150,000 units/L in December. Diatoms (Bacillariophyta) were by far the most abundant kinds of algae. Green algae (Chlorophyta) were the second most abundant. The relative abundance of green algae, diatoms, and blue-green algae (Cyanophyta) changed little at various stations, indicating a nonselective loss of phytoplankton.

In 1972 and 1973, both density and standing crop of phytoplankton were low in January, February, and March at SSES and Falls, ranging from 57,000 to 1,160,000 units/L. Density and standing crop began a marked increase in April (1972) and May (1973). Data from samples collected monthly in 1972 and 1973 indicated that density increased dramatically in August at both stations. Density reached a maximum of 73,400,000 and 71,400,000 units/L at SSES and 64,400,000 and 101,900,000 units/L at Falls in 1972 and 1973, respectively. Density declined sharply in autumn.

Blooms occurred at SSES in July (109,100,000 units/L), August (71,400,000 units/L), and September (73,500,000 units/L). The standing crop of phytoplankton, which tended to be high in summer when riverflows were low, increased relatively little in comparison to the great increase in phytoplankton density.

Diatoms, relatively the most abundant kinds of algae during most of the year at Falls and SSES, made up about 90% or more of the total phytoplankton in winter and early spring. Green algae became relatively more abundant in summer and in 1973 composed the largest percentage of units in the July, August, and September blooms at SSES. Blue-green algae were extremely abundant in August 1972, when they composed about 90% of the August phytoplankton blooms. This great abundance of blue-green algae did not occur at any other time during the study. This bloom may have been caused by additional nutrients in the river from inoperative sewage treatment plants after tropical storm Agnes. Generally, about the same numbers of genera were found in the sewage-polluted water at SSES as were found in the relatively clean water at Falls.

The pH affinities of the various diatom species support the physicochemical analyses, as discussed in Section 2.5.2.1. Based on Reference 45, the applicant has rated most of the diatom species collected in 1974 and 1977 as "alkaliphilous," though a few species are "indifferent to pH."

A substantial number of genera in the plankton samples were periphytic algae that were probably scoured from river stones by the current. Periphyton was sampled using artificial substrate samplers. Artificial substrates were left submerged at Falls and SSES for periods of from 1 to 12 months so that short-term changes in colonization rates and long-term changes in structure of the algal community could be observed.

Periphyton samples were also taken from river stones near the artificial substrates by a scuba diver using a bar-clamp sampler that enclosed 387-mm^2 surface area and cleaned by vibration of an ultrasonic dental cleaning probe. Samples were concentrated by settling and decanting. The reader is referred to Section 2.2.1.3 of the applicant's ER-OL for further details.

2.5.2.3 Zooplankton

Zooplankton are utilized as food by macroinvertebrates, young fish, and some adult fishes. Zooplankton samples consisted of 40, 80, or 100 L of water pumped through a number-20 mesh plankton net. Samples were taken from near the bottom as well as near the surface.

The zooplankton of the Susquehanna River were numerically dominated by rotifers; these organisms composed 93 and 97% of the zooplankton at SSES in 1972 and 1973, respectively. Distinct seasonal fluctuations in rotifer densities were significantly correlated with water temperature. Rotifer blooms may result from increases in temperature, light intensity, or nutrients, and vary from year to year. In 1972, rotifer blooms at SSES occurred in April (109 × 10^5 organisms/s) and July (510 × 10^5 organisms/s). In 1973, a rotifer bloom occurred in May (493 × 10^5 organisms/s). During non-bloom times of the year, rotifer standing crop was generally less than 50 × 10^5 organisms/s, and in October 1972 it was less than 1 × 10^5 organisms/s.

Microcrustaceans were relatively scarce in samples collected in the river channel but large numbers of individuals of several species were found in some backwaters near SSES. *Bosmina longirostris*, *Diaphanosoma brachyurum*, and *Chydorus sphaericus* were the most numerous cladocerans collected; *Cyclops vernalis* and *Eucyclops speratus* were the most common copepods. Cladoceran and adult copepod densities were usually much less, and never exceeded 350 org/m^3.

When river levels rise, microcrustaceans are flushed from backwaters and the substrate into the water column. There was a significant positive correlation between river discharge and the densities of both immature copepods and adult copepods at SSES. Densities of microcrustaceans in the water column usually decrease sharply after an initial "wash-out," before river levels begin to decline.

Zooplankton species composition was similar between SSES and Falls, but annual mean densities of total zooplankton were considerably higher at SSES due to rotifer blooms that were not observed at Falls.

Nonzooplankters were usually a minor component of total organisms in zooplankton samples, but occasionally they were abundant and composed as much as 60% of all organisms collected. Nematodes (roundworms) were the most numerous nonzooplankters; oligochaetes (especially *Chaetogaster langi* and *Nais pardalis*), ostracods (seed shrimp), hydracarinids (water mites), stalked protozoans, and tardigrades (water bears) were also commonly collected in low numbers during most months.

2.5.2.4 Aquatic Vascular Plants

The Susquehanna River presents a harsh environment for most rooted aquatic plants. The strong currents, rocky substrates, and widely fluctuating water levels are not conducive to the development of extensive rooted plant communities.

Of the 29 species of aquatic vascular plants found in the study area (SSES upriver to Coxton, PA), only six were attached submergents (ER-OL, Table 2.2-22). *Potamogeton nodosus* was the most abundant submergent species. Emergent plants, which are better secured and able to withstand the current and whose leaves extend above the water, are less affected by high turbidity and were relatively more abundant than submergents. *Justica americana* and *Eleocharis acicularis* were the most abundant species of emergents.

In 1971, 64 submergent plant beds covered about 6% of the river's bottom between Coxton and Berwick, PA; these plant beds were severely damaged in the flood caused by tropical storm Agnes in 1972. By the following year, the beds had reestablished themselves and covered about the same area as in 1971. Although emergent plants were less affected by the flood, flowering was delayed.

Aquatic vascular plants in the study area do not seem to be a major component of the aquatic food chain, partly because of their paucity, but also because iron compounds coat their stems and leaves. The iron makes the vegetation undesirable as food and shelter for most aquatic invertebrates.

2.5.2.5 Macroinvertebrates

Macroinvertebrates were collected from Falls to Danville, PA, from 1971 through 1977 (Fig. 2.8). As in other aquatic environments stressed by mine pollution, chironomid larvae (Diptera: Chironomidae) were the most abundant organisms at all sites on the SSES transect and Bell Bend I; they made up as much as 96% of all macroinvertebrates in the area, with densities reaching 78,000 org/m^2. A total of 44 different chironomids have been identified in the study area

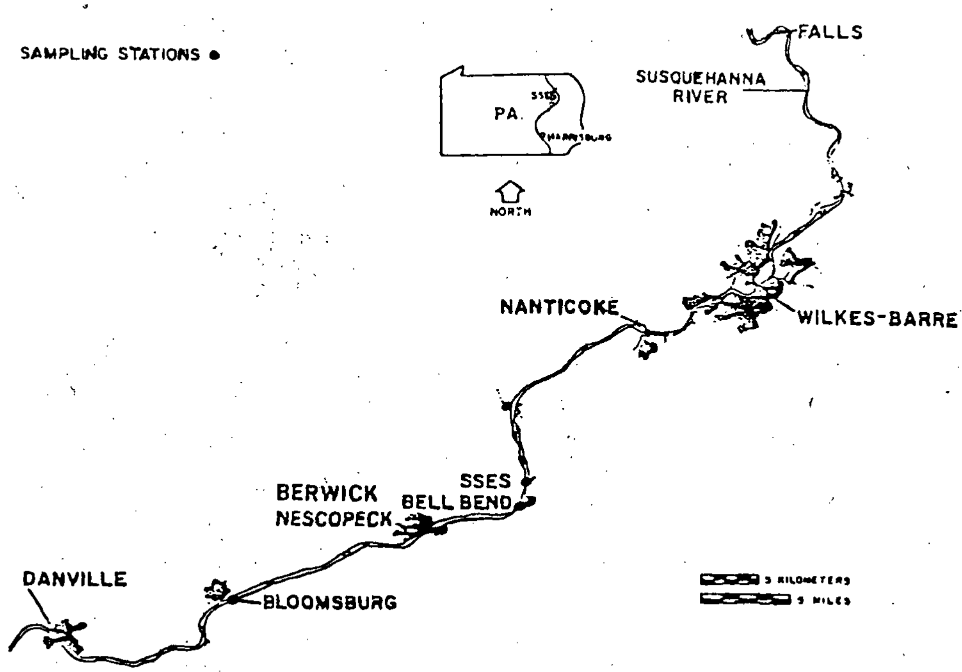

Fig. 2.8. Macroinvertebrate Sampling Stations.[42] Adapted from ER-OL, Fig. 2.2-6.

(ER-OL, Table 2.2-29). *Rheotanytarsus* was the most numerous in the vicinity of SSES, composing between 54 and 72% of all chironomids collected in 1975. The sharp increases in macroinvertebrate densities from July through September in 1973 and 1974 were due to the abundance of this predominant chironomid.

Hydropsychid caddisflies (Trichoptera: Hydropsychidae) were also abundant at all sites. *Cheumatopsyche* was especially common; densities approached 6000 org/m^2 (50% of all organisms, exclusive of chironomids) at SSES in September 1974. This organism, known for its tolerance to mine-drainage pollution, like several chironomid species, thrived under conditions at SSES that were too adverse for most other invertebrates.

Four taxa (Oligochaeta, Heptaqueniidae, Hydropsychidae, and Chironomidae) composed from 74.7 (SSES-2) to 88.4% (Bell Bend I) of the total damp weight of organisms collected near SSES in 1975. Damp weights ranged from 3.9 to 15.3 kg/ha (mean = 9.2 kg/ha) at SSES-1, from 4.3 to 19.5 kg/ha (mean = 10.0 kg/ha) at SSES-2, and from 3.8 to 43.1 kg/ha (mean = 22.7 kg/ha) at Bell Bend I.

Falls, the control station upriver from most major mine effluents, had up to fivefold more taxa than the SSES sites during 1973 and 1974. Clean-water organisms such as mayflies, stoneflies, and caddisflies were found in much greater densities at Falls than at SSES.

Downriver from SSES and Bell Bend I, the effects of mine-drainage pollution diminished. Whereas chironomids made up nearly 90% of the benthos at SSES-1 in September 1974, they composed only 19% at Nescopeck. Ancylid snails (*Ferrissia* sp.), which are associated with clean cobble substrates and alkaline water quality, composed 12% of the benthos at Nescopeck but were absent or rare (0.2%) at the SSES sites. Much of the difference between the benthos at the two stations resulted from greater river turbulence at Nescopeck which inhibited iron deposition, thereby keeping the substrate cleaner. Iron deposition was almost four times as high at SSES (mean = 4265 mg/m^2) as at Nescopeck during the summer of 1974.

In summary, most macroinvertebrate populations in the vicinity of the site were suppressed due to the effects of mine-drainage pollution. Suspended and settled ferric hydroxide, primarily from mine drainage, had a greater effect on the benthos than did a lowered pH and a lack of dissolved oxygen. Since invertebrates and their eggs were coated with iron, some may have been smothered. Iron also decreased light penetration and inhibited the growth of algae upon which grazing macroinvertebrates fed. When populations of herbivorous macroinvertebrates are restricted fish and predaceous macroinvertebrates that feed on these organisms are also reduced in numbers.

2.5.2.6 Fish

Eggs or nest larvae of at least 16 species of fish were found in the river near SSES from 1974 to 1975 (ER-OL, Table 2.2-15) from mid-April through mid-August. Eggs of the spotfin shiner (*Notropis spilopterus*), a crevice spawner, were collected from early June to mid-August. Quillback (*Carpiodes cyprinus*) were the most widely distributed of all species encountered.

In the vicinity of SSES, 25 species of larval fish were identified from net and pump samples collected between 1972 and 1975 (ER-OL, Table 2.2-31). Carp, minnows, quillback, white sucker, shorthead redhorse, and perch composed more than 95% of the total number of larvae collected in 1973-1975.

From 1975 to 1977, maximum larvae densities occurred between 20 May and 20 June. Larvae of all species captured moved toward the surface between 1800 and 2100 hours; during these hours, when peak number of drifting larvae occurred, more larvae were captured near the surface and at 1 m than in deeper water.

More larvae were collected along the banks than in mid-channel. In 1974, catch per unit effort was higher near the east bank than the west bank. The larger number of larvae collected along the riverbanks was probably due to the shoreward migration of the postlarval fishes.

Number and species composition of the fish captured from 1971 to 1975 are listed in Table 2.2-42 of the ER-OL. The majority of the fish were warmwater species capable of tolerating various levels of pollution. "Important" forage and game fishes are listed in Table 2.12.

Table 2.12. Important Forage and Game Fishes[a]

Forage	
Spottail shiner	*(Notropis hudsonius)*
Spotfin shiner	*(Notropis spilopterus)*
Quillback	*(Carpiodes cyprinus)*
White sucker	*(Catostomus comersoni)*
Shorthead redhorse	*(Moxostoma macrolepidotum)*
Game	
Muskellunge	*(Esox masquinongy)*
Brown bullhead	*(Ictalurus nebulosus)*
Channel catfish	*(Ictalurus punctatus)*
Smallmouth bass	*(Micropterus dolomieui)*
Walleye	*(Stizostedion vitreum)*

[a]"Important" as defined in NRC Reg. Guide 4.2, Rev. 2, July 1976.

In 1971-1975 the relative numerical importance of the northern hog sucker (*Hypentelium nigricans*) and smallmouth bass (*Micropterus dolomieui*) in the catch increased at SSES. The relative numbers of these species may have increased because of improved water quality. Levels of total iron, dissolved iron, sulfate, conductivity, total residue, and turbidity at the site decreased from 1972 to 1975. Spotfin shiner, white sucker, bluegill, white crappie, and spottail shiner were the most abundant species captured.

Studies conducted in 1972 and 1973 showed that invertebrates made up the largest percentage of food items consumed by most fishes; these organisms comprised more than 50% of the food eaten by the comely shiner, spotfin shiner, fallfish, northern hog sucker, rock bass, pumpkinseed, bluegill, smallmouth bass, largemouth bass, and yellow perch. Detritus and organic material were also found in the stomachs of most fishes; carp, spottail shiner, quillback, white sucker, and shorthead redhorse had the largest amounts of detritus. Plant material was an important food for carp, spottail shiner, and brown bullhead.

Walleye, chain pickerel, smallmouth bass, largemouth bass, white crappie, and black crappie largely feed upon smaller fish. Fish composed 70% of the food (by volume) for walleye. Sunfish, the walleye's (17.5 - 63.0 cm long) most common forage, comprised 28% of the number of fish consumed; they were followed by minnows and carp (25%), suckers (21%), perches (15%), and catfish (11%).

The food habits of the northern hog sucker differed from those of other suckers in that it consumed a comparatively larger percentage of invertebrates and a smaller percentage of detritus. Invertebrates made up more than 50% of the volume of material in the stomachs of the northern hog sucker and less than 32% of the material in the stomachs of quillback, white sucker, and shorthead redhorse.

2.5.2.7 Rare and Endangered Species

No threatened or endangered fishes[37,41] (as listed in the Federal Register) were captured. However, two cisco (*Coregonus artedii*), listed as rare by the Pennsylvania Fish Commission, were collected. These fish probably entered the river near Nanticoke by way of Harvey's Creek, the outlet of Harvey's Lake. The Pennsylvania Fish Commission introduced the cisco into Harvey's Lake from 1969 to 1972. Because cisco prefer deeper lake waters, there is little likelihood that a population of cisco has been or will be established in the river as a result of escapement from Harvey's Lake.

2.6 CULTURAL RESOURCES

2.6.1 Regional Profile

Historic and archeological sites and natural landmarks are summarized in Section 2.3 of the CP-FES.

The general area surrounding the plant is reported to have numerous sites of historic, ethnohistoric, and prehistoric importance.[12,46,47] A number of prehistoric populations occupied eastern Pennsylvania, beginning perhaps as early as 8,000 to 10,000 B.C., and material remains of their subsistence-settlement systems are frequently found along major waterways, including the Susquehanna River and its branches.[48,49] Ethnohistoric village sites and trails associated with the Shawanese, Nanticokes, Delaware, and other American Indian groups are also reported to have been in the Susquehanna Valley.[12] By the mid-eighteenth century, settlers began to occupy and lay claim to the area, which was then called Wyoming. In the years that followed, periods of war and unrest were frequent as various European, pioneer, and Indian groups sought possession of the "Wyoming" lands. It was not until the beginning of the nineteenth century that substantial settlement and development stabilized in that part of the "Wyoming" area that later became Luzerne County.[12,46] By 1900, the economic base of Luzerne County had shifted from agriculture, fishing, and lumbering to mining and manufacturing centered in three urban areas: Wilkes-Barre, Hazleton, and Pittstown.[46]

The protection and preservation of cultural resources, in the "Wyoming" area in particular and in Luzerne County in general, is an integral part of the county's long-term administrative plan.[11] Moreover, the Economic Development Council of Northeastern Pennsylvania, as part of its mandate, has also developed a regional policy for preserving the architectural, historical, and environmental heritage of the people.[50] Discovering that historical [prehistoric] resources are endangered, this council proposed a program to locate/identify, zone, and control activities threatening cultural resources.[50]

2.6.2 The Plant Site

Since publication of the CP-FES, two cultural resources studies have been made on the Susquehanna Electric Station property.

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3. THE PLANT

3.1 RÉSUMÉ

There have been a number of changes in station and transmission system designs since the FES-CP was issued. With the exception of changes in the transmission line corridors, these changes are minor. Changes in the transmission system are discussed in Section 3.2.5. More detailed information is now available on the design of specific plant components, such as on the dimensions of the cooling tower, design of the intake and discharge structures, and in water use. Changes in design of the intake structure are presented in Section 3.2.2.2. The Susquehanna River Basin Commission has placed restrictions on the use of water from the river during periods of low flow (Sec. 3.2.1).

After the FES-CP was issued, the applicant modified the liquid, gaseous, and solid radwaste treatment systems as described in the final safety analysis report and evaluated in the staff's safety evaluation report. New liquid and gaseous source terms based on more recent operating data applicable to the station during normal operation and anticipated operational occurrences have been provided in Section 3.2.3.

3.2 DESIGN AND OTHER SIGNIFICANT CHANGES

3.2.1 Water Use

The design for basic station water-use and circulation patterns has not been changed since the construction permit was granted in 1973. Flow rates through different parts of the station and for various station operating and meteorological conditions are presented in Table 3.1. The annual average flow rates estimated in 1972 for the construction permit are also listed in the table for comparative purposes.

During plant operation, water will be withdrawn from the Susquehanna River at a rate varying from 1.9 to 2.5 m^3/s and will be primarily used for the makeup of evaporation loss from the cooling towers and blowdown returned to the river. Evaporation from the spray pond, which will serve as a holdup facility for cooling tower blowdown, is expected to be compensated by the direct precipitation on the pond surface.

According to a new regulation promulgated by the Susquehanna River Basin Commission (SRBC) in 1976, the applicant will be required to replace, starting on 1 July 1984, the amount of water consumed when the river flow at the station intake is at or below the 7-day, 10-year low flow (Q_{7-10}) plus the station's actual consumptive use. The SRBC has determined that, based on 77 years (1900-1976) of riverflow data measured at the Wilkes-Barre gaging station, the Q_{7-10} value applicable to the station is 22.7 m^3/s. The applicant could, however, meet the SRBC requirements by electing not to operate SSES during specific periods of low river flow. This option is discussed in greater detail in Appendix A, Section A.5.

A low-flow analysis recently made by the U.S.G.S. confirms this number (22.7 m^3/s). The station's major consumptive water use is for the cooling-tower evaporation which, as indicated in Table 3.1, varies from 1.3 to 1.8 m^3/s. In order to meet the low-flow compensation requirements of SRBC, the applicant has considered several alternatives including the construction of a water storage reservoir about 3.7 km upstream of the station. The applicant has submitted an Environment Report to SRBC (copy to NRC) to apply for a permit to build the reservoir. NRC's assessment of the environmental and other impacts of this facility is presented in Appendix A. The reservoir is expected to be in service for compensation operation in 1983 before the 1 July 1984 deadline established by the SRBC for compliance with the consumptive water make-up requirements. The applicant indicated that the reservoir was designed to be able to supply the required replacement water to the Susquehanna River during a recurrence of the record drought of 1964. During this drought, flow at Wilkes-Barre was below 24.5 m^3/s (Q_{7-10} plus maximum consumptive use) for 107 days, including one period of 84 consecutive days. If it were assumed that the make-up water would be released at a rate of 1.8 m^3/s, the active reservoir storage of 27.1×10^6 m^3 would last for about 170 days. This is longer than the number of days for which replacement water would be required during a repeat of the record drought. The staff therefore agrees with the applicant that the proposed reservoir design will meet the low-flow compensation requirement of SRBC.

Table 3.1. Flows of Major Station Streams[a]

Point	Flow	Minimum Monthly Average[b] m³/s	Maximum Monthly Average[c] m³/s	Annual Average[d] m³/s	Maximum Flow[e] m³/s	Shutdown Flow[f] m³/s	1972 Estimate Average Flow m³/s
1.	Intake from river	1.89	2.20	2.04	2.45	0	2.04
2.	Condenser cooling flow (2 condensers)	56.5	56.5	56.5	56.5	0	56.8
3.	Service water flow (2 units)	3.8	3.8	3.8	3.8	0	3.8
4.	Cooling-tower flow (2 towers)	60.3	60.3	60.3	60.3	0	60.6
5.	Cooling-tower evaporation (2 towers)	1.25	1.54	1.40	1.81	0	1.41
6.	Cooling-tower drift[g] (2 towers)	0.011	0.011	0.011	0.011	0	0.012
7.	Cooling-tower makeup (2 towers)	1.88	2.17	2.03	2.44	0	2.02
8.	Makeup to water treatment plant	0.013	0.013	0.013	0.027	0	0.005
9.	Spray pond makeup	0.003	0.003	0.003	n/a	0	n/a
10.	Spray pond evaporation and drift	0.003	0.003	0.003	n/a	0.018	n/a
11.	Emergency service water/residual heat removal systems flow (2 units)	0	0	0	0	1.9	0
12.	Radwaste treatment outlet to river	0-0.013	0-0.013	0-0.013	0-0.013	0-0.013	≤ 0.003
13.	Diffuser flow (less cooling-tower drift)	0.63	0.63	0.63	0.63	0	0.63

[a]Adapted from ER-OL and ER-CP.

[b]Flows calculated for month of February.

[c]Flows calculated for month of August.

[d]Calculated at 100% level; expected plant capacity factor is 80%.

[e]Evaporation losses calculated at 73°F wet bulb and 65% RH; design flow at full load (two towers).

[f]Flow based upon shutdown condition imposed by failure of distribution grid and loss of offsite power.

[g]Calculated from guaranteed minimum drift; actual drift expected to be less than 10% of indicated value.

Cooling water makeup passes through a coarse screen, but is essentially untreated river water. Water for other uses is treated by one or more of the processes listed in the sequence in Table 3.2.

Table 3.2. Water Treatment

Treatment[a]	Use
1. Coarse screening	Cooling water
2. Chlorination	
3. Clarification	
4. Filtration	Pump seal lubrication; non-radioactive housekeeping, fire protection
5. Chlorination	Potable water
6. Activated carbon filtration	
7. Two-bed ion exchange	
8. Mixed-bed ion exchange	Steam power cycle makeup

[a]The treatment processes are cumulative. Any water treated by mixed-bed ion exchange has been treated by the other seven processes.

3.2.2 Heat Dissipation System

3.2.2.1 Cooling Towers

At the time the FES-CP was prepared in 1973, the final design parameters for the plant condenser cooling system had not been established. The plant will use two counterflow natural-draft cooling towers, one for each unit, to transfer more than 99% of the station's unconverted heat energy to the atmosphere.

Operating at full power, the plant (2 units) will produce 16.9×10^{12} J/hr of waste heat that will be transferred to the cooling water circulating at about 30 m^3/s through each condenser (ER-OL, Sec. 3.4). The temperature rise across the condensers will be about 14°C. In addition, 0.38×10^{12} J/hr of waste heat will be transferred to the cooling towers by the 0.25 m^3/s flow in the service cooling-water system.

Each hyperbolic cooling tower will be 165 m tall with a base diameter of 128 m. At design conditions (air temperature of 30.6°C, wet-bulb temperature of 22.8°C, and relative humidity of 65%), the approach to wet-bulb temperature is 7.8°C.

A 2.8-ha spray pond, containing about 9.5×10^4 m^3 of water, will be used as the plant's ultimate heat sink for the emergency service water systems. This pond will also be used to supply cooling and cooling water for the residual heat removal service water system during normal unit shutdowns and to cool the diesel generators. Makeup water for the spray pond will, if needed, be supplied by the makeup system for the circulating water system.

3.2.2.2 Intake Structure

At the time of the FES-CP, a "conventional type intake structure and pumphouse" was proposed (FES-CP, Sec. 3.3.5, p. 3-9). More detailed information is now available (ER-OL, Sec. 3.4.2, pp. 3.4-2 and 3.4-4). The current intake design consists of an embayment and pumphouse.

The river intake structure is located on the west bank of the Susquehanna River as shown on Figure 3.1. An earth embankment extends 6.0 m above the floodplain to elevation 157.8 m MSL, which is 0.3 m above the maximum water elevation for the postulated Standard Project Flood (SPF). The floor level of the intake superstructure (Fig.3.2) is located at the top of the graded embankment. The elevated embankment and the riverbank at the intake entrance are to be covered with a blanket of heavy riprap for erosion protection during high riverflow conditions.

The intake structure consists of a steel superstructure above the operating floor and a reinforced concrete substructure extending into the rock below the level of the river bottom. The superstructure houses the makeup water pumps and associated equipment, including switchgear, automatic operating equipment for trash-handling screens, motor control centers, screen wash strainers, and a debris-handling facility.

The substructure contains two water entrance chambers that house the traveling screens and two pump chambers. The intake openings are formed by the floor and sides of the entrance chambers (Fig. 3.3). The top of the intake openings is formed by an inverted weir extending 0.3 m below the minimum river water level (elevation 145.2 m) to intercept floating oil and debris. The front of the intake is at the riverbank with flared wing walls extending down the natural slope of the bank to provide for an even and gradual water-approach velocity.

The dimensions of the wing walls are shown in Figure 3.2. The applicant has computed the area of the embayment created by the wing walls as approximately 502 m^2 (horizontal projection). During periods of low flow, the embayment will contain approximately 1071 m^3 of water (based on an elevation of 147 m MSL). At normal flow (based on mean flow derived from June 1973 to May 1978) the calculated volume of the embayment will be 1683 m^3; at high flow (top of wing walls at an elevation of 154 m MSL) or maximum volume of the embayment, the volume will be 2448 m^3.

Riprap protecting the east slope of the intake structure facing the river extends approximately 49 m south and 27 m north from the respective edges of the structure. The riprap was placed by "end dumping" on a two-horizontal-to-one-vertical slope to an approximate elevation of 147 m MSL. The riprap on the north and south side of the embankment covers approximately 232 m^2 and 576 m^2, respectively. The total surface area of riprap behind the wing walls from elevation 154 m (top of wing walls) to elevation 147 m MSL is about 808 m^2.

The intake-flow velocity is perpendicular to and less than the river velocity. Figure 3.3 shows the average horizontal velocity of the water flowing from the river to the intake pumps.

Four nominal one-third capacity intake pumps with a capacity of 0.85 m^3/s each are installed in the intake structure. Station load operation (100%) of both units can be supported by three pumps with a 2.5 m^3/s intake flow under the least favorable (1%) meteorological conditions.

Each of the two water entrance chambers is equipped with two automatically operated trash removal screens in series. A bar screen behind each of the inverted weir intake openings prevents large debris from impeding operation of the automatic traveling screen. The bar screen, trash racks, and traveling screens are operated automatically either by differential pressure sensors or by a timer for periodic cleaning. Water-spray systems wash debris from the screens into a pit for disposal whenever the trash rack or traveling screens operate. The bar screens consist of vertical 3.17-cm bars with a 2.54-cm opening between bars. The traveling screens have 0.95 cm mesh wire openings.

Stop-log slots are provided in front of and behind the screens so that the provided stop-logs may be lowered and the chamber dewatered for repair of the screens. Another set of stop-logs may be used to close the slot in the center wall for the purpose of dewatering one of the pump chambers. The insertion of these barriers requires the effort of heavy portable equipment and a maintenance crew. Such an effort will normally be scheduled during a period of reduced station load when less water is required and design-intake velocities are not being exceeded.

With three pumps in operation (the flow being 2.5 m^3/s), the velocity of water through both intake-structure passages is:

a. 0.11 m/s through the entrance openings (i.e., under inverted weir); this value is independent of river level.

b. 0.17 m/s through the clean bar screen openings at minimum river level 147 m above MSL.

c. 0.19 m/s through the clean traveling screen openings at the minimum river level 147 m above MSL.

Since there is the capability to block off one or more of the passages, there is a potential for increased velocities.

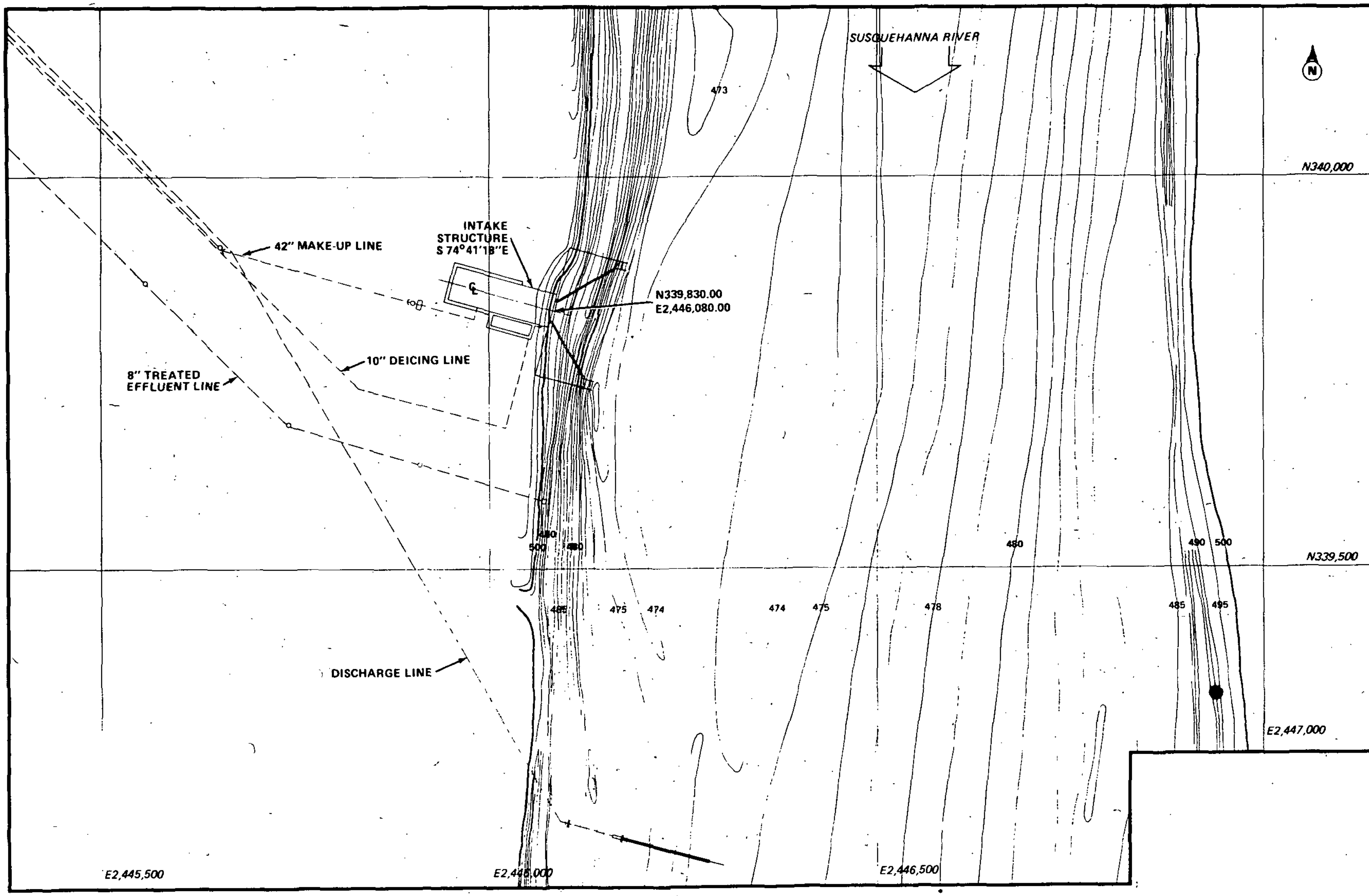

Fig. 3.1. River Intake Structure and Area. From ER-OL (Fig. 3.4-3).

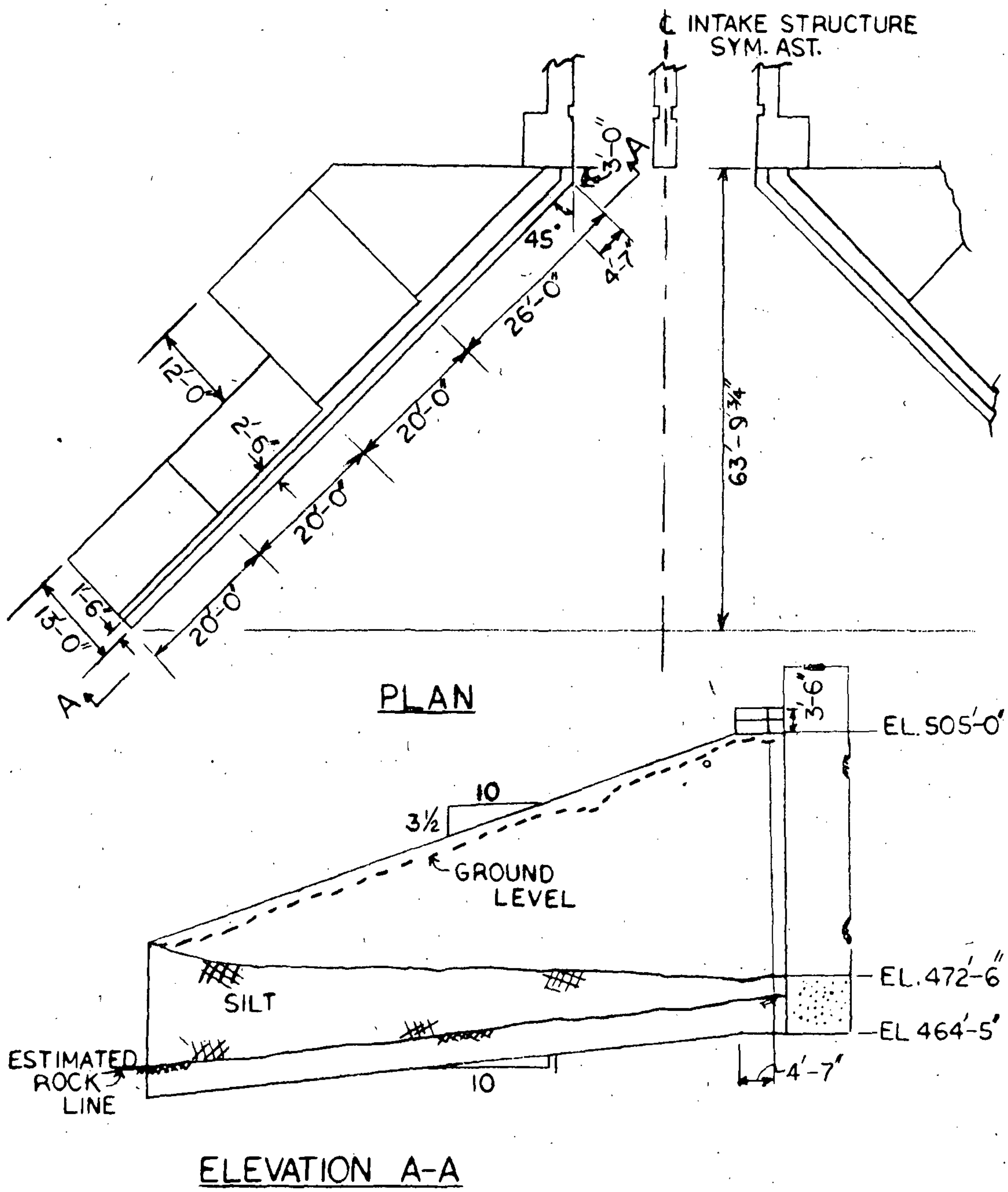

Fig. 3.2. River Intake Structure Plan and Elevation.

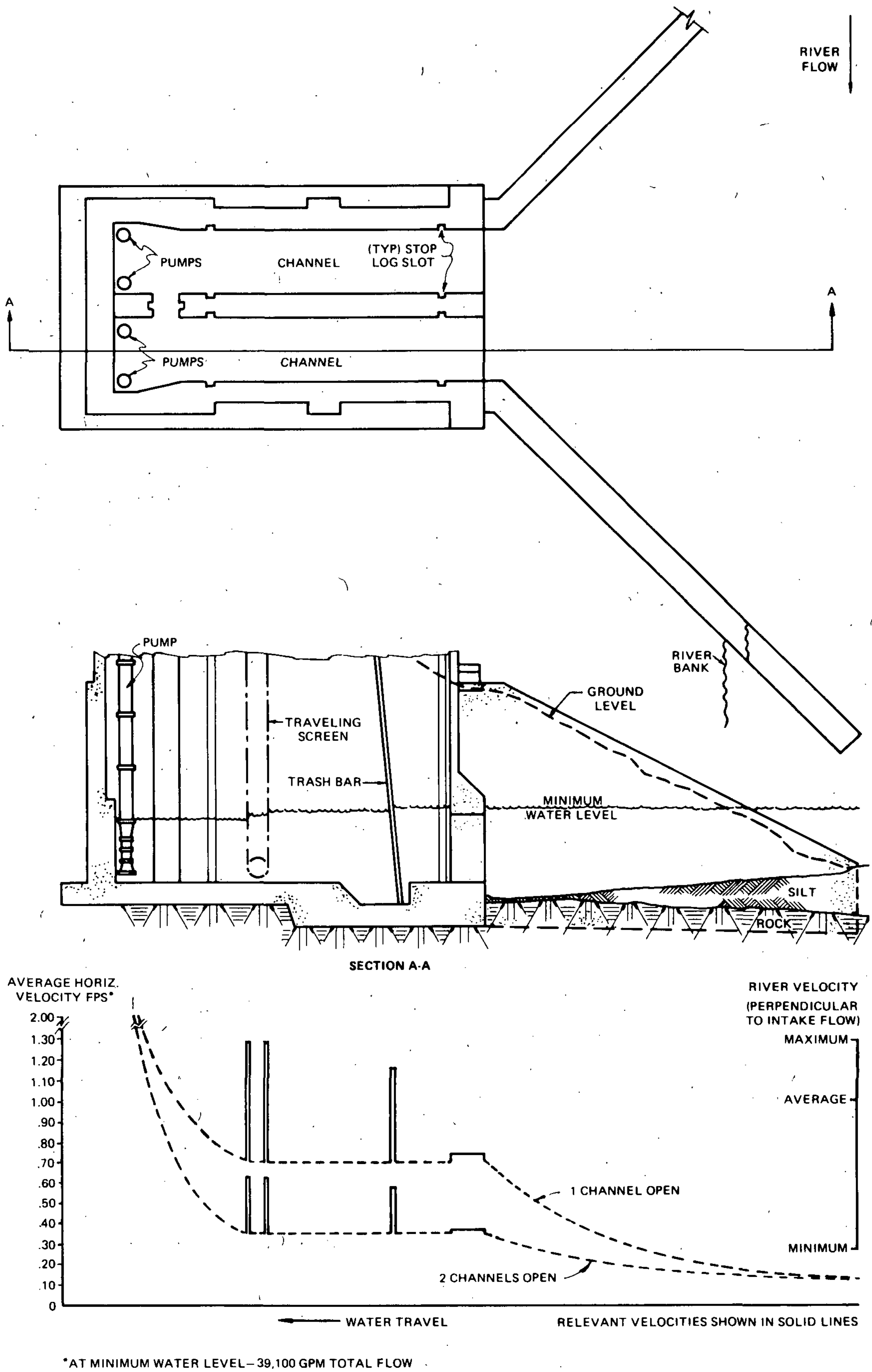

Fig. 3.3. River Intake Structure and Velocity Profile. From ER-OL (Fig. 3.4-4).

Under the worst case anticipated, with three pumps operating at a flow of 2.5 m^3/s and with only one passage open, the inlet velocity would be 2.2 m/s. As noted elsewhere, there is no need for four-pump operation since three pumps will exceed the maximum station demand for water. The insertion of stop-logs is regulated by strict administrative procedures.

Deicing Line

During winter conditions, a portion of the circulating water on the hot side of the cooling tower will be diverted down to the intake structure to a point just within the entrance to prevent ice buildup. The deicing-line discharge is designed so that the warm water will be swept into the intake structure by the incoming river water as part of the makeup water.

3.2.2.3 Condenser Cooling Water Discharge

The final design of the condenser cooling-water system differs only in minor aspects and is described in greater detail than the preliminary design discussed in the FES-CP. A discussion of the changes and some additional details follow.

A 1.07-m diameter diffuser pipe beginning about 36 m from the riverbank and extending outward 36.6 m will be used for discharge. The top of the pipe will be about 0.24 m above the river bottom and will be 2.4 m and 4.1 m below the water surface at 7-day, 10-year minimum river flow (22.7 m^3/s) and average river flow (380 m^3/s), respectively. The effluent will be discharged from seventy-two 0.1016-m diameter ports, rather than the forty-four similar ports cited in the FES-CP; the same flow velocity, 1.8 m/s, is assumed. However, the maximum velocity (and momentum) will be developed at the *vena contracta* in front of the port rather than at the port as described in the original model. The jet diameter at the *vena contracta* will be about 0.077 m.

3.2.3 Radioactive Waste Systems

Part 50.34a of Title 10 of the Code of Federal Regulations requires an applicant for a permit to construct a nuclear power reactor to include a preliminary description of the design of equipment to be installed for keeping levels of radioactive materials in effluents to unrestricted areas as low as is reasonably achievable. The latter term means as low as is reasonably achievable taking into account the state of technology and the economics of improvement in relation to benefits to public health and safety and other societal and socioeconomic considerations and in relation to the utilization of atomic energy in the public interest. Appendix I to 10 CFR Part 50 provides numerical guidance on design objectives for light-water-cooled nuclear power reactors to meet the requirements that radioactive materials in effluents released to unrestricted areas be kept as low as is reasonably achievable.

To meet the requirements of 10 CFR Part 50.34a, the applicant has provided final designs of radwaste systems and effluent control measures for keeping levels of radioactive materials in effluents to unrestricted areas as low as is reasonably achievable within the requirements of Appendix I to 10 CFR Part 50. In addition, the applicant has provided an estimate of the quantity of each principal radionuclide expected to be released annually to unrestricted areas in liquid and gaseous effluents produced from normal operation including anticipated operational occurrences.

The staff's detailed evaluation of the radwaste system and the capability of these systems to meet the requirements of Appendix I are presented in Chapter 11 of the Safety Evaluation Report. The quantities of radioactive material calculated by the staff to be released from the plant are also presented in Chapter 11 of the Safety Evaluation Report and in Section 4.5 of this Environmental Statement with the calculated doses to individuals and the population that will result from these effluent quantities.

The staff will issue Technical Specifications, which will establish release rates for radioactive material in liquid and gaseous effluents and provide for routine monitoring and measurement of all principal release points to assure that the facility operates in conformance with the requirements of Appendix I to 10 CFR Part 50, with the operating license.

3.2.4 Chemical, Sanitary, and Other Waste Treatment

3.2.4.1 Industrial Wastes

The sulfuric acid added to the circulating cooling water is the major source of industrial chemical waste and of potential chemical impacts on the aquatic and terrestrial environment. Other chemicals added are sodium hydroxide (caustic), used together with sulfuric acid for demineralizer regeneration, and the chemicals (aluminum sulfate, sodium hydroxide, and the coagulant aid, Separan) used in the clarification of raw water for domestic, potable, and other purposes.

The principal change in chemical waste treatment and disposal reported since the construction-permit stage is the discharge of makeup demineralizer wastes to the circulating cooling-water system instead of to the blowdown. The regenerant waste from the condensate demineralizer will be treated in the chemical radwaste system and the effluent from this system (condensate of low chemical content) will be discharged directly to the blowdown as originally planned. Low volume wastes will be treated in three separate waste basins. The treatment will consist of retention, oil and grease removal, and pH adjustment. Since all added chemicals will still be discharged to the river eventually, the total chemical discharge from the plant will remain virtually unchanged.

3.2.4.2 Sulfuric Acid for Scale Control

Calcium carbonate saturation conditions were not evaluated in detail in the FES-CP. It was concluded that little or no sulfuric acid addition would be necessary under conditions of minimum alkalinity. For average conditions, the applicant's estimate of required alkalinity (60 mg/L $CaCO_3$) was accepted, and the preliminary calculations gave good agreement with the applicant's estimate of daily acid usage.

The Susquehanna River already contains a high and variable sulfate concentration, resulting principally from mine drainage. The staff considered it important to limit the sulfate ion concentration added by the plant. For this reason, the calcium carbonate saturation conditions have been re-evaluated in greater detail and consideration has been given to the conflicting requirements of scale and corrosion control.* While the present evaluation confirms the applicant's estimates of sulfuric acid usage for complete scale control (zero saturation index), it is suggested that better corrosion control and reduced sulfate discharge could be achieved by reducing the acid usage; i.e., by operating at a more positive saturation index. The new evaluation assumes a maximum condenser temperature of 50°C, a dissolved carbon dioxide concentration (as molecular CO_2 plus H_2CO_3) of 5 mg/L, and a constant blowdown rate of 631 L/s with both units operating.

For minimum values of calcium concentration and alkalinity, it is found that the saturation index will be negative (-0.3) at the average concentration factor (cycles) of 3.22, and close to zero for maximum concentration factor (3.87), confirming the conclusion that little or no sulfuric acid addition will be necessary under these conditions. However, prolonged operation with a negative saturation index may possibly give rise to corrosion problems, especially in the cooler parts of the circulating water system where the saturation index will be more negative and the water will be in contact with carbon steel. It is calculated that at 30°C an alkalinity of about 130 mg/L $CaCO_3$ and a pH of about 7.7, would be necessary to give zero saturation index. Under minimum conditions, the alkalinity without added acid would be only about 70 mg/L at the average concentration factor, and the applicant might be advised to consider the addition of alkali (sodium hydroxide or carbonate) to control corrosion, should the problem arise.

Table 3.3 shows the important parameters, calcium concentration, alkalinity, saturation index, and pH without added acid, for the two conditions: 1) average river concentrations with average concentration factors, and 2) maximum river concentrations with maximum concentration factor. Since the saturation index is positive in both cases, acid addition will be necessary to reduce it to a value close to zero. Table 3.4 shows the estimated alkalinity, acid usage, added sulfate concentration, and final blowdown pH for the same two cases, at zero saturation index.

The acid usages shown in Table 3.4 range from 3,480 to 12,350 kg/day for average and maximum conditions, in reasonable agreement with the applicant's estimates. The higher value should be regarded as a maximum short-term rate of addition during temporary and infrequent periods of extreme river concentrations, corresponding to simultaneous occurrence of maximum recorded values of all impurities and of alkalinity.

As a compromise between scale and corrosion control, a saturation index of at least +0.4 is often recommended. Values as high as +0.6 have been proposed in several plants evaluated by the staff in recent years where the water source has a high calcium content and alkalinity and very large quantities of sulfuric acid would be required to give a zero index. Table 3.5 shows the estimated alkalinity, acid usage, added sulfate concentration, and blowdown pH for a saturation index of +0.6. For the average case, the saturation index without acid addition is +0.64 and the acid requirement is small. The maximum short-term rate of acid addition for this case is 9400 kg/day. On the basis of the Ryznar Index,[1] these conditions appear to be close to optimal.

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*It is well known that water slightly supersaturated with calcium carbonate inhibits corrosion of metals, because the local deposition of $CaCO_3$ at cathode sites probably prevents access of dissolved oxygen. As indicated by the title of Langelier's original paper, "The Analytical Control of Anti-Corrosion Water Treatment," corrosion control was the primary purpose in defining the saturation index.[2]

Table 3.3. Alkalinity and Saturation Index in Circulating Water Without Acid Addition

	Average Concentrations and Concentration Factor (3.22)	Maximum Concentrations and Concentration Factor (3.87)
Calcium (mg/L)	102	252
Alkalinity (mg/L $CaCO_3$)	139	286
Saturation index	+0.64	+1.43
pH	7.62	7.89
Ryznar index[a]	6.35	5.04

[a]The Ryznar stability index[1] is an empirical parameter that is often used in place of the Langelier saturation index to define scaling or corrosive conditions. A value between 6 and 7 is usually regarded as acceptable.

Table 3.4. Alkalinity and Acid Usage: Zero Saturation Index

	Average Concentrations and Concentration Factor (3.22)	Maximum Concentrations and Concentration Factor (3.87)
Required alkalinity (mg/L $CaCO_3$)	67	55
Acid usage (kg/day)	3,840	12,350
Added Sulfate (mg/L)	69	222
Blowdown pH	7.30	7.18
Ryznar Index[a]	7.30	7.18

[a]See note a/ for Table 3.3.

Table 3.5. Alkalinity and Acid Usage: Saturation Index = +0.6

	Average Concentrations and Concentration Factor (3.22)	Maximum Concentrations and Concentration Factor (3.87)
Required alkalinity (mg/L $CaCO_3$)	133	110
Acid usage (kg/day)	300	9,400
Added sulfate (mg/L)	5	169
Blowdown pH	7.60	7.48
Ryznar Index[a]	6.40	6.28

[a]See note a/ for Table 3.3.

3.2.5 Transmission Systems

The transmission system constructed to distribute energy generated at SSES is markedly different from that proposed in the FES-CP. NRC received on 15 October 1975 the applicant's proposed changes in the transmission routes previously evaluated for SSES. Additional details concerning these changes were provided in Amendments 4 and 5 to the ER-CP, submitted on 26 February and 30 June 1976.

The staff reviewed the information and prepared an environmental assessment of the proposed changes (see Appendix C). The findings and conclusions in the environmental assessment concur with those of the FES-CP. Therefore, the staff has concluded that the modifications proposed in Amendments 4 and 5 are acceptable and fall within the scope of the environmental impact evaluation conducted in connection with initial application.

Although the length of the transmission lines and the area required are now different from those originally given in the FES-CP, the land-use types, as given in the FES-CP, remain essentially the same.

References

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4. ENVIRONMENTAL EFFECTS OF STATION OPERATION

4.1 RÉSUMÉ

There have been several minor changes in the staff's evaluation of the environmental effects of station operation since the issuance of the FES-CP. Some of these changes are the result of new information that has become available since 1973. The area of the site has been increased from 387 to 435 ha (Sec. 4.2), and the area for the transmission lines has been increased from about 700 to 1140 ha (Sec. 4.4.1.2). The changes in size and location of the site and transmission corridors have resulted in small changes in the expected impacts (Sec. 4.4.1 and Appendix C). A new subsection on the socioeconomic impacts due to station operation has been added (Sec. 4.6). The recreation area planned for the floodplain will increase the amount of such land available to the public in the area (Sec. 4.6.2.3).

The final design of the intake system and its surrounding areas may result in greater fish and aquatic biota losses than expected earlier (Sec. 4.4.2).

Impacts on the terrestrial environment of the station area that have been evaluated or reassessed include those related to steam and drift emissions from the emergency spray pond and cooling towers, obstructions to flying birds, operational noise emissions, landscape alterations, and implementation of the applicant's post-construction landscaping plan (Sec. 4.4.1).

The evaluation of radiological impacts has been updated using new source-term calculations; a comparison of station radioactive emission levels with 10 CFR Part 50, Appendix I, design objectives has also been added (Sec. 4.5). New generic material has been added concerning transportation of radioactive material and the environmental effects of the uranium fuel cycle (Sec. 4.5).

4.2 IMPACTS ON LAND USE

There have been several changes in land use since the FES-CP was issued. The land area of the site has been increased from 387 ha to 435 ha through the purchase of residential property. This has dislocated many residents of Bell Bend and has caused some changes in the lives of residents who have remained (see Section 2.2). Some of the remaining residents believe that they will be directly and/or indirectly affected by the PP&L purchases of residences for several reasons: 1) there is a concern that land-use changes will affect land-development plans and anticipated prices (Site visit) and 2) informal controls over access to private land in the Bell Bend area for hunting was characterized as a neighborhood effort. Concerns have also been raised that PP&L's role in controlling access to its new properties, which are adjacent to private land, may be inadequate (Site visit). The applicant states that anyone caught trespassing will be asked to leave; law enforcement officials will be called if there is a lack of cooperation (ER-OL, Socioeconomic Question 12).

About 49 ha, or 12%, of the site are commited to station facilities for the lifetime of the plant; about 40 ha of the site will remain available for cultivation. This conversion results in a net loss of about 60 ha of cultivated farmlands. The 170-ha floodplain along the Susquehanna River will be developed into a recreation area open to the public. Twenty-one-hectare Gould Island will be left in its natural state as part of the recreation area. There have been no significant changes in planned recreation areas since the FES-CP was issued.

Other than the changes in transmission corridors and the small increase in land area of the site, the staff's analysis of land-use impacts in Section 5.1.1 of the FES-CP remains valid.

4.3 IMPACTS ON WATER USE

4.3.1 Thermal Impacts in Water Use

The effluent limitations, monitoring requirements, and other standard and special conditions of the Commonwealth of Pennsylvania Water Quality Management Permit (No. 4076203) have been superseded by the terms and the conditions of the NPDES Permit (No. PA-0047325). (See part C, paragraph B of NPDES permit, Appendix F.)

The applicant has used the Jirka and Harleman procedure[1] in its analysis of the discharge, as did the staff for the FES-CP (Chapter 11); the applicant's results for a variety of conditions are shown in Table 4.1. These results, essentially the same as those reported by the staff in the FES-CP, are based on the assumption of complete mixing with a minimum dilution factor of seven or greater at low river flow. A minor difference between the staff's calculation and that of the applicant is that the staff considers full mixing to take place within 2.5 times the water depth[1] whereas the applicant uses 10 times the water depth; the actual distance is uncertain and depends on the specific characteristics of each discharge system and river.

The results have been reconfirmed by the staff using the current design parameters. A minor difference from the applicant's and from the staff's earlier analysis is that the staff now believes that a stagnant wedge of heated water may form upstream of the discharge pipe under very low flow conditions with a large temperature difference (7.5°C) between river and discharge. Compliance with the limitations cited will not be affected. The biological impacts of warmwater discharges are discussed in Section 4.4.2.2.

4.3.2 Hydrologic Alterations and Plant Water Supply

4.3.2.1 Plant Water Supply

The discussion of plant water consumption and its relation to the physical availability of Susquehanna River water in the FES-CP (Sec. 5.2.1) is still valid. However, a regulation (Fed. Reg. 30 September 1976) promulgated by the Susquehanna River Basin Commission after the issuance of the construction permit, requires river-water users to replace the amount of water consumed during periods of low river flow. The regulation requires replacement of water consumed when the river flow at the intake is at or below the seven-day, ten-year low flow plus the water user's consumptive use. The seven-day, ten-year low flow near the site is estimated by the applicant to be 22.7 m^3/s and plant consumptive use will vary from 1.3 to 1.8 m^3/s (see Table 3.1). The effective date of the new SRBC requirement is 1 July 1984.

The applicant has studied several options in order to have replacement water available for periods of low river flow (see Sec. 3.2.1). Should the plant become operational before a replacement water supply is available, the plant will be required to shut down during periods of low flow. The plant can be safely shut down, using water from the onsite spray pond, without using river water (a more detailed discussion of the spray pond can be found in the Safety Evaluation Report).

Based on historical riverflow records, the requirement for replacement of river water will occur on an average of 4 days per year (Appendix A). However, based upon the historical record of drought occurrence and duration, the applicant states that there is only a 17% probability of this low flow occurring in any one year. During the record drought of 1964 (August to November), the Susquehanna River flow fell below the maximum flow rate of 24.5 m^3/s requiring replacement for 107 days, including 84 consecutive days in September, October, and November.

The staff has made an evaluation of plant water supply and impacts based upon the assumption that the plant will have to be shut down for an average of 4 days per year due to low river flow (described in Appendix A as "river following").

4.3.2.2 Floodplain Effects

The floodplain (as defined in Executive Order 11988, Flood Plain Management) of the Susquehanna River in the vicinity of the site is shown in Figure 2.2. In addition to some minor structures in the recreational area (e.g., restroom facilities, picnic pavilions, etc.), the only structures constructed on the floodplain are the intake structure and its access road embankment. The intake structure is founded on bedrock and is designed to be operational during the Standard Project Flood (a more severe event than the one-percent chance flood). In addition, the plant can be safely shut down using the onsite spray pond, which is unaffected by Susquehanna River floods.

The intake-structure access road, varying in elevation, reaches its lowest elevation of 157 m MSL for an approximate 240-m segment. The applicant states that the side slopes of the embankment are to be seeded to protect them from erosion and washout. The roadway will be built above the one-percent chance flood level (156.4 m MSL) to provide access to the intake structure under adverse conditions. Because the roadway will be above the surrounding floodplain, it will act as a dam or weir during flood conditions and will increase water levels upstream. To quantify this increase, the applicant performed backwater computations using the Corps of Engineers HEC-2 program. The results showed that the water level during the one-percent chance flood would be increased by a maximum of 9 cm on the upstream side of the embankment; the effect would extend as far as 550 m upstream of the road. Because of the small magnitude of the altered flood level and

Table 4.1. Blowdown Plume Characteristics

Case	Blowdown Temp. (°F)[a]	River Data: Temp. (°F)[a]	River Data: Flow (cfs)	River Data: Depth (ft)[a]	River Data: Width (ft)[a]	Mixing Zone: Length (ft)[a]	Mixing Zone: Width (ft)[a]	Temp. Rise at Edge of Mixing Zone (°F)[a]	Concentration Factor at Edge of Mixing Zone ($\Delta T/\Delta T_0$)[b]
June									
Mean flow	89.8	72	9,080	16.0	885	160	120	0.5	0.025
7-day, 10-year low flow	89.8	72	1,880	18.0	846	180	120	1.2	0.067
August									
Mean flow	91.8	77(85)[c]	3,400	14.0	860	140	120	0.8(0.4)[c]	0.36
7-day, 10-year low flow	91.8	77(85)	880	11.5	820	115	120	2.0(0.9)[c]	0.148
December									
Mean flow	78.6	82	12,800	16.5	885	165	120	1.0	0.025
7-day, 10-year low flow	78.6	82	1,680	18.0	845	180	120	3.5	0.083

[a]Conversion Factors: To convert °F to °C, multiply (°F-32) by .5555.
To convert ft to m, multiply by 0.3048.

[b]Concentration factor = $\frac{\Delta T}{\Delta T_o} = \frac{\text{Temperature at mixing zone boundary minus river temperature}}{\text{Temperature of blowdown minus river temperature}}$

Chemical dilution factor = $\frac{\Delta C}{\Delta C_o} = \frac{\text{TDS at boundary of mixing zone minus river TDS}}{\text{TDS of blowdown minus river TDS}}$

[c]Values in parentheses represent blowdown plume characteristics corresponding to the applicant's highest observed river temperature recorded on 18 August 1970.

because it will be confined to the applicant's property (which extends upstream from the intake location for nearly 1.6 km on both sides of the river), the staff concluded that the floodplain effects would be acceptable and that no mitigative actions will be required.

4.3.3 Industrial Chemical Wastes

4.3.3.1 Discharge Composition

The staff's estimates of discharge composition, including the effects of evaporative concentration and added chemicals, are shown in Table 4.2 for average conditions (average concentrations and concentration factor) and for maximum conditions (maximum observed concentrations, assumed to occur simultaneously with maximum concentration factor). The "design maximum" concentrations used in the ER-OL are generally 8 to 9% less than the observed maxima. Since the simultaneous occurrence of maximum observed concentrations and maximum concentration factors will occur very infrequently, the staff assumptions are conservative, leading to an overestimate of adverse effects. In practice, beneficial changes in water quality, such as control of mine drainage, are more likely than adverse changes.

Table 4.2. Estimated Discharge Compositions

	Average Conditions[a]			Maximum Conditions[b]		
Constituent	River (mg/L)	Discharge (mg/L)	Plant Concentration factor, R	River (mg/L)	Discharge (mg/L)	Plant Concentration factor, R
Calcium	31.6	101.8	3.22	65.2	252.3	3.87
Magnesium	9.6	30.9	3.22	42.0	162.5	3.87
Sodium	8.4	27.7	3.30	16.7	65.3	3.91
Ammonium	0.35	1.13	3.22	1.08	4.18	3.87
Potassium	0.51	1.64	3.22	35.1[c]	135.8[c]	3.87
Iron	3.42	11.0[d]	3.22	17.3	67.0[d]	3.87
Sulfate[e]	71.1	301.7	4.24	222.5	1087	4.89
Chloride	13.1	46.2	3.53	32.8	130.9	3.99
Nitrate	2.6	8.4	3.22	7.4	28.6	3.87
Bicarbonate[f]	52.5	81.3	1.55	90.3	67.5	0.747

[a]Average observed concentrations; average concentration factor (3.22).

[b]Maximum observed concentrations; maximum concentration factor (3.87).

[c]The maximum observed potassium concentrations are anomalously high, but since no potassium is added, this does not affect the evaluation of effects on river water quality.

[d]Maximum; due to settling of solids in cooling tower basin, iron in discharge will probably have about the same concentration as intake (applicant, Appendix B).

[e]Including H_2SO_4 added for scale control (zero saturation index) and demineralizer regeneration.

[f]Derived from alkalinity (observed or calculated).

The discharge compositions shown in Table 4.2 were calculated by using the acid additions estimated in Section 3.2.4.2 for zero saturation index, and include the sulfate ion contributed by demineralizer waste. As pointed out in Section 3.2.4.2, these acid additions could be reduced considerably by operating with a positive saturation index, which would also provide improved corrosion protection and would reduce discharge of sulfate to the Susquehanna River. Table 4.2 also includes the sodium ion contribution from demineralizer wastes. The chloride concentrations are based on the conservative assumption that all the added chlorine will be reduced to chloride before discharge, either by reaction with chlorine demand or by dechlorination with sulfur dioxide. In practice, a fraction of the added chlorine will be lost by evaporation in the cooling towers.

The bicarbonate concentrations are derived from the alkalinity values (1 mg/L $CaCO_3 \equiv 1.22$ mg/L HC In the maximum case, the reduction in alkalinity caused by acid addition gives a discharge value less than the ambient river value.

4.3.3.2 Effect on River Water Quality

When the discharge enters the river it will be diluted by a factor, D, equal to the ratio of discharge to dilution water at a given point in the river. Close to the discharge point this dilution will be determined by the thermohydraulic effects. Farther downstream, it may be assumed that complete mixing occurs and the dilution is determined by the total river flow relative to the discharge flow. The final concentration of a given ion after mixing (at a given point), C_f is given by

$$C_f = C_o\left(1 + (R-1)D\right)$$

Where C_o is the ambient concentration and R is the effective concentration factor for the given ion in the plant, including any effect of added chemicals. For ions unaffected by added chemicals R will be equal to the evaporative concentration factor in the cooling system, determined by makeup, blowdown, and evaporation rates. The above expression takes into account the reduction in river flow caused by the plant intake upstream of the discharge point.

At the edge of the thermal mixing zone, about 40 m downstream of the discharge point, and varying seasonally (ER-OL, Table 5.1.3), the dilution factor D is assumed by the applicant to be about 0.17, corresponding to a 1:6 volume ratio (ER-OL Section 5.3.2). At this point the concentrations of the ions unaffected by added chemicals will be increased by factors of 1.37 for average evaporative concentration (R=3.22) and 1.48 for maximum concentration (R=3.87). These factors will be greater for the ions added in the plant (sodium, sulfate, chloride). For complete mixing, with the August 7-day, 10-year low flow of 21.8 m^3/s, the dilution factor for a discharge of 631 L/s is 0.029, or 34.5:1 on a volume basis. Ions not added in the plant will be concentrated by a factor of from 1.06 to 1.08 after complete mixing.

The final concentrations after dilution are compared with the ambient river concentrations in Table 4.3 for sodium, sulfate, and chloride ions which are added in the plant, and for calcium ion which is neither added nor removed (unless extensive scale deposition occurs). The applicant's estimates of these concentrations are also shown; present staff estimates are shown to be in reasonable agreement with the applicant's estimates.

4.3.3.3 Trace Metals

The concentration of iron in the Susquehanna River is variable and occasionally quite high, depending on contamination by acid-mine drainage. The staff concludes that unless extensive corrosion of carbon steel takes place, operation of the plant will not increase this concentration since much of the iron will precipitate and settle out in the cooling-tower basin.

Since the condenser tubes are of stainless steel, no significant corrosion products are expected from this source. Corrosion inhibitors containing chromium will be used in closed-loop cooling systems; some commercial products also contain zinc. These materials will not be released under normal operating conditions. Cadmium is not among the metallic impurities detected in the river (ER-OL, Table 2.4-13), and the staff is not aware of any possible source of this contaminant in the plant.

All trace metals present in the river will be concentrated slightly (by less than 10%) over their ambient concentrations after complete mixing with the river water, even under the most adverse conditions.

The staff concludes that the effect of plant operation on trace-metal concentration will be insignificant compared to the observed variations in these concentrations and will not affect any existing water uses.

4.3.3.4 Depletion of Dissolved Oxygen

The addition of sulfur dioxide in excess of the quantity required to react with residual chlorine could cause depletion of dissolved oxygen. This effect has been addressed by the applicant (ER-OL, Sec. 3.6.10). If the sulfur dioxide treatment is controlled according to this specification, the staff agrees that the depletion of dissolved oxygen in the discharge will be less than 0.1 mg/L, and the effect on river-water quality will be undetectable.

Table 4.3. Effect of Discharge on River Water Quality (concentrations in mg/L)

	Average Conditions[a]				Maximum Conditions[b]			
	Ambient	Edge of Mixing Zone[c]		Complete Mixing[d]	Ambient	Edge of Mixing Zone		Complete Mixing[d]
Constituent	River	Staff	Applicant[e]	Staff	River	Staff	Applicant[f]	Staff
Calcium[h]	31.6	41.6	--	33.6	65.2	91.9	--	70.6
Sodium	8.4	11.2	13	8.9	16.7	23.6	23	17.9
Sulfate	71.1	104.0	117	77.6	222.5	346	336	247
Chloride	13.1	17.8	21	14.0	32.8	46.8	47	35.2
Bicarbonate[g] (alkalinity)	52.5 (43)	56.6 (46)	55 (45)	53.3 (44)	90.3 (74)	87.0 (71)	93 (76.2)	89.7 (73.5)

[a]Average observed concentrations (ER-OL, Table 3.3-2); average evaporative concentration factor (3.22).

[b]Maximum recorded concentrations (ER-OL, Table 3.3-2); maximum evaporative concentration factor (3.87). Maximum recorded alkalinity. (see Note f/).

[c]Dilution 6:1.

[d]Dilution 34.5:1. Not quoted in ER-OL.

[e]ER-OL, Table 5.3-5.

[f]The applicant used "design maximum" values in calculation of sulfuric acid addition. These were generally somewhat less than the maximum recorded values. The "design maximum" alkalinity of 68.5 mg/L $CaCO_3$ was used, giving an ambient bicarbonate concentration of 84 mg/L. For this reason the applicant predicts an increase in bicarbonate concentration at the edge of the mixing zone in the maximum case, while the staff, using a higher ambient alkalinity, (74 mg/L $CaCO_3$ from ER-OL, Table 3.3-2) predicts a decrease.

[g]Alkalinity as $CaCO_3$ (mg/L) shown in parentheses.

[h]Applicant does not estimate calcium concentrations. Other ions unaffected by chemcial additions are increased in the same ratio as calcium.

4.3.4 EPA Effluent Guidelines and Limitations

Section 301 of the Federal Water Pollution Control Act, as amended, requires SSES, classified as a "generating unit," to comply with the effluent limitations promulgated by EPA pursuant to this act. SSES is required to achieve compliance with these limitations through the use of the best practicable control technology currently available. The station shall also meet more stringent limitations, including those necessary to meet water quality standards, treatment standards, or schedules of compliance established pursuant to any state law or regulation (under authority preserved by Section 501) or any other federal law or regulation or required to implement any applicable water-quality standard established pursuant to PL 92-500.

The Department of Environmental Resources (DER) of the Commonwealth of Pennsylvania has issued an Industrial Waste Permit to the applicant. This permit regulates the quantity and quality of wastewater discharges from the station, including blowdown. In addition to the DER limits, the EPA has also imposed limits on heat dissipation discharges. These limits are contained in the construction NPDES permit issued by EPA to the applicant with an effective date of 31 July 1979. This permit has been extended until January 1983.

An additional limitation on the water/waste management of the heat dissipation system has been imposed by the Susquehanna River Basin Commission. This limitation requires that an approved method of flow compensation be provided by the applicant to compensate for withdrawals for consumptive use at SSES and for other present (or future) utility consumptive uses during periods related to the seven-day, ten-year low flow condition.

4.3.5 Effects on Water Users through Changes in Water Quality

The staff has considered the health effects of chlorine used in SSES and subsequently discharged into the Susquehanna River in the blowdown. Several cities downstream of the plant use the river as a source of drinking water. The power plant will add about 15,000 kg per month of chlorine to the cooling water and other systems, which will be discharged in about 1.6 × 10^6 m^3 of blowdown. Almost all of this chlorine will be converted to chloride ion before or shortly after discharge; the discharge will increase the river chloride by a maximum of 0.3 mg/L, assuming full mixing and minimum stream flow. This amount of chloride has no significance for public health.

Within the plant, some of the chlorine will be present in the form of hypochlorite ion or combined with ammonia or amines (certain types of nitrogen-containing organic compounds in the form of chloramines). The concentrations of these compounds would be about equal to those found in a swimming pool or in drinking water as it leaves the water-treatment plant. The materials are unstable and rapidly destroyed in natural waters. In addition, the Susquehanna plant will treat the blowdown with SO_2 to destroy most or all of this residual chlorine. Thus, it is extremely unlikely that any residual chlorine from SSES could reach the water intakes of downstream cities, such as Danville, PA (about 42 km downstream).

A very small amount of the chlorine added will react with natural organic chemicals in the river water to form stable compounds known as trihalomethanes, which are suspected to be carcinogenic to humans. The amounts of these organic chlorine compounds formed will depend largely on the amount of organic material in the water at the time of chlorination. Although an accurate estimate of these concentrations at SSES is not available, the preliminary results of field studies at operating closed-cycle freshwater-cooled nuclear power plants indicate chloroform concentrations in the plant discharges of from less than 0.1 μg/L to 2.1 μg/L, with total trihalomethane concentrations of from less than 0.1 μg/L to 5.1 μg/L.[2] These concentrations are small compared to those found by EPA in the National Organics Monitoring Survey of drinking water in 113 cities, which showed chlorform concentrations as high as 540 μg/L (mean value 69 μg/L) and total trihalomethane concentrations as high as 695 μg/L (mean value 100 μg/L).[3] The concentrations found to date in the power plant discharges are also small compared to the maximum contaminant level of 100 μg/L for total trihalomethanes in drinking water,[4] which is transported directly to consumers without dilution.

4.3.6 Sanitary Wastes

The sewage treatment plant has been constructed and used during the construction period, giving an effluent that meets applicable standards (ER-OL, Sec. 3.7.1). During station operation the treatment plant will be operating at about one third of its design capacity. The plant has 3 parallel one-third capacity units to ensure full efficiency at reduced flow. The staff concludes that applicable standards will be met during station operation and that these discharges will produce no adverse impacts on downstream water users.

4.4 ENVIRONMENTAL IMPACTS

4.4.1 Terrestrial Environment

4.4.1.1 The Station

The applicant proposes that future management of the project site be in accord with multiple land-use principles consistent with public needs, environmental protection, and energy production. Accordingly, upon completion of station construction, project laydown areas, construction parking lots, sites occupied by structures not needed for operation, and other disturbed areas not previously treated, will be reclaimed. These areas, as well as other portions of the site, will be landscaped in accordance with a site-wide plan. The principal objectives to be achieved by landscaping include erosion control, establishing tree plantings as peripheral buffers, and general reforestation (ER-OL, Sec. 3.1.5). The staff has reviewed the applicant's landscaping plan and concludes that implementation of the proposed measures will result in an enhancement of the environmental quality of the project site and adjacent areas.

Several of the adverse impacts that will prevail during station operation are not directly related to energy production. For example, the physical presence of the station facilities, especially the taller structures such as the meteorological and cooling towers, will appear as incongruent features with respect to the surrounding landscape. The surrounding hilly terrain and the peripheral vegetative buffers to be established onsite will limit the locations from which the towers will be visible. The staff considers these visual effects to be tolerable when compared to the adverse impacts associated with alternative heat dissipation systems (FES-CP, Sec. 9.2.1). These towers will also constitute hazards to flying birds. Results of bird-impingement surveys conducted by the applicant in the vicinity of the meteorological tower and a partially constructed cooling tower during September and October 1978 (ER-OL, Question TER-1.1) indicate that a total of 82 birds, representing 15 species, were "probably" killed by impingement on the towers. The killed birds consisted almost exclusively of red-eye vireos and various species of wood warblers; no endangered or threatened species were involved. The staff does not regard the number of bird-kills to be a meaningful threat to the general populations of the affected species.

Potential operational impacts directly attributable to energy production will include audible noise generated by various station facilities and activities. Other noticeable impacts on the terrestrial environment will occur as the result of airborne emissions from cooling towers and the 2.8-ha retention or emergency spray cooling pond.

Noise impacts were not discussed in the FES-CP, but surveys of ambient and construction noise levels have been conducted in the station area (ER-OL, Sec. 2.9). The applicant has also estimated the anticipated operational noise levels that will prevail at various locations surrounding the station. The estimates are based on considerations of equipment design specifications, local terrain, distance, and sound propagation effects. The cooling towers and the large pumps and motors of the circulating and intake water systems will be major sources of noise generation. However, since the latter types of equipment will be housed, the emitted noise is not expected to exceed ambient sound levels in offsite areas (ER-OL, Sec. 5.1.4.3). It is estimated that noise levels associated with cooling-tower operation will exceed median ambient levels in areas to the west, southwest, and southeast and within 1.6 km of the station. The cumulative effects of all noise sources associated with station operation were estimated to be less than the EPA recommended limit of 55 dBA at all but one of the offsite survey locations. The exception is an area 670 to 915 m southwest of the station where the projected noise level is expected to be 56 dBA. The EPA recommended limit (55 dBA) pertains to outdoor activity interference and is measured as a day-night equivalent sound level "requisite to protect public health and welfare with an adequate margin of safety."[5] The staff believes the applicant's estimates are reasonable expectations and concludes that noise emissions during station operation will not cause other than minor nuisance problems with the possible exception of the offsite area mentioned above (see Sec. 5.3.5).

The effects of steam fog and drift (droplets) emanating from the emergency spray pond during plant operation and reactor shutdown were discussed in the FES-CP. The impact area was described as localized, within about 33 m of the pond. The staff currently believes that the potential impact area was somewhat underestimated. During a two-unit emergency shutdown, evaporation and drift losses from the pond could be as much as 1450 m^3 and 492 m^3 of water per day, respectively (ER-OL, Sec. 3.4.6). Thus the transport of vapor and liquid from the pond during periods of very cold temperatures and high wind conditions, when the spray nozzles are activated, could result in ice-loading of adjacent vegetation and other structures. The drift would be deposited locally but the visible vapor emissions could be transported beyond the 33 m previously mentioned. Ice formation on vegetation downwind from a spray canal has been reported as up to 1.3 cm thick at about 150 to 210 m, and at about half that thickness at 300 m.[6] The staff believes the occurrence of these impacts would be infrequent and primarily limited to onsite areas, but offsite effects of icing are possible during periods of high winds.

The effects of cooling-tower operation on the terrestrial environment were addressed in the FES-CP. Among other considerations, the staff estimated that the drift dispersed from the cooling towers would result in a maximum surface deposition of 28 kg of dissolved solids per hectare per year. This estimate was based on the assumption that 0.02% of the water moved through the cooling towers would be dispersed as drift. However, the applicant has presented documentation to substantiate the expectation that the actual drift loss rate will be considerably less than the manufacturer's guaranteed rate (0.02%) (ER-OL, Supp. Response to Question COO-9.1). Based on an assumed 0.002% drift loss, the applicant estimates that the maximum salt deposition rate resulting from tower drift will be 880 g/ha per month (ER-OL, Table 5.1-22). Water from the Susquehanna River will be used for cooling purposes. Studies conducted at the Chalk Point Power Plant (Maryland) are of interest since brackish water is used as the cooling medium at this plant.[7,8] Based on reviews of these studies, where brackish water does not affect the surrounding biota, the staff reaffirms the previous conclusion (FES-CP) that cooling towers using fresh water, as in the case of SSES, will not measurably impact the surrounding biota and soils.

The characteristics of the vapor plume generated during cooling-tower operation will vary with the prevailing meteorological conditions. In any event, the staff believes the plume will generally be considered as an adverse visual effect with respect to the local landscape. The potential for plumes of natural-draft cooling towers descending to cause fogging and icing conditions is discussed in Section 4.4.3. For the reasons discussed in Section 4.4.3, the staff does not consider this a meaningful concern in the SSES area. Nor is the reduction of incident solar radiation due to plume shadow likely to cause measurable effects other than in the immediate vicinity of the towers.

4.4.1.2 Transmission System

As noted in Section 3.2.5, the design and routing of transmission facilities initially proposed and described in the FES-CP were subsequently modified in accordance with proposed alterations presented in Amendments 4 and 5 to the applicant's ER-CP. Construction impacts and alternative actions related to the proposed modifications were evaluated by the staff (Appendix C), and letters indicating acceptability of the modifications were forwarded to the applicant in March 1976 and January 1977.[9,10]

No significant environmental impacts due to the operation of these transmission lines are expected (Appendix C).

As indicated in Appendix C (p. C-7), the staff is keeping abreast of research efforts,[11] investigating possible ill effects from electric fields generated by transmission systems. It is the staff's conclusion that there is no evidence to date that the operation of 500 kV power lines will have any significant biological effects on humans.

4.4.2 Aquatic Environment

4.4.2.1 Intake System

It is the staff's opinion that operation of the intake as currently sited and designed will adversely affect the aquatic community within the immediate vicinity of the wing walls and associated riprap. In order to provide adequate water supply for power-plant use during periods of low river flow, the intake has been sited on a pool of the Susquehanna River (see Fig. 3.1.). River pools, areas of low velocity and zones of deposition, provide spawning habitat, food sources, and/or resting places for various organisms listed in Sec. 2.5.2. Since fish and other free-swimming organisms assemble in these pools, particularly during periods of low flow, the siting of an intake on a river pool increases the potential for entrainment and/or impingement. Based on the applicant's annual reports and on the ER-OL, the staff believes that the intake site is not particularly unique to the Susquehanna River.

The use of wing walls creates an embayment. It is generally agreed[12,13] that embayment-type intakes and associated riprap have a greater potential for "attracting" fish than do other designs. Embayments create "quiet areas," or pools, where, as discussed previously, fish and other free-swimming aquatic organisms concentrate. In essence, the applicant has created an alluring habitat within a river pool.

The proposed riprap behind the wing walls is to be composed of a 1.5-m thick limestone layer. This riprap will increase the productivity of the area by providing additional substrate for attached algae and benthic invertebrates. In addition, it will provide added spawning sites for various species of fish in the vicinity. Based upon riverflow data for spawning periods (mid-April through mid-August) from 1974 through 1977, the applicant has determined that from 167 m^2 to 697 m^2 of riprap will be available for spawning.

According to the applicant's ER, the spotfin shiner (*Notropis spilopterus*) is the most abundant fish (in terms of numbers) in the vicinity.[14] A paper by Gale and Gale (sponsored by the applicant) on the spawning habits of the spotfin shiner, indicates that this species breeds in rock crevices and interstitial spaces between rocks. The authors observed that crevices used by spotfin shiners at the SSES site ranged from 5 to 10 cm in length. A brief experiment in 1976 revealed that although spotfins preferred long crevices, they could spawn in crevices only 2 cm long.[15] Other important species[16] in the vicinity that may utilize the riprap for spawning include the white sucker (*Catostomus comersoni*), brown bullhead (*Ictalurus nebulosus*), channel catfish (*Ictalurus punctatus*) and smallmouth bass (*Micropterus dolomieui*).[17,18]

It is stated in the ER-OL that the American shad (*Alosa sapidissima*) may be reintroduced to the Susquehanna River. Hopefully a shad run would contribute to the commercial fishery of the river. During their early spring upstream migration, adult shad generally stay in the main channel, using pool areas for resting.[19] Therefore, it is likely that operation of SSES intake would have a minimal effect on the upstream migration.

Although shad eggs are demersal, they may be carried from 2 to 6 km downstream from the spawning sites after water hardening.[20] Larval shad generally stay close to the bottom of the main channel; young-of-the-year shad (Y-O-Y) utilize pools more than the main channel.

Though it is unlikely that shad will be spawning in the SSES intake vicinity, the downstream migration in the fall, particularly of Y-O-Y, will be adversely affected by operation of the intake system. It is not possible at this time to quantify the potential entrainment and/or impingement losses of shad at SSES without knowing how successful the reintroduction of shad will be in terms of fecundity and mortality of eggs.

During winter conditions, a portion of the circulating water on the hot side of the cooling tower will be diverted down to the intake structure to a point just within its entrance to prevent ice buildup. Because of the location of the deicing discharge, the staff concludes that this will not contribute to attracting additional fish during winter conditions.

The applicant states that entrainment and impingement "should be relatively small" at SSES.[14] This unsupported statement assumes that the habitat will not be altered due to construction of the intake, wing walls, and associated riprap. This is not a valid assumption for reasons presented in this section. It has been the staff's experience that given the same fish population, an embayment intake will remove more biomass than an alternative intake such as a shoreline intake with the traveling screens flush with the shoreline.[21]

With respect to impingement and entrainment studies, PDER has accepted the applicant's predictive impingement study and will not require monitoring of fish impingement at this time. Special Condition C of the NPDES permit (PA0047325) will, however, require monitoring for entrainment of fish eggs and larvae (see Sec. 5.3.4).

4.4.2.2 Discharge

Potential effects of the thermal discharge are to be mitigated by use of a diffuser. Warm wastewater will be jetted towards the surface of the river at a 45° angle through ports along the 36.6-m diffuser pipe located on the bottom of the river. Turbulence, created by the jetted water will not harm aquatic organisms and the port velocity will be sufficient (1.8 m/s) to discourage most fishes from swimming in the mixing zone near the diffuser for extended periods. Since the diffuser will be located in the river as opposed to a channel or isolated embayment, mixing of the waste heat discharge will be achieved quickly thus reducing the potential for large numbers of fish to be attracted to and remain in the mixing zone, which will extend a maximum of 61 m downstream from the diffuser. At no time will the waste heat discharge create a thermal block across the river preventing movement of aquatic organisms past the station. Planktonic organisms that pass through the mixing zone will probably not be adversely affected because of their short residence time.

Gas bubble disease at SSES should not be a major problem because the discharge diffuser will quickly mix any supersaturated effluents with river water. Should supersaturation occur, it is expected that only a small portion of the river in the immediate vicinity of the diffuser will contain enough dissolved gases to adversely affect fish. Furthermore, it is unlikely that fishes would remain in the supersaturated waters long enough (several days) for mortality to occur.

Due to turbulence created by the jetted water, the staff feels that there may be some scouring of the riverbed immediately downstream of the diffuser. As a result, there may be some loss of spawning habitat. Because the habitat in the vicinity of the discharge is not particularly unique to the river, any loss of habitat there should not have a significant impact on the various populations.

Effects of chemical discharges, as discussed in the applicant's ER-OL (Sec. 3.6.10) should have minimum effects on the biota in the vicinity of the discharge. The staff concludes that the use of SO_2 in the dechlorination process will be acceptable.

4.4.3 Atmospheric Effects of Cooling-Tower Operation

The primary effluents resulting from the operation of the plant will be the heat and moisture transferred to the atmosphere by the two natural-draft cooling towers (NDCTs). Considerable information on the atmospheric effects of plumes from NDCTs has been collected and analyzed since the FES-CP was issued in June 1973. The new information has been summarized by Carson,[22] Hanna,[23] the April 1974 issue of Atmospheric Environment, and the proceedings of two symposia (Cooling Tower Environment--1974[24] and 1978[25]).

Observations at NDCTs in Europe and the United States show that the conclusions reached by the staff in the FES-CP in regard to operation of NDCTs remain valid: little or no fogging and icing, very low drift fallout rates, and no adverse effects due to salt deposition from drift.

The primary atmospheric effect of the operation of natural-draft cooling towers is the generation of visible plumes that remain aloft. In mountainous terrain, these plumes may occasionally strike elevated areas.[22,23] Observations at operating NDCTs indicate that downwash rarely, if ever, brings the visible plumes to ground level. Isolated, detached puffs of the visible plume at ground level are occasionally observed downwind of a cluster of eight NDCTs in England and in the mountainous terrain downwind of the three NDCTs in Pennsylvania. Snow can fall from natural-draft and mechanical-draft cooling-tower plumes in very cold weather.[22,23,26,27]

4.4.3.1 Applicant's Analysis

The applicant's ER-OL used two computer models to predict plume length, plume rise, fogging, icing, and drift effects (ER-OL, Secs. 6.1.3.2.4 and 6.1.3.2.5); these revised models contain several changes from those used in the ER-CP. These changes include the use of a power law to allow for the increase in wind speed with height and a more realistic method of handling two elevated release points. One year (1976) of onsite meteorological data were used in the revised calculations, rather than a longer (3-year) period from a distant airport. The conservative assumptions of 100% operation of both towers was used in the calculations.

The output of the applicant's revised plume-length and drift models are discussed in the ER-OL, Sections 5.1.4 and 5.3.4, and summarized in Tables 5.1-21, -22, -23, 5.3-9 and -10.

The values listed in ER-OL, Table 5.21, show predictions of the frequency of long plumes. For example, plumes measuring 1.8 km or more are predicted to occur 99% of the time; plumes of 3.7 km or more, 90%; and those of 6.1 km or more, 73%. Plumes measuring 6.1 km or longer towards the NE and ENE, the most frequent wind directions, are calculated to occur 19.3% of all hours. These long-plume frequency values are higher than those calculated for the ER-CP. The staff concludes that these are gross overpredictions of the frequency of long plumes.

The model predicted no occurrences of ground-level fogging or icing (the model does allow for variable terrain elevations) due to either the downward dispersion of moisture from an elevated plume or the visible plume extending downwards to intersect the land surface. The staff agrees with this conclusion.

The output of the applicant's drift calculations are given in ER-OL Tables 5.1-22 (maximum salt deposition rates), 5.3-10 (average salt deposition), 5.1-23 (maximum liquid deposition rates), and 5.3-9 (average liquid deposition rates). The maximum drift-deposition rate is calculated to occur one kilometer SSW of the towers; the highest salt-deposition rate calculated is 88 kg/km^2 per month; and the average annual value at this point is 34 kg/km^2 per month. These calculations were made using the realistic assumption of a drift rate of 0.002% of the circulating water. The staff agrees that the impacts of wetting and salt deposition due to drift will be minimal.

4.4.3.2 Staff's Analysis

Local atmospheric changes will occur due to the large amounts of heat and water vapor added to the atmosphere over a small area by wet cooling towers. These atmospheric modifications can be separated into four general categories: elevated visible plumes, ground-level fogging and icing, drift effects, and cloud and precipitation formation.

Visible Plumes

Part of the evaporated water in a natural-draft cooling system recondenses inside the tower. When the effluent leaves the tower, it mixes with cooler, less humid ambient air and more of the water vapor in the discharge condenses in the form of a visible cloud-like plume. Because of the plume's buoyancy and momentum, under most conditions it will continue to rise and carry along with it a mist of water droplets (drift) swept from the circulating water in the fill. The drift will contain whatever soluble and suspended chemicals are present in the circulating water.

Under most meteorological conditions, the water droplets in the visible plume evaporate within a few hundred meters of the towers. Hanna[23] reports that the median plume length for NDCTs with a heat load similar to that of the two-unit SSES is about 250 to 500 m in summer and 500 to 1000 m in winter; plumes as short as 50 m have been observed on sunny summer afternoons. Hanna's data, combined with other observations of plume lengths (References 22, 24, and 25) show that the applicant's model grossly overpredicts the frequency of long visible plumes. Under other conditions (especially periods with low air temperatures, high humidity, moderate wind speeds, and a stable atmosphere), the visible plume may extend for many kilometers, sometimes forming a stratus deck below the main cloud deck. Under these conditions, the plume may rise one or more kilometers before leveling off, typically below the base of an inversion aloft.[22-24]

Ground-level Fogging and Icing

Fog could be created downwind of NDCTs in two ways: aerodynamic downwash (as discussed) and downward dispersion of moisture from an elevated plume. Due to the height of the NDCTs and added plume rise caused by buoyancy and momentum, downwash fog is a rare event in level terrain. No cases of ground-level fog caused by the downward dispersion of humidity from NDCT plumes have been reported.[22,23]

Drift

A small fraction (estimated at 0.002% or less for towers with modern drift eliminators in good repair) of the cooling water is carried into the plume and discharged into the atmosphere as drift. These droplets, carrying dissolved and suspended solids in the circulating water, could cause impacts due to wetting, icing, and deposition of salts onto soil, plants, and structures. Most droplets that fall from the plume evaporate before reaching the ground close to the towers. Evaporation results in small salt particles that are carried away by wind; these salt particles return to earth through precipitation or dry deposition. Some drift droplets do not evaporate before reaching the ground and are deposited at varying distances from the tower, depending on drop size and atmospheric conditions.

Observations at dozens of modern NDCTs with state-of-the-art drift eliminators in Europe and the United States show that most of the drops that reach the ground do so within 0.5 to 1.0 km of the towers and that most of the predicted adverse drift impacts do not, in fact, occur.[22-25,28]

Cloud and Precipitation Formation

The visible plume from a cooling tower is an artificial cloud. In addition, clouds are sometimes observed to form in the updraft created by a cooling tower after the initial visible plume has evaporated. A few occurrences of snow due to cooling-tower plumes have been reported, but never liquid precipitation.[22,23,26,27] Cooling-tower plumes slightly alter the amount of incident solar radiation reaching the ground in the immediate area, but no evidence is available to indicate that they significantly alter local weather conditions or generate thunderstorms.[23]

Summary and Conclusions

The natural-draft cooling tower is a proven, effective, economical way to dissipate large heat loads. The atmospheric impacts of such a tower, using fresh water for makeup, are minimal. The primary adverse impact is visual, i.e., the structures and their visible plumes.[22,23,27,28] Natural-draft cooling towers rarely, if ever, cause significant ground-level fog and icing; drift impacts are negligible for units with state-of-the-art drift eliminators in good repair using fresh water for makeup.

Based on experience with many natural-draft cooling towers in the northeastern section of the country, the staff expects no adverse environmental impacts, other than the occasional generation of long plumes aloft during the winter season and perhaps the generation of local snowfalls, from the operation of the two cooling towers at the Susquehanna Steam Electric Station.

4.5 RADIOLOGICAL IMPACTS FROM ROUTINE OPERATION

4.5.1 Exposure Pathways

The environmental pathways considered in preparing this section are shown in Figure 4.1. The specific pathways evaluated were:

1. Direct radiation from the plant
2. For gaseous effluents
   a. Immersion in the gaseous plume
   b. Inhalation of iodines and particulates
   c. Ingestion of iodines and particulates through the milk cow, goat, meat animal, and vegetation pathways
   d. Radiation from iodines and particulates deposited on the ground
3. For liquid effluents
   a. Drinking water
   b. Ingestion of fish
   c. Shoreline activities, boating and swimming in water containing radioactive effluents

Only those pathways associated with gaseous effluents reported to exist at a single location were combined to calculate the total exposure to a maximally exposed individual. Pathways associated with liquid effluents were combined without regard to location and were assumed to be associated with a maximally exposed individual other than the individual from gaseous effluent pathways.

The models and considerations for environmental pathways leading to estimates of radiation doses to individuals near the plant and to the population within an 80-km radius of the plant resulting from plant operations are discussed in detail in Regulatory Guide 1.109. Use of these models with additional assumptions for environmental pathways leading to exposure to populations outside the 80-km radius are described in Appendix D of this Statement.

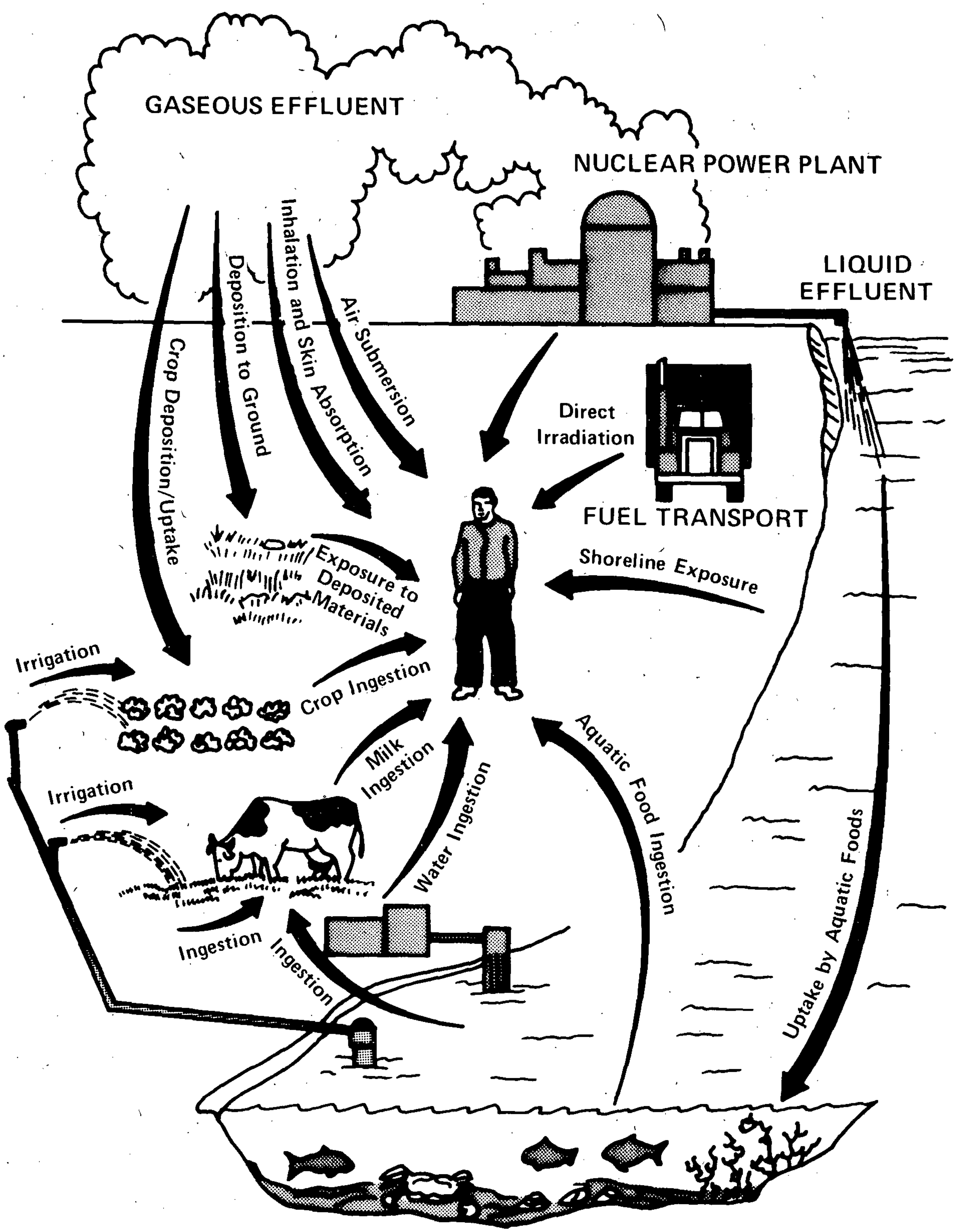

Fig. 4.1. Exposure Pathways to Humans

4.5.2 Dose Commitments

The quantities of radioactive material that may be released annually from the plant are estimated based on the description of the radwaste systems given in the applicant's environmental report and FSAR and using the calculational model and parameters described in NUREG 0016, Revision 7 ("Calculation of Releases of Radioactive Materials in Gaseous Liquid Effluents from Boiling Water Reactors"). The applicant's site and environmental data provided in the environmental report and in subsequent answers to NRC staff questions were used extensively in the dose calculations. Using this information on the quantities of radioactive materials released and exposure pathways, the dose commitments to individuals and the population were estimated. Population doses were based on the projected population distribution for the year 2000.

The dose commitments in this statement represent the total dose received over a period of 50 years following the intake of radioactivity for one year under the conditions existing 15 years after the station is started up. For the younger age groups, changes in organ mass with age after the initial intake of radioactivity are accounted for in a stepwise manner.

In the analysis of all effluent radionuclides released from the plant, tritium, carbon-14, cesium, cobalt, krypton, xenon and iodine, inhaled with air and ingested with food and water were found to account for essentially all total-body dose commitments to individuals and the population within 80 km of the plant.

Dose Commitments from Radioactive Releases to the Atmosphere

Radioactive effluents released to the atmosphere from Susquehanna Station, Units 1 and 2, will result in small radiation doses to individuals and populations. NRC staff estimates of the expected gaseous and particulate releases listed in Table 4.4 and the site meteorological considerations discussed in Section 2.4 of this statement and summarized in Table 4.5 were used to estimate radiation dose to individuals and populations. A discussion of the results of the calculations follows.

1) Radiation Dose Commitments to Individuals

Individual receptor locations and pathway locations considered for the maximum individual are listed in Table 4.6. The estimated dose commitments to the maximum individual from radioiodine and particulate releases at selected offsite locations are listed in Tables 4.7, 4.8, and 4.9. The individual exposed to maximum doses is assumed to consume well above average quantities of the foods considered (see Table E-5 in Regulatory Guide 1.109).

The maximum annual beta and gamma air dose and the maximum total body and skin dose to an individual, at the maximum site boundary, are also presented in Tables 4.7, 4.8, and 4.9.

2) Radiation Dose Commitments to Populations

Annual radiation dose commitments from airborne radioactive releases from the Susquehanna nuclear station are estimated for two populations in the year 2000: 1) the population within 80 km of the station (see Table 4.8) and 2) the entire U.S. population (Table 4.10). Dose commitments beyond 80 km are based on the assumptions discussed in Appendix D. For perspective, annual background radiation doses are given for the population within 80 km of the site (see Table 4.8) and for the entire U.S. population (see Table 4.10). The total body population dose to the population within 80 km of the site from airborne radioactive releases from Susquehanna Units 1 and 2 (i.e., about 9.4 person-rem) is a small fraction (less than 0.01 percent) of the corresponding population dose from natural background radiation (i.e., about 160,000 person-rem). The total body population dose to the entire U.S. population from airborne radioactive releases from Susquehanna Units 1 and 2 (i.e., about 51 person-rem) is an even smaller fraction (less than 0.0002 percent) of the corresponding U.S. population dose from natural background radiation (i.e., about 27 million person-rem).

Dose Commitments from Radioactive Liquid Releases to the Hydrosphere

Radioactive effluents released to the hydrosphere from Susquehanna Station, Units 1 and 2, during normal operation will result in small radiation doses to individuals and populations. NRC staff estimates of the expected liquid releases listed in Table 4.11 and the site hydrological considerations discussed in Section 2.3 of this statement and summarized in Table 4.12

Table 4.4. Calculated Releases of Radioactive Materials in Gaseous Effluents from Susquehanna Nuclear Power Station (Ci/yr per reactor)

Nuclides	Waste-Gas Offgas System	Building Ventilation			Gland Seal and Mechanical Vacuum Pump	Total
		Reactor	Radwaste	Turbine Vent		
Ar-41	a	25	a	a	a	25
Kr-83m	4	b	b	b	b	4
Kr-85m	1,700	6	b	14	b	1,700
Kr-85	270	b	b	b	b	270
Kr-87	b	6	b	26	b	32
Kr-88	610	6	b	46	b	660
Kr-89	b	b	b	b	b	b
Xe-131m	71	b	b	b	b	71
Xe-133m	14	b	b	b	b	14
Xe-133	10,000	130	10	50	2,300	12,500
Xe-135m	b	92	b	130	b	220
Xe-135	b	72	45	130	350	590
Xe-137	b	b	b	b	b	b
Xe-138	b	14	b	280	b	290
I-131	b	3.4×10^{-2}	5×10^{-2}	1.9×10^{-2}	3×10^{-2}	1.2×10^{-1}
I-133	b	1.4×10^{-1}	1.8×10^{-1}	7.6×10^{-2}	b	3.3×10^{-1}
H-3	a	-	-	-	-	69
C-14	8.0	1.5	b	b	b	9.5
Cr-51	a	6×10^{-6}	9×10^{-5}	2.6×10^{-5}	a	1.2×10^{-4}
Mn-54	a	6×10^{-5}	3×10^{-4}	1.2×10^{-6}	a	3.6×10^{-4}
Fe-59	a	8×10^{-6}	1.5×10^{-4}	1×10^{-6}	a	1.6×10^{-4}
Co-58	a	1.2×10^{-5}	4.5×10^{-5}	1.2×10^{-6}	a	5.8×10^{-5}
Co-60	a	2×10^{-4}	9×10^{-4}	4×10^{-6}	a	1.1×10^{-3}
Zn-65	a	4×10^{-5}	1.5×10^{-5}	4×10^{-7}	a	5.5×10^{-5}
Sr-89	a	1.8×10^{-6}	4.5×10^{-6}	1.2×10^{-5}	a	1.8×10^{-5}
Sr-90	a	1×10^{-7}	3×10^{-6}	4×10^{-8}	a	3.1×10^{-6}
Zr-95	a	8×10^{-6}	5×10^{-7}	2×10^{-7}	a	8.7×10^{-6}
Sb-124	a	4×10^{-6}	5×10^{-7}	6×10^{-7}	a	5.1×10^{-6}
Cs-134	a	8×10^{-5}	4.5×10^{-5}	6×10^{-7}	3×10^{-6}	1.3×10^{-4}
Cs-136	a	6×10^{-6}	4.5×10^{-6}	1×10^{-7}	2×10^{-6}	1.3×10^{-3}
Cs-137	a	1.1×10^{-4}	9×10^{-5}	1.2×10^{-6}	1×10^{-5}	2.1×10^{-4}
Ba-140	a	8×10^{-6}	1×10^{-6}	2.2×10^{-5}	1.1×10^{-5}	4.2×10^{-5}
Ce-141	a	2×10^{-6}	2.6×10^{-5}	1.2×10^{-6}	a	2.9×10^{-5}

[a] = less than 1% of total nuclide.

[b] = less than 1.0 Curie/yr per reactor for noble gases and carbon-14; less than 10^{-4} curie/yr per reactor for iodine.

Table 4.5. Summary of Atmospheric Dispersion Factors and Deposition Values for Maximum Site Boundary and Receptor Locations Near SSES[a]

Location	Source	χ/Q (s/m^3)	Relative Deposition (m^{-2})
Nearest[b] site land boundary (0.71 mi WNW)[c]	A	3.7×10^{-6}	8.0×10^{-9}
	B	5.8×10^{-6}	1.1×10^{-8}
	C	2.3×10^{-5}	4.2×10^{-8}
Nearest residence, garden, milk animal, and meat animal (2.2 mi E)[c,d]	A	6.0×10^{-7}	3.3×10^{-9}
	B	6.2×10^{-7}	3.3×10^{-9}
	C	1.4×10^{-6}	7.8×10^{-9}

[a]Source A is reactor building; source B is turbine building for Unit 2, continuous release; source C is turbine building for Unit 2, periodic release. Meteorological dispersion factors for Unit 1 are slightly lower for the location (0.7 mi WNW).

[b]"Nearest" refers to that type of location where the highest radiation dose is expected to occur from all appropriate pathways.

[c]To convert mi to km, multiply by 1.6093.

[d]The maximum receptor location for iodines and particulates in the Draft Environmental Statement (DES) was listed as 0.7 mi NW. New information concerning this location, received since publication of the DES, has resulted in a change in the location of the maximum receptor location to 2.2 mi E.

Table 4.6. Pathway Locations Considered for Selecting Maximum Individual Dose Commitments[a]

Sector	Site Boundary	Residence	Garden	Milk Animal	Meat Animal
N	660	1140	805	--	2410
NNE	740	1609	1450	--	8040
NE	1770	3700	3700	6120	4180
ENE	1530	3860	4510	--	5150
E	1270	2090	1130	3540	3380
ESE	760	756	2410	3860	3860
SE	550	610	644	4020	644
SSE	550	1130	644	4020[b]	4020
S	550	1770	1930	3860	3860
SSW	690	1220	966	4020	4020
SW	610	1290	1290	4020	4020
WSW	1130	1770	1930	2580	1930
W	1030	1930	1130	7890	5470
WNW	1030	1140	2090	--	2250
NW	870	1290	1130	1130	1130
NNW	690	1220	1130	6600	6600

[a]All distance given in m.

[b]Milk goat at 5310 m.

Table 4.7. Annual Dose Commitments to a Maximum Individual Near the Susquehanna Station

Location	Pathway	Annual Dose Commitment			
		Noble Gases in Gaseous Effluents[a]			
		Total Body, mrem/unit	Skin, mrem/unit	Gamma Air Dose, mrad/unit	Beta Air Dose, mrad/unit
Nearest[b] site boundary (0.71 mi WNW)[c]	Direct radiation from plume	2.6	5.7	4.1	5.5
		Iodine and Particulates in Gaseous Effluents			
		Total Body, mrem/unit	Thyroid, mrem/unit	Other Organ (if >10% of dose), mrem/unit	
Nearest[d] residence (2.2 mi E)[c,e]	Ground deposit[f]	<0.1	<0.1		
	Inhalation	<0.1	<0.1		
	Vegetation	0.13	0.35	0.6 (bone)	
	Milk (infant)	0.14	4.2	0.6 (bone)	
	Meat	<0.1	<0.1	0.1 (bone)	
		Liquid Effluents			
		Total Body, mrem/unit	Other Organ (if >10% of dose), mrem/unit		
Nearest drinking water at Danville	Water ingestion	<0.1	0.46 (thyroid)		
Nearest fish near station discharge	Fish ingestion	0.48	0.99 (bone)		

[a]The doses for gaseous effluents presented in this table and Tables 4.8 and 4.9 are corrected for radioactive decay and cloud depletion from deposition, where appropriate, in accordance with Regulatory Guide 1.111, Rev. 1, "Methods for Estimating Transport and Dispersion of Gaseous Effluents in Routine Releases from Light Water Reactors," July 1977.

[b]"Nearest" refers to that site boundary location where the highest radiation doses due to gaseous effluents have been estimated to occur.

[c]To convert mi to km, multiply by 1.6093.

[d]"Nearest" refers to the location where the highest radiation dose to an individual from all applicable pathways has been estimated.

[e]See note d/, Table 4.5.

[f]To a receptor.

Table 4.8. Calculated Dose Commitments to a Maximum Individual and the Population from the Operation of SSES

	Annual Dose per Reactor Unit	
	Maximum Individual Doses	
	Appendix I Design Objectives[a]	Calculated Doses[b]
Liquid effluents		
Dose to total body from all pathways	3 mrem	0.5 mrem
Dose to any organ from all pathways (bone)	10 mrem	1.0 mrem
Noble gas effluents (at site boundary)[c]		
Gamma dose in air	10 mrad	4.1 mrad
Beta dose in air	20 mrad	5.5 mrad
Dose to total body of an individual	5 mrem	2.6 mrem
Dose to skin of an individual	15 mrem	5.7 mrem
Radioiodines and particulates[d]		
Dose to any organ from all pathways (infant thyroid)	15 mrem	4.3 mrem
	Population Doses Within 80 km	
	Total Body	Thyroid
Natural radiation background[e]	1.6×10^5 person-rem	
Liquid effluents	0.12 person-rem	3.5 person-rem
Noble gas effluents	3.7 person-rem	3.7 person-rem
Radioiodines and particulates	1.0 person-rem	5.5 person-rem

[a]Appendix I design objectives from Sections II.A, II.B, II.C, and II.D of Appendix I, 10 CFR Part 50, considers doses to maximum individuals and populations per reactor unit. From Fed. Reg. V. 40, p. 19443, May 5, 1975.

[b]See footnote a/ of Table 4.7.

[c]The calculated doses are from noble gas effluents from Unit 2, doses from noble gas effluents from Unit 1 are slightly lower.

[d]Carbon-14 and tritium have been added to this category.

[e]"Natural Radiation Exposure in the United States," U.S. Environmental Protection Agency, ORP-SID-72-1, June 1972; using the average Pennsylvania state background dose (96.8 mrem/yr), and year 2000 projected population of 1,610,000.

Table 4.9. Calculated Dose Commitments to a Maximum Individual from Operation of SSES

	Annual Dose per Site	
	RM-50-2 Design Objectives[a]	Calculated Doses[b]
Liquid effluents		
Dose to total body or any organ from all pathways	5 mrem	1.0 mrem
Noble gas effluents (at site boundary)		
Gamma dose in air	10 mrad	7.6 mrad
Beta dose in air	20 mrad	11.0 mrad
Dose to total body of an individual	5 mrem	4.9 mrem
Dose to skin of an individual	15 mrem	11.0 mrem
Radioiodine and particulates[c]		
Dose to any organ from all pathways	15 mrem	8.6 mrem

[a]Guides on Design Objectives proposed by the NRC staff on 20 February 1974, consider doses to individuals from all units on site. From "Concluding Statement of Position of the Regulatory Staff," Docket No. RM-50-2, 20 February 1974, pp. 25-30, U.S. Atomic Energy Commission, Washington, D.C., also published as Annex to Appendix I to 10 CFR Part 50.

[b]See footnote a/ of Table 4.7.

[c]Carbon-14 and tritium have been added to this category.

Table 4.10. Annual Total Body Population Dose Commitments in the Year 2000

Category	U.S. Population Dose Commitment, person-rem/yr per site
Natural background radiation	26,800,000[a]
Susquehanna nuclear plant operation	
Plant workers	3,200
General public:	
Radioiodine and particulates	41
Liquid effluents	0.3
Noble gas effluents	10
Transportation of fuel and waste	14

[a]Using the average U.S. background dose (102 mrem/yr) and year 2000 projected U.S. population from "Population Estimates and Projections," Series II, U.S. Dept. of Commerce, Bureau of the Census, Series P-25, No. 541, February 1975. See also footnote a/ of Table 4.7.

Table 4.11. Calculated Releases of Radioactive Materials in Liquid Effluents from Susquehanna

Nuclide	Ci/yr per reactor	Nuclide	Ci/yr per reactor
	Corrosion and Activation Products		
Na-24	6.4×10^{-3}[a]	Cu-64	1.7×10^{-2}
P-32	7.1×10^{-4}	Zn-65	8.8×10^{-4}
Cr-51	2×10^{-2}	Zn-69m	1.3×10^{-3}
Mn-54	1.3×10^{-3}	Zn-69	1.4×10^{-3}
Mn-56	4.2×10^{-4}	Zr-95	1.4×10^{-3}
Fe-55	4.5×10^{-3}	Nb-95	2×10^{-3}
Fe-59	1.2×10^{-4}	W-187	3.6×10^{-4}
Co-58	4.8×10^{-3}	Np-239	1.5×10^{-2}
Co-60	1×10^{-2}		
	Fission Products		
Br-83	2×10^{-5}	Te-131m	1.5×10^{-4}
Sr-89	4.2×10^{-4}	Te-131	3×10^{-5}
Sr-90	3×10^{-5}	I-131	2.5×10^{-1}
Y-90	1×10^{-5}	Te-132	2×10^{-5}
Sr-91	1.4×10^{-3}	I-132	1.8×10^{-4}
Y-91m	9.3×10^{-4}	I-133	2.2×10^{-2}
Y-91	2.7×10^{-4}	Cs-134	1.8×10^{-2}
Sr-92	1×10^{-4}	I-135	3.4×10^{-3}
Y-92	7.7×10^{-4}	Cs-136	3.1×10^{-3}
Y-93	1.6×10^{-3}	Cs-137	3.6×10^{-2}
Zr-95	3×10^{-5}	Ba-137m	1.1×10^{-2}
Nb-95	3×10^{-5}	Ba-140	1.4×10^{-3}
Mo-99	4.6×10^{-3}	La-140	7.8×10^{-4}
Tc-99m	6.8×10^{-3}	La-141	3×10^{-5}
Ru-103	2.2×10^{-4}	Ce-141	1.4×10^{-4}
Rh-103m	8×10^{-5}	Ce-143	5×10^{-5}
Ru-105	1.2×10^{-4}	Pr-143	1.5×10^{-4}
Rh-105m	1.2×10^{-4}	Ce-144	5.2×10^{-3}
Rh-105	4.4×10^{-4}	Pr-144	1×10^{-5}
Ru-106	2.4×10^{-3}	All Others	4×10^{-5}
Rh-106	1×10^{-5}		
Ag-110m	4.4×10^{-4}	Total	
Te-129m	1.6×10^{-4}	(except H-3)	4.6×10^{-1}
Te-129	1×10^{-4}		
		H-3	17

[a]Nuclides with release rates of less than 10^{-5} Ci/yr per reactor are not listed individually but are included in the category "All Others."

Table 4.12. Summary of Hydrologic Transport and Dispersion for Liquid Releases from the Susquehanna Nuclear Power Station[a]

Location	Transit time (hr)	Dilution Factor
Nearest drinking water intake (Berwick)	22	70
Nearest sport fishing location (plant discharge area)[b]	24	45
Nearest shoreline (plant discharge area)[b]	0.1	5

[a]See Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," April 1977.

[b]Assumed for purposes of an upper limit estimate, detailed information not available.

were used to estimate radiation dose commitments to individuals and populations. A discussion of the results of the calculations follows.

1) Radiation Dose Commitments to Individuals

The estimated dose commitments to the maximum individual from liquid releases at selected offsite locations are listed in Tables 4.7, 4.8, and 4.9. The maximum individual is assumed to consume well above average quantities of the foods considered and spend more time at the shoreline than the average person (see Table E-5 in Regulatory Guide 1.109).

2) Radiation Dose Commitments to Populations

Annual radiation dose commitment from liquid radioactive releases from the Susquehanna nuclear station are estimated for two populations in the year 2000: 1) the population within 80 km of the station (see Table 4.8) and 2) the entire U.S. population (see Table 4.10). Dose commitments beyond 80 km are based on the assumptions discussed in Appendix D. For perspective, annual background radiation doses are given for the population within 80 km of the site (see Table 4.8) and for the entire U.S. population (see Table 4.10). The total body population dose to the population within 80 km of the site from liquid radioactive releases from Susquehanna Units 1 and 2 (i.e., about 0.3 person-rem) is a small fraction (less than 0.001 percent) of the corresponding population dose from natural background radiation (i.e., about 160,000 person-rem). The total body population dose to the entire U.S. population from liquid radioactive releases from Susquehanna Units 1 and 2 (i.e., about 0.3 person-rem) is an even smaller fraction (less than 0.00001 percent) of the corresponding U.S. population dose from natural background radiation (i.e., about 27 million person-rem).

3) Radiation Exposure to Construction Workers

During the period between the operation of Unit 1 and the startup of Unit 2, the construction personnel working on Unit 2 will be exposed to sources of radiation from the operation of Unit 1. The applicant has estimated the integrated dose to construction personnel to be 31 person-rem. Estimated values for other LWRs have ranged from 5 to 500 person-rem.

Direct Radiation

1) Radiation from the Facility

Radiation fields are produced in nuclear plant environs as a result of radioactivity contained within the reactor and its associated components. The applicant has calculated a maximum direct radiation dose of 2.7 mrad/yr per unit at a site boundary location 550 m south of the plant.

Direct radiation doses from sources within the plant are primarily due to nitrogen 16, a radionuclide produced in the reactor core. In boiling-water reactors, nitrogen-16 is transported with the primary coolant to the turbine building. The orientation of piping and turbine components in the turbine building determines, in part, the exposure rates outside the plant. Because of variations in equipment layout, exposure rates are strongly dependent upon overall plant design.

Based on radiation surveys that have been performed around several operating BWRs, it appears to be very difficult to develop a reasonable model to predict direct shine doses. Thus, older plants should have actual measurements performed if information regarding direct radiation and skyshine rates is needed.

For newer BWR plants, with a standardized design, dose rates have been estimated using sophisticated Monte Carlo techniques. The turbine island design proposed in the Braun SAR[29] is estimated to have direct radiation and skyshine dose rates on the order of 20 mrem/yr per unit at a typical site boundary distance of 0.6 km from the turbine building. This dose rate is assumed to be typical of the new generation of boiling water reactors. The integrated population dose from such a facility would be less than one person-rem/yr per unit.

Low level radioactivity storage containers outside the plant are estimated to contribute less than 0.01 mrem/yr at the site boundary.

2) Occupational Radiation Exposure

The dose to nuclear plant workers varies from reactor to reactor and can be projected for environmental impact purposes by using the experience to date with modern boiling water reactors (BWRs). Most of the dose to nuclear plant workers is due to external exposure to radiation from radioactive materials outside of the body rather than from internal exposure from inhaled or ingested radioactive materials. Recently licensed 1000-MWe BWRs are designed and operated in a manner consistent with the new (post 1975) regulatory requirements and guidance. These new requirements and guidance place increased emphasis on maintaining occupational exposure at nuclear power plants as low as is reasonably achievable (ALARA), and are outlined in 10 CFR Part 20, Standard Review Plan Chapter 12, and Regulatory Guide 8.8.[30-32] The applicant's proposed implementation of these requirements and guidelines are reviewed by the staff at the construction-permit licensing stage, the operating-license licensing stage, and during actual operation. Approval of the proposed implementation of these requirements and guidelines is granted only after the review indicates that an ALARA program can actually be implemented. As a result of the staff's review of the Summer safety analysis report, it was determined that the applicant is committed to design features and operating practices that will assure that individual occupational radiation doses can be maintained within the limits of 10 CFR Part 20 and that individual and population doses will be as low as is reasonably achievable.

Based on actual operating experience, it has been observed that occupational dose has varied considerably from plant to plant and from year to year. Average individual and collective dose information is available from over 125 reactor years of operation between 1974 and 1979. These data indicate that the average reactor annual dose at BWRs has been about 650 person-rems, with particular plants experiencing an average lifetime annual dose as high as 1600 person-rems.[33] These dose averages are based on widely varying yearly doses at BWRs. For example, annual collective doses for BWRs have ranged from 44 to 3142 person-rems per reactor.[33] The average annual dose per nuclear plant worker has been about 0.8 rem.[33]

The wide range of annual doses (44 to 3142 person-rems) experienced by U.S. BWRs is dependent on a number of factors, such as the amount of required routine and special maintenance and the degree of reactor operations and in-plant surveillance. Since these factors can vary in an unpredictable manner, it is impossible to determine in advance a specific year-to-year or average annual occupational radiation dose for a particular plant over its operating lifetime. The need for high doses can occur, even at plants with radiation protection programs that have been developed to assure that occupational radiation doses will be kept at levels that are ALARA. Consequently, occupational dose estimates for environmental impact purposes for the Susquehanna Station Units 1 and 2 are based on the staff's conservative assumption that the Susquehanna plants may have a higher than average level of special maintenance work. Based on the staff's review of the applicant's Safety Analysis Report as well as occupational dose data from more than 125 BWR reactor operating years,[34] the staff projects that the occupational doses at the Susquehanna Station could average as much as 1600 person-rems/yr per unit when averaged over the life of the plant. However, actual year-to-year doses at the Susquehanna Station may differ greatly from this average, depending on actual plant operating conditions.

3) Transportation of Radioactive Material

The transportation of cold fuel to a reactor, of irradiated fuel from the reactor to a fuel reprocessing plant, and of solid radioactive waste from the reactor to burial grounds is within the scope of the NRC report entitled, "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants." The estimated population dose commitments associated with transportation of fuels and wastes are listed in Tables 4.10 and 4.13.

4.5.3 Radiological Impact on Humans

The quantities of radioactive material that may be released annually from the plant are estimated based on the description of the radwaste systems given in the applicant's environmental report and FSAR. Therefore, the actual radiological impact associated with the operation of the proposed Susquehanna nuclear power station will depend, in part, on the manner in which the radioactive waste treatment system is operated. Based on NRC staff's evaluation of the potential performance of the radwaste system, it is concluded that the system, as proposed, is capable of meeting the dose design objectives of 10 CFR Part 50, Appendix I, and those of RM50-2, contained in the annex to Appendix I. The applicant chose to show compliance with the design objectives of RM50-2 as an optional method of demonstrating compliance with the cost-benefit section of Appendix I, Section II.D. Table 4.9 compares the calculated maximum individual doses to the dose design objectives. However, since the facility's operation will be governed by operating license technical specifications and since the technical specifications will be based on the dose design objectives of 10 CFR Part 50, Appendix I, as shown in the first column of Table 4.8, the actual radiological impact of plant operation may result in doses close to the dose design objectives. Even if this situation exists the individual doses will still be very

Table 4.13. Environmental Impact of Transportation of Fuel and Waste to and from One Light-Water-Cooled Nuclear Power Reactor[a]

Normal Conditions of Transport	
Heat (per irradiated fuel cask in transit)	260 MJ/hr
Weight (governed by Federal or State restrictions)	33,000 kg per truck; 90,000 kg per cask per rail car
Traffic density:	
Truck	< 1 per day
Rail	< 3 per month

Exposed Population	Estimated Number of Persons Exposed	Range of Doses to Exposed Individuals[b] (mrem per reactor yr)	Cumulative Dose to Exposed Population (person-rem per reactor yr)[c]
Transportation worker	200	0.01 to 300	4
General Public:			
Onlookers	1,000	0.003 to 1.3	
Along route	600,000	0.0001 to 0.06	3

Accidents in Transport	
Radiological effects	Small[d]
Common (nonradiological) causes	1 fatal injury in 100 reactor years 1 nonfatal injury in 10 reactor years $475 property damage per reactor year

[a]Data supporting this table are given in the Commission's "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants," December 1972, and Supplement I, NUREG-75/038, April 1975.

[b]The Federal Radiation Council has recommended that the radiation doses from all sources of radiation other than natural background and medical exposures be limited to 5000 mrem/yr for individuals as a result of occupational exposure and to 500 mrem/yr for individuals in the general population. The dose to individuals due to average natural background radiation is about 102 mrem/yr.

[c]Person-rem is an expression for the summation of whole body doses to individuals in a group. Thus, if each member of a population group of 1000 people were to receive a dose of 0.001 rem (1 mrem), or if 2 people were to receive a dose of 0.5 rem (500 mrem) each, the total cumulative dose in each case would be 1 person-rem.

[d]Although the environmental risk of radiological effects stemming from transportation accidents cannot currently be numerically quantified, the risk remains small regardless of whether it is being applied to a single reactor or a multireactor site.

small compared to natural background doses (∿ 100 mrem/yr) or of the dose limits specified in 10 CFR Part 20. As a result, the staff concluded that there will be no measurable radiological impact on humans from routine operation of the plant.

Effective 1 December 1979, the licensee will also be regulated according to the Environmental Protection Agency's 40 CFR Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations," which specifies that the annual dose equivalent cannot exceed 25 mrems to the whole body, 75 mrems to the thyroid, and 25 mrems to any other organ of any member of the public as the result of exposure to planned discharges of radioactive materials, radon and its daughters excepted, to the general environment from uranium fuel-cycle operations and radiation from these operations.

4.5.4 Radiological Impacts on Biota Other Than Humans

Depending on the pathway and radiation source, terrestrial and aquatic biota will receive doses approximately the same or somewhat higher than humans receive. Although guidelines have not been established for acceptable limits for radiation exposure to these species, it is generally agreed that the limits established for humans are also conservative for other species. Experience has shown that it is the maintenance of population stability that is crucial to the survival of a species, and species in most ecosystems suffer rather high mortality rates from natural causes. While the existence of extremely radiosensitive biota is possible, and whereas increased radiosensitivity in organisms may result from environmental interactions with other stresses (e.g., heat, biocides, etc.), no biota have yet been discovered that show a sensitivity (in terms of increased morbidity or mortality) to radiation exposures as low as those expected in the area surrounding the Susquehanna nuclear power plant. Furthermore, there have been no cases of exposures that can be considered significant in terms of harm to the species or that approach the exposure limits to members of the public permitted by 10 CFR Part 20 in any of the plants where an analysis of radiation exposure to biota other than humans has been made.[35] Since the BEIR Report[36] concluded that the evidence to date indicates that other living organisms are not much more radiosensitive than humans, no measurable radiological impact on populations of biota is expected as a result of the routine operation of this plant.

4.5.5 Risks Due to Radiation Exposure from Normal Operations

The individual doses associated with exposures will be controlled so that the limits set forth in 10 CFR Part 20 for exposure of workers and the general public are not exceeded. In addition, the licensee's operating license will contain Technical Specifications to maintain radioactive effluents to values as low as reasonably achievable according to the dose design objectives of 10 CFR 50, Appendix I, for the general public. The limits in 10 CFR Part 20 and the annual dose design objectives in 10 CFR 50, Appendix I, are intended to ensure that the risk to any exposed individual is extremely small.

The risk estimates used in this report are derived from the recommendations of the National Academy of Sciences Biological Effects of Ionizing Radiation Committee and GESMO.[36,37] The estimates of the risks to workers and the general public are based on conservative assumptions (i.e., the estimates are probably higher than the actual number). The following risk estimators were used to estimate health effects: 135 potential deaths from cancer per million person-rem and 258 potential cases of all forms of genetic disorders per million persons-rem. The cancer fatality risk estimates are based on the "absolute risk" model in BEIR I. Higher estimates can be developed by use of the "relative risk" model along with the assumption that risk prevails for the duration of life. This would produce risk values up to about four times greater than those used in this report. The staff regards this as an upper limit of the range of uncertainty. The lower limit of the range would be zero. The range of uncertainty in the genetic risk estimates extends a factor of about 6 above and about 4 below the preceding value (i.e., 258 potential cases of all forms of genetic disorder per million person-rem). The number of potential nonfatal cancers would be approximately 1.5 to 2 times the number of potential fatal cancers.[38]

The preceding values for risk estimators are consistent with the recommendations of a number of recognized radiation protection organizations, such as the International Commission on Radiological Protection (ICRP), the National Council on Radiation Protection and Measurement (NCRP), the National Academy of Sciences BEIR III Report, and the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR).[38-41]

4.5.5.1 Occupational Exposure

This section contains estimates of the risk of occupational radiation exposure for three categories: 1) the nonradiological and radiological occupational risk experienced by the average nuclear-power-plant worker, 2) the risk of potential fatal cancers in the exposed workforce population, and 3) the risk of potential genetic disorders in all future generations of the exposed workforce population.

Risk to Workers

The average annual dose per nuclear-plant worker at operating LWRs (about 0.8 rem) has been well within the limits of 10 CFR Part 20. However, for comparative purposes, the staff has estimated the risk experienced by nuclear-power-plant workers. The nuclear-plant workers' risk is equal to the sum of the radiation-related risk and the nonradiation-related risk. The occupational risk associated with the industry-wide average radiation dose is about 11 potential premature deaths per 10^5 person-years due to cancer.* The number of potential nonfatal cancers would be

*Exposure to individual workers will vary from the average; however, exposure to individual workers will be limited so as not to exceed the limits in 10 CFR Part 20 for occupational exposure.

approximately 1.5 to 2 times the number of potential fatal cancers.[38] The nonradiation-related fatality incidence of nuclear-plant workers is expected to be no greater than the fatality incidence for similar types of work. The average nonradiation-related risk for seven U.S. electrical utilities over the period 1970-1979 is about 12 actual premature deaths per 10^5 person-years.[42] Adding the nonradiation-related risk to the potential radiation-related risk, the comparable risk to a nuclear-power-plant worker receiving the average annual dose would be about 23 premature deaths per 10^5 person-years.

The risks of various occupations, including nuclear-plant workers, are shown in Table 4.14. In terms of job-related fatalities, the occupational risk to a nuclear-power-plant worker (i.e., about 23 premature deaths per 10^5 person-years) is higher than the average private sector risk (i.e., 10 premature deaths per 10^5 person-years). However, the risk to nuclear-plant workers is lower than the risk for a number of other groups. The potential fatality incidence rates due to radiation exposure that account for about half of the fatalities for the nuclear-power-plant workers that are listed in Table 4.14 are conservative estimates (i.e., the actual risk may be much less than the estimates), whereas the fatality incidences for other groups are based on known instances of actual job-related fatalities. Based on these comparisons, the staff concludes that the risk to nuclear-plant workers from operation of Susquehanna Station, Units 1 and 2, is comparable to the risks associated with other occupations.

Table 4.14. Incidence of Job-Related Fatalities

Occupational Group	Fatality Incidence Rates (premature deaths per 10^5 person-years)
Underground metal miners[a]	1275
Uranium miners[a]	422
Smelter workers[a]	194
Mining[b]	61
Agriculture, forestry, and fisheries[b]	35
Contract construction[b]	33
Transportation and public utilities	24
Nuclear-plant worker[c]	23
Manufacturing	7
Wholesale and retail trade[b]	6
Finance, insurance, and real estate[b]	3
Services[b]	3
Total private sector[b]	10

[a]The President's Report on Occupational Safety and Health, "Report on Occupational Safety and Health by the U.S. Department of Health, Education, and Welfare," E. L. Richardson, Secretary, May 1972 (Reference 43).

[b]U.S. Bureau of Labor Statistics, "Occupational Injuries and Illness in the United States by Industry, 1975," Bulletin 1981, 1978 (Reference 44).

[c]The fatality incidence rate for nuclear-plant workers is based on an annual exposure of 0.8 rem to the average worker, and the nonradiation-related fatalities for seven large U.S. electrical utilities over the period 1970-1979.[42] About half of the estimated fatality incidence rate for nuclear-plant workers is potential, rather than actual, premature deaths that might be caused by radiation exposure.

Risk to Workforce Population

The risk of potential fatal cancers in the exposed workforce population, and the risk of potential genetic disorders in all future generations of the exposed workforce population, is estimated as follows. Multiplying the annual plant worker population dose (i.e., about 3200 person-rem) by the risk estimators, the staff estimates that about 0.4 cancer deaths may occur in the exposed population and about 0.8 genetic disorders may occur in all future generations of the exposed population. The value of 0.4 cancer deaths means that the probability of one cancer death over the lifetime of the entire workforce due to one year of operations at Susquehanna Station, Units 1 and 2, is about 4 chances in 10. The number of potential nonfatal cancers would be about 1.5 to 2 times the number of potential fatal cancers. The value of 0.8 genetic disorders means that the probability of 1 genetic disorder in all future generations due to one year of operations at SSES is about 8 chances in 10. These health impacts will not be measurable when spread over the lifetime of the entire workforce.

4.5.5.2 Exposure of the General Public

The doses associated with exposure of the general public from radioactive effluents from normal operations at SSES will be controlled so as not to exceed the limits set forth in 10 CFR 20. In addition, the licensee's operating license will contain Technical Specifications to maintain radioactive effluents to values as low as reasonably achievable according to the annual dose design objectives in 10 CFR 50, Appendix I. The following estimates of the risks to the general public are based on conservative assumptions. For example, the BEIR III Committee has stated:

> It is by no means clear whether dose rates of gamma or X-ray radiation of about 100 mrads/yr are in any way detrimental to exposed people; any somatic effects would be masked by environmental or other factors that produce the same types of health effects as does ionizing radiation. It is unlikely that carcinogenic effects of low-LET radiation administered at this dose rate will be demonstrated in the foreseeable future.[38]

The estimated annual doses associated with exposure of the general public from radioactive effluents from normal operations at SSES are below the dose rate of 100 mrads/yr referred to by the BEIR III Committee. Nonetheless, using conservative assumptions, calculations can be made of the risk of potential premature death from cancer to individuals and populations in the vicinity of nuclear power reactors.

Risks to Individuals

Multiplying the risk estimators in the preceding section by the 10 CFR 50, Appendix I, annual dose design objectives, the risk of potential premature death from cancer to the maximum individual from exposure to radioactive effluents from one year of reactor operations is less than one chance in a million (i.e., about 7×10^{-7} for exposure to gaseous effluents and about 4×10^{-7} for exposure to liquid effluents) over the average lifetime.* The risk of potential premature death from cancer to the average individual within 80 km of the reactor from exposure to radioactive effluents from the reactors is less than 1 percent of the risk to the maximum individual. The risk of potential nonfatal cancers is approximately 1.5 to 2 times the risk of death from potential fatal cancers.

For comparative purposes, the staff has estimated the risk of potential premature death from cancer to the general public from exposure to other sources of radiation in the United States (Table 4.15). These risks have been estimated using the same conservative assumptions that were used in estimating risks to workers and the general public from exposure to radiation from nuclear power plants. The risk to the maximum individual from expsoure to gaseous or liquid radioactive effluents from one year of reactor operations is much less than the risk from exposure to any of the major sources of radiation (e.g., smoking, medical exposure, and natural background radiation) and within the same range as the risk from exposure to many of the other common sources of radiation (e.g., airline travel, natural gas heating, and television viewing). Since the risk from exposure to gaseous or liquid radioactive effluents from nuclear power plants is so low compared with many other types of risk (radiation-related or otherwise), and since the radiation-related risks are based on conservative assumptions, the staff considers the risk to real individuals from exposure to radioactive effluents from normal operations at the Susquehanna Station, Units 1 and 2, to be insignificant.

Risk to U.S. Population

Multiplying the annual U.S. general public population dose from exposure to radioactive effluents and transportation of fuel and waste from the operation of SSES (i.e., 65 person-rem) by the

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*The risk of potential premature death from cancer to the maximum individual from exposure to radioiodines and particulates would be in the same range as the risk from exposure to the other types of effluents.

Table 4.15. Approximate Ranking of Risks from Various Sources of Radiation Exposure in the United States

Source of Exposure	Exposed Group	Part of Body Exposed	Average Annual Dose[a] (mrem)	Approximate Risk,[b] Chance of Premature Death in a Million
Natural radioactivity in tobacco	smokers	bronchial epithelium	8000	180
Medical diagnosis by radiopharmaceuticals	patients	bone marrow	300	40
Medical diagnosis by X-rays	adult patients	bone marrow	103	14
Natural background radiation	total population	whole body	∿80	11
Many types of radio-luminous clocks	users	whole body	∿8	1.1
Building materials	population in brick and masonry buildings	whole body	7	0.9
Commercial nuclear power plants				
Gaseous effluents	maximum individual	total body	5 (Appendix I objective)	0.7
Liquid effluents	maximum individual	total body	3 (Appendix I objective)	0.4
Atmospheric weapons tests	total population	whole body	∿4	0.5
Unvented heaters using natural gas	users	bronchial epithelium	22	0.5
Airline travel	passengers	whole body	3	0.4
Dental diagnosis	adult patients	bone marrow	3	0.4
Many types of luminous wristwatches	users	gonadal dose equivalent	3	0.4
Natural-gas cooking ranges	users	bronchial epithelium	∿7	0.2
Television receivers	viewing population	gonads	∿0.8	0.1
Commercial nuclear power plants				
Liquid and gaseous effluents	population within 80 km	total body	∿0.003	0.0004

[a]Average annual doses for all sources except commercial nuclear power plants were taken from either BEIR III[38] or NCRP.[45] The average annual dose to the maximum individual from effluents from commercial nuclear power plants is the 10 CFR 50, Appendix I, total-body annual dose design objectives. While other body organs may receive slightly higher doses (e.g., the thyroid dose is limited to 15 mrem/yr from radioiodines and particulates), the risk from the dose to other body organs will not significantly affect the approximate ranking. The average annual dose to the average individual within 80 km of a commercial nuclear power plant is derived from Table 4.8.

[b]Risk was calculated by multiplying the average annual dose (in rem) by risk estimates of 135 and 22.2 potential cancer deaths per million person-rem for total body and lung exposures, respectively. The total-body risk estimator was used to approximate the risk from the dose to the bone marrow from medical exposure. The risk of potential nonfatal cancers would be about 1.5 to 2 times the risk of potential cancer fatalities.

preceding risk estimators, the staff estimates that 0.009 cancer deaths may occur in the exposed population and 0.02 genetic disorders may occur in all future generations of the exposed population. The number of potential nonfatal cancers would be approximately 1.5 to 2 times the number of potential cancer deaths. The probability of one cancer death over the lifetimes of the U.S. general public due to exposure to radioactive effluents and transportation of fuel and waste from normal annual operation of Susquehanna Units 1 and 2 is less than one chance in 100. The probability of one genetic disorder in future generations of the U.S. general public due to exposure to radioactive effluents and transportation of fuel and waste from normal annual operation of Susquehanna Units 1 and 2 is less than 1 chance in 50. For comparative purposes, the staff has estimated the risk of potential premature death from cancer to the general public from exposure to natural background radiation. Multiplying the U.S. population dose from one year's exposure to background radiation by the preceding risk estimators, the staff estimates that about 3600 cancer deaths may occur in the exposed population and about 7000 genetic disorders may occur in the future generations of the U.S. population due to exposure to one year of background radiation. The risks to the general population from exposure to radioactive effluents and transportation of fuel and waste from each year of operation of the Susquehanna nuclear station are a very small fraction (less than 0.0003%) of the risks to the U.S. population from each year of exposure to natural background radiation.

Another way to put the risk to the general public from exposure to radioactive effluents and transportation of fuel and waste from the annual operation of SSES in perspective is to compare the preceding risks (i.e., 0.009 potential cancer deaths and 0.02 potential genetic disorders) with the risk to the year 2000 population using the current incidence of actual cancer fatalities and actual genetic disorders. Multiplying the estimated U.S. population for the year 2000 (i.e., ∿260 million persons) by the current incidence of actual cancer fatalities (i.e., ∿20%) and the current incidence of actual genetic diseases (i.e., ∿6%), about 52 million cancer deaths and about 16 million genetic abnormalities are expected.[36,46] The risk to the general public from exposure to radioactive effluents and transportation of fuel and wastes from the annual operation of Susquehanna Station, Units 1 and 2, are very small fractions (about 1 part in a billion or less) of the estimated incidence of cancer fatalities and genetic abnormalities in the year 2000 population.

On the basis of the preceding comparisons (i.e., comparing the risk from exposure to radioactive effluents and transportation of fuel and waste from the annual operation of the Susquehanna Units 1 and 2 with the risk from exposure to other sources of radiation, and the risk from the estimated incidence of cancer fatalities and genetic abnormalities in the year 2000 population), the staff concludes that the risk to the public health and safety from exposure to radioactive effluents and the transportation of fuel and wastes from normal operation of Susquehanna Station, Units 1 and 2, will not be significant.

4.5.6 The Uranium Fuel Cycle

On 14 March 1977, NRC presented in the Federal Register (42 FR 13803) an interim rule regarding the environmental considerations of the uranium fuel cycle. It revises Table S-3 (reproduced here as Table 4.16) of Paragraph (e) of 10 CFR Part 51.20. In a subsequent announcement on 14 April 1978 (43 FR 15613), the Commission further amended Table S-3 to delete the numerical entry for the estimate of radon releases and to explain that the table does not cover health effects. The effectiveness of the interim rule has been extended several times.

On 27 July 1979, the Commission approved a final rule setting out revised environmental-impact values for the uranium fuel cycle to be included in environmental reports and environmental statements for reactors (44 FR 45362). The final rule reflects the latest information relative to reprocessing of spent fuel and radioactive waste management as discussed in NUREG-0116, "Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle"[47] and NUREG-0216,[48] which presents staff responses to comments on NUREG-0116. The rule also considers other environmental factors of the uranium fuel cycle, including aspects of mining and milling, isotopic enrichment, fuel fabrication, and management of low- and high-level wastes. These are described in the Atomic Energy Commission report WASH-1248, "Environmental Survey of the Uranium Fuel Cycle".[49]

Specific categories of natural-resource use are included in Table S-3 of the final rule and are reproduced here as Table 4.16.* These categories relate to land use, water consumption, thermal effluents, radioactive releases, burial of transuranic and high- and low-level wastes, and radiation doses from transportation and occupational exposures. The contributions in Table S-3

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*A narrative explanation of Table S-3 was published on 4 March 1981, in the Federal Register (46 FR 15154-15175).

Table 4.16. (Table S-3) Summary of Environmental Considerations for the Uranium Fuel Cycle[a]

Normalized to model LWR annual fuel requirement (WASH-1248) or reference reactor year (NUREG-0116)

Natural resource use	Total	Maximum effect per annual fuel requirement or reference reactor year of model 1000-MWe LWR
Land, acres		
Temporarily committed[b]	100	
Undisturbed area	79	
Disturbed area	22	Equivalent to 110-MWe coal-fired power plant
Permanently committed	13	
Overburden moved, millions of metric tons	2.8	Equivalent to 95-MWe coal-fired power plant
Water, millions of gallons		
Discharged to air	160	Equals 2% of model 1000-MWe LWR with cooling tower
Discharged to water bodies	11,090	
Discharged to ground	127	
Total	11,377	Less than 4% of model 1000-MWe LWR with once-through cooling
Fossil fuel		
Electrical energy, thousands of megawatt hours	323	Less than 5% of model 1000-MWe LWR output
Equivalent coal, thousands of metric tons	118	Equivalent to the consumption of a 45-MWe coal-fired power plant
Natural gas, millions of standard cubic feet	135	Less than 0.3% of model 1000-MWe energy output
Effluents – chemical, metric tons		
Gases (including entrainment)[c]		
SO_x	4,400	
NO_x[d]	1,190	Equivalent to emissions from 45-MWe coal-fired power plant for a year
Hydrocarbons	14	
CO	29.6	
Particulates	1,154	
Other gases		
F^-	0.67	Principally from UF_6 production, enrichment, and reprocessing. Concentration within range of state standards – *below level that has effects on human health*
HCl	0.014	
Liquids		
SO_4^{2-}	9.9	From enrichment, fuel fabrication, and reprocessing steps. Components that constitute a potential for adverse environmental effect are present in dilute concentrations and receive additional dilution by receiving bodies *of water to levels below permissible standards. The constituents that require dilution and the flow of dilu-* tion water are:
NO_3^-	25.8	NH_3 – 600 cfs
Fluoride	12.9	NO_3 – 20 cfs
Ca^{2+}	5.4	Fluoride – 70 cfs
Cl^-	8.5	
Na^+	12.1	
NH_3	10.0	
Fe	0.4	
Tailings solutions, thousands of metric tons	240	From mills only – no significant effluents to environment
Solids	91,000	Principally from mills – no significant effluents to environment
Effluents – radiological, curies		
Gases (including entrainment)		
Rn-222	—	Presently under reconsideration by the Commission
Ra-226	0.02	
Th-230	0.02	
Uranium	0.034	
Tritium, thousands	18.1	
C-14	24	
Kr-85, thousands	400	
Ru-106	0.14	Principally from fuel reprocessing plants
I-129	1.3	
I-131	0.83	
Tc-99		Presently under consideration by the Commission
Fission products and transuranics	0.203	
Liquids		
Uranium and daughters	2.1	Principally from milling – included in tailings liquor and returned to ground – no effluents; therefore, no effect on environment
Ra-226	0.0034	From UF_6 production
Th-230	0.0015	
Th-234	0.01	From fuel fabrication plants – concentration 10% of 10 CFR Part 20 for total processing 26 annual fuel requirements for model LWR
Fission and activation products	5.9×10^{-6}	
Solids (buried on site)		
Other than high level (shallow)	11,300	9100 Ci come from low-level reactor wastes and 1500 Ci come from reactor decontamination and decommissioning – buried at land burial facilities. Mills produce 600 Ci – included in tailings returned to ground; about 60 Ci come from conversion and spent-fuel storage. No significant effluent to the environment
TRU and HLW (deep)	1.1×10^7	Buried at Federal repository
Effluents – thermal, billions of British thermal units	4,063	Less than 4% of model 1000-MWe LWR
Transportation, person-rems	2.5	
Exposure of workers and general public		
Occupational exposure, person-rems	22.6	From reprocessing and waste management

[a] In some cases where no entry appears, it is clear from the background documents that the matter was addressed and that, in effect, this table should be read as if a specific zero entry *had been made. However, there are other areas that are not addressed at al in this table. Table S-3 of WASH-1248 does not include health effects from the effluents described in this* table or estimates of releases of Radon-222 from the uranium fuel cycle. These issues which are not addressed at all by this table may be the subject of litigation in individual licensing proceedings. Data supporting this table are given in the *Environmental Survey of the Uranium Fuel Cycle,* WASH-1248, April 1974; the *Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle,* NUREG-0116 (Suppl. 1 to WASH-1248); and the *Discussion of Comments Regarding the Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle,* NUREG-0216 (Suppl. 2 to WASH-1248). The contributions from reprocessing, waste management, and transportation of wastes are maximized for either of the two fuel cycles (uranium only and no-recyle). The contribution from transportation excludes transportation of coal fuel to a reactor and of irradiated fuel and radioactive wastes from a reactor which are considered in Table S-4 of Sect. 51.20(g). The contributions from the other steps of the fuel cycle are given in columns A – E of Table S-3A of WASH-1248.

[b] The contributions to temporarily committed land from reprocessing are not prorated over 30 years, because the complete temporary impact accrues regardless of whether the plant services 1 reactor for 1 year or 57 reactors for 30 years.

[c] Estimated effluents based on combustion of equivalent coal for power generation.

[d] 1.2% from natural gas use and process.

for reprocessing, waste management, and transportation of wastes are maximized for either of the two fuel cycles (uranium only and no recycle); that is, the cycle that results in the greater impact is used.

The following assessment of the environmental impacts of the fuel cycle as related to the operation of the proposed project is based on the values given in Table S-3 and the staff's analysis of the radiological impact from radon and technetium-99 releases. For the sake of consistency, the analysis of fuel-cycle impacts has been cast in terms of a model 1000-MWe light-water-cooled reactor (LWR) operating at an annual capacity factor of 80%. In the following review and evaluation of the environmental impacts of the fuel cycle, the staff's analysis and conclusions would not be altered if the analysis were to be based on the net electrical power output of the proposed project.

4.5.6.1 Land Use

The total annual land requirement for the fuel cycle supporting a model 1000-MWe LWR is about 46 ha. About 5 ha/yr are permanently committed land and 41 ha/yr are temporarily committed.* Of the 41 ha/yr of temporarily committed land, 32 ha/yr are undisturbed and 9 ha/yr are disturbed. Considering common classes of land use in the United States,** fuel-cycle land-use requirements to support the model 1000-MWe LWR do not represent a significant impact.

4.5.6.2 Water Use

The principal water-use requirement for the fuel cycle supporting a model 1000-MWe LWR is that required for removal of waste heat from the power stations supplying electrical energy to the enrichment step of this cycle. Of the total annual requirement of 43×10^6 m^3, about 42×10^6 m^3 are required for this purpose, assuming that these plants use once-through cooling. Other water uses involve the discharge to air (e.g. evaporation losses in process cooling) of about 0.6×10^6 m^3/yr and water discharged to ground (e.g. mine drainage) of about 0.5×10^6 m^3/yr.

On a thermal-effluent basis, annual discharges from the nuclear fuel cycle are about 4% of those from the model 1000-MWe LWR using once-through cooling. The consumptive water use of 0.6×10^6 m^3/yr is about 2% of that from the model 1000-MWe LWR using cooling towers. The maximum consumptive water use (assuming that all plants supplying electrical energy to the nuclear fuel cycle use cooling towers) would be about 6% of that of the model 1000-MWe LWR using cooling towers. Under this condition, thermal effluents would be negligible. The staff finds that these combinations of thermal loadings and water consumption are acceptable relative to the water use and thermal discharges of the proposed project.

4.5.6.3 Fossil-Fuel Consumption

Electrical energy and process heat are required during various phases of the fuel-cycle process. The electrical energy is usually produced by the combustion of fossil fuel at conventional power plants. Electrical energy associated with the fuel cycle represents about 5% of the annual electrical power production of the model 1000-MWe LWR. Process heat is generated primarily by the combustion of natural gas. This gas consumption, if used to generate electricity, would be less than 0.3% of the electrical output from the model plant. The staff finds that the direct and indirect consumptions of electrical energy for fuel-cycle operations are small and acceptable relative to the net power production of the proposed project.

4.5.6.4 Chemical Effluents

The quantities of chemical, gaseous, and particulate effluents associated with fuel-cycle-processes are given in Table S-3. The principal species are sulfur oxides, nitrogen oxides, and particulates. Judging from data in a Council on Environmental Quality report,[50] the staff finds that these emissions constitute an extremely small additional atmospheric loading in comparison with those from the stationary fuel-combustion and -transportation sectors in the United States; i.e. about 0.02% of the annual national releases for each of these species. The staff believes that such small increases in releases of these pollutants are acceptable.

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*A "temporary" land commitment is a commitment for the life of the specific fuel-cycle plant; e.g. mill, enrichment plant, or succeeding plants. On abandonment or decommissioning, such land can be used for any purpose. "Permanent" commitments represent land that may not be released for use after plant shutdown and/or decommissioning.

**A coal-fired power plant of 1000-MWe capacity using strip-mined coal requires the disturbance of about 81 ha/yr for fuel alone.

Liquid chemical effluents produced in fuel-cycle processes are related to fuel-enrichment, -fabrication, and -reprocessing operations and may be released to receiving waters. These effluents are usually present in dilute concentrations such that only small amounts of dilution water are required to reach levels of concentration that are within established standards. The flow of dilution water required for specific constituents is specified in Table S-3. Additionally, all liquid discharges into the navigable waters of the United States from plants associated with the fuel-cycle operations will be subject to requirements and limitations set forth in the NPDES permit.

Tailings solutions and solids are generated during the milling process. These solutions and solids are not released in quantities sufficient to have a significant impact on the environment.

4.5.6.5 Radioactive Effluents

Radioactive effluents estimated to be released to the environment from reprocessing and waste-management activities and certain other phases of the fuel-cycle process are listed in Table S-3. Using these data, the staff has calculated the 100-year involuntary environmental dose commitment* to the U.S. population. It is estimated from these calculations that the overall involuntary total-body gaseous dose commitment to the U.S. population from the fuel cycle (excluding reactor releases and the dose commitment due to radon-222 and Tc-99) would be about 400 person-rem for each year of operation of the model 1000-MWe LWR (reference reactor year, or RRY). Based on Table S-3 values, the additional involuntary total-body dose commitment to the U.S. population from radioactive liquid effluents (excluding Tc-99) due to all fuel-cycle operations other than reactor operation would be about 100 person-rem for each year of operation. Thus, the estimated involuntary 100-year environmental dose commitment to the U.S. population from radioactive gaseous and liquid releases due to these portions of the fuel cycle is about 500 person-rem (whole body) per RRY.

At this time, the radiological impacts associated with radon-222 and Tc-99 releases are not addressed in Table S-3. Principal radon releases occur during mining and milling operations and as emissions from mill tailings, whereas principal technetium-99 releases occur from gaseous diffusion enrichment facilities. The staff has determined that radon-222 releases per RRY from these operations are as given in Table 4.17. The staff has calculated population-dose commitments for these sources of radon-222 using the RABGAD computer code described in NUREG-0002, Appendix A, Section IV.J.[37] The results of these calculations for mining and milling activities prior to reclamation of open-pit uranium mines and tailings stabilization are given in Table 4.18.

Table 4.17. Radon Releases from Mining and Milling Operations and Mill Tailings for Each Year of Operation of the Model 1000-MWe LWR

Source	Radon-222 Release
Mining[a]	4060 Ci
Milling and tailings[b] (during active milling)	780 Ci
Inactive tailings[b] (prior to stabilization)	350 Ci
Stabilized tailings[b] (for several hundred years)	1 to 10 Ci/yr
Stabilized tailings[b] (after several hundred years)	110 Ci/yr

[a]Testimony of R. Wilde from: "In the Matter of Duke Power Company (Perkins Nuclear Station)," U.S. Nuclear Regulatory Commission, Docket No. 50-488, filed April 17, 1978.

[b]Testimony of P. Magno from: "In the Matter of Duke Power Company (Perkins Nuclear Station)," U.S. Nuclear Regulatory Commission, Docket No. 50-488, filed April 17, 1978.

*The environmental dose commitment (EDC) is the integrated population dose for 100 years; i.e. it represents the sum of the annual population doses for a total of 100 years. The population dose varies with time, and it is not practical to calculate this dose for every year.

Table 4.18. Estimated 100-Year Environmental Dose Commitment for each Year of Operation of the Model 1000-MWe LWR

Source	Radon-222 Release (Ci)	Population-Dose Commitment (person-rem)		
		Total Body	Bone	Lung (bronchial epithelium)
Mining	4100	110	2800	2300
Milling and active tailings	1100	29	750	620
Total		140	3600	2900

When added to the 500 person-rem total-body dose commitment for the balance of the fuel cycle, the overall estimated total-body involuntary 100-year environmental dose commitment to the U.S. population from the fuel cycle for the model 1000-MWe LWR is about 640 person-rem. Over this period of time, this dose is equivalent to 0.00002% of the natural-background total-body dose of about three billion person-rem to the U.S. population.*

The staff has considered health effects associated with the releases of radon-222, including both the short-term effects of mining, milling, and active tailings, and the potential long-term effects from unreclaimed open-pit mines and stabilized tailings. The staff has assumed that underground mines will be sealed after completion of active mining, with the result that releases of radon-222 from them will return to background levels. For purposes of providing an upper-bound impact assessment, the staff has assumed that open-pit mines will be unreclaimed and has calculated that, if all ore were produced from open-pit mines, releases from them would be 110 Ci/yr per RRY. However, because the distribution of uranium-ore reserves available using conventional mining methods is 66.8% underground and 33.2% open-pit,[51] the staff has further assumed that uranium to fuel LWRs will be produced by conventional mining methods in these proportions. This means that long-term releases from unreclaimed open-pit mines will be 37 Ci/yr (0.332 × 110) per RRY.

Based on these assumptions, the radon released from unreclaimed open-pit mines over 100- and 1000-year periods would be about 3700 Ci and 37,000 Ci per RRY, respectively. The total dose commitments for periods of 100, 500, and 1000 years would be as shown in Table 4.19. These commitments represent a worst-case situation because no mitigating circumstances are assumed. However, it is very probable that reclamation will be required for open-pit uranium mines. If so, long-term releases from such mines should approach background levels.

Table 4.19. Population-Dose Commitments from Unreclaimed Open-Pit Mines for Each Year of Operation of the Model 1000-MWe LWR

Time Period (yr)	Radon-222 Release (Ci)	Population-Dose Commitment (person-rem)		
		Total Body	Bone	Lung (bronchial epithelium)
100	3,700	96	2,500	2,000
500	19,000	480	13,000	11,000
1,000	37,000	960	25,000	20,000

*Based on an annual average natural-background individual dose commitment of 100 mrem and a stabilized U.S. population of 300 million.

For long-term radon releases from stabilized-tailings piles the staff has assumed that the tailings would emit, per RRY, 1 Ci/yr for 100 years, 10 Ci/yr for the next 400 years, and 100 Ci/yr for periods beyond 500 years. With these assumptions, the cumulative radon-222 release per RRY from stabilized-tailings piles would be 100 Ci in 100 years, 4090 Ci in 500 years, and 53,800 Ci in 1000 years.[37] The total-body, bone, and bronchial-epithelium dose commitments for these periods are as shown in Table 4.20.

Table 4.20. Population-Dose Commitments from Stabilized-Tailings Piles for Each Year of Operation of the Model 1000-MWe LWR

Time Period (yr)	Radon-222 Release (Ci)	Population-Dose Commitment (person-rem)		
		Total Body	Bone	Lung (bronchial epithelium)
100	100	2.6	68	56
500	4,090	110	2,800	2,300
1,000	53,800	1,400	37,000	30,000

Using risk estimators of 135, 6.9, and 22.2 cancer deaths per million person-rem for total-body, bone, and lung exposures, respectively, the estimated risk of cancer mortality due to mining, milling, and active-tailings emissions of radon-222 is about 0.11 cancer fatality per RRY. When the risk due to radon-222 emissions from stabilized tailings over a 100-year release period is added, the estimated risk of cancer mortality over a 100-year period is unchanged. Similarly, a risk of about 1.2 cancer fatalities per RRY over a 1000-year release period is estimated. When potential radon releases from reclaimed and unreclaimed open-pit mines are included, the overall risks of radon-induced cancer fatalities per RRY range as follows:

0.11-0.19 fatality for a 100-year period,
0.19-0.57 fatality for a 500-year period, and
1.2 -2.0 fatalities for a 1000-year period.

To illustrate: A single model 1000-MWe LWR operating at an 80% capacity factor for 30 years would be predicted to induce between 3.3 and 5.7 cancer fatalities in 100 years, 5.7 and 17 in 500 years, and 36 and 60 in 1000 years as a result of releases of radon-222.

These doses and predicted health effects have been compared with those that can be expected from natural-background emissions of radon-222. Using data from the National Council on Radiation Protection (NCRP),[52] the average radon-222 concentration in air in the contiguous United States is about 150 pCi/m^3, which the NCRP estimates will result in an annual dose to the bronchial epithelium of 450 mrem. For a stabilized future U.S. population of 300 million, this represents a total lung-dose commitment of 135 million person-rem per year. Using the same risk estimator of 22.2 lung-cancer fatalities per million person-rem (lung) used to predict cancer fatalities for the model 1000-MWe LWR, lung-cancer fatalities alone from background radon-222 in the air can be calculated to be about 3000 per year, or 300,000 to 3,000,000 lung-cancer deaths over periods of 100 and 1000 years, respectively.

The staff is currently in the process of formulating a specific model for analyzing the potential impact and health effects from the release of technetium-99 during the fuel cycle. However, for the interim period until the model is completed, the staff has calculated that the potential population dose commitment from the release of Tc-99 should not exceed 100 person-rem per RRY. These calculations are based on the gaseous and the hydrological pathway model systems described in NUREG-002, Section IV. J., Appendix A. When added to the 640 person-rem total-body dose commitment for the balance of the fuel cycle, including Rn-222, the overall estimated total-body involuntary 100-year environmental dose commitment to the U.S. population from the fuel cycle for the model 1000-MWe LWR is about 740 person-rem. Over this period of time, this dose is equivalent to 0.00002% of the natural-background total-body dose of about three billion person-rem to the U.S. population.*

*Based on an annual average natural-background individual dose commitment of 100 mrem and a stabilized U.S. population of 300 million.

The staff also considered the potential health effects associated with this release of technetium-99. Using the modeling systems described in NUREG-002, the major risks from Tc-99 are from exposure of the GI tract and kidney, although there is a small risk from total-body exposure. Using the BEIR-I organ specific risk estimators, these individual organ risks can be converted to total-body risk equivalent doses. Then, by using the total-body risk estimator of 135 cancer deaths per million person-rem, the estimated risk of cancer mortality due to technetium-99 releases from the nuclear fuel cycle is on the order of one chance in a 100 per RRY over the subsequent 100 to 1000 years.

In addition to the radon- and technetium-related potential health effects from the fuel cycle, other nuclides produced in the cycle, such as carbon-14, will contribute to population exposures. It is estimated that an additional 0.08 to 0.12 cancer death per RRY may occur (assuming that no cure for or prevention of cancer is ever developed) over the next 100 to 1000 years, respectively, from exposures to these other nuclides.

These exposures also can be compared with those from naturally-occurring terrestrial and cosmic-ray sources, which average about 100 mrem. Therefore, for a stable future population of 300 million persons, the whole-body dose commitment would be about 30 million person-rem per year, or three billion person-rem and 30 billion person-rem for periods of 100 and 1000 years, respectively. These dose commitments could produce about 400,000 and 4,000,000 cancer deaths during the same time periods. From the preceding analysis, the staff concludes that both the dose commitments and health effects of the uranium fuel cycle are insignificant when compared with dose commitments and potential health effects to the U.S. population resulting from all natural-background sources.

4.5.6.6 Radioactive Wastes

The quantities of buried radioactive waste material (low-level, high-level, and transuranic wastes) are specified in Table S-3. For low-level waste disposal at land-burial facilities, the Commission notes in Table S-3 that there will be no significant radioactive releases to the environment. For high-level and transuranic wastes, the Commission notes that these are to be buried at a federal repository, and that no release to the environment is associated with such disposal. It is indicated in NUREG-0116,[47] in which are provided background and context for the high-level and transuranic Table S-3 values established by the Commission, that these high-level and transuranic wastes will be buried and will not be released to the biosphere. No radiological environmental impact is expected from such disposal.

4.5.6.7 Occupational Dose

The annual occupational dose attributable to all phases of the fuel cycle for the model 1000-MWe LWR is about 200 person-rem. The staff concludes that this occupational dose will not have a significant environmental impact.

4.5.6.8 Transportation

The transportation dose to workers and the public is specified in Table S-3. This dose is small and is not considered significant in comparison with the natural-background dose.

4.5.6.9 Fuel Cycle

The staff analysis of the uranium fuel cycle does not depend on the selected fuel cycle (no recycle or uranium-only recycle), because the data provided in Table S-3 include maximum recycle-option impact for each element of the fuel cycle. Thus, the staff's conclusions as to acceptability of the environmental impacts of the fuel cycle are not affected by the specific fuel cycle selected.

4.6 SOCIOECONOMIC IMPACTS

The following is an assessment of the potential socioeconomic impacts of the Susquehanna plant's operation on local communities in Luzerne and Columbia counties. Direct and indirect changes to the sociocultural subsystems of local communities are primarily the result of the effects of the operational workforce, the presence in a rural area of a large generating plant with transmission corridors, and the functioning of PP&L public educational and recreational facilities.

4.6.1 Demography

The total operational workforce will comprise 358 individuals of which 170 have already been employed (ER-OL, Socioeconomic Question 1). In November 1978 the applicant submitted a questionnaire to these 170 workers; varying numbers of individuals (122 to 157) responded to demographic, settlement pattern, and occupational questions (ER-OL, Question SOC No. 1). This information is summarized in Table 4.21; these responses were used to project trends that may be expected for the entire workforce. About 80% of the sample were in-migrants, with a bi-modal tendency in family size centering on two and four persons, respectively; the mean household size was 2.93. If this survey is representative of trends for the entire workforce, the total operational workforce, including family, will be about 1050 individuals; 839 of them will be in-migrants.

Table 4.21. Current and Projected Profile for the Operational Workforce

Operational Workforce 1978[a] Currently Employed--170			Projected Operational Workforce Total Expected Employment--358	
Number of Survey Respondents (125)			Workforce Projections (358)	
Family Size	Operational Workers	% of Respondents	% Projected for Total Employees	Projected Family Size for Total Workforce
1 person	23	18.4	66	66
2 persons	33	26.4	95	190
3 persons	19	15.2	54	162
4 persons	35	28.0	100	400
5 persons	11	8.8	32	160
More than 5 persons	4	3.2	11	72[b]
Total	125		358	1050
Average Family Size = 2.93				

Number of Survey Respondents (156)			Residency Projections	
Residency Status	Operational Workers	% of Respondents	Residency Status	Projected Residency Status
In-migrants	124	79.5	In-migrants	285
Local residents	32	20.5	Local residents	73
Total	156		Total	358

Number of Survey Respondents (122)			Household Type Projections (358)	
Residence Type	Operational Workers	% of Respondents	Residence Types	Projected Number of Households
Single-family home	86	70.5	Single-family home	252
Apartment	30	24.6	Apartment	88
Mobile home/duplex	6	4.9	Mobile home/duplex	18
Total	122		Total	358

[a]Data in this column was derived from the applicant's November 1978 questionnaire survey of the part of the operational workforce currently employed.

[b]Estimated.

In addition, the population may also increase due to the in-migration of service workers, although it is difficult to reliably assess the number of people and associated family members that may be generated by the needs of the operational workforce. The applicant used the HUD Base-to-Service Multiplier, which requires 243 secondary service workers for an operational workforce of 358 individuals (ER-OL, Socioeconomic Question 3) to arrive at its projection. Approximately 80% of the secondary workers are expected to be in-migrants. Assuming that there would be 194 secondary in-migrants (ca. 80%) and that they would have the same average family size (2.93) as the operational workforce, another 570 individuals could move into the area. However, due to the high local unemployment, this projected estimate of in-migrants may be too large for this particular area.

The average household size of the operational workforce is comparable to patterns identified for the local residents. The principal age group of the in-migrants is estimated to be between 20 and 50 years.[53,54] In-migrants in the lower end of this age group may help to counter some of the strong out-migration trends that have been experienced in both Luzerne and Columbia counties (see Sec. 2.2.2.2).

4.6.2 Settlement Pattern

4.6.2.1 Housing

Based on housing type and locational preference identified in the applicant's survey, the staff has projected a general model for housing needs and county settlement pattern trends for the entire workforce (see Table 4.21). This projection assumes: 1) no difference in housing preference and family size between in-migrants and local residents and 2) that each of the 358 operational workers is the head of a separate household. Approximately 839 in-migrants, representing 286 families with an average size of 2.93 people per family, will require 201 single-family homes, 70 apartments, and 14 duplexes or mobile homes. An estimated 57% of the in-migrants will settle in Columbia County while 43% will elect to live in Luzerne County. All respondents prefer living in a rural/small town setting (ER-OL, Socioeconomic Question 1). In addition, another 570 service workers and their families could move into the area; this is probably a maximal estimate (information on housing preference was not available for this group).

Although it is expected that the majority of in-migrants will relocate in Columbia County, locational data were not specific enough to predict the exact neighborhoods or rural areas likely to experience housing demands from in-migrant operational workers and in-migrant households. However, it is possible that some areas in the two-county region could experience significant demand for housing.

4.6.2.2 Industry

The staff's experience indicates that there are no instances of rapid industrialization in vicinities of nuclear power plant areas because of the power plants.

4.6.2.3 Recreation

The applicant is developing a 148-ha public recreational and educational facility on the floodplain below the plant (ER-OL, Sec. 2.1 and 3.1.6). This facility is designed to minimize disruption of the natural environment, maintain prime land in agricultural reserves, and improve the wildlife habitat (ER-OL, Sec. 3.1.6). Outdoor recreational facilities will include a small lake, restoration of the North Branch Canal and Towpath, family and group picnic areas, and a hiking trail system (ER-OL, Sec. 3.1.6). Table 4.22 lists the kinds of recreational areas that are planned and specific details on the estimated annual visitor use (projected to be 800 people per day). An Energy Information Center will also be available for visitor orientation and indoor public programs (ER-OL, Sec. 3.1.6). Once the recreational area is completed, PP&L will supply a permanent staff, as well as scheduling and maintenance programs, during the plant's operation (ER-OL, Question No. 10).

The use of the floodplain for recreation and tourism, preservation of open space, and restoration of the historic canal are compatible with the recreational goals of Luzerne County and the recreational areas projected for this area (see Sec. 2.2.3.3). The applicant's facility will provide almost half of the projected recreational area needed for the Wilkes-Barre area county and community parks by the year 2000. The construction and maintenance of this facility by PP&L will benefit the local area because it will contribute to projected county land-use needs and local demands for more facilities, particularly small parks and open space, without drawing upon county, township, or borough funds (see Sec. 2.2.3.3).

Table 4.22. Estimated Annual Visitor Use for Planned Recreational Areas[a]

Area	Daily Capacity			
	Cars	People/Car	Turnover	People/Day
Two-family picnic areas	100 (50 ea)	3.5	1.5	525
Group picnic area	30	4.5	1	135
Boating and fishing	30	2.5	1.5	75[b] (113)[c]
Nature preserves	20	3	1	60
				795[b] (833)[c]

Annual Capacity

Daily capacity - 800 × capacity days/yr - 50 = 40,000[b] (42,000)[c]/year.

[a]Data derived from ER-OL, Response to Socioeconomic Question 5.

[b]Applicant's estimate.

[c]Staff estimate.

4.6.3 Social Organization

4.6.3.1 Direct Impacts

Impacts to the social organization of the two-county area are a result of the effects of in-migrant operational and service workers on the social structure of local communities and neighborhoods; these may affect the lives of local residents as well as the workforce and their families. Direct social impacts will probably be minimal since the settlement pattern of the in-migrants is likely to be dispersed. Many of the current in-migrants appear to have been accepted into local communities[54,55] and this may be the case for the operational workforce as well. Moreover, it has been suggested by Policy Research Associates that rural industrialization either has little effect on social participation rates or has actually resulted in increased participation.[56] Social-participation rates are usually correlated with social integration and stability in an area.[56] Thus severe social stress is not expected to affect local or in-migrant families.

4.6.3.2 Indirect Impacts

The in-migration of new residents and the siting of a new industrial facility contribute to changing a rural area and associated lifestyles. Desired additional changes should be planned to ensure that new growth will not destroy the specific features that originally attracted residents.[57]

4.6.4 Social Services

Impacts to social services will result from: 1) increased demands from the in-migrant workforce, service workers, and families (see Sec. 4.6.2) and from 2) municipal services that are traditionally supported by voluntary funds and that will be used by PP&L for the local homes that have been purchased and that will be maintained in the Bell Bend area.

4.6.4.1 Education and Hospitals

Based on available data (see Sec. 2.2.4.2), the in-migrant population is not expected to stress current and projected educational and hospital facilities because current facilities are operating below their capacities.

4.6.4.2 Sewage and Water

Household water requirements are approximately 190-265 L/person per day.[58] Sewage-treatment needs for septic and public facilities are estimated to be comparable. Service limitations, new expansions, and improvements are planned in both counties (see Sec. 2.2.4.2), although the applicant's monitoring study did not identify construction-related "service" stresses in 1976.[54] Unless site- or neighborhood-specific sewage/water problems already exist, a dispersed in-migrant population is expected to have little impact on these service categories.

4.6.4.3 Police and Fire Protection

In the northeastern part of the state, police and fire protection personnel per 1000 population are 3.31 and 1.92, respectively.[59] Given these ratios, approximately 4 to 6 police and 2 to 3 fire personnel would be needed regionally for the estimated 1409 new in-migrants if regional maintenance service standards are to be consistent with other northeastern cities and municipalities. Specific communities or service districts receiving concentrations of in-migrants might experience stresses on personnel.

Use of police and fire services for the applicant's purchased residential properties will place a burden on such services.

4.6.5 Political Organization

Operational impacts to the political organization of local municipalities, boroughs, townships, and counties will involve decision making and financing on two basic issues. One involves the meeting of service needs if the in-migrant population settles in areas where select services are at or near capacity. The second concerns future land-use alternatives and the best planning decisions for the siting of new housing developments and industry. The latter issue may be of particular importance in Salem Township (see Sec. 4.6.3.1).

4.6.6 Economic Impacts

The economic impacts will consist of the jobs, expenditures, and taxes generated by the plant. There will also be impacts on land and housing prices. These impacts will occur both locally, in Luzerne and Columbia counties, and outside the impact region. For example, taxes paid by public utilities are paid directly to the State of Pennsylvania and then disbursed by a formula designed to account for fiscal effects in communities throughout the state. Jobs and expenditures will also be generated outside the region to the extent that jobs are taken by in-migrants (rather than local residents) and to the extent that infrequent, specialized, and larger expenditures are incurred in Scranton or elsewhere.

4.6.6.1 Employment and Income Impacts

As noted in Table 4.21, approximately 80% of the operational workforce hired by November 1978 were in-migrants rather than local workers. Typical "mid-range" salaries for Union Local 1600 indicate that relative to the economic base industries examined in Sec. 2, the Susquehanna plant is a desirable employer with respect to wage level (ER-OL, Socioeconomic questions). A further benefit to the local area is the skills and training received. The fact that more local residents are not hired has been a concern in the local community.[54] Given the "low wage" composition of the Luzerne and Columbia counties employment base, the local residents' concern has a definite link to perceived opportunities to improve the economic climate of the local area.

Because the Berwick-Bloomsburg area in Columbia County is not within the geographic boundaries of many union hiring halls, the non-resident/resident ratio may be considered unfavorable to the local area during the construction period. The objective of increasing the local share of job opportunities is potentially of even greater local concern during the operation period. The jobs offered are likely to be permanent and desirable relative to other opportunities in the area. More local hires would also help to reduce the pressure on housing demand.

During the construction period, Bechtel, the contractor, offered a training program. As of June 1976, forty-six of the fifty-two people who went through the program were local residents.[54]

Although the definition of "local area" varies, it cannot be expected that jobs will be confined to communities receiving the impacts. Many migrants may be expected to move to Columbia County communities and find housing in reasonable proximity to the site because their communities offer more attributes of rural living than do the Luzerne communities. In contrast, the more populous Luzerne County is apt to be a better labor market for "local hires" and it is expected many of these residents would not move their present homes in order to be a few kilometers closer to the site. For this reason, the perception that PP&L is not hiring locally may persist even if the statistics indicate reasonable success at local recruitment.

The income-wage distribution from the construction period indicates that approximately 70% of the wages (1973-1982; projected)[54] are being paid to residents of Luzerne and Columbia counties. Locally-spent income will be largely retained in those counties although Lackawanna County may benefit to some extent.

4.6.6.2 Taxes

Taxes paid by PP&L to the state and then distributed to local communities indicate that Luzerne County can expect to receive about $55,000 per year and Columbia County about $10,000 (ER-OL, Socioeconomic questions). The total state tax bill for the two Susquehanna units will be about $5.5 million. The small proportion of the total taxes that will be distributed locally is attributable to the State of Pennsylvania tax law regarding utilities; this law helps to equalize tax benefits and burdens around the state.

While it may be argued, based on Sections 2 and 4, that Columbia County has received a greater relative share of the impacts due to the nuclear units compared to the tax benefits, the Pennsylvania law allows some tax relief to Columbia County. Not all the tax benefits would go to Luzerne County, as would be the case in most states; the Pennsylvania Public Realty tax law allows for distribution of funds throughout state. For example, Luzerne's 1977 share of the public utility realty tax from all sources was $519,974, while Columbia's was $93,180 (ER-OL Socioeconomic questions). No additional state funds are available to Columbia and Luzerne counties, but homes purchased by PP&L in Bell Bend remain part of the locally taxable portion of the site. In 1978, PP&L paid $1,480.95 in local property taxes in Luzerne and $4,309.60 for Berwick area schools in Columbia County. These property and school taxes are in addition to those paid directly to the state.

4.6.7 Summary and Conclusions

The staff concludes that operational impacts in the two-county region will be minimal if the in-migrants are dispersed throughout this area. The applicant's recreational and educational facilities will be of direct benefit to the needs of the local communities. However, specific problems could occur if the in-migrant operational and service workforce and families concentrate in communities or rural areas that are currently experiencing a tight housing market and stresses in water and sewage services.

At the regional level, additional police and fire personnel may be needed if the area population grows. Moreover, some individuals, families, and communities may experience dissatisfaction with changes that could affect the rural appearance of their surroundings and associated life-styles. Planning and managing any associated changes in the land use of the area will be a concern of the local communities (see Sec. 4.2).

The staff considers continued applicant efforts to locally recruit operation workforce personnel as a valuable benefit to the communities for reasons presented in Sections 2 and 4. The two nuclear units represent valuable employment and training opportunities in the area (particularly relative to existing industries); local hires will also help to mitigate the demand for housing. The applicant should work with local and state agencies to recruit and train local personnel for jobs required for the plant's operation.

4.7 IMPACTS TO CULTURAL RESOURCES

Direct impacts of the plant's operation on cultural resource sites are expected to be minimal if known prehistoric sites are protected by a well-designed mitigation/avoidance program, and if care is exercised to recognize and protect cultural resources discovered during operational activities involving disruption of topsoil or vegetation.

The staff and the State Historic Preservation Office are currently reviewing the floodplain survey. Upon consultation with the State Historic Preservation Office, the staff will seek a determination of eligibility of those sites deemed significant and will instruct the applicant to provide protection to those sites.

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5. ENVIRONMENTAL MONITORING

5.1 RÉSUMÉ

The applicant's preoperational and operational monitoring programs have been evaluated. The preoperational monitoring programs are discussed in Section 5.2 and include meteorology, water quality studies, groundwater monitoring, terrestrial and aquatic ecological studies, and background radiological monitoring. The operational monitoring programs are discussed in Section 5.3. The operational meteorological, radiological, and other monitoring programs will be extensions of the preoperational programs. Limited operational water quality and effluent monitoring will be performed in conjunction with biological monitoring and NPDES permit requirements.

5.2 PREOPERATIONAL MONITORING PROGRAMS

5.2.1 Onsite Meteorological Program

In November 1972, a 91.5-m tower was installed about 340 m southeast of the nearest station structure. Wind speed and direction are measured at the 9.6-m and the 91.5-m levels. Ambient temperature and dewpoint readings are made at the 9.6-m level. Temperature differences are measured between 30.5 and 9.6 m and between 91.5 and 9.6 m; these measurements are used to estimate atmospheric stability. Precipitation is recorded near the base of the tower. In 1973, recovery frequency of the joint temperature gradient and wind data measured at the 9.6-m level was only 70%. More than half of the winter season's and about half of the summer months' joint wind speed, wind direction, and vertical temperature gradient were missing. During 1974 and 1975, an unusually high frequency of unstable atmospheric conditions were recorded in comparison with data representative of long-term conditions collected at other sites in the area. Data for the calendar year 1976 appeared to be reasonable with good data recovery (94%). In addition, 23-m and 3-m poles were installed in the site vicinity to study local flow patterns; data were collected for several years before decommissioning in 1974 and 1975, respectively.[1]

5.2.2 Water Quality Monitoring

As stipulated in the NPDES (permit number PA0027448) issued for the construction phase for SSES, Pennsylvania Power & Light Company has monitored the Susquehanna River for flow rates, total suspended solids, BOD-5, fecal coliforms, and pH. These measurements and others made by the applicant and by its consultant (Ichthyological Associates) are summarized in Sec. 2.3.4.1.

5.2.3 Groundwater Monitoring

The quality of the groundwater in 14 wells was monitored for 29 different parameters. Measurements made during 1977 are summarized in Sec. 2.3.4.2.

5.2.4 Aquatic Biology

The preoperational aquatic monitoring program was not presented in the FES-CP; however, since 1971 the applicant has conducted several environmental monitoring programs in the vicinity of SSES to collect baseline data. Aquatic parameters that have been monitored include: physical/chemical parameters, phytoplankton, periphyton, aquatic vascular plants, zooplankton, macroinvertebrates, larval fish, and fishes. Results of these monitoring programs are summarized in Sec. 2.5.2 of this report. Detailed discussions of the programs can be found in the applicant's ER-OL and the various annual reports. The applicant's consultant, Ichthyological Associates, Inc., also published many papers that resulted from the preoperational studies conducted in the vicinity of SSES in professional journals; these are listed as References 2-32.

5.2.5 Terrestrial Monitoring Programs

The preoperational terrestrial monitoring efforts were outlined in the FES-CP (Appendix B) issued in 1973. The results of the various surveys or studies of the terrestrial biota in the vicinity of the Susquehanna Station that were subsequently reported include the following. Transect and community studies of the local vegetation were conducted in 1973-1974 (ER-OL, Sec. 2.2.2.1) and in 1977.[33] Mammal surveys, including trapping studies, were completed during the 1972-1974 period (ER-OL, Sec. 2.2.2.4). Migratory and resident waterfowl populations occurring in segments of the Susquehanna River adjacent to the station were censused in 1971-1973 (ER-OL, Sec. 2.2.1.9) and 1977;[33] upland bird studies were conducted in 1973-1974 (ER-OL, Sec. 2.2.2.3) and 1977.[33] Locally occurring reptiles and amphibians were collected or observed in 1972-1973 surveys. Additionally, a survey of bird impingements on the meteorological tower and the nearly completed cooling tower at the Susquehanna Station was conducted during the 1978 fall migration period; this survey will be "resumed for the spring migration" (ER-OL, Supp., Response to Q.TER-1.1).

Ambient sound pressure levels at various offsite locations surrounding the station were surveyed from 1972 through a portion of 1974, prior to initiation of station construction activities (ER-OL, Sec. 2.7). Results of these surveys will serve to establish incremental noise due to station operation.

The staff considers that the preoperational monitoring efforts completed or planned by the applicant will provide an adequate information base for detecting and evaluating station operational impacts on terrestrial environments.

5.2.6 Radiological Monitoring

Radiological environmental monitoring programs are established to provide data on measurable levels of radiation and radioactive materials in the site environs. Appendix I to 10 CFR Part 50 requires that the relationship between quantities of radioactive material released in effluents during normal operation, including anticipated operational occurrences, and resultant radioactive doses to individuals from principal pathways of exposure be evaluated. Monitoring programs are conducted to verify the effectiveness of in-plant controls used for reducing the release of radioactive materials and to reassure the public that undetected radioactivity will not build up in the environment. A surveillance program is established to identify changes in the use of unrestricted areas to provide a basis for modifications of the monitoring programs.

The preoperational phase of the monitoring program provides for the measurement of background levels and their variations along the anticipated important pathways in the area surrounding the plant; the training of personnel; and the evaluation of procedures, equipment, and techniques.

This is discussed in greater detail in NRC Regulatory Guide 4.1, Rev. 1, "Programs for Monitoring Radioactivity in the Environs of Nuclear Power Plants," and the Radiological Assessment Branch's Technical Position, Rev. 1, November 1979, "An Acceptable Radiological Environmental Monitoring Program."

The applicant has proposed a radiological environmental monitoring program to meet the objectives discussed in the Branch Technical Position, Rev. 1, November 1979. The applicant's proposed preoperational radiological environmental monitoring program is presented in Section 6.1.5 and Appendix F of the applicant's Environmental Report and summarized here in Table 5.1.

The applicant has initiated parts of the program prior to the operations of the facility, with the remaining portions beginning either six months or one year prior to operation. The staff concludes that the preoperational monitoring program proposed by the applicant is generally acceptable provided that a few changes are made (e.g. the number of direct radiation measurement stations should be increased) to conform with Revision 1 of the Branch Technical Position.

5.3 OPERATIONAL MONITORING

5.3.1 Onsite Meteorological Program

The onsite meteorological measurements program will continue in operation during the lifetime of the Susquehanna Nuclear Generating Station.

5.3.2 Water Quality Monitoring

The applicant has applied for an NPDES permit for plant operation from the State of Pennsylvania (see Appendix F). The quality of effluents discharged to the Susquehanna River shall meet the requirements stipulated by the NPDES permit. The NPDES permit will also stipulate the frequency and type of water quality monitoring to be conducted. The NPDES permit will require monitoring at all discharge points for any effluent which has the potential for exceeding federal or state regulations.

Table 5.1. SSES Radiological Environmental Monitoring Program[a]

Sample Type	Location	Collection Frequency[b]	Analysis	Analytical Frequency[b]	Lower Limit of Detection[c]	Units
Air Particulates						
SS-AP-5S3	North of I.A.					
SS-AP-11A1	SW corner of site					
SS-AP-9B1	Near transmission field	W	Gross beta	W	0.01	pCi/m^3
SS-AP-12E1	Berwick Hospital		Gamma emitters	QC	0.01	pCi/m^3
SS-AI-7H1	PP&L roof					
Air Iodine						
SS-AI-5S3	North of I.A.					
SS-AI-11A1	SW corner of site					
SS-AI-9B1	Near transmission field	W	I-131	W	0.07	pCi/m^3
SS-AI-12E1	Berwick Hospital					
SS-AI-7H1	PP&L roof					
Surface Water						
SS-SW-1D2	At I.A.	M	Gamma emitters	M	15	pCi/L
SS-SW-12F1	Berwick Bridge		H-3	Q	2,000	pCi/L
Drinking Water						
SS-PWT-12F2	Berwick Water Co.					
	(treated)	M	Gross beta	M	4	pCi/L
SS-PWT-12H2	Danville Water Co.		Gamma emitters	M	10	pCi/L
	(treated)		H-3	QC	1,000	pCi/L
Fish[d]						
SS-AQF-IN1	Outfall	SA	Gamma emitters	SA	130	pCi/kg (wet)
SS-AQF-2G1	Upstream					
Sediment						
SS-AQS-11C1	Hess Is. area	SA	Gamma emitters	SA	150	pCi/kg (dry)
Milk						
SS-M-10C1	Farm					
SS-M-12B1	Schultz Farm	2/M[e]	I-131	2/M[e]	1	pCi/L
SS-M-12B2	Young Farm		Gamma emitters	2/M[e]	15	pCi/L
SS-9G1	Crystal Spring Dairy					
Food Products						
SS-FP-5B1	Farm	A	Gamma emitters	A	130	pCi/kg (wet)
Direct Radiation						
SS-ID-3S1	Susquehanna River					
SS-ID-4S1	Susquehanna River					
SS-ID-5S1	North of I.A.					
SS-ID-7S1	On 230-kV tower	Q	Gamma dose	Q	--	mrem/std. mo.
SS-ID-11S1	On 230-kV tower					
SS-ID-9B1	Near transmission field					
SS-ID-12E1	Berwick Hospital					
SS-ID-7H1	PP&L roof					

[a]From enclosure to letter from N.W. Curtis, PP&L, to D.E. Sells, NRC, 10 September 1979.

[b]Frequency Codes: W = weekly; M = monthly; Q = quarterly; SA = semiannually; A = annually; 2/M = twice each month; C = composite.

[c]LLDs per Draft Radiological Effluent Technical Specifications (BWR), NUREG 0473, October 1978.

[d]Important classes of fish will be analyzed separately (bottom feeders and game fish).

[e]Milk collected and analyzed semimonthly from April through October, monthly during other months.

5.3.3 Groundwater Monitoring

The applicant has not suggested a plan for groundwater monitoring during operation of the plant. The staff has reviewed groundwater monitoring and found it to be accpetable (NUREG 0776, Sec. 2.4.7).

5.3.4 Aquatic Biological Monitoring

Thermal characteristics of the cooling water discharge, pH, biocide concentrations and other chemicals that may affect water quality are to be monitored as stated in the applicant's ER-OL. Monitoring for these data will be defined in the applicant's operational NPDES permit. Monitoring requirements will be defined in the applicant's NPDES permit. Because Pennsylvania is an agreement state, the Pennsylvania Department of Environmental Resources has the authority to issue the NPDES permit.

With respect to impingement and entrainment studies, DER has accepted the applicant's predictive impingement study and will not require monitoring of fish impingement at this time. However, Special Condition C of the NPDES permit will require monitoring for entrainment of fish eggs and larvae (see Appendix G).[34,35]

Impingement/entrainment studies can be required by EPA and/or the agreement states as often as every five years, if conditions warrant. For example, if American shad are reintroduced into the Susquehanna River, the applicant may be required to re-evaluate the operational impacts associated with the SSES intake.

The applicant also proposes to monitor algae and benthic macroinvertebrates both above the intake and below the discharge.

5.3.5 Terrestrial Monitoring Program

The applicant is committed to conducting studies designed to evaluate station operational impacts on terrestrial biota (ER-OL, Supp., Response to Q.TER-4.1). The monitoring period will extend for at least two years after Station Unit 2 is in operation (ER-CP, Sec. 5.5.5.2). In view of the general nature of the applicant's monitoring, the staff has identified specific areas of concern.

The staff requires that general monitoring for bird impingement on cooling towers be continued.

Based on projections by the applicant, noise levels attributable to station operation will exceed the EPA recommended limit of 55 dBA (day-night equivalent sound level) at offsite locations to the southwest of the station (Sec. 4.4.1.1). The projected levels are based on calculations involving various assumptions (ER-OL, Sec. 2.7), and are therefore cause for an unknown degree of uncertainty. Accordingly, the staff requires that the applicant monitor operational noise levels in the above mentioned area as well as at other locations where relatively high noise levels can be anticipated. The sound surveys should be conducted during the first year of on-line operation for each of the two reactor units.

The applicant will be required to maintain records of transmission line management. The records shall include observations made during inspection surveys as well as details concerning all management actions undertaken. Of particular import, all pertinent information, i.e., kinds, amounts, concentrations, application methods, etc., relevant to chemicals used in right-of-way management shall be specified. Likewise, inspection surveys and remedial actions to ensure the efficacy of erosion control measures shall be documented. Brief summary reports of inspections and management actions shall be submitted as a part of routine environmental operating reports (ER-OL, Appendix F).

5.3.6 Radiological Monitoring

The operational offsite radiological monitoring program is conducted to measure radiation levels and radioactivity in the plant environs. It assists and provides backup support to the effluent monitoring program as recommended in NRC Regulatory Guide 1.21, "Measuring, Evaluating and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water Cooled Nuclear Power Plants." The effluent monitoring program is required to evaluate individual and population exposures and verify projected or anticipated radioactivity concentrations.

The applicant plans essentially to continue the proposed preoperational program during the operating period. However, refinements may be made in the program to reflect changes in land use or preoperational monitoring experience.

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6. ENVIRONMENTAL IMPACT OF POSTULATED ACCIDENTS

6.1 PLANT ACCIDENTS

The staff has considered the potential radiological impacts on the environment of possible accidents at the Susquehanna Steam Electric Station Units 1 and 2 in accordance with a Statement of Interim Policy published by the Nuclear Regulatory Commission on June 13, 1980.(1) The following discussion reflects these considerations and conclusions.

The first section deals with general characteristics of nuclear power plant accidents including a brief summary of safety measures to minimize the probability of their occurrence and to mitigate their consequences if they should occur. Also described are the important properties of radioactive materials and the pathways by which they could be transported to become environmental hazards. Potential adverse health effects and impacts on society associated with actions to avoid such health effects are also identified.

Next, actual experience with nuclear power plant accidents and their observed health effects and other societal impacts are then described. This is followed by a summary review of safety features of the Susquehanna Units 1 and 2 facilities and of the site that act to mitigate the consequences of accidents.

The results of calculations of the potential consequences of accidents that have been postulated in the design basis are then given. Also described are the results of calculations for the Susquehanna site using probabilistic methods to estimate the possible impacts and the risks associated with severe accident sequences of exceedingly low probability of occurrence.

6.1.1 General Characteristics of Accidents

The term accident, as used in this section, refers to any unintentional event not addressed in Section 4.5 that results in a release of radioactive materials into the environment. The predominant focus, therefore, is on events that can lead to releases substantially in excess of permissible limits for normal operation. Such limits are specified in the Commission's regulations at 10 CFR Part 20 and 10 CFR Part 50, Appendix I.

There are several features which combine to reduce the risk associated with accidents at nuclear power plants. Safety features in the design, construction, and operation comprising the first line of defense are to a very large extent devoted to the prevention of the release of these radioactive materials from their normal places of confinement within the plant. There are also a number of additional lines of defenses that are designed to mitigate the consequences of failures in the first line. Descriptions of these features for the Susquehanna Units 1 and 2 plant may be found in the applicant's Final Safety Analysis Report,(2) and in the staff's Safety Evaluation Report.(3) The most important mitigative features are described in Section 6.1.3.1 below.

These safety features are designed taking into consideration the specific locations of radioactive materials within the plant, their amounts, their nuclear, physical, and chemical properties, and their relative tendency to be transported into and for creating biological hazards in the environment.

6.1.1.1 Fission Product Characteristics

By far the largest inventory of radioactive material in a nuclear power plant is produced as a byproduct of the fission process and is located in the uranium oxide fuel pellets in the the reactor core in the form of fission products. During periodic refueling shutdowns, the assemblies containing these fuel pellets are transferred to a spent fuel storage pool so that the second largest inventory of radioactive material is located in this storage area. Much smaller inventories of radioactive materials are also normally present in the water that circulates in the reactor coolant system and in the systems used to process gaseous and liquid radioactive wastes in the plant.

These radioactive materials exist in a variety of physical and chemical forms. Their potential for dispersion into the environment is dependent not only on mechanical forces that might physically transport them, but also upon their inherent properties, particularly their volatility. The majority of these materials exist as nonvolatile solids over a wide range of temperatures. Some, however, are relatively volatile solids and a few are gaseous in nature. These characteristics have a significant bearing upon the assessment of the environmental radiological impact of accidents.

The gaseous materials include radioactive forms of the chemcially inert noble gases krypton and xenon. These have the highest potential for release into the atmosphere. If a reactor accident were to occur involving degradation of the fuel cladding, the release of substantial quantities of these radioactive gases from the fuel is a virtual certainty. Such accidents are very low frequency but credible events (cf Section 6.1.2). It is for this reason that the safety analysis of each nuclear power plant analyzes a hypothetical design basis accident that postulates the release of the entire contained inventory of radioactive noble gases from the fuel into the containment system. If further released to the environment as a possible result of failure of safety features, the hazard to individuals from these noble gases would arise predominantly through the external gamma radiation from the airborne plume. The reactor containment system is designed to minimize this type of release.

Radioactive forms of iodine are formed in substantial quantities in the fuel by the fission process and in some chemical forms may be quite volatile. For these reasons, they have traditionally been regarded as having a relatively high potential for release from the fuel. If released to the environment, the principal radiological hazard associated with the radioiodines is ingestion into the human body and subsequent concentration in the thyroid gland. Because of this, its potential for release to the atmosphere is reduced by the use of special systems designed to retain the iodine.

The chemical forms in which the fission product radioiodines are found are generally solid materials at room temperature, however, so that they have a strong tendency to condense (or "plate out") upon cooler surfaces. In addition, most of the iodine compounds are quite soluble in, or chemically reactive with, water. Although these properties do not inhibit the release of radioiodines from degraded fuel, they do act to mitigate the release from containment systems that have large internal surface areas and that contain large quantities of water as a result of an accident. The same properties affect the behavior of radioiodines that may "escape" into the atmosphere. Thus, if rainfall occurs during a release, or if there is moisture on exposed surfaces, e.g., dew, the radioiodines will show a strong tendency to be absorbed by the moisture.

Other radioactive materials formed during the operation of a nuclear power plant have lower volatilities and therefore, by comparison with the noble gases and iodine, a much smaller tendency to escape from degraded fuel unless the temperature of the fuel becomes very high. By the same token, such materials, if they escape by volatilization from the fuel, tend to condense quite rapidly to solid form again when transported to a lower temperature region and/or dissolve in water when present. The former mechanism can have the result of producing some solid particles of sufficiently small size to be carried some distance by a moving stream of gas or air. If such particulate materials are dispersed into the atmosphere as a result of failure of the containment barrier, they will tend to be carried downwind and deposit on surface features by gravitational settling or by precipitation (fallout), where they will become "contamination" hazards in the environment.

All of these radioactive materials exhibit the property of radioactive decay with characteristic half-lives ranging from fractions of a second to many days or years (see Table 6.1.4-3). Many of them decay through a sequence or chain of decay processes and all eventually become stable (nonradioactive) materials. The radiation emitted during these decay processes is the reason that they are hazardous materials.

6.1.1.2 Exposure Pathways

The radiation exposure (hazard) to individuals is determined by their proximity to the radioactive material, the duration of exposure, and factors that act to shield the individual from the radiation. Pathways for the transport of radiation and radioactive materials that lead to radiation exposure hazards to humans are generally the same for accidental as for "normal" releases. These are depicted in Section 4, Figure 4.1. There are two additional possible pathways that could be significant for accident releases that are not shown in Figure 4.1. One of these is the fallout onto open bodies of water of radioactivity initially carried in the air. The second would be unique to an accident that results in temperatures inside the reactor core sufficiently high to cause melting and subsequent penetration of the basemat underlying the reactor by the molten core debris. This creates the potential for the release of radioactive material into the hydrosphere through contact with ground water. These pathways may lead to external exposure to radiation, and to internal exposures if radioactivity is inhaled, or ingested from contaminated food or water.

It is characteristic of these pathways that during the transport of radioactive material by wind or by water, the material tends to spread and disperse, like a plume of smoke from a smokestack, becoming less concentrated in larger volumes of air or water. The result of these natural processes is to lessen the intensity of exposure to individuals downwind or downstream of the point of release, but they also tend to increase the number who may be exposed. For a release into the atmosphere, the degree to which dispersion reduces the concentration in the plume at any downwind point is governed by the turbulence characteristics of the atmosphere which vary considerably with time and from place to place. This fact, taken in conjunction with the variability of wind direction and the presence or absence of precipitation, means that consequences of accidental releases to the atmosphere would be very much dependent upon the weather conditions existing at the time.

6.1.1.3 Health Effects

The cause and effect relationships between radiation exposure and adverse health effects are quite complex[4a] but they have been more exhaustively studied than any other environmental contaminant.

Whole-body radiation exposure resulting in a dose greater than about 10 rem for a few persons and about 25 rem for nearly all people over a short period of time (hours) is necessary before any physiological effects to an individual are clinically detectable. Doses about ten to twenty times larger, also received over a relatively short period of time (hours to a few days), can be expected to cause some fatal injuries. At the severe, but extremely low probability end of the accident spectrum, exposures of these magnitudes are theoretically possible for persons in the close proximity of such accidents if measures are not or cannot be taken to provide protection, e.g., by sheltering or evacuation.

Lower levels of exposures may also constitute a health risk, but the ability to define a direct cause and effect relationship between any given health effect and a known exposure to radiation is difficult given the backdrop of the many other possible reasons why a particular effect is observed in a specific individual. For this reason, it is necessary to assess such effects on a statistical basis. Such effects include randomly occurring cancer in the exposed population and genetic changes in future generations after exposure of a prospective parent. Cancer in the exposed population may begin to develop only after a lapse of 2 to 15 years (latent period) from the time of exposure and then continue over a period of about 30 years (plateau period). However, in the case of exposure of fetuses (in utero), cancer may begin to develop at birth (no latent period) and end at age 10 (i.e., the plateau period is 10 years). The health consequences model currently being used is based on the 1972 BEIR Report of the National Academy of Sciences.[5]

Most authorities are in agreement that a reasonable and probably conservative estimate of the randomly occurring number of health effects of low levels of radiation exposure to a large number of people is within the range of about 10 to 500 potential cancer deaths per million person-rem (although zero is not excluded by the data). The range comes from the latest NAS BEIR III Report[6] (1980) which also indicates a probable value of about 150. This value is virtually identical to the value of about 140 used in the current NRC health effects models. In addition, approximately 220 randomly occurring genetic changes per million person-rem would be projected by BEIR III over succeeding generations. That also compares well with the value of about 260 per million person-rem currently used by the NRC staff.

6.1.1.4 Health Effects Avoidance

Radiation hazards in the environment tend to disappear by the natural process of radioactive decay. Where the decay process is a slow one, however, and where the material becomes relatively fixed in its location as an environmental contaminant (e.g., in soil), the hazard can continue to exist for a relatively long period of time--months, years, or even decades. Thus, a possible consequential environmental societal impact of severe accidents is the avoidance of the health hazard rather than the health hazard itself, by restrictions on the use of the contaminated property or contaminated foodstuffs, milk, and drinking water. The potential economic impacts that this can cause are discussed below.

6.1.2 Accident Experience and Observed Impacts

The evidence of accident frequency and impacts in the past is a useful indicator of future probabilities and impacts. As of mid-1980, there were 69 commercial nuclear power reactor units licensed for operation in the United States at 48 sites with power generating capacities ranging from 50 to 1130 megawatts electric (MWe). (The Susquehanna Units 1 and 2 are designed for 1135 MWe each.) The combined experience with these units represents approximately 500 reactor years of operation over an elapsed time of about 20 years. Accidents have occurred at several of these facilities.[7] Some of these have resulted in releases of radioactive material to the environment, ranging from very small fractions of a curie to a few million curies. None is known to have caused any radiation injury or fatality to any member of the public, nor any significant individual or collective public radiation exposure, nor any significant contamination of the environment. This experience base is not large enough to permit a reliable quantitative statistical inference. It does, however, suggest that significant environmental impacts due to accidents are very unlikely to occur over time periods of a few decades.

Melting or severe degradation of reactor fuel has occurred in only one of these units, during the accident at Three Mile Island - Unit 2 (TMI-2) on March 28, 1979. In addition to the release of a few million curies of xenon-133, it has been estimated that approximately 15 curies of radioiodine was also released to the environment at TMI-2.[8] This amount represents an extremely minute fraction of the total radioiodine inventory present in the reactor at the time of the accident. No other radioactive fission products were released in measurable quantity.

It has been estimated that the maximum cumulative offsite radiation dose to an individual was less than 100 millirem.[8,9] The total population exposure has been estimated to be in the range from about 1000 to 3000 person-rem. This exposure could produce between none and one additional fatal cancer over the lifetime of the exposed population. The same population receives each year from natural background radiation about 240,000 person-rem and approximately a half-million cancers are expected to develop in this group over its lifetime,[8,9] primarily from causes other than radiation. Trace quantities (barely above the limit of detectability) of radioiodine were found in a few samples of milk produced in the area. No other food or water supplies were impacted.

Accidents at nuclear power plants have also caused occupational injuries and a few fatalities but none attributed to radiation exposure. Individual worker exposures have ranged up to about 4 rems as a direct consequence of accidents, but the collective worker exposure levels (person-rem) due to accidents are a small fraction of the exposures experienced during normal routine operations that average about 500 person-rem per reactor year.

Accidents have also occurred at other nuclear reactor facilities in the United States and in other countries.[7] Due to inherent differences in design, construction, operation, and purpose of most of these other facilities, their accident record has only indirect relevance to current nuclear power plants. Melting of reactor fuel occurred in at least seven of these accidents, including the one in 1966 at the Enrico Fermi Atomic Power Plant Unit 1. This was a sodium-cooled fast breeder demonstration reactor designed to generate 61 MWe. The damages were repaired and the reactor reached full power in four years following the accident. It operated successfully and completed its mission in 1973. This accident did not release any radioactivity to the environment.

A reactor accident in 1957 at Windscale, England released a significant quantity of radioiodine, approximately 20,000 curies, to the environment. This reactor, which was not operated to generate electricity, used air rather than water to cool the uranium fuel. During a special operation to heat the large amount of graphite in this reactor, the fuel overheated and radioiodine and noble gases were released directly to the atmosphere from a 405-foot stack. Milk produced in a 200-square mile area around the facility was impounded for up to 44 days. This kind of accident cannot occur in a water-cooled reactor like Susquehanna, however.

6.1.3 Mitigation of Accident Consequences

Pursuant to the Atomic Energy Act of 1954, the Nuclear Regulatory Commission has conducted a safety evaluation of the application to operate Susquehanna Units 1 and 2. Although this evaluation contains more detailed information on plant design, the principal design features are presented in the following section.

6.1.3.1 Design Features

Susquehanna Units 1 and 2 are essentially identical units. Each contains features designed to prevent accidental release of radioactive fission products from the fuel and to lessen the consequences should such a release occur. Many of the design and operating specifications of these features are derived from the analysis of postulated events known as design basis accidents. These accident preventive and mitigative features are collectively referred to as engineered safety features (ESF).

The containment system, one such ESF, is a passive mitigating system designed to minimize accidental radioactivity releases to the environment. The containment system is composed of two parts. The primary containment encloses the reactor vessel, the reactor coolant recirculation loops, and other reactor coolant system components. The secondary containment (also known as the reactor building) encloses the primary containment, the spent fuel pool, and other auxiliary equipment.

An emergency core cooling system (ECCS) is designed to provide cooling water to the reactor core during an accident to prevent or minimize fuel damage. A pressure suppression system is installed to prevent containment failure due to overpressure following an accident.

The Standby Gas Treatment System (SGTS) is designed to establish and maintain a negative pressure in the secondary containment following the signal for its isolation in the event of release of radioactivity to this building in an accident. Negative pressure, with respect to the outside atmosphere, would prevent out-leakage of radioactivity from this building to the environment except along the release path controlled by the SGTS. Radioactive iodine and particulate fission products would be substantially removed from the flow stream by safety-grade activated charcoal and high-efficiency particulate air filters.

The main steam isolation valve leakage control system is designed to control the release of fission products through the main steam isolation valves. This system directs the leakage through these valves to the area served by the SGTS. The spent fuel storage pool is located in the secondary containment where potential radioactive leakage from the stored fuel can be directed through the SGTS.

The mechanical systems mentioned above are supplied with emergency power from onsite diesel generators in the event that normal offsite station power is interrupted.

Much more extensive discussions of the safety features and characteristics of Susquehanna Units 1 and 2 may be found in the applicant's Final Safety Analysis Report.(2) The staff evaluation of these features are addressed in the Safety Evaluation Report.(3) In addition, the implementation of the lessons learned from the TMI-2 accident, in the form of improvements in design and procedures, and operator training, will significantly reduce the likelihood of a degraded core accident which could result in large releases of fission products to the containment. Specifically, the applicant will be required to meet those TMI-related requirements specified in NUREG-0737. As noted in Section 6.1.4.7, no credit has been taken for these actions and improvements in discussing the radiological risk of accidents.

6.1.3.2 Site Features

In the process of considering the suitability of the site of Susquehanna Units 1 and 2, pursuant to NRC's Reactor site criteria in 10 CFR Part 100, consideration was given to certain factors that tend to minimize the risk and the potential impact of accidents. First, the site has an exclusion area as provided in 10 CFR Part 100. The exclusion area of the 1,075-acre site has a minimum exclusion distance of 1800 feet from the common release point to the closest site boundary. The applicant owns the exclusion area including mineral rights and, therefore, has complete authority to determine all activities within that area, as required by Part 100. The only area within the exclusion area in which activities unrelated to plant operation will occur is Township Route T-419. This road serves several local residences and does not carry through traffic. It is approximately 1600 feet from the center of the exclusion area. The applicant has made arrangements with Salem Township Supervisors and with the Pennsylvania State Police for control of traffic on Township Route T-419 in the event of an emergency.

Second, beyond and surrounding the exclusion area is a low population zone (LPZ), also required by 10 CFR Part 100. This is a circular area with a radius of three miles. Within this zone the applicant must assure that there is a reasonable probability that appropriate and effective measures could be taken on behalf of the residents and other members of the public in the event of a serious accident. In case of a radiological emergency, the applicants have made arrangements with agencies of the state and local governments to control all traffic on the railroad and roadways near the nuclear plant.

Third, Part 100 also requires that the nearest population center of about 25,000 or more persons be no closer than one and one-third times the outer radius of the LPZ. The purpose of this criterion is a recognition that since accidents of greater potential hazards than those commonly postulated as representing an upper limit are conceivable, although highly improbable, it was considered desirable to add the population center distance requirement to provide for protection against excessive exposure doses to people in large centers.

The population within the three mile low population zone is about 2423. The nearest population center is Hazelton, Pennsylvania (population of 30,246), located about 15 miles southeast. This distance is at least 1-1/3 times the low population zone distance, as required by Part 100. The Wilkes-Barre/Scranton corridor with a total population of 388,700 is located from 10 to 40 miles northeast of the site.

The transient population within the low population zone is low. No schools, hospitals, state or municipal parks are located within the LPZ. Industrial activities within the LPZ include the Luzerne Outerwear Company, employing 486 persons, CAR-MAR, employing 70 persons, and two sand and gravel processing facilities. No explosives are used or stored at the latter two facilities.

The safety evaluation of the Susquehanna site has also included a review of potential external hazards, i.e., activities offsite that might adversely affect the operation of the plant and cause an accident. This review encompassed nearby industrial, transportation, and military facilities that might create explosive, missile, toxic gas, or similar hazards. The staff has concluded that the hazards from nearby industrial, military, mining, pipelines, air transportation, waterways, and railways are negligibly small. The staff has recently learned of an industrual park near the site and has requested additional information from the applicant. The results will be reported in the staff's Safety Evaluation Report, as amended. A more detailed discussion of the site features is included in the Safety Evaluation Report.

6.1.3.3 Emergency Preparedness

Emergency preparedness plans including protective action measures for the Susquehanna facility and environs are in an advanced, but not yet fully completed stage. In accordance with the provisions of 10 CFR Section 50.47, effective November 3, 1980, no operating license will be issued to the applicant unless a finding is made by the NRC that the state of onsite and offsite emergency preparedness provides reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency. Among the standards that must be met by these plans are provisions for two Emergency Planning Zones (EPZ). A plume exposure pathway EPZ of about 10 miles in radius and an ingestion exposure pathway EPZ of about 50 miles in radius are required. Other standards include appropriate ranges of protective actions for each of these zones, provisions for dissemination to the public of basic emergency planning information, provisions for rapid notification of the public during a serious reactor emergency, and methods, systems, and equipment for assessing and monitoring actual or potential offsite consequences in the EPZs of a radiological emergency condition.

NRC findings will be based upon a review of the Federal Emergency Management Agency (FEMA) findings and determinations as to whether State and local government emergency plans are adequate and capable of being implemented, and on the NRC assessment as to whether the applicant's onsite plans are adequate and capable of being implemented. Although the presence of adequate and tested emergency plans cannot prevent the occurrence of an accident, it is the judgment of the staff that their implementation can and will substantially mitigate the consequences to the public if an accident should occur.

6.1.4 Accident Risk and Impact Assessment

6.1.4.1 Design Basis Accidents

As a means of assuring that certain features of the Susquehanna Units 1 and 2 plants meet acceptable design and performance criteria, both the applicant and the staff have analyzed the potential consequences of a number of postulated accidents. Some of these could lead to significant releases of radioactive materials to the environment, and calculations have been performed to estimate the potential radiological consequences to persons offsite. For each postulated initiating event, the potential radiological consequences cover a considerable range of values depending upon the particular course taken by the accident and the conditions, including wind direction and weather, prevalent during the accident.

In the safety analysis and evaluation of the Susquehanna Units 1 and 2 plants, three categories of accidents have been considered by the applicant and the staff. These categories are based upon their probability of occurrence and include (a) incidents of moderate frequency, i.e., events that can reasonably be expected to occur during any year of operation, (b) infrequent accidents, i.e., events that might occur once during the lifetime of the plant, and (c) limiting faults, i.e., accidents not expected to occur but that have the potential for significant releases of radioactivity. The radiological consequences of incidents in the first category, also called anticipated operational occurrences, are discussed in Section 4. Some of the initiating events postulated in the second and third categories for the Susquehanna Units 1 and 2 are shown in Table 6.1.4-1. These events are designated design basis accidents in that specific design and operating features as described above in Section 6.1.3.1 are provided to limit their potential radiological consequences. Approximate radiation doses that might be received by a person at the nearest site boundary (1800 feet from the plant) are also shown in the table, along with a characterization of the time duration of the releases. The results shown in the table reflect the expectation that engineered safety and operating features designed to mitigate the consequences of the postulated accidents would function as intended.

An important implication of this expectation is that the radioactive releases considered are limited to noble gases and radioiodines and that any other radioactive materials e.g., in particulate form, are not expected to be released. The results are also quasi-probabilistic in nature in the sense that the meteorological dispersion conditions are taken to be neither the best nor the worst for the site, but rather at an average value determined by actual site measurements. In order to contrast the results of these calculations with those using more pessimistic, or conservative, assumptions described below, the doses shown in Table 6.1.4-1 are sometimes referred to as "realistic" doses.

Calculated population exposures for these events range from a small fraction of a person-rem to about 37 person-rem for the population within 50 miles of the Susquehanna Steam Electric Station. These calculations for both individual and population exposures indicate that the risk of incurring any adverse health effects as a consequence of design basis accidents is exceedingly small. By comparison with the estimates of radiological impact for normal operations shown in Chapter 4, we also conclude that radiation exposures from design basis accidents are roughly comparable to the exposures to individuals and the population from normal station operations over the expected lifetime of the plant.

The staff has also carried out calculations to estimate the potential upper bounds for individual exposures from the same initiating accidents in Table 6.1.4-1 for the purpose of implementing the provisions of 10 CFR Part 100, "Reactor Site Criteria." For these calculations, much more pessimistic (conservative or worst case) assumptions are made as to the course taken by the accident and the prevailing conditions. These assumptions include much larger amounts of radioactive material released by the initiating events, additional single failures in equipment, operation of ESF's in a degraded mode,* and very poor meteorological dispersion conditions. The results of these calculations show that, for these events, the limiting whole-body exposures are not expected to exceed 1 rem to any individual at the site boundary. They also show that radioiodine releases have the potential for offsite exposures ranging up to about 150 rem to the thyroid. For such an exposure to occur, an individual would have to be located at a point on the site boundary where the radioiodine concentration in the plume has its highest value and inhale at a breathing rate characteristic of a person jogging, for a period of two hours. The health risk to an individual receiving such a thyroid exposure is the potential appearance of benign or malignant thyroid nodules in about 5 out of 100 cases, and the development of a fatal cancer in about 2 out of 1000 cases.

*The containment system, however, is assumed to prevent leakage in excess of that which can be demonstrated by testing, as provided in 10 CFR Part 100.11(a).

None of the calculations of the impacts of design basis accidents described in this section take into consideration possible reductions in individual or population exposures as a result of taking any protective actions.

6.1.4.2 Probabilistic Assessment of Severe Accidents

In this and the following three sections, there is a discussion of the probabilities and consequences of accidents of greater severity than the design basis accidents identified in the previous section. As a class, they are considered less likely to occur, but their consequences could be more severe, both for the plant itself and for the environment. These severe accidents, heretofore frequently called Class 9 accidents, can be distinguished from design basis accidents in two primary respects: they involve substantial physical deterioration of the fuel in the reactor core, including overheating to the point of melting, and they involve deterioration of the capability of the containment system to perform its intended function of limiting the release of radioactive materials to the environment.

The assessment methodology employed is that described in the Reactor Safety Study (RSS) which was published in 1975.(10)* However, the sets of accident sequences that were found in the RSS to be the dominant contributors to the risk in the prototype BWR (Peach Bottom Unit 2) have recently been updated(11) ("rebaselined"). The rebaselining has been done largely to incorporate peer group comments(12), and better data and analytical techniques resulting from research and development after the publication of the RSS. Entailed in the rebaselining effort was the evaluation of the individual dominant accident sequences as they are understood to evolve. The earlier technique of grouping a number of accident sequences into the encompassing Release Categories as was done in the RSS has been largely eliminated.

The Susquehanna Units 1 and 2 are General Electric designed BWRs having similar design and operating characteristics to the RSS prototype BWR. Therefore, the present assessment for Susquehanna has used as its starting point the rebaselined accident sequences and sequence groups referred to above, and more fully described in Appendix J. Characteristics of the sequences (and sequence groups) used (all of which involve partial to complete melting of the reactor core) are shown in Table 6.1.4-2. Sequences initiated by natural phenomena such as tornadoes, floods, or seismic events and those that could be initiated by deliberate acts of sabotage are not included in these event sequences. The radiological consequences of such events would not be different in kind from those which have been treated. Moreover, it is the staff's judgment, based upon design requirements of 10 CFR Part 50, Appendix A, relating to effects of natural phenomena, and safeguards requirements of 10 CFR Part 73, that these events do not contribute significantly to risk.

Calculated probability per reactor year associated with each accident sequence (or sequence group) used is shown in the second column in Table 6.1.4-2. As in the RSS there are substantial uncertainties in these probabilities. This is due, in part, to difficulties associated with the quantification of human

*Because this report has been the subject of considerable controversy, a discussion of the uncertainties surrounding it is provided in Section 6.1.4.7.

error and to inadequacies in the data base on failure rates of individual plant components that were used to calculate the probabilities.[12] (See Section 6.1.4.7 below.) The probability of accident sequences from the Peach Bottom plant were used to give a perspective of the societal risk at Susquehanna Units 1 and 2 because, although the probabilities of particular accident sequences may be substantially different or even improved for Susquehanna, the overall effect of all sequences taken together is likely to be within the uncertainties (see Section 6.1.4.7 for discussion of uncertainties in risk estimates).

The magnitudes (curies) of radioactivity releases for each accident sequence or sequence group are obtained by multiplying the release fractions shown in Table 6.1.4-2 by the amounts that would be present in the core at the time of the hypothetical accident. These are shown in Table 6.1.4-3 for a Susquehanna plant at the core thermal power level of 3440 megawatts.

The potential radiological consequences of these releases have been calculated by the consequence model used in the RSS[13] and adapted to apply to a specific site. The essential elements are shown in schematic form in Figure 6.1.4-1. Environmental parameters specific to the Susquehanna site have been used and include the following:

(1) Meteorological data for the site representing a full year of consecutive hourly measurements and seasonal variations.

(2) Projected population for the year 2000 extending throughout regions of 50 and 350 miles radius from the site (the latter region includes parts of Canada).

(3) The habitable land fraction within the 350-mile radius, and

(4) Land use statistics, on a state-wide basis, including farm land values, farm product values including dairy production, and growing season information, for the State of Pennsylvania and each surrounding State within the 350-mile region.

(5) Land use statistics including farm land values, farm product values including dairy production, and growing season information for the adjoining regions of Canada, within 350 miles, based on comparison with the values for the nearby states of the U.S.

To obtain a probability distribution of consequences, the calculations are performed assuming the occurrence of each accident release sequence at each of 91 different "start" times throughout a one-year period. Each calculation utilizes the site-specific hourly meteorological data and seasonal information for the time period following each "start" time. The consequence model also contains provisions for incorporating the consequence reduction benefits of evacuation and other protective actions. Early evacuation of people would considerably reduce the exposure from the radioactive cloud and the contaminated ground in the wake of the cloud passage. The evacuation model used (see Appendix K) has been revised from that used in the RSS for better site-specific application. The quantitative characteristics of the evacuation model used for the Susquehanna site are best estimate values made by the staff and based upon preliminary evacuation time estimates prepared by the applicant. Actual evacuation effectiveness could be greater or less than that characterized but would not be expected to be very much less.

The other protective actions include: (a) either complete denial of use (interdiction), or permitting use only at a sufficiently later time after appropriate decontamination of food stuffs such as crops and milk, (b) decontamination of severely contaminated environment (land and property) when it is considered to be economically feasible to lower the levels of contamination to protective action guide (PAG) levels, and (c) denial of use (interdiction) of severely contaminated land and property for varying periods of time until the contamination levels reduce to such values by radioactive decay and weathering so that land and property can be economically decontaminated as in (b) above. These actions would reduce the radiological exposure to the people from immediate and/or subsequent use of or living in the contaminated environment.

Early evacuation within the plume exposure pathway EPZ and other protective actions as mentioned above are considered as essential sequels to serious nuclear reactor accidents involving significant release of radioactivity to the atmosphere. Therefore, the results shown for the Susquehanna reactors include the benefits of these protective actions.

There are also uncertainties in the estimates of consequences, and the error bounds may be as large as they are for the accident probabilities. It is the judgment of the staff, however, that it is more likely that the calculated results are overestimates of consequences rather than underestimates.

The results of the calculations using this consequence model are radiological doses to individuals and to populations, health effects that might result from these exposures, costs of implementing protective actions, and costs associated with property damage by radioactive contamination.

6.1.4.3 Dose and Health Impacts of Atmospheric Releases

The results of the calculations of dose and health impacts performed for the Susquehanna facility and site are presented in the form of probability distributions in Figures 6.1.4-2 through 5 and are included in the impact Summary Table 6.1.4-4. All of the six accident sequences and sequence groups shown in Table 6.1.4-2 contribute to the results, the consequences from each being weighted by its associated probability.

Figure 6.1.4-2 shows the probability distribution for the number of persons who might receive whole-body doses equal to or greater than 200 rem and 25 rem, and thyroid doses equal to or greater than 300 rem from early exposure,* all on a per-reactor-year basis. The 200-rem whole-body dose figure corresponds approximately to a threshold value for which hospitalization would be indicated for the treatment of radiation injury. The 25-rem whole-body (which has been identified earlier as the lower limit for a clinically observable physiological effect in nearly all people) and 300-rem thyroid figures correspond to the Commission's guideline values for reactor siting in 10 CFR Part 100.

*Early exposure to an individual includes external doses from the radioactive cloud and the contaminated ground, and the dose from internally deposited radionuclides from inhalation of contaminated air during the cloud passage. Other pathways of exposure are excluded.

The figure shows in the left-hand portion that there is less than two chances in 100,000 per year (i.e., 2×10^{-5}) that one or more persons may receive doses equal to or greater than any of the doses specified. The fact that each of the three curves approaches a horizontal line shows that if one person were to receive such doses the chances are about the same that several tens to hundreds would be so exposed. The chances of larger numbers of persons being exposed at these levels are seen to be considerably smaller. For example, the chances are less than 2 in 10,000,000 (2×10^{-7}) that 10,000 or more people might receive whole body doses of 200 rem or greater. A majority of the exposures reflected in this figure would be expected to occur to persons within a 20-mile radius of the plant. Virtually all would occur within a 100-mile radius.

Figure 6.1.4-3 shows the probability distribution for the total population exposure in person-rem, i.e., the probability per year that the total population exposure will equal or exceed the values given. Most of the population exposure up to 10 million person-rem would occur within 50 miles, but the more severe accident sequences or sequence groups such as the first three in Table 6.1.4-2 would result in exposure to persons beyond the 50-mile range as shown.

For perspective, population doses shown in Figure 6.1.4-3 may be compared with the annual average dose to the population within 50 miles of the Susquehanna site due to natural background radiation of 160,000 person-rem, and to the anticipated annual population dose to the general public from normal station operation of about 65 person-rem (excluding plant workers)--see Section 4.

Figure 6.1.4-4 shows the probability distributions for acute fatalities, representing radiation injuries that would produce fatalities within about one year after exposure. All of the acute fatalities would be expected to occur within a 20-mile radius and the majority within a 15-mile radius. The results of the calculations shown in this figure and in Table 6.1.4-4 reflect the effect of evacuation within the 10-mile plume exposure pathway EPZ only. For the very low probability accidents having the potential for causing radiation exposures above the threshold for acute fatality at distances beyond 10 miles, it would be realistic to expect that authorities would evacuate persons at all distances at which such exposures might occur. Acute fatality consequences would therefore reasonably be expected to be very much less than the numbers shown. (Figure K-1 of Appendix K illustrates the potential benefits of evacuation within 15 miles. Calculations predict zero acute fatality for evacuation within 20 miles.)

Figure 6.1.4-5 represents the statistical relationship between population exposure and the induction of fatal cancers that might appear over a period of many years following exposure. The impacts on the total population and the population within 50 miles are shown separately. Further, the fatal, latent cancers have been subdivided into those attributable to exposures of the thyroid and all other organs.

6.1.4.4 Economic and Societal Impacts

As noted in Section 6.1.1, various measures for avoidance of adverse health effects including those due to residual radioactive contamination in the environment are possible consequential impacts of severe accidents. Calculations of the probabilities and magnitudes of such impacts for the Susquehanna facility and environs have also been made. Unlike the radiation exposure and adverse health effect impacts discussed above, impacts associated with adverse health effects avoidance are more readily transformed into economic impacts.

The results are shown as the probability distribution for costs of offsite mitigating actions in Figure 6.1.4-6 and are included in the impact Summary Table 6.1.4-4. The factors contributing to these estimated costs include the following:

- Evacuation costs
- Value of crops contaminated and condemned
- Value of milk contaminated and condemned
- Costs of decontamination of property where practical
- Indirect costs due to loss of use of property and incomes derived therefrom.

The last named costs would derive from the necessity for interdiction to prevent the use of property until it is either free of contamination or can be economically decontaminated.

Figure 6.1.4-6 shows that at the extreme end of the accident spectrum these costs could exceed ten billion dollars but that the probability that this would occur is exceedingly small, less than one chance in ten million per reactor-year.

Additional economic impacts that can be monetized include costs of decontamination of the facility itself and the costs of replacement power. Probability distributions for these impacts have not been calculated, but they are included in the discussion of risk considerations in Section 6.1.4.6 below.

6.1.4.5 Releases to Groundwater

As identified in Section 6.1.1.2, accidental releases of radioactivity to ground water could provide a pathway for public radiation exposure and environmental contamination. Consideration has been given to the potential environmental impact of this pathway for the Susquehanna plant. The principal contributors to the risk are the core melt accidents. The penetration of the basemat of the containment building can release molten core debris to the strata beneath the plant. Soluble radionuclides in this debris can be leached and transported with groundwater to downgradient domestic wells used for drinking or to surface water bodies used for drinking water, aquatic food and recreation.

An analysis of the potential consequences of a liquid pathway release of radioactivity for generic sites was presented in the "Liquid Pathway Generic Study" (LPGS).[14] The LPGS compared the risk of accidents involving the liquid pathway (drinking water, irrigation, aquatic food, swimming and shoreline usage) for four conventional, generic land-based nuclear plants and a floating nuclear plant, for which the nuclear reactors would be mounted on a barge and moored in a water body. Parameters for the land-based sites were chosen to represent averages for a wide range of real sites and are thus "typical," but represented no real site in particular.

The discussion in this section is an analysis to determine whether or not the Susquehanna site liquid pathway consequences would be unique when compared to land-based sites considered in the LPGS. The method consists of a direct scaling of the LPGS population doses based on the relative values of key parameters characterizing the LPGS "river" site and the Susquehanna site. The parameters which were evaluated included amounts of radioactive materials entering the ground, groundwater travel time, sorption on geological media, surface water transport, aquatic food consumption, and shoreline usage.

Doses to individuals and populations were calculated in the LPGS without consideration of interdiction methods such as isolating the contaminated groundwater or denying use of the water. In the event of surface water contamination, commercial and sports fishing, as well as many other water-related activities would be restricted. The consequences would therefore be largely economic or social, rather than radiological. In any event, the individual and population doses for the liquid pathway range from fractions to very small fractions of those that can arise from the airborne pathways.

The Susquehanna reactors are founded on a Devonian shale, the Mahantango Formation, that is overlain by Pleistocene sand and gravel deposits. Groundwater flow is primarily in the upper, fractured portion of the bedrock and in the overburden. The water table is above the basemat of the reactors. The groundwater gradient is generally east toward the Susquehanna River, although it is locally controlled by the thickness and permeability of the overburden.

There are 2 potential groundwater pathways from the reactor buildings to the river. Groundwater contour maps drawn by the applicant show a gradient to a bedrock valley north of the plant area. From there the gradient is directly to the river. There is also a bedrock valley south of the plant area and the potential exists for the groundwater gradient to be towards this valley, especially from the unit 2 reactor. The groundwater gradient within this valley is also towards the river. The pathways, via the two valleys, are discussed separately in the following paragraphs.

There are no offsite wells that could be affected by contaminated ground water between the plant and the river via the northern bedrock valley pathway.

The staff conservatively estimated the travel time in the groundwater to the river to be 9.2 years. For travel times that long, the only potentially significant contributers to population dose are Sr-90 and Cs-137. Values of retardation factors, which reflect the effects of sorption of the radionuclides within the aquifer, were conservatively estimated to be 35 for Sr-90 and 500 for Cs-137 in the overburden and 1 for both nuclides in the fractured bedrock.(15) The mean transport time from the reactor buildings to the Susquehanna River is conservatively estimated to be 264 years for Sr-90 and 3750 years for Cs-137. When compared to the 5.7 years for Sr-90 and 51 years for Cs-137 in the LPGS land-based river case, the longer travel times for the Susquehanna site would allow a larger proportion of the original radionuclide to decay in the aquifer and a relatively smaller percentage of radioactivity to enter the river. This reduction in radioactivity entering the river is about a factor of 375 for Sr-90 compared to the LPGS value. Virtually all of the Cs-137 will have decayed before reaching the Susquehanna River.

The population dose calculated for the LPGS study was based upon a hypothetical surface drinking water population of 620,000 people, an annual fish harvest of 1.2×10^6 Kg, and recreational usage. Neither the drinking water population nor the annual fish harvest downstream of the Susquehanna site is a factor of 375 times as great as the LPGS values. Additionally, the LPGS recreational usage population dose results almost exclusively from Cs-137, a nuclide that would have virtually disappeared, through radioactive decay, before contaminated groundwater could reach the Susquehanna River. We therefore conclude that the contribution to population dose from the northern bedrock valley pathway is smaller than that predicted for the LPGS river site.

The groundwater transport characteristics for the southern bedrock valley pathway would be similar to that of the northern bedrock valley pathway. The conclusions with respect to population dose attributable to surface water usage would thus also be similar, i.e., the population dose would be less than that estimated for the LPGS river site.

There are, however, 17 wells and 2 springs between the plant and the Susquehanna River near the postulated southern groundwater pathway. These wells and springs currently serve less than 200 people including about 100 daily customers at a restaurant. The closest well is about 600 meters southeast of the plant. In the event of a core melt accident and a groundwater pathway along the southern bedrock valley, concentrations of at least some nuclides could be in excess of 10 CFR 20, Appendix B limits. Wells and springs would thus have to be abandoned. However, since the groundwater travel time to the nearest well is estimated to be 3.2 years, there would be ample time to establish a groundwater monitoring program and to arrange for alternative water supplies.

Finally, there are measures which could be taken to minimize the impact of the liquid pathway. The staff estimated the minimum groundwater travel time from the plant to the closest well to be in excess of 3 years. The travel time to the Susquehanna River was estimated to be 9.2 years, with many radionuclides having a much longer travel time. There is, therefore, ample time for engineering measures, such as slurry walls and well-point dewatering, to be completed and thus isolate the radioactive contaminants near the plant.

6.1.4.6 Risk Considerations

The foregoing discussions have dealt with both the frequency (or likelihood of occurrence) of accidents and their impacts (or consequences). Since the ranges of both factors are quite broad, it is useful to combine them to obtain average measures of environmental risk. Such averages can be particularly instructive as an aid to the comparison of radiological risks associated with accident releases and with normal operational releases.

A common way in which this combination of factors is used to estimate risk is to multiply the probabilities by the consequences. The resultant risk is then expressed as a number of consequences expected per unit of time. Such a quantification of risk does not at all mean that there is universal agreement that people's attitudes about risk, or what constitutes an acceptable risk, can or should be governed solely by such a measure. At best, it can be a contributing factor to a risk judgment, but not necessarily a decisive factor.

In Table 6.1.4-5 are shown average values of risk associated with population dose, acute fatalities, latent fatalities, and costs for early evacuation and other protective actions. These average values are obtained by summing the probabilities multiplied by the consequences over the entire range of the distributions. Since the probabilities are on a per-reactor-year basis, the averages shown are also on a per-reactor-year basis.

The population exposure risk due to accidents may be compared with that for normal operations. These are shown in Section 4, for Susquehanna Units 1 and 2 operating concurrently. The radiological dose to the population from normal operation of each unit may result in about 33 person-rem per year which may result in about 0.005 latent cancer in the exposed population. The comparison of 0.005 latent cancer death for normal operation with about 0.023 latent cancer death from Table 6.1.4-5 shows that the accident risks are comparable to those for normal operation.

There are no acute fatality nor economic risks associated with protective actions and decontamination for normal releases; therefore, these risks are unique for accidents. For perspective and understanding of the meaning of the acute fatality risk of about 0.0008 per year, however, we note that to a good approximation the population at risk is that within about 10 miles of the plant, about 61,000 persons in the year 2000. Accidental fatalities per year for a population of this size, based upon overall averages for the United States, are approximately 13 for motor vehicle accidents, 5 from falls, 2 from drowning, 3 from burns, and 1 from firearms.[4b]

Figure 6.1.4-7 shows the calculated risk expressed as whole-body dose to an individual from early exposure as a function of the distance from the plant within the plume exposure pathway EPZ. The values are on a per-reactor-year basis and all accident sequences and sequence groups in Table 6.1.4-2 contributed to the dose, weighted by their associated probabilities.

Evacuation and other protective actions reduce the risks to an individual of acute and latent cancer fatalities. Calculations show that the best estimate evacuation can reduce the risk of acute fatality to an individual to near zero within the 10-mile radius plume exposure pathway EPZ. Figure 6.1.4-8 shows curves of constant risks per reactor-year to an individual living within the plume exposure pathway EPZ of the Susquehanna plant of death from latent cancer as functions of distance due to potential accidents in the reactors. Directional variation of these curves reflect the variation in the average fraction of the year the wind would be blowing into different directions from the plant. For comparison the following risks of fatality per year to an individual living in the U.S. may be noted[4b]; automobile accident 2.2×10^{-4}, falls 7.7×10^{-5}, drowning 3.1×10^{-5}, burning 2.9×10^{-5}, and firearms 1.2×10^{-5}.

The economic risk associated with protective actions and decontamination could be compared with property damage costs associated with alternative energy generation technologies. The use of fossil fuels, coal or oil, for example, would emit substantial quantities of sulfur dioxide and nitrogen oxides into the atmosphere, and, among other things, lead to environmental and ecological damage through the phenomenon of acid rain.[4c] This effect has not, however, been sufficiently quantified to draw a useful comparison at this time.

There are other economic impacts and risks that can be monetized that are not included in the cost calculations discussed in Section 6.1.4.4. These are accident impacts on the facility itself that result in added costs to the public, i.e., ratepayers, taxpayers, and/or shareholders. These are costs associated with decontamination of the facility itself and costs for replacement power.

No detailed methodology has been developed for estimating the contribution to economic risk associated with cleanup and decontamination of a nuclear power plant that has undergone a serious accident toward either a decommissioning or a resumption of operation. Experience with such costs is currently being accumulated as a result of the Three Mile Island accident. It is already clear, however, that such costs can approach or even exceed the original capital cost of such a facility. As an illustration of the possible contribution to the economic risk, if the probability of an accident serious enough to require extensive cleanup and decontamination is taken as the sum of the six accident sequences and sequence groups in Table 6.1.4-2, i.e., about 2.4 chances in 100,000 per year, and if the "average" decontamination cost for these sequences is assumed to be one billion dollars, then the estimated economic risk would be about $24,000 per year.

Other costs, besides damage to or loss of the facility result from accidents. The major additional costs are replacement power and either building a new facility or cleanup and decontamination of the damaged unit. These costs are affected by the point in the lifetime of the plant at which an accident might occur. The present worth cost is highest for an accident occurring at the beginning of the plant operating life and decreasing over the plant life. It is assumed for these calculations, that one unit of Susquehanna 1 or 2 is permanently lost and replaced by new capacity after eight years and the undamaged unit is shut down for three years before restart. For illustrative purposes, the costs and economic risk have been estimated for a "worst case" situation for the 2100 megawatt (electric) Susquehanna 1 and 2 plant by postulating a total loss of one of the units in the first year of a projected 30-year operating life. Net replacement power cost of 40 mills/kwh is assumed as the difference between fuel oil costs and nuclear fuel costs. The applicant operates both coal and oil plants. Since coal plants are lower cost to operate, they are likely to already be fully used and additional capacity would come from oil-fire plants. Using a 60% capacity factor, the annual cost of replacement power would be $440 million for the two units in 1980 dollars. The additional capital costs as a result of having to construct a new facility are about $60 million per year, again in 1980 dollars.

If the probability of sustaining a total loss of the original facility is taken as the probability of the occurrence of a core melt accident (approximated by the sum of probabilities for the accident sequences and sequence groups in

Table 6.1.4.2, i.e., about 2.4 chances in 100,000 per year), then the average contribution to economic risk that would result from a loss early in the operating life of a Susquehanna unit is about $12,000 for each of the first three years until the undamaged plant is returned to service, then $7,000 per year until the damaged unit is replaced, and $1,500 per year additional capital costs for the assumed remaining 22 years of plant service.

6.1.4.7 Uncertainties

The foregoing probabilistic and risk assessment discussion has been based upon the methodology presented in the Reactor Safety Study (RSS) which was published in 1975.

In July 1977, the NRC organized an Independent Risk Assessment Review Group to (1) clarify the achievements and limitations of the Reactor Safety Study Group, (2) assess the peer comments thereon and the responses to the comments, (3) study the current state of such risk assessment methodology, and (4) recommend to the Commission how and whether such methodology can be used in the regulatory and licensing process. The results of this study were issued September 1978.[5] This report, called the Lewis Report, contains several findings and recommendations concerning the RSS. Some of the more significant findings are summarized below.

(1) A number of sources of both conservatism and nonconservatism in the probability calculations in RSS were found, which were very difficult to balance. The Review Group was unable to determine whether the overall probability of a core melt given in the RSS was high or low, but they did conclude that the error bands were understated.

(2) The methodology, which was an important advance over earlier methodologies that had been applied to reactor risk, was sound.

(3) It is very difficult to follow the detailed thread of calculations through the RSS. In particular, the Executive Summary is a poor description of the contents of the report, should not be used as such, and has lent itself to misuse in the discussion of reactor risk.

On January 19, 1979, the Commission issued a statement of policy concerning the RSS and the Review Group Report. The Commission accepted the findings of the Review Group.

The accident at Three Mile Island occurred in March 1979 at a time when the accumulated experience record was about 400 reactor years. It is of interest to note that this was within the range of frequencies estimated by the RSS for an accident of this severity.[4d] It should also be noted that the Three Mile Island accident has resulted in a very comprehensive evaluation of reactor accidents like that one, by a significant number of investigative groups both within NRC and outside of it. Actions to improve the safety of nuclear power plants have come out of these investigations, including those from the President's Commission on the Accident at Three Mile Island, and NRC staff investigations and task forces. A comprehensive "NRC Action Plan Developed as a Result of the TMI-2 Accident," NUREG-0660, Vol. I, May 1980 collects the various recommendations of these groups and describes them under the subject areas of: Operational Safety; Siting and Design; Emergency Preparedness and Radiation Effects; Practices and Procedures; and NRC Policy, Organization and Management. The action plan presents a sequence of actions, some already taken, that will result in a gradually increasing improvement in safety as individual actions are completed. The Susquehanna plant is receiving and will receive the benefit of these actions on the schedule indicated in NUREG-0660. The improvement in safety from these actions has not been quantified, however, and the radiological risk of accidents discussed in this chapter does not reflect these improvements.

6.1.5 Conclusions

The foregoing sections consider the potential environmental impacts from accidents at the Susquehanna facility. These have covered a broad spectrum of possible accidental releases of radioactive materials into the environment by atmospheric and groundwater pathways. Included in the considerations are postulated design basis accidents and more severe accident sequences that lead to a severely damaged reactor core or core melt.

The environmental impacts that have been considered include potential radiation exposures to individuals and to the population as a whole, the risk of near- and long-term adverse health effects that such exposures could entail, and the potential economic and societal consequences of accidental contamination of the environment. These impacts could be severe, but the likelihood of their occurrence is judged to be small. This conclusion is based on (a) the fact that considerable experience has been gained with the operation of similar facilities without significant degradation of the environment; (b) that, in order to obtain a license to operate the Susquehanna facility, it must comply with the applicable Commission regulations and requirements; and (c) a probabilistic assessment of the risk based upon the methodology developed in the Reactor Safety Study. The overall assessment of environmental risk of accidents shows that it is roughly comparable to the risk for normal operational releases although accidents have a potential for acute fatalities and economic costs that cannot arise from normal operations. The risks of acute fatality from potential accidents at the site are small in comparison with the risks of acute fatality from other human activities in a comparably-sized population.

We have concluded that there are no special or unique features about the Susquehanna site and environs that would warrant special mitigation features for the Susquehanna plants.

Table 6.1.4-1

Approximate Radiation Doses from Design Basis Accidents

		Dose (rem) at 1800 feet*
Infrequent Accidents	Duration of Release**	Whole Body
Radioactive Waste System Failure:		
Equipment Leakage or Malfunction	< 2 hr	0.19
Release of Waste-Gas Storage Tank Contents	< 2 hr	0.077
Release of Liquid-Waste Storage Contents	< 2 hr	0.0005
Small-Break LOCA	hours-days	0.00005
Fuel Handling Accident (Fuel-Cask Crop)	< 2 hr	0.044
Limiting Faults		
Main Steam Line Break	< 2 hr	0.016
Control Rod Drop	hrs-days	0.004
Large-Break LOCA	hrs-days	0.028

*The nearest site (or exclusion area) boundary.

**< means "less than".

Table 6.1.4-2

Summary of Atmospheric Releases in Hypothetical Accident Sequences in a BWR (Rebaselined)

Accident Sequence or Sequence Group[b]	Probability (reactor-yr^{-1})	Fraction of Core Inventory Released[a]						
		Xe-Kr	I	Cs-Rb	Te-Sb	Ba-Sr	Ru[c]	La[d]
TCγ'	2.0 x10^{-6}	1.0	0.45	0.67	0.64	0.073	0.052	0.0083
TWγ'	3.0 x10^{-6}	1.0	0.098	0.27	0.41	0.025	0.028	0.005
TQUVγ' AEγ' S_1Eγ' S_2Eγ'	3.0 x10^{-7}	1.0	0.095	0.3	0.36	0.034	0.027	0.005
TCγ	8.0 x10^{-6}	1.0	0.07	0.14	0.12	0.015	0.01	0.002
TWγ	1.0 x10^{-5}	1.0	0.003	0.11	0.083	0.011	0.007	0.001
TQUVγ AEγ S_1Eγ S_2Eγ	1.0 x10^{-6}	1.0	0.02	0.055	0.11	0.006	0.007	0.0013

[a] Background on the isotope groups and release mechanisms is presented in Appendix VII, WASH 1400 (Ref. 10).

[b] See Appendix H for description of the accident sequences and sequence groups.

[c] Includes Ru, Rh, Co, Mo, Tc.

[d] Includes Y, La, Zr, Nb, Ce, Pr, Nd, Np, Pu, Am, Cm.

NOTE: Please refer to Section 6.1.4.7 for a discussion of uncertainties in risk estimates.

Table 6.1.4-3

Activity of Radionuclides in a Susquehanna Reactor Core at 3440 MWt

Group/Radionuclide	Radioactive Inventory in Millions of Curies	Half-Life (days)
A. NOBLE GASES		
Krypton-85	0.60	3,950
Krypton-85m	26	0.183
Krypton-87	51	0.0528
Krypton-88	73	0.117
Xenon-133	183	5.28
Xenon-135	37	0.384
B. IODINES		
Iodine-131	91	8.05
Iodine-132	129	0.0958
Iodine-133	183	0.875
Iodine-134	204	0.0366
Iodine-135	161	0.280
C. ALKALI METALS		
Rubidium-86	0.028	18.7
Cesium-134	8.1	750
Cesium-136	3.2	13.0
Cesium-137	5.1	11,000
D. TELLURIUM-ANTIMONY		
Tellurium-127	6.3	0.391
Tellurium-127m	1.2	109
Tellurium-129	33	0.048
Tellurium-129m	5.7	34.0
Tellurium-131m	14	1.25
Tellurium-132	129	3.25
Antimony-127	6.6	3.88
Antimony-129	35	0.179
E. ALKALINE EARTHS		
Strontium-89	101	52.1
Strontium-90	4.0	11,030
Strontium-91	118	0.403
Barium-140	172	12.8
F. COBALT AND NOBLE METALS		
Cobalt-58	0.84	71.0
Cobalt-60	0.31	1,920
Molybdenum-99	172	2.8
Technetium-99m	151	0.25
Ruthenium-103	118	39.5
Ruthenium-105	77	0.185
Ruthenium-106	27	366
Rhodium-105	53	1.50

Table 6.1.4-3 (Continued)

Group/Radionuclide	Radioactive Inventory in Millions of Curies	Half-Life (days)
G. RARE EARTHS, REFRACTORY OXIDES AND TRANSURANICS		
Yttrium-90	4.2	2.67
Yttrium-91	129	59.0
Zirconium-95	161	65.2
Zirconium-97	161	0.71
Niobium-95	161	35.0
Lanthanum-140	172	1.67
Cerium-141	161	32.3
Cerium-143	140	1.38
Cerium-144	91	284
Praseodymium-143	140	13.7
Neodymium-147	65	11.1
Neptunium-239	1800	2.35
Plutonium-238	0.061	32,500
Plutonium-239	0.023	8.9×10^6
Plutonium-240	0.023	2.4×10^6
Plutonium-241	3.7	5,350
Americium-241	0.0018	1.5×10^5
Curium-242	0.54	163
Curium-244	0.025	6,630

NOTE: The above grouping of radionuclides corresponds to that in Table 6.1.4-2.

Table 6.1.4-4

Summary of Environmental Impacts and Probabilities

Probability of Impact Per Reactor-Year	Persons Exposed over 200 rem	Persons Exposed over 25 rem	Acute Fatalities	Population Exposure Millions of person-rem 50 mi/Total	Latent* Cancers 50 mi/ Total	Cost of Offsite Mitigating Actions Millions of Dollars
10^{-4}	0	0	0	0/0	0/0	0
10^{-5}	0	2,000	0	1.8/60	110/400	160
5×10^{-6}	0	10,000	0	4/17	290/1,100	400
10^{-6}	1,000	55,000	0	12/70	1,100/4,400	1,300
10^{-7}	14,000	200,000	1,900	30/300	3,500/17,000	6,000
10^{-8}	40,000	500,000	12,000	42/450	4,500/21,000	---
Related Figure	6.1.4-2	6.1.4-2	6.1.4-4	6.1.4-3	6.1.4-5	6.1.4-6

*Includes cancers of all organs. Thirty times the values shown in the Figure 6.1.4-5 are shown in this column reflecting the thirty-year period over which cancers might occur. Genetic effects might be approximately twice the number of latent cancers.

NOTE: Please refer to Section 6.1.4.7 for a discussion of uncertainties in risk estimates.

TABLE 6.1.4-5

Average Values of Environmental Risks
Due to Accidents Per Reactor-Year

Population exposure	
person-rem within 50 miles	72
person-rem total	360
Acute Fatalities	0.00077
Latent cancer fatalities	
all organs excluding thyroid	0.020
thyroid only	0.0027
Cost of protective actions and decontamination	$9,000

NOTE: Please see Section 6.1.4.7 for discussions of uncertainties in risk estimates.

REFERENCES

1. Statement of Interim Policy, "Nuclear Power Plant Accident Considerations Under the National Environmental Policy Act of 1969," 45 FR 40101-40104, June 13, 1980.

2. "Final Safety Analysis Report (FSAR), Susquehanna Steam Electric Station Units 1 and 2, Docket Numbers 50-387 and 50-388," Pennsylvania Power and Light Company, April 10, 1978, as amended.*

3. "Safety Evaluation Report (SER) related to the operation of Susquehanna Steam Electric Station, Units 1 and 2, Docket Nos. 50-387 and 50-388," NUREG-0776, April 1981.***

4a. "Energy in Transition 1985 - 2010, "Final Report of the Committee on Nuclear and Alternative Energy Systems (CONAES), National Research Council, 1979, Chapter 9, pp. 517-534; also C.E. Land, Science 209, 1197, September 12, 1980.

4b. CONAES Report, loc cit, p 577.

4c. CONAES Report, loc cit, pp 559-560.

4d. CONAES Report, loc cit, p 553.

5. "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation," Advisory Committee on the Biological Effects of Ionizing Radiations (BEIR), National Academy of Sciences/National Research Council (November 1972).

6. "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation," Committee on the Biological Effects of Ionizing Radiations (BEIR), National Academy of Sciences/National Research Council, July 1980.

7. "Descriptions of Selected Accidents that Have Occurred at Nuclear Reactor Facilities," H.W. Bertini et al., Nuclear Safety Information Center, Oak Ridge National Laboratory, ORNL/NSIC-176, April 1980; also, "Evaluation of Steam Generator Tube Rupture Accidents," L.B. Marsh, NUREG-0651, March 1980.***

8. "Three Mile Island - A Report to the Commissioners and the Public," Vol. I, Mitchell Rogovin, Director, Nuclear Regulatory Commission Special Inquiry Group, January 1980, Summary Section 9, NUREG/CR-1250.***

9. "Report of the President's Commission on the Accident at Three Mile Island," October 1979, Commission Findings B, Health Effects.

10. "Reactor Safety Study," WASH-1400 (NUREG-75/014), October 1975.

11. "Task Force Report on Interim Operation of Indian Point," NUREG-0715, August 1980.***

12. "Risk Assessment Review Group Report to the U.S. Nuclear Regulatory Commission," H.W. Lewis et al., NUREG/CR-0400, September 1978.**

13. "Overview of the Reactor Safety Study Consequences Model," NUREG-0340, October 1977.**

14. "Liquid Pathway Generic Study," NUREG-0440, February 1978.**

15. Isherwood, Dana, "Preliminary Report on Retardation Factors and Radionuclides Migration," Lawrence Livermore Laboratories, UCID-A3.44, August 5, 1977.

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*Available in the NRC Public Document Room for inspection and copying for a fee.

**Available for purchase from the National Technical Information Service, Springfield, VA 22161.

***Available for purchase from the NRC/GPO Sales Program, U.S. Nuclear Regulatory Commission, Washington, DC 20555, and te National Technical Information Service.

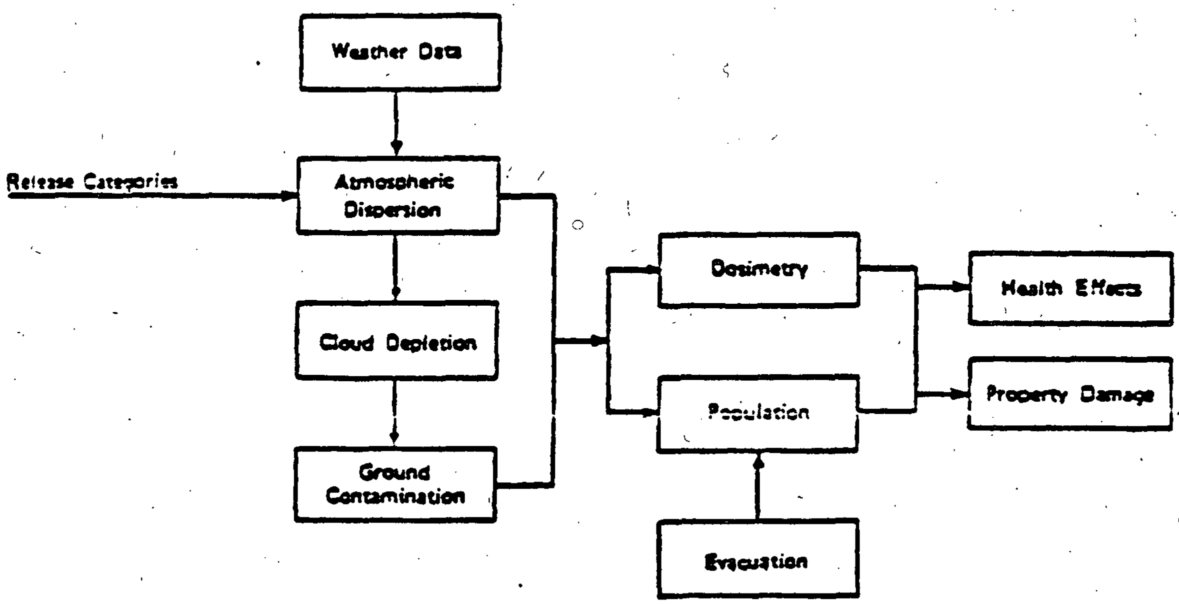


Figure 6.1.4-1 Schematic Outline of Consequence Model

PROBABILITY DISTRIBUTIONS OF INDIVIDUAL DOSE IMPACTS

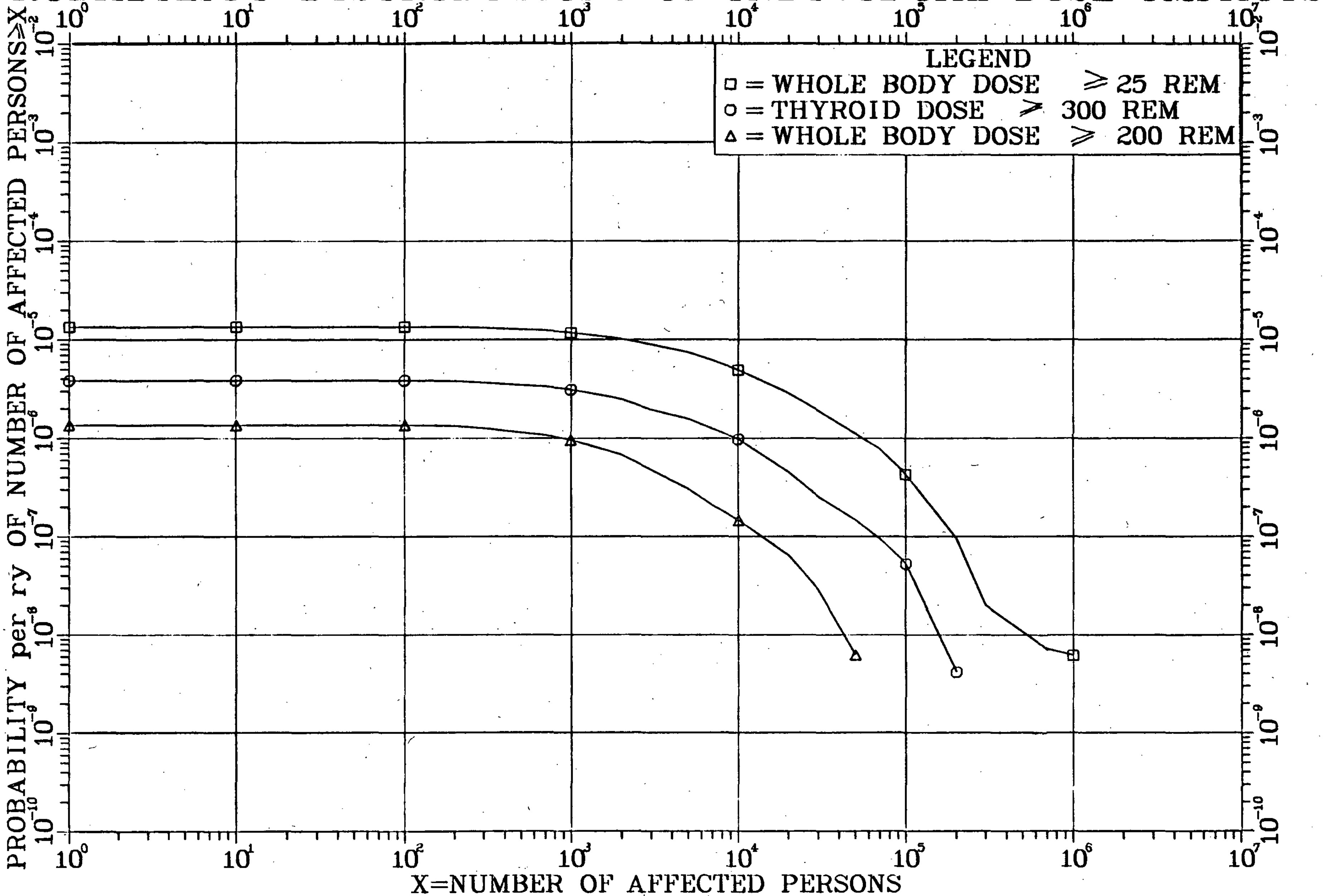


Fig. 6.1.4-2

NOTE: Please see Section 6.1.4.7 for discussion of uncertainties in risk estimates.

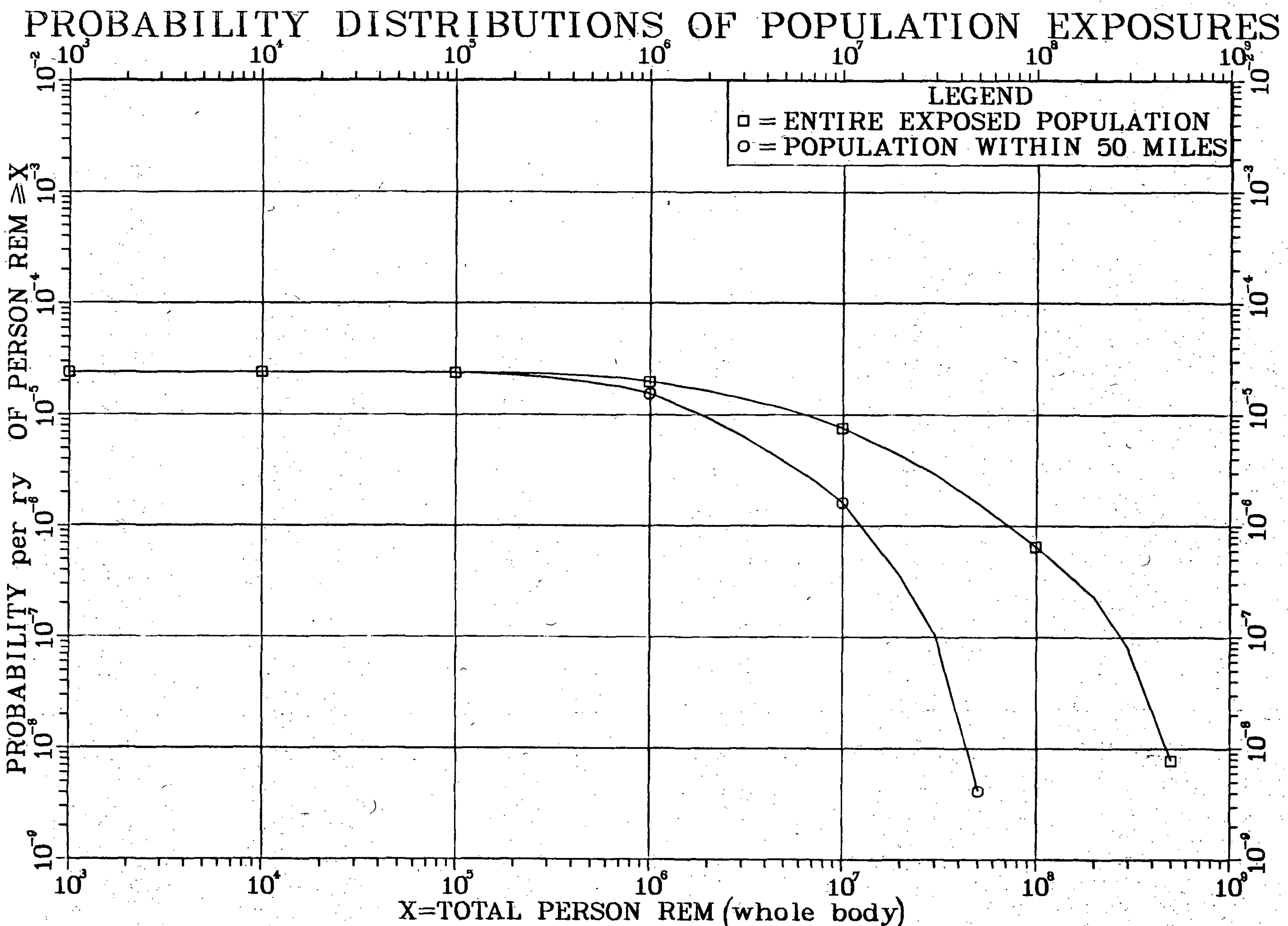


Fig. 6.1.4-3

NOTE: Please see Section 6.1.4.7 for discussion of uncertainties in risk estimates.

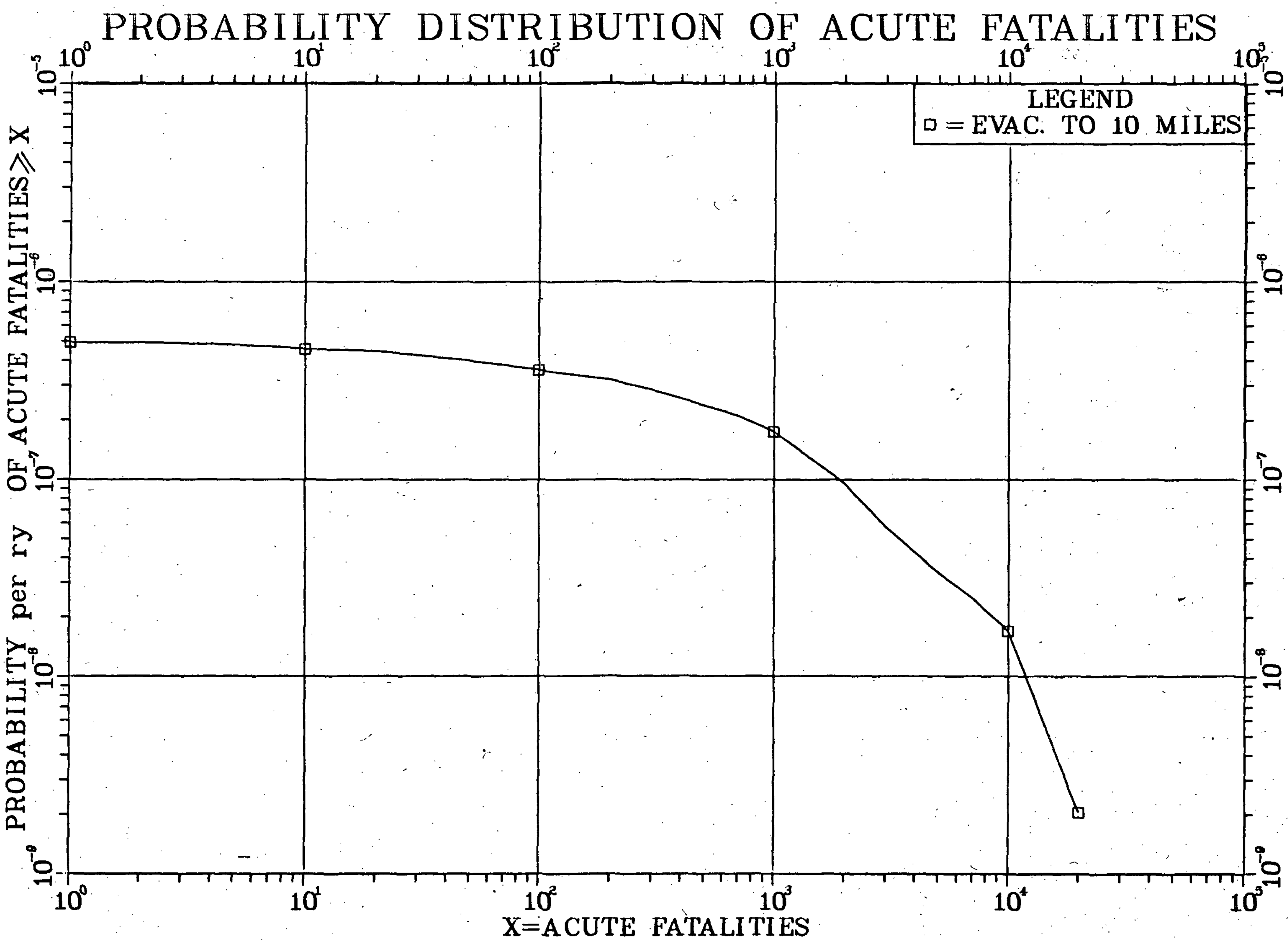


Fig. 6.1.4-4

NOTE: Please see Section 6.1.4.7 for discussion of uncertainties in risk estimates.

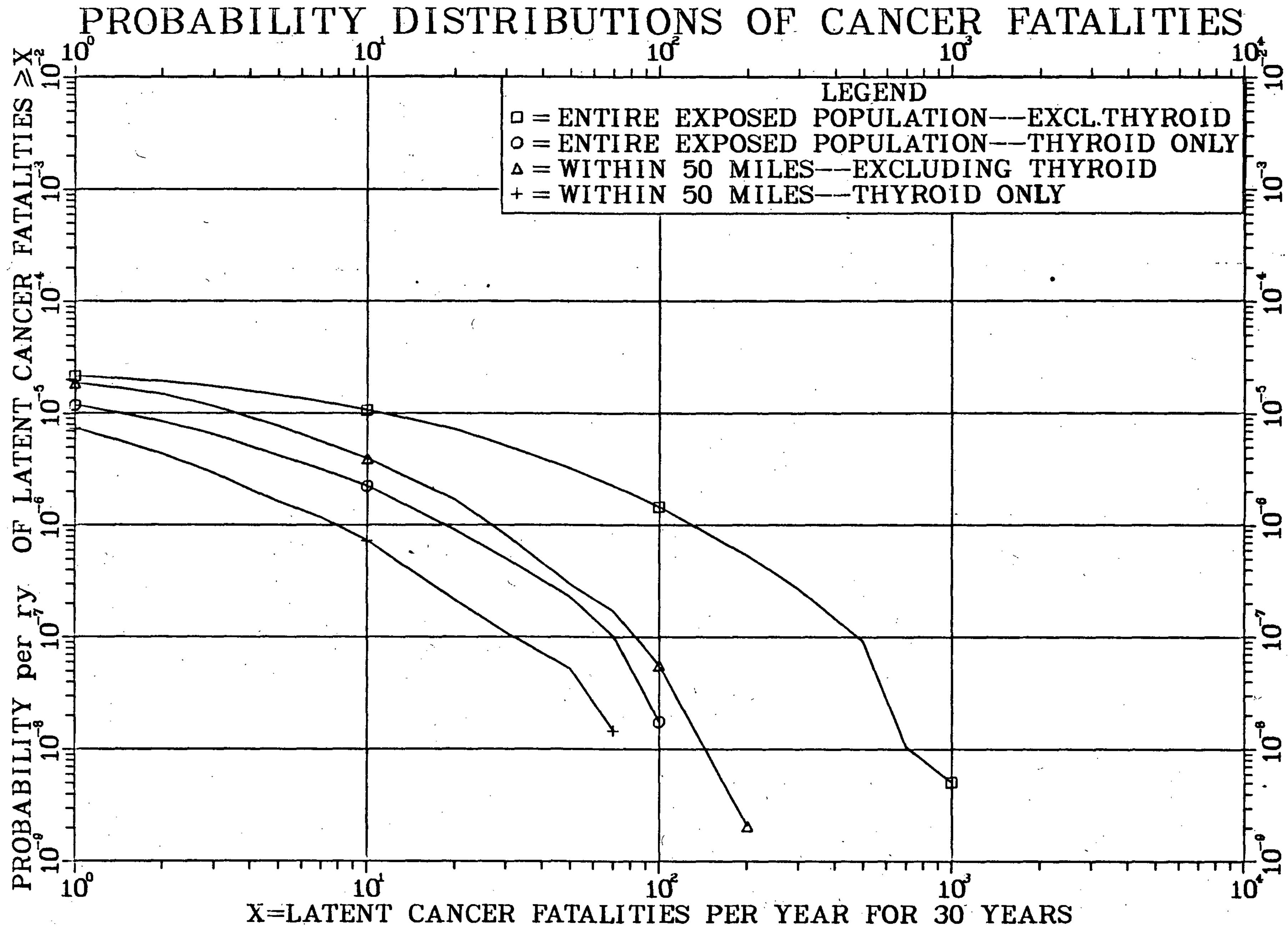


Fig. 6.1.4-5

NOTE: Please see Section 6.1.4.7 for discussion of uncertainties in risk estimates.

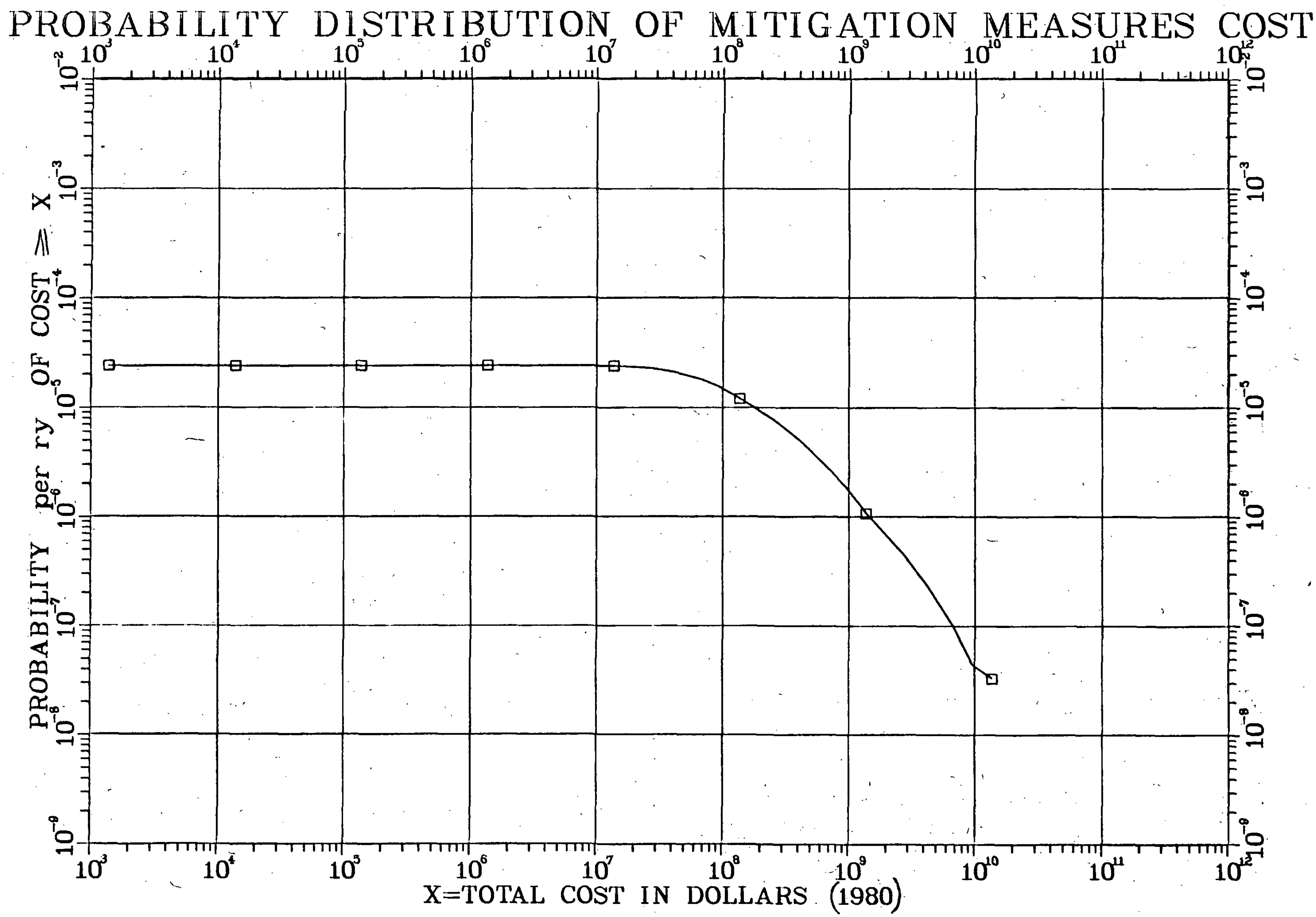


Fig. 6.1.4-6

NOTE: Please see Section 6.1.4.7 for discussion of uncertainties in risk estimates.

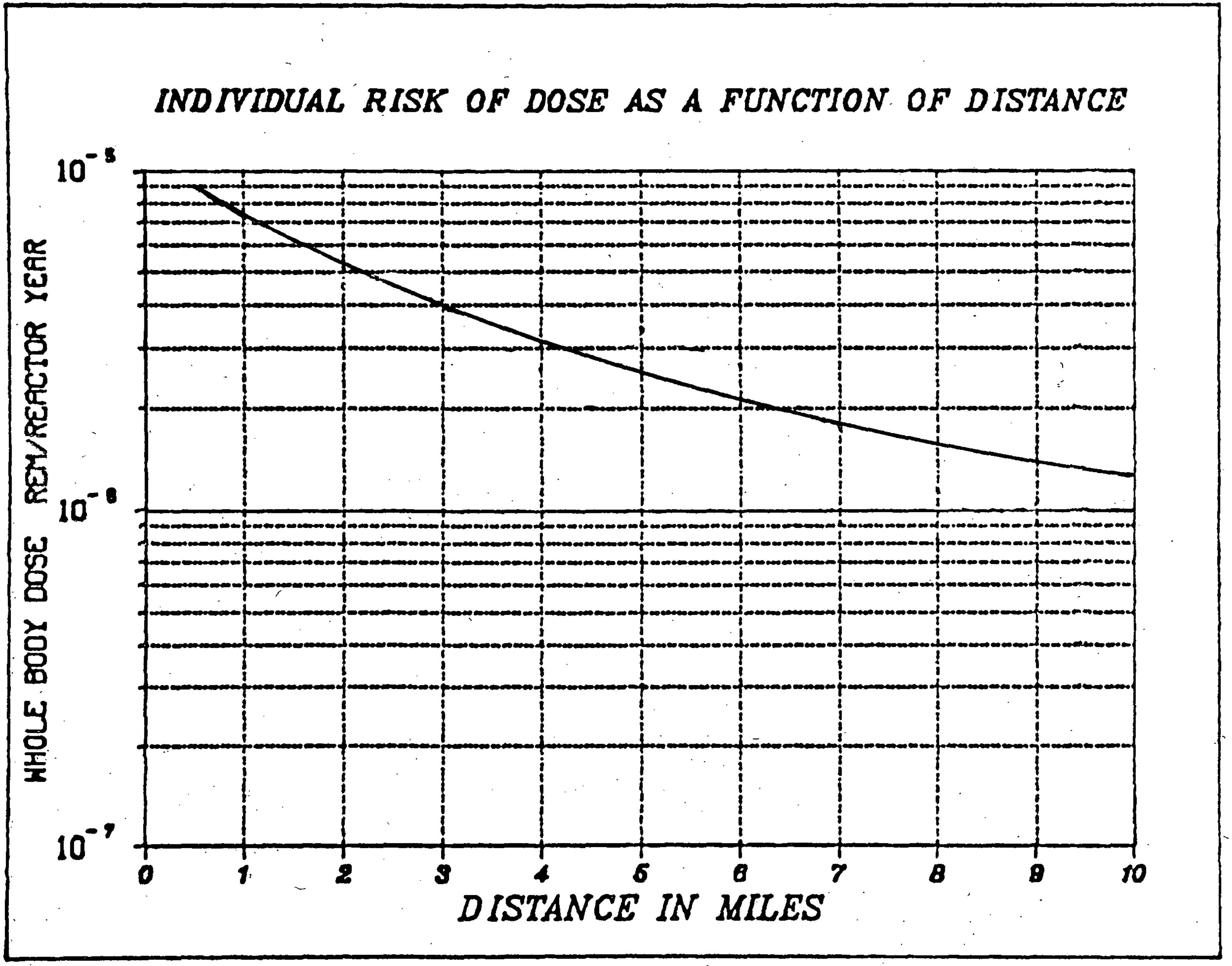
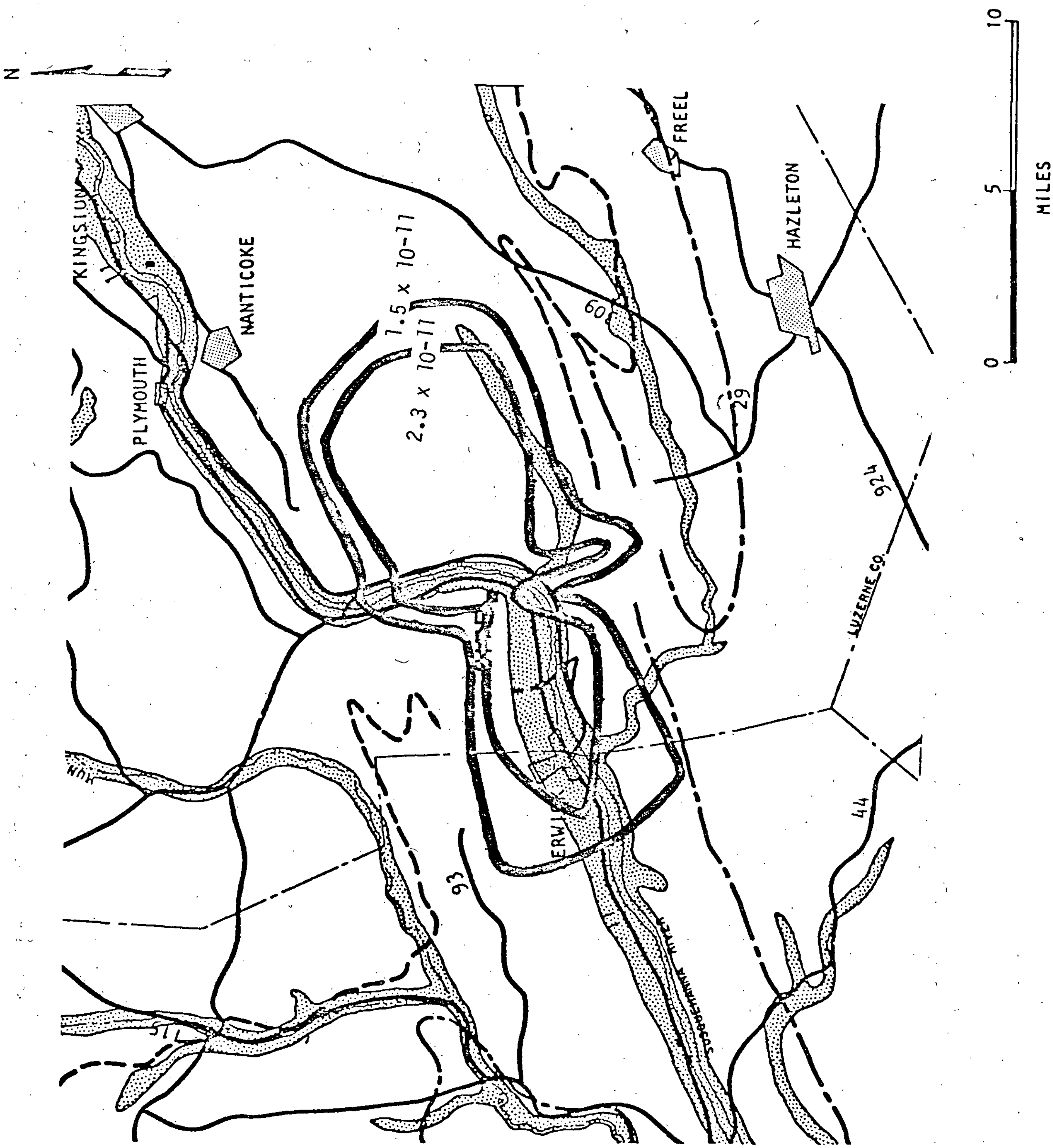


Fig. 6.1.4-7

Note: Please see Section 6.1.4.7.for discussion of uncertainties in risk estimates.



·ISOPLETHS OF RISK OF LATENT CANCER
FATALITY PER REACTOR YEAR TO AN INDIVIDUAL

Fig. 6.1.4-8

NOTE: Please see Section 6.1.4.7 for discussion of uncertainties in risk estimates.

6.1.6 COMMENTS ON SUPPLEMENT 2 TO DES*

This section includes comments on Supplement 2 to NUREG-0564, "Draft Environmental Statement related to the operation of Susquehanna Steam Electric Station, Units 1 and 2," dated March 1981. Staff responses immediately follow those comments.

The following listing indicates the abbreviations used to identify the commentors and order in which the comments apply. The Federal Energy Regulatory Commission provided no comments, and no responses from the staff were required.

Abbreviation	Commentor
DOI	Department of the Interior
EPA	Environmental Protection Agency
ACRS	Advisory Committee on Reactor Safeguards
Susq. Alliance	Susquehanna Alliance
MIL	Marvin I. Lewis
JP	Jim Perkins
PP&L	Pennsylvania Power & Light Company

* Responses to comments on Section 6 of the Draft Environmental Statement issued in June 1979 are contained in Section 10.6 of this Final Environmental Statement.

FEDERAL ENERGY REGULATORY COMMISSION

WASHINGTON 20426

IN REPLY REFER TO:

May 14, 1981

RECEIVED MAY 21 1981 U.S. NUCLEAR REGULATORY COMMISSION

Mr. B. J. Youngblood
Chief, Licensing Branch No. 1
Division of Licensing
U.S. Nuclear Regulatory Comm.
Washington, D. C. 20555

Dear Mr. Youngblood:

I am replying to your request of May 8, 1981 to the Federal Energy Regulatory Commission for comments on the Draft Environmental Impact Statement on the Enrico Fermi Atomic Power Plant, Unit No. 2. This Draft EIS has been reviewed by appropriate FERC staff components upon whose evaluation this response is based.

This staff concentrates its review of other agencies' environmental impact statements basically on those areas of the electric power, natural gas, and oil pipeline industries for which the Commission has jurisdiction by law, or where staff has special expertise in evaluating environmental impacts involed with the proposed action. It does not appear that there would be any significant impacts in these areas of concern nor serious conflicts with this agency's responsibilities should this action be undertaken.

Thank you for the opportunity to review this statement.

Sincerely,

Jack M. Heinemann
Advisor on Environmental Quality

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United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

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MAY 18 1981

RECEIVED MAY 20 1981 U.S. NUCLEAR REGULATORY COMMISSION

Mr. B. J. Youngblood, Chief
Licensing Branch No. 1
Division of Licensing
Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Youngblood:

Thank you for your letter of March 31, 1981, which transmitted copies of Supplement No. 2 to the draft environmental statement for the Susquehanna Steam Electric Station, Units 1 and 2, Luzerne County, Pennsylvania. We have the following comments.

The final supplement should assess potential impacts to fish and wildlife resources from a nuclear accident. The impacts such radioactive releases to water or the atmosphere would have on aquatic and terrestrial ecosystems should be assessed. In particular, the effect on fish and wildlife growth and reproduction from radioactive materials likely to accumulate or magnify in the food chain during and after an accident should be described. The short- and long-term effects on the human use of fish and wildlife resources, especially in downstream reaches of the Susquehanna River and Chesapeake Bay, which otherwise would be consumed if not exposed or contaminated by accidentally released radioactive materials should be presented. DOI(1)

Our Bureau of Mines Mineral Industry Location System (MILS) shows that an active sand and gravel pit and processing plant is located within the 3-mile radius of the low population zone (LPZ) as defined on page 6-8 of the supplement. This operation should be mentioned in section 6.1.3.2, Site Features, of the supplement. An active mineral producer within the LPZ would include a work force that requires the "appropriate and effective measures...in the event of a serious accident," referred to in the first paragraph on page 6-8. DOI(2) DOI(3)

We hope these comments will be helpful to you in the preparation of a final statement.

Sincerely,

CECIL S. HOFFMANN

Special Assistant to
Assistant SECRETARY

-DOI(1)

Only localized impacts on terrestrial ecosystems from atmospheric releases of radionuclides in serious reactor accidents are likely to occur. Such local impacts (over areas of a few square miles or less) would not significantly affect the ecological stability of widely distributed species, since normal mortality is relatively high in most species. Impacts on aquatic or terrestrial ecosystems from the releases to the ground water would be very small because of long travel times of the radionuclides before any contamination of the surface waters would occur.

-DOI(2)

The discussion of Site Features in the DES is intended to provide a general overview and how the site complies with the NRC's siting regulation, 10 CFR Part 100. The staff's Safety Evaluation Report (NUREG-0776) did note the existence of two sand and gravel processing facilities about 2.5 miles southwest of the Susquehanna plant, and indicated that no explosives were used or stored there. Section 6.1.3.2 of the FES has been revised to reflect this.

-DOI(3)

New NRC emergency planning regulations 10CFR50 and Appendix E thereto require emergency plans and the ability to take protective action for a plume exposure pathway Emergency Planning Zone (EPZ) of about 10 miles (NUREG-0654 provides further guidance). There is no requirement for specifically addressing industry or institutions in the LPZ. Susquehanna is procurring and installing a prompt alerting system with about 105 sirens to warn the public within the 10 mile EPZ within about 15 minutes of a decision to warn the public. This system should be capable of warning the mining operation referenced in the comment. Later, after installation of the Siren Systems, FEMA (Federal Emergency Management Agency) will conduct surveys to determine the effectiveness of the Warning System as well as the ability to take offsite protective actions.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
6TH AND WALNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

MAY 28 1981

RECEIVED
JUN 01 1981
U.S. NUCLEAR REGULATORY COMMISSION

Mr. B. J. Youngblood, Chief
Licensing Branch No. 1
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Youngblood:

We have completed our review of the Supplement to the Draft Environmental Impact Statement related to the operation of the Susquehanna Steam Electric Station Units 1 and 2. We offer the following comments for your consideration.

The Commission is to be commended for its decision to prepare this Supplement discussing the environmental and societal impacts of a core melt down accident.

EPA has emphasized the need to review an evaluation of the environmental impacts resulting from different LWR accident scenarios including Class 9 accidents.

The assessment of environmental impacts relating to severe accidents at the plant employs methods originally developed in the Reactor Safety Study (WASH-1400). These two studies will be the basis for similar environmental assessments of other nuclear power plants so that we recommend that NRC refer to EPA's original technical comments on these studies. The comments are included in the publication "Reactor Safety Study (WASH-1400): A Review of the Final Report" and a letter from EPA's Office of Federal Activities to NRC dated February 8, 1977.

The Table 6.1.4-4 (p. 6-26) should correspond on a one-to-one basis with the accident sequence or sequence groups of Table 6.1.4-2 (p. 6-23). The notations relating to this Table (6.1.4-2) and described in Appendix H needs clarification. The uninitiated reading this, we believe would be very confused. EPA(1)

The discussion of impacts of infrequent accidents and limiting faults, in both the original DES and the Supplement, addresses probabilities of occurrence qualitatively. In the discussion, however, of the more severe core melt accidents, the probabilities of occurrence are quantified (Table 6.1.4-2). For uniformity in the presentation of all environmental risks, the probabilities of occurrence of infrequent accidents and limiting faults Design Basis Accidents should be provided. EPA(2)

It is not clear whether the risks listed in Table 6.1.4-5, <u>Annual Average Values of Environmental Risks Due to Accidents</u>, include those from infrequent accidents

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and limiting faults (Table 6.1.4-1), postulated accidents (Table 6.2 of the original Draft Environmental Impact Statement), and accidents leading to the sequence groups listed in Table 6.1.4-2. The Final Environmental Impact Statement should include all risks from moderate frequency accidents, infrequent accidents, limiting faults and severe core melt accidents. The risk of the infrequent accidents, and limiting faults is "judged to be extremely small" but should be fully presented and not overshadowed by the risks from core melt accidents. The risks from the more probable yet lower consequence accidents may indeed be significant to the individual risk and should be listed. It would also be informative to extend Figures 6.1.4-3 and 6.1.4-5 to include higher probability accidents. EPA (3)

It would also be helpful to develop a summary table of the annual average value of the environmental risks from operation of all the reactors at the Susquehanna site. The risks should include those from normal operations, moderate frequency accidents, infrequent accidents, limiting faults and severe core melt accidents; societal and individual risks should also be addressed. EPA (4)

The Three Mile Island-2 accident demonstrated a factor that should be addressed. The cost of reactor building decontamination and the replacement power economics have proved to be very sizeable items. These factors are significant and important to the benefit-cost analysis. These facts underscore the need to develop standard methods for estimating the contribution of these costs to economic risks. Impact Statements or Supplements should include these economics in their benefit-cost balance. EPA (5)

We would classify this document in EPA's Reporting Category ER-2. This means we have reservations concerning the manner in which the accidents are treated and we also believe additional clarification is required.

We thank you for the opportunity to review the document and await the issuance of the final.

Sincerely yours,

John R. Pomponio

John R. Pomponio
Chief
EIS & Wetlands Review Section

-EPA(1)

Six (6) tables could have been provided to show the impact contributions of each of the six accident sequences or sequence groups. It is the staff's judgement, however, that the summary table, reflecting the sums of contributions from all of the sequences and sequence groups, provides a better overview, while giving sufficient detail to support the staff's conclusions.

Notations used in the Table 6.1.4-2 and Appendix H are the same as used in WASH-1400. A copy of the page 82 of WASH-1400 Main Report which provides the key to BWR accident sequence symbols is now provided as on page H-4.

-EPA(2)

Accidents bounded by the envelope of the design basis accidents are not significant contributors to environmental risk, and therefore have not been subjected to the same kind of probabilistic analysis.

-EPA(3)

Table 6.1.4-5 contains annual average values of environmental risks calculated for the accident sequences or sequence groups shown in Table 6.1.4-2. Accidents falling within the design basis envelope are negligible contributors to either individual or societal risk. The risk estimates would not noticeably change even if the precisely calculated contributions from the accidents within the design basis accidents envelope would be added to these values. It may be concluded, therefore, that the Table 6.1.4-5 presents the total annual average values of environmental risks from the entire spectrum of reactor accidents.

-EPA(4)

The risk from normal operation has been analysed for all (i.e. two) reactors at the Susquehanna site. (See chapter 4 of the FES) The accident risks have been calculated for one reactor to facilitate easy comparison with other sites and facilities. To obtain an estimate of the accident risk from two reactors, the reported risk values should be doubled.

-EPA(5)

See Section 6.1.4.6, Risk Considerations.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, D. C. 20555

May 13, 1981

MEMORANDUM FOR: Mr. Richard Stark, Project Manager
Susquehanna Steam Electric Station, Units 1 and 2

FROM: Garry G. Young
Staff Engineer

SUBJECT: NUREG-0564, SUPPLEMENT NO. 2, "SUPPLEMENT TO DRAFT ENVIRONMENTAL STATEMENT RELATED TO THE OPERATION OF SUSQUEHANNA STEAM ELECTRIC STATION, UNITS 1 AND 2"

In preparation for the ACRS Subcommittee Meeting on Susquehanna, currently scheduled for July 23 and 24, 1981, Dr. Kerr has requested that the NRC Staff be prepared to respond to the attached comments, questions and suggestions concerning the Draft Environmental Statement, Supplement No. 2, for Susquehanna (NUREG-0564). These comments were forwarded to Dr. Kerr by another ACRS Member based on his personal review of the environmental statement. If you have any questions concerning this request, please contact me.

Attachment:
Comments on NUREG-0564, Supplement No. 2

cc: W. Kerr, ACRS
C. Mark, ACRS
D. Moeller, ACRS
R. Fraley, ACRS
M. Libarkin, ACRS
J. McKinley, ACRS
R. Tedesco, NRR
B. Youngblood, NRR

COMMENTS ON NUREG-0564, SUPPLEMENT NO. 2

(1) Subsection 6.1.2 (4th Para.)

"The same population receives each year from natural background radiation about 240,000 person-rem and approximately a half-million cancers are expected ...."

The two statements should be separated since, as put, it could be taken to imply about 2 cancers per person-rem. The person-rem datum should be moved up to where it compares directly with the estimated person-rem from the accident; and the cancer estimates (accident-induced vs. normal incidence) should similarly be brought together for a direct comparison.

(2) Subsection 6.1.4.3 (Top Page 6-14)

Much more is needed concerning the evacuation model:

a) Is a "down wind direction" what is actually used?, or is it radial?

b) Is this really the most effective tactic? Or is it merely a limitation of the CRAC code? Since people out to a distance of about 7 miles on the axis of the sector are closer to the edge of the sector than they are to the 10-mile radial point, it might seem preferable for them to proceed cross-wind. Supposing this restriction to be a limitation of the code, why is it deemed useful to publish the results?

(3) Is it assumed (as the text would seem to suggest) that the evacuees would come to a halt at the 10-mile point? If so, why make this assumption?

(4) Subsection 6.1.4.5 (3rd Para. P. 6-16)

The discussion of "travel times" could rather easily be clarified by stating:

a) That the travel time for water has been estimated to be 9.2 years.

b) That the travel time for materials transported by the water is at least this long; and usually considerably longer, because of physico-chemical interactions between the water, the soil, and the material considered.

c) That the degree of retardation in the motion of some particular material is strongly dependent on the chemical properties of the material, the physical and chemical properties of the rock or soil through which it is moving, and the chemical properties of the ground water; and, as a consequence, that the arrival of any such transported material --though it may begin at 9.2 years -- is stretched out over a considerable period (and in some cases over an enormously extended period) after the first arrival of the groundwater itself.

d) (in the following paragraph)

The statement that, "We therefore conclude that the contribution -- is smaller --." could much better be replaced by a statement to the effect that the contribution is trivial.

5) Subsection 6.1.5 (final Paragraph, P 6-21)

Since there is no indication on the part of the NRC Staff to allow any credit for "additional" engineered safety features, this is a vacuous statement.

6) Subsection Table 6.1.4-5

The only "protection action" described in the body of the text is that of dashing off "downwind" to the 10-mile marker, and piling up there. It is true that in Subsection 6.1.4.6 it is said that "early evacuation of the population within 10 miles and other protective actions" are considered. None of this prepares one to imagine what (if any) protective actions may have been taken into account at distances greater than 50 miles. However, this Table claims that by "protective action" the person-rem beyond 50 miles is reduced from 600 to 290. What does the Table actually show?

7) Subsection Figure 6.1.4-2

The curve for ≥ 300 rem to the thyroid shows, for example, 200,000 affected people, with a probability of 10^{-8} per year. Does this include the ingestion estimates of WASH-1400, whereby everyone drinks 0.7 liters per day of milk from cows on contaminated pasture? If it does not, OK. If it does (and this term is significant), then the curve is nonsense; since there is nothing more straightforward and certain than that such milk would be impounded -- as it was at Windscale, without any "benefits" from Class 9 and emergency procedures rulemakings.

ACRS(1)

In the FES, "primarily from causes other than radiation". has been added at the end of the sentence for clarification.

ACRS(2)

See Appendix I in the FES for more information on the evacuation model. CRAC code treats the wind directions as radial only - it is a limitation of the code. Evacuation model assumed movement of evacuees in the downwind direction only for assessment of radiation exposure. This is a limitation of the evacuation model in CRAC. Actual movement of the people will involve intelligent use of the available road net-work to avoid the radioactive plume.

ACRS(3)

The particular sentence in the text in DES was inadvertently mis-structured. The Sections 6.1.4.2 and 6.1.4.3 have been re-written for the FES.

ACRS(5)

The final paragraph has been revised in the FES.

ACRS(6)

Please see the revised text in Section 6.1.4.2

ACRS(7)

Please see the foot-note in Section 6.1.4.3

Susquehanna Alliance
P O Box 249
Lewisburg, PA 17837
May 23, 1981

Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Att: Director, Division of Licensing

Sir/Madam:

We are enclosing our comments in relation to the Supplement to the Draft Environmental Impact Statement related to the operation of Susquehanna Steam Electric Station, Units 1 and 2. Docket numbers 50-387 and 50-388.

Since so much time has elapsed from the date of the original Draft EIS, it would be in the highest public interest to issue a 2nd full Draft EIS incorporating all previous comments and NRC responses. This 2nd full draft would provide the Commission with further information with which to base its decision regarding the environmental impacts of operating the Susquehanna Steam Electric Station.

Sincerely,

Michael M. Molesevich

Michael M. Molesevich

for the Susquehanna Alliance

C02
5/1

COMMENTS ON DRAFT SUPPLEMENT TO DRAFT EIS FOR THE SUSQUEHANNA STEAM ELECTRIC STATION, NUREG-0564, SUPPLEMENT NO. 2

1) The purpose of this supplement was to assess the additional environmental risks due to class nine accidents. These accidents previously have been considered to have minimal environmental effects because their probabilities have been thought to be low. However, since the accident at Three Mile Island, the conclusion of this supplement has not changed from the conclusion of the original Draft, EIS, of June 1979. Supplement: "These impacts could be severe, but the likelihood of their occurrence is judged to be small." Page 6-2 of the original Draft states: "Their consequences could be severe. However, the probability of their occurrence is judged so small that their environmental risk is extremely low." It is obvious that this supplement does not achieve its purpose. Therefore, the Susquehanna Alliance requests that another supplement be made available that adequately addresses the additional environmental risks due to class nine accidents.

2) This supplement does not address the long-term, man-made, and natural surface contamination from radionucleides. According to one source the delayed cancers and genetic defects due to radiation from ground and buildings contaminated with long-lived radioactive cesium could be the most severe consequence from a major release. (J. Beyea, Some Long-Term Consequences of Hypothetical Major Releases of Radioactivity to the Atmosphere from Three Mile Island, President's Council on Environmental Quality, September, 1979)

3) To always assume that downwind recipients of radioactive fallout will receive less dosage than those closer to the plant (source of radionucleides) is false.(Section 6.1.1.2) The plume does not always disperse more radionucleides closer and less further away due to certain meteorlogical conditions, i.e. ground base inversion. Also, the dosimeter readings 9 miles northeast of TMI, near Harrisburg, were higher than were the readings closer to the plant.

4) The supplement relies too much on sheltering and evacuation measures to help mitigate the effects on the local population. This ignores the potential for for the sequences of an accident which can take place in a very short time.(6.1.1.3) For example, anticipated transients without SCRAM which, according to Dr. Richard Webb can breach the reactor vessel within 6 seconds.

5) On page 6-5, section 6.1.2 the supplement states, "This experience base is not large enough to permit a reliable quantitative statistical inference." No large-scale-commercial reactor has yet gone through a complete life cycle. Therefore, to state that, "...significant environmental impacts due to accidents are very unlikely to occur over time periods of a few decades.", is an inaccurate conclusion.

6) To state that, "...a few million curies of xenon-133,..." were released at TMI implies a lesser severity when the NRC has stated that at least 13 million curies were released.

7) The Unit 2 reactor at TMI was very young. The fuel was only in service (fissioning) for three months. Had an accident of this severity occured with an older fuel assembly, then the inventory of the fission products available for release to the environment would have been much greater.

8) There are many assumptions based on the events, data, and results on the accident at TMI. However, there are many uncertainties in the analysis of the accident itself. While the supplement recognizes that the numbers used for population exposures are estimates, it does not discuss the uncertainties within those estimates.(6.1.2) "It has been estimated that..." For example, the monitors located on the stack vents were pegged off scale, and many of the off-site dosimeters were not brought into service until 3 days after the accident—when most of the radionucleides had already escaped.

9) The psychological impacts of the population surrounding the plant for at least a 75-mile radius must also be considered. It is obvious that the psychological effects of the people surrounding TMI and of central Pennsylvania were profound and continue today.

10) The supplement assumes that the owners of the Susquehanna Plant will have control of the water from the river by restricting its use during and after an accident (6.1.4.5) thereby claiming that the consequences would be more economic and social, and not radiological. The supplement does not address the use of water from the river by: the borough of Danville, the city of Sunbury and other downstream communities who withdraw their drinking water from the river, farmers that use water from the river for irrigation and other agricultural related activities (and especially Amish farmers who might not be aware of an accident miles downstream), industries that are located on the river that also use its water i.e. Merck Co. in Danville, and unalerted people who may be fishing the river at the time of the accident. The supplement should also address the uptake of radionucleides into the aquatic food chain.

11) The statement that arrangements have already been made to control highway traffic (6.1.3.2) seem premature since the Emergency Preparedness Plans for Susquehanna are in an advanced but not fully completed stage.

12) The supplement recognizes the substantial uncertainties calculated by the Reactor Safety Study. However, these uncertainties are not reflected in the tables where firm numbers are used. These tables should use ranges of numbers to reflect these uncertainties. Also, the range of accidents do *not* appear to have been adjusted to reflect the accident at TMI.(6.1.4.7)

13) The calculated, estimated, economic risk per year (p.6-19) reflects an inconsistency in the use of the Reactor Safety Study. In taking the example of an average decontamination cost of one billion dollars, the supplement assumes the probability of 2.4 chances of this occuring in 100,000 reactor years. Thus yielding an estimated economic cost of

24,000 dollars per year. However, on page 6-20, section 6.1.4.7, it is implied that the reactor safety study predicted the probability of a TMI-type accident as greater than one chance in 400 reactor years. Since this accident has an estimated clean-up cost of at least one billion dollars, then the economic risk could be calculated at 2.5 million dollars using the latter probability. It should be noted that this figure is somewhat larger than 24,000 dollars.

14) An obvious shortcoming of the accident at TMI was that there was no plan of recovery—either with the facility itself or the off-site consequences. At present they are developing the strategy and plans for the recovery of that accident along with its environmental impact. With the safety of the public in mind, this should have been prepared before the accident had occurred. Therefore, a plan of recovery and its environmental impact should be included in the analysis of an accident.

15) The economic risk associated with protective action and decontamination cannot be compared with the property damage costs associated with alternative energy technologies—especially anthracite coal. Anthracite does not have the same amount of sulfur compounds that most other coals have and would not lead to a substantial amount of acid rain as would the use of bituminous. Also, the increased use of anthracite can only lead to improved environmental conditions in that area. Since much of the area is already impacted then more mining would alleviate such problems found in that area such as: acid mine drainage, abandoned mines and spoils, a distressed economy, and the elimination of underground mine fires, open shafts and pits, and other dangerous conditions. This would be possible because all new/recent mining would meet stringent environmental laws and guidelines that were not in effect years ago when most of the damage was done. Page 6-18,(sect. 6.1.4.6)

16) Why are there no thyroid doses included on table 6.1.4-1?

17) Accident sequence or sequence groups should be expressed in terms rather than symbols or letters. (table 6.1.4-2)

18) Probability should be expressed as a range in table 6.1.4-2.

19) Other tables should include sum totals of land/surface accumulations of radionucleides based on probability and economics of decontamination.(table 6.1.4-4)

20) Evacuation item can also be considered probabilistically and the health effects should be more properly treated using site specific data. Considering the range of susceptibility to the health effects of radiation and other factors would be helpful to place on the figures the background radiation and other data from TMI. (figures 6.1.4-1, -2, -3, -4, -5)

21) The consequences of the accident at TMI should also be included in figure 6.1.4-6.

22) The maps are of the poorest quality and should be improved so that they could be read more clearly. (figures 6.1.4-7 and 6.1.4-8)

23) Add a map or maps that would show the isopleths of costs of mitigation.

24) The speed of groundwater movement seems to be highly underestimated, especially in the local glacial material, and epspecially under saturated ground conditions.(6.1.4.5)

25) There should be references sited of past work or studies that show effective isolation of radioactive contaminants in groundwater. (6.1.4.5)

26) This supplement should address site-specific conditions and not generic conditions as it seems to have done.

Susq. Alliance(1)

Ths staff believes that this FES provides a fair evaluation of impacts of reactor accidents and that the analysis as presented in the FES meets the intent of the Commission's Statement of the Interim Policy on plant accidents. The detailed analyses of severe core melt accidents included in this evaluation supports the conclusion that the risks of reactor accidents are low compared to the risks associated with many other human activities, even when accidents in the category previously identified as "Class 9" are included.

Susq. Alliance(2)

Contributions to risks from long-term (Chronic) exposure fnom the contaminated environment are included in the risks presented in Section 6.

Susq. Alliance(3)

The analysis of accident consequences, is based on actual meteorological data collected at the Susquehanna site. Although the observation concerning possible meteorological conditions is correct this observation does not negate the validity of the FES analysis, since the extent to which such conditions occur at the Susquehanna site have been included in the analysis.

Susq. Alliance(4)

All accident sequences and sequence groups included in Table 6.1.4-2 have values of time to release, release duration and warning time of at least 1.5 hr, 0.5 hr, and 1.0 hr. respectively (See WASH-1400, Appendix VI, Section 2 for definitions of these times). The staff has not taken any extra credit for public evacuation, sheltering or relocation which is not consistant with these times associated with the accident sequences and sequence groups used, and the evacuation parameters (see FES Appendix I) for the Susquehanna site.

Regarding the speculation of the six-second accident scenario credited to Dr. Richard Webb, the staff is familiar with it and considers it to be highly unlikely for the Susquehanna BWRs. Even if such a sequence would occur, the associated release magnitudes would be small since the core would take a much longer time than six-seconds to melt. Risks from such speculated sequence would be small compared to those from the sequences in Table 6.1.4-2.

Susq. Alliance(5)

The staff's conclusions concerning the likelihood of severe accidents are based on about 500 reactor years of power reactor operation, as well as sound engineering principle and conservatism employeed in their evaluation. The stated conclusion is supported by analytical evaluations of the nuclear power plant systems together with the fact that the experience base to date is accommodated within the theoretical calculations.

Susq. Alliance(6)

13 million curies as the magnitude of xe-133 release from TMI-2 accident was the result of early and preliminary estimate. This figure has been revised and 1.5 million curies is considered as the best estimate of xe-133 release from that accident. See Rogovin Report, vol. 2, Pt. 2, pp 359-360.

Susq. Alliance(7)

This comment is a correct statement. The Susquehanna FES analysis is based on a fully irradiated equilibrium core.

-Susq. Alliance(8)

A number of estimates of population exposures were made following the accident based largely on thermoluminescent dosimeters (TLDs) located around the plant site to distances of several miles. Estimates of radioactive releases and of total dose have been independently made by several groups including the President's commission and the NRC's internal investigation by M. Rogovin. In addition, A. Hull of Brookhaven National Lab. and K. Woodard of Pickard, Lowe & Garrick have estimated radioactivity releases and public doses. All these sources provide confirmation that the maximum individual dose was less than 100 mrem and the integrated population dose was less than 3500 person-rem with some estimates lower than 1000 person-rem.

Susq. Alliance(9)

It is the judgement of the Commission that the assessment of psychological impact is not required under the scope of NEPA.

-Susq. Alliance(10)

The staff has adequately demonstrated that the potential consequences of releases from core melt accidents to the ground water system would be much smaller than those of a "typical" generic site used in the Liquid Pathway Generic Study (NUREG-0440). The current NRC practice in evaluating core melt accident liquid pathway consequences relies on the comparison of the existing site with those sites presented in NUREG-0440.

The staff clearly states in section 6.1.4.5 that the minimum travel time for radioactive contamination via the ground water pathway would be 9.2 years, and that the travel time for Sr-90 and Cs-137 would be much greater. The staff has further concluded that there would be ample time for engineering measures to isolate the contaminated water from the river if it were found to be necessary.

-Susq. Alliance(11)

The NRC's siting regulation, 10 CFR Part 100, requires an applicant to show that arrangements have been made to control traffic on any transportation routes traversing the exclusion area, thus, the discussion in Section 6.1.3.2 was intended to show how the applicant was in compliance with the NRC's site criteria. There was no implication that the Emergency Plans, or the staff's review, has been completed.

With regard to the comment that the DES writeup does acknowledge the uncertainties calculated by the Reactor Safety Study (RSS) but that the DES tables do not reflect these uncertainties, the staff assumes that this comment reflects an editorial preference by the Commentor. For example, we have acknowledged the uncertainties on Table 6.1.4-2 which contains consequence model inputs quite similar to the RSS tables (although the RSS tables did not contain such an acknowledgement as has been done in DES). The staff will accept this editorial comment and explicitly include such an acknowledgement of uncertainties on tables where none now appears.

With regard to the comment that the tables do not appear to have been adjusted to reflect the accident at TMI (which involved PWR accident sequences of the type previously identified in the RSS for the PWR deisgn therein) the staff believes it is not necessary to include the PWR sequences into sequences for the BWR design- although this could be done. However, we believe that the overall health related risks to the public shown in the DES for various BWR core damage accidents dominate and adequately cover those from the TMI accident.

-Susq. Alliance(13)

The RSS economic modeling considered only the off-site costs as public property damage. The on-site costs and loss of returns to the plant owner(s) associated with plant damage, downtime purchased power, cleanup etc. were assumed to be private costs and were not included in the RSS modeling. If private costs associated with plant damage, loss of returns etc. were to be included into the RSS modeling then it is obvious that accidents (core damage or otherwise) involving long plant downtimes - whether or not such accidents present any off-site radiological health impacts - which would have large economic losses could be predicted. It is an arguable question whether or not the RSS should have included such private costs into an assessment of the public risk from reactor accidents. One point should be obvious from TMI-2 and that is that the plant owners should have considerable economic incentive to maintain a high level of safety in their plant design and operations or the private economic risks can far outweigh those predicted for the public off-site. Please also see responses to JP(7) and JP(9).

Susq. Alliance(14)

Procedures for plant recovery following an accident would depend on the type of the accident the plant would actually experience and the actual conditions prevailing in the plant in the post accident period. The environmental impact of such recovery procedures cannot be determined at this time. The impact of a specific recovery operation would be assessed at that time when the need for such an operation arises.

-Susq. Alliance(15)

The staff does not state that such risk cannot be compared because of philosophical differences; the DES states that such comparisons cannot be made because the costs of acid rain, etc. have not been "sufficiently quantified to draw a useful comparison at this time." Such comparisons may become possible in the years ahead as better data becomes available. The argument of the use of anthracite vs. bituminous coal is irrelevant since all fossil fuels emit sulfur and nitrogen oxides (and therefore acid rain), only the quantities vary. Secondly, anthracite is a very limited and irreplaceable resource that is seldom used for generating electricity. Because of its low sulfur content, the major use of anthracite is the manufacture of metallurgical coke for smelting iron ore. Byproducts include benzene (used in unleaded gasoline and pharmaceuaticals, for example), toluene, xylenes, naphthalene, anthracene, phenol, cresol and pyridine. These chemicals in turn are used to make many of the materials necessary for modern life such as medicines, dyes, explosives, preservatives, fungicides, lubricants and plastics.

Susq. Alliance(16)

Thyroid doses from the accidents included in Table 6.1.4-1 were not reported explicity because these doses would not show any trends different from that which is demonstrated by the WB doses shown in the table. It should be noted that the consequences of the exposure of the thyroid (i.e. thyroid nodules) from the more severe accidents are shown in Fig. 6.1.4-5. The risk from the thyroid exposure for the accidents within the design basis are negligible by comparison . The staff's experience with the methodologies and assumptions used for calculation of realistic doses such as shown in Table 6.1.4-1 (See Section 6.1.4.1) is that these doses are in the range of factors of 10 to 1000 lower than the doses calculated conservatively for the Safety Evaluation Report (SER).

Susq. Alliance(17)

A table of keys to BWR accident sequence symbols is provided on page H-4.

-Susq. Alliance(18)

This comment appears to reflect an editorial preference similar to that reflected in comment #12. The staff believes that the foot note on table 6.1.4-2 should suffice as acknowledgement of uncertainties.

Susq. Alliance(19)

The calculations of areas of decontamination and interdiction are intermediate steps in the determination of the costs of decontamination and interdiction of land areas. The latter results are reported in order to provide a complete assessment of the costs associated with ground contamination.

Susq. Alliance(20)

Probabilistic treatment of evacuation parameters would substantially increase the complexity of the reported results. The effects of changing the evacuation parameters, however, have been analysed, and are discussed in Appendix I in FES. With respect to using TMI as a reference point for health effects estimates, it should be noted that measurable consequences at TMI were so small that they would be off-scale on all figures of the supplement or FES.

Susq. Alliance(21)

Accurate cost figures for TMI-2 accident mitigation measures are not available at this time. It is the staff's judgement, however, that these costs would not exceed those shown in Figure 6.1.4-6.

Susq. Alliance(22)

A different map is now provided.

Susq. Alliance(23)

Risk isopleths for cost, as well as other consequences would have trends and patterns similar to those evidient from Fig. 6.1.4-8

-Susq. Alliance(24)

The ground water velocities used in our analysis are based on well-founded principles of hydrology and on conservative values of hydrologic parameters measured at the site.

-Susq. Alliance(25)

It is a well-established fact that many radioactive and stable elements are retarded by the process of "sorption" and therefore move at a rate much slower than that of the water itself. Rather than list references, which are too numerous to mention, the staff refers you to a survey article: M. P. Anderson, "Using models to simulate the movement of contaminants through ground water flow systems" in CRC Critical Reviews in Environmental Control, Vol. 9, Issue 2, pp 97-156, 1979.

Susq. Alliance(26)

The Supplement mostly addressed site specific conditions.

6-62

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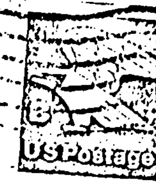
PHILADELPHIA, PA 191
PM
28 APR
1981



Director , Divisoin of Licensing
Office of NRR
USNRC
Washington, D.C. 20555

Phil

Docket 50-361
-362
-387
-388

Marvin I. Lewis
6504 Bradfordterrace
phila. PA 19149
4-27-81.

Tedesco

Director ,Division of Licensing
Office of Nuclear Regulation
USNRC

RECEIVED
1981 APR 31 AM 9 51
COMMISSION
SECTION

Dear SIR;

Please accept the following comments as my comments on both the Supplement 2 NUREG 0564 Supplement to DES Susquehanna Untis 1 and 2 and also NUREG 0490 Supplement to DES San Onofre Units 2 and 3. Both of these NUREGS are very , very similar . In fact , they are exactly the same page for page. Except for using the number 7 in NUREG 0490 and the number 6 in Nureg 0564 , they both have identical Table of Contents.

The use of boilerplate (identical forms and wording) is acceptable in many instances. I do not believe that boilerplate shows reasonable care where human lives and the safety of the public is at stake. Boilerplate can too easily hide the reality of inadequate care and attention to detail. There is no way to see beyond the 'boilerplate' to verify the correctness of the prose and technical details. MIL(1)

paragraph 7.13.1 (NUREG 0490) 6.1.3.1 (NUREG 0564). Thisparagraph in their respective NUREGs refer to mitigative measures included in the Design Features. Several of the design features discussed to mitigate accidents do not appear to be ESF, engineered safety features , which have fulfilled all the GDC, General Design Criteria . For a feature to be ESF and for that feature to be considered a mitigative feature in an accident , That feature must meet all applicable General Design Criteria. In both nuregs , mitigative features discussed in the Paragraph Design Features have not all passed all applicable General Design Criteria. MIL(2)

Apparently, some mitigative value is attached to non-ESF systems . This is in direct conflict with GDC requirements and the Atomic Energy Act.

Although there are many extremely misleading and error-filled sections in this report, I shall limit my comments to the very worst and most misleading paragraphs in these NUREGS: 6.1.13 (NUREG 0564) and 7.1.1.3 (NUREG 0490) .

both these NUREGS start the respective health effects pragragh exactly the same": "The cause and effects relationships between radiation and adverse health effects are quite complex but they have been more exhaustively studied than any other environmental cantaminant." The point is not that radiation has been studied more than any other enwironmental contaminant, the point is what has this study accomplished. To understand what this exhaustive study has accomplished, we must look at what this exhaustive studied was supposed to accomplish.

MIL(3)

For instance the purposex and goal of a 1964 federal study of cancer a nd related radiation exposure among workers at US facilities was originally undertaken for 'Political ' reasons; namely, to thwart workers efforts to obtain compensation for illness. These findings were reported by the House subcommittee on Health and the Environment in Feb, 1978 and confimed by a Freedom of Information Request from Dr Mancuso and the Public Citizen Litigation Group.(Critical Mass Journal Feb 1979.)

Obviously research done for such nefarious and unworthy reasons cannot be trusted. This is the research that Dr Gotchy , who wrote this chapter,wouldhave us believe. (NUREG -0564 Page vii)

The entire field of radiation research is tainted with questionable research by Government and other interests who have a stake in lulling the justifiable fears of an informed public.

I respectfully request that the reviewers of my comments read "SECRET FALLOUT" by Ernest Sternglass(McGraw Hill 1981.) The government and the nuclear industries are still attempting to cover up the dangers of radiation. Dr Tokuhata (Penna Do Health) is still messaging data in a most sinuous way to come out with distorted data. (Commonwealth of PA , Testimony of Ge Tokuhata , NRC Docket 50 -289, Submitted 4-16-81.)

To demonstrate the backround that Dr Tokuhata co mes from, he and the State of Penna are presently being sued for sex discrimination. This is the type of person that we are entrusting our radiation research to.

There has been good radiation researdh. The vested interests and the NRC have consistently shied away from any research that displayed radiation effects higher than those determined by Government and industry backed research. Even Acedemia has fallen prey to being a vested interest . Funding is few and far between for researchers like Dr Rosalie Bertell,GSM.

Mancuso and Brous have gotten their funding cut off. Dr Sterngkss as been the object of slurs and vituperation. Dr xskgx Webb has xhR had difficulty finding employment despite unique credentials.
Much good research has come from across the sea only to be ignored by the Atomic Establishment. (Heidelberg Report 1978 NRC Translation 520 TIDC 520)
Equally good research has been done in America and consistently ignored by the Atomic Establishment.
METHODOLOGIES FOR THE STUDY OF LOW LEVEL RADIATION IN THE MIDWEST Dixon Anvil Press 1979.
RADIATION STANDARDS ADN PUBLIC HEALTH Proceedings of a scond Congressional Seminar on Low Level Radiation 2-10-78 Lib of Congress.
Truly excellent and telling research has been accomplished in the USSR on the fauna and flora exposed to nuclear radiation in the release ata place called Kyshtym. How this release happened and how th research the data in the literatüre is detailed in an interesting book by Zhores A. Medvedev entitled NUCLEAR DISASTE R IN THE URALS.(Vantage 1980)
All of these source s have been consistently ignored because the data show clearly that the effect of low level madiation is higher by orders of magnitude than that which the NRC used .

The remainder of the paragraph or section is as flawed as the opening sentence.
"10 th 500 ~~prrsonxremsxxpsrxmillion~~ potential cancer deaths per million person-rem"
In order to be"conservative, " the highest number of deaths must be used in the calculations. The choice of"150"in <u>not</u> conservative!
The same argument is valid for using 260 genetic changes per million person-rems instead of 220.
<u>Disclaimer:</u> I have neither the time nor inclination to comment upon all the insufficiencies, errors, and just plain lies in these NUREGS. This is a farce that will eventuall y take the live of American Citizens just as surely as xwar War.
May God forgive this Great Evil of Nuclear Power for I do not have it in me to forgive this trespass against Mankind.
If anyone wishes to contact me confidentially, my number is ~~RHxKSxSSKKx~~ 215 CU 9 5964. You need not give your name and all information will be used without giving the source.

For a better tomorrow,

Marvin I . Lewis. 6-65

MIL(1)

The staff does not agree that an identical Table of Contents for several environmental statements demonstrates a lack of care concerning the health and safety of the public. By following a detailed, standardized outline, the staff assures that all significant environmental impacts are properly addressed for each application. Sections of the FES having the same or similar prose are intended for general and background information for the reader, addressing common aspects of reactor accidents, and the methods of analysis employed by the staff.

MIL(2)

The term "pressure suppression system" has been substituted for "heat removal system" to clarify the specific engineered safety feature discussed in this section. This system, as well as the other systems and features described in this section are indeed engineered safety features meeting the requirements of Part 50.

With regard to his claim that the staff estimate of 150 cancer deaths per million person-rem and 260 genetic effects per million person-rem are not conservative, the staff makes the following response:

The National Academy of Sciences BEIR III range of 10 to 500 cancer deaths per million person-rems shows the latest authoritative estimates of uncertainty are fairly wide, (and for radiation of the type released from nuclear power reactors, could be zero). However, it also shows that the value used by the staff (140) is about a factor of 4 below the maximum possible value and about a factor of 14 above the lowest value considered plausible by this dedicated and responsible group of expert scientists. Even Dr. Radford, whose dissenting views have been widely publicized, was only arguing that cancer risks are a factor of 2 to 3 times higher than the "best estimates" of the majority of the BEIR III committee. Since the staff risk estimate is much nearer the upper end of the possible range, it is regarded as realistically conservative.

Similarly, 260 genetic effects per million person-rem over all future generations represents the geometric mean of the range of possible values in BEIR I. Since the genetic effects estimates are based primarily on animal data (the survivors of the Japanese A-bomb survivors have not yet shown any detectable increase in mutations), such a value appears to be reasonable and is in fact higher (i.e., more conservative) than the value derived from the BEIR III report in the same manner. However, the value used by the staff is a factor of 4 lower than the maximum possible value and about a factor of 4 higher than the lowest possible value considered plausible by the BEIR III Committee.

Box 1378
State College, Pa. 16801

May 22, 1981

RECEIVED
MAY 26 1981
U.S. NUCLEAR REGULATORY COMMISSION

Office of Nuclear Reactor Regulation
USNRC
Washington, DC 20555

ATTN: Director, Division of Licensing

Hello:

Attached is a copy of my comments on the Supplement #2 to the DES for Susquehanna 1 and 2. Dockets 50-387, 388.

The comments are divided into two parts. First come specific responses to specific claims I noted as I read the draft. Next is a longer treatment of the section dealing with estimated economic risk.

It is in this second section that I think the draft is at its worst. My analyses indicate that the draft's estimates are low by a factor of 100 to 150. These are the figures that affect the cost estimates for the plant.

If I didn't know better I would say that the draft's authors were consultants hired by the Applicant to shed the best possible light on the situation.

I firmly believe that this draft is so inadequate that it cannot serve as a final draft. As unpopular as it may be with the new wave coming from the Administration and the Hill, I urge the NRC to prepare a real draft, one that treats the problem and the economics properly. Then ask again for public comment and then proceed to the FES. I realize this is not a pleasant prospect; neither was reading this draft a pleasant experience.

The role of the NRC is to resist pressures from the Applicants, the opponents and the government officials in order to ensure the most thorough review of the problems associated with this plant. Do not let yourself be bullied into accepting a half-hearted job.

Sincerely,

Jim Perkins

Jim Perkins

Copies: Allen Ertel
David Mann
Morris Udall
Richard Ottinger

Comments on Supplement to Draft Environmental Statement related to the Operation of Susquehanna Steam Electric Station, Units 1 and 2 Dockets 50-387, 388

Selected comments below result from a general reading of the text. Comments on the economic assessment rely, in addition, on information obtained by asking from PP&L. This information should surely have been available to the preparer of this document.

p. 6-4, section 6.1.1.3

The numbers cited from the BEIR III report were criticized by the committee head as being unduly generous, i.e. non-conservative. A recent article in Science indicates that the information relied upon by the BEIR committee overestimated the influence of neutrons in Hiroshima; hence, the conservative figure should probably be revised upward by the factor of 2 or 3 indicated by Dr. Radford. Furthermore, Karl Morgan and Alice Stewart, among others, are beginning to question the conservativeness of the linear hypothesis. As a responsible agency, not an adjudicative board of scientific studies, the NRC should assume the work of these reputable scientists defines the conservative "line". That's what being conservative means, not that one accepts the average. JP(1)

p. 6-5, section 6.1.2

Where the draft says, "None is known to have caused any radiation injury or fatality to any member of the public," could equally have been written, None is known not to have caused any radiation injury or fatality to any member of the public. It is clearly the case that no study has been done which would indicate that the draft's claim is true. I would suggest that such comments, which are unnecessary to the NRC's case, although perhaps not to the Applicant's, be eliminated. JP(2)

Regarding the estimates of releases from TMI-2, has there been any published estimates of the releases had TMI-2 not had the extra-thick containment? JP(3)

"It has been estimated that the maximum cumulative offsite radiation dose to an individual was less than 100 millirem." The Staff has failed to note that there have been far higher estimates presented to it, to which it has failed to respond. In particular, in Docket #50-272 with regard to the intervention by Lower Alloways Creek Township, Intervenor submitted a report in response to a Board Question on the accident at Three Mile Island. Utilizing the methodology provided in the TMI-2 Final Safety Analysis Report the report's author calculated that the release of Xenon-133 from the accident at TMI would have provided a 280 rem dose for a 2 hour exposure at the exclusion boundary and a 45 rem dose for a thirty day exposure at the low population zone boundary. These figures have been in the hands of the NRC since August, 1979. JP(4)

-In the continuing aftermath of the accident at TMI radioisotopes of several different types than iodine and xenon have been found outside the plant, in water samples. JP(4)

p. 6-8, section 6.1.3.2

I wonder how the residents of the Borough of Berwick, 6 miles to the south of the plant site, will feel to learn they are not a population center. JP(5)

p. 6-14, section 6.1.4.4

The draft neglects the costs associated with the physical and psychological health effects of an accident. With substantial awards being made by courts to individuals or families of individuals for the loss of one life, the costs associated with the loss of tens or hundreds or thousands should not be shrugged off. JP(6)

p. 6-19, section 6.1.4.6

This section regarding the chance of an accident whose decontamination cost is $1 billion is ludicrous. This I believe makes a mockery of the whole effort. "if the probability of an accident serious enough to require extensive cleanup and decont-mination is taken as . . . 2.4 chances in 100,000 per year, and if the average decontamination cost . ; . is assumed to be one billion dollars, then the estimated risk would be about $24,000 per year." I won't quibble with this because it is merely a mathematical statement. If, however, the draft's authors mean to suggest that the hypothesis of the statement is reasonable, then I will argue. On the very next page, as the authors try to explain their reliance on the Reactor Safety Study, they write, "The accident at Three Mile Island occurred in March 1979 at a time when the accumulated experience record was about 400 reactor years. It is of interest to note that this was within the range of frequencies estimated by the RSS for an accident of this severity."

The authors cannot have the best of each world. The TMI accident will cost at least $1 billion to decontaminate. Hence it fits in with the average accident cited by the authors. It occurred within the range of frequencies suggested by the RSS. Hence 2.4 in 100,000 per year is not a reasonable estimate. Rather clearly 1 in 400 per year is the reaonable assumption if we are not allowing for the impact of "lessons learned", as the draft's authors have claimed. So, let's use the methodology of the sentence quoted above: JP(7)

$\frac{1}{400}$ x $1,000,000,000 = $2,500,000 per year as the estimated economic risk.

The draft errs by a factor of 100.

Further, I would suggest that $1 billion may not be a reasonable estimate. Where did it come from?

Continuing on section 6.1.4.6

The cost of the TMI accident decontamination is now estimated at $1.3 billion. The cost of replacement power for ratepayers is estimated at $1.2 billion through 1985 alone. The proposed industry insurance scheme for replacement power, sponsored by the Nuclear Electric Insurance Limited of Bermuda, would have provided a maximum of $156 million for the GPU ratepayers had it been in place. So we can reduce costs to GPU ratepayers to $1.05 billion through 1985, and add on for the following years some figure. Since TMI-2 couldn't possibly be put back into service until 1990, it seems conservative to add another $1 billion for the years 1985 to 1990. Making the generous assumption that decontamination doesn't cost more than 1.3 billion, we are thus faced with a cost of at least $3.35 billion. Hence, the annual estimated economic risk is now $8,375,000.

Furthermore, if the RSS was reasonably accurate we can expect another TMI-type accident before 1985.

Missing from the draft was any mention of control rod failures of the sort that occurred at Brown's Ferry 3 in June of 1980. Also missing, though understandably, was any comment on the new concern about boiling water reactors' scram systems reported on by the NRC's Office for Analysis and Evaluation of Operational Data. These gaps should be filled.

JP(8)

Page 6-19, Section6.1.4.6

Comments on the worst case suggested by the draft's authors and on the proposed case to be studied.

Worst case: One unit lost in first year. The draft doesn't suggest the result on the other in this scenario, so I will take their three year estimate for a delay in restart.

Carrying charges for the lost plant are estimated by the company at 18% per year of final cost. Assuming a $3.5 billion final cost and an even distribution of the costs between the two units, the carrying charges on the undamaged facility would total $945 million. The lost carrying charges on the damaged facility would total $9.128 billion dollars. (Levelized 16.3% per year for 32 years) JP(9) Net replacement power at 40 mills per kwh at the company's expected 68.9% capacity would total $456 million per year. In addition, the company would lose out on its sales to the PJM by some predicted 5 to 6 billion kwh per year. At a split savings profit of 16 mills per kwh, the loss of each unit would cost ratepayers at least $40 million per year.
We will assume a $1 billion cost to decontaminate and five years. Then we will assume that the company still has sufficient wherewithall to build a replacement for the damaged unit. That will take ten years and will be paid for in inflated dollars, not in 1980 dollars.

Thus the final cost of the accident, neglecting the costs of offsite damages and settlements, can be calculated.

	damaged unit	undamaged unit	(millions $)
carrying charges	9,128	$945	
ruined fuel	50	-	
replacement power	3,420*	684	
lost sales to grid	600*	120	
cost of cleanup	+ 1,000	+ -	
	$14,198	$1,749	

Plus a plant constructed and paid for in year 1998 dollars will have a substantially higher cost to ratepayers. For the moment we'll neglect that.

The bill, neglecting rather a lot, is $15,947,000,000 for a $1 billion accident.

Now utilizing the techniques of the draft's preceeding paragraph and the Rasmussean probability of 1 in 400 per year we get an annual estimated economic risk of $39,867,500.

* assuming fifteen years until capacity replaced.

the proposed case: one unit fails after 8 years of operation and the second is down for 3 years until restart

Carrying charges for the lost plant would equal a levelized 12.2% per year. Assuming a $3.5 billion final cost and an even distribution of the costs between the facilities, the carrying charges for the lost plant would total $5.119 billion. Lost carrying charges of the undamaged facility would total $885 million. (These figures are in mixed dollars.) Net replacement power at 40 mills (1980 mills) per kwh at the company's expected capacity of 70% would total $696 million for the undamaged facility and $3.48 billion for the fifteen years until the capacity is replaced. Again the company would lose out on its sales to the PJM grid of $40 million (1980 dollars) per year.

Assuming a $1 billion cleanup (in 1980 dollars, for consistency) and the construction of replacement capacity in mixed dollars which will be capitalized in 2006, we can compile the following chart.

	damaged unit	undamaged unit	($million)
carrying charges	$5,119	$885	
ruined fuel	50	-	
replacement power	3,480	696	JP(9)
lost sales to grid	600	120	
cost of cleanup	+ 1,000	+ -	
	$10,249	$1,701	

carrying charges are in mixed dollars, 1991 to 2014 for the damaged unit and 1991 to 1993 for the undamaged. All others are in 1980 dollars. To get the 1991 figure we can assume a conservative 10% annual inflation rate for fuel, replacement power, lost sales, and cost. From 1983 to 1991 a compounded 10% amounts to a 114% increase.

	damaged unit	undamaged unit	($ m)
carrying charges	$5,119	$885	
fuel	107	-	
replacement power	7,447	1,489	
lost sales to grid	1,284	257	JP(9)
cost of cleanup	+ 2,140	+ -	
	$16,097	$2,631	

So, in comparison with the figure on the preceeding page representing the "worst" case, we have an annual economic risk of $46,820,000. mostly in 1991 dollars.

Because the analysis above included some mixed dollars for carrying charges, I decided to take the worst case once more, this time calculating the effects in 1983 dollars. For every year of the company's proposed carrying charge schedule, I have used a factor based on a 10% inflation rate to adjust the figure back to a 1983 dollar cost. The draft's staff used 40 mills as a net replacement cost, a figure probably conservative* for 1983. I have used a 16 mill per kwh rate of earnings from the grid for 1983, based upon some analysis of the past record of the company. $1 billion is the draft's estimate of cost. Assume a $3.5 billion final cost and an even distribution between the two units. The company assumes an average capacity of 68.9% for each unit.

Reduced as described, the carrying charges foregone for the damaged facility would total $2,959,000,000 in 1983 dollars. The three years of carrying charges for the undamaged plnt would total $861,000,000.

	damaged unit	undamaged unit
carrying charges	$2,959	$861
damaged fuel	50	-
replacement power	3,420	684
lost sales to grid	600	120
cost of cleanup	+ 1,000	+ -
	$ 8,029	$1,665

JP(9)

So, in constant 1983 dollars the cost of a hypothetical $1 billion accident which destroyed one unit and rendered the other out of service for three years would be $9,694,000,000. This neglects entirely offsite damages and injuries and that a utility trying to handle a $9 billion loss and major cleanup would have a hard time entering the capital market for construction funds.

JP(7)

At the RSS figure quoted by the draft's authors of 1 in 400 per year for a billion dollar accident, this figure translates to an estimated $24.2 million economic risk for the first year of Susquehanna's operation. This figure is more that 100 times as high as the draft's.

* conservative, used here, means <u>low</u>

-JP(1)

The staff agrees that the BEIR III values may be affected by the reevaluation of the Hiroshima and Nagasaki doses to survivors and that preliminary estimates indicate the BEIR III risk estimates could increase by factors of 2 or 3. However, it is far too early to revise estimates of risk based on such unconfirmed estimates. When all the work has been completed and reviewed by the scientific community, and the BEIR III Committee has reevaluated its recommendations and provided new guidance for Federal agencies, the NRC will move quickly to implement any recommended changes. In the interim, an increase of a factor or 2 or 3 in the recommended BEIR III risk estimators would still be within the range of 10 to 500 deaths per million person-rem provided by the present BEIR III report. Finally, it is worth nothing that while the BEIR III Chairman criticized the BEIR III committee for being non-conservative, three other members criticized it for being overly-conservative.

-JP(2)

Staff agrees it cannot be demonstrated whether injury has or has not been caused, and only pointed out the <u>fact</u> that no one knows.

-JP(3)

Thickness of the containment did not play any role in the amount of radioactivity release from the TMI-2 accident.

-JP(4)

There is no obvious relationship between hypothetical calculated radiation doses resulting from assumed worst case releases and meteorology, and the real measured doses resulting from the TMI-2 accident.

Iodine and xenon (as well as several krypton radionuclides and some radioactive particulate progency) were detected in gaseous effluents from TMI-2. In addition, tritium and traces of Cs-137 have been found in on-site test borings taken near the Unit-1 borated water storage tank due to a leaking valve to the tank. However, the leak occurred prior to the Unit-2 accident, and no radioactivity has been identified off-site as a result of liquid releases from TMI-2 since the accident.

-JP(5)

The NRC's siting regulation, 10 CFR Part 100, defines the term nearest population center to be the nearest "densely populated center containing more than about 25,000 residents". Since the Borough of Berwick had a 1980 estimated population of 11,781 (1970 population of 12,274), it was not identified as the nearest population center, according to the above definition.

-JP(6)

While the only identifiable health effects resulting from the TMI-2 accident were psychological in nature, the Commission has concluded such impacts are outside the scope of NEPA.

-JP(7), JP(9)

The commentor computes an annual economic risk for the Susquehanna nuclear units under three different scenarios and arrives at figures of approximately \$40 million, \$47 million and \$24 million respectively for the three scenarios compared to the staff's calculated total annual economic risk of \$142 thousand spread over several years. The commentor's calculation is thus about 150 to 350 times that of the staff. We believe that the commentor has erred in three principal ways for each of the three scenarios:

(1) an improper probability factor,

(2) improper application of fixed charges, and

(3) double counting of certain costs

The principle difference lies in the probability factor used. Staff used a probability factor of 2.4×10^{-5} (2.4 chances in 100,000) whereas the commentor used a factor of 2.5×10^{-3} (2.5 chances in 1,000); a difference of more than 100 times. The commentor's probability factor was derived based on the TMI accident happening after about 400 years of reactor operation. A single event cannot be used to determine a probability factor. The best way to describe this for one not versed in statistical methods is to note that the probability of throwing snake eyes cannot be determined by a single throw of the dice. The commentor supports his factor in part by noting that the one chance in 400 is within the range of frequencies estimated by the RSS (1975 Reactor Safety Study) for an accident of this severity. The range estimated by the RSS varied from 1 in 300 to 1 in 30,000 reactor years of operation. Thus, the 1 in 400 value is at the very upper end of the range in frequencies. Conversely, the 2.4×10^{-5} probability factor used in the

Supplement to Draft Environmental Statement is lower than the lower range of frequencies given in the 1975 RSS. However, as noted in Appendix H-1 of the DES, the RSS has been re-baselined since 1975 to reflect use of advanced modeling of the processes involved.

Other than the probability factor, another major difference between the commentor's calculations and those of the staff is in the computation of carrying charges. Carrying charges include interest charges and return on investment, depreciation or recovery of the capital, interim replacements, taxes and insurance. Carrying charges must be paid if the plant is operating or not operating. These do not, therefore, represent additional costs while the facilities are shut down. While the generating units are not operating and until the damaged unit is replaced or decommissioned, the loss in benefits of not being able to operate the units is fully reflected by the replacement power costs. To charge for both the costs, and the benefits not realized, would be double counting.

After the damaged unit is replaced, the only carrying charges applicable for the replaced unit are those associated with interest charges and recovery of capital. Interim replacements, taxes and insurance are no longer applicable to the damaged unit after it is replaced or decommissioned.

Susan M. Shanaman, Chairman of the Pennsylvania Public Utility Commission, appeared before the Subcommittee on Oversight and Investigations of the House Committee on Energy and Commerce. On March 30, 1981, Ms. Shanaman gave the following costs for Three Mile Island in prepared testimony:

Decontamination	$1,000 Million
Reconstruction Cost	600 Million
Less Insurance	(300)
Net Investment Cost	$1,300 Million

The above costs compares to staff estimates in the Supplement No. 2 of the Susquehanna DES of $1,000 Million for decontamination plus return and capital recovery costs of $60 million for 22 years for reconstruction. The $60 million for 22 years is equivalent to a present worth lump sum of $491 million at an 11% discount rate. Although the Three Mile Island costs are not necessarily appropriate for Susquehanna, these estimates indicate that the staff's estimates are of a proper order of magnitude.

The commentor calculates additional carrying charges of $10,073 million, $6,004 million and $3,820 million, respectively, for the three scenarios that were developed. Staff believes that the only appropriate additional carrying charges due to the accident at Three Mile Island are those reflected by the $600 million reconstruction cost in Ms. Shanaman's testimony.

The commentor also estimates an additional charge for damaged fuel of $50 million. This would already be included in the $600 million reconstruction cost.

The commentor's calculations also include charges for lost sales to the grid. Staff believes that these costs are already reflected in the replacement power costs. It is double counting to charge for costs of buying power (or generating power) and also for not selling power.

-JP(8)

Regarding the comment that the DES did not address the Browns Ferry, Unit 3 scram system malfunctions in June 1980, it is not clear to the staff that this reflects any gap or new NRC concern. The matter of ATWS initiated core damage accidents has been a generic safety issue in NRC for some time now for which analyses have been completed and rule making is presently underway independent of the DES (See NUREG-0460). Furthermore, the risk analysis presented in the DES for the BWR design contains sequences that involve total failure to shutdown the reactor (including failure to insert all control rods). This particular sequence was in fact found to dominate the overall risks as these are presented in the DES (i.e. sequences designated as TC).

PP&L

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50-387

RECEIVED MAY 27 1981 U.S. NUCLEAR REGULATORY COMMISSION

May 26, 1981

Mr. B. J. Youngblood, Chief
Licensing Branch No. 1
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

SUSQUEHANNA STEAM ELECTRIC STATION
COMMENTS ON SUPPLEMENT 2 OF
DRAFT ENVIRONMENTAL STATEMENT
ER 100450 FILE 991-2 PLA-818

Dear Mr. Youngblood:

Attached are PP&L's comments on Supplement 2 of the Draft Environmental Statement.

Very truly yours,

NW Curtis

N. W. Curtis
Vice President-Engineering & Construction-Nuclear

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Applicants have reviewed Supplement No. 2 to the Draft Environmental Statement related to the operation of the Susquehanna Steam Electric Station Units 1 and 2 (NUREG-0564) and in general concur with the Staff's analyses, evaluations, and conclusions. Applicants believe the Supplement meets the intent of the Commission's statement of interim policy regarding accident considerations and agree with the Staff's conclusion that while the environmental impacts of the accidents considered may be severe, the likelihood of their occurrence is remote. Therefore, the conclusions reached in the Draft Environmental Statement should remain unchanged.

Applicants do have the following specific comments on Supplement No. 2.

A) The Staff's analysis makes several assumptions which tend to overstate the impacts of the events being considered.

1. <u>7-Day Ground Dose Assumption</u>

Page 6-12 of Supplement No. 2 contains the following statement:

> The RSS consequence model also contains a provision for incorporating the consequence reduction benefits of evacuation and other protective actions. Except as otherwise indicated below, the results shown for Susquehanna do not include this provision. With respect to this aspect of the calculations, therefore, the results are "worst case" estimates. The model does, however, provide for relocation of persons to avoid prolonged exposure to ground contamination. Unless otherwise specified, the calculations for Susquehanna incorporate this provision for relocation following seven days of exposure.

PP&L (A

This "seven days of exposure" refers to irradiation from fission products deposited on the ground following a postulated core-melt accident. It is extremely conservative to assume the population would remain in place and be exposed to this radiation for as long as seven days. This overconservatism is particularly great for early health effects, such as acute fatalities. The results of the Reactor Safety Study (RSS)[1] show that in the highly unlikely event of accidental releases of large amounts of radioactivity, the incidence of acute fatalities in the population is dominated by the radiation dose from deposited gamma-emitters.[2] It is therefore particularly important to try to make a more realistic estimate of the magnitude of this dose, taking into account what can reasonably be expected by way of protective actions such as evacuation. The Staff recognizes this, since it refers to the results as being "worst case" and includes calculations which incorporate a model for early evacuation as indicated in Table 6.1.4-5. The use of the seven-day ground dose in Supplement No. 2 results in the prediction of unwarrantedly large consequences and conveys an incorrect impression of the risk of reactor accidents.

Realistic values should be presented as the main results of the report. Table 6.1.4-5 shows that the use of realistic protective actions reduces the predicted annual average values of public risk due to population exposure or to latent cancer fatalities by a factor of between five and twelve. The risk due to early fatalities is similarly reduced by a factor of about thirty. Figure 6.1.4-4 shows the marked reduction in acute fatalities which results when realistic protective means are assumed. However, most of the data in Supplement No. 2 does not reflect realistic protective actions and is therefore overly conservative. (See figures 6.1.4-2, 6.1.4-3, 6.1.4-5, 6.1.4-7, 6.1.4-8.) The plot of isopleths in Fig. 6.1.4-7 and Fig. 6.1.4-8 by incorporating the 7-day ground dose assumption gives a misleading impression of how far downwind acute fatalities might be expected to occur following a reactor accident.*

2. Comments on the Use of CRAC

It is Applicants' understanding that the version of the CRAC (Calculation of Reactor Accident Consequences) computer code used in the preparation of Supplement No. 2 was essentially the same as that used for the preparation of the RSS. A significant difference was the incorporation of an evacuation model, recently developed at Sandia Laboratories[3]. Although this model represents an improvement over that used in the RSS, there are other modifications which could be incorporated into CRAC. These have been described in recent studies such as that of the Limerick BWR[4]. Applicants believe the omission of these modifications is another significant source of conservatism. Examples of these conservative elements include: PP&L (A2)

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* Applicants also have reservations about the meaningfulness of isopleths of individual risk at the 10^{-10} or 10^{-11} per year level. At this vanishingly small probability level (one in 10 billion or one in 100 billion per year), these values have little meaning.

(a) Plume Width

The width of the plume in the dispersion model used in the RSS and in Supplement No. 2 is based upon releases of radioactive material for only three minutes duration; that is, the formulae used for calculating the plume width are phenomenological fits to data taken in experiments in which the duration of release was about three minutes. In practice, the shortest release duration considered in the RSS and Supplement No. 2 was thirty minutes. It is a well-known characteristic of dispersing plumes that, roughly speaking, their average width is an increasing function of the duration of cloud passage.(1) If plume widths for a thirty-minute release are used, predicted plume center line concentrations are reduced by a factor of about two. Radiation doses are also reduced by the same factor. The predicted effect on the number of acute fatalities depends upon the population distribution around the reactor, but should be a reduction by at least a factor of two.

(b) Shielding Factors

The CRAC analysis incorporates shielding factors for people assumed to be sheltered from gamma-rays emitted by deposited fission products. In the RSS and presumably Supplement No. 2, a shielding factor of 0.3 was used. In the Limerick Study(4) the shielding factor was estimated by considering the shielding provided by typical houses found in Pennsylvania. Since brick houses with basements are common there, with excellent shielding characteristics, a more realistic shielding factor of 0.15 was deduced. Since the accumulated ground dose is the dominant contributor to the radiation dose that is used in calculations of early fatalities, this shielding factor can lead to a substantial reduction in that dose.

Taken together with the factor of two due to the change from a 3-minute to a 30-minute plume width, a reduction by a factor of 3-4 in predicted doses is possible. The corresponding reduction in the predicted number of early deaths may be even greater because of the thresholds in the early fatality dose-risk relationships. These considerations would suggest that a considerable reduction of the acute fatality probability distributions shown on Figure 6.1.4-4 is possible with appropriate changes in CRAC. Consequently, the results as shown are conservative and overstate the risk.

B) Table 6.1.4-1 provides a list of some Design Basis Accidents. The indicated frequency categories for these accidents are not consistent with previous NRC documents. This table implies that these accidents were included in the design basis as Infrequent Accidents, when in fact they have been considered as Limiting Faults based on the acceptance criteria contained in the Standard Review Plan. PP&L(B)

C) On pages 6-8 in Section 6.1.3.2, the fourth paragraph states that only one industrial plant, the Luzerne Outerwear Company, is located within the LPZ. Last summer, CAR-MAR moved into an industrial park which is also within the LPZ. CAR-MAR employs approximately 70 people. This industrial park is located in Sector 10 approximately 1.7 miles from the site. PP&L(C)

D) On page 6-16, the second paragraph in Section 6.1.4.5 states that there are no wells between the plant and the river via the northern bedrock valley pathway. While this statement is correct in terms of pathways for exposure to the public, there are five wells located on Applicants' property in the area in question. In the unlikely event of an accident involving releases to groundwater, these wells would not be used. PP&L(D)

<u>REFERENCES</u>:

1. Reactor Safety Study, WASH-1400 (NUREG 75/014), 1975.

2. Wall, I.B. Yaniv, S.S., Blond, R.M., <u>et al</u>, "Overview of the Reactor Safety Study." Paper presented at the International Conference of Nuclear Systems Reliability Engineering and Risk Assessment, Gatlinburg, Tennessee, June 19-25, (1977).

3. Aldrich, D.C., Blond, R.M. and Jones, R.B., "A Model of Public Evacuation for Atmospheric Radiological Releases", Sandia Laboratories Report SAND, 78-0092 (1978).

4. Probabilistic Risk Assessment, Limerick Generating Station, Philadelphia Electric Company, Docket Nos. 50-352 and 50-353, (March, 1981).

-PP&L(A1)

Analyses and text now presented in FES are different from those in the DES Supp. No. 2.

Regarding use of individual risk at 10^{-10} or 10^{-11} levels per reactor-year in the isopleths, these levels are not meaningless when there would be distribution of several million persons in the regions spanned by these isopleths. Societal risk from those regions would be in the range of 10^{-4} to 10^{-5} cases per reactor year - as directly derived by multiplying the individual risks and the number of persons in the regions.

-PP&L(A2)

The staff has not completed the review of the accident consequence calculations in the Limerick Risk Analysis Study referenced in the comment.

However, the licensing staff is in the process of reviewing the recent changes made to the CRAC code used at the Sandia National Laboratories and the staff will incorporate any appropriate and qualified changes into the version of CRAC currently used in licensing actions.

-PP&L(B)

See minor text change in the second paragraph of Section 6.1.4.1 Design Basis Accidents.

-PP&L(C)

The staff has recently learned of this industrial activity near the site. The staff is requesting additional information from the applicant regarding CAR-MAR activities, as well as anticipated plans for the industrial park, and will provide an evaluation in a forthcoming supplement to the Safety Evaluation Report.

-PP&L(D)

The staff has corrected the statment to indicate that there are no offsite wells that could be encountered via the northern bedrock valley pathway.

7. NEED FOR PLANT AND ALTERNATIVES TO THE PROPOSED ACTION

7.1 RÉSUMÉ

When the FES-CP was issued in June 1973, the applicant, Pennsylvania Power & Light Co., scheduled operation of the Susquehanna Steam Electric Station, Units 1 and 2, to begin operation in 1981 and 1982, respectively. In 1973, need for the plant was projected to occur between 1978 and 1982 in order to meet the projected annual energy demand increase of 7.2%. Since 1973, the oil embargo and rising electricity costs have led to a decline in growth of electrical energy and peak demands in the nation and in the PP&L service area. The PP&L service area demand for power did not continue to grow at the historical rates occurring prior to the 1973 Arab oil embargo. PP&L had projected a 1980 winter peak demand of 4970 MW, without UGI (Luzerne Electric Division of UGI Corp.), a 25% reduction from the 1973 forecast of 6600 MW. Construction has proceeded approximately on schedule with operation of Susquehanna Units 1 and 2 now scheduled for the second quarter of 1982 and the second quarter of 1983, respectively. Since 1973, PP&L has agreed to sell a 10% share of both units to the Allegheny Electric Cooperative.

During the construction-permit stage, the staff analyzed alternative sites, plant designs, and methods of power generation, including the alternative of not adding production capacity. The staff concluded, based on its analysis of these alternatives, as well as on a cost-benefit analysis, that additional capacity was needed, that a nuclear-fueled plant would be an environmentally acceptable means of providing the capacity, and that SSES, Units 1 and 2, at a specified site and of a specified design, were acceptable from both economic and environmental perspectives. Since that time, construction of SSES has been nearly completed; and many of the economic and environmental costs associated with the construction of the station have already been incurred and must be viewed as "sunk costs" in any prospective assessment.

7.2 APPLICANT'S SERVICE AREA AND REGIONAL RELATIONSHIPS

The PP&L service region is shown in Figure 8.1 of the FES-CP. The applicant supplies electric power to about 26,000 km^2 in east central Pennsylvania (22% of the area of the state). In 1973, the population of the service area was about 2.3 million (20% of the state total). Major cities served by PP&L include Allentown, Bethlehem, Harrisburg, Hazelton, Lancaster, Scranton, Wilkes-Barre, and Williamsport.

Along with the following utilities, PP&L is a signee to the Pennsylvania-New Jersey-Maryland (PJM) Interconnection Agreement: Public Service Electric and Gas Co. (PS); Philadelphia Electric Company (PE); Baltimore Gas and Electric Company (BC); General Public Utility (GPU), which consists of Jersey Central Power & Light Company (JC), Metropolitan Edison Company (ME), and Pennsylvania Electric Company (PN); Potomac Electric Power Company (PEPCO); Atlantic City Electric Company (AE); Delmarva Power & Light Company (DPL); and Luzerne Electric Division of UGI Corporation (UGI). These eleven companies, operating their transmission and generation facilities as a single system with free-flowing power interchange between companies, account for energy flow between companies and use after-the-fact accounting procedures. The agreement with PJM requires that PP&L meet its generation capacity obligation as a part of the PJM interconnection.

7.3 BENEFITS OF OPERATING THE PLANT

SSES-1 and -2 are being constructed for the purpose of assuring an adequate low cost supply of electrical energy for the needs of the PP&L and PJM service area needs. At the operating license stage, consideration of alternatives involves only the decision as to whether the plant should operate or not. This decision is based on a weighing of the benefits of operation against environmental impacts (including production costs). Potential benefits of operating Susquehanna 1 and 2 include reliability, diversity, and economic advantage.

7.3.1 Operation of the PJM Interchange

One of the most important concepts of the PJM interconnection is its economic operation as a single system with centralized dispatch of generation and free-flowing power exchanges between member companies. Transmission lines connecting the various PJM companies provide for the transfer of energy from one company to another as required to meet the loads of each company. This allows for the full utilization of the resources of all companies to meet the customer loads of all companies most economically. Coordination is not restricted to the generation phase; it is also implemented in capacity, maintenance, and transmission planning.

Central dispatch of all PJM generating units is accomplished by providing the Interconnection Office, located at Valley Forge, PA, with the necessary data, control equipment, and computers to economically load all PJM units at levels needed to meet the PJM load. The Interconnection Office, a central coordinating office, is connected to all company dispatch centers (i.e., applicant's Allentown Power Control Center) via voice, digital and analog computers, and teletypewriter circuits.

In order to meet a specific PJM load the Interconnection Office transmits to all companies the incremental cost, taken from the combined loading schedule, needed to provide generation at the required level. As the PJM load increases, higher incremental cost values are transmitted to the various companies and the level of generation is increased. Each company will raise or lower generation on its units according to the PJM incremental cost signal regardless of its own load requirement.

Occasionally, due to unit operating constraints, transmission limitations, or reliability considerations, units are operated at above the incremental cost level at either the company's or PJM's request, depending upon the circumstances.

Since some companies have a larger amount of less expensive generation, such as nuclear or coal-fired units, these companies may be generating at levels above their own load and as such may be supplying energy to other companies over the interconnected transmission lines. To provide a means of compensating for this exchange of energy between member companies, an accounting procedure, based on the split-savings principle, is used.

The interchange accounting procedure used on PJM provides both the supplying companies (sellers) and the receiving companies (buyers) with a savings as a result of the energy transactions between them. The billing for each transaction is halfway between the cost incurred by the supplying companies and the cost that would have been incurred by the receiving companies had they used their own higher-cost generation to meet their loads (split-savings principle).

7.3.2 Minimization of Production Costs

In order to determine the potential economic advantage of operating SSES, the staff studied the cost associated with operation of SSES Units 1 and 2 and the projected cost of replacement electricity. The unit costs for fuel, operation and maintenance, and the projected source and its share of supply of replacement electricity provided by the applicant are shown in Table 7.1. It appears that 75% of the replacement electricity would come from other members of the PJM interchange. Compared to other sources, the cost projections provided by the applicant are reasonable (Table 7.2). Based on the applicant's 90% share of SSES-1 and the unit's projected operation at 70%, the savings (in fuel and operation and maintenance costs) for the initial year of operation are estimated to be $64.5 million ($1980). However, the applicant's assumption as to the capacity factor of the Susquehanna units during their initial years of operation is probably high (based on the experience of nuclear units in general).[1] If a lower capacity factor were assumed, e.g., 50% to 60%, the savings per unit per year would be about $46 million to $55 million. However, the cost savings would not be confined only to the initial year of operation; the applicant would continue to save as long as SSES Units 1 and 2 were capable of operating, a period of about 30 years.

In 1980, the fuel cost for generating electricity from an oil-fired unit was 43.1 mills/kWh, which is higher than the applicant's projection (made in 1978) of 25 mills/kWh.[2] This is due to the rapid rise in the price that electric utilities paid for oil from 1978 to 1980. Hence, the savings to the applicant, using current cost of oil-fired generated electricity, would be $100 million and $118 million per unit per year, respectively (assuming the units were operating at 60% and 70% capacity factor). If it is assumed that the replacement cost of electricity to Allegheny Electric Cooperative, Inc., which owns 10% undivided interest in SSES Units 1 and 2, is the same, the total savings from the operation of SSES would be $112 million per unit per year (assuming the units were operating at 60% capacity). In calculating the savings, it was assumed that the quantity of electricity demanded would remain the same regardless of whether or not SSES were operated.

The staff views the applicant's assessment of potential savings as reasonable to conservative (ER-OL, p. 1.1-4). The results could not be significantly altered if the demand for electricity grew at a lower rate than assumed; this is because the applicant's marginal energy source would continue to be oil. Thus, the staff concludes that economic considerations justify adding the Susquehanna facility in the scheduled time period.

Table 7.1. Projected Type/Cost[a] of Replacement Energy Associated with Applicant's Share[b] of Susquehanna Unit 1

	Susquehanna Nuclear	Applicant			PJM (less applicant)		
		Coal	Oil[c]	Combustion Turbine[c]	Coal	Oil[c]	Combustion Turbine[c]
Percent or replacement energy generated	-	15	10	-	30	40	5
Fuel cost[d] (mills/kWh)	9	14	25	50	14	27	45
O&M costs[c] (mills/kWh)	4	2	1	10	2	1	10
Total operating cost (mills/kWh)	12[d]	16	26	60	16	28	55
Partial costs (million dollars)	73	13.9	15.0	-	27.8	64.9	15.9
Total costs (million dollars)	73				137.5		

[a]1980 dollars.

[b]With a 70% unit capacity factor, applicant's 90% share (945 MW) of Susquehanna Unit 1 would provide approximately 5794 GWh.

[c]Does not reflect price increases due to events in the Mideast during 1979.

[d]Due to rounding errors, column does not add up.

Table 7.2. A Relative Comparison of Projected Cost by PP&L, Commonwealth Edison, and NRC (mills/kWh)

	Nuclear	Coal	Oil
PP&L[a] (in projected $1980)	13	16	26
CE (in $1977)	9	17[c]	27
NRC[d] (in projected $1980)	10	16	

[a]From Table 7.1, in 1980 dollars.

[b]In 1977 dollars. See Reference 3.

[c]Low-sulfur coal without scrubbers.

[d]Based on 1980 as first year of operation. See Reference 4.

7.3.3 Diversity of Supply Source

Regardless of the relative economic advantage of nuclear or coal, it is to the advantage of a public utility to have diverse sources of power available. In the event of the unavailability of imported oil, major strikes, frozen coal piles, enrichment facility shortages, or regulatory uncertainties, a reliance upon one primary fuel, especially for baseload operation, could cause cutbacks in power to the grid. Currently, all of PP&L's baseload units utilize coal or oil. As noted in Table 7.1, no baseload nuclear is available to PP&L as replacement power. With the Susquehanna nuclear station in operation, PP&L will be better prepared to meet unexpected changes in the supply of coal and oil. The fact that operation of SSES Units 1 and 2 will improve the diversity of generation supply for the applicant is an important factor in support of issuing an operating license.

7.3.4 Reliability Analysis

7.3.4.1 PP&L Projections

Table 7.3 presents the applicant's historical winter peak load and energy between 1966 and 1977 and the projected winter peak load and energy sales between 1978 and 1990. The growth rates for winter peak and energy sales for the period 1966 to 1977 were 7.1% and 6.8%, respectively. The rates of increase of peak load and energy sales through the projected period 1978 to 1990 are 2.7% and 3.1%, respectively.

7.3.4.2 PP&L Reserve Margin

The PP&L reserve margin, with and without the Susquehanna facility, is presented in Table 7.4 for the period 1978 through 1985. Adjusted peak is defined to be "peak load plus sales minus purchases." Reserve is defined as "capacity minus adjusted peak," and reserve margin as "reserve divided by adjusted peak."

The rate of growth of peak demand and energy has been much smaller than anticipated during the planning for construction of Susquehanna. Consequently, the reserve margin for PP&L, even without the Susquehanna facility, is much larger than the 5% required by the interchange agreement or the 15 to 25% recommended by the Federal Economic Regulatory Commission (formerly Federal Power Administration).* At the time construction was planned (early 1970s), the reserve requirement was 20% (not 5% as now). There is, however, the possibility that this reserve requirement could increase toward the current PJM reserve requirement of 20%. If PJM summer-peaking companies tend toward winter peaking as more electric heating loads are substituted for gas and oil, the applicant's credit for peak load diversity will be reduced and its capacity obligation could approach the 20% requirement of PJM. If the PJM reserve requirement increases as a result of such conditions, it is expected that an equivalent and direct change

*PP&L's 5% reserve margin is due to diversity on the PJM system; i.e., with the exception of PP&L, all utilities belonging to PJM are summer peaking. PP&L can rely upon the capacity of other PJM utilities to support its winter peak load.

Table 7.3. Applicant's Peak Load and Energy Sales: Past and Projected[a]

Year	Energy Sales kWh × 10^6	Energy Sales % Increase	Winter Peak MW	Winter Peak % Increase
Historical				
1966	10,157	--	2,085	--
1967	10,967	8.0	2,326	13.3
1968	12,081	10.1	2,514	8.1
1969	13,531	12.0	2,850	13.4
1970	14,683	8.5	3,238	13.6
1971	15,685	6.8	3,294	1.7
1972	17,013	8.5	3,598	9.2
1973	18,865	10.9	3,662	1.8
1974	18,963	0.5	3,772	3.0
1975	19,113	0.8	4,122	9.3
1976	20,354	6.5	4,514	9.5
1977	20,926	0.3	4,431	-1.8
Projected				
1978	21,650	3.5	4,650	4.9
1979	22,400	3.5	4,790	3.0
1980	23,400	4.5	4,970	3.7
1981	24,350	4.0	5,140	3.4
1982	25,251	3.7	5,310	3.3
1983	26,110	3.4	5,480	3.2
1984	26,919	3.1	5,630	2.7
1985	27,673	2.8	5,770	2.5
1986	28,379	2.6	5,910	2.4
1987	29,069	2.4	6,030	2.0
1988	29,754	2.4	6,160	2.1
1989	30,439	2.3	6,290	2.1
1990	31,124	2.2	6,420	2.1

[a]Source: ER-OL, Table 1.1-9.

Table 7.4. 1977 Projection of Applicant's Loads, Capacity, and Reserves for the 1978-1985 Period (mid-range load projection)[a]

	1978	1979	1980	1981	1982	1983	1984	1985
Winter Peak (MWe)	4,650	4,790	4,970	5,140	5,310	5,480	5,630	5,770
Total capacities (MWe)								
Fossil (coal)	4,145	4,145	4,145	4,145	4,145	4,145	4,145	4,145
Fossil (oil)	1,640	1,640	1,640	1,640	1,640	1,640	1,640	1,640
CT & Diesel	539	539	539	539	539	539	539	539
Hydro	146	146	146	146	146	146	146	209
Nuclear	--	--	--	--	945	1,890	1,890	1,890
Firm purchase	76	76	76	76	76	76	76	76
Capacity Transactions	(41)	(50)	(110)	(65)	(31)	(62)	(93)	(125)
Total (MWe)	6,505	6,496	6,436	6,481	7,460	8,374	8,343	8,374
Adjusted peak	4,650	4,790	4,970	5,140	5,310	5,480	5,630	5,770
With Susquehanna								
Reserve (MWe)	--	--	--	--	2,150	2,894	2,713	2,604
Reserve margin (%)	--	--	--	--	40	53	48	45
Without Susquehanna								
Reserve (MWe)	1,855	1,706	1,466	1,341	1,205	1,004	823	714
Reserve margin (%)	40	36	29	26	23	18	15	12

[a]Data from ER-OL, Answer to Cost-Benefit questions January 1979, Table CAB-11.1; ER-OL, Table 1.1-4.

in the applicant's capacity obligation will occur. The staff also recognizes that additional reserve capacity above 20% may be desirable for a system with units that are large in relation to system size (as will be the case with the Susquehanna facility in service).

7.3.4.3 PJM Reserve Margin

In Table 7.5, the staff presents the reserve and reserve-margin calculations for PJM with and without the Susquehanna facility through 1985. Since there are no firm purchases or sales outside PJM and since all PJM utilities except PP&L are summer peaking, the reserve margin is defined as "capacity minus summer peak load, divided by summer peak load." Without the Susquehanna facility, the reserve margin of PJM could be as low as 23% in 1983 and 1984. In an interchange such as PJM, with about 7000 MW or more than 20% nuclear baseload operation, a 23% reserve margin might not be adequate to meet minimum reliability standards. With the Susquehanna facility, the reserve margin for PJM will be an acceptable 28% in 1983 and 1984.

Table 7.5. Projection of PJM Loads, Capacities, and Reserves

	1978	1979	1980	1981	1982	1983	1984	1985
Summer peak (MWe)	31,686[a]	33,670	34,870	36,200	37,630	39,000	40,310	41,650
Total capacities (MWe)								
Fossil (coal)	15,501	15,487	15,887	15,870	15,884	15,791	15,791	16,191
Fossil (oil)	12,132	12,132	12,132	12,132	13,164	13,383	13,993	13,525
Nuclear	6,197	8,192	8,192	8,192	9,182	10,242	11,362	13,484
CT and diesel	7,926	7,960	7,960	7,959	7,972	8,247	8,246	8,132
Hydro	2,236	2,236	2,236	2,267	2,267	2,267	2,267	2,267
Total (MWe)[b]	43,992	46,007	46,407	46,420	48,469	49,930	51,659	53,599
Reserve over summer peak:								
With Susquehanna								
Reserve (MWe)	--	--	--	--	10,839	10,930	11,349	11,949
Reserve margin (%)	--	--	--	--	29	28	28	29
Without Susquehanna								
Reserve (MWe)	12,306	12,337	11,537	10,220	9,849	8,960	9,399	10,019
Reserve margin (%)	39	37	33	28	26	23	23	24

[a]Actual 1978 summer peak; occurred on 16 August 1978.

[b]Capacity as shown in "Load and Capacity Forecast," PJM Interconnection, 1 June 1978.

7.4 ALTERNATIVES

The staff believes that the only reasonable alternative to the proposed action of granting an operating license for SSES available for consideration at the operating license stage is denying the license for operation of the facility and thereby not permitting the constructed nuclear facility to be added to the applicant's generating system. Alternatives such as construction at alternative sites, extensive station modification, or construction of facilities utilizing different energy sources would each require additional construction activity with its accompanying economic and environmental costs, whereas operation of the already constructed plant would not create these costs. Therefore, unless major safety or environmental concerns resulting from operating the plant that were not evident and considered during the construction-permit review are revealed, these alternatives are unreasonable as compared to operating the already constructed plant. No such concerns have been revealed with regard to operation of SSES.

With respect to the proposed action of operating the facility, it was shown that the addition of SSES to the PJM system is expected to result in savings in system production costs of about $112 million per year for each of the two units of SSES. Further, as stated, operation of these units will provide diversity of fuel sources, thereby decreasing dependence on fuel supplies of uncertain availability (gas, oil, and lignite) and will contribute to increased system reliability. The environmental impacts of operation are reassessed in Section 4 of this Statement. As discussed in Section 4, as a result of this reassessment, the staff has been able to forecast more accurately the effects of operation of SSES and has determined that the station will operate with acceptable environmental impact.

The alternative of not operating the facility will require the utility to substitute approximately 11 billion kWh per year of electrical energy that would have been provided by SSES with other sources of energy that have a greater economic cost and an equal or greater environmental cost. As indicated, the additional economic cost has been estimated at approximately $112 million per year for each of the two units.

After weighing the described options, the staff concludes that the preferable choice is operation of SSES.

References

1. U.S. Nuclear Regulatory Commission, "Licensed Operating Reactor Status Report," Vol. 5, No. 2, NUREG-0020, February 1981.*

2. "Energy Review," Vol. 5, No. 2, Spring 1981.

3. A. D. Rossin and T. A. Rieck, "Economics of Power," Science (201)582-589, 18 August 1978.

4. J. O. Roberts, S. M. Davis, and D. A. Nash, "Coal and Nuclear: A Comparison of the Cost of Generating Baseload Electricity by Region," NUREG-0480, December 1978.**

*Available for purchase from the NRC/GPO Sales Program, U.S. Nuclear Regulatory Commission, Washington, DC 20555, and/or the National Technical Information Service, Springfield, VA 22161.
**Available for purchase from the National Technical Information Service, Springfield, VA 22161.

8. EVALUATION OF THE PROPOSED ACTION

8.1 ADVERSE EFFECTS THAT CANNOT BE AVOIDED

The staff has re-assessed the physical, social, biological, and economic impacts that can be attributed to the operation of SSES. Inasmuch as the units are currently under construction, many of the predicted and expected adverse impacts of the construction phase are evident. The staff has not identified any additional adverse effects from those presented in the FES-CP that will be caused by the operation of the units. The applicant is committed to a program of restoration and redress of the station site that will begin at the end of the construction period.

8.2 SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

There have been no significant changes in the staff's evaluation of the use of land for the Susquehanna Steam Electric Station since the preconstruction environmental review. There have been major changes in the location of some of the transmission corridors since the FES-CP was issued; however, the staff's evaluation of the environmental impacts of the transmission lines remains essentially as before. The presence of the station in Luzerne County will continue to influence the future use of other land in its immediate environs as well as the continued removal of county land from agricultural and timber use as the result of any increased industrialization.

8.3 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

There has been no change in the staff's assessment of this impact since the earlier review except that the continuing escalation of costs has increased the dollar values of the materials used for construction and fueling of the plant. The staff has expanded and updated the discussion of uranium fuel availability in Section 8.5.

8.4 COMPARISON OF NUCLEAR AND COAL-FIRED POWER PLANTS

8.4.1 Health Effects

In addition to the environmental costs attributable to coal and nuclear fuels (Table 8.1), the differing health effects from using coal and nuclear fuels have been considered in the environmental assessment of each alternative. In making these assessments, the entire fuel cycle rather than just the power-generation phase was considered to compare the total impacts of each cycle. For coal, the cycle consists of mining, processing, fuel transportation, power generation, and waste disposal. The nuclear fuel cycle includes mining, milling, uranium enrichment, fuel preparation, fuel transportation, power generation, irradiated fuel transportation and reprocessing, and waste disposal.

In preparing this assessment it was recognized that there are great uncertainties due to the lack of an adequate data base in certain areas of each fuel-cycle alternative. The overall uncertainty in the nuclear fuel cycle is probably about an order of magnitude (increased or decreased by a factor of 10) over 100 years and about two or more orders of magnitude over 1000 years. The uncertainty associated with the coal fuel cycle tends to be much larger because of the inability to estimate total health impacts from all the pollutants released to the environment from that cycle. However, if one assumes most of the public impact over a period of several decades is caused by inhalation of sulfur compounds and associated pollutants, there is as much as a two-order-of-magnitude uncertainty in the assessment of the coal fuel cycle. The much greater uncertainty associated with the coal fuel cycle results from the relatively sparse and equivocal data regarding cause-effect relationships for most of the principal pollutants in the coal fuel cycle, the effect of federal laws on the future performance of coal-fired power plants, mine safety, and culm-bank stabilization, and the long-term impacts of coal ash and flue gas desulfurization sludges.

"Health effects," as the term is used here, is intended to mean excess mortality, morbidity (disease and illness), and injury among occupational workers and the general public ("excess" refers to mean effects occurring at a higher-than-normal rate; in the case of death, "excess" is

Table 8.1. Comparative Environmental Costs for an 1800-MWe Coal Plant and SSES at Full Output

Impact	Coal	Nuclear
Land use, ha		
Station proper and associated ponds; fuel and waste storage areas	≈1,600	470
Release to air[a]		
Dust, kg/day	20,000	None
Sulfur dioxide, kg/day	230,000	None
Nitrogen oxides, kg/day	132,000	None
Radioactivity, Ci/yr	Small	21,000
Releases to surface water		
Chemicals dissolved in blowdown, kg/day	b/	
Radioactivity, Ci/yr	None	160
Water consumed, m^3/min	≈55	106
Fuel		
Consumed, kg/day	≈20,000,000	186[c]
Ash, kg/day	≈2,000,000	
Social	Moderate	Moderate
Esthetic	Both require large industrial-type structures and cooling towers	
	Coal yard, ash pit, tall stack required	

[a]Coal-fired plant emissions estimated on the basis that the plant just meets applicable EPA standards.

[b]Information not available.

[c]Of U_3O_8.

used synonymously with "premature mortality"). The most recent and detailed assessments of health effects of the coal fuel cycle have been prepared by the Brookhaven and Argonne national laboratories.[1-6] The most complete and recent assessment of the radiological health effects of the uranium fuel cycle for normal operations was prepared for the "Final Generic Environmental Statement on the Use of Recycle Plutonium in Mixed Oxide Fuel in Light Water Cooled Reactors (GESMO I)".[7]

However, in accordance with 10 CFR Part 51.20(e), the current impact of the uranium fuel cycle (excluding reactors and mines) is defined by the 14 March 1977 revision of Table S-3, 10 CFR Part 51. [Consistent with the Commission's announced intention to reexamine the rule periodically to accommodate new information (39 FR 14188, 22 April 1974, and 42 FR 13803, 14 March 1977), staff studies are under way to determine what areas, in addition to waste management and reprocessing, may require updating in Table S-3 (Notice of Proposed Rulemaking, Docket No. RM 50-3, Environmental Effects of the Uranium Fuel Cycle, 41 FR 45849, 18 October 1976).] Using the Table S-3 effluents and the models developed for GESMO I, it was possible to estimate the impact of the uranium fuel cycle on the general public for routine operations. These values are shown in Tables 8.2-8.7 and some critical assumptions related to estimates are shown in Appendix H.

Because Table S-3 (Table 4.16) excludes radon releases from uranium mines, the health effects of such releases on the general public are not included in Tables 8.2-8.7. The effects of such releases would result in some small increases in the total risks of mortality and morbidity as discussed further under "Other Considerations."

Table 8.2. Summary of Current Energy Source Excess Mortality per Year per 0.8 GWy(e)

Fuel Cycle	Occupational Accident	Occupational Disease	General Public Accident	General Public Disease	Total
Nuclear (U.S. population)					
All nuclear	0.22[a]	0.14[b]	0.05[c]	0.18-1.3[b]	0.59-1.7 (1.0)[d]
With 100% of electricity used in the fuel cycle produced by coal power	0.24-0.25[a,e]	0.14-0.46[a,b]	0.10[c,f]	0.77-6.3[g]	1.2-6.8 (2.9)
Coal (regional population)	0.35-0.65[e]	0-7[h]	1.2[f]	13-110[g]	15-120 (42)
Ratio of coal to nuclear (range): (geometric means)	42 (all nuclear) 14 (with coal power)[i]				

[a]Primarily fatal nonradiological accidents, such as falls or explosions.

[b]Primarily fatal radiogenic cancers and leukemias from normal operations at mines, mills, power plants, and reprocessing plants.

[c]Primarily fatal transportation accidents (Table S-4, 10 CFR Part 51) and serious nuclear accidents.

[d]Values in parentheses are the geometric means of the ranges ($\sqrt{ab}$).

[e]Primarily fatal mining accidents, such as cave-ins, fires, and explosions.

[f]Primarily members of the general public killed at rail crossings by coal trains.

[g]Primarily respiratory failure among the sick and elderly from combustion products from power plants, but includes deaths from waste-coal-bank fires.

[h]Primarily coal workers pneumoconiosis (CWP) and related respiratory diseases leading to respiratory failure.

[i]With 100% of all electricity consumed by the nuclear fuel cycle produced by coal power; amounts to 45 MWe per 0.8 GWy(e).

Although Table S-3 no longer includes release estimates for Rn-222 from uranium and milling operations,* the staff has reevaluated the question and prepared new estimates which were used in this assessment. These new estimates indicate that Rn-222 releases account for most of the potential premature mortality from the uranium fuel cycle.

In addition, Table S-3 does not generically address releases for light-water-cooled power reactors. The estimated total body population dose commitments for both occupational workers and the general public were taken from GESMO I (uranium recycle only option). In addition, the occupational dose commitments to workers in uranium mines, mills, uranium hexafluoride plants, uranium fuel plants, and uranium enrichment plants were taken from GESMO I, because they are not considered in Table S-3. However, these dose commitments are comparable to those that would result from the radiological releases described in NUREG-0216, which provides background support for Table S-3.

The dose commitments to the public and occupational workers in the March 1977 Table S-3 were used for estimating health effects from the reprocessing and waste-management aspects of the uranium fuel cycle. The risk estimators used to estimate health effects from radiation dose commitments were taken from GESMO I and WASH-1400.[8]

*Effective 14 April 1978 [Fed. Reg. 43(15613) (11 April 1978)], NRC directed the staff to delete the 74.5-Ci Rn-222 source term from Table S-3 (10 CFR Part 51), and consider such health effects as might result from radon releases from mining and milling one RRY of uranium on a case-by-case basis.

Table 8.3. Excess Mortality per 0.8 GWy(e) -- Nuclear[a]

Fuel-cycle Component	Occupational Accident[b]	Occupational Disease[c,d,e]	General Public Accident[e,f]	General Public Disease[g]	Total
Resource recovery (mining, drilling, etc.)	0.2	0.038	≈0	0.085	
Processing[h]	0.005[i]	0.042	j/	0.026-1.18	
Power generation	0.01	0.061	0.04	0.016-0.20	
Fuel storage	j/	≈0	j/	≈0	
Transportation	≈0	≈0	0.01	≈0	
Reprocessing	j/	0.003	j/	0.054-0.062	
Waste management	j/	≈0	j/	0.001	
Total	0.22	0.14	0.05	0.18-1.3	0.59-1.7

[a]Breakdown of Table 8.2.

[b]L. D. Hamilton, ed., "The Health and Environmental Effects of Electricity Generation: A Preliminary Report," Brookhaven National Laboratory, July 1974.

[c]U.S. Nuclear Regulatory Commission, "Final Generic Environmental Statement on the Use of Recycle Plutonium in Mixed Oxide Fuel in Light Water Cooled Reactors," NUREG-0002 (August 1976).

[d]10 CFR Part 51, Table S-3.

[e]10 CFR Part 51, Table S-4.

[f]U.S. Nuclear Regulatory Commission, "Reactor Safety Study," WASH-1400 (NUREG-75-014), October 1975.

[g]Long-term effects from Rn-222 releases from mills and tailings piles account for all but 0.001 health effects.

[h]Includes milling, uranium hexafluoride production, uranium enrichment, and fuel fabrication.

[i]Corrected for factor of 10 error based on referenced value (report WASH-1250).

[j]The effects associated with these activities are not known at this time. Although such effects are generally believed to be small, they would increase the total in the column.

Table 8.4. Excess Mortality per 0.8 GWy(e) -- Coal[a]

Fuel-cycle Component	Occupational Accident	Occupational Disease	General Public Accident	General Public Disease	Total
Resource recovery (mining, drilling, etc.)	0.3-0.6	0-7	b/	b/	
Processing	0.04	b/	b/	10	
Power generation	0.01	b/	b/	3-100	
Fuel storage	b/	b/	b/	b/	
Transportation	b/	b/	1.2	b/	
Waste management	b/	b/	b/	b/	
Total	0.35-0.65	0-7	1.2	13-110	15-120

[a]Breakdown of Table 8.2. See also L. D. Hamilton, ed., "The Health and Environmental Effects of Electricity Generation: A Preliminary Report," Brookhaven National Laboratory, July 1974.

[b]The effects associated with these activities are not known at this time. Although such effects are generally believed to be small, they would increase the total in the column.

Table 8.5. Summary of Current Energy Source Excess Morbidity and Injury per 0.8 GWy(e) Power Plant

Fuel Cycle	Occupational		General Public		Total
	Morbidity	Injury	Morbidity	Injury	
Nuclear (U.S. population)					
All nuclear	0.84[a]	12[b]	1.0-3.1[c]	0.1[d]	14-16 (15)[e]
With 100% of electricity used by the fuel cycle produced by coal power	1.7-4.1[f]	13-14[b]	1.5-7.6[g]	0.55[h]	17-24 (21)
Coal (regional population)[i]	20-70[f]	17-34[j]	10-100[g]	10[h]	57-210 (109)
Ratio of coal to nuclear (range): (geometric means)	7.3 (all nuclear) 5.2 (with coal power)[k]				

[a]Primarily nonfatal cancers and thyroid nodules.

[b]Primarily nonfatal injuries associated with accidents in uranium mines, such as rock falls or explosions.

[c]Primarily nonfatal cancers, thyroid nodules, genetically related diseases, and nonfatal illnesses (such as radiation thyroiditis, prodromal vomiting, and temporary sterility) following high radiation doses.

[d]Transportation-related injuries from Table S-4, 10 CFR Part 51.

[e]Values in parentheses are the geometric means of the ranges ($\sqrt{ab}$).

[f]Primarily nonfatal diseases associated with coal mining such as CWP, bronchitis, and emphysema.

[g]Primarily respiratory diseases among adults and children caused by sulfur emissions from coal-fired power plants and waste-coal bank fires.

[h]Primarily nonfatal injuries among members of the general public from collisions with coal trains at railroad crossings.

[i]Coal effects are based on a regional population of 3.8 million people within 80 km of the coal plant.

[j]Primarily injuries to coal miners from cave-ins, fires, and explosions.

[k]With 100% of all electricity consumed by the nuclear fuel cycle produced by coal power; amounts to 45 MWe per 0.8 GWy(e).

The impact of accidents in fuel-cycle facilities[9] and reactors[8] generally does not markedly increase the impact of normal operations for the uranium fuel cycle, but has been included in this assessment for completeness. No comparable analysis of health effects resulting from accidents in coal-fired plants is available at this time.

Estimates of death, disease and injury from nonradiological causes for the uranium fuel cycle are from the Brookhaven evaluations,[1-3] with the exception of transportation-accident-related deaths, which were taken from Table S-4, 10 CFR Part 51. The results of these assessments are shown in Tables 8.2-8.7. It should be noted that there are two lines under the nuclear fuel cycle: the first assumes all of the electricity used within the uranium fuel cycle is generated by nuclear power (i.e., all-nuclear economy); the second line assumes, as shown in Table S-3 (10 CFR Part 51), that 100% of the electricity used within the nuclear fuel cycle comes from coal power. This is equivalent to a 45-MWe coal-fired plant, or 4.5% of the power produced.

8.4.2 The Uranium Fuel Cycle

Currently the NRC estimates that the excess deaths per 0.8 gigawatt-year electric [GWy(e)] will be about 0.47 for an all-nuclear economy. This is probably somewhat high due to the conservatism required in evaluations of generic plants and sites ("Conservatism" is used to mean that assumptions regarding atmospheric dispersion, deposition of particulates, bioaccumulation, etc., generally

Table 8.6. Morbidity and Injury per 0.8 GWy(e) -- Nuclear[a]

Fuel-cycle Component	Occupational Morbidity	Occupational Injury[b]	General Public Morbidity	General Public Injury[c]	Total
Resource recovery (mining and drilling)	d/	10	e/	≈0	
Processing[f]	d/	0.6	e/	≈0	
Power generation	d/	1.3	e/	≈0	
Fuel storage	d/	g/	e/	≈0	
Transportation	d/	<1	e/	0.1	
Reprocessing	d/	g/	e/	g/	
Waste management	d/	g/	e/	≈0	
Total	0.84	12	1.0-3.1	0.1	14-16

[a]Breakdown of Table 8.5.

[b]L. D. Hamilton, ed., "The Health and Environmental Effects of Electricity Generation: A Preliminary Report," Brookhaven National Laboratory, July 1974.

[c]Table S-4, 10 CFR Part 51.

[d]Nonfatal cancers ≤ fatal cancers (excluding thyroid) or ≈0.14. Nonfatal thyroid cancers and benign nodules ≈3 x fatal cancers or ≈0.42. Genetic defects ≈2 x fatal cancers or ≈0.28.

[e]Reactor accidents: 10 x fatalities or ≈0.40 nonfatal cases.
Normal operations: Nonfatal cancers ≤ fatal cancers or ≈0.18-1.3.
Nonfatal thyroid cancers and nodules ≈3 x fatal cancers (from total body doses) or ≈0.26-0.84.
Genetic effects ≈2 x fatal cancers (from total body doses) or ≈0.17-0.56.

[f]Includes milling, uranium hexafluoride production, uranium enrichment, and fuel fabrication.

[g]The effects associated with these activities are not known at this time. Although such effects are generally believed to be small, they would increase the total in the column.

Table 8.7. Morbidity and Injury per 0.8 gWy(e) -- Coal[a]

Fuel-cycle Component	Occupational Morbidity	Occupational Injury	General Public Morbidity	General Public Injury	Total
Resource recovery (mining and drilling)	20-70	13-30	b/	b/	
Processing	b/	3	b/	b/	
Power generation	b/	1.2	10-100	b/	
Fuel storage	b/	b/	b/	b/	
Transportation	b/	b/	b/	10	
Waste management	b/	b/	b/	b/	
Total	20-70	17-34	10-100	10	57-210

[a]Breakdown of Table 8.5. See also L. D. Hamilton, ed., "The Health and Environmental Effects of Electricity Generation: A Preliminary Report," Brookhaven National Laboratory, July 1974.

[b]The effects associated with these activities are not known at this time. Although such effects are generally believed to be small, they would increase the total in the column.

result in estimates of impact that are typically upper bound estimates. In most cases, the estimates would be lower for real plants). However, it is not greatly different from estimates by others such as Comar and Sagan[10] (0.11 to 1.0), Hamilton[1] (0.7 to 1.6), and Rose et al.[11] (0.50). The uncertainty in the estimate is about an order of magnitude for periods up to about 100 years, and probably two or more orders of magnitude for estimates as far into the future as 1000 years. If, as shown in Table S-3, 100% of the electrical power used by the uranium fuel cycle comes from coal-fired power plants, NRC estimates there would be about 1.1 to 5.4 excess deaths per 0.8 GWy(e). Of this total, about 0.62 to 4.9 excess deaths per 0.8 GWy(e) would be attributable to coal power (Table 8.6). The uncertainty in the estimate is about one order of magnitude.

The total number of injuries and diseases that might occur among workers and the entire U.S. population as a result of normal operations and accidents in the uranium fuel cycle was estimated to be about 14 per 0.8 GWy(e) for an all-nuclear economy. Injuries among uranium miners from accidents account for 10 of the 14 cases (Table 8.5). If 100% of the electrical power used by the uranium fuel cycle comes from coal-fired power plants, NRC estimates there would be about 17 to 24 injuries and diseases per 0.8 GWy(e). Of this total, about 3 to 10 excess events per 0.8 GWy(e) would be attributable to coal power (Table 8.6). The uncertainty in the estimate is also about one order of magnitude.

Although anticipated somatic (nongenetic) effects associated with normal releases of radioactive effluents from the nuclear fuel cycle are limited to potential cancers and leukemias, for the higher doses associated with serious nuclear accidents there is some small risk of various non-fatal somatic effects (Table 8.5, Footnote c). At this time only light-water-cooled power reactors have been thoroughly evaluated.[8] However, it should be noted that power reactors probably account for most of the potential health effects associated with nuclear accidents in the uranium fuel cycle.

This results from the fact that power reactors represent 80% of all fuel-cycle facilities expected to be operating for the balance of this century[7] and account for the majority of occupationally exposed individuals. In addition, although the probability of serious accidents is extremely small, if one were to occur, the health effects would be larger than for any other type of fuel-cycle facility. Serious nuclear accidents in power reactors might also contribute about 0.04 excess deaths per 0.8 GWy(e), whereas transportation-related accidents are estimated to contribute about 0.01 excess deaths per 0.8 GWy(e) (Table 8.2, Footnote c).

Early and latent nonfatal somatic effects that might be expected after high radiation doses include a variety of effects (Table 8.5, Footnote c). It is possible that nonfatal somatic effects could be an order of magnitude greater than excess deaths resulting from accidents;[8] thus, the total number per 0.8 GWy(e) would be about 0.4. This accounts for about one third of the morbidity shown for the general public and an all-nuclear economy in Table 8.5. The number of nonfatal thyroid cancers (5-10% mortality rate) and benign thyroid nodules would be about 0.6 per 0.8 GWy(e) from routine releases to the public and occupational exposures (primarily external irradiation), whereas other nonfatal cancers would be less than or equal in number to fatal cancers [about 0.2 per 0.8 GWy(e)] (Table 8.5, Footnote c).

It is believed that genetically related diseases (e.g., cystic fibrosis, hemophilia, certain anemias, and congenital abnormalities such as mental retardation, short-limbed dwarfism, and extra digits), and abnormalities in the descendants of workers and the general public from both normal operations and accidents would be perhaps twice the number of excess deaths due to cancer from total body irradiation;[6,12] this could add another 0.3 health effects per 0.8 GWy(e) among workers and 0.2 health effects per 0.8 GWy(e) among the general public (Tables 8.5 and 8.6, Footnote c).

In assessing the impact of coal power used in the uranium fuel cycle, Table S-3 (10 CFR Part 51) was the basis for the assumption that 100% of the electricity used in the uranium fuel cycle, primarily for uranium enrichment and reactor operation, came from coal-fired plants. Adding 4.5% of the health effects per 0.8 GWy(e) from the coal fuel cycle significantly increases the health effects power 0.8 GWy(e) from the uranium fuel cycle, as shown on the second lines of Tables 8.2 and 8.7.

8.4.3 The Coal Fuel Cycle*

Current estimates of mortality and morbidity resulting from the coal fuel cycle are quite uncertain; this is the principal reason for the wide range of values reported in the literature. These uncertainties result from the limited number of epidemiological studies and differences in

*See also "Activities, Effects, and Impacts of the Coal Fuel Cycle for a 1,000 MWe Electric Power Generating Plant," NUREG/CR-1060, U.S. Nuclear Regulatory Commission, February 1980.

interpretation of the results of such studies. There is additional uncertainty regarding the effects of new federal laws on coal cycle facilities in the next decade. Current estimates of excess deaths for the entire coal cycle range from 15 to 120 per 0.8 GWy(e), whereas disease and injury estimates range from 57 to 210 per 0.8 GWy(e).

In the case of occupational effects, there is considerable uncertainty because of anticipated reductions in health effects resulting from the implementation of the Federal Coal Mine Health and Safety Act of 1969 (PL 91-173). The provisions of this act should result in significant improvement of the underground work environment, particularly regarding coal dust. Coal dust is both a cause of underground explosions and fires and a cause of coal workers pneumoconiosis (CWP), commonly called black lung disease, and subsequent progressive massive fibrosis (PMF).[1-5] In addition, more coal in the years ahead is expected to be produced by strip mining, which results in lower mortality rates.[1] As a result, the frequencies of both types of events are anticipated to decline in the years ahead, on a per GWy(e) basis. On the other hand, statistics show new coal miners experience higher mortality and injury rates than experienced miners.[5] As a result of expected increases in coal production, an influx of inexperienced miners will tend to increase the mortality and injury rates for miners as a group.

For the general public, there is also considerable uncertainty in the estimation of health effects. (In the case of coal-plant effluents, consideration of health effects was limited to the population within 80 km of such plants.) For example, although there are estimates of health effects related to burning culm banks (waste banks from coal screening), recent efforts by mine operators have greatly reduced such fires, and future processing activities are expected to avoid fires as a result of new methods of stabilizing the banks to prevent slides.[13] Current estimates of excess deaths in the public from sulfates from such fires range from one to ten per 0.8 GWy(e) (Table 8.2, Footnote f). Power generation is estimated to result in 3 to 100 excess deaths per 0.8 GWy(e) (Table 8.2, Footnote f), whereas excess morbidity ranges from about 10-100 per 0.8 GWy(e) (Table 8.5, Footnote e).

The uncertainties are even greater in the power-generation phase of the coal cycle, where estimates of health effects range over several orders of magnitude.[10] This is largely due to the lack of a reliable data base for predicting health effects from the various pollutants emitted from coal plants, and the effect of the EPA New Source Performance Standards for coal plants regarding particulate and sulfur emissions in future years on a long-term basis. There is some uncertainty as to whether these standards can be met in large coal-fired power plants over the life of the plant. The major pollutants emitted include:

1. Particulates: Contain large amounts of toxic trace metals in respirable particle size[14] such as arsenic, antimony, cadmium, lead, selenium, manganese, and thallium;[5] significant quantities of beryllium, chromium, nickel, titanium, zinc, molybdenum, and cobalt;[15] and traces of Ra-226 and -228 and Th-228 and -232[16]
2. Hydrocarbons: Include very potent carcinogens (cancer-causing substances) such as benzo(a)pyrene
3. Sulfur oxides
4. Nitrogen oxides
5. Other gases: Include ozone, carbon monoxide, carbon dioxide, mercury vapor, and Rn-222

Regarding the preceding list of pollutants, there are no well-established epidemiologic cause-effect relationships that can be used to estimate total health effects accurately, either from acute exposures during air-pollution episodes or from chronic long-term exposures.

Although definitive cause-effect relationships are lacking, tentative cause-effect relationships for sulfur emissions have been used by numerous groups to estimate health effects from sulfur emissions from coal plants; they are described by the National Academy of Sciences in a recent report to the U.S. Senate.[17] The most widely quoted studies are those by Lave and Seskin,[18] Winkelstein et al.,[19] and an unpublished study by EPA that was used in the NAS/NRC study for the U.S. Senate.[17]

In general, the effects range from excess deaths from cardiovascular failure and increases in asthma attacks during severe air pollution to excess respiratory disease from long-term chronic exposures. Most of the acute deaths are among the elderly and the severely ill, whereas morbidity from long-term exposure also includes children. Although widely accepted cause-effect relationships were not derived from studies of acute air-pollution episodes in London in 1952;[20] Donora, Pennsylvania, 1948;[21] and New York,[22] these studies definitely support the conclusions regarding excess death and disease associated with emissions from combustion of coal.

There are no estimates of possible long-term carcinogenic effects by sulfur oxides or associated pollutants. In addition, the large-scale EPA Community Health and Environmental Surveillance System (CHESS) study (completed in 1976) failed to provide any new or definitive cause-effect relationships for any of the pollutants from coal-fired plants that could be used to provide better estimates of health effects than are currently available.[23] The $22 million CHESS study attempted to correlate air-pollution data collected from six U.S. cities with a variety of health problems.

Assuming that new coal-fired plants in the 1980s can meet EPA New Source Performance Standards (which could require 90% sulfur removal for high-sulfur coal and about 99% particulate removal) and other federal laws regarding mine safety and culm-bank stabilization, the number of deaths should be reduced. Thus, current estimates of 15 to 120 per 0.8 GWy(e), due largely to sulfates from combustion of coal, may be reduced by about half.

Argonne National Laboratory recently developed a predictive model for deaths from emission of benzo(a)pyrene, which indicates about 1 to 4 deaths per 0.8 GWy(e) depending on use of conventional combustion or fluidized-bed combustion.[6] Such effects, although greater than the expected deaths from the entire uranium fuel cycle (all-nuclear economy), do not significantly change the total impact of the coal fuel cycle and were not included in the effects listed in Table 8.2.

Probably the most reliable estimates of deaths associated with the coal fuel cycle are those associated with transportation accidents. Because a 1000-MWe coal-fired plant consumes about 2.7 million tonnes (three million tons) of coal per year, there are literally thousands of carloads of coal being transported by rail from mines to plants. It has been estimated that about one out of every ten trains in the U.S. is a coal train going to a coal-fired power plant.[24] These trains are estimated to travel an average distance of about 480 km from the mine to the plants.[13] As a result, there are about 1.2 deaths per 0.8 GWy(e) among workers and the general public. Further, because most of these deaths occur at railroad crossings, the numbers can be expected to increase as more automobiles are operated and driven greater distances, and as rail-transportation distances increase when hauling low-sulfur western coals to eastern markets.

Sickness among coal miners and the general public accounts for most of the nonfatal occurrences in the coal fuel cycle, with most of the remainder due to injuries among coal miners. As a result of implementation of federal laws, it is probable that future rates among underground miners will be substantially reduced. It is not unreasonable to assume that current estimates of about 57 to 210 cases of sickness and injury among workers and the general public could be reduced in the years ahead, inasmuch as occupational sickness and injury currently account for about half of the total nonfatal health effects.

The overall uncertainty in the estimates of health effects for the coal fuel cycle in this assessment is probably about one to two orders of magnitude. Although the breakdown estimates generally fall within the range of estimates in the literature, such estimates represent only the impacts occurring over a period of a few decades (e.g., while a power plant is operating) and do not include potential long-term health effects resulting from Rn-222 and toxic heavy metals which may be released to the biosphere from coal ash and flue gas desulfurization sludge waste pits. Such releases, which may occur over centuries or millenia, could substantially increase the estimated health impacts presented in this assessment. Therefore, these potential long-term impacts substantially increase the uncertainty in the health impacts just discussed.

8.4.4 Other Considerations

Although the Reactor Safety Study[8] has helped provide a perspective of the risk of mortality or morbidity from potential power-reactor accidents (the current experience for serious accidents is zero),* there is the additional problem associated with individual perception of risk. Thus,

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*In July 1977, NRC organized the independent Risk Assessment Review Group to: 1) clarify the achievements and limitations of the Reactor Safety Study (RSS); 2) assess peer comments thereon and responses to those comments; 3) study the present state of such risk assessment methodology; and 4) recommend how and whether such methodology can be used in the regulatory and licensing process. The results of this study were issued in September 1978 (NRC, "Risk Assessment Review Group Report," NUREG/CR-0400, September 1978). While praising the RSS's general methodology and recognizing its contribution to assessing the risks of nuclear power, the Review Group found that it was unable to determine whether the absolute probabilities of accident sequences in report WASH-1400 are high or low; it did conclude that the error bounds on those estimates are, in general, greatly understated. On 19 January 1979, NRC issued a statement of policy concerning the RSS and Review Group Report. NRC accepted the findings of the Review Group and concluded that the RSS's numerical estimates of the overall risks of reactor accidents should not be regarded as reliable.

The importance of this uncertainty can be better perceived by considering the effects of an increase in the risks of reactor accidents on the estimated overall mortality rate associated with the nuclear fuel cycle. Assuming the reactor accident risk to be 100 times that estimated in the RSS, the upper bound of the range of mortality per reference reactor year presented in this document from the nuclear fuel cycle could increase from 1.7 to 3.7. If, however, the risk of such accidents were lower than estimated in the RSS, the lower bound of the range of mortality would not change appreciably.

although the study concluded that "All non-nuclear accidents examined in this study, including fires, explosions, toxic chemical releases, dam failures, airplane crashes, earthquakes, hurricanes and tornadoes, are much more likely to occur and can have consequences comparable to or larger than, those of nuclear accidents," uncertainty will continue to be associated with such evaluations. Furthermore, there may be a problem of public acceptance of potential accidents, because the consequences can be severe. In fact, it appears that some people[25] more readily accept, for example, having 55,000 people actually killed each year in violent highway accidents, one or two at a time, than they do the unlikely occurrence of perhaps several thousand possible deaths from a single catastrophic accident during their lifetime.

As noted in Footnote 5 to the March 1977 revision of Table S-3 the GESMO I Rn-222 release increases from 74.5 Ci to about 4800 Ci when releases from mines are included. This would result in a small increase in the total number of excess deaths shown in Table 8.2, although the mortality per 0.8 GWy(e) for the general public would increase by about 30%.

With regard to the coal fuel cycle, it is a well-established fact that the use of coal results in numerous other costs to society that have not yet been adequately quantified. These include:

1. The short- and long-term impacts of sulfur and nitrogen oxides on biota and materials. Acid rain, for example, is known to be severely damaging to terrestrial and aquatic habitats. Argonne National Laboratory provides a detailed discussion of these and other effects of sulfur and nitrogen oxide emissions.[5] However, as more coal plants come on line, these effects can be expected to expand to surrounding areas.

2. Damage to materials, such as paints, building surfaces, statuary, and metals, caused by emissions of sulfur oxides, ozone, and nitrogen oxides. A 1976 review of such effects indicates that the costs could range into billions of dollars per year in the United States alone.[26]

3. Contamination of soil and vegetation to toxic levels by such mechanisms as deposition and bioaccumulation of trace elements present in gaseous emissions.

4. Destruction of entire ecosystems in streams and rivers by acid-mine drainage, and the potential for public-health effects from downstream use of such water for domestic or agricultural purposes.

5. In addition to the occurrence of excess mortalities, injuries, and morbidities, the costs to society in terms of medical costs, lost productivity, and other social losses, represent a significant consideration that has not been completely evaluated at this time. Two recent studies, which dealt with these extremely complex issues,[27,28] concluded that social costs from one coal-fired plant may currently be about $50 million per year, not considering the rest of the costs for the coal fuel cycle.

6. The possibility of the so-called "greenhouse effect," a phenomenon expected to occur sometime early in the next century as a result of the present and future anticipated production rates of carbon dioxide from the combustion of fossil fuels.[29] Because each 1000-MWe coal plant produces about 7.5 to 10.5 million tons of carbon dioxide per year,[1] it is believed that these emissions from hundreds of fossil-fueled power plants may result in greater releases of carbon dioxide than the atmosphere and oceans can cycle. As a result, the carbon dioxide concentrations would be expected to increase in the atmosphere. Because carbon dioxide strongly absorbs infrared, it is postulated that the mean atmospheric temperature will rise several degrees. This may cause all or part of the polar ice caps to melt, resulting in inundation of many inhabited areas of the world. At the same time, drought would be expected to prevail in many of the agricultural areas of the temperate zones, resulting in huge crop losses. It is possible that the particulates emitted by fossil plants will counteract some of the greenhouse effect by reducing the amount of sunlight reaching the surface of the earth.

   However, another effect from carbon dioxide released by coal combustion occurs because coal has essentially no carbon-14. In effect, the stable carbon dilutes the carbon-14 in the biosphere, resulting in a reduction in the radiological impact of both naturally occurring and manufactured carbon-14.

7. An additional consideration that has not been evaluated for the coal cycle is the radiological impact of mining and burning coal. Of interest is the release of radon-222 from the decay of radium-226 in coal. Not only is the radon released during mining and combustion, but it will continue to emanate from flyash for millions of years after the coal has been burned. Although Pohl[30] has shown that this is not a problem with most eastern coal (generally of high sulfur content but with 1-3 ppm uranium content), the average uranium and radium content of some reserves of low-sulfur western coal is as much as 50 times higher than that of most eastern coal.[31,32] Combustion of the coal and disposal of the remaining ash leads to about the same health effects from radon-222 emissions as do uranium-mill-tailings piles. These releases would account for less than one excess death per 0.8 GWy(e) due to fuel-cycle activities during the rest of this century. As a result, such releases do not significantly affect the conclusions reached with regard to a comparison of the two alternative fuel cycles. In addition, some

believe[33] that if the physical and biological properties of the radium released from conventional coal-powered plants (burning coal with 1-2 ppm U-238 and Th-232) are considered, such plants discharge relatively greater quantities of radioactive materials into the atmosphere than do nuclear plants of comparable size. The Environmental Protection Agency has estimated radiation doses from coal and nuclear plants of early designs and reached similar conclusions.[17]

8.4.5 Summary and Conclusions

For the reasons discussed, it is extremely difficult to provide precise quantitative values for excess mortality and morbidity, particularly for the coal fuel cycle. Nevertheless, a number of estimates of mortality and morbidity have been prepared based on present-day knowledge of health effects, and present-day plant design and anticipated emission rates, occupational experience and other data. These are summarized in Tables 8.2 and 8.5 (see Footnote k, Table 8.5), with some important assumptions inherent in the calculations of health effects listed in Appendix H.

Although future technological improvements in both fuel cycles may result in significant reductions in health effects, based on current estimates for present-day technology, it must be concluded that the nuclear fuel cycle is considerably less harmful to man than the coal fuel cycle.[1-5,10,11,27,28,33-36] As shown in Tables 8.2-8.7, the coal fuel-cycle alternative may be more harmful to humans by factors of 7 to 42 depending on the effect being considered, for an all-nuclear economy, or factors of 6 to 14 with the assumption that all of the electricity used by the uranium fuel cycle comes from coal-powered plants.

Although there are large uncertainties in the estimates of most of the potential health effects of the coal cycle, it should be noted that the impact of transportation of coal is based on firm statistics; this impact alone is greater than the conservative estimates of health effects for the entire uranium fuel cycle (all-nuclear economy) and can reasonably be expected to worsen as more coal is shipped over greater distances. In the case where coal-generated electricity is used in the nuclear fuel cycle, primarily for uranium enrichment and auxiliary reactor systems, the impact of the coal power accounts for essentially all of the impact of the uranium fuel cycle.

However, lest the results of this be misunderstood, it should be emphasized that the increased risk of health effects for either fuel cycle represents a very small incremental risk to the average public individual. For example, Comar and Sagan[10] have shown that such increases in risk of health effects represent minute increases in the normal expectation of mortality from other causes.

A more comprehensive assessment of these two alternatives and others is anticipated in 1979 from the National Research Council Committee on Nuclear and Alternative Energy Systems. This study may assist substantially in reducing much of the uncertainty in the analysis presented.

8.5 URANIUM RESOURCE AVAILABILITY

This section reviews information available from the Department of Energy (DOE) on the domestic uranium resource situation and the outlook for development of additional domestic supplies, availability of foreign uranium, and the relationship of uranium supply to planned nuclear generating capacity.

Analysis of uranium resources and their availability has been carried out by the government since the late 1940s. The work was carried out for many years by the Atomic Energy Commission (AEC). The activity was made part of the Energy Research and Development Administration (ERDA) when the agency was created in early 1975[37] and was subsequently transferred to DOE when the department was formed 1 October 1977.

8.5.1 U.S. Resource Position

To establish some basic terminology, a review of resource concepts and nomenclature would be worthwhile. Figure 8.1 defines resource categories based on varying geologic knowledge. Resources designated as ore reserves have the highest assurance regarding their magnitude and economic availability. Estimates of reserves are based on detailed sampling data, primarily from gamma ray logs of drill holes. DOE obtains basic data from industry from its exploration effort and estimates the reserves in individual deposits. In estimating ore reserves, detailed studies of feasible mining, transportation, and milling techniques and costs are made. Consistent engineering, geologic, and economic criteria are employed. The methods used are the result of more than thirty years of effort in uranium resource evaluation.

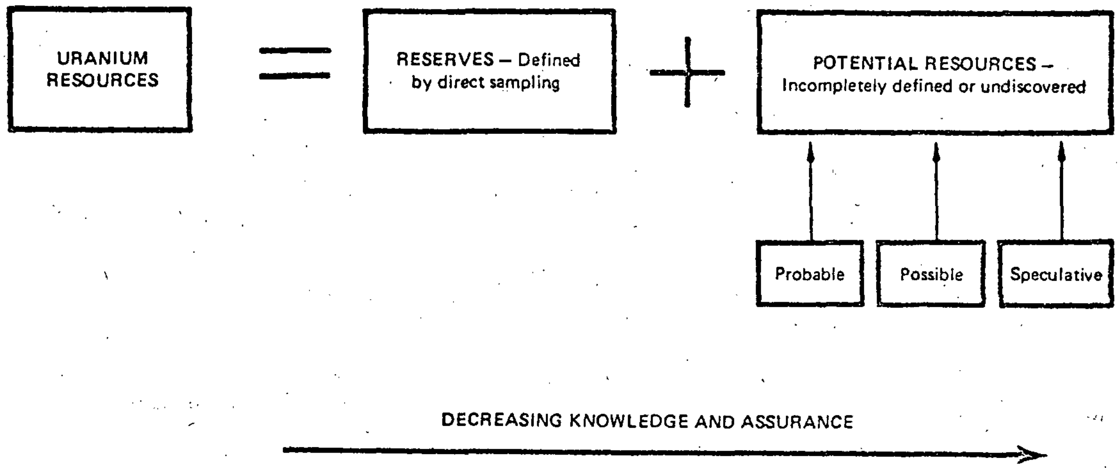

Fig. 8.1. DOE Uranium Resource Categories.

Resources that do not meet the stringent requirements of reserves are classed as potential resources. For its study of resources, DOE subdivides potential resources into three categories: probable, possible, and speculative.[38] Probable potential resources are those contained within favorable trends, largely delineated by drilling, within productive uranium districts, i.e., those having more than 10 tons of U_3O_8 production and reserves. Quantitative estimates of potential resources are made by considering the extent of the identified favorable areas and by comparing certain geologic characteristics with those associated with known ore deposits.

Possible potential resources are outside of identified mineral trends but are in geologic provinces and formations that have been productive. Speculative resources are those estimated to occur in formations or geologic provinces that have not been productive but which, based on the evaluation of available geologic data, are considered to be favorable for the occurrence of uranium deposits.

Because any evaluation of resources is dependent upon the availability of information, the estimates themselves are, to a large degree, a scorecard on the state of development of information. Thus, appraisal of U.S. uranium resources is heavily dependent on the completeness of exploration efforts and on the availability of subsurface geologic data. Since the geology of the United States as it relates to mineral deposits can never be completely known in detail, it is not possible to produce a truly complete appraisal of domestic uranium resources. It is likely that the total resource picture will eventually prove larger than currently estimated, given the nature and status of estimation methodology. The key factor may be the timeliness with which resources are identified, developed, and produced.

Conceptually, a resource, whether uranium or other mineral commodity, would initially be in the potential category. Development of additional data and clarification of production techniques and economics would be required to delineate and understand specific ore deposits to a degree that they could be categorized as reserves.

We can expect a dynamic balance between anticipated markets and prices and the extent to which exploration and reserve delineation will be done. There is no economic incentive for industry to expand reserves if the additional uranium will not be needed for many years, and especially if the long-term market outlook is uncertain. This has been true for uranium. The mining companies are concentrating on markets for the next five to fifteen years. The utilities and government are concerned with the outlook for the next thirty to forty years.

Conversion of the currently estimated potential resources into ore reserves will take many years and will cost several billion dollars. It would be difficult to economically justify accelerating such an effort to delineate ore reserve levels equal to lifetime requirements of all planned reactors covering some thirty to forty years in the future simply to satisfy planners. Supply assurance through continued timely additions to reserves and maintenance of a resource base adequate to support production demands, coupled with carefully developed information on potential resources, is considered to be adequate and a more realistic and economic approach.

The conversion of potential resources to ore reserves and expansion of production facilities can be accomplished when needed as markets expand and production is needed.

All uranium resource estimates made by DOE and its predecessor agencies before 1979 were single estimates of tons of ore and grade for various cost categories. The estimtes were made by experienced geologists and engineers according to standard procedures, and represented a reasonable measure of resources. The current procedures for estimating uranium resources provide both mean values and distributions to characterize the reliability of the estimates at specific confidence levels. All available geologic information and the expertise of the estimators are fully utilized. These procedures are standardized and documented to minimize personal biases and to facilitate reviews and revisions as new information is acquired.

The estimates of resources in the United States are developed from a data base accumulated during the past three decades of government and industry activities and enhanced by National Uranium Resource Evaluation program investigations of the past five years. Data acquired to support resource assessment have been extensive and varied. The assessment includes the evaluation of several hundred thousand industry-drilled holes; aerial radiometric surveys; sampling and geochemical analyses of groundwater, stream water, and stream sediment; selective drilling to fill voids in subsurface information; and extensive geologic field examinations. These data have been evaluated to determine those areas favorable for uranium occurrences. Evaluation criteria have been developed from studies of uranium deposits throughout the world. In favorable areas, the uranium endowment, material greater than 0.01 percent U_3O_8, is estimated, and subsequently economic factors are applied to assess the potential resources available at selected costs.

The costs used to calculate uranium resources are forward costs that consider both operating and capital costs (in current dollars) that would be incurred in producing the uranium. These costs include power, labor, materials, royalties, payroll, severance and ad valorem taxes, insurance, and applicable general and administrative costs. All previous expenditures (before the time of the estimate) for such items as property acquisition, exploration, mine development, and mill construction are excluded. Also excluded are income taxes, profit, and the cost of money. The resources assigned to the various cost categories are independent of the market price at which the uranium might be sold.

There are two major methodologies in uranium assessment: one is used for the estimation of reserves based on sample results from drill holes on specific properties, the second involves the use of a variety of geologic information to subjectively estimate potential resources. Reserves are calculated individually for properties throughout the United States using data voluntarily provided by the uranium companies to DOE. The data consist primarily of radiometric drill hole logs and maps. Parameters evaluated include thickness and tenor of mineralized rock; depth and spatial relationships, mining methods, ore dilution, and recovery; and amenability of ores to processing. The amounts of uranium that could be exploited at the forward cost levels are calculated according to conventional engineering practices utilizing available engineering, geologic, and economic data.

A regional reserves distribution estimate is obtained by mathematically combining the estimates of individual distributions for each property. These regional distributions are then combined to provide a total for the United States. Estimates include all material over a selected minimum thickness with a uranium content above 0.01% U_3O_8. A recovery factor is applied, after rate procedures are used for properties on which solution mining is in progress or is planned.

Potential resource estimates are based on geologic analogy. Geologic characteristics related to uranium potential in the area being investigated are compared with those in an area with similar characteristics, that is, a control area that contains uranium deposits for which the frequency distribution of grades and tonnages in the deposits has been developed. The analogy-based methodology is made feasible by DOE's extensive data base from which detailed characterizations of the distribution of uranium have been developed. From systematic comparison with an appropriate control area, an estimate is developed of the total amount of uranium, above 0.01% U_3O_8, that might be present in an area being evaluated. Uranium endowment factors, such as surface area, fraction underlain by endowment, grade, and tonnage are estimated at three confidence levels, i.e., a modal value that is considered as most likely, and a low and high estimate corresponding respectively to a 95 and 5% probability that the factor is at least that large. The endowment estimate is analyzed to determine the portions that are producible at various cost categories within stated confidence levels.

Table 8.8 provides the mean reserve and potential resource estimates for each cost category, as well as estimates at the 95th and 5th percentile. The 95th percentile value provides an estimate for which there is a 95% confidence that at least that amount exists. The 5th percentile provides an estimate for which there is a 5% probability that it will be exceeded. Due to the correlation of the individual estimates that are aggregated to generate the regional and national totals, the estimates at the 95th and 5th percentile are not directly additive; however, the mean values are additive.

Table 8.8. Uranium Resources of the United States[a]

Forward-cost Category	Mean	95th Percentile	5th Percentile
At \$15 per pound uf U_3O_8 [b]			
Reserves	225,000	190,000	260,000
Probable	295,000	185,000	448,000
Possible	87,000	42,000	156,000
Speculative	74,000	30,000	162,000
Totals	681,000	447,000	1,026,000
At \$30 per pound of U_3O_8 [c,d]			
Reserves	645,000	567,000	729,000
Probable	885,000	659,000	1,161,000
Possible	346,000	194,000	530,000
Speculative	311,000	155,000	600,000
Totals	2,187,000	1,731,000	2,748,000
At \$50 per pound of U_3O_8 [c,e]			
Reserves	936,000	821,000	1,060,000
Probable	1,426,000	1,102,000	1,802,000
Possible	641,000	346,000	973,000
Speculative	482,000	251,000	890,000
Totals	3,485,000	2,771,000	4,313,000
At \$100 per pound of U_3O_8 [c,f]			
Reserves	1,122,000	971,000	1,291,000
Probable	2,080,000	1,646,000	2,573,000
Possible	1,005,000	521,000	1,526,000
Speculative	696,000	378,000	1,225,000
Totals	4,903,000	3,875,000	6,056,000

[a]Uranium resources are estimated quantities recoverable by mining. Reserves shown as of 1 January 1980; other resources as of 7 October 1980. Tons U_3O_8 probability distribution values.

[b]\$6.80/kg.

[c]Includes lower cost resource categories.

[d]\$13.60/kg.

[e]\$22.65/kg.

[f]\$45.30/kg.

Conversion Factors: to convert lb to kg, multiply by 0.454.
to convert tons to tonnes, multiply by 0.907.

Most of the uranium resources are located in a few areas in the Colorado Plateau of New Mexico, Arizona, Colorado, and Utah, in the Wyoming Basins, and in the Texas Gulf Coastal Plain (Figs. 8.2 and 8.3). It should be noted that the reserve estimates in Table 8.8 were as of 1 January 1980, and the lower cost reserves have undoubtedly decreased since that date because of continuing rising costs.

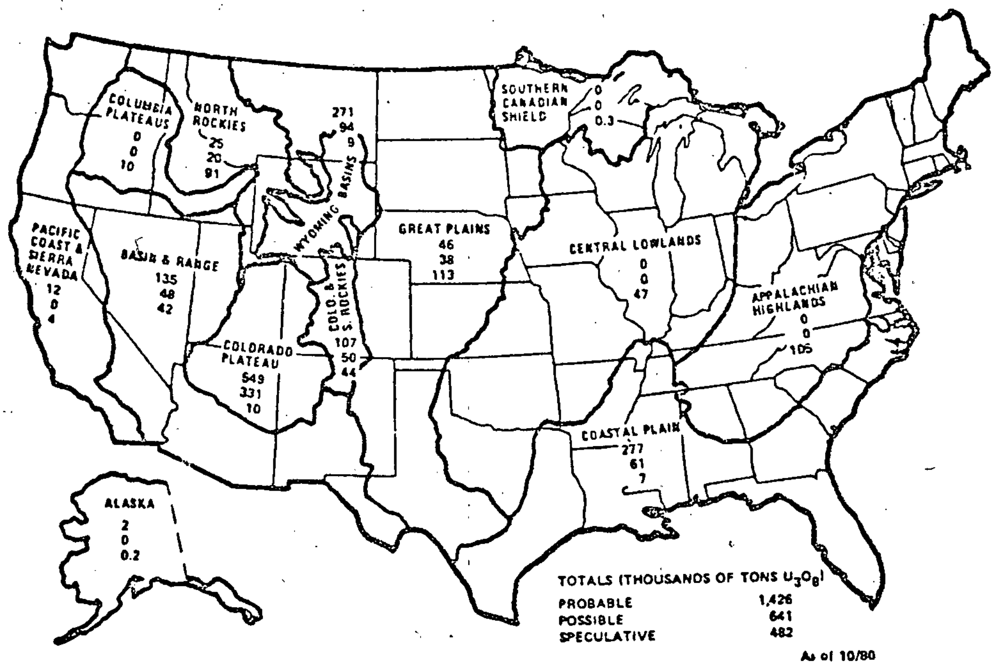

Fig. 8.2. Potential Uranium Resources by Region ($22.65/kg; $50/lb of U_3O_8).

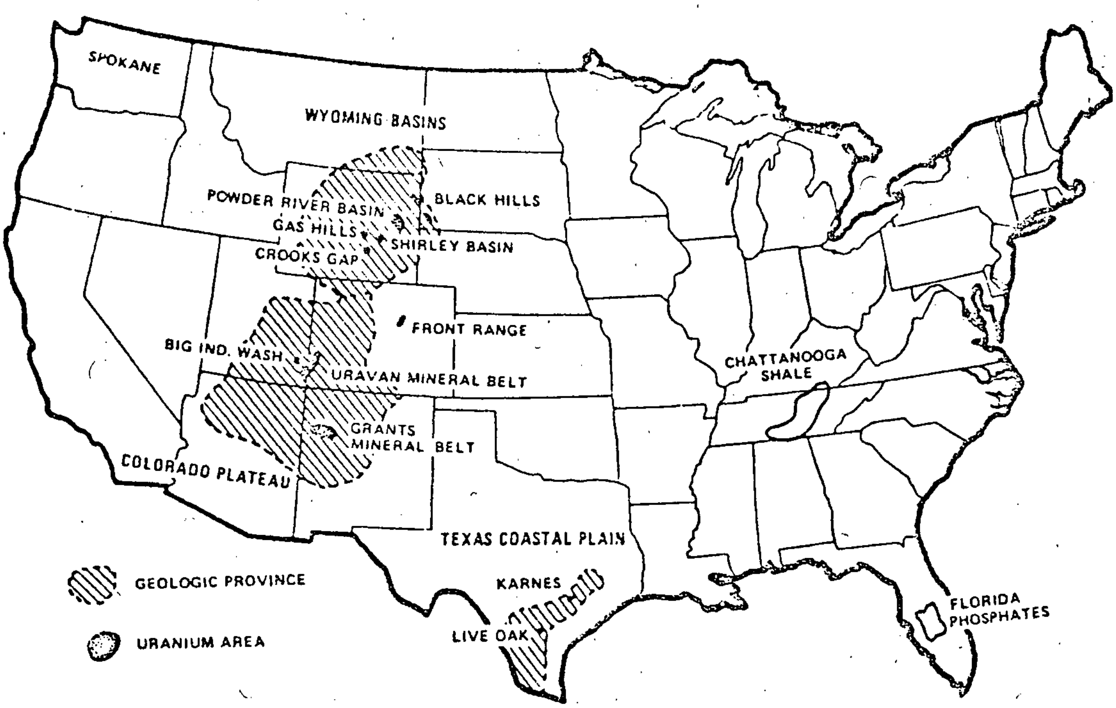

Fig. 8.3. Uranium Areas of the United States.

8.5.2 Uranium Exploration Activities

Uranium exploration in the United States reached its all-time high in 1978 as measured by the principal exploration indicator, surface drilling. Data provided to DOE by the exploration companies indicated a total of 14.6 million meters of drilling in 1978. In 1979, however, drilling declined to 12.5 million meters and the downward trend steepened during 1980 with drilling estimated to be approximately 8.5 million meters for the year (Fig. 8.4).

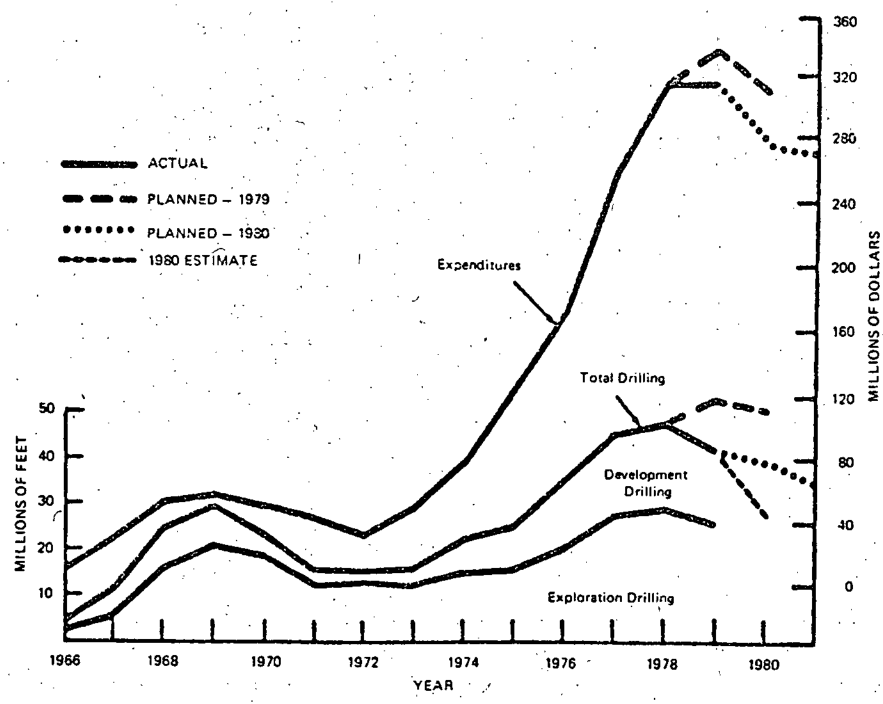

Fig. 8.4. U.S. Exploration Activity and Plans. (To convert ft. to m, multiply by 0.3048.)

Annual gross additions to reserves, a measure of exploration success, have been at high levels for the higher cost, i.e., \$13.60 to \$22.65 per kilogram U_3O_8 categories, but have been decreasing for lower cost levels. Costs have increased significantly in recent years raising the quality of resources needed to produce at a given cost level and reducing the quantities available at that level. For example, in 1979 only 907 tonnes (1000 tons) were added to \$6.80 (\$15) cost revenues, but 47,164 tonnes (52,000 tons) were removed, largely because of inflation, and an additional 12,698 tonnes (14,000 tons) were depleted by production. Hence, in 1979, \$6.80 (\$15) reserves decreased from 263,030 to 204,075 tonnes (290,000 to 225,000 tons). This trend continued in 1980. On the other hand, in 1979 some 84,351 tonnes (93,000 tons) were added to \$22.65 (\$50) reserves and 69,839 tonnes (77,000 tons) removed for a net increase of 14,512 tonnes (16,000 tons) U_3O_8. Thus, while exploration has been successful, the costs of producing the resources found are high in comparison with current prices and concurrently the cost of producing previously found resources has also increased.

The sharp rise in exploration resulted from the increase in prices in the 1974 to 1976 period, the active procurement activity of utilities, and the optimistic projections of future growth in uranium demand. Many new companies became active in exploration. More than 150 companies were involved in exploration in 1979. Considering the drop in requirement projections, the level of activity reached probably was in excess of real needs. Therefore, some reduction of effort more in line with future needs is not detrimental.

8.5.3 Domestic Uranium Production and Capability

Domestic uranium production in 1980 was 19,573 tonnes (21,850 tons) U_3O_8 in concentrate. This represents a 15% increase over 1979 and is the highest U.S. production level for any single year. Production in recent months has been at record rates; the equivalent of more than 19,954 tonnes (22,000 tons) U_3O_8 per year. This production comes from conventional mine-mill operations as well as from such nonconventional sources as solution mining and byproduct recovery from processing of other minerals. The high production levels are in response to prior sales contracts. Buyers are actually receiving uranium in excess of their currently scheduled needs.

Several new uranium processing facilities are under construction or planned, which could bring the total national capacity to around 27,000 tonnes (30,000 tons) per year by the mid-1980s.

Despite the increases in ore throughput and uranium production in 1980, a widespread curtailment of uranium mining and milling activities is underway. Production at some operating mines has been reduced and some planned mill expansions and construction are being postponed. The reduction in mine output will not be reflected in decreased uranium production until mine and mill ore stockpiles are reduced.

Studies have been conducted on attainable uranium production levels from uranium reserves in the United States and related costs. The uranium production capability projections should not be construed as being estimates of actual future supply, but simply as potential production that may be available to meet whatever demand eventually exists.

Using the "production center" concept, U.S. uranium production capability has been projected from ore reserves estimated as of January 1980, to be available at forward costs of $13.60 to $22.65 per kilogram U_3O_8 or less. The production centers consist of operating (Class 1), committed (Class 2), planned (Class 3) uranium extraction and processing facilities, and projected (Class 4) facilities based on probable potential resources. The study included conventional mills supplied by open-pit and/or underground mines; solution mining and heap-leach operations; and operations where uranium is recovered as a byproduct of phosphate, copper, or beryllium mining and processing activities.

Projections are based primarily on operating conditions--average ore grades, mill recoveries, and operating and capital costs--similar to those currently prevalent in the uranium mining and milling industry. Specific information on company plans, costs, and operating methods has been considered.

Figure 8.5 shows the total projected production capability for $13.60 ($30) resources by resource category. Figure 8.6 shows the capability for $22.65 ($50) resources. Projected uranium demand and current sales commitments are also shown. Domestic demand is based on the DOE's Office of Uranium Resources and Enrichment (URE) 1980 nuclear-power growth projections, assuming no reprocessing and a 0.20% U-235 enrichment tails assay.

8.5.4 Domestic Reactor Requirements

The outlook for uranium requirements is closely related to the growth of nuclear power. On 1 December 1980, 75 nuclear power reactors were licensed to operate in the United States, concentrated mostly in the East and Midwest. These plants have an electrical generating capacity of 55 GWe. In addition to operating plants, 86 plants are under construction with a total rated capacity of 95 GWe. Some of the plants are at such an early construction stage that they may be deferred or canceled completely. An additional 17 reactors with 20 GWe capacity are on order. Together the group aggregates 170 GWe of capacity. However, the future for some of the ordered reactors is questionable.

Latest projections of nuclear-power growth by URE and the Energy Information Administration (EIA) (Table 8.9) show an increase in nuclear power licensed to operate from 55 GWe at the end of 1980 to 96 GWe in 1985, 129 GWe in 1990, 155 GWe in 1995, and 180 GWe in 2000. EIA also projected a low case of 160 GWe and a high case of 200 GWe for the year 2000.

There are alternative views on U.S. power growth. The DOE's Office of Planning and Analysis has projected nuclear growth to the year 1990 at 125 GWe and to the year 2000 at 150 GWe, based on historic delays to nuclear power growth. The DOE Office of the Assistant Secretary of Nuclear Energy has projected 400 GWe, based on energy demand, growth, nuclear competitiveness, and industry construction capability. All of these values are sharply reduced from the projected growth of the nuclear industry of just a few years ago. For example, in 1976 U.S. nuclear capacity in the year 2000 had been projected to be 500 GWe, and in 1978 it had been projected to be 320 GWe.

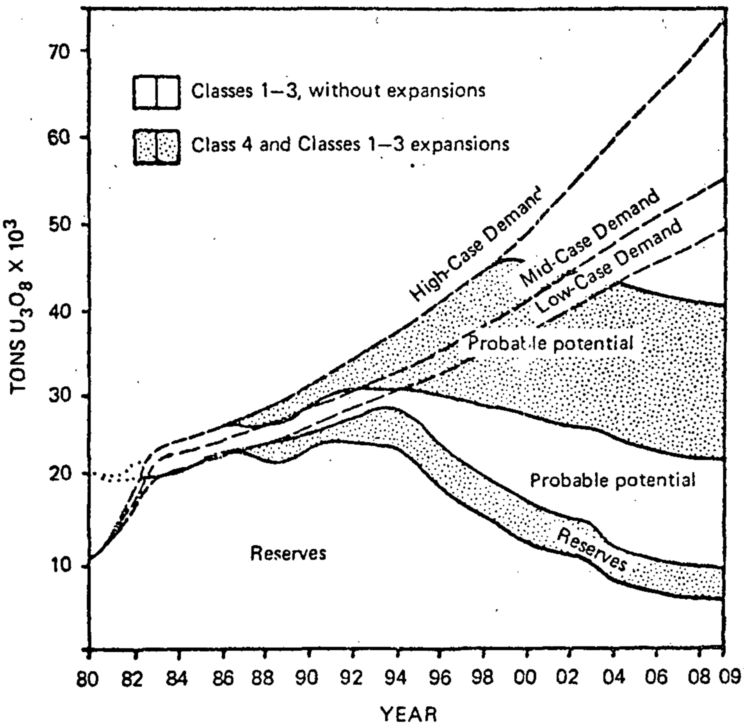

Fig. 8.5. Estimated Annual Near-term Production Capability from Resources Available at \$13.60/kg of U_3O_8 or Less with Class 1, 2, and 3 Expansions and Class 4.

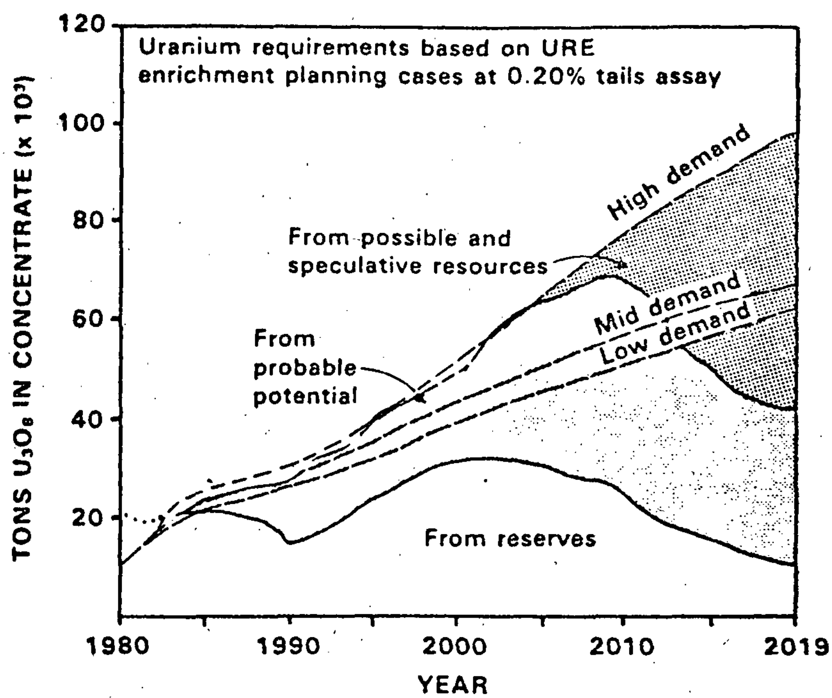

Fig. 8.6. Annual Production Capability from Resources Available at \$22.65/kg of U_3O_8 or Less Projected to Meet Nuclear-Power Growth Demand.

Table 8.9. U.S. Nuclear-Power Growth Projections, June 1980

End of Year	Power Range (GWe)		
	Low	Mid	High
1985	85	96	105
1990	125	129	140
1995	142	155	165
2000	160	180	200

Even at the more conservative estimates, nuclear capacity still is expected to expand substantially and to provide a significant portion of future domestic electric capacity. Current methods of projecting nuclear growth and uranium requirements are based on estimates of reactor startup dates considering construction and licensing times, and systems power requirements. Accurate forecasts have proven to be difficult.

The uranium needed to be delivered by uranium concentrate-producing plants as fuel for the nuclear plants will also increase over time; for the URE mid-case, from 12,063 tonnes (13,300 tons) U_3O_8 in 1981 to 21,405 (23,600) in 1985, 26,212 (28,900) in 1990, 31,745 tonnes (35,000 tons) in 1995, and 36,280 tonnes (40,000 tons) in 2000, if the enrichment plants are operated at 0.20% U-235 tails assay. Cumulative uranium requirements through the year 2000 range from 462,570 to 562,340 tonnes (510,000 to 620,000 tons) U_3O_8 with 516,990 tonnes (570,000 tons) U_3O_8 for the mid-case.

Uranium requirements are based on normal lead times for fuel-cycle steps and current technology for enrichment and for reactor design and operation. There are possible improvements in enrichment that would allow use of lower tails assays, which would reduce uranium requirements. There are also possible improvements to reactor design and operation that could reduce uranium requirements. These factors are not likely to have a significant impact on uranium demands until at least well into the 1990s.

8.5.5 Uranium Inventories

Buyers' inventories of uranium have been increasing for several years as actual deliveries have been in excess of needs. Inventories at the beginning of 1980 totalled 32,742 tonnes (36,100 tons) of natural uranium (Table 8.10), with 25,033 tonnes (27,600 tons) held by utilities. In 1980, U.S. utilities sent an equivalent of 15,691 tonnes (17,300 tons) U_3O_8 to the DOE gaseous diffusion plants for enrichment. Thus, the 25,033 tonnes (27,600 tons) inventory level amounted to 1.6 years of U.S. utilities' needs. Of those U.S. utilities that responded to questions on inventory levels, most indicated that they desire a level amounting to about one year's needs, although some reported inventory levels as small as three month's needs, while others desire inventories as great as two year's needs. Producers also had inventories of about 2,177 tonnes (2,400 tons) U_3O_8 at the beginning of 1980, which is about a normal working inventory. The outlook is for a continuing buildup of buyers' inventories, as current contracted deliveries are in excess of actual needs.

Table 8.10. Buyers' Inventories of Natural Uranium in Tons U_3O_8

Beginning of Year	Domestic Origin	Foreign Origin	Total
1976	22,600	1,100	23,700
1977	25,800	3,500	29,300
1978	25,100	3,600	28,700
1979	28,000	5,200	33,200
1980	30,800	5,300	36,100

Conversion Factor: to convert tons to tonnes, multiply by 0.907.

8.5.6 Analysis of Production Capability and Reactor Capacity

Study of attainable production capability from currently estimated $13.60 ($30) U.S. ore reserves and probable potential resource indicates that production levels of 40,815 tonnes (45,000 tons) U_3O_8 per year can be achieved with aggressive resource development and exploitation, including both mining and milling. Although the level may be achieved by use of domestic $13.60 ($30) ore reserves and probable resources alone, development and utilization of $30 possible and speculative categories and use of $22.65 ($50) ore reserves and potential resources would provide added assurance that the levels could be attained and sustained. Considering the use of $22.65 ($50) resource, a level of 54,240 tonnes (60,000-tons) per year supply is achievable from currently estimated resources. Such a level could be reached by the early 1990s. Imported uranium and inventories would add to the supply from these projections.

The level of nuclear generating capacity supportable with 54,240 tonnes (60,000 tons) per year of uranium, will vary with enrichment tails assay and recycle assumptions. Without recycle of uranium or plutonium and with a 0.30% U-235 enrichment tails assay, about 260,000 MWe could be supported. Without recycle and at 0.20% tails assay, about 310,000 MWe could be supported. With recycle of uranium and plutonium and a 0.20% tails assay, about 520,000 MWe could be supported. All the levels of supportable capacity are above the 170,000 MWe of capacity in operation (55,000 MWe), under construction (95,000 MWe), and on order (20,000 MWe), as of late 1980. Thus, currently estimated resources can provide adequate uranium supplies for a sizable expansion to U.S. nuclear generating capacity.

The cumulative lifetime (30 years) uranium requirements for all of the above reactors (170,000 MWe) would be about 0.907 million tonnes (1.0 million tons) U_3O_8 at 0.20% enrichment tails with no recycle, compared to the 1.45 million tonnes (1.6 million tons) mean value in $13.60 [($30) or the 2.27 million tonnes at $22.65 (2.5 million tons at $50)] ore reserves, by-product, and probable potential resources. Evaluation of long-term fuel commitments on the basis of ore reserves and probable potential resources is considered a prudent course for planning. The lifetime commitment would be less than one third of currently estimated $22.65 ($50) domestic resources, including the possible and speculative categories (see Table 8.8).

8.5.7 Uranium Resource Recovery

In regard to the availability of estimated uranium resources considering recoveries in mining and ore processing, estimates of U.S. uranium resources represent the quantity of uranium estimated to be minable expressed as tons of U_3O_8 of ore in the ground. These estimates are a reflection of the information available to DOE at the time of the estimate; thus, they are dependent on the extent of exploration. In view of the considerations involved in preparing the resource estimates and the uranium resource outlook, no adjustment for losses is warranted.

U.S. mining practice results in recovery of high percentages of the uranium contained in a deposit. DOE resource estimation procedures consider the capabilities and requirements of mining systems currently in use so that the estimates are a realistic appraisal of what is minable. Because deposits frequently are not fully delineated before they are developed, it is not unusual for more uranium to be recovered from deposits than was included in ore reserves before such deposits were put into production. Mining company practice seeks to recover as much of the contained mineral content as possible before abandoning a mine. A strong incentive for such practice is the increase in financial returns. In the processing of uranium ores, recoveries generally are over 90%; in 1980, mill recovery averaged about 93%. Higher recoveries are usually possible if economically justified.

8.5.8 High Cost Resources

An alternative to identification of additional low-cost resources is the utilization of higher cost resources. The highest cutoff cost category included in DOE resources in Table 8.8 is $45.30/kg of U_3O_8. This level is an upper range of what might be of interest for utilization in light water reactors over the next few decades.

The increased price of oil and coal in the last few years has been a contributing factor to the increased price of uranium economically acceptable in light water reactors. This impact results from the relative insensitivity of nuclear electric power costs to increases in uranium prices. The cost of fuel is a very small fraction of the cost of power from a nuclear plant. In turn, the cost of natural uranium is only a small fraction of the fuel cost; enrichment, fabrication, reprocessing, and carrying charges make up the balance. As a result, large increases in uranium prices result in comparatively small increases in power costs. As pointed out in Section 8.5.6, nuclear capacity currently in operation, under construction, and on order is expected to have adequate supplies of U_3O_8 at prices much lower than $45.30/kg in 1980 dollars.

Knowledge of U.S. resources in the above \$22.65 (\$50) category is meager, largely because of the lack of past economic interest. There has been virtually no industry activity to search for or to develop such resources. Prospects for discovery of higher cost resources in the United States are considered promising at this stage of U.S. exploration. The principal large, very low-grade deposits that have been studied in some detail in the past are the shales and phosphates. The Chattanooga shale in Tennessee is of particular interest because of its large size. This deposit was extensively drilled, sampled, and studied in the 1950s. The higher grade part of the Chattanooga shale has an average uranium content of about 60 to 80 ppm compared to 1500 ppm in present-day ores. It contains in excess of 4.5 million tonnes (5 million tons) of U_3O_8 that may be producible at a cost of \$45.30 or more per kilogram of U_3O_8. Additional work to develop production technology will be needed.

If Chattanooga shale were mined to fuel an 1150-MWe reactor, assuming recycle of uranium (but not of plutonium) and a 0.3% enrichment tail, about 11,428 tonnes (12,600 tons) of shale would have to be processed each day; with uranium and plutonium recycle (should that be practiced) and 0.20% enrichment tails, about 7,710 tonnes (8500 tons) per day would have to be processed. An average of about 10,250 tonnes (11,300 tons) of coal would have to be burned each day if 20 MJ/kg of coal were used to produce power equivalent to that produced by a 1150-MWe reactor.

Utilization of the very low-grade resources such as Chattanooga shale would, of course, involve mining and processing very much larger quantities of ore than is currently mined to produce the same amount of uranium. From an environmental as well as from an economic point of view, identification and utilization of additional higher grade ores would be preferable. However, the shales are available if their use should become necessary.

8.5.9 Prices

During the period 1973-1979, the average delivery price per kilogram of U_3O_8 for sales from domestic producers to domestic buyers, in year-of-delivery dollars, increased from \$3.22 to \$10.80, as shown in Table 8.11.

Table 8.11. Historical Trend of Average Uranium Prices

Year	Final Price[a]
1973	3.22
1974	3.58
1975	4.76
1976	7.30
1977	8.95
1978	9.78
1979	10.80

[a] In dollars/kg in year-of-delivery dollars.

Future prices for material under contract as of 1 July 1980, as reported to DOE, is shown in Table 8.12. Also shown are the percentages of material under contract price arrangements covering the price presented. The remainder is in market price contracts or in captive production.

8.5.10 Foreign Uranium Resource Position

The most reliable source of information on world uranium resources is that compiled by the Working Party on Uranium Resources sponsored jointly by the Nuclear Energy Agency (NEA) and the International Atomic Energy Agency (IAEA). This group has been gathering and publishing uranium resource estimates since 1965 and includes most of the significant uranium resource countries. In compiling its estimates, this group classifies resources as "reasonably assured" resources

Table 8.12. Average Contract Prices and Settled Market Price Contracts for Uranium, 1 July 1980

Year	Price[a]	Percentages of Procurement under Contract Price Contracts
1980	11.78[b]	66
1981	13.00[b]	55
1982	15.76	47
1983	18.75	43
1984	19.68	35
1985	19.68	32
1986	21.22	16
1987	19.73	18
1988	19.34	22
1989	23.49	23
1990	24.12	16

[a] In dollars/kg in year-of-delivery dollars.

[b] These years include settled market price contracts. Market price contract prices are determined sometime before delivery, based on prevailing market prices.

(roughly comparable to ore reserves in the usual mining industry sense) and "estimated additional" resources (roughly comparable to DOE's probable potential resources). Resources in the world outside of the centrally planned economies area (WOCA) are tabulated by continents and major countries in Table 8.13.

Almost 80% of these resources are concentrated in three continents: North America, Africa, and Australia. Six countries, within those continents--the United States, Canada, South Africa, Namibia, Niger, and Australia--have about three quarters of the reasonably assured resources. This geographic concentration is a reflection of the geologic favorability of these areas as well as the extent of exploration and resource appraisal efforts to date.

8.5.11 Foreign Production Capacity and Plans

Studies by the NEA and the IAEA have also provided reliable information on world production capacity. The current production capacity of existing non-U.S. plants (Class 1) is about 34,466 tonnes (38,000 tons) U_3O_8 annually, as shown in Table 8.14. This production is primarily in Canada, France, Namibia, Niger, and South Africa.

Construction of new plants (Class 2) with a capacity of about 7,256 additional tonnes (8,000 tons) is taking place, primarily in Australia and Canada. Plants that are planned (Class 3), could increase total annual production by another 32,652 tonnes (36,000 tons) U_3O_8 for a total of 76,188 tonnes (84,000 tons) U_3O_8 by 1990. Since needs for uranium are well below attainable production capacity levels, and prices would not justify all operations, it is likely that many of the projected plants will be built on a deferred schedule. It is also possible that some new plants will replace existing operations. Countries of particular significance in future production expansion are Australia and Canada, which have 82% of capacity under construction and 70% of the planned additional capacity.

8.5.12 Foreign Reactor Requirements

The uranium requirements in non-Communist foreign countries have been projected by the Energy Information Administration based on the reactors planned and timing of construction. Table 8.15 shows three cases of power plant growth which, by the year 2000, range from 300 to 400 GWe of

Table 8.13. World Uranium Resources by Continent[a]

Continent	Reasonably Assured $30/lb[b]	Reasonably Assured $50/lb[b]	Estimated Additional $30/lb[b]	Estimated Additional $50/lb[b]
North America				
United States	645	940	885	1,430
Canada	280	305	480	945
Other	9	44	44	65
Total	930	1,290	1,410	2,440
Africa				
South Africa	320	508	70	180
Niger	210	210	69	69
Namibia	152	173	39	69
Other	109	115	2	22
Total	790	1,000	180	340
Australia				
Total	380	390	165	180
Europe				
France	51	72	34	60
Spain	13	13	11	11
Sweden	1	390	0	4
Other	22	31	19	53
Total	90	510	60	130
Asia				
India	39	39	1	31
Other	13	21	0	0
Total	50	60	0	30
South America				
Brazil	96	96	117	117
Argentina	30	36	5	12
Other	0	0	7	8
Total	130	130	130	140
Worldwide total (rounded)	2,400	3,400	1,900	3,300

[a]Modified from "Uranium Resources, Production and Demand" OECD, Nuclear Energy Agency (NEA), and the International Atomic Energy Agency (IAEA), December 1979. "World" refers to world outside centrally planned economic area. Resources given in 1000 tons U_3O_8.

[b]Includes resources at $30 per pound of U_3O_8.

Conversion Factors: to convert tons to tonnes, multiply by 0.907
to convert $/lb to $/kg, multiply by 0.453.

Table 8.14. Foreign Uranium Production Capability[a]

Year	Australia 1[b]	2	3	Canada 1	2	3	France 1	2	3	Namibia 1	2	3	Niger 1	2	3	S. Africa 1	2	3	Other[c] 1	2	3	Foreign Total 1	2	3
1980	1.3	0	0	9.8	0	0	4.5	0	0	5.3	0	0	5.2	0	0	8.3	0	0	4.1	0	0	38.5	0	0
1981	1.8	1.1	0	9.8	1.4	0	4.5	0.2	0	5.3	0	0	5.2	0	0	8.3	0	1.2	4.1	0	0.8	39.0	2.7	2.0
1982	1.8	3.3	0	9.8	1.9	0	4.5	0.5	0	5.3	0	0	5.2	0	0	8.3	0	2.9	4.1	0	3.0	39.0	5.7	5.9
1983	1.8	3.3	0	10.5	1.9	2.0	4.5	0.7	0	5.3	0	1.2	5.2	0	0	8.3	0	4.6	4.1	0	4.1	39.7	5.9	11.9
1984	1.8	3.3	0	11.0	2.9	4.0	4.5	0.7	0	5.3	0	1.2	5.2	0	0.7	8.3	0	5.2	4.1	0	4.4	40.2	6.9	15.5
1985	1.8	3.3	6.5	12.0	2.9	5.0	4.5	0.7	0	5.3	0	1.2	5.2	0	2.5	8.3	0	5.5	4.1	0	5.1	41.2	6.9	25.8
1986	1.2	3.3	11.5	12.0	2.9	7.2	4.5	1.4	0	5.3	0	1.2	5.2	0	5.2	8.3	0	5.6	4.1	0	5.1	40.6	7.6	35.8
1987	1.2	3.3	11.5	12.0	2.9	7.2	4.5	1.4	0	5.3	0	1.2	5.2	0	5.2	8.3	0	5.6	4.1	0	5.2	40.6	7.6	35.9
1988	1.2	3.3	11.5	12.0	2.9	7.2	4.5	1.4	0	5.3	0	1.2	5.2	0	5.2	8.3	0	5.5	4.1	0	5.3	40.6	7.6	35.9
1989	1.2	3.3	11.5	12.0	2.9	7.2	4.5	1.4	0	5.3	0	1.2	5.2	0	5.2	8.3	0	5.5	4.1	0	5.4	40.6	7.6	36.0
1990	1.2	3.3	11.5	12.0	2.9	7.2	4.5	1.4	0	5.3	0	1.2	5.2	0	5.2	8.3	0	5.2	4.1	0	5.5	40.6	7.6	35.8
Total																							84.0	

[a]In thousand tons U_3O_8 per year.

[b]Class: 1. Currently operating plants
2. Plants under construction
3. Planned plants

[c]Includes Argentina, Brazil, CAR, Gabon, India, Italy, Mexico, Portugal, Spain, Yugoslavia. Based on "Uranium Resources, Production and Demand," December 1979.

Conversion Factor: to convert tons to tonnes, multiply by 0.907.

Table 8.15. Foreign Nuclear Capacity and Uranium Requirements

	Capacity (GWe)			Requirements (tons U_3O_8)[a]		
Year	Low	Mid	High	Low	Mid	High
1980	66	68	77	17,300	18,400	19,800
1985	117	124	128	24,000	26,200	29,200
1990	165	181	201	27,500	31,600	32,700
1995	229	252	280	34,600	41,500	47,800
2000	300	350	400	42,700	54,100	64,300

[a]0.20% U-235 tails assay.

Conversion Factor: to convert tons to tonnes, multiply by 0.907.

nuclear power in operation. The mid-case is taken as the most likely one. However, nuclear power growth projections have been subject to continual downward revision in the last several years.

In order to supply these nuclear plants, EIA has estimated the amount of uranium required assuming 0.20% U-235 enrichment plant tails and no recycle of uranium or plutonium. Table 8.15 gives the annual tons U_3O_8 from 1980 to 2000 for high-, mid-, and low-cases.

For the mid-case foreign requirements increase from 16,689 tonnes (18,400 tons) U_3O_8 in 1980 to 23,763 tonnes (26,200 tons) U_3O_8 in 1985, and to 49,069 tonnes (54,100 tons) U_3O_8 in the year 2000. Cumulative requirements through the year 2000 total 650,319 tonnes (717,000 tons) U_3O_8.

If all the planned foreign mine-mill production came on-stream as currently projected, there would be considerable excess capacity. If only operating mills or those under construction were available by the late 1980s, production capacity would cover annual demands through the late 1990s.

Additional projections of WOCA nuclear growth and uranium requirements were developed during the International Nuclear Fuel Cycle Evaluation (INFCE). While the projections are now considered as high by many, they do provide an additional, more optimistic, viewpoint on future nuclear growth. The INFCE low case--modified to exclude the United States--indicated a growth in foreign (WOCA) nuclear capacity from 82 GWe at the end of 1980 to 217 GWe in 1990 and to 580 GWe in the year 2000. Corresponding foreign uranium requirements would be 19,047 tonnes (21,000 tons) in 1980, 45,350 tonnes (50,000 tons) in 1990, and 108,840 tonnes (120,000 tons) in 2000. Such projections indicate a much larger possible growth in future uranium demands.

8.5.13 Foreign Competition and the Domestic Industry

The concentration of world uranium resources and production has, in past periods of low prices and ore production, fostered attempts to form cartel-like organizations seeking to restrict the free movement of uranium and influence pricing. The concentration of uranium production in a few countries will continue for some time, though there is an increasing diversity of supply sources. The opportunity for future foreign cartel-like activities will continue, particularly if uranium producer country governments are involved, which has been the case in the past. However, the severe criticism of such practice and the legal actions that have resulted in the United States might operate to discourage such activities in the future. Since the United States has the capability of producing a large portion, or all, of its uranium needs, and since United States uranium buyers historically have shown a strong preference for domestic uranium, the United States is not expected to develop a large dependence on foreign uranium. These factors would tend to reduce the susceptibility of the United States to direct impacts of any cartel-like activity.

8.5.14 Conclusions

In conclusion, DOE assessment of uranium resources indicates that currently estimated ore reserves and probable potential resources at forward costs up to \$13.60/kg U_3O_8 total more than 1.36 million tonnes (1.5 million tons), and at forward costs up to \$22.65/kg U_3O_8 total almost 2.17 million tonnes (2.4 million tons). The 2.17 million tonnes (2.4 million tons) U_3O_8 will support 390 GWe of nuclear power generating capacity, assuming a 30-year life for the reactors, no spent fuel reprocessing and an enrichment plant tails assay of 0.20% U-235. Under the latest DOE forecast for nuclear generating capacity in the post-2000 period, these resources should support U.S. nuclear power growth, including SSES 1 and 2, well into the next century. However, meeting the uranium requirements for an expanding U.S. nuclear power industry will require extensive industry efforts to sustain exploration, and success in discovering and developing the potential uranium resources.

Foreign uranium resources are substantial and have been growing. Some of the more recently discovered deposits, especially in Canada and Australia, will have comparatively low-cost uranium production. The staff, therefore, concludes that there will be sufficient nuclear fuel available for SSES 1 and 2.

8.6 DECOMMISSIONING

Termination of a nuclear license is required at the end of facility life. Such termination requires decontamination of the facility so that the level of any residual radioactivity remaining at the site is low enough to allow either unrestricted use of the site for nuclear or nonnuclear purposes. The objective of NRC regulatory policy in decommissioning nuclear facilities is to ensure that proper and explicit procedures are followed to mitigate any potential for adverse impact on public health and safety or on the environment.

Three alternative methods can be and have been used to decommission reactors.[39] DECON means to remove immediately all radioactive materials down to levels that would permit the property to be released for unrestricted use. SAFSTOR is defined as those activities required to place and maintain a radioactive facility in such condition that 1) the risk to safety is within acceptable bounds and 2) the facility can be safely stored for as long a time as desired and subsequently decontaminated to levels that would permit release of the facility for unrestricted use. ENTOMB means to encase and maintain property in a strong and structurally long-lived material to ensure retention until radioactivity decays to a level acceptable for releasing the facility for unrestricted use.

For a large BWR, DECON is estimated to cost $43.6 million (in 1978 dollars); SAFSTOR is estimated to cost $59.9 million with a 30-yr safe-storage period and $55.6 million with a 100-yr safe-storage period. ENTOMB is estimated to cost $35.0 million with the pressure vessel and its internals retained and $41.7 million with the pressure vessel and internals removed; a $40,000 annual maintenance and surveillance cost would be added in both cases. Either ENTOMB option requires indefinite dedication of the site as a radioactive waste burial ground. The security of the site could not be assured for thousands of years necessary for radioactive decay so this option will probably not be viable.

Although DECON is less costly than SAFSTOR, it results in slightly higher radiation exposures to the decommissioning workers and to the public. The person-rem of occupational exposure is estimated at 1955 for DECON as compared to 442 for 30-year SAFSTOR and 1624 for ENTOMB (internals retained). The person-rem exposure to the public is minimal for any of the alternatives: 10 for DECON, 2 for 30-year SAFSTOR, or 5 for ENTOMB.

Radiation doses to the public as a result of decommissioning activities should be very small and would come primarily from the transportation of decommissioning waste to waste burial grounds. Radiation doses to decommissioning workers should be a small fraction of the exposure they experience over the operating lifetime of the facility; these doses will usually be well within the occupational exposure limits imposed by regulatory requirements.

Decommissioning of nuclear facilities is not an imminent health and safety problem. However, planning for decommissioning can have an impact on health and safety as well as cost. Essential to such planning activity is the decommissioning alternative to be used and the timing. Also to be considered are 1) acceptable residual radioactivity levels for unrestricted use of the facility, 2) financial assurance that funds will be available for performing required decommissioning activities at the end of the facility operation (including permature closure), and 3) the facilitation of decommissioning.

Decommissioning of a nuclear facility generally has a positive environmental impact. Compared to operational requirements, the commitment of resources for decommissioning is generally small. The major environmental impact of decommissioning is the commitment of small amounts of land for the burial of waste. This is in exchange for being able to reuse the facility and site for other nuclear or nonnuclear purposes. Because the land has valuable resource capability, in many instances (such as at a reactor facility) the return of this land to the commercial or public sector is highly desirable.

8.7 EMERGENCY PLANNING

In connection with the promulgation of the Commission's upgraded emergency planning requirements, the staff (Office of Standards Development) issued NUREG-0685, "Environmental Assessment for Effective Changes to 10 CFR Part 50 and Appendix E to 10 CFR Part 50; Emergency Planning Requirements for Nuclear Power Plants," (August 1980). At this time, however, the staff does not have sufficient information to determine whether any environmental impacts will result from implementation by the applicant of the upgraded emergency planning requirements in 10 CFR Part 50, Appendix E, such as construction of a near-site emergency operations facility and the conduct of emergency preparedness exercises. Upon receipt of all components of the applicant's emergency plan and implementing procedures, the staff will be in a position to determine whether or not such plan and implementing procedures will result in significant environmental impacts. The NRC staff will discuss emergency planning in a Supplement to the Safety Evaluation Report.

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39. U.S. Nuclear Regulatory Commission, "Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities," NUREG-0586, January 1981.**

*Available for purchase from the National Technical Information Service, Springfield, VA 22161.
**Available free upon written request to the Division of Technical Information and Document Control, U.S. Nuclear Regulatory Commission, Washington, DC 20555.

9. BENEFIT-COST ANALYSIS

9.1 RÉSUMÉ

The following sections summarize the economic, environmental, and social benefits and costs associated with the operation of Susquehanna Units 1 and 2. Table 9.1 summarizes all benefits and costs of plant operation. Reduced generating costs are presented for the expected energy demand situation. The environmental costs are calculated for an assumed worst-case situation.

9.2 BENEFITS

The direct benefits of the plant to the PJM interchange include the approximately 11.0 to 12.9 billion kWh of electrical power the plant will be able to produce on an annual basis (assuming a plant capacity factor of between 60% and 70%), the increase in system reliability brought about by the addition of 1890 MW of generating capacity to the PJM interchange and 210 MW to the Cooperative, and the saving of $112 million in production costs per unit per year ($ 1980).[1] If "river-following" were to be undertaken by the applicant (see Appendix A, Sec. A.5.1), the staff has determined that occasional low-flow conditions resulting in forced outages would cause less than a 2% decrease in the direct energy benefit.

9.3 SOCIETAL COSTS

No significant socioeconomic costs are expected from either station operation or station personnel and their families living in the area.

9.4 ECONOMIC COSTS

The capital cost for completion of Susquehanna Units 1 and 2 is presently estimated to be $1833 million. Fuel and operation and maintenance costs for the first full year of operation of Unit 1 are estimated to be $51 and $22 million dollars, respectively. Decommissioning costs for the complete restoration of the site are estimated at $78.5 million ($ 1980).

9.5 ENVIRONMENTAL COSTS

The environmental costs of most land-use, water-use, and biological effects previously evaluated have not increased or otherwise adversely changed. The staff review of the water-intake structure revealed that there may be an increase in fish kills due to impingement and entrainment.

Chemical usage will result in a maximum discharge of 1.4×10^6 kg of chemicals per year into the Susquehanna River. This discharge should not result in any adverse effects to the environment.

The heat discharge system will result in an average water consumption of 1.4 m^3/s from evaporation and other uses. A maximum of 3.4×10^{11} J/hr will be rejected from the reactors into the Susquehanna River as heat. No adverse impacts are expected as a result of this discharge.

The design of the radioactive waste systems has been finalized. Under normal operation, each reactor will be in conformance with Appendix I to 10 CFR 50 and discharge a total of 17 curies of tritium and 0.46 curies of all other radionuclides to the Susquehanna River annually. Each reactor will also discharge approximately 19,000 curies of noble gases, 0.52 curies of radioiodines, 0.004 curies of radioactive particulates, 9.5 curies of carbon-14, and 69 curies of tritium into the atmosphere surrounding the Susquehanna Steam Electric Station facility annually. These effluents will result in a total body dose commitment of 40 person-rem per year to the general public of the U.S. population in the unrestricted area. This dose commitment will have no discernible effect on the population.

The operation of the Susquehanna facility, even for a brief period of time, will produce a radioactive structure requiring decommissioning and long-term protective storage. However, the

Table 9.1. Benefit-Cost Summary

Primary Impact and Population or Resource Affected	Unit Measure	Magnitude of Impact
	Direct Benefits	
Energy	kWh/yr × 10^6	11,000
Capacity	kw × 10^3	2,100
Reduced generating costs	\$(1980)/yr	About \$224,000,000
	Economic Costs	
Operating:		
Fuel	\$(1980)/yr per unit	51,000,000
Operation & maintenance	\$(1980)/yr per unit	22,000,000
Decommissioning	\$ (1980)	78,500,000
	Environmental Costs	
1. Impact on water		
1.1 Consumption (average)	m^3/s	1.4
1.2 Heat discharge to natural water body		
1.2.1 Cooling capacity of water body	J/hr	3.4 × 10^{11} (maximum)
1.2.2 Aquatic biota		Minor, acceptable
1.2.3 Migratory fish		Minor, acceptable
1.3 Chemical discharge to natural water body		
1.3.1 People		Not discernible
1.3.2 Aquatic biota		0
1.3.3 Water quality		0
1.3.4 Chemical discharge	kg/yr	1,400,000
1.4 Radionuclide contamination of natural surface water body		
1.4.1 All except tritium	Ci/yr per reactor	0.46
1.4.2 Tritium	Ci/yr per reactor	17.0
1.5 Chemical contamination of groundwater		
1.5.1 People		Not discernible
1.5.2 Plants		Not discernible
1.6 Radionuclide contamination of groundwater		
1.6.1 People		
1.6.2 Plants and animals		
1.7 Raising/lowering of groundwater levels		
1.7.1 People		Not discernible
1.7.2 Plants		Not discernible
1.8 Effects on natural water body of intake structure and condenser cooling systems		
1.8.1 Primary producers and consumers		Chemical discharges discernible but most likely of acceptable concentration
1.8.2 Fisheries		Minimal unless increased productivity caused by intake
1.9 Natural water drainage		
1.9.1 Flood control		No damage
1.9.2 Erosion control		Insignificant

Table 9.1. (Cont'd)

Primary Impact and Population or Resource Affected	Unit Measure	Magnitude of Impact
Environmental Costs (cont'd)		
2. Impact on air		
2.1 Chemical Discharge to ambient air		
2.1.1 Air quality, chemical		
2.1.1.1 CO	kg/yr	2,900
2.1.1.2 SO_2	kg/yr	Negligible
2.1.1.3 NO_x	kg/yr	8,700
2.1.1.4 Particulates	kg/yr	Negligible
2.1.1.5 HC	kg/yr	130
2.1.2 Air quality, odor		Negligible
2.2 Radionuclides discharged to ambient air		
2.2.1 Noble gases	Ci/yr per reactor	19,000
2.2.2 Radioiodines	Ci/yr per reactor	0.52
2.2.3 Particulates	Ci/yr per reactor	0.004
2.2.4 Carbon-14	Ci/yr per reactor	9.5
2.2.5 Tritium	Ci/yr per reactor	69.0
2.3 Fogging and icing		
2.3.1 Ground transportation		None
2.3.2 Air transportation		Negligible
2.3.3 Water transportation		None
2.3.4 Plants		Negligible
2.3.4.1 Cooling tower emissions		Not discernible
2.3.4.2 Spray pond emissions		Potential local ice-loading offsite
2.4 Salt discharge from cooling system		
2.4.1 People		Negligible
2.4.2 Plants and soil	kg/ha per yr	28.0 (maximum), staff estimate
	kg/ha per mo	0.88 (maximum), applicant's estimate
2.4.3 Property		Not discernible
3. Impacts on terrestrial systems		
3.1 Station area		
3.1.1 Proposed post-construction reclamation of station area (e.g., landscaping, erosion control)		Acceptable
3.2 Bird impingements on station facilities (e.g., cooling towers)	Individual impingements	Unknown (to be monitored)
4. Transmission line corridors		
4.1 Right-of-way maintenance and inspection		Acceptable
4.2 Production of ozone, other gaseous pollutants		Inconsequential
4.3 Audible noise		Minimal
4.4 Radio and TV interference	Individual complaints	Reception problems resolved by applicant as necessary
4.5 Electrical field effects		Acceptable
5. Total body dose commitments to U.S. population general public, unrestricted area	person-rem/yr	65
Societal Costs		
1. Operational fuel disposition		
1.1 Fuel transport (new)	Trucks/yr	10
1.2 Fuel storage		
1.3 Waste products (spent fuel)	Rail shipments/yr	
2. Plant labor force	people	200
3. Historical and archeological sites		Acceptable
4. Station operational noise	Sound level, dBA	Acceptable with proper mitigation; to be monitored.
5. Esthetics		
5.1 Visual impacts to station structures		Acceptable
5.2 Visual impacts to cooling tower plumes		Acceptable
5.3 Visual impacts of transmission corridors		Acceptable

nuclear waste associated with decommissioning of the Susquehanna facility will be a small quantity compared to that already generated by commercial and military nuclear applications.

9.6 ENVIRONMENTAL COSTS OF THE URANIUM FUEL CYCLE

The contribution of environmental effects associated with the uranium fuel cycle is indicated in Table 4.16 and described in Section 4.5.6. The staff has evaluated the environmental impacts of the fuel-cycle releases presented in Table 4.16 and has found these impacts to be sufficiently small so that, when they are superimposed upon the other environmental impacts assessed with respect to the construction and operation of the plant, they do not affect the benefit-cost balance.

9.7 ENVIRONMENTAL COSTS OF URANIUM FUEL TRANSPORTATION

The contribution of environmental effects associated with the transportation of fuel and waste to and from the facility are summarized in Section 4.5.2 and Table 4.13. These effects are sufficiently small so as not to affect the benefit-cost balance.

9.8 SUMMARY OF BENEFIT-COST

As a result of the analysis and review of potential environmental, technical, economic, and social impacts, the staff has been able to forecast more accurately the effects of the station's operation. No new information has been acquired that would alter the overall balancing of the benefits of this station versus the environmental costs. Consequently, the staff has determined that it would be possible to operate the station with only minimal environmental impacts. The staff believes that the primary benefits of providing 2100 MW of electrical energy, minimizing system production costs, and increasing system reliability through the addition of 2100 MW baseload capacity will greatly outweigh the environmental, social, technical, and economic costs. Benefit-costs are summarized in Table 9.1, which is explained in Appendix E.

Reference

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10. DISCUSSION OF COMMENTS RECEIVED ON THE DRAFT ENVIRONMENTAL STATEMENT

Pursuant to Paragraph A.6 of Appendix D to 10 CFR Part 50, the Draft Environmental Statement for the Susquehanna Steam Electric Station, Units 1 and 2, was transmitted, with a request for comments, to

Advisory Council on Historic Preservation
Department of Agriculture
Department of the Army, Corps of Engineers
Department of Commerce
Department of Health, Education, and Welfare
Department of Housing and Urban Development
Department of the Interior
Department of Transportation
Department of Energy
Environmental Protection Agency
Federal Energy Regulatory Administration
Pennsylvania State Clearinghouse
Pennsylvania Department of Environmental Resources
Luzerne County Planning Commission
Economic Development Council of Northeastern Pennsylvania
Board of Supervisors, Berwick

The Draft Supplement to the Draft Environmental Statement Related to Operation of Susquehanna Steam Electric Station, Units 1 and 2, was transmitted, with a request for comments, to the same federal, state, and local agencies. The Draft Supplement was also transmitted to:

Susquehanna River Basin Commission

In addition, the NRC requested comments on the Draft Environmental Statement from interested persons by a notice published in the Federal Register on 24 June 1979. In response to the requests referred to above, comments were received from

Department of Agriculture, Forest Service (DA-FS)
Department of Agriculture, Soil Conservation Service (DA-SCS)
Department of Commerce (DOC)
Department of Health, Education, and Welfare (HEW)
Department of Housing and Urban Development (HUD)
Department of the Interior (DOI)
Department of Transportation (DOT)
T.R. Duck
Economic Development Council (EDC)
Environmental Protection Agency (EPA)
Federal Energy Regulatory Commission (FERC)
T.J. Halligan
M.L. Hershey
M.J. Huntington
H.C. Jeppsen
S. Laughland
W.A. Lochstet
Luzerne County Planning Commission (LUZ)
M.M. Molesevich
L. Moses
D. Oberst
Pennsylvania Power & Light Company (PP&L)
Pennsylvania State Clearinghouse, Department of Environmental Resources (PDER)
W.L. Prelesnik
SEDA - Council of Governments (SEDA)
F.L. Shelly
S. Shortz

Sierra Club, Pennsylvania Chapter (Sierra)
Susquehanna Alliance (SA)
Susquehanna River Basin Commission (SRBC)
F. Thompson
L.E. Watson

The comments are reproduced in this Statement as Appendix B. The staff's consideration of the comments received and its disposition of the issues involved are reflected in part by revised text in the pertinent sections of this Final Environmental Statement and in part by the following discussion. The comments are referenced by use of the abbreviations indicated above; also, the pages in Appendix B on which copies of the comments appear are indicated.

10.1 SUMMARY AND CONCLUSIONS, FOREWORD, INTRODUCTION

10.1.1 Summary and Conclusions (SRBC 8/30/79:B-68; HUD:B-6)

The staff agrees that the estimate of the 7-day, 10-year low flow based upon the longer record should be used. They concur in the value of 22.7 m^3/s. However, the controlling discharge should be considered fixed at 22.7 m^3/s to preclude annual changes due to new data affecting the 7-day, 10-year flow.

10.1.2 Foreword (SA 8/17/79:B-62; T.J. Halligan:B-26)

The Atomic Safety and Licensing Board for Susquehanna has considered the question of "piece-mealing" the NEPA review and has found no merit to this argument. It is the staff's conclusion that the Final Environmental Statement represents a comprehensive environmental assessment.

The NRC has published draft proposed procedures for implementing NEPA regulations. Public and agency comments have been received on the draft proposed procedures, and proposed final regulations are now before the Commissioners for approval. The final regulations provide that actions undertaken prior to publication of the final rule will not require adherence to the new procedures.

10.1.3 Introduction (PP&L 9/4/79:B-42; PDER 8/20/79:B-50)

National Pollution Discharge Elimination System (NPDES) Permit No. PA-0047325, effective 31 July 1979, was issued to cover the blowdown and other lesser discharges. This permit prohibited the discharge of floating debris, visible foam, and polychlorinated biphenyl compounds (PCBs); it also set limits for the discharge of free available chlorine, total iron, total suspended solids, oil and grease, but did not specify limits for sulfate in the discharge. The staff notes that this permit expired on 30 September 1980 and was administratively extended by PDER. Upon receipt of a new permit application from PP&L under the EPA's Consolidated Permit Regulation Program (45 FR 33425, 19 May 1980), the permit will be renewed. This is expected to occur by March 1982.

10.2 THE SITE

10.2.1 Résumé

No comments.

10.2.2 Sociocultural Profile (EDC 9/26/79:B-14)

10.2.2.1 Introduction

No comments.

10.2.2.2 Demography

No comments.

10.2.2.3 Settlement Pattern (M.M. Molesevich:B-39)

Figure 2.1 has been revised to reflect these comments.

10.2.2.4 Social Organization (M.M. Molesevich:B-39, EDC 8/27/79:B-13)

The state and local evacuation plans will be reviewed by NRC and the Federal Emergency Management Agency (FEMA) before the operating license can be issued. FEMA requires that the plans include all hospitals and institutions within the Susquehanna plant plume exposure.

10.2.2.5 Political Organization

No comments.

10.2.2.6 Land Use (M.M. Molesevich:B-39)

The text has been revised to reflect the comments on land-use categories.

10.2.2.7 Changes in the Local Economy

No comments.

10.2.3 Water Use (EPA 8/17/79:B-17; EDC 9/26/79:B-14)

The third paragraph of Comment B-17 is not clear: if it is intended to indicate the possibility of interactive effects, any such effects should be reflected in appropriate standards. Regarding stoichiometry, it is pointed out in Section 10.3.2.4 that the "maximum" conditions assumed in estimating chemical discharges are inconsistent and could not occur in practice. This inconsistency is largely responsible for the apparently high sulfate discharges estimated in the DES.

The applicant gave the following response to this comment (applicant's responses 13 November 1979):

> The NPDES permit for the Susquehanna SES has specified no average limitation on iron but a daily maximum of 7 mg/L. The iron content in the Susquehanna River normally does not meet Pennsylvania Department of Environmental Resources, Chapter 93, Water Quality Criteria. On DES pages 4-4 through 4-7 and Table 4-3, the discussion of the discharge from the station does not indicate the settling rate of suspended solids in the cooling tower basins. The ratio of suspended solids of the water in the cooling tower basins to the water in the discharge is about 3 to 1 which approximately offsets the concentration factors listed in Table 4-3. If the concentration of iron in the river exceeds DER criteria, the station will discharge approximately the same concentration. This is noted in the NPDES permit which states that the effluent quality need not exceed the quality of the raw water supply.

Since the DES was published, the applicant has indicated that the parking-lot pond has been deleted. Figure 2.3 has been amended accordingly. The only water discharged to the river through the drainage ditch will be rainfall-generated water and treated waste water from sumps and drains in non-radioactive plant areas (e.g. condenser, pumphouse, diesel generator and electrical equipment areas), estimated as 9.1 L/s. Oil will be separated and recovered where necessary. The waste water from raw water treatment (essentially clarified water) will be recycled to the condenser cooling system together with neutralized and filtered demineralizer waste. The total water so recycled is estimated as 3.15 L/s. The average demineralizer waste flow was estimated in the ER-CP as 0.21 L/s.

The applicant has provided the following additional information on other internal station flow rates (applicant's responses dated November 13, 1979):

Flow Path	Quantity
Raw Water Treatment Plant to Radioactive Area Waste Uses	0-12.6 L/s
Raw Water Treatment Plant to Demineralizer	7.6 L/s (batch)
Demineralizer to Radioactive Area Water Uses	1-12.6 L/s
Demineralizer to General Plant Uses	0-9.1 L/s
Raw Water Treatment Plant to General Plant Uses	0-9.1 L/s

Because these flow rates are variable or intermittent, a precise water balance is not possible, but the average rates are so small that the effect on the overall plant water balance will be negligible. In estimating the chemical discharges, the staff did not find it necessary to establish a precise water balance for each of these unit processes.

All water recycled to the condenser cooling system will be filtered. The solids from the water recovery filter will be trucked offsite and disposed of in a licensed landfill.

The staff has analyzed the construction and use of Pond Hill Reservoir in Appendix A. Responsibility for regulating downstream uses and users of water is assigned to the U.S. Environmental Protection Agency, the Susquehanna River Basin Commission, and the Pennsylvania Department of Environmental Resources.

The location of the plant relative to the floodplain of the Susquehanna River is discussed in Section 4.3.2.2. The major plant structures are well above the floodplain; only the intake structure, its access road, and some recreational facilities are in the floodplain.

The Tioga-Hammond Dam is primarily a flood control project. An analysis of the effects of its (hypothetical) sudden catastrophic failure showed that resulting water levels on the Susquehanna River near the plant site would be lower than the level of the flood for which the plant is designed.

10.2.3.1 Regional Water Use

No comments.

10.2.3.2 Hydrology

No comments.

10.2.3.3 Water Sources (PP&L 9/4/79:B-42)

Figure 2.3 has been modified as a result of the design change.

10.2.3.4 Water Quality (EPA 8/17/79:B-17; PP&L 9/4/79:B-42)

Table 2.8 has been updated to show the revised State Water Criteria published in July 1979, and applicable to the North Branch Susquehanna River from the Lackawanna River to the West Branch confluence, including the waters in the vicinity of the site, which are classified WWF (protection of warm water fishery). The criteria include the state-wide list plus dissolved oxygen, temperature, and manganese, but sulfate and chloride are not included. Although criteria for sulfate and chloride do not currently apply to this stretch of the river, criteria for them do exist in the state. These limitations could be applied in the future if deemed necessary by the state.

Section 2.3.4.1 has been revised to respond to the comments made.

10.2.4 <u>Meteorology</u> (PP&L 9/4/79:B-42)

The recovery rate of approximately 70% for onsite meteorological data collected during calendar year 1973 cited in the Susquehanna DES is for wind speed and wind direction measurements at the 9.6 m level and on temperature differential measured between 91.7 m and 9.6 m. The staff agrees that the data recoverability of joint wind speed, wind direction, and temperature differential may be enhanced by using temperature differences measured between 30.5 m and 9.6 m when the 91.7 m to 9.6 m are not available. However, because of the large difference in the depths of the two layers over which the temperature differences were measured (62.1 m and 20.9 m) and particularly the shallow depth of the lower layer (20.9 m), the staff questions the result of direct substitution of the lower temperature differential measurement when the 91.7 m to 9.6 m data are missing.

The staff acknowledges that the unusually high occurrence of unstable atmospheric conditions recorded at the Susquehanna site may represent the meteorological conditions that occurred in 1974 and 1975. However, in the staff's opinion, this period does not adequately represent average conditions expected to occur during the lifetime of the plant. Since these data would represent a substantial part of the meteorological data base if they were used in the evaluation, they could deceptively weight the resultant dispersion estimates. Therefore, the staff did not include the meteorological data collected during the 1974 and 1975 calendar years in its atmospheric dispersion evaluation.

The staff agrees that the wind from the west-southwest and west directions as recorded at the 9.6-m level occurred with frequencies of 13.5% and about 12.0%, respectively, during calendar year 1976. The recorded frequency of calm was 1.5%. These corrections have been made in the appropriate section of the text.

10.2.5 Site Ecology

10.2.5.1 Terrestrial Ecology (PP&L 9/4/79:B-42)

Section 2.5.1.3 has been revised to reflect the comment made.

10.2.5.2 Aquatic Ecology

No comments.

10.2.6 Cultural Resources (Sierra:B-61; SA 8/17/79:B-62; PDER 8/20/79:B-50; DOI 9/10/79: B-7; EDC 9/26/79:B-14)

See Section 10.4.7.

10.3 THE PLANT

10.3.1 Résumé

No comments.

10.3.2 Design and Other Significant Changes

10.3.2.1 Water Use (SRBC 8/30/79:B-68; EDC 8/27/79:B-13 and 9/26/79:B-14)

Section 3.2.1 has been revised to reflect the applicable comments. Table 3.1 has also been revised.

The applicant has calculated that, under the worst meteorological condition, which runs 1% of the time (a dry bulb temperature of 29.4°C or 85°F and a wet bulb of 23.9°C or 75°F) and a maximum plant load, the maximum evaporation rate will be 1.81 m^3/s.

Appendix A addresses the compensation reservoir proposed by the applicant to meet the Susquehanna River Basin Commission's regulations with respect to consumptive water use during periods of low river flow.

The plant river intake structure is designed to be operational during the Standard Project Flood (SPF), which is the most severe flood reasonably characteristic of the region. The calculated river level of the SPF at the intake location is more than 2.4 m above the maximum recorded level, which resulted from Tropical Storm Agnes. In the SPF analysis, no credit was taken for any protection the proposed Tioga-Hammond Dam would provide. In addition, it must be emphasized that the plant can be safely shut down without using the Susquehanna River intake. For further discussion of the safety-related aspects of plant water supply, see the Safety Evaluation Report (SER).

The effects of floods on SSES are discussed in detail in the SER, Section 2.4. The plant is well above the level of any credible flood on the Susquehanna River. The ability of the plant to safely shut down using the onsite spray pond in the event that the river intake structure is flooded is also addressed in the SER, Section 2.4.

10.3.2.2 Heat Dissipation System (EPA 8/17/79:B-17; SRBC 8/30/79:B-68)

The staff is familiar with EPA Document 660/2-73-016. Construction of the intake was essentially complete at the time of the site visit (September 1978). Determination of compliance with Section 316(b) of the Clean Water Act is the responsibility of EPA, not the NRC. Approval of the applicant's impingement/entrainment study, either under Section 402 or 316(b) of the Clean Water Act, is interpreted by NRC to mean that the design of a given intake is EPA approved. PDER (Pennsylvania being an agreement state) approved the applicant's impingement/entrainment study on 29 April 1980.[2] Should the applicant's entrainment study indicate that mitigative measures are necessary, appropriate modifications will be made. Section 5.3.4 has also been updated to reflect this information.

Construction of the intake is essentially complete. Determination of compliance with Section 316(b) of the Clean Water Act is the responsibility of EPA. Pennsylvania is an EPA agreement state with the Pennsylvania Department of Environmental Resources responsible for determining compliance with Section 316(b). PDER has accepted the applicant's proposed impingement/entrainment study.[1,2] A determination of the environmental acceptability of the intake will be made by PDER after the 316(b) study is complete. Section 5.3.4 has also been updated to reflect this information.

10.3.2.3 Radioactive Waste Systems

No comments.

10.3.2.4 Chemical, Sanitary, and Other Waste Treatment (EPA 8/17/79:B-17; DOI 9/10/79:B-7)

Sulfate

The NPDES permit does not limit the sulfate concentration in the discharge. The only currently applicable standards for river water quality are those shown in Table 2.8. The state criteria for protection of aquatic life in the stretch of the river adjacent to the plant site do not currently include a limit on sulfate concentration, although a limit of 250 mg/L for drinking water is included in the list of specific criteria, which could be applied if deemed desirable to any stream in the state. The recommended drinking water standard is based on taste perception; adverse (laxative) effects are not noticeable at sulfate concentrations below 400 mg/L.

Under the most adverse conditions, the staff estimates that the sulfate concentration in the river will not exceed 250 mg/L (Table 4.3) after complete mixing of the blowdown with the minimum river flow. As stated in Section 4.3.3.2, impurities not added in the plant will be concentrated by a factor of 1.06 to 1.08 by evaporation in the cooling towers. With a maximum observed sulfate concentration of 222.5 mg/L, the maximum final concentration would be about 241 mg/L if no sulfuric acid were added; thus, the maximum sulfate addition would produce an increase of only 6 mg/L under these unlikely conditions. As shown in Section 3.2.4.2, it may be possible to reduce this small contribution even further by operating with a more positive saturation index, which would also improve corrosion protection.

Other

Sulfuric acid addition is the most effective and economical method of scale control; it is used in virtually all large generating stations, nuclear and fossil-fueled, where water quality demands scale control. Its action depends on well-known physicochemical principles and the dosage can be calculated quite accurately for given water quality and plant conditions. Sulfate ion is present in most natural waters; its environmental effects have been well studied, and are reflected in water quality criteria. The staff's evaluation shows that sulfuric acid can be used at SSES without violating these criteria, although careful analytical control will be necessary because of the high and variable ambient sulfate level. The Amertap system of mechanical cleaning may retard the buildup of calcium carbonate scale, should scaling conditions prevail for prolonged periods. Controlled sulfuric acid addition should avoid these conditions.

Theoretically, hydrochloric acid could be used to reduce alkalinity and control scale, but it is never used for this purpose; corrosion is a major objection. EPA has already expressed concern regarding the chloride concentration in the discharge (see EPA 8/17/79, p. B-17); this would be greatly increased by the use of hydrochloric acid.

Organic scale control agents (tannins, lignins, polyacrylates, polyphosphonates) are known to be effective. They inhibit crystal growth rather than increase solubility. These agents are not in common use in large cooling systems, and their environmental effects are not well known. The phosphonates appear to be the most effective, but the release of phosphorus compounds on a large scale appears highly undesirable.

In any event, the purpose of the Environmental Impact Statement at the Operating License Stage is to assess the impacts of the station as designed; alternatives are not normally considered at this stage, unless the impact of the proposed system or procedure is assessed as being unacceptable. That is not the situation in this circumstance. A more detailed analysis is therefore not warranted.

10.3.2.5 Transmission Systems (Sierra:B-61)

The staff interprets the comment as being related to the Pennsylvania Scenic Rivers Act of 1972, which authorizes establishment of a scenic rivers system. Accordingly, the Pennsylvania Department of Environmental Resources conducts river studies and reports to the governor and general assembly regarding designation and management of candidate waterways.

The applicant indicates that the transmission line crossing at the Lehigh River Gorge was specifically selected to minimize the visibility of the line. The PDER reviewed and concurred with plans for the crossing (ER-CP, Amendment 5). The staff also notes that the PDER granted the applicant a permit for crossing the gorge (ER-OL, Sec. 12.1.2).

The staff has also contacted the Department of the Interior Heritage Conservation and Recreation Service (HCRS) concerning the status of the Lehigh River Gorge area for consideration in the National Wild and Scenic Rivers System. A Nationwide River Inventory has recently been developed by HCRS and the Lehigh River Gorge area is listed as having potential for inclusion in the Nationwide River System. However, it is the staff's understanding that, because the excavation, construction, and erection of the towers at the gorge crossing began in the fall of 1978, prior to publication of the Nationwide River Inventory list, the Susquehanna 500-kv line would not impact the future status of this river segment for inclusion into the National Wild and Scenic River System.

10.4 ENVIRONMENTAL EFFECTS OF STATION OPERATION

10.4.1 Résumé

No comments.

10.4.2 Impacts on Land Use (M.M. Molesevich:B-39)

The state and local evacuation plans will be reviewed by NRC and the Federal Emergency Management Agency (FEMA) before the operating license can be issued. FEMA requires that the plans include all hospitals and institutions within the Susquehanna plant plume exposure.

10.4.3 Impacts on Water Use (T.R. Duck:B-11)

The Pond Hill Reservoir is being planned to supplement river flow during periods of low river flow. The Susquehanna River Basin Commission has directed that the reservoir be constructed by 1 July 1984. The Pond Hill Reservoir is not required for the safe operation of the nuclear plant. Therefore, the Environmental Statement review dealt only with the effect of the construction and operation of the Pond Hill Reservoir on the environment.

10.4.3.1 Thermal Impacts in Water Use (PP&L 9/4/79:B-42; L.E. Watson:B-75)

Section 4.3.1 has been revised to reflect the conditions specified in the NPDES permit. Table 4.1 has also been revised.

The staff assumes that "additional destruction of habitat" refers to wildlife habitat. This was discussed in Section 4.3.1 of Appendix A.

10.4.3.2 Hydrological Alterations and Plant Water Supply

No comments.

10.4.3.3 Industrial Chemical Wastes (EPA 8/17/79:B-17; PP&L 9/4/79:B-42; PDER 8/20/79:B-50)

The increase in chloride ion is due primarily to evaporative concentration of the ambient chloride content, but the chlorine added as a biocide also contributes significantly. The applicant has demonstrated to the staff's satisfaction that the proposed chlorine usage does not exceed the quantity required to maintain an adequate biocidal concentration (Response to Staff Question CHE-1 in ER-OL, Rev. 1, 1/79). Even so, the estimated chloride concentrations at the edge of the mixing zone (Table 4.3) do not exceed the proposed criteria.

The applicant states that inhibitors containing chromium will be used in closed cooling loops. The text (Section 4.3.3.3) has been amended accordingly.

The frequency of discharge, if any, from these loops has not been specified by the applicant. However, review of the applicant's NPDES permit application indicates that none of the waste streams from the plant will contain chromium. This is consistent with the recently proposed EPA Effluent Limitations Guidelines for the Steam Electric Power Generating Point Source Category, which would prohibit discharge of power plant waste streams containing chromium.

The comment on sulfate concentration was addressed in Section 10.3.2.4.

10.4.3.4 EPA Effluent Guidelines and Limitations (EPA 8/17/79:B-17; DOI 9/10/79:B-7, EDC 9/26/79:B-14)

Section 4.3.4 has been revised to reflect the comments made.

An entrainment study will be conducted as part of the applicant's NPDES requirements.[1] The FES text has been modified to reflect this new information.

10.4.3.5 Effects on Water Users through Changes in Water Quality

No comments.

10.4.3.6 Sanitary Wastes (EPA 8/17/79:B-17)

The treated sanitary effluent is discharged to the river at a separate outfall (see FES Fig. 2.3). The treatment plant uses the activated sludge, extended aeration process. There are three independent aeration tanks and clarifiers, each designed for 15,000 gal/day. During construction, all three units were used, but the applicant expects to use only two units during operation, with the third as a standby for peak employment periods such as maintenance or refueling. The modular design should permit the effective handling of reduced loads without serious underloading.

10.4.4 Environmental Impacts

10.4.4.1 Terrestrial Environment (DA-FS:B-4; DA-SCS:B-4; DOI 9/10/79:B-7; EDC 9/26/79:B-14; W.L. Prelesnik:B-55)

Commitments by the applicant include a stipulation that "any chemicals used to control vegetation will be approved by state and federal authorities and applied as directed by said authorities" (ER-CP, Amendment 4, p. 5.5-4 and Amendment 5, p. 5.5-4). This commitment was a consideration in the staff's assessment, as indicated on page C-6, Appendix C of this Statement. Recent information indicates the "applicants presently anticipate using primarily Dicambra and Fosamine."[3] Ammonium sulfamate may also be used in watershed areas to a limited extent.

The staff differentiates between construction and operation impacts; the latter being the principal focus of this Statement. The staff does not foresee instances in which routine operation of the station and transmission facilities will result in appreciable impacts on additional important farmlands.

The environmental impacts of construction and use of the Pond Hill Reservoir are discussed in Appendix A; impacts related to the operation of the cooling towers are addressed in Section 4.4.3. Impacts on terrestrial wildlife habitat and aquatic organisms resulting from the proposed development and operation of the Pond Hill Reservoir are discussed in Section A.4.3.1.

The staff is not aware of any instance in which the planned operation of SSES will result in a temporary loss of habitat that "would kill all fish and wildlife currently living near the site." The staff does not foresee how operational impacts on aquatic communities would result in killing <u>all</u> local wildlife.

The staff offers the following observations. As indicated in Section 4.4.1.1, the anticipated operational noise levels referred to are estimates based on calculations and various assumptions. Thus, the extent to which operational noise may warrant mitigation is not clear at this time. The staff also wishes to point out that the applicant will be required to monitor local noise levels following initial operation of the station (see Section 5.3.5). Comparisons between preconstruction surveys and operational monitoring data will enable the estimation of increased noise levels attributable to station operation. If need for mitigation is indicated, the operational monitoring data will provide a basis for selecting between alternative methods, structures, and/or equipment to be used in reducing noise emissions from the station.

10.4.4.2 Aquatic Environment (EPA 8/17/79:B-17; PP&L 9/4/79:B-42; PDER 8/20/79:B-50; SRBC 8/30/79:B-68; EDC 9/26/79:B-14)

The staff agrees that the practicability of reintroducing shad to the Susquehanna River is questionable; however, the staff is also aware that various state and regional agencies are considering such a possibility. Therefore, the discussion is warranted.

With respect to the adult shad, the adults generally remain in the main channel of the river during their upstream migration. Operation of the existing intake would have a potential impact on those adults using the intake pool for resting. The staff feels that the greatest impact to migrating shad would be during the fall when young-of-the-year are using the pools and shallower portions of the river during the downstream migration.

The entrainment study to be conducted as part of the applicant's NPDES permit requirements will indicate what, if any, mitigative measures are necessary. The EPA has the authority to require future studies if conditions warrant them. Section 5.3.4 has also been updated to reflect this information.

The staff still believes that "the intake design at SSES as currently sited and designed will adversely affect the aquatic community within the immediate vicinity of the wing walls and associated riprap" (DES p. 4-9). Also, the staff stands by its statement relative to embayment-type intakes having a greater potential for "attracting" fish than other intakes. At the time the DES was written, the Pennsylvania Department of Environmental Resources had not accepted or rejected the intake design at SSES. With the acceptance of the applicant's impingement/entrainment study,[1] the PDER rules the intake design as environmentally acceptable. The entrainment study will indicate if mitigative measures are required to be in compliance with Section 316(b) of the Clean Water Act. The staff does not have the authority to require impingement/entrainment studies.

The staff agrees with the comment that the intake site does not necessarily occupy a particularly unique area of the river. The first paragraph of Section 4.4.2.1 of the FES has been modified to reflect this opinion. The staff feels the term "pool" is properly defined and used in the FES.

Page 4-10 has been modified to reflect new information on the impingement/entrainment study; however, the staff is still not convinced that impingement impacts can be accurately predicted based on results at another power plant.

The staff still does not believe that monitoring of the benthic community in the vicinity of the discharge is necessary. As stated on page 4-10 of the DES, "the vicinity of the discharge is not particularly unique to the river and any loss of habitat should not have a significant impact on the various populations."

The applicant will be operating the Pond Hill Reservoir to compensate for water consumed during periods of low flows; therefore, the staff concludes that impacts due to operation of SSES during low-flow periods will not be significant.

10.4.4.3 Atmospheric Effects of Cooling-Tower Operation (PDER 8/20/79:B-50; M.M. Molesevich: B-39)

The use of SSES in its planned baseload mode will probably result in the conversion of one or more oil- or coal-fired power plants to load-following or peaking duty. Since the operation of SSES will result in essentially zero emissions of particulates, SO_2, NO_x and other pollutants characteristic of fossil units, the staff expects an improvement in the region's air quality as a result of the use of SSES.

Test plants observed in the Chalk Point studies referenced in Section 4.4.1.1 include corn (*Zea mays*), soybeans (*Glycine max*), tobacco (*Nicotiana tobaccum*), dogwood (*Cornus florida*), black locust (*Robinia pseudo-acacia*), Virginia pine (*Pinus virginiana*), and sassafras (*Sassafras albidum*). Additional test species observed in other related studies include tulip poplar (*Liriodendron tulipifera*); privet (*Ligustrum* spp.); Amur and red maples (*Acer ginnala*, *A. rubrum*); and Scotch, white, and lobbolly pines (*Pinus sylvestria*, *P. strobus*, *P. taeda*).[4] Distributions of these species are not limited to Maryland nor to coastal areas affected by salt depositions of oceanic origin. In view of the extensive occurrence of these species in Pennsylvania, the staff believes that the Chalk Point vegetation studies are relevant to the future operation of the Susquehanna station. Soil investigations are also considered pertinent;[5] the staff is uncertain as to the intended meaning of statements implying that some soils are tolerant of or "accustomed to" salt depositions.

As reported in 1978, investigations (1975-1977) of test plant species and local soils at Chalk Point failed to reveal effects that could be attributed to cooling-tower operation. Conclusions presented by investigators included various caveats such as the need for future studies to document long-term effects. However, simulated salt-drift studies are indicative of levels of salt depositions being investigated. For example, "applications of salt up to 3.6 kg/ha per week failed to induce statistically significant reductions in yields for corn and soybeans" (Section 4, Reference 7). "Of the agricultural species investigated thus far," corn exhibits the highest sensitivity to salt drift.[5] In other simulated drift studies at Chalk Point involving an estimated salt deposition rate of 7.46 kg/ha per month, the reporting investigators concluded that "some injury may occur to a sensitive species such as dogwood under certain cooling tower operating conditions."[6] The investigators also cautioned against assuming that the reported deposition rate was "a general indicator of any salt drift injury." However, the staff believes a general comparison is warranted since the reported deposition rate (7.4 kg/ha per month) is almost nine times greater than the maximum deposition rate (880 g/ha per month) estimated to occur during SSES operation.

Postoperational surveys of vegetation in the vicinity of the Three Mile Island Nuclear Station are also of interest since the Susquehanna River is the source of that station's cooling water. Reported results of 1975 plant pathology surveys and quantitative vegetation studies did not indicate any effects that could be attributed to salt drift from station cooling towers.[7] Nor were any effects detected in 1974.

The staff expects no adverse effects from the mineral drift from the plant's cooling towers due to the low salt deposition rates, the nature of the material deposited (primarily calcium sulfate vs sodium chloride typical of coastal areas), and the natural rainfall that is expected to dilute and wash away the salt deposits. This conclusion is supported by studies made at freshwater cooling towers (Refs. 22-25 and 29 of Chapter 4; also a recent study for USEPA: G. A. Englesson and M.C. Hu, Nonwater Quality Impacts of Closed-Cycle Cooling Systems and the Interaction of Stack Gas and Cooling Tower Plumes, EPA-600/7-79-090, Industrial Environmental Research Laboratory, Research Triangle Park, N.C., 1979, 214 pp.).

Observations of plume from natural-draft cooling towers, including several in Pennsylvania and Kentucky, show that the plumes do not reach to the ground and cause ground fog and icing because of their height and plume rise due to buoyancy and momentum. This is discussed in the DES and the references cited above.

10.4.5 Radiological Impacts from Routine Operation (SA 8/17/79:B-62; W.A. Lochstet:B-32; L.E. Watson:B-75; W.L. Prelesnik:B-55; EDC 8/27/79:B-13; EPA 8/17/79:B-17; F.L. Shelly: B-57)

Risks from Low-Level Radiation

The NRC staff is not aware of any studies that have established that there is no safe level of radiation. However, as a conservative and prudent assumption, it has been assumed that no amount of radiation is safe. For more than four decades, the effect of a radiation on humans and animals has been thoroughly studied. Numerous major biological research programs have been well documented and may be found in the open literature. The United States has been the forerunner in radiation research, but many other countries also have pursued similar programs and have contributed substantially to current knowledge. While the relationship between ionizing radiation dose and biological effects among humans is not precisely known for all levels of radiation, the principal uncertainty exists at very low dose levels where natural sources of radiation (cosmic and terrestrial) and the variations in these sources are comparable to the doses being evaluated. The most important biological effects from radiation are somatic diseases (principally cancer), hereditary diseases, abortions, and congenital anomalies. These effects are identical to those that occur normally among humans from other causes. It is this last point, in combination with other confounding factors, e.g., magnitude and variations 1) in normal incidence of diseases, 2) in doses from natural radiation sources, 3) in radiation doses from human-made sources other than the nuclear industry, and 4) in exposures to other (non-nuclear) carcinogens, that is responsible for much of the uncertainty in the dose-risk relationship at low dose levels.

Data from studies of animals and humans are reviewed continuously by teams of scientific experts who evaluate radiological information and provide recommendations. In the United States, the principal expertise in radiological matters lies with the National Council on Radiological Protection and Measurements and the National Academy of Science/National Research Council (NAS/NRC). Federal agencies also retain expertise in the radiologic disciplines in order to fulfill their responsibilities; these agencies, however, rely heavily on recommendations of the previously mentioned advisory organizations. Other countries have national advisory organizations similar to those of the United States. There are also cooperative international organizations that evaluate data from all sources and present recommendations and conclusions; for example, the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) and the International Commission on Radiological Protection (ICRP). In summary, not only have the radiological data been ascertained by the world's outstanding biologists and epidemiologists, but the data have been evaluated independently by their peers.

In lieu of precise knowledge of the relationship between low-level radiation and biological effects, a linear non-threshold extrapolation from high radiation levels to the lower levels is assumed for radiation protection purposes. This means that it is assumed that any dose of radiation, no matter how low, may be harmful. Several federal agencies, principally EPA, the Occupational Safety and Health Administration (OSHA), and NRC have responsibilities for regulating exposures to radiation or radioactive material. In all cases, the staffs of these agencies are well aware of the potential health effects and have expertise in biology and the other disciplines needed either within the staff or available to them.

The basis for the risk estimators on p. 4-27 of NUREG-0564 is more fully described in Chapter 4, Section J, Appendix B, "Health Risks from Irradiation," of the Final Environmental Statement on the Use of Recycle Plutonium in Mixed Oxide Fuel in Light Water Cooled Reactors (NUREG-0002). As stated in NUREG-0002, "Though these risk estimates are the upper bound estimates given in the Rasmussen Report,[3] higher estimates can be developed by use of the 'relative risk' model along with the assumption that risk prevails for the duration of life. This would produce risk values up to sevenfold greater than those used in GESMO." Consequently, the risk estimators in NUREG-0511 are consistent with those used in NUREG-0002.

Several of the general statements in W. L. Prelesnik's comment reflect some misunderstandings regarding NRC policy and positions. Therefore, the staff has attempted to provide more detail on some of these concerns.

First, it is stated that "any low-level radiation releases are significant as has been admitted and proven, even by the old AEC and the NRC's own studies. There is no safe level of radiation exposure." The staff is not aware of any studies that have established that there is no safe level of radiation. However, as a conservative and prudent assumption, the staff assumes that no amount of radiation is safe (see Section 4.5.5 of the FES for additional information).

Secondly, it is stated that "The current standards were initially set in order to justify atomic bomb testing. Those standards were kept in order to justify nuclear power plants because the nuclear industry and our government recognizes that no plant operates without 'normal' releases of radiation." General information about radiation standards is provided in the NRC's "Radiation Standards Fact Sheet" (a copy has been sent to W. L. Prelesnik in a letter dated 18 October 1979, however, it is too lengthy to repeat here). As noted in this fact sheet and in Section 10.4.5, the radiation protection standards were based on the best scientific judgment available in the world.

In addition, see Section 4.5.5 of the FES and responses to comments in Section 10.6.2.

Impacts from the Fuel Cycle

Dr. Lochstet's basic contention is that "the health consequences of radon-222 emissions from the uranium fuel cycle are improperly evaluated" in the Susquehanna Draft Environmental Statement (DES, NUREG-0564). The basis for Lochstet's contention is that the staff has arbitrarily evaluated the health impacts of radon-222 releases from the wastes generated in the fuel cycle for 1000 years or less, rather than for "the entire toxic life of the wastes." Lochstet then estimates that radon-222 emissions from the wastes from each annual reactor fuel requirement will cause about 600,000 to 12 million deaths over a period of more than 1 billion years.

The major difference between the staff's estimated number of health effects from radon-222 emissions and Lochstet's estimated values is the issue of the time period over which dose commitments and health effects from long-lived radioactive effluents should be evaluated. Lochstet has integrated dose commitments and health effects over what amounts to an infinite time inverval, whereas the staff has integrated dose commitments from radon-222 releases over a 100-year period, a 500-year period, and a 1000-year period.

The staff has not estimated health effects from radon-222 emissions beyond 1000 years for the following reasons. Predictions over time periods greater than 100 years are subject to great uncertainties. These uncertainties result from, but are not limited to, political and social considerations, population size, health characteristics, and, for time periods on the order of thousands of years, geologic and climatologic effects. In contrast to Lochstet's conclusion, some authors[8] estimate that the long-term (thousands of years) impacts from the uranium used in reactors will be less than the long-term impacts from an equivalent amount of uranium left undisturbed in the ground. Consequently, the staff has limited its period of consideration to 1,000 years or less for decision-making and impact-calculational purposes.

With regard to Dr. Kepford's testimony regarding use of $1,000 per person-rem for environmental health costs, the staff would like to make the following points.

The $1,000 per person-rem value was selected by the commissioners as the upper bound of all the numerical estimates in the literature. The purpose was to estimate the potential monetary costs of health effects during the lifetimes of persons living within 80 km of a nuclear power plant (no other facility) so that those potential costs could be compared with the real costs of adding additional radiological waste treatment systems to each proposed nuclear power plant to determine if the operation of the plant would result in meeting the 10 CFR Part 50, Appendix I "as low as reasonably achievable" rule. It was never the intent of the commissioners to use that monetary value for any other purpose, such as estimating the monetary costs of future health effects from other sources on today's populations or future populations. The absurdity of future monetary costs can be demonstrated very simply, assuming human institutions and the human race persist into the future in the same manner as today. Ignoring the real possibility that radon health effects may not occur in the future due to technological advances in the cure and prevention of such effects, it is possible to calculate how much money would have to be deposited in a savings account now to meet "future monetary costs" of $10 billion per reference reactor year.

As a conservative estimate, it was assumed that a 5 percent simple interest rate would demonstrate the meaninglessness of such calculations. Conservative staff estimates indicate that only a few health effects might occur within 1000 years. It is obvious that essentially all of Dr. Kepford's "health effects" would occur over periods of time that exceed the probable life expectancy of the human race and our solar system. Nevertheless, tongue-in-cheek, it can be shown that, if the utility were to deposit one cent in a perpetual savings account to pay for any future health costs that might occur, that fund would contain nearly $16 million-trillion after only 1000 years. Clearly, one cent would not significantly modify the future costs of electrical power generated today.

With regard to Dr. Kepford's estimates of millions of future deaths from radon-222 per reference reactor year, see also Section 10.4.5.3.

The contention that "the NRC itself has been unable to disagree with Dr. Kepford's findings that 1.2 million people per year will die in the future from the effects of radon gas emitted from the tailings produced just to fuel TMI," is incorrect. The staff has refuted such claims in several hearings as meaningless for many reasons. Some of the more important reasons were discussed earlier.

It is the responsibility of NRC to protect the health and safety of the public as they relate to nuclear plant operations. NRC requires that the design and operations of nuclear facilities consider and protect the health and safety of the public. NRC reviews each nuclear facility and determines if it will endanger the health and safety of the public. NRC will only permit operation of a facility if it finds the facility can be safely operated.

<u>Significance of Radiological Impact</u>

W.L. Prelesnik's comments asked the following questions (responses follow each question):

Question 1: What is your definition of significant, and how was it arrived at?

Response: NRC currently evaluates the radiological impact to three individuals: 1) a hypothetical maximally exposed individual, 2) an average individual within 80 km of the site, and 3) an average individual in the United States. The risk to the first two types of individuals from radioactive effluents from one year of reactor operations is quantified in Table 4.17 of the FES.

For example, the risk of premature death to the hypothetical maximum exposed individual from gaseous effluents from one year of reactor operations is less than one chance in a million. (The risk from liquid and gaseous effluents has not been added because it is very unlikely that any real individual would be exposed at the maximum level from both sources.) This risk is much less than similarly calculated risks from many other types of radiation exposure (e.g., medical radiation exposure, natural background radiation, and air travel.) The risk to the maximum individual is within the range of many other common sources of radiation (e.g., airline travel, natural gas heating, and television viewing.) The risk to the average individual within 80 km of the site, and the risk to the average individual in the United States from one year of reactor operations is less than 1/100 of the risk to the maximum hypothetical individual. Since the risk from radioactive effluents from nuclear power plants is so low compared with many other types of risk (radiation related or otherwise) and since the radiation-related risks are based on conservative assumptions, the staff considers the risk to real individuals in the vicinity of nuclear power stations from normal operations to be insignificant. See Section 4.5.5 of the FES for additional information comparing the risk from annual operation of the reactor(s) with the risk from other sources of radiation, and the risk from the current incidence of cancer fatalities and genetic abnormalities.

Question 2: On what basis do you calculate the "<u>anticipated</u>" occurrences? The Rasmussen Report has already been proven to be incorrect.

Response: The anticipated occurrences to which the comments refer are based on operational occurrences and not on accident considerations. The Rasmussen Report is not used to calculate the impacts from operational occurrences. Furthermore, the Rasmussen report has not been proven to be incorrect, but as a result of the Lewis Committee report, it has been suggested that the numerical results may have a wider range of uncertainty than as suggested by the Rasmussen Report.

Question 3: How do you define "normal"? Normal operation levels of radiation emission are quite different and separate from normal background levels of radiation already existing in the environment. Also, because of bomb testing and power plants, the "normal" levels of background radiation have increased over the past 30 years.

Response: NRC regulations (10 CFR Part 50) require the light-water-cooled nuclear power stations be designed and operated in a manner that will limit radiation exposures to any individual in the general population to a small fraction of the general radiation standards during normal operation. An extensive rule-making proceeding (Docket No. RM-2) was conducted over a several-year period (December 1970 to May 1975) to quantify the numerical guides for keeping levels of radioactive material in the effluents of light-water-cooled nuclear power reactors as low as is reasonably achievable during normal operating conditions (Appendix I of 10 CFR Part 50). The normal operating conditions for these reactors were characterized by NRC during the course of the rule-making, based primarily upon data obtained during operations. Considerable more data have been obtained since 1975. The procedures used by the staff to characterize the radioactive material in the effluents are given in Regulatory Guide 1.112, "Calculation of Releases of Radioactive Material in Gaseous and Liquid Effluents from Light-Water-Cooled Power Reactors." This guide is used in conjunction with information in NUREG-0016 and NUREG-0017 for boiling-water reactors and pressurized-water reactors, respectively (copies may be obtained from NRC). A narrative explanation of the population dose for the entire uranium fuel cycle for light water reactors was published on 4 March 1981 in the Federal Register (46 FR 15154-15175).

The estimated U.S. population dose from radioactive effluents from one year's operation of Susquehanna, Units 1 and 2, is about 50 person-rem (Table 4.10). This estimate is based upon a 15-year buildup of activity in sediment and soil (i.e., the nominal midpoint of the reactor's life). This dose is a very small fraction (less than 0.0002%) of the annual U.S. population dose from natural background radiation (i.e., 26,800,000 person-rem).

Question 4: What individuals, by name, set these "normal" levels?

Response: The "normal" levels of radiation from radioactive releases from nuclear reactors referred to are contained in Title 10 Code of Federal Regulations, Part 50, Appendix I (10 CFR 50, App. I). The annual dose design objectives set in 10 CFR 50, App. I, were set in a rule-making hearing by NRC. Although many people participated in the rule-making hearing, Commissioners Anders, Rowden, Mason, Gilinsky, and Kennedy made the final decision to adopt the limits set in 10 CFR 50, App. I. A copy of the Commission opinion in the matter of 10 CFR 50, App. I, has been sent to W. L. Prelesnik.

Question 5: How much "normal" radiation will be expected to be released in Berwick?

Response: The calculated releases of radioactive materials in liquid effluents are provided in Table 4.11 of the FES, and the calculated releases of radioactive materials in gaseous effluents are provided in Table 4.4. These two calculated source terms represent annual releases per reactor from normal operation, including anticipated operational occurrences, when averaged over the 30-year operating life of the plant. These source terms were used to calculate exposures due to releases (Table 4.8 of the FES). Dose estimates and lifetime risk estimates from these releases are given in Section 4.5 of the FES.

Question 6: What are the NRC's recorded, documented levels of "normal" radiation releases from the operating plants in the United States?

Response: The quantity of radioactive materials released from nuclear power plants in the year 1977 is contained in a document entitled, "Radioactive Materials Released from Nuclear Power Plants - Annual Report 1977," (NUREG-0521). NUREG-0521 contains a nuclide-by-nuclide summary of the radioactive effluents released from operating reactors in the year 1977, as well as a categorical summary (i.e., noble gases, I-131 and particulates, tritium, mixed fission and activation products) for earlier years. Excerpts from NUREG-0521 are too lengthy to repeat here, but have been sent to W. L. Prelesnik.

Population dose commitments for the year 1975 for about 50 reactors are given in a document entitled, "Population Dose Commitments Due to Radioactive Releases from Nuclear Power Plant Sites in 1975"; D. A. Baker, J. K. Soldat, and E. C. Watson; Battelle Pacific Northwest Laboratories; PNL-2439; pp. 3-4; October 1977. Population dose commitments were calculated for the population between 2 and 80 km of each reactor site. The average individual dose commitment to that population (about 0.02 mrem) represents about a 0.02% annual increase over background radiation. The dose to the hypothetical maximum individual would be higher.

10.4.5.1 Exposure Pathways

No comments.

10.4.5.2 Dose Commitments (PDER 8/20/79:B-50; EPA 8/17/79:B-17)

The Safety Evaluation Report was published in April 1981.

Modifications and design changes to the radwaste treatment systems since the FES/CP were considered in calculating the source terms. The staff's detailed evaluation of these systems and the capability of these systems to meet the requirements of Appendix I will be presented in Chapter II of the Safety Evaluation Report. However, for the FES, the quantities of radioactive materials in effluents used to assess radiological impacts are given in Tables 4.4 and 4.11.

The calculated value for the direct radiation dose (20 mrem/yr at a typical site boundary 0.6 km from the turbine building) given in the Braun Safety Analysis Report is for a standard BWR plant design. The direct radiation dose of 2.7 mrad/yr in NUREG-0564 is an estimated dose for the specific design incorporated in the Susquehanna plant. Since the direct radiation dose is dependent on the shielding incorporated in the specific plant design, the above values are not directly comparable. Nonetheless, since the actual direct radiation dose could be higher (or lower) than 2.7 mrad/yr, a survey will be required at the time of plant operation. If the survey indicates that the limits of 40 CFR 190 could be exceeded, steps will be taken to reduce the dose.

Annual doses per site from liquid effluents were given in Table 4.9. The estimated dose to the total body or any organ of the hypothetical maximum individual from all pathways was about 1.0 mrem/yr for the site. This dose includes the dose from ingestion of fish as well as consumption of water. The dose to the average individual using the nearest community water system would be less than 1.0 mrem/yr. The Environmental Protection Agency's "National Interim Primary Drinking Water Regulation" states that "the average annual concentration of beta particle and photon radioactivity from man-made radionuclides in drinking water shall not produce an annual dose equivalent to the total body or any internal organ greater than 4 millirem/year" (Sec. 141.16). The annual doses from liquid effluents from Susquehanna, Units 1 and 2, are below the above limits.

10.4.5.3 Radiological Impacts on Humans (M.L. Hershey:B-27; EPA 8/17/79:B-17; T.R. Duck:B-11; PP&L 9/4/79:B-42; SA 6/10/80:B-64)

A formal program for the management of low-level radioactive wastes disposed of in commercial burial grounds is provided in "The NRC Low-Level Radioactive Waste Management Program," NUREG-0240, September 1977, available at the Public Document Room, NRC, 1717 H Street NW, Washington, DC, 20555. The program recommended new regulations and requirements for the Disposal of Low-Level Radioactive Waste and Low-Activity Bulk Solid Waste (Draft Regulation 10 CFR Part 61); these are presently being developed.

The staff does not believe that presently available worldwide dose models are capable of making such projections with meaningful results. The staff has determined that present models for the United States sufficiently represent the population exposure due to operation of this plant.

Environmental impacts from uranium mining and milling are addressed in Section 4.5.6, "Uranium Fuel Cycle Impacts," of NUREG-0564.

The FES includes credit for the leakoff collection system for the turbine building releases. The off-gas system releases were based on ambient operation conditions of 77°F (dew point 45°F) for the adsorption unit in reasonable agreement with the applicant's proposal of 60 to 65°F (dew point 40°F).

Table 4.12 provides estimates of transit time for effluents from various locations. As indicated in this table, it is assumed that sport fishermen may use the area near the plant discharge area. This is considered the "nearest sport fishing location" for purposes of an upper limit estimate.

Radiological Models

The staff has reviewed a report known formally as the "Radioecological Assessment of the Wyhl Nuclear Power Plant," and informally as the "Heidelberg Report." The report was written by a private group of individuals at the University of Heidelberg, West Germany, concerned with energy and environmental issues. The authors of this report are affiliated with a group called Institute for Energy and Environmental Research (IFEU), and have not been authorized to use the name of the University of Heidelberg. Hence, their report is now referred to as the IFEU Report, although it has been referred to as the "Heidelberg Report" in the past. The IFEU Report presents an assessment of the environmental radiological impact of a proposed pressurized-water reactor to be built near Wyhl, West Germany.

The assessment is based largely on mathematical models used to calculate doses to humans in the area surrounding a reactor site and to describe the movement of radioactive materials in the environment. These are the same mathematical models used by NRC to calculate doses to ensure that any radiation exposure resulting from reactor operations is far below national and international recommended "safe" levels.

The staff reviewed the IFEU Report because the report implied that NRC may be substantially underestimating doses to individuals living near nuclear power plants by using incorrect values for parameters in mathematical models. Although the IFEU Report assessment is based largely on environmental models described in four NRC Regulatory Guides, the staff's review of the report indicates that the IFEU authors used values for some model parameters that are too high.

As a result, the IFEU Report estimated doses to the public by some pathways that are up to 10,000 times higher than the doses calculated using the NRC's values for those parameters.

The staff's review concluded that the IFEU Report does not provide any substantial evidence that NRC significantly underestimates doses. This conclusion is based on: 1) measured effluent releases at reactors operating in the United States, which are much less than those used in the IFEU Report; 2) measured environmental concentrations near reactors operating in the United States, which are much lower than those calcualted in the IFEU Report; and 3) a detailed review of the literature regarding critical parameters employed in the models in question, which does not support the values used in the IFEU Report.

The results of the staff review have been published in draft form for public comment, both as a main report for the technical community (NUREG-0668) and as a summary report for general public information. The final report is expected in 1981.

In response to the contention that the "old AEC ... deliberately rigged the experiments," while NRC acknowledges that some of the AEC experiments done for some radionuclides in the 1950s could be done better today in light of advancements in technology, the staff has never characterized these studies as fraudulent and knows of no evidence to support such a claim.

The comment also states that the "Heidelberg Report is the first time that independent scientists have examined the NRC's safety assurances about routine emissions from operating plants," thus implying that the validity of NRC radionuclide transport and dose models have not been reviewed and assessed by scientists outside NRC. This is absolutely incorrect. The Environmental Protection Agency, Argonne National Laboratory, Oak Ridge National Laboratory, Battelle Northwest Laboratory, privately owned technical consulting companies, and numerous national and international scientific organizations all have radionuclide transport and dose models based on field measurements that yield results consistent with the NRC calculations. In September 1977, a workshop of "The Evaluation of Models Used for the Environmental Assessment of Radionuclide Releases" was held in Gatlinburg, TN, and the results were published as CONF-770901. Participants in this workshop were selected to ensure an appropriate combination of individuals representing a spectrum of scientific and administrative expertise. The working group on terrestrial food-chain transport at this meeting, whose members were predominantly from organizations other than NRC, concluded that transport models, as given in NRC Regulatory Guide 1.109, are very adequate for demonstrating compliance with NRC's regulations (as given in Appendix I of 10 CFR Part 50).

10.4.5.4 Radiological Impacts on Biota Other Than Humans

No comments.

10.4.5.5 The Uranium Fuel Cycle (Sierra:B-61; EPA 8/17/79:B-17; SA 8/17/79:B-62; F. Thompson: B-74; M.J. Huntington:B-27; S. Laughland:B-32; PDER 8/20/79:B-50)

Section 4.5.5,"The Uranium Fuel Cycle," (now Sec. 4.5.6) has been revised to reflect the Commission's final rule published to the Federal Register on 2 August 1979 (44 FR 45362). An explanatory narrative of the significance of release in Table 4-14 was also published in the Federal Register (46 FR 15154-15175, 4 March 1981).

Since there will be no radioactive waste disposal at the Susquehanna Steam Electric Station, waste disposal techniques are not part of the facility FES but will be considered in the formulation of regulations and the licensing of disposal facilities.

The models used in estimating doses in the environmental statement for the operating license are state-of-the-art models. The source-term, meteorological dosimetry models have been improved since the issuance of the construction permit. These models have been reviewed by EPA in regard to implementing the Uranium Fuel Cycle Standard (40 CFR 190). The doses calculated by using these models are thought to be conservative (i.e., the models probably overestimate actual doses). In addition, new information since the publication of the DES concerning the receptor location at 0.7 miles NW has resulted in a change in the maximum receptor location for iodines and particulates from 0.7 miles NW to 2.2 miles E.

Spent Fuel Storage

The storage of spent fuel is addressed in an NRC document entitled "Final Generic Environmental Impact Statement on Handling and Storage of Spent Light Water Power Reactor Fuel" (NUREG-0575). The storage of spent fuel addressed in NUREG-0575 is considered to be an interim action, not a final solution. The commission has clearly distinguished between permanent disposal and interim storage.[8]

One of the findings of NUREG-0575 is that the storage of light water reactor (LWR) spent fuels in water pools has an insignificant impact on the environment, whether stored at a reactor or away from a reactor. Primarily this is because of the physical form of the material, sintered ceramic oxide fuel pellets hermetically sealed in Zircaloy cladding tubes. Zircaloy is a zirconium-tin alloy which was developed for nuclear power applications because of its high resistance to water corrosion in addition to its favorable nuclear properties. Even in cases where defective tubes expose the fuel material to the water environment, there is little attack on the ceramic fuel.

The technology of water pool storage is well developed; radioactivity levels are routinely maintained at about 5×10^{-4} μCi/mL. Maintenance of this purity requires treatment (filtration and ion exchange) of the pool water. Radioactive waste that is generated is readily confined and represents little potential hazard to the health and safety of the public.

There may be small quantities of ^{85}Kr released to the environment from defective fuel elements. However, for the fuel involved (fuel at least one year after discharge), experience has shown this to be not detectable beyond the immediate environs of a storage pool.

There will be no significant discharge of radioactive liquid effluents from a spent fuel storage operation as wastes will be in solid form.

This statement supports the finding that the storage of spent fuel in away-from-reactor facilities is economically and environmentally acceptable.

10.4.6 Socioeconomic Impacts (EDC 9/26/79:B-14; S. Shortz:B-60)

The staff is unaware of any specific land use changes that have not been evaluated either in connection with the plant or reservoir. Unless the context of land use change is made more specific, monitoring effort would be an exercise without an objective.

10.4.6.1 Demography

No comments.

10.4.6.2 Settlement Pattern

No comments.

10.4.6.3 Social Organization

No comments.

10.4.6.4 Social Services (DOT 8/9/79:B-10)

The transportation impacts have been adequately addressed to the satisfaction of DOT, with the exception of sufficient coordination. It is the staff's view that the applicant and DOT should work together to consider adequate design of the access road to the reservoir as well as attendant impacts. NRC will not preempt DOT expertise in matters of design and traffic coordination.

The comment attributes many of the changes in the past years to construction of SSES. Many of these changes are due to other projects, including past highway construction, and to urbanization trends independent of SSES. The record shows that the blasting during construction did adversely affect residents, but this should not be considered in a decision as to whether or not the plant should be operated. The comment correctly states that the land used by SSES is an irrevocable loss, but the opinion that its former use was the best use cannot be demonstrated on economic grounds. The EIS mentions the effect of hurricane Agnes as part of the recent history and is not meant to characterize the local area surrounding the plant.

10.4.6.5 Political Organization (EDC 9/26/79:B-14)

The distribution of taxes generated by SSES is primarily a state and local government responsibility. For a discussion of taxes, see Section 4.6.6.2.

10.4.6.6 Economic Impacts (EDC 9/26/79:B-14)

The comment on anticipated noise levels was addressed in Section 10.4.4.

PP&L has undertaken a program of hiring local workers as discussed in Section 4.6.6.1.

10.4.6.7 Summary and Conclusions

No comments.

10.4.7 Impacts to Cultural Resources (DOI 5/29/80:B-9; Sierra:B-61; EDC 9/26/79:B-14; SA 8/17/79:B-62 and 6/10/80:B-64; PDER 8/20/79:B-50)

In the June 1973 FES-CP, the staff reviewed the effects of construction and aspects of operation on the total plant site plus the transmission line corridors. In that document, the staff identified those sites listed in the National Register that were within 32 km of the facility. The Advisory Council on Historic Preservation found the staff's statement procedurally adequate and suggested contact with the State Liaison Officer for Historic Preservation. The State Liaison Officer for Historic Preservation indicated that the project would not affect a known archeological or historical site or historical structure, and that it appeared to be consistent with the plans and objectives of the Pennsylvania Historical and Museum Commission.

In 1975, in Appendix B to the DES-OL (June 1979), the staff reviewed the applicants' proposed alternate transmission line corridors and determined that neither of the lines under review crossed or passed in the vicinity of any registered historic site. In the DES-OL, the staff requested that a survey be done of the recreation area. The staff later requested a survey of the Pond Hill Reservoir. These surveys resulted in the identification of three significant sites and one potentially significant site in the recreation area, which the staff, after consultation with the Pennsylvania Historic Preservation Officer, will submit to the Keeper of the National Register for a determination of eligibility.

10.5 ENVIRONMENTAL MONITORING

10.5.1 Résumé

No comments.

10.5.2 Preoperational Monitoring Program

10.5.2.1 Onsite Meteorological Program

No comments.

10.5.2.2 Water Quality Monitoring

No comments.

10.5.2.3 Groundwater Monitoring (DOI 9/10/79:B-7)

The applicant states that "In general, groundwater in the Paleozoic rock formations of the Appalachian Highlands flows from the topographically higher areas (recharge areas) to the valleys. This groundwater, it is believed, discharges to springs and to the streams and rivers of the region, except at flood stage" (ER-OL, p. 2.4-12). Consequently, the doses from ingestion of groundwater should be no greater than the doses from ingestion of water from the river. Any use of groundwater as a drinking water supply should be balanced by a decrease in river water as a drinking water supply.

10.5.2.4 Aquatic Biology

No comments.

10.5.2.5 Terrestrial Monitoring Program

No comments.

10.5.2.6 Radiological Monitoring (PP&L 9/4/79:B-42)

The revisions discussed in PP&L's comment will be used in establishing that the environmental radiation monitoring program meets the staff's position on environmental monitoring. Lower limits of detection will be incorporated in the applicant's technical specifications.

10.5.3 <u>Operational Monitoring</u> (SRBC 8/30/79:B-68; L.E. Watson:B-75; EDC 9/26/79:B-14)

As discussed in Section A.3.2.2, consumptive water use will be determined by measuring the difference in volume between the intake flows for SSES and blowdown to the river.

Results of radiological monitoring programs at nuclear power reactors are routinely made available to the public. For an example of radiological effluent monitoring see an NRC document entitled "Radioactive Materials Released from Nuclear Power Plants, Annual Report 1977" (NUREG-0521). Individual licensee reports on radiological environmental monitoring are available in the NRC Public Document Room, 1717 H Street NW, Washington, DC 20555, and in local document rooms located near each licensed facility.

NRC has factored the impact of the Three Mile Island accident into the review of the Susquehanna application. Specifically, the Environmental Statement has been supplemented to evaluate the site-specific environmental impacts attributable to plant-specific accident sequences that lead to releases of radiation and/or radioactive materials, including sequences that can result in inadequate cooling of reactor fuel and melting of the reactor core (see Sec. 6).

10.5.3.1 Onsite Meteorological Program

No comments.

10.5.3.2 Water Quality Monitoring

No comments.

10.5.3.3 Groundwater Monitoring

No comments.

10.5.3.4 Aquatic Biological Monitoring

No comments.

10.5.3.5 Terrestrial Monitoring Program

No comments.

10.5.3.6 Radiological Monitoring (M.M. Molesevich:B-39)

Radiological environmental monitoring is not the only type of radiological monitoring required at the Susquehanna Station. NRC requires two types of radiological monitoring at nuclear power reactors to ensure that radioactive effluents are within acceptable limits: 1) radiological effluent monitoring and 2) radiological environmental monitoring. Radiological effluent monitors are required to monitor and control, as applicable, the releases of radioactive materials in liquid and gaseous effluents during actual or potential releases. The radiological effluent monitors operate continuously. In addition, NRC requires that the licensee operator of a nuclear power reactor conduct radiological environmental monitoring to confirm that measured releases of radioactivity (i.e., radiological effluent monitoring) from the plant do not result in unanticipated buildups in the environment.

The requirements for an acceptable radiological environmental monitoring program for nuclear power reactors are contained in the NRC's "Branch Technical Position" (Revision 1, Nov. 1979; copies are available from NRC's Radiological Assessment Branch). The Branch Technical Position was developed by experts in the field of radiological environmental monitoring. The staff does not require more frequent sample collections for several reasons. First, based upon the staffs estimate of doses to maximum individuals (e.g., see Table 4.8), the staff does not anticipate a significant buildup of radioactivity in the environment due to normal operation of Susquehanna, Units 1 and 2. Second, hundreds of reactor-years of environmental monitoring experienced at nuclear power plants have shown that the concentrations of radioactive materials in environmental samples are at or very near background levels due to natural sources and previous atmospheric weapons tests. In addition, while it is true that the most frequent collection of environmental samples is on a weekly basis, this does not mean that environmental monitors are required to be in place continuously in order to obtain an integrated dose. The Susquehanna Station radiological monitoring program meets the basic requirements of the NRC's "Branch Technical Position" in regards to collection frequency.

The radiological environmental monitoring program is not described more fully in the final Environmental Impact Statement because the impacts of the monitoring program are negligible. However, individual licensee monitoring reports are available in the NRC Public Document Room, 1717 H Street NW, Washington, DC 20555, and in local document rooms located near each licensed facility.

10.6 ENVIRONMENTAL IMPACT OF POSTULATED ACCIDENTS

10.6.1 Résumé

No comments.

10.6.2 Postulated Accidents Involving Radioactive Materials (D. Oberst:B-41; H. C. Jeppsen: B-31; LUZ:B-38; L. Moses:B-41; Sierra:B-61; EPA 8/17/79:B-17; SA 8/17/79:B-62 and 6/10/80:B-64; F.L. Shelly:B-57; S. Shortz:B-60; M.J. Huntington:B-27; PP&L 9/4/79:B-42; PDER 8/20/79:B-50; T.R. Duck:B-11; L.E. Watson:B-75; DOI 9/10/79:B-7; EDC 9/26/79:B-14; SEDA:B-56; M.M. Molesevich:B-39)

NRC has factored the impact of the Three Mile Island accident into the review of the Susquehanna application. Specifically, the Environmental Statement has been supplemented to evaluate the site-specific environmental impacts attributable to plant-specific accident sequences that lead to releases of radiation and/or radioactive materials, including sequences that can result in inadequate cooling of reactor fuel and melting of the reactor core (see Sec. 6).

Emergency Response Plans are required by the Atomic Energy Act. Under this act, the NRC and the Federal Emergency Management Agency (FEMA) are responsible for reviewing evacuation plans. State and local evacuation plans will be generated and reviewed by the NRC and the Federal Emergency Management Agency (FEMA) before an operating license is issued.

The 28 March 1979 accident at TMI-2 resulted in greater amounts of radioactive water and waste than could be processed by the installed radwaste treatment systems in a short time. The solution to the problem was to contain these wastes so as to permit time for radioactive decay and for installing additional treatment equipment. The new equipment has been installed and cleanup is underway as planned.

For a discussion of the responsibility of NRC to protect the health and safety of the public as they relate to nuclear plants, see Section 10.4.5.

NRC has included an evaluation of Class 9 accidents in the FES. The radiation monitors described in Table 5.1 are for preoperational purposes only. The Technical Specifications will require additional monitors for operation.

State and local evacuation plans will be reviewed by the Federal Emergency Management Agency before an operating license is issued.

Animal and food-crop samples were taken prior to the startup of the plant; the background activity in these samples is determined by destructive means. Similar destructive testing of humans would not be possible. Although whole-body counting (a non-destructive test) could be done of humans near the site, this would not be effective because of the mobility of the human population and the cost of whole-body counting.

NRC has studied postulated accidents associated with the storage of spent fuel at the Susquehanna site. The spent fuel storage area was evaluated by postulating the effects of floods, missiles, pipe breaks, and seismic events. The results of the NRC evaluation are documented in NUREG 0776, Section 9.1.2.

NRC has a full-time resident inspector at the Susquehanna site. As a result, the reporting of any accidents by PP&L will be supplemented with an independent NRC report and assessment.

10.6.3 Transportation Accidents

No comments.

10.7 NEED FOR PLANT

10.7.1 Résumé (L. Moses:B-41; PP&L 9/4/79:B-42)

Section 7.1 has been modified to incorporate the latest information on startup dates.

10.7.2 Applicant's Service Area and Regional Relationships

No comments.

10.7.3 Benefits of Operating the Plant (SA 8/17/79:B-62; F. Thompson:B-74; M.J. Huntington: B-27; PP&L 9/4/79:B-42; T.R. Duck:B-11; EDC 9/26/79:B-14; M.M. Molesevich:B-39)

The basis for operating SSES does not depend solely on reserve margin considerations. In the near-term, the economic basis is the lower cost of electricity production. In a few years, the staff expects that reserve margin requirements will no longer be adequate, and that SSES will be needed for peak-load as well as baseload energy. A further consideration is that the reserve margins were calculated as if both units of the Three Mile Island nuclear plant were in operation; the EIS has therefore overstated the actual energy available in the region, at least until decisions on operation of the TMI Units 1 and/or 2 are made and the unit(s) are back on line.

As discussed in the comparison of coal and nuclear fuel costs, the need for SSES in the immediate future depends on lower production costs of SSES compared to other units in the system. The comment points out that SSES could help replace energy loss due to TMI; this factor was not evaluated in the EIS. In the long run, reserve margins will not be adequate without SSES. SSES operation as scheduled and planned makes economic sense because of lower production costs and because of its contribution to meet peak energy needs.

The Price Anderson Act and government subsidies for research of waste disposal technology do represent cost advantages to nuclear energy that are available to the industry as a whole. Removal of these advantages would not make the cost of power from SSES prohibitive as you state. All insurance premiums are now paid by nuclear plant operators. Federally funded research in waste disposal quite likely will be a small part of the cost of waste disposal, which in turn is a small part of the cost of fuel. Waste disposal costs are already included in estimated fuel costs for SSES. Operation of SSES would prove economical even if the Price Anderson Act were repealed and government-sponsored research stopped.

Reasons for operating the plant were discussed and evaluated and do not consist solely of reserve margin considerations. See summary and conclusions (p. iv). Also note responses to similar questions in Coal vs. Nuclear and Benefit-Cost Analysis sections.

Although staff notes that EDC concurs that the plant is needed, reserve margin consideration is only one of several reasons for operating the plant as scheduled.

Anthracite is discussed in response to other comments on the subject (see Sec. 10.8.4).

10.7.3.1 Operation of the PJM Interchange

No comments.

10.7.3.2 Minimization of Production Costs (PP&L 9/4/79:B-42)

The text has been revised to reflect these comments.

10.7.3.3 Diversity of Supply Source

No comments.

10.7.3.4 Reliability of Analysis (M.M. Molesevich:B-39)

As discussed in Section 7.3.4.2 of the FES, a reserve capacity larger than 20% may be desirable for a system with units that are large in relation to the size of the system (as will be the case with SSES in service).

Table 7.4 has been revised to reflect the comments.

10.8 EVALUATION OF THE PROPOSED ACTION

10.8.1 Adverse Effects That Cannot Be Avoided

No comments.

10.8.2 Short-Term Uses and Long-Term Productivity

No comments.

10.8.3 Irreversible and Irretrievable Commitments of Resources

No comments.

10.8.4 Comparison of Nuclear and Coal-Fired Power Plants (H.C. Jeppsen:B-31; DOT 8/9/79: B-10; DA-FS:B-4; Sierra:B-61; SA 8/17/79:B-62 and 6/10/80:B-64; S. Shortz:B-60; M.J. Huntington:B-27; EDC 9/26/79:B-14)

The benefits of revitalizing the anthracite-coal-producing areas is a separate issue and not related to the operation of SSES. Very small amounts of anthracite are used for steam production by the utility industry primarily due to the high price of anthracite coal. The new source performance standards (NSPS) were rewritten to encourage the use of Eastern coal. These standards require removal of at least 70% of the SO_2 in the fluegas if an emission rate of 0.6 lb. of SO_2 per million Btus can be achieved. Ninety percent removal of SO_2 is required if the limit cannot be met.

Although these new rules do encourage the use of Eastern rather than low-sulfur Western coal because some scrubbing is required, there is plenty of Eastern bituminous coal that can meet these requirements. Much of this coal can be obtained in Pennsylvania. It is not likely that anthracite coal can economically compete as steam-market coal. Anthracite coal revitalization depends more on the steel industry; increased demand is also more likely to come from exports rather than domestic uses.

The economic argument for operating SSES rather than a coal plant is based on the lower operating cost of SSES compared to coal-fired plants. The cost of coal is two to three times the cost of comparable nuclear fuel. Nuclear fuel costs have ceased their rapid price escalation, while real coal prices are forecast to increase at 2.2% per year through 1990 and at 1.7% per year to the year 2000; this is over and above the rate of inflation (DRI, Energy Review, Autumn 1980, Lexington, MA).

The long-run differences between nuclear and coal prices are not expected to diminish. Currently negotiated uranium prices are at the level they were in late 1975; i.e. about \$28/lb U_3O_8. Primarily because of the difference in fuel costs, delay of operation of SSES makes no economic sense, even if more energy could be obtained from existing coal-fired plants. Construction of a new coal-fired plant to replace SSES would be economically unwise since SSES has already been constructed.

Comparison of coal vs. nuclear using anthracite coal as a reference case would not improve the economics of burning coal. Since SSES has already been constructed, the use of coal can only be evaluated for use in existing plants. Not only is anthracite more expensive than bituminous at the mine, but boilers and auxiliary equipment would have to be refurbished to use a different coal type. Derating may also be involved.

As stated in NUREG-0564, there is a considerable amount of uncertainty in estimating health effects over long periods of time (greater than 100 years). The overall uncertainty in the nuclear fuel cycle is probably about an order of magnitude (increased or decreased by a factor of 10) over 100 years and about two or more orders of magnitude over 1000 years. The uncertainty associated with the coal fuel cycle tends to be much larger because of the inability to estimate total health impacts from all the pollutants released to the environment from that cycle. However, if one assumes that most of the public impact over a period of several decades is caused by inhalation of sulfur compounds and associated pollutants, there is as much as a two-order-of-magnitude uncertainty in the assessment of the coal fuel cycle. In view of the large uncertainties in any comparison of the health effects of coal versus nuclear power plants, a site-specific comparison is not warranted.

Increased use of coal and solar power are expected, but these should not be considered as alternatives to the operation of SSES. Nuclear power may be as safe or safer than coal with respect to release of harmful emissions (Sec. 8.4). Solar power for electrical generation has not been developed to the stage that baseload electrical generation needs can be satisfied even with increased conservation.

The staff does not consider solar energy, biomass, cogeneration, and conservation to be adequate substitutes for amounts of power that will be generated by SSES, nor would the cost of generation from SSES be nearly as high as from building and operating these alternatives.

For a discussion of the transportation effects, see Section 10.4.6.

Impacts associated with both the coal and uranium fuel cycles have been addressed within a generic framework involving the development and use of various models (i.e. model mines and mining methods, model power plants, etc.). Discussion of the land requirements for supporting the uranium fuel cycle of a model 1000-mWe LWR is presented in Section 4.5.5. In contrast, Dvorak et. al. characterized the coal fuel cycle within selected source areas, thereby factoring in regional differences in coal quality, bed thickness, mining conditions, etc.[9] Accordingly, land disturbance resulting from surface mining to supply the annual fuel requirement of a model power plant (1000 MWe) from the various source areas was estimated as follows: Wyoming-12.1 ha, Arizona-40.5 ha, Pennsylvania 66.8 ha, Illinois 76.9 ha, and eastern Kentucky 78.9 ha. However, the listed areas (in hectares) pertain only to lands overlying the coal to be extracted. The total affected area would be dependent on the disposition of excavated overburden and, in some cases, may be twice or more times the areas listed.

The staff agrees that a general trend exists whereby continued extraction of a given unit of coal or uranium results in increasingly greater adverse impacts on the landscape. However, it should also be noted that contemporary requirements, standards, and reclamation programs implemented to limit such impacts are also becoming increasingly more stringent. The Surface Mining Control and Reclamation Act (SMCRA) of 1977 exemplifies the increasing public awareness of the need to prevent, control, and/or mitigate mining-related impacts. One provision of the act mandates the establishment of environmental and other criteria whereby some coal resource areas are or will be designated as unsuitable for surface mining. Some of the reclamation requirements of the act include specifications relative to restoring natural land contours, topsoil management and replacement, restoring land-use potentials to levels comparable to or exceeding those existing prior to mining, and revegetation standards.

The indirect impacts of the coal and nuclear fuel cycles have been treated in depth in other documents. Consideration of the coal fuel cycle is beyond the scope of this proposed action; however, nuclear power does compare favorably when "indirect effect of mining on the landscape" are examined. A comprehensive evaluation of uranium mining and milling is presented in the "Generic Environmental Impact Statement on Uranium Milling," April 1979, NUREG-0511 (two volumes).

If utilities choose to build coal-fired plants rather than nuclear plants in the future, it is not necessarily true that the cheapest coal will come from the area near the plant. It is unlikely that anthracite coal will be used because of the premium that that type of coal commands on the market.

The staff does not see any relation between the issuing of a permit for the construction of Pond Hill Reservoir and the impact of a renewed anthracite industry on the region. At this point, the cost of building a new coal plant and the recovery cost of SSES would be very large as compared to the benefit derived from the renewed anthracite industry.

10.8.4.1 Health Effects (PP&L 9/4/79:B-42)

Table 8.1 has been revised to reflect this comment.

10.8.4.2 The Uranium Fuel Cycle

No comments.

10.8.4.3 The Coal Fuel Cycle

No comments.

10.8.4.4 Other Considerations (T.R. Duck:B-11)

NRC has factored the impact of the Three Mile Island accident into the review of the Susquehanna application. Specifically, the Environmental Statement has been supplemented to evaluate the site-specific environmental impacts attributable to plant-specific accident sequences that lead to releases of radiation and/or radioactive materials, including sequences that can result in inadequate cooling of reactor fuel and melting of the reactor core.

10.8.4.5 Summary and Conclusions

No comments.

10.8.5 Uranium-Resource Availability (T.R. Duck:B-11)

Section 8.5 has been revised to reflect recent changes in the outlook for future uranium-fuel supplies.

10.8.6 Decommissioning (EPA 8/17/79:B-17; SA 8/17/79:B-61; T.R. Duck:B-11)

The discussion in Section 8.6 has been revised to reflect the current staff position relative to the decommissioning of nuclear facilities. These revisions summarize a more extensive treatment of this subject published in the "Draft Generic Environmental Input Statement on Decommissioning of Nuclear Facilities" (NUREG-0586, January 1981, U.S. Nuclear Regulatory Commission).

The decommissioning alternatives for a nuclear reactor are discussed in detail in NUREG-0586. The dollar amount indicated in the benefit-cost section refers to one of several decommissioning methods; no specific method of decommissioning for SSES has been selected at this time. All reasonable methods of decommissioning can be planned for with respect to engineering and financial considerations. The comparison to Three Mile Island is not appropriate, because TMI involves problems of criticality, the extent of the contamination at Unit two, and extraordinary precautions necessary to minimize occupational exposure.

10.9 BENEFIT-COST ANALYSIS

10.9.1 Résumé (F.L. Shelly:B-57; F. Thompson:B-74; M.J. Huntington:B-27; S. Laughland:B-32)

The assertion that nuclear power is not competitive with other sources of electrical energy production is incorrect. SSES has already been constructed and, because this is at least half of the electricity production cost, there is no need to evaluate the coal vs. nuclear vs. alternative sources issue. The overall energy source comparison is useful only at the construction stage, when all costs are variable and economic choices of interest are the widest possible. At the construction stage, SSES is a competitive option; at the operation stage, it is the only logical economic choice.

The use of 60 to 70% capacity factor is realistic for new nuclear plants; average capacity for nuclear units in 1979 was 65.2%. In 1979, with TMI included in the data for the first ten months, the average capacity factor was 58.9% (NUREG 0020, Operating Units Status Report, Vol. 4, No. 9, September 1980, p. 1-3).

The availability of electrical energy affects the demand for use through the price. With increasing electrical energy prices, the additional power provided by SSES is not going to encourage increased usage.

The subsidies to nuclear power mentioned in the comment cannot be attributed to the construction and operation of SSES. No subsidies were provided for this commercial plant. Waste disposal costs have been included in studies of nuclear power economics. Plant capacity factors of 60 to 70% and no accidents that release significant levels of radioactivity to the atmosphere are the expected future of SSES; therefore, these assumptions are the proper basis for the benefit-cost assessment.

The stress to some residents near TMI is real. The stress on those residents cannot be compared to that on people who live within a few miles of plants that have operated successfully without accident.

The comparative relative cost of nuclear power operation was used as the basis for assessing SSES; the absolute costs will change.

The capacity factors cited in M.J. Huntington's comment do not reflect current data. It is true that, over the life of a nuclear plant, capacity factors rise and then fall in the latter years. However, this is true of coal plants as well; this does not represent a disadvantage of nuclear plants.

The need for the plant in the proposed operating time frame is based primarily on the savings in fuel costs. SSES is also needed in the longer run to replace energy due to loss of generating capability, and to meet future demand for energy.

10.9.2 Benefits

No comments.

10.9.3 Societal Costs

No comments.

10.9.4 Economic Costs (M.M. Molesevich:B-39)

Decommissioning plans are prepared for plants that have completed their useful lives. In the case of TMI or any other accident, where decommissioning is considered prior to completion of a useful operating life of from 30 to 40 years, a special investigation and study would be required. Any attempt to speculate in advance on a decommissioning plan under such extraordinary circumstances would be useful only in a generic assessment and could not be specifically applied to SSES. The decommissioning cost is estimated in 1978 dollars and represents only one mode of decommissioning. No decommissioning alternative based on reasonable cost ranges would affect the conclusion that the plant should operate.

10.9.5 Environmental Costs

No comments.

10.9.6 Environmental Costs of the Uranium Fuel Cycle

No comments.

10.9.7 Environmental Costs of Uranium Fuel Transportation

No comments.

10.9.8 Summary of Benefit-Cost (SA 8/17/79:B-62; PP&L 9/4/79:B-42; EDC 9/26/79:B-14; M.M. Molesevich:B-39)

The text has been revised to reflect applicable comments.

The staff has found no evidence that employees in the area would quit their jobs if SSES were allowed to operate.

The cost/benefit analysis for Pond Hill is given in Section A.5.3.

10.A APPENDIX A: FINAL SUPPLEMENT TO THE EIS FOR SSES

10.A.1 Summary and Conclusions, Foreword, Introduction

10.A.1.1 Summary and Conclusions and Foreward (LUZ:B-38; PDER 5/20/80:B-54; HEW:B-6; DOI 5/29/80:B-9; PP&L 5/29/80:B-47)

The text of the Summary and Conclusion has been changed to reflect applicable comments.

The applicant has proposed the construction of a compensation reservoir at Pond Hill Creek in order to meet requirements of the Susquehanna River Basin Commission during periods of low flow. Discussion of the proposed Pond Hill Reservoir is contained in Appendix A.

Item 3.0 has been added to the Summary and Conclusions section of Appendix A. The operation of Pond Hill Reservoir for compensation releases will have a minimal impact on downstream portions of the Susquehanna River (Sec. 4).

The SRBC has established 1 July 1984 as the deadline for compliance with its consumptive water makeup requirements (SRBC Regulation 1, Section 803.61).

The Pennsylvania Fish Commission has been added to the distribution list for the Final Environmental Impact Statement.

10.A.1.2 Introduction (PP&L 5/29/80:B-47)

The text of the Introduction has been changed to reflect the applicable comments.

10.A.2 The Site and Its Environs (DOC:B-5)

The applicant will be required to determine if any USGS markers are located in the proposed construction area. If any markers are in this area, the applicant will notify the National Ocean Survey of the National Oceanic and Atmospheric Administration (NOAA) and take appropriate steps to relocate the markers.

10.A.2.1 Plant Location (PP&L 5/29/80:B-47)

Figures A.2.2, A.2.3, and A.2.4 have been replaced with revised figures.

10.A.2.2 Land Use

No comments.

10.A.2.3 Meteorology and Hydrology (PP&L 5/29/80:B-47)

Section A.2.3.3 has been revised to include a discussion of the spring within the project boundary.

10.A.2.4 Geology and Seismology

No comments.

10.A.2.5 Site Ecology (PP&L 5/29/80:B-47)

The references have been corrected.

10.A.2.6 Socioeconomic Profile of the Local Area

No comments.

10.A.2.7 Cultural Resources (SA 6/10/80:B-64)

For a discussion of cultural resources, see revised Section A.2.7.

10.A.3 Reservoir Description

The text of Section A.3 has been changed to reflect applicable comments.

10.A.3.1 Introduction (PP&L 5/29/80:B-47; SRBC 4/30/80:B-69)

Figures A.3.1 and A.3.2 have been replaced with revised figures. Revised Plates A-1, 2, 5, 6, 17, and 19, supplied by PP&L, were used to correct the figures.

10.A.3.2 Mode of Operation (EPA 5/30/80:B-23; PP&L 5/29/80:B-47; SRBC 4/30/80:B-69)

The staff has estimated the probability of occurrence of different periods (number of days) of low river flow that would interrupt the operation of the power station based on historical riverflow measurement. Replacement and starting energy costs associated with each shutdown have also been calculated (Table A.5.3). Because future occurrences of low river flow are impossible to forecast, the staff has simply provided the cost associated with probable different low riverflow periods. The decision to accept or reject the riverflow alternative will depend upon one's confidence that future river flow will follow the historic pattern. At present, the Susquehanna River has a greater degree of flow control than it had in the past. The analysis shows that, if there is an average of four days per year of low river flow over a period of 30 years, the cost of the Pond Hill project will be more than the replacement energy cost.

10.A.3.3 Recreation Area (EDC 9/26/79:B-14)

PP&L has proposed a recreational program for the Pond Hill Reservoir. The details of this program are provided in the Environmental Statement in Section A.3.3.

10.A.3.4 Esthetics

No comments.

10.A.4 <u>Environmental Effects of Construction and Operation</u>

10.A.4.1 Impacts on Land Use (DOT 4/28/80:B-11)

The transportation impacts have been adequately addressed to the satisfaction of DOT, with the exception of sufficient coordination. It is the staff's view that the applicant and DOT should work together to consider adequate design of the access road to the reservoir as well as attendant impacts. NRC will not preempt DOT expertise in matters of design and traffic coordination.

The comment attributes many of the changes in the past years to construction of SSES. Many of these changes are due to other projects, including past highway construction, and to urbanization trends independent of SSES. The record shows that the blasting during construction did adversely affect residents, but this should not be considered in a decision as to whether or not the plant should be operated. The comment correctly states that the land used by SSES is an irrevocable loss, but the opinion that its former use was the best use cannot be demonstrated on economic grounds. The EIS mentions the effect of Hurricane Agnes as part of the recent history and is not meant to characterize the local area surrounding the plant.

10.A.4.2 Impacts on Water Use (EPA 5/30/80:B-23; SRBC 4/30/80:B-69; SA 6/10/80:B-64)

Evaporation from and precipitation into the reservoir were included in the simulation of the drought of record.

The text has been changed to reflect these comments.

10.A.4.3 Environmental Impacts (PP&L 5/29/80:B-47; EPA 5/30/80:B-23; DOI 5/29/80:B-9; SRBC 4/30/80:B-69)

The text and Figure A.4.1 have been revised to reflect applicable comments.

The statements in the text do not support the comment pertaining to "significantly negative impact on water quality." With respect to phosphorous levels, the text states that ambient phosphorous level exceeds criteria.

The expression "approximate original contours" (Appendix A, Sec. A.4.3.1) is in general accord with the applicant's commitment: "The borrow areas will be restored as closely as possible to their original condition" (ER-OL, Appendix H, Sec. 4.2.2.4). The extent to which original contours can be restored will vary; however, the staff expects the applicant to reestablish original onsite drainage to the extent possible, thereby avoiding undue disruption of offsite drainage patterns.

PP&L's commitment on drainage features is in general agreement with a staff recommendation presented in the Section A.4.3.1, paragraph 6.

The staff acknowledges EPA's comment to the effect that "discussion on wildlife resources is acceptable." However, the rationale whereby the staff's statement concerning the relatively low density of eastern cottontail at the Pond Hill project site has been interpreted as asserting that the cottontail is of "minor importance" is not readily apparent, nor does the staff clearly understand the intended meaning of "minor importance." Given that populations of cottontail exhibit cyclic fluctuations in northern states (as do those of ruffed grouse and snowshoe hare), the local densities of cottontails generally parallel the availability of proper food and cover habitat. The extensive second-growth forest vegetation of the project site is approaching maturity, and the increasing closure of the overhead canopy has inhibited, and continues to inhibit, the production of shrubby and herbaceous vegetation that serves as food and cover for the cottontails. This principal consideration underlying the staff's contention is in general agreement with a citation (page A.2-12) to the effect that the cottontail population at the proposed reservoir site "is much lower due in part to the relatively sparse open field and meadow acreage and to high predation by great horned owl, eastern red and eastern gray foxes, and wild dogs."

The implementation of the fish and wildlife management plan is a state responsibility and is not normally handled by the NRC. The Pennsylvania State Fish Commission and the Pennsylvania Game

Commission, with the aid of the U.S. Fish and Wildlife Service, will design a state fish and wildlife management plan.

The text of Section A.4.3.2.3 ("Operational Impacts of Discharge System") has been revised to reflect this new information as well as the change in the design of the inlet-outlet structure. As a result of the design change, most compensation releases from the reservoir will be from the epilimnion layer, minimizing the potential for cold shock in the river.

Several points need to be considered. First, the staff agrees that nutrients may be resuspended during turnover. Water quality data presented in Table A.4.1 of the DES indicated pH values for Pond Hill Creek and the Susquehanna River. The staff feels the pH of the reservoir will be such that nutrients suspended during turnover will quickly precipitate and return to the bottom sediments. A second point is that high levels of phosphorous are already present in the river. It is therefore incorrect to imply that phosphorous levels associated with eutrophic conditions in the reservoir will adversely effect the Susquehanna at times of compensation. The third point is that information presented in Table 1.3.2-1 of Volume IV of the ER-OL suggests that compensation releases will primarily occur in early fall and therefore precede fall turnover. Table 1.3.2-1 has been added to Section 4.3.2.2 of the text.

Iron levels are already high in the river and have been shown not to have reduced primary productivity.

10.A.4.4 Hydrologic Impacts (DOI 5/29/80:B-9; EPA 5/30/80:B-23; SRBC 4/30/80:B-69; SA 6/10/80: B-64; PP&L 5/20/80:B-47)

The applicant has revised the spillway design. See Section A.4.4.2.3.

As stated in Section A.2.3.3, there is no information on historic flood flows in Pond Hill Creek because there is no gaging station on the stream.

The figures showing the floodplains of the Susquehanna River and Pond Hill Creek have been revised. See Figures A.2.5 and A.2.6.

Changes in the floodplain due to the construction and operation of the project are discussed in Section A.4 "Environmental Effects of Construction and Operation."

The difference between EPA's estimate of 986 mm and NRC's estimate of 973 mm for the 6-hr PMF is insignificant and would not alter the conclusions reached in Section A.4.4.2.3. The design precipitation series is chosen to represent an upper bound. The reservoir is designed to be able to accommodate this precipitation series without being overtopped. Less intense storms will result in lower maximum reservoir elevations.

The saddle referred to has a minimum elevation of 302.1 m MSL, 0.3 m above the dam crest elevation of 301.8 m MSL and 2.7 m above the emergency spillway weir elevation of 299.4 m MSL. The applicant is considering the construction of an impervious cutoff across this saddle, as shown in Figure A.3.2. The minimum elevation between Lily Lake and the reservoir is 311 m MSL, more than 9 m above the elevation of the dam crest. Therefore, the possibility of either of these locations becoming spillways during a flood is precluded.

The applicant calculated the discharge temperatures from the larger reservoir using the revised inlet-outlet structure (Section A.3.1.3 and Figure A.4.1), the larger reservoir area and volume, and both 1964 and 1975 temperature data (see PP&L 5/29/80, p. B-47). The calculated temperatures for the effluent stream flow, based on releases of 2.89 m^3/s are given in the cited comment.

The staff's assessment of the thermal impact of releases from Pond Hill Reservoir has not changed as a result of this design change and the modeling studies are based on 1975 meteorological data.

The reservoir is well above the level of any credible flood event on the Susquehanna River. The downstream toe of the dam is more than 70 m above the normal river level and more than 65 m above the historical maximum Susquehanna River stage (Tropical Storm Agnes, 1972). See Section A.4.4.2.3 for a discussion of the hydrologic design of the dam with the proposed revised spillway.

Table 1.3.2-1 of Volume IV of the ER-OL presents past history data on the Susquehanna River. This table indicates that withdrawal from the reservoir can be expected to be infrequent. This table has been included in Section A.4.3.2.2 of the text and should aid in clarifying the discussion.

The responsibility for requiring monitoring is the function of the EPA (see EPA 5/30/80, p. B-23), not the NRC. NRC cannot require monitoring of water quality. EPA is responsible for water quality monitoring and water quality.

Section A.4.4.2.1 has been revised to reflect these comments. The larger reservoir has been planned to meet SRBC's requirements and not specifically for the purpose of supplying additional storage capacity for other users or uses, such as sales to other utilities or industries on the Susquehanna River. Although these other uses are possible, the staff has not attempted to evaluate them.

10.A.4.5 Socioeconomic Impacts (EPA 5/30/80:B-23)

The section has been revised to reflect these comments.

10.A.4.6 Impacts to Cultural Resources (DOI 5/29/80:B-9)

For a discussion of cultural resources, see revised Section A.2.7.

10.A.5 Alternatives, Need for Facility, and Benefit-Cost Analysis

Section A.5 has been revised to incorporate applicable comments.

10.A.5.1 Alternatives to Constructing a Water Storage Reservoir (EPA 5/30/80:B-23; PP&L 5/29/80:B-47; SRBC 4/30/80:B-69; FERC:B-25; SA 6/10/80:B-64)

The Pond Hill Reservoir is being planned to supplement riverflow during periods of low riverflow. The Susquehanna River Basin Commission has directed that the reservoir be constructed by 1 July 1984. The Pond Hill Reservoir is not required for the safe operation of the nuclear plant. Therefore, the Environmental Statement review dealt only with the effect of the construction and operation of the Pond Hill Reservoir on the environment.

The staff does not see any relation between the issuing of a permit for the construction of Pond Hill Reservoir and the impact of a renewed anthracite industry on the region. At this point, the cost of building a new coal plant, and the recovery cost of nuclear portions of SSES would be very large as compared to the benefit derived from the renewed anthracite industry.

SRBC has failed to indicate in its comments the effect it believed its recommendation would have on the availability of a back-up water supply contemporaneous with construction and operation of SSES. The staff notes, however, that the conclusions reached in the FES do not rest on the availability of a back-up water supply. Instead, the staff assumed compliance with the SRBC rules without such a system.

The FES (see Sec. A.5.1.2) has been revised to reflect the SRBC's position on the Cowanesque Reservoir.

10.A.5.2 Alternative Sites (SRBC 4/30/80:B-69)

The text of Paragraph 1 of Section A.5.2 is correct. As stated in References 24 and 29 of Section 2 of this Appendix, the initial design criteria for the water storage reservoir were based on a Q_{7-10} river flow of 21.8 m^3/s; the alternative site analyses were conducted on this basis, including the 96-day compensation flow requirement. Later, the Q_{7-10} value was changed to 22.7 m^3/s. The dam design given in the ER-OL, Appendix H, and in this Environmental Statement is based on the higher Q_{7-10} value.

10.A.5.3 Benefit-Cost Analysis (FERC:B-25; PP&L 5/29/80:B-47; SRBC 4/30/80:B-69)

The staff disagrees with the change suggested by PP&L (5/29/80, p. B-47). If PP&L meets PJM's reserve requirements, PJM could still buy the needed amount of electricity from PP&L and would not suffer the loss of sale. However, the ability of PP&L to supply power to the rest of the network would be reduced if the river-following mode of operation were utilized.

The probability of a shutdown of less than or equal to 14 days is 94.1%. Section A.5.3.1 has been revised to reflect this comment.

A mathematical average of four-day shutdown does not mean that the plant will be closed every year for four days. Like any average, it simply means that the plant may be closed for more than four days in some years and for less than four days in others. Over the period of observation, the sum of deviation from the mean is expected to be zero. The calculation of the present value of the replacement energy cost gives an estimate of the cost incurred by the applicant if the future riverflow follows a similar historical pattern. Table 5.3 does present the cost associated with different expected values of number of days of plant shutdown.

As per the applicant's response, the average annual energy requirement, including the purchase of replacement energy during the four-day shutdown and the energy needed to start the plant are between 160,000 and 170,000 MWh, depending on the length of time associated with cold or hot reactor shutdown conditions. The staff assumed that the incremental amount of electricity required to start up the plant from cold vs. hot reaction shutdown condition to be 10,000 MWh. As there is no definite knowledge at this point of the plant shutdown condition, the staff assumed a 50/50 chance of hot or cold shutdown over the life of the project. Under this assumption, the yearly average amount of electricity requirement comes to 165,000 MWh. The staff assumes that the energy requirement is 146,000 MWh (2100 MW x 4 days x 24 hr/day x 0.70 cap. factor + 5000 MWh).

The staff agrees that there may not be a substantial savings in the operating variable cost during the shutdown period. The amount of savings realized (if any) would not alter the findings of the analysis.

The staff does not find any cost difference between the report based on the applicant's response and the one by the comment. Please note that the present value of the cost reported here includes the cost of the project ($65 million) and the yearly operating cost of $100,700 over 30 years.

The staff agrees that such a situation may arise (see PP&L 5/29/80, p. B-47), but it is highly unlikely that low river flow and fuel-oil curtailment would occur at the same time.

Table A.5.4 has been revised to reflect this comment.

10.A.5.4 Evaluation of Unavoidable Adverse Environmental Impacts of the Proposed Action

No comments.

10.B COMMENTS ON DES

No comments.

10.C ENVIRONMENTAL ASSESSMENT BY THE DIVISION OF SITE SAFETY AND ENVIRONMENTAL ANALYSIS FOR PROPOSED MODIFICATIONS TO THE TRANSMISSION LINE SYSTEM (DA-SCS:B-4; DOI 9/10/79:B-7; M.M. Molesevich:B-39)

Information presented by the applicant indicates that they sought and received an "erosion control program and permit" from the PDER (ER-OL, Sec. 12.1.2). Similar information indicates that the applicant periodically consulted with the Soil and Water Conservation Districts regarding methods to control soil erosion (ER-OL, Sec. 4.5). Furthermore, the staff evaluated the applicant's proposed plans for controlling erosion during transmission-line construction; such plans were found acceptable (see Appendix C, p. C-6 and Sec. 5.3.5).

The staff would also like to point out that land disturbance at the plant site and within transmission-line rights-of-way results primarily from construction activities; whereas the focus of this statement is on impacts associated with operation of the station and transmission facilities. The staff foresees no instances in which routine operation of the facilities will result in significant land disturbance.

The staff has elected to address the "possibility" referred to in the comment as follows. The applicant states that easements are usually acquired for transmission-line rights-of-way (ROW). These easements allow the owners continued use of the ROW consistent with safe and efficient operation and maintenance of the transmission lines and structures (ER-CP, Section 3.2.6). Thus, the future use of cleared ROW will be subject to individual agreements between the owners and the applicant, and may or may not involve plantings for wildlife food or cover.

As indicated in Appendix B (p. B-6), woody vegetation will be removed from the ROW by "selective" or "tailored" methods of clearing. Accordingly, complete removal of trees and underbrush will occur only in limited areas, such as tower-construction sites and service roads. In general, only tall trees and those of growth habits that could interfere with energy transmission will be removed from the ROW. Certain trees of limited-height growth potential, shrubs, herbs, and grasses will be preserved "to the greatest extent practical" (ER-CP, Amendment 5, Exhibit B), thereby limiting the area of disturbance and erosion potential. In many instances, the residual vegetation is expected to be sufficiently beneficial for wildlife so that plantings for food and cover will be unnecessary.

The staff encourages the establishment of wildlife habitat in areas where such management is compatible with other land-use priorities. However, "using plantings recommended by the

Pennsylvania Game Commission for all forested areas cleared during transmission line construction" is not considered a realistic objective.[10]

Figures have been changed in response to the comment made.

References

1. Letter from M.R. Buring (PP&L) to J.T. Ulanowski (PDER), 9 April 1980.

2. Letter from J.T. Ulanowski (PDER) to M.R. Buring (PP&L), 29 April 1980.

3. Letter from N.W. Curtis (PP&L) to D.E. Sells (NRC), 13 November 1979.

4. G.W. Patterson, C.R. Curtis, T.L. Lauves, and G. Hosokaiva, "Chalk Point Cooling Tower Project, Native Vegetation Study, Final Report, FY '78," Report No. PPSP-CPCTP-24, WRRC Special Report No. 10, Water Resources Research Center, University of Maryland, College Park, MD, June 1978.

5. C.L. Mulchi, D.C. Wolfe, and J.A. Armbruster, "Cooling Tower Effects on Crops and Soils, Postoperational Report No. 3, Final Report, FY-78," PPSP-CPCTP-23, WRRC Special Report No. 11, Water Resources Research Center, University of Maryland, College Park, MD, 1978.

6. C.R. Curtis, B.A. Francis, and T.L. Lauver, "Dogwood as a Bioindicator Species for Saline Drift," pp. I-65 through I-77, In Proceedings of a Symposium on Environmental Effects of Cooling Tower Emissions, May 2-4, 1978, University of Maryland, College Park, MD, 1978.

7. "An Ecological Study of the Susquehanna River in the Vicinity of the Three Mile Island Nuclear Station, Annual Report for 1975," By W.A. Potter, Project Leader, and Associates, for Metropolitan Edison Company, Ichthyological Associates, Inc., Ithaca, NY, February 1976.

8. B.L. Cohen, "Radon: Characteristics, Natural Occurrence, Technological Enhancement, and Health Effects," Vol. 4, Progress in Nuclear Energy, 1979.

9. A.J. Dvorak et al., "The Environmental Effects of Using Coal for Generating Electricity," NUREG-0252, prepared by Argonne National Laboratory for the U.S. Nuclear Regulatory Commission, 1977.*

10. Natural Resources Defense Council, "Denial of Petition for Rulemaking," 42 FR 34391, 5 July 1977, Available in the NRC Public Document Room.

11. U.S. Department of the Interior, Fish and Wildlife Service, "Management of Transmission Line Rights-of-Way for Fish and Wildlife," Vol. I, Chapter 3, Section 14, FWS/OBS-79/22, 1979.

*Available for purchase from the National Technical Information Service, Springfield, VA 22161.

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APPENDIX A

FINAL SUPPLEMENT

TO THE

ENVIRONMENTAL STATEMENT

BY THE

U.S. NUCLEAR REGULATORY COMMISSION

FOR

SUSQUEHANNA STEAM ELECTRIC STATION, UNITS 1 AND 2

proposed by

PENNSYLVANIA POWER AND LIGHT COMPANY
ALLEGHENY ELECTRIC COOPERATIVE, INC.

Docket Nos. 50-387
50-388

SUMMARY AND CONCLUSIONS

This Appendix to the Final Environmental Statement was prepared by the U.S. Nuclear Regulatory Commission (NRC), Office of Nuclear Reactor Regulation (the staff).

1. The action is administrative.

2. The proposed action is the issuance of construction permits by local, state, and federal agencies (including the Susquehanna River Basin Commission, SRBC) for the construction of a water storage reservoir in the Pond Hill Creek drainage basin. The proposed site is located on a small tributary of the Susquehanna River in Conyngham Township, Luzerne County, Pennsylvania. The site is approximately 11 km northeast of the borough of Berwick, Pennsylvania, and about 3.7 km northeast of the Susquehanna Steam Electric Station (SSES), now under construction. The purpose of the proposed reservoir is to supply water to the Susquehanna River during periods of low river flow to replace the water consumptively used by SSES.

   Action by the NRC is not required for the issuance of construction permits for this reservoir. This Environmental Statement has been prepared by the Nuclear Regulatory Commission to describe the environmental impacts of construction and operation of the Pond Hill Reservoir since the facility is associated with the operation of the Susquehanna Steam Electric Station.

   The facility will consist of an earth and rockfill dam constructed across the valley, about 1.3 km east of the Susquehanna River, a spillway, an inlet-outlet structure, a pipeline, and a pumping station. The dam would be about 730 m in length at crest level; the maximum height above the streambed will be about 67 m. Normal water storage capacity of the reservoir would be about 30×10^6 m^3 (24,100 acre-feet), of which about 90% (27×10^6 m^3), will be available for compensation flow. The water area of the reservoir will be about 128 ha at the design normal water level of 299 m MSL.

3. The information in this statement represents an assessment of the environmental impacts associated with the construction of the Pond Hill Reservoir, pursuant to the guidelines of the National Environmental Policy Act of 1969 (NEPA) and 10 CFR 51 of the Commission's regulations. The staff has reviewed the impacts that would occur due to the construction and operation of the reservoir. The staff's analysis is based on a review of material supplied by the applicant, Pennsylvania Power & Light Co. (PP&L); a review of other material secured independently; a visit to the proposed and four of the alternate sites; and discussions with various state, local, and federal officials. The potential impacts, both beneficial and adverse, are summarized as follows:

   a. The valley and Pond Hill Creek will be permanently altered.

   b. Approximately 525 ha of land will be dedicated to the reservoir for the life of the facility.

   c. About 2.3 km of Pond Hill Creek will be converted from a free-flowing stream to a reservoir; the 1.3-km section of the creek below the dam will be converted from a free-flowing, sometimes intermittent, stream to a partially regulated stream with a minimum flow maintained by releases from the reservoir.

   d. As much as 195 ha of terrestrial environment may be directly affected and variously altered due to development of the Pond Hill Reservoir. About 128 ha of forested area will be inundated. Impoundment structures will occupy about 16 ha. Most of the remaining disturbed area will be reclaimed and landscaped following construction.

   e. Vegetation in the areas covered by water and structures will be converted into habitat for aquatic biota.

   f. Some wildlife mortality will occur as the result of construction activities and the initial filling of the reservoir; in addition, some animals will be displaced from affected areas. Adverse effects on terrestrial wildlife will be variously offset by reclamation of disturbed areas, creation of aquatic habitat, and the implementation of a wildlife habitat improvement program.

g. Land-clearing and construction activities will temporarily cause locally increased levels of noise as well as emissions of smoke and dust. Some soil erosion will occur despite the implementation of control measures. Also, topsoil materials used in reclamation will have undergone adverse physical and chemical changes that may be reflected by reduced future productivity of the affected areas.

h. Fluctuating water levels, to the extent the project is used for low-flow compensation, will result in exposed areas and will alter some of the aquatic habitat created by the dam for the period of drawdown and refill.

i. There will be a temporary increase in highway traffic due to workers commuting to and from the area during construction and to trucks bringing in construction materials and supplies and removing refuse.

j. The water quality of Pond Hill Creek below the reservoir will generally be lower than that prior to reservoir establishment.

k. Based on the droughts of record, the discharge and storage capacities of the reservoir are greater than those required to provide compensation water to the Susquehanna River as a result of SSES operation.

l. About 145 ha of land will be converted from their present use to certain recreational uses, such as hunting and hiking. The reservoir may be developed for certain water recreational activities, such as non-power boating and fishing.

m. As a result of reservoir development, an increase in waterfowl and aquatic and shoreline wildlife may occur.

n. Minor changes in local demography, settlement patterns, and sociocultural structures will result from the construction and operation of the reservoir.

o. The operation of Pond Hill Reservoir will have a minimal impact on water quality and aquatic ecology in the downstream portions of the Susquehanna River.

4. On the basis of the analysis and evaluation set forth in this Statement, and after weighing the environmental, economic, technical, and other benefits against environmental costs and after considering available alternatives it is concluded that the construction of the Pond Hill Reservoir is an acceptable method for complying with the low-flow water use requirements of the Susquehanna River Basin Commission. The staff's assessment indicates that the environmental and other impacts of the reservoir will be minimal.

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FOREWORD

This Appendix to the Final Environmental Statement was prepared by the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation (the staff), in accordance with the Commission's regulation, 10 CFR 51, which implements the requirements of the National Environmental Policy Act of 1969 (NEPA).

NEPA states, among other things, that it is the continuing responsibility of the federal government to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate federal plans, functions, programs, and resources to the end that the nation may:

- Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.
- Assure for all Americans safe, healthful, productive, and esthetically and culturally pleasing surroundings.
- Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences.
- Preserve important historic, cultural, and natural aspects of the national heritage, and maintain, wherever possible, an environment that supports diversity and variety of individual choice.
- Achieve a balance between population and resource use that will permit high standards of living and a wide sharing of life's amenities.
- Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

Further, with respect to major federal actions significantly affecting the quality of the human environment, Section 102(2)(C) of NEPA calls for preparation of a detailed statement on:

(i) the environmental impact of the proposed action

(ii) any adverse environmental effects that cannot be avoided should the proposal be implemented

(iii) alternatives to the proposed action

(iv) the relationship between local short-term uses of the human environment and the maintenance and enhancement of long-term productivity

(v) any irreversible and irretrievable commitments of resources that would be involved in the proposed action, should it be implemented

An environmental report accompanies each application for a construction permit. A public announcement of the availability of the report is made. Any comments on the report by interested persons are considered by the staff. In conducting the required NEPA review, the staff meets with the applicant to discuss items of information in the environmental report, to seek new information from the applicant that might be needed for an adequate assessment, and generally to ensure that the staff has a thorough understanding of the proposed project. In addition, the staff seeks information from other sources that will assist in the evaluation and visits and inspects the project site and surrounding vicinity. Members of the staff may meet with state and local officials charged with protecting state and local interests. On the basis of all the foregoing and other such activities or inquiries as are deemed useful and appropriate, the staff makes an independent assessment of the considerations specified in Section 102(2)(c) of NEPA and 10 CFR 51.

This evaluation leads to the publication of a draft environmental statement, prepared by the Office of Nuclear Reactor Regulation, which is then circulated to federal, state, and local governmental agencies for comment. A summary notice of the availability of the applicant's environmental report and the draft environmental statement is published in the Federal Register. Interested persons are also invited to comment on the proposed action and the draft statement. Comments should be addressed to the Director, Division of Licensing, at the address shown below.

After receipt and consideration of comments on the draft statement, the staff prepares a final environmental statement, which includes a discussion of questions and objections raised by the comments and the disposition thereof; a final benefit-cost analysis, which considers and balances the environmental effects of the facility and the alternatives available for reducing or avoiding adverse environmental effects with the environmental, economic, technical, and other benefits of the facility.

This environmental review deals with the impact of construction and operation of the Pond Hill Reservoir on the environment. This evaluation is based on information supplied by the applicant, Pennsylvania Power & Light Company, in Appendix H to the Environmental Report for the Susquehanna Steam Electric Station (May 1979) and other documents, a visit to the site of the proposed reservoir (and four of the alternate sites), and meetings with state and local officials.

No NRC action is required prior to the start of construction or operation of this facility, since the nuclear power plant can be granted an operating license without the reservoir. Prior to start of construction, the applicant will obtain the necessary permits from state, local and federal agencies, such as the Susquehanna River Basin Commission (SRBC), U.S. Corps of Engineers (COE), and the U.S. Environmental Protection Agency (EPA).

Copies of this statement are available for inspection at the Commission's Public Document Room, 1717 H Street NW, Washington, DC, and at the Ousterhout Free Library, Reference Department, 71 South Franklin Street, Wilkes Barre, PA. Single copies of this statement may be obtained by writing to:

Director, Division of Licensing
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Mr. Richard M. Stark is the NRC Project Manager for this project. Mr. Stark may be contacted at the above address or at 301/492-7238.

A.1. INTRODUCTION

A.1.1 HISTORY

Makeup water for the two nuclear reactors of the Susquehanna Steam Electric Station (SSES) will be withdrawn from the Susquehanna River. When construction permits CPPR-101 and CPPR-102 were issued on 2 November 1973, there were no restrictions on the amount of water that could be consumptively used by SSES. Water uses and withdrawals in the Susquehanna River Basin are controlled by the Susquehanna River Basin Commission (SRBC). This commission, formed by a compact between the states of New York, Pennsylvania, and Maryland and the federal government, issued new rules in 1976 prohibiting large water users, such as the applicant, from withdrawing water from the river and using it consumptively during periods of low river flow without returning to the river, from offstream storage reservoirs, water at a rate equal to actual consumptive losses. The cutoff point for limiting withdrawals has been set by the SRBC as the consecutive seven-day low flow to be expected every ten years (called the Q7-10 flow rate). In February 1980, SRBC established 1 July 1984 as the deadline for compliance with its water make-up requirements (SRBC Regulations, Sec. 803.61).

The SRBC has determined that, based on 80 years of riverflow data, the Q7-10 value applicable to SSES is 22.7 m^3/s, as measured at the Wilkes-Barre gauge (letter from R. J. Bielo, SRBC, to W. H. Regan, Jr., NRC, 30 August 1979).

The applicant has considered three alternatives for meeting the low-flow compensation requirements of SRBC:

1. Not to operate the plant whenever river flow is at or below the Q7-10 value plus consumptive use.

2. To purchase the required water from an existing reservoir.

3. To construct its own water storage reservoir.

Option 1, called "river following," would require replacement electrical-generating capacity, either from other Pennsylvania Power & Light facilities or from the PJM* grid.

The applicant has examined the relative merits of these three alternatives and has concluded that the most economically desirable and most reliable means of meeting the low-flow compensation requirement would be by the construction of a new reservoir owned and controlled by PP&L.

After examining thirteen sites along the Susquehanna River, the applicant selected a small unnamed valley on the east bank of the river about 3.7 km upstream of SSES as the site for the proposed reservoir. The valley contains a small creek that flows intermittently and is near the settlement of Pond Hill. The company has named the proposed facility "Pond Hill Reservoir."

A.1.2 PERMITS AND LICENSES

The NRC has no legal authority for the issuance or denial of any permit to construct or operate a water storage reservoir, since SSES can be granted an operating license without such a facility.

The NRC has reviewed the applicant's request to build an offstream water storage reservoir and has prepared this Appendix to the Final Environmental Statement to describe the environmental impacts of the proposed facility as well as alternatives to the proposed action.

In March 1979 the applicant submitted an application to the SRBC to build the Pond Hill Reservoir; to date the Commission has not completed its review of the application. The applicant will obtain the necessary permits from the Corps of Engineers, U.S. Department of Commerce National Ocean Survey, and other federal, state, and local officials. The proposed facility is in Conyngham Township, Luzerne County, Pennsylvania.

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*Interconnection Group located in Pennsylvania, New Jersey, and Maryland.

A.2. THE SITE AND ITS ENVIRONS

A.2.1 PLANT LOCATION

The site of the proposed Pond Hill Reservoir is a small valley drained by a small tributary of the Susquehanna River, about 3.7 km upstream of SSES (Fig. A.2.1). The site is about 24 km southwest of the city of Wilkes-Barre and 11 km northeast of the Borough of Berwick, PA. The site is about 32 river kilometers downstream of Wilkes-Barre. The creek draining this valley is not named on detailed U.S. Geological Survey maps (Nanticoke 7.5 minute U.S.G.S. Quadrangle), but is known locally as Catfish Creek. Figure A.2.2 is a plan view of the proposed project, showing the location of various structures as well as high and low water levels in the proposed reservoir.

The site of the proposed facility is in Conyngham Township of Luzerne County. Since the creek and valley are located just north of the settlement of Pond Hill, the applicant has used the terms Pond Hill Reservoir for the water storage facility and Pond Hill Creek for the tributary.

The coordinates of the site are 40°8'N, 76°7'W. Present access to the site is over secondary roads through the settlement of Pond Hill.

The north slope of the valley is steep, with a ridge rising from about 215 to 245 m above the valley floor (see Figs. A.2.2 and A.2.3). The south slope of the Pond Hill Creek drainage area is flatter, with a ridge line about 60 to 90 m above streambed.

State Highway 239 parallels the Susquehanna River just to the west of the site and connects the villages of Wapwallopen and Mocanaqua. The Pennsylvania Department of Transportation estimated that the average daily traffic on this stretch of Route 239 was 1550 cars/day in 1978. Local Road 40120 is the primary access road from Route 239, the Pond Hill Reservoir site, the settlement of Pond Hill, and the Lily Lake community bordering the lake; estimated usage in 1978 was 750 cars/day.

The Delaware and Hudson Railroad runs a single-track, north-south line parallel to the river just to the west of State Route 239. Maximum daily use of this line is four trains per day.

A.2.2 LAND USE

Although the exact site boundaries (and, therefore, the site area) have not yet been established, the area of the site is expected to be about 525 ha. The tentative site boundaries are shown in Figure A.2.3; this figure also shows local roads, local topography, and the settlements of Pond Hill and Lily Lake.

One unoccupied structure lies within the proposed site area. There are no inhabited structures.

About 93% of the site is presently covered with second-growth forests and about 7% consists of old fields and croplands. Less than 1% of the area is classified as wetlands.

Recreational use of the site includes walking, hiking, nature study, and hunting. Fishing is not now possible since the stream does not support a viable gamefish population.

A.2.3 METEOROLOGY AND HYDROLOGY

A.2.3.1 Meteorology

Since the site of the proposed reservoir is less than 4 km northeast of the site of SSES, meteorological and climatological conditions of the site are the same as those given in Section 2.4 of this Environmental Statement.

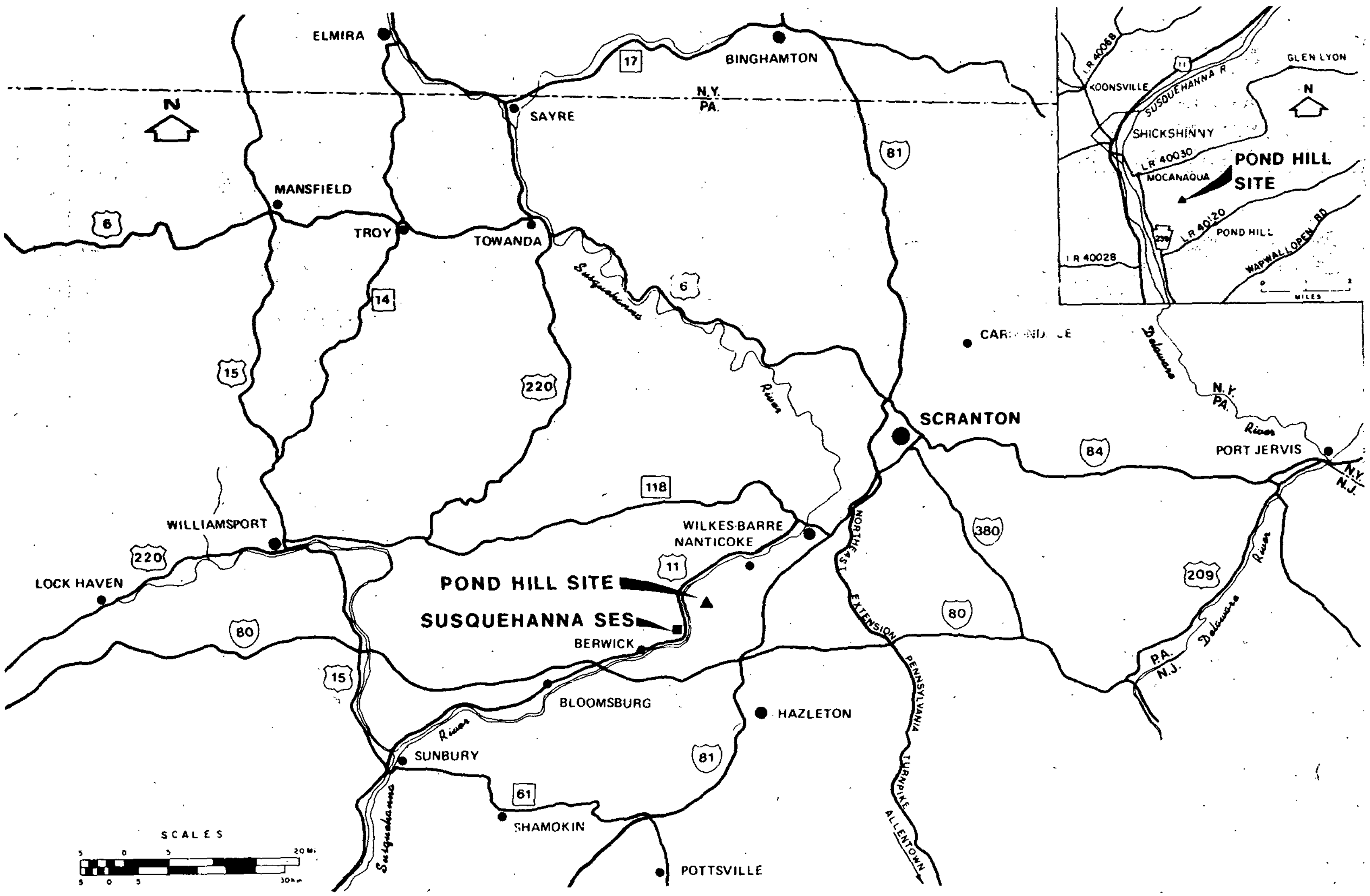


Fig. A.2.1. Pond Hill Reservoir Site Location.

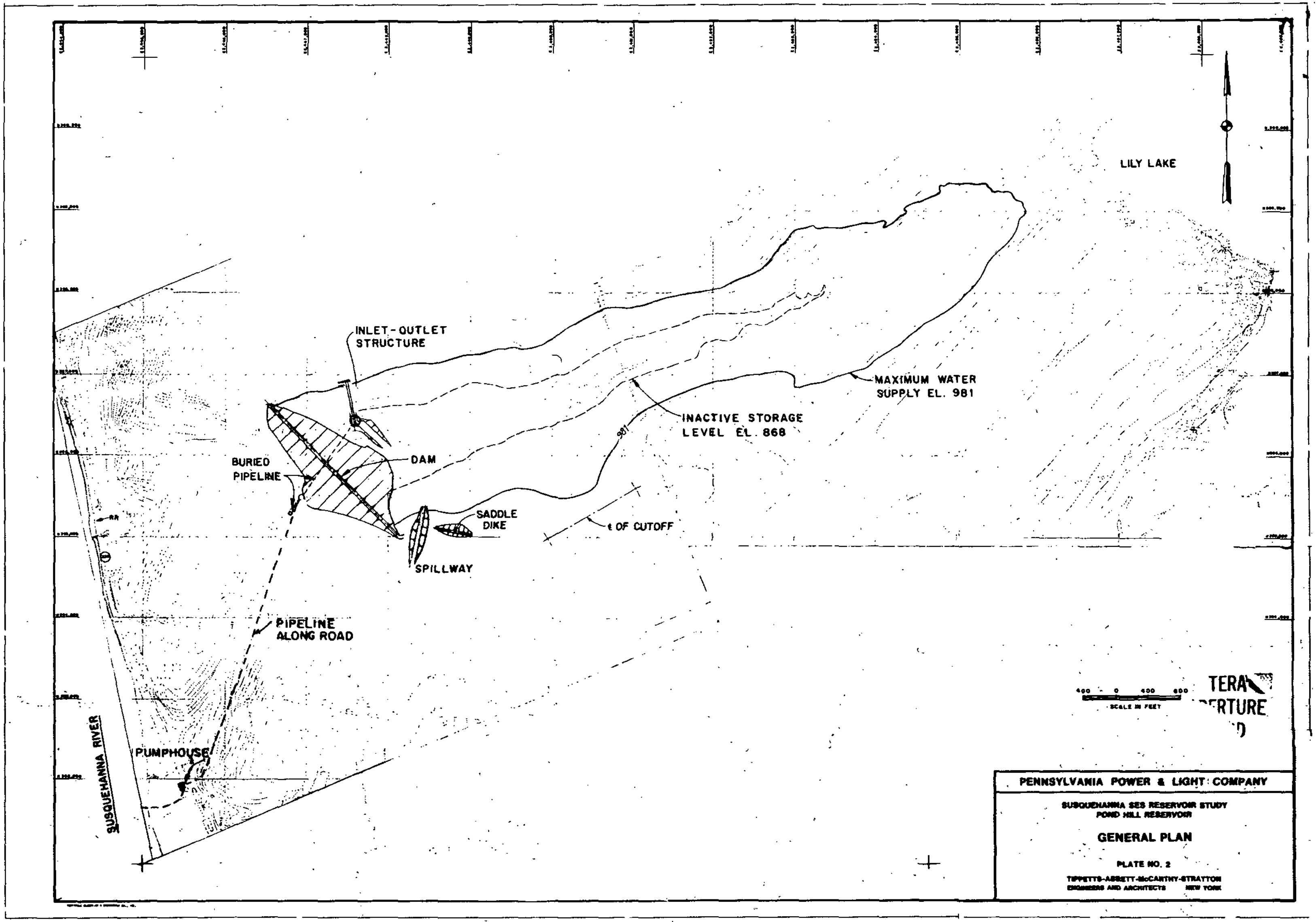


Fig. A.2.2. General Plan of the Pond Hill Reservoir Project

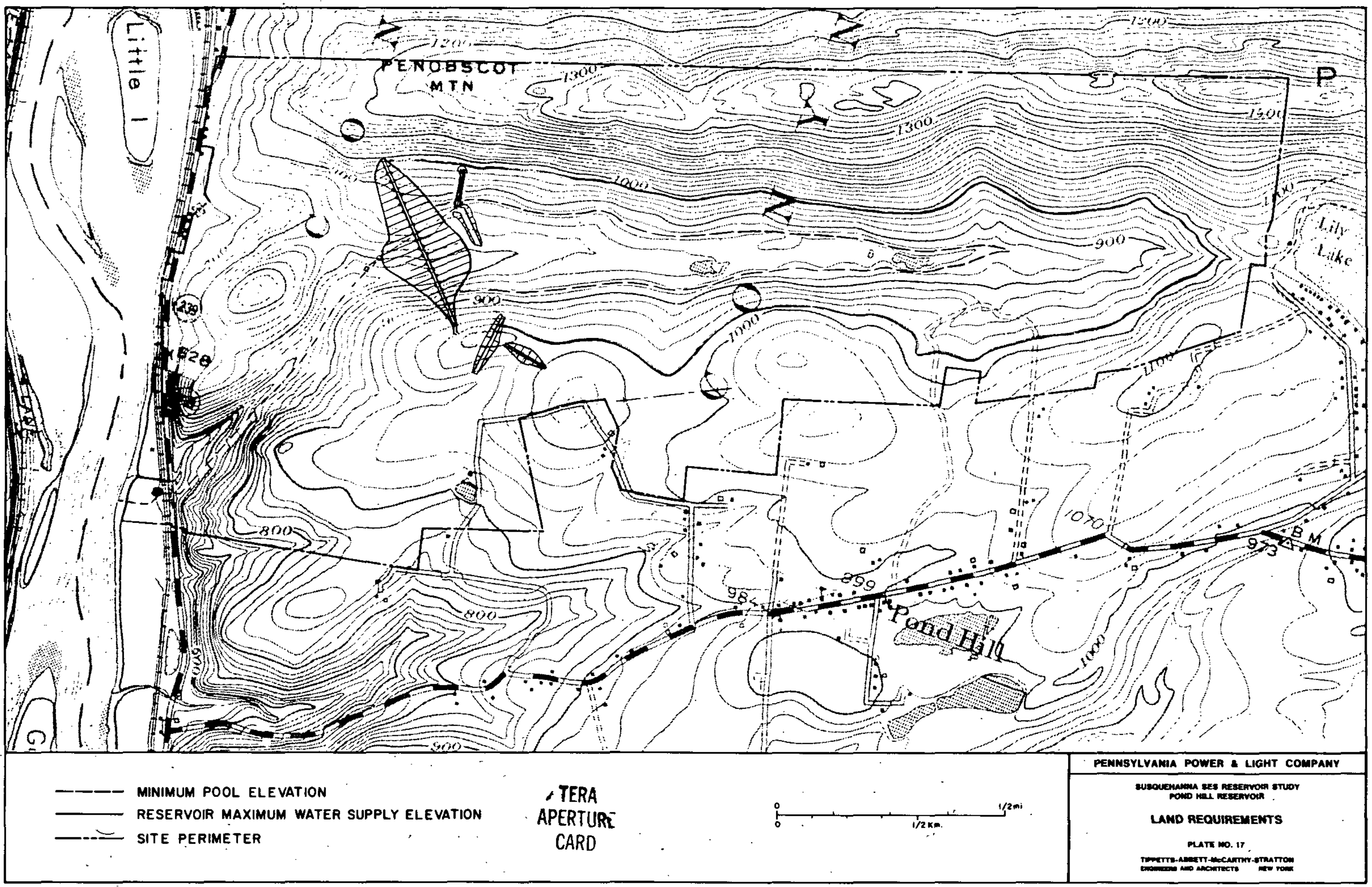


Fig. A.2.3. Land Requirements for the Pond Hill Reservoir Project

A.2.3.2 Hydrology

Pond Hill Creek is a small stream with headwaters approximately 1.3 km north of the town of Pond Hill. The stream flows westerly for 3.5 km to its confluence with the Susquehanna River, 3.7 km upstream from the Susquehanna Steam Electric Station. There are no significant tributaries to Pond Hill Creek. During dry periods, the streamflow decreases and some sections become essentially intermittent, with water remaining only in the streambed interstices. The proposed reservoir will inundate a 2.3-km (64%) upstream section of the stream, leaving 1.3 km from the dam to the Susquehanna River. For purposes of this discussion, the flooded stream and lower, unflooded section are referred to as the "upper" and "lower" portions of Pond Hill Creek, respectively.

The upper section of Pond Hill Creek has an average 11 m/km stream gradient. Throughout most of this section, the stream alternates between small-pool and riffle habitats, with a substrate of boulders, rubble, and some bedrock. This pattern is interrupted in two areas, which were previously inundated as a result of beaver dams. In these areas, the streambed is mostly silt, mud, and gravel. Thus, the resultant stream habitat becomes a long, continuous run. The upper stream has a 2.1-m average width, with measurements ranging from 0.8 to 3.6 m throughout the year. The average depth is approximately 0.1 m, with a total range of from 0.03 to 0.39 m. Current velocities average 0.005 m/s, ranging from 0.003 to 0.02 m/s.

The lower section of Pond Hill Creek has a much steeper gradient; the average stream gradient in this section is about 70 m/km. The 2.6-m average stream width ranges from 0.9 to 4.2 m, and the average depth is approximately 0.1 m, with a minimum of 0.03 and a maximum of 0.39 m. Current velocities average roughly 0.007 m/s, ranging from 0.003 to 0.02 m/s. Characteristically, the stream substrate is bedrock and boulders along with some rubble and isolated patches of gravel. Because of the sharp gradient, stream habitats are typically shallow, fast-flowing riffles interspersed with small pools. There are several small, and one relatively large, waterfalls in this part of the stream. In addition, at Route 239, the stream passes through a culvert and falls about 1.5 m from the elevated culvert back into the stream channel.

Since there are neither extensive nor accessible published data concerning the aquatic ecology of Pond Hill Creek, information presented in the following sections was gathered from field surveys conducted by the applicant from September 1977 to August 1978 (ER-OL, Section 3.2.3.1.1). The locations of the water quality and biological sampling stations used at Pond Hill Creek are presented in Figure A.2.4. Water quality samples were taken monthly at the site, and biological samples were collected quarterly. In addition, a fish sample was taken from three small farm ponds, which are located at the site and drain into Pond Hill Creek.

The drainage area of the stream above the proposed site of the dam is 329 ha. Because there is no gauging station on the stream, no information on historic flows is available. The applicant did, however, estimate flood flows using standard hydrologic methods. The estimated 4% chance (25-year recurrence) flood flow is 39.3 m^3/s, the 1% chance (100-year) flood flow is 49.7 m^3/s, and the estimated probable maximum flood flow is 202 m^3/s. In addition, the methodology utilized by the Pennsylvania Department of Environmental Resources (DER) to estimate the seven-day, ten-year low flow results in a flow of 0.005 m^3/s. It is probable, however, that the stream does not flow at all during drought periods. The hydrology of the Susquehanna River was discussed earlier.

The floodplain of Pond Hill Creek below the proposed site of the dam is very narrow (Fig. A.2.5). The floodplain of the Susquehanna River in the vicinity of the proposed location of the pumping station is shown in Figure A.2.6.

Data from borings and wells indicate that the groundwater contours in the vicinity of the proposed reservoir generally follow the surface contours. On the ridges north and south of the stream channel, groundwater was usually encountered between 4 and 15 m below the surface. The stream valley contains several marshes, springs, and farm ponds.

A.2.3.3 Water Sources

At present there are no users of Pond Hill Creek water. A spring within the proposed project boundary is used as a water supply during part of the year. Its use would have to be abandoned. Most of the nearby residences obtain water from individual wells. There are no wells within the proposed project boundary.

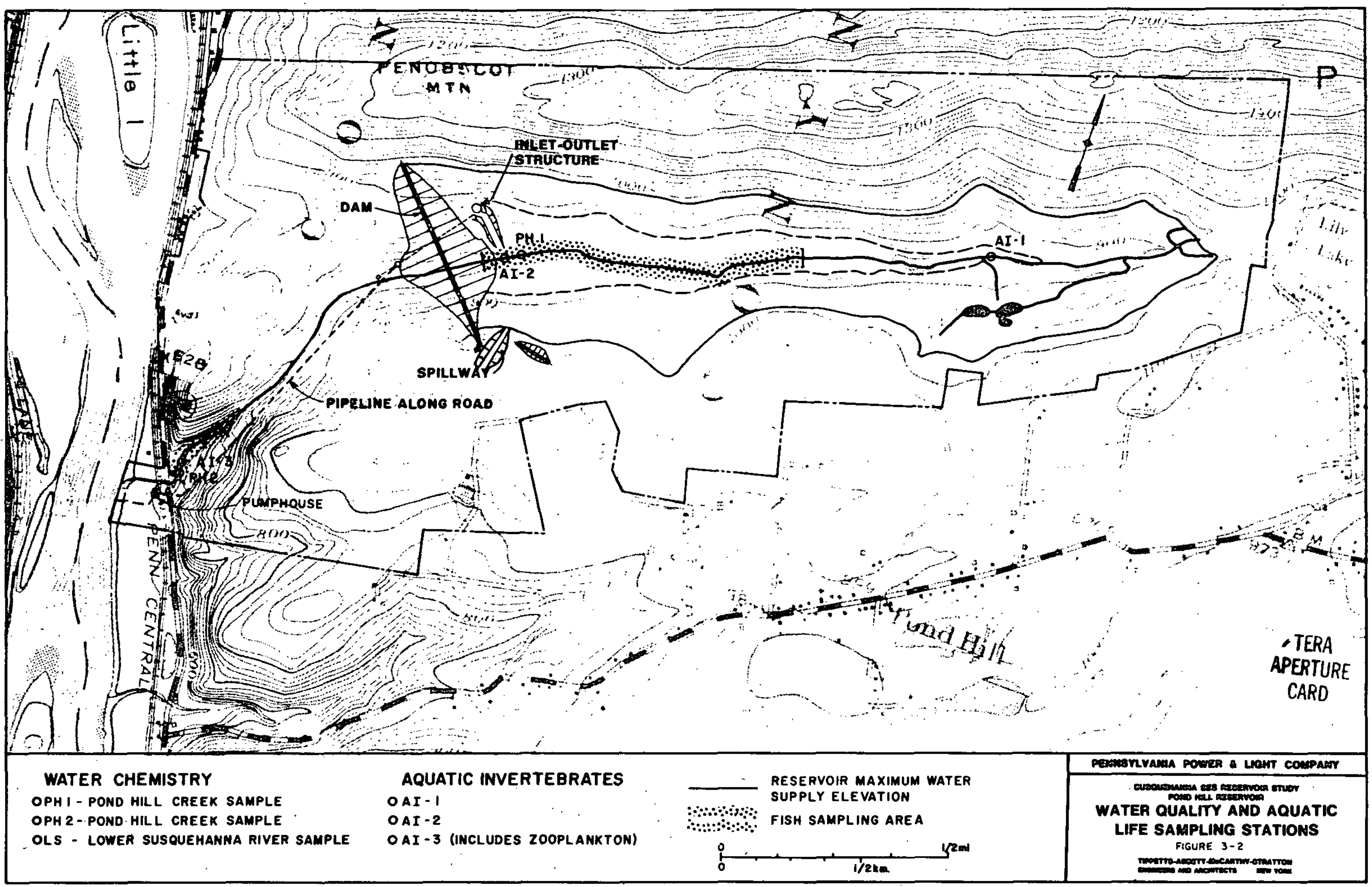
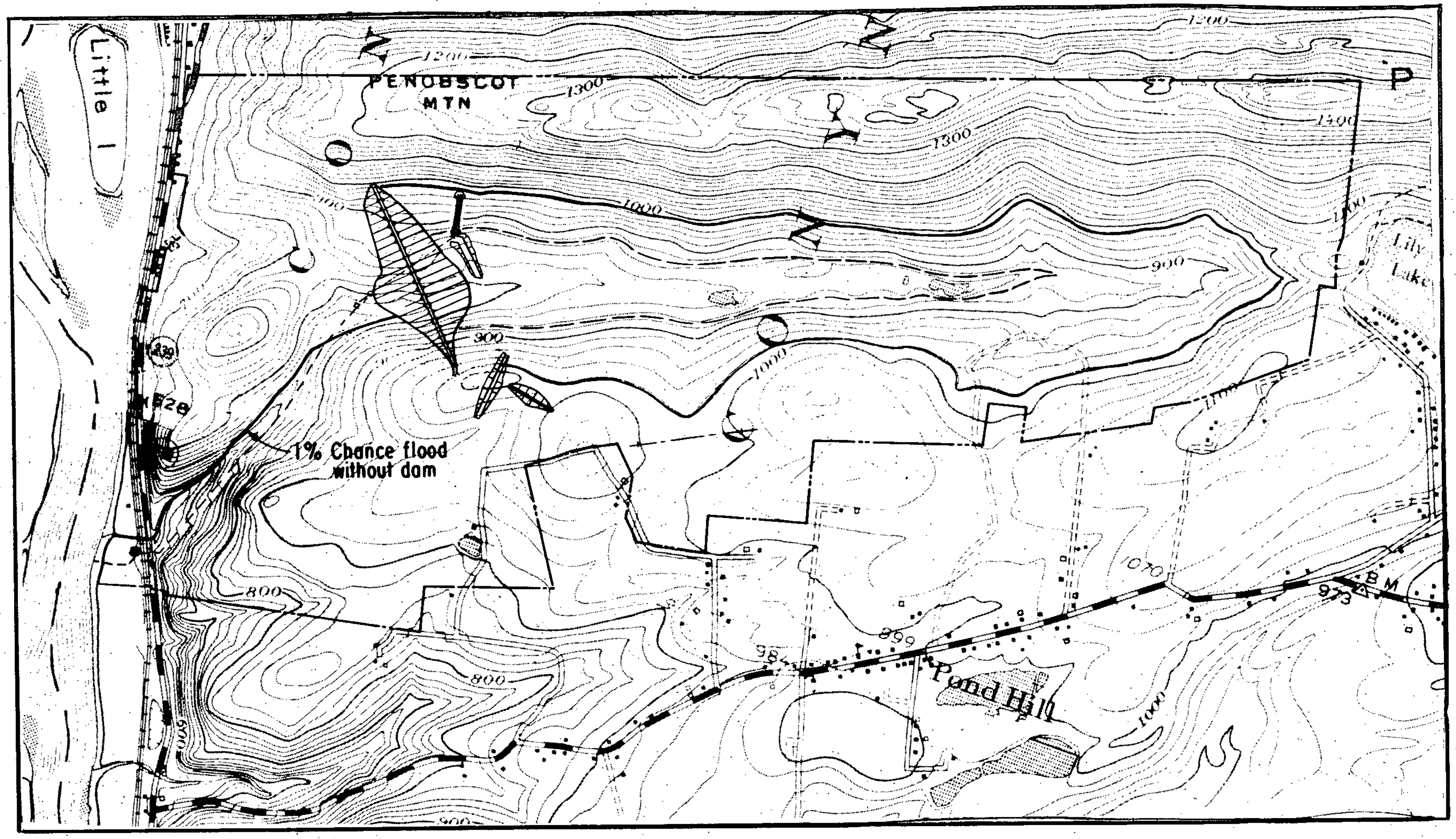


Fig. A.2.4. Water Quality and Aquatic Life Sampling Stations at Pond Hill Creek (Source: Tippetts-Abbett-McCarthy-Stratton/Engineering and Architects).



MINIMUM POOL ELEVATION

RESERVOIR MAXIMUM WATER SUPPLY ELEVATION

SITE PERIMETER

0 — 1/2 mi
0 — 1/2 Km.

Fig. A.2.5. Floodplain of Pond Hill Creek

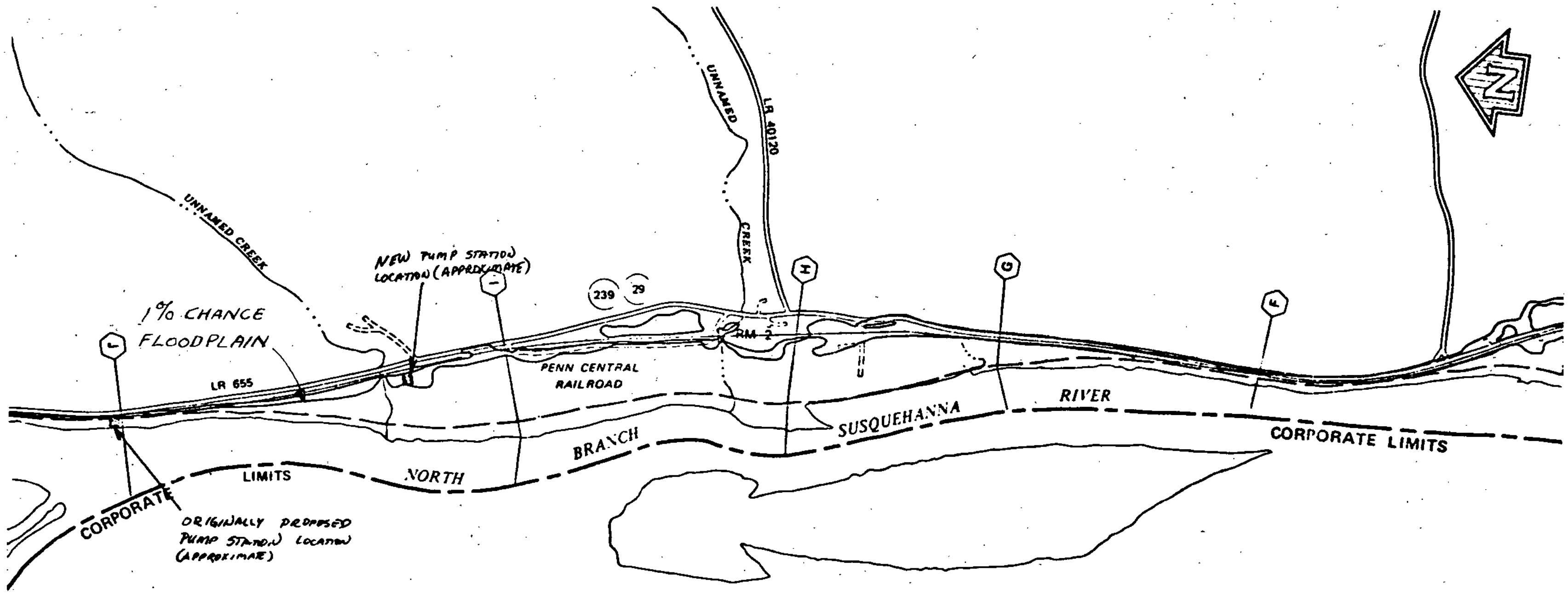


Fig. A.2.6. Floodplain of the Susquehanna River in the Vicinity of the Pond Hill Site.

A.2.4 GEOLOGY AND SEISMOLOGY

A.2.4.1 Geology

The proposed Pond Hill Reservoir site is located in the Penobscot Mountain area in the northern portion of the Valley and Ridge Physiographic Province. The province is characterized by intensely faulted and deeply eroded sedimentary rocks of Paleozoic age. Topographically, erosion-resistant sandstone formations form long narrow ridges; valleys were formed in the less resistant limestones and shales.

During the Paleozoic Era, the Appalachian Mountain region was a depositional basin collecting thick sediments. Sedimentation was interrupted several times by mountain-building activities climaxing in the Appalachian Mountains toward the end of the era. Since that time, the primary ongoing geologic process has been erosion.

The reservoir site is in an area that was glaciated during the last ice age, the Pleistocene Epoch. As a result, the highly weathered rocks (parent material) and original soil were removed; the present soils are typical of those formed in glaciated regions.

Bedrock in the reservoir area consists of sandstone, siltstone, and shale of the Catskill formation of Devonian age. To the north, the Catskill formation is overlain by younger Mississippian and Pennsylvanian formations including anthracite coal beds. To the south, the Catskill formation is underlain by older sedimentary rocks.

The strike of the formations is N 68 degrees E, and dip is northwesterly at angles from about 40 to 60 degrees, averaging about 45 degrees. Jointing is evident and primarily parallels the bedding, although a few low and high angle joints are also present. Joints in the weathered zone are filled with clay. Below the weatherbed zone, the joints are generally tight; some have been healed with calcite.

A.2.4.2 Seismology

The site is located in Zone 1 (minor damage) on the Seismic Risk Map of the Conterminous United States.[1] The site is about 160 km from the nearest Zone 2 (moderate damage) boundary and 210 km from the nearest Zone 3 (major damage) boundary.

Records of earthquake history in the site region were examined together with an evaluation of regional and local geologic structures to estimate the seismic risk at the site. This analysis resulted in a recommended design basis seismic coefficient of 0.025.

Several Intensity VI (Modified Mercalli Scale) earthquakes have been recorded within 160 km of the site. Many of these were not felt at the site; others were felt at the site with intensities equal to or less than IV.

No known faults have been identified in the vicinity of the site. Although low angle thrust faults abound in this part of the Valley and Ridge Province, they ordinarily cannot be identified except through detailed mapping. Thrust faults, however, are not generally associated with recurring seismic activity.

Reservoir-induced earthquakes are not anticipated as the proposed reservoir is small and there are no known subsurface structural weaknesses.

On the basis of this assessment, the seismic coefficient of 0.05 that has been used in the design of project features is considered by the staff as conservative.

A.2.5 SITE ECOLOGY

A.2.5.1 Terrestrial Ecology

The north and south boundaries of the Pond Hill site generally parallel the upper ridges of a small, steep-walled valley; thus the environmental conditions at given locations within the site strongly reflect the influence of the local topography (see Fig. A.2.3). The occurrence of aquatic environments is essentially limited to the narrow valley bottom traversed by Pond Hill Creek, a small drainageway that converges with the Susquehanna River near the west boundary of the site. In general, soil moisture levels in terrestrial environments decrease at increasing distances normal to Pond Hill Creek. However, the topographic influence on local soil moisture gradients is most pronounced in the northern portion of the site, where the valley wall is higher, the slopes are uniformly steeper, and the predominately south-facing slopes are exposed to greater insolation. Accordingly, plant communities occurring on the middle and upper valley slopes tend to be dominated by species tolerant of relatively low soil moisture levels, while lowland vegetation is typically dominated by species with relatively high moisture requirements.

A.2.5.1.1 Vegetation

The Pond Hill site is located in the extreme northern portion of the Ridge and Valley Section, a subdivision of the Oak-Chestnut Region delineated by Braun.[2] Although hardwood communities were considered characteristic vegetation for this part of the section, Braun also noted the presence of hemlock and hemlock-white pine communities, referred to as the "most mesic" communities of the higher valleys. The occurrence of hemlock and white pine was considered indicative of transition to the more northerly Hemlock-White Pine-Northern Hardwoods Region. The foregoing and other reported observations are generally consistent with the applicant's characterization of forest vegetation occurring at the Pond Hill site.

The applicant differentiated vegetation of the site into two forest types, two wetland communties, and undifferentiated old fields and cropland (ER-OL, Appendix H, Table 3-1). About 92% of the total site (525 ha) is classified as forest land, about 7% as old fields and cropland, and less than 1% as wetlands. Principal species of each vegetation type are indicated in Table A.2.1.

Essentially all forest vegetation is second growth having developed subsequent to logging believed to have occurred during the early 1900s (ER-OL, Appendix H, Section 3.2.2.2). Most of the forest stands have not been disturbed for the last 30 to 40 years. The Mixed Deciduous is the most extensive of the two forest types, occurring on about 74% of the site; the Mixed Coniferous-Deciduous type on about 19%. The latter type is present in relatively narrow, irregular belts paralleling all but the extreme lower portion of Pond Hill Creek where the stream gradient is particularly steep. This type also occurs as scattered stands on the lower slopes adjacent to the Susquehanna River, and as relatively small outliers on upland portions of the south valley slope where the more favorable soil moisture conditions prevail. The Mixed Deciduous type generally occurs on the drier uplands, thus flanking distributions of the Mixed Coniferous-Deciduous type. Stands of the Mixed Deciduous type do, however, occur adjacent to Pond Hill Creek in limited areas. Wetlands, old fields and cropland occurs on the remaining 7% of the site.

Small wetlands are located in the valley bottom adjacent to Pond Hill Creek. The Type 3 wetland, an inland shallow fresh marsh,[3] resulting from the union of several seeps and soils are saturated throughout the year. The presence of at least five small areas of Type 2 wetlands, inland fresh meadows, is attributed to previous beaver activities; the beaver dams are presently in disrepair.

Old field and cropland vegetation occurs as variously scattered blocks adjacent to, or near, the south boundary of the Pond Hill site. The distribution of this vegetation type generally corresponds with relatively level areas of upland terrain where farm machinery can be operated with relative ease. As observed by the staff during site inspection, most of these areas were being managed for hay production.

In addition to a general site survey, the applicant sampled systematically selected forest stands that would be inundated or otherwise disturbed during completion of the proposed project. The applicant's analysis involved pooling data and calculating overall importance values for individual species (ER-OL, Appendix H, Table 3.2.2-3). Accordingly, the principal overstory species include the following, in decreasing order of importance: red maple, American elm, white oak, eastern white pine, eastern hemlock, and shagbark hickory. A similar listing of understory species includes: American elm, red maple, flowering dogwood, witch-hazel, hawthorn, and round-leaved dogwood.

A.2.5.1.2 Wildlife Resources

A relatively broad array of wildlife habitat types exists within the Pond Hill site. However, as indicated in Section A.2.5.1.1, forest habitats prevail throughout most of the site. The predominance and the distribution of forest vegetation occurring onsite tends to limit the occurrence of less mobile animals that are at least partially dependent on resources of other habitat types. In general, transitions or ecotones between diverse, adjoining plant communities are utilized by animals common to both communities, as well as additional species variously dependent on habitat conditions existing only in the ecotone. The density of animals associated with the ecotone also frequently exceeds that for either of the adjoining communities.[4] Thus the diversity and density of wildlife animals associated with extensive, uniform forest vegetation tend to be lower than for populations frequenting an equal area in which forest and other plant communities are variously interspersed. In view of the greater interspersion of habitats (forest types, old fields, cropland, and wetlands) in the southern uplands and valley floor of the Pond Hill site, the abundance and diversity of wildlife populations is expected to be relatively high compared to that for northern portions of the site, where the vegetation consists primarily of uniform deciduous forest.

Table A.2.1. Principal Plant Species of Terrestrial Vegetation Types Occurring at the Pond Hill Site[a]

Vegetation Types	Principal Species
Mixed Coniferous-Deciduous	
Overstory:	American elm (*Ulmus Americana*), eastern hemlock (*Tsuga canadensis*), red maple (*Acer rubrum*), eastern white pine (*Pinus strobus*), white ash (*Fraxinus americana*)
Associate species:	Black ash (*Fraxinus nigra*), white oak (*Quercus alba*), round-leaved dogwood (*Cornus rugosa*), flowering dogwood (*C. florida*), hawthorn (*Crataegus* sp.), shagbark hickory (*Carya ovata*)
Understory and ground flora:	Chestnut oak (*Quercus prinus*), swamp white oak (*Q. bicolor*), American beech (*Fagus grandifolia*), witch-hazel (*Hamamelis virginiana*), hawthorn, Virginia creeper (*Parthenocissus quinquefolia*), lady fern (*Athyrium filix-femina*), Christmas fern (*Polystichum acrostichoides*) poison ivy (*Rhus radicans*)
Mixed Deciduous	
Overstory:	American elm, red maple, white oak, shagbark hickory, sassafrass (*Sassafras albidum*)
Associate species:	Chestnut oak, flowering dogwood, eastern white pine, eastern hemlock, gray birch (*Betula populifolia*)
Understory and ground flora:	Flowering and round-leaved dogwood, witch-hazel, American elm, red maple, white oak, gray birch, sassafrass, American chestnut (*Castanea dentata*), mountain laurel (*Kalmia latifolia*), ground cedar (*Lycopodium tristachyum*), tree clubmoss (*Lycopodium obscurum*)
Type 2 wetland:	
Overstory:	Dead trees
Understory and ground flora:	Mad-dog skullcap (*Scutellaria laterifolia*), goldenrods (*Solidago* sp.), sphagnum (*Sphagnum* sp.), skunk-cabbage (*Symplocarpus foetidus*)
Type 3 wetland:	
Overstory:	Eastern hemlock
Understory and ground flora:	Sphagnum, skunk-cabbage, cinnamon fern (*Osmunda cinnamomea*), common cattail (*Typha latifolia*), shining clubmoss (*Lycopodium lucidulum*), mayapple (*Podophyllum peltatum*)
Old-fields and cropland	
Ground flora:	White and red clover (*Trifolium repens*, *T. pratense*), common sorrel (*Rumex acetosella*), ox eye daisy (*Chrisanthemum leucanthemum*), common and English plantains (*Plantago major*, *P. lanceolata*), timothy (*Phelum pratense*), junegrass (*Koelria cristata*), sweet vernal grass (*Anthoxanthum odoratum*)

[a]Source: ER-OL, Appendix H, Section 3.2.2.2.

Mammals

Published distribution maps indicate that the Pond Hill site is within the ranges of about 55 mammals,[5] however, habitat requirements for many of these species is lacking or poorly represented at the site. The applicant has identified 15 species as being "field checked" during site surveys; an additional species, porcupine (*Erethizon dorsatum*), was subsequently observed at the site (ER-OL, Supp., Response to NRC Q.13, 28 September 1979).

The whitetail deer (*Odocoileus virginianus*) and black bear (*Ursus americanus*) are the largest of the game species occurring in the area. Eastern gray squirrels (*Sciurus carolinensis*) are abundant, but the density of eastern cottontail (*Sylvilagus floridanus*), a popular game species, is relatively low compared to that of other areas (ER-OL, Appendix H, Section 3.2.2.3). Other species that may be legally hunted with firearms and are known or likely to occur in the area include: eastern fox squirrel (*Sciurus niger*), red squirrel (*Tamiasciurus hudsonicus*), raccoon (*Procyon lotor*), woodchuck (*Marmota monax*), and snowshoe hare (*Lepus americanus*). Locally trapped species of fur-bearing animals include: raccoon, striped skunk (*Mephitis mephitis*), shorttail and longtail weasels (*Mustela erminea, M. frenata*), opossum (*Didelphis marsupialis*), mink (*Mustela vison*), red fox (*Vulpes fulva*), gray fox (*Urocyon cinereoargenteus*), muskrat (*Ondatra zibethica*), and beaver (*Castor canadensis*).

The applicant conducted small-mammal trapping studies at the site, resulting in the capture of shorttail shrew (*Blarina brevicauda*), boreal redback vole (*Clethrionomys gapperi*), and white-footed mouse (*Peromyscus leucopus*). The pine vole (*Pitymys pinetorum*), eastern chipmunk (*Tamias striatus*), and deer mouse (*Peromyscus maniculatus*) were also observed (ER-OL, Appendix H, Table 3.2.2.6).

None of the ten bat species reported to occur in the region[2] were observed during site surveys; however, all are variously associated with forest or woodland habitats. Some species probably frequent the site, at least on occasion. Other likely inhabitants of the site are noted as follows. Meadow jumping mouse (*Zapus hudsonius*) and meadow vole (*Microtus pennsylvanicus*) are frequently occurring species of moist meadows, old fields, and cropland.[6] Masked and smoky shrews (*Sorex cinereus, S. fumeus*) are also typical inhabitants; the former inhabits a wide range of habitats, the latter inhabits hemlock forest.

Birds

Information presented by the appliant indicates that "the list of birds for the region" includes 135 species, and that recent seasonal surveys verified the occurrence of 75 resident and migratory species at the Pond Hill site. Also noted, "60 species not field checked may also be using the area" (ER-OL, Supp., Response to NRC Q.11, 28 September 1979). However, a total of 210 bird species were identified during surveys conducted in the vicinity of the Susquehanna Steam Electric Station located about 4 km downstream from the Pond Hill site.[7] All species identified at Pond Hill are included in the inventory compiled from surveys at the SSES site. The inventories for the two sites are also similar in that both are comprised of a high proportion of species representative of the families Parulidae (wood warblers) and Fringillidae (grosbeaks, finches, sparrows). In combination, species of the named families comprise 35.8% (21.1 and 14.7%, respectively) of the Pond Hill species inventory. As derived from 1978 surveys at the SSES site, comparable percentages for the two families were 15.1 and 13.5, respectively.

The major difference between the SSES and Pond Hill inventories is apparent in that the latter does not include waterfowl and other species variously associated with aquatic habitats. However, the 1978 SSES surveys entailed censusing the Susquehanna River, including that portion of the river adjacent to the Pond Hill site. The species most frequently observed during the spring migration period included, in decreasing order of occurrence: Canada goose (*Branta canadensis*), mallard (*Anas platyrhynchos*), woodduck (*Aix sponsa*), common merganser (*Mergus merganser*), ring-necked duck (*Aythya collaris*), and black duck (*Anas rubripes*). Some of these species, especially woodduck and mallard, probably inhabit the Pond Hill site at various times. Other recorded species that variously use habitats similar to those onsite include: killdeer (*Charadrius vociferus*), spotted sandpiper (*Actitis macularia*), greater and lesser yellowlegs (*Tringa melanoleucus, T. flavipes*), belted kingfisher (*Megaceryle alcyon*), and great blue heron (*Ardea herodius*).

Upland game birds identified during surveys at the Pond Hill site include only ruffed grouse (*Bonasa umbellus*) and wild turkey (*Meleagris gallopavo*) (ER-OL, Appendix H, Table 3.2.2-6). Eastern portions of the site are periodically stocked with turkey and ring-necked pheasants (*Phasianus colchicus*); the latter species was not observed during surveys. Typical habitat of the American woodcock (*Philohela minor*) exists onsite, and, although not observed, the species is expected to be present (ER-OL, Appendix H, Section 3.2.2.3). The bobwhite (*Colinus virginianus*) is also known to occur in the Pond Hill area.[7] Ruffed grouse was the only commonly observed game bird species during site survey.

Information concerning the relative abundance of nongame birds that frequent the Pond Hill site is not available, but other studies serve to characterize local bird populations.[7,8] Accordingly, the characteristic species of forest habitats include: black-capped chickadee (*Parus atricapillus*), slate-colored junco (*Junco hyemalis*), white-breasted nuthatch (*Sitta carolinensis*), golden-crowned kinglet (*Regulus satrapa*), and downy woodpecker (*Dendrocopus pubescens*). Other species abundant during two or more seasons include: blue jay (*Cyanositta cristata*), ovenbird (*Seirus aurocapillus*), and wood thrush (*Hylocichla mustelina*).

Bird populations of open-field habitats tend to be dominated by field sparrows (*Spizella pusilla*), song sparrows (*Melospiza melodia*), starling (*Sturnus vulgaris*), and American goldfinch (*Spinis tristis*). Other seasonally abundant species include: yellowthroat (*Geothlypis trichas*), slate-colored junco, and indigo bunting (*Passerina cyanea*).

Characteristic species of wetland habitats include: swamp sparrows (*Melospiza georgiana*), song sparrows, red-winged blackbird (*Agelaius phoeniceus*), cardinal (*Richmondena cardinalis*), and American goldfinch. Other species well represented during two or more seasons include: robin (*Turdus migratorius*), yellow warbler (*Dendroica petechia*), gray catbird (*Dumetella carolinensis*), yellowthroat, and starling.

Reptiles and Amphibians

Inventories of reptiles and amphibians reported occurring in Pennsylvania consist of 48 and 38 species and subspecies, respectively.[9] Based on published species-distribution maps, only 20 amphibians and 19 reptiles are likely to inhabit the Pond Hill area.[10] Inventories compiled from surveys of the Pond Hill site consist of 5 reptiles and 17 amphibians (ER-OL, Appendix H, Table 3.2.2-6).

Reptiles reported as occurring onsite include 3 snakes and 2 turtles. The venomous northern copperhead (*Agkistrodon contortrix mokasen*) is associated with forest habitat; the northern water snake (*Ratrix sipedon sipedon*) with all aquatic habitats, and the eastern garter snake (*Thamnophis sirtalis sirtalis*) with all terrestrial and aquatic habitats. Midland painted turtles (*Chrysemys picta marginata*) were observed in the marshes; the eastern box turtle (*Terrapene carolina carolina*) occurred in all terrestrial habitats (ER-OL, Appendix H, Table 3.2.2-6).

Anurans (frogs and toads) reported as occurring in forest habitats near water include: American toad (*Bufo americanus*), spring peeper (*Hyla crucifer*), and gray treefrog (*Hyla versicolor*). Wood frog (*Rana sylvatica*) were observed in moist woods, as well as streamside. Northern leopard frog (*Rana pipiens*) was observed to frequent meadow habitats. Other anurans (3 frogs) identified during surveys were associated with the limited stream and marsh habitats occurring onsite. Similarly, most salamanders, as well as the red-spotted newt (*Notopthalmus viridescens viridescens*) were observed in streamside habitats. The exceptions, red-backed and slimy salamanders (*Plethodon cinereus cinereus, Plethodon glutinosus glutinosus*), were associated with forest and rocky woodland habitats. Mountain dusky salamanders (*Desmognathus ochrophaeus*) and northern spring salamanders (*Gyrinophilus porphayriticus*) were reported to frequent wet woods as well as streamside habitats.

A.2.5.1.3 Endangered and Threatened Species

None of the current federally designated plant species (including varieties) of endangered or threatened status occur in Pennsylvania.[11] Five plants that were proposed for federal listing in 1976[12] are reported to occur in the state; known distributions of these five species, however, do not include Luzerne County, within which the Pond Hill site is located (see Appendix A). A grass species (*Poa paludigina*) proposed for federal listing in 1975[13] has been collected in Luzerne County; however, the species was not observed in 1979 site surveys (ER-OL, Supp., Response to NRC Q.9, 28 September 1979).

The Pond Hill site is within the reported distributional range of two mammals and three birds included in the federal list of threatened and endangered species;[11] namely, the eastern cougar (*Felis concolor cougar*), Indiana bat (*Myotis sodalis*), bald eagle (*Haliaeetus leucocephalus*), and American and arctic peregrine falcons (*Falco peregrinus anatum, F. p. tundrius*). None of these animals was observed during surveys of the Pond Hill site (ER-OL, Appendix H, Section 3.2.2.3), although recent local sightings of bald eagle and American peregrine falcon have been reported.[7,8] The nature of these sightings is consistent with information received by the staff that indicates federally listed or proposed endangered or threatened animals under the jurisdiction of the U. S. Fish and Wildlife Service (including those mentioned) are not known to frequent the Pond Hill area other than as occasional transient individuals (see Appendix A).

None of the reptiles and amphibians designated as threatened or endangered species by the Pennsylvania Fish Commission[14] were observed during surveys of the Pond Hill site (ER-OL, Appendix H, Section 3.2.2.3). Comparable state designations of endangered or threatened mammals and birds have not been made at this time (ER-OL, Supp., Response to NRC Q. TER- 6.1).

A.2.5.1.4 Soils

An estimated 84% of the Pond Hill site soils are of Capability Classes V through VIII as defined by the U.S. Soil Conservation Service (ER-OL, Appendix H, Table 3.2.6-4) and are unsuited for normal tillage of agricultural crops. These onsite soils are characterized by excessive stoniness, wetness, shallowness, and/or erosion hazard. Capability Class II soils (including prime farmland) are present on about 9.6% of the site, and occur as scattered, irregular tracts near or adjacent to the south boundary of the site. The distribution of Class II soils is limited to the more level areas of upland terrain.

The remaining soils of the site are designated as Class III and IV soils (ER-OL, Appendix H, Fig. 3-13), thus indicating suitability for the production of cultivated crops. However, the respective severe and very severe limitations of Class III and IV soils restrict cropland management alternatives, such as choice of crop plants and/or soil management practices required to conserve the soil resource. Some scattered patches of Class III and IV soils occur in the valley bottom and adjacent to the Susquehanna River; most of these soils, however, are contiguous with Class II soils in uplands of the southern portion of the site.

The foregoing groupings of onsite soils are based on relative potentials for agricultural productivity. In view of the high proportion of forest vegetation occurring onsite, soil-woodland site index correlations are also indicative of onsite soil productivity. With one exception, woodland productivity ratings for the major grouping of onsite soils are high (ER-OL, Appendix H, Table 3.2.6-5).

A.2.5.2 <u>Aquatic Ecology</u>

A.2.5.2.1 Water Quality

A.2.5.2.1.1 *POND HILL CREEK.* The Pennsylvania Department of Environmental Resources has recently promulgated a revised set of water quality regulations for the state's surface waters. The water quality criteria that apply to Pond Hill Creek under these regulations are presented in Table A.2.2. In this system, Pond Hill Creek is classified with the unnamed tributaries to the North Branch of the Susquehanna River, and has a designated protected water use for the maintenance and/or propagation of coldwater fishes, specifically the Salmonidae (trout); however, fish sampling failed to reveal the presence of trout in the stream (ER-OL, Section 3.2.3.1.2).

Monthly water samples were collected from both the upper and lower sections of Pond Hill Creek. Results of the analyses of these samples are presented in Tables A.2.3 and A.2.4. In general, Pond Hill Creek is a clear, highly oxygenated, coldwater stream. It has soft water and is weakly buffered. The water quality of Pond Hill Creek meets both the criteria proposed by DER and those recommended for fish and other aquatic life by EPA. A few parameters, specifically fecal coliforms and ammonia, occasionally exceeded DER criteria, but the magnitude by which the standards were surpassed was not excessive.

A.2.5.2.1.2 *SUSQUEHANNA RIVER AT RESERVOIR PUMP STATION SITE.* Water quality criteria and analyses for the Susquehanna River were discussed in the main body of this Statement.

Additional samples were collected from the river at the proposed intake location; results of the analyses are tabulated in Table A.2.5. Sampling was conducted from March to August 1978. The data indicate that all parameters except total iron and fecal coliform bacteria comply with the DER recommended criteria for the river.

A.2.5.2.2 Aquatic Life

A.2.5.2.2.1 *POND HILL CREEK.* Qualitative samples of plankton, periphyton, and macrophytes were collected in Pond Hill Creek. Quantitative sampling was conducted for benthic macroinvertebrates (ER-OL, Section 3.2.3.1.3) and fishes.

Very few organisms were found in any of the plankton samples taken at Pond Hill Creek. Virtually all of the planktonic species collected were washed out or detached from the periphyton community. These included the diatoms (*Synedra, Nitzschia, Navicula,* and *Stauroneis*) along with fragments of the filamentous green algae (*Spriogyra*). Zooplankton samples revealed the presence of a few rotifers, ostracods, cladocerans, copepods, and some drifting insect larvae. In general, the plankton of Pond Hill Creek is typical of most small streams, where the constant turbulent

Table A.2.2. Water Quality Criteria for Pond Hill Creek[a]

Stream	Zone
Unnamed Tributaries of the Susquehanna River (North Branch)	Basins, Lackawanna River to West Branch Susquehanna River
Protected water uses	Coldwater fishes; maintenance and/or propagation of fish species including the family Salmonidae and additional flora and fauna indigenous to a coldwater habitat.
Dissolved oxygen	Minimum daily average 6.0 mg/L; no value less than 5.0 mg/L. For lakes and impoundments only, no value less than 5.0 mg/L at any point.
pH	Not less than 6.0 and not more than 9.0.
Iron	Not to exceed 1.5 mg/L as total iron; not to exceed 0.3 mg/L as dissolved iron.
Temperature	No measurable rise when ambient temperature is 14¼C or above; not more than a 2.8¼C rise above ambient temperature until stream temperature reaches 14¼C; not to be changed by more than 1.1¼C during any one-hour period.
Total filterable residue at 105¼C	Not more than 500 mg/L as a monthly average value; not more than 750 mg/L at any time.
Bacteria (fecal coliform)	During the swimming season (May 1 - September 30), the fecal coliform level shall not exceed a geometric mean of 200 per 100 mL based on five consecutive samples collected on different days; for the remainder of the year, the fecal coliform level shall not exceed a geometric mean of 2000 per 100 mL based on five consecutive samples collected on different days.
Alkalinity	Alkalinity shall be 20 mg/L or more as $CaCO_3$ for freshwater aquatic life, except where natural conditions are less.
Total manganese	Not to exceed 1.0 mg/L.
Flouride	Not to exceed 2.0 mg/L.
Cyanide	Not to exceed 0.005 mg/L as free cyanide.
Sulfate	Not to exceed 250 mg/L.
Phenol	Not to exceed 0.005 mg/L.
Copper	Not to exceed 0.1 of the 96-hour LC 50 for representative important species.
Zinc	Not to exceed 0.01 of the 96-hour LC 50 for representative important species.
Aluminum	Not to exceed 0.1 of the 96-hour LC 50 for representative important species.
Arsenic	Not to exceed 0.05 mg/L.
Chromium	Not to exceed 0.05 mg/L as hexavalent chromium.
Lead	Not to exceed 0.05 mg/L.
Nickel	Not to exceed 0.01 of the 96-hour LC 50 for representative important species.
Nitrite plus nitrate as nitrogen	Not to exceed 10 mg/L as nitrate nitrogen.
Ammonia nitrogen	Not more than 0.5 mg/L.

[a]Source: ER-OL, Vol. IV, Appendix H, Table 3.2.3-1.

Table A.2.3 Water Quality Data from the Upper Section of Pond Hill Creek[a]

Parameter[b]	1977 Sept.	1977 Oct.	1977 Nov.	1977 Dec.	1978 Jan.	1978 Feb.	1978 Mar.	1978 Apr.	1978 May	1978 June	1978 July	1978 Aug.	N[c]	Mean	S.D.[d]	Max.	Min.
Temperature, water (°C)	17.0	9.0	6.0	3.5	-0.5	0.0	5.0	8.0	10.0	12.0	14.0	17.5	12	8.5	2.92	17.5	-0.5
Dissolved oxygen (ppm)	9.3	11.2	11.3	12.5	13.0	12.4	--	12.3	11.6	9.9	8.4	8.2	11	10.9	3.30	13.0	8.2
BOD	7.0	3.0	2.1	0.5	<0.5	<1	<1	<1	2.0	<1.0	<1.0	1.0	12	1.8	1.33	7.0	<0.5
COD	10.1	8.0	3.6	4.0	<5	7.3	<5	<5	<5	17.0	9.0	23.0	12	8.5	2.92	23.0	3.6
pH (s.u.)	7.00	6.30	7.25	6.70	6.80	7.25	6.45	7.20	--	7.30	6.60	6.80	11	6.88	2.622	7.30	6.30
Alkalinity as $CaCO_3$	5.5	2.8	2.3	6.4	17.5	3.7	1.8	8.3	4.0	14.0	17.0	17.0	12	8.4	2.89	17.5	1.8
Total hardness as $CaCO_3$	24.0	17.0	20.0	15.0	15.0	16.0	17.5	30.0	14.0	18.0	82.0	20.0	12	24.0	4.90	82.0	14.0
Total dissolved solids	89.4	44.8	8.4	<0.5	99.4	37.8	3.0	45.5	37.6	56.5	47.4	50.4	12	43.4	6.59	99.4	<0.5
Total suspended solids	150.0	<0.5	516.0	3.4	11.3	13.1	6.1	6.3	2.5	9.6	6.3	40.7	12	63.8	7.99	516.0	0.5
Turbidity (JTU)	--	1.0	2.5	0.6	2.2	6.0	2.3	2.0	1.9	5.5	7.0	10.0	11	3.7	1.93	10.0	0.6
Specific conductance (μmhos)	55	48	42	46	48	48	48	52	52	49	--	53	11	49.2	7.10	55	42
Color (CPU)	11	<1	3	4	5	6	<1	7	10	22	23	28	12	10.1	3.18	28	<1
Sulphate as S	13.7	11.0	12.0	11.0	16.0	10.5	11.3	12.0	11.0	6.0	1.0	<1.0	12	9.7	3.12	16.0	1
Ortho phosphate as P	0.02	0.01	0.01	0.02	0.01	0.04	0.01	<0.02	0.03	0.02	0.05	<0.01	12	0.02	0.144	0.05	0.01
Total phosphate as P	0.01	0.02	0.02	0.08	0.01	0.04	0.06	0.03	0.09	<0.02	0.05	1.11	12	0.13	0.358	1.11	0.01
Nitrate as N	0.01	0.05	0.10	0.03	0.27	0.20	0.24	0.20	0.43	0.13	0.12	0.16	12	0.16	0.402	0.43	0.01
Chloride	1.6	3.4	2.3	4.3	5.5	3.1	<0.5	0.5	1.7	0.4	1.7	0.6	12	2.1	1.461	5.5	0.4
Total copper	<0.02	<0.02	<0.02	0.03	<0.02	0.05	0.02	0.02	<0.02	<0.02	<0.02	<0.02	12	0.02	0.153	0.05	<0.02
Total iron	0.47	0.49	0.21	0.26	0.29	0.39	0.40	0.35	0.80	0.87	1.40	1.64	12	0.63	0.794	1.64	0.21
Total manganese	0.05	0.03	0.03	<0.02	0.02	0.02	0.04	<0.02	0.05	0.05	0.07	0.02	12	0.05	0.224	0.20	<0.02
Coliform total MPN/100 mL	1100	1100	1100	210	43	240	240	>2400	210	>2400	1100	2400	12	1045.3	32.33	>2400	43
Coliform fecal MPN/100 mL	93	93	150	64	<3	<3	240	460	23	1100	23	1100	12	279.3	16.71	1100	<3
Fecal streptococci MPN/100 mL	<1	<1	5	25	<1	<1	<1	<1	20	35	10	30	12	10.9	3.30	35	<1

[a]Source: ER-OL, Vol. IV, Appendix H, Table 3.2.3-2.

[b]Units mg/L unless stated otherwise.

[c]N = number of samples.

[d]S.D. = standard deviation.

Table A.2.4. Water Quality Data from the Lower Section of Pond Hill Creek[a]

Parameter[b]	1977				1978								N[c]	Mean	S.D.[d]	Max.	Min.
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.					
Temperature, water (°C)	16.0	9.0	6.5	3.5	0.0	1.0	4.0	6.5	8.0	10.0	14.5	19.0	12	8.2	2.86	16.0	0.0
Dissolved oxygen (ppm)	9.5	11.8	12.0	13.0	13.9	13.1	--	13.3	13.2	12.4	8.9	8.0	11	11.7	3.43	13.9	8.0
BOD	8.0	4.0	1.2	0.5	<0.5	<1	3	<1	2.0	<1.0	<1	1.0	12	2.0	1.42	8.0	<0.5
COD	11.1	7.4	3.4	9.0	6.8	<5.0	<5.0	<5.0	<5.0	7.0	18.0	12.0	12	7.9	2.81	18.0	3.4
pH (s.u.)	7.10	6.65	7.60	7.10	7.00	7.30	7.30	7.55	--	7.10	6.70	6.80	11	7.11	2.666	7.60	6.65
Alkalinity as $CaCO_3$	7.4	11.0	2.3	1.8	23.0	1.8	<1.0	11.0	5.0	11.0	19.0	16.0	12	9.2	3.03	23.0	<1.0
Total hardness as $CaCO_3$	24.0	23.0	19.0	15.0	16.0	17.0	15.5	21.0	22.0	14.0	20.0	21.0	12	19.0	4.35	24.0	14.0
Total dissolved solids	108.0	49.6	15.4	<0.5	102.0	56.0	14.2	133.0	43.3	52.3	44.4	56.2	12	56.2	7.50	133.0	<0.5
Total suspended solids	120.0	<0.5	1.4	3.1	8.9	6.1	5.2	4.9	8.3	8.2	22.4	8.0	12	16.4	4.05	120.0	<0.5
Turbidity (JTU)	--	0.7	3.0	0.8	1.6	5.5	0.6	1.3	2.5	3.6	5.2	3.8	11	2.6	1.61	5.5	0.7
Specific conductance (μmhos)	59	45	48	48	46	45	68	49	50	50	--	55	11	51	7.2	68	45
Color (CPU)	10	<1	3	4	5	4	<1	3	15	12	10	22	12	8	2.7	22	1
Sulphate as S	13.2	12.0	11.8	12.5	16.8	13.6	11.9	11.0	9.0	12.0	6.0	7.0	12	11.4	3.38	16.8	6.0
Ortho phosphate as P	0.02	0.01	0.02	<0.01	0.02	<0.02	0.02	<0.02	0.04	0.06	0.02	<0.01	12	0.02	0.150	0.06	<0.01
Total phosphate as P	0.01	<0.01	0.02	<0.01	0.01	0.05	0.10	<0.02	0.08	0.04	0.02	0.47	12	0.07	0.265	0.47	<0.01
Nitrate as N	<0.01	0.07	<0.05	0.03	0.33	0.21	0.12	<0.10	0.08	0.27	0.24	0.21	12	0.14	0.379	0.33	0.01
Chloride	0.7	2.6	9.5	<0.5	2.9	11.1	<0.5	<0.5	2.1	0.4	1.08	1.1	12	2.7	1.66	11.1	0.4
Total copper	<0.02	<0.02	<0.02	0.03	0.03	0.06	0.02	<0.02	<0.02	0.02	<0.02	<0.02	12	0.03	0.158	0.06	<0.02
Total iron	0.60	0.46	0.22	0.20	0.25	0.39	0.34	0.25	0.41	1.08	3.11	0.65	12	0.66	0.814	3.11	0.20
Total manganese	0.03	0.04	0.02	0.04	0.02	0.02	<0.02	<0.02	0.03	0.04	0.21	0.10	12	0.05	0.222	0.21	<0.02
Coliform total MPN/100 mL	460	240	150	150	43	43	460	460	210	>2400	240	>2400	12	609	24.7	>2400	43
Coliform fecal MPN/100 mL	240	9	23	23	4	<3	43	43	43	93	9	93	12	52	7.2	240	<3
Fecal streptococci MPN/100 mL	10	<1	<1	<1	<1	<1	<1	<1	10	20	<1	<1	12	4	2.0	20	<1

[a]Source: ER-OL, Vol, IV, Appendix H, Table 3.2.3-3.

[b]Units mg/L unless stated otherwise.

[c]N = number of samples.

[d]S.D. = standard deviation.

Table A.2.5. Water Quality in the Susquehanna River near the Proposed Intake Site[a]

Parameter[b]	1978						N[c]	Mean	S.D.[d]	Max.	Min.
	Mar.	Apr.	May	June	July	Aug.					
Temperature, water (°C)	3.0	7.0	13.5	16.0	22.0	25.0	6	14.4	3.80	25.0	3.0
Dissolved oxygen (ppm)	--	12.6	10.7	14.9	8.9	9.0	5	11.2	3.35	14.9	3.35
BOD	1.0	<1	3.0	<1	2.0	5.0	6	2.2	1.47	5.0	<1
COD	7.0	24.0	5.0	7.0	10.0	25.0	6	13.0	3.61	25.0	5.0
pH (s.u.)	7.25	7.60	--	8.60	7.20	7.20	5	7.57	2.751	8.60	7.20
Alkalinity as $CaCO_3$	23.0	41.4	19.0	46.0	66.0	60.0	6	42.6	6.52	66.0	19.0
Total hardness as $CaCO_3$	66.1	84.0	73.0	109.0	167.0	136.0	6	105.9	10.29	167.0	66.1
Total dissolved solids	67.2	122.0	138.0	196.0	290.0	215.0	6	171.4	13.09	290.0	67.2
Total suspended solids	9.1	21.7	7.5	19.9	9.5	36.5	6	17.4	4.17	36.5	9.1
Turbidity (JTU)	16	7.5	5.1	9.8	11.0	12.0	6	10.2	3.20	16.0	5.1
Specific conductance (μmhos)	160	190	200	230	--	330	5	222	14.9	330	160
Color (CPU)	26	7	25	68	65	80	6	45	6.72	80	7
Sulphate as S	28.8	30.0	46.0	97.0	180.0	148.0	6	88.3	9.40	180.0	28.8
Ortho phosphate as P	0.06	0.04	0.06	0.02	<0.01	0.10	6	0.05	0.22	0.10	<0.01
Total phosphate as P	0.07	0.05	0.12	0.10	0.04	0.84	6	0.20	0.45	0.84	0.04
Nitrate as N	0.97	1.00	0.73	0.61	0.43	0.55	6	0.72	0.846	1.00	0.43
Chloride	12.8	11.0	6.2	11.5	18.4	14.5	6	12.4	3.52	18.4	6.2
Total copper	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	6	<0.02	0.141	<0.02	<0.02
Total iron	2.11	1.96	1.63	2.43	2.34	4.70	6	2.53	1.590	4.70	1.63
Total manganese	0.29	0.19	0.32	0.49	0.66	0.90	6	0.48	0.689	0.90	0.19
Coliform, total MPN/100 mL	>2400	43	>2400	>2400	>2400	>2400	6	2007	44.8	>2400	43
Coliform, fecal MPN/100 mL	240	3	210	460	460	1100	6	412	20.3	1100	3
Fecal streptococci MPN/100 mL	10	<1	35	85	10	65	6	34	5.9	85	<1

[a]Source: ER-OL, Vol. IV, Appendix H, Table 3.2.3-7.

[b]Units mg/L unless stated otherwise.

[c]N = number of samples.

[d]S.D. = standard deviation.

and fast-flowing water usually inhibits the development of a true self-reproducing drift community. Instead, a normally sparse make-shift plankton community is derived from organisms washed out of small ponds and quiet backwaters or dislodged from the streambed and periphyton.

The periphyton community in Pond Hill Creek is dominated by filamentous algae and attached diatoms. The most abundant diatoms were those listed in the previous paragraph. Other relatively common diatoms included *Melosira* and *Cymbella*. The most commonly observed filamentous algae was the green algae *Spirogyra*. Collectively, filaments of *Spriogyra* often formed noticeable tufts upon rocks, sticks, and other debris in the stream. Other filamentous algae present in the periphyton included green algae (*Oedogonium* and *Desmidium*), red algae (*Batrachospermum*), and blue-green algae (*Oscillatoria*). Microfauna found in the periphyton consisted primarily of protozoans, particularly the ciliate *Colpidium* and rotifers from the family Brachionidae.

The most common flowering plants found in the stream included cattails (*Typha*), pondweed (*Potamogeton*), bush pondweed (*Najas*), waterweed (*Elodea*), iris (*Iris*), and watercress (*Nasturtium*). Cattails, pondweeds, and waterweeds were relatively abundant in the upper section of Pond Hill Creek in areas previously inundated by beaver dams. However, the most noticeable macrophytes in the stream were water moss (*Fontinalis*) and leafy liverwort (*Chiloscyphus*), both of which formed dense growths on most of the stones and boulders in the streambed. Water moss and liverwort are generally considered typical inhabitants of hard-bottomed, coldwater streams.[15]

A total of 12,435 macroinvertebrate specimens were collected from seasonal visits to each of three sampling stations at Pond Hill Creek. The average density of these macroinvertebrates was 3,844 organisms/m^2, ranging from a low of 1,789 to a high of 10,411.

The dominant insects found in the macroinvertebrate community of Pond Hill Creek were fly larvae (Diptera) and mayfly nymph (Ephemeroptera). These two groups of insect larvae comprised 44.2 and 28.3%, respectively, of all organisms collected. The most abundant Dipteran larvae were midge larvae of the family Chironomidae. *Ironopsis* and *Ephemerella* were the most numerous mayflies observed. Other well-represented macroinvertebrates included stonefly larvae (10.3% of the total specimens), caddisfly larvae (8.8%), beetles (2.3%), clams (2.1%), and worms (1.9%). Collectively, these macroinvertebrates are typical of stony-bottomed, small streams.

Diversity indices calculated for all of the macroinvertebrate samples collected in Pond Hill Creek ranged from 2.87 to 4.18. Only two of the twelve indices were below 3.0. The overall average index was 3.66. These very high values indicate that Pond Hill Creek supports a well-balanced community of macroinvertebrates.

The stream supports a very limited fish community. Seasonal fish samples collected in the upper and lower sections of the stream revealed only five species. The primary factor limiting the fish community in Pond Hill Creek is apparently the intermittent nature of the stream. Also, since fish are prevented from moving up into the stream from the Susquehanna River by an elevated culvert near the stream's mouth, there are no migratory species present in the stream.

Fish sampling in Pond Hill Creek covered a distance of about 250 m of the lower section and approximately 830 m of the upper section. Samples were collected with an electrical shocker and minnow seines.

Of the five species found, only the blacknose dace (*Rhinichthys atratulus*), a common minnow species in Pennsylvania and other parts of the northeastern United States, was abundant. Other common minnow species found included: golden shiners (*Notemigonus crysoleucas*), fathead minnows (*Pimephales promelas*), and creek chub (*Semotilus atromaculatus*). However, only 9, 10, and 1 specimens, respectively, of these three species were collected. The remaining fish species was represented by a single specimen of largemouth bass (*Micropterus salmoides*) caught in the lower section of the stream in December 1977. Since only this one individual was found in all the fish samples, it is clear that Pond Hill Creek does not support a large resident population of this species. Furthermore, it is probable that the single bass juvenile originated from one of the small farm ponds located near the stream. These ponds are connected to Pond Hill Creek near its source by a small rivulet.

None of the species found in Pond Hill Creek is included on either the U. S. Fish and Wildlife Service's list of Endangered and Threatened Wildlife and Plants or the Pennsylvania Fish Commission's list of Endangered, Threatened or Indeterminate Fishes, Amphibians or Reptiles of Pennsylvania. The stream has never been stocked by the Pennsylvania Fish Commission, and no fishermen were observed on the stream during the sampling program.

A.2.5.2.2.2 *SUSQUEHANNA RIVER AT RESERVOIR PUMP STATION SITE*. Biological data gathered near SSES provide the most adequate representation of the nature of the aquatic biota in the vicinity of the proposed reservoir intake site.

The reader is referred to the applicant's annual reports and to the main body of this Environmental Statement for additional information about the site.[16-20]

A.2.6 SOCIOECONOMIC PROFILE OF THE LOCAL AREA

The socioeconomic profile for the area surrounding the proposed Pond Hill reservoir will focus on Conyngham Township, Luzerne County. This area has been selected because the proposed reservoir site is centrally located in this township, and the most direct impacts of construction and operation are expected to occur here.

A.2.6.1 Demography

In 1970, the total population of Luzerne County was 342,301, a 22.5% decrease from 1940 (ER-OL, Table 3.1-1). Between 1970 and 1977, population declined at a rate of 1% per year.[21] In comparison, Conyngham Township's populations totaled 1,693 in 1970 and was projected to have increased to 1,788 in 1976, an increase of 5.6%.[22]

Compared to national trends, the age structure of the county and township can be characterized as an older population because of the proportion of people over 65 years of age.[22,23] In 1970, the proportion of people over 65 was 13.0% for the county and 13.1% for the township, as compared to 10.8% for the state.[24]

A.2.6.2 Settlement Pattern

Population concentrations are located in four areas of Conyngham Township: Mocanaqua, Wapwallopen, Pond Hill, and Lily Lake.[24] Scattered houses and small farms were observed surrounding these small population centers and in the areas between them.

Housing

In general, the township housing stock is characterized as old; about 83% of the current structures were built before 1939.[24] However, the condition of the available 1976 housing was still rated as fair to good, and the demand for new houses is expected to increase by 1980.[25] Repair and renovation of older homes and summer homes was observed by the staff, particularly in the Pond Hill and Lily Lake areas.

Recreation

A series of recreational facilities are located in Conyngham Township; these have been listed in a county recreational study and presented as Table 3.8.3 of Reference 24. In addition to these listed facilities, trout fishing is available in Little Wapwallopen Creek, fishing and boating opportunities at Lily Lake, and hunting and hiking in several of the state gamelands.[24]

Detailed information on current recreational needs and plans for the township are not available. However, a need for additional recreational facilities of different types has been identified for all of Luzerne County, which would include Conyngham Township (see Section 2.2.3.3).

A.2.6.3 Social Organization

An estimated 80% of the 1970 households in the township were composed of families. The sociocultural characteristics of the township have been described as rural in terms of its population density, atmosphere, and available services. However, the population concentrated in the settlement of Mocanaqua, which has been historically associated with the coal-mining industry, is now distinctively agricultural and more diverse than that typically associated with rural areas.[24]

A.2.6.4 Social Services

Sewage and Water

Public water services are currently available in Mocanaqua and Wapwallopen.[24] Mocanaqua has some public sewage, but needs renovation of its system.[26] Sewage treatment is planned for Wapwallopen and Lily Lake.[26]

Fire and Police Protection

The township has a part-time police force made up of four persons and is also served by the state police.[24] Volunteer fire companies provide fire protection.[24]

A.2.6.5 Political Organization

Conyngham is defined as a second-class township because it has fewer than 300 residents per square mile.[27] The township is governed by a board of three supervisors elected at-large for six-year terms.[27] The board exercises general governmental functions, including maintenance of a police force, the road system, and the levy and collection of taxes.[24]

A.2.6.6 Economic Organization

By the 1920s, anthracite mining was the chief source of employment and the economic base of Luzerne County.[27] As coal production began to decline in the 1930s, the economic base was diversified to counteract serious income and job losses.[27] Today the economy is broad-based and has a strong apparel-industry orientation.[27,28]

In 1976, the Department of Commerce listed only four establishments for this township employing a total of 154 employees.[28] One business is a sawmill, another a footwear firm;[24,27] two businesses were undefined. Additional retail and service facilities are located within the township, primarily in Mocanaqua, Wapwallopen, and Pond Hill.[24]

A.2.6.7 Sociocultural Characteristics

The staff observed no resident population living on the proposed site. The applicant states that the property does not contain any facilities or structures used by the local communities nor does it support any commercial or industrial activities.[24] The applicant also reports that there is no residential activity below the dam site.[24]

Recreation

The applicant stated that this site is used for walking, hiking, hunting, and nature study by the people living in the nearby vicinity.[24] Since this information has not been quantified,[24] neither the number of individuals using this site nor the person-days of usage can be determined. The applicant identified and characterized esthetic qualities of the site.[24] During the site visit, the staff observed that the site area was esthetically pleasing because of the steep topography, rock outcrops, waterfalls, and dense, but variable, forest cover. Therefore, it is reasonable that people would be attracted to the site to hike and enjoy the kind of natural environment present on the property.

In addition to recreational use of the natural area, the staff observed that a pond has been constructed on the site. The applicant stated that the pond was used for fishing and swimming by several local residents. The extent of the pond's usage cannot be quantified at this time.

A.2.7 CULTURAL RESOURCES

A.2.7.1 Region

A regional culture history for Luzerne and Columbia county areas is provided in Section 2.6.] of this Environmental Statement.

A.2.7.2 Pond Hill Site

A prehistoric cultural survey has been made in two areas of the Pond Hill Site: 1) on the property designated for the reservoir and within the high water mark and 2) on a section of the floodplain. Fifty-meter intervals and walkover was utilized for the uplands, while closer spaced transects and test trenching were used in the floodplain.[29]

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17. ________________, Annual Report for 1975, ________________, August 1976.

18. ________________, Annual Report for 1976, ________________, October 1977.

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A.3. RESERVOIR DESCRIPTION

A.3.1 INTRODUCTION

In order to provide the desired water storage, a dam will be constructed across Pond Hill Creek 1.3 km upstream from its confluence with the Susquehanna River. The reservoir will have all of the features typical of this type of project, including a spillway and an inlet-outlet structure. Since the drainage area above the dam is too small to fill and refill the reservoir and also keep it full between uses, an intake structure and pumping plant near the bank of the Susquehanna River and a water conduit from the pumping station to the inlet-outlet structure on the north shore of the reservoir will be constructed. A permanent access road will be provided. During construction, a concrete batch plant and borrow pits will be used. The location of the batch plant and borrow pits are shown on Fig. A.3.1.

The applicant has supplied detailed design information for a dam with a normal water level of 287 m MSL and an active storage volume of 12.5×10^6 m^3 and a total water storage volume of 16.0×10^6 m^3 (ER-OL, Appendix H). In response to comments by PDER and SRBC regarding the desirability of optional development of the site to meet water supply needs in addition to those of SSES, the applicant submitted design information on a larger dam, one utilizing 85% of the valley's maximum capacity. The higher, larger dam (normal water level 299 m MSL) will have a storage volume of about 27.1×10^6 m^3 and a total volume of 29.7×10^6 m^3 (responses to NRC questions, letters from N.W. Curtis, PP&L, to D.E. Sells, NRC, 12 October, 13 November, and 17 December 1979). The minimum water level for the larger reservoir is 264.6 m MSL.

The following analyses are for the larger (299-m normal water level) dam and reservoir and the Q 10-7 riverflow value of 22.7 m^3/s.

Figures A.2.2 and A.2.3 show local topography, the layout of the higher dam and the other structures, and the area to be covered by water at maximum and minimum water elevations. Figure A.3.2 is a detailed plan view of the higher dam and related structures.

A.3.1.1 Embankment Dam

The dam will be of earth and rockfill construction using materials obtained mostly from the area to be inundated. The crest of the dam will be about 730 m long at 302 m MSL. The maximum height of the crest of the dam above the existing creekbed will be about 67 m. The applicant's engineering studies have shown that sufficient core materials are available from onsite borrow areas.

Because of low topography along the southern edge of the reservoir, construction of two additional water retention barriers will be required (see Fig. A.3.2). In the saddle area, immediately southeast of the main dam, a shallow dike (about 150 m long and 2.4 m high) will be constructed. About 800 m east of the dam an impervious subsurface cutoff (about 380 m long and 6 m deep) will be required to prevent seepage through the saddle.

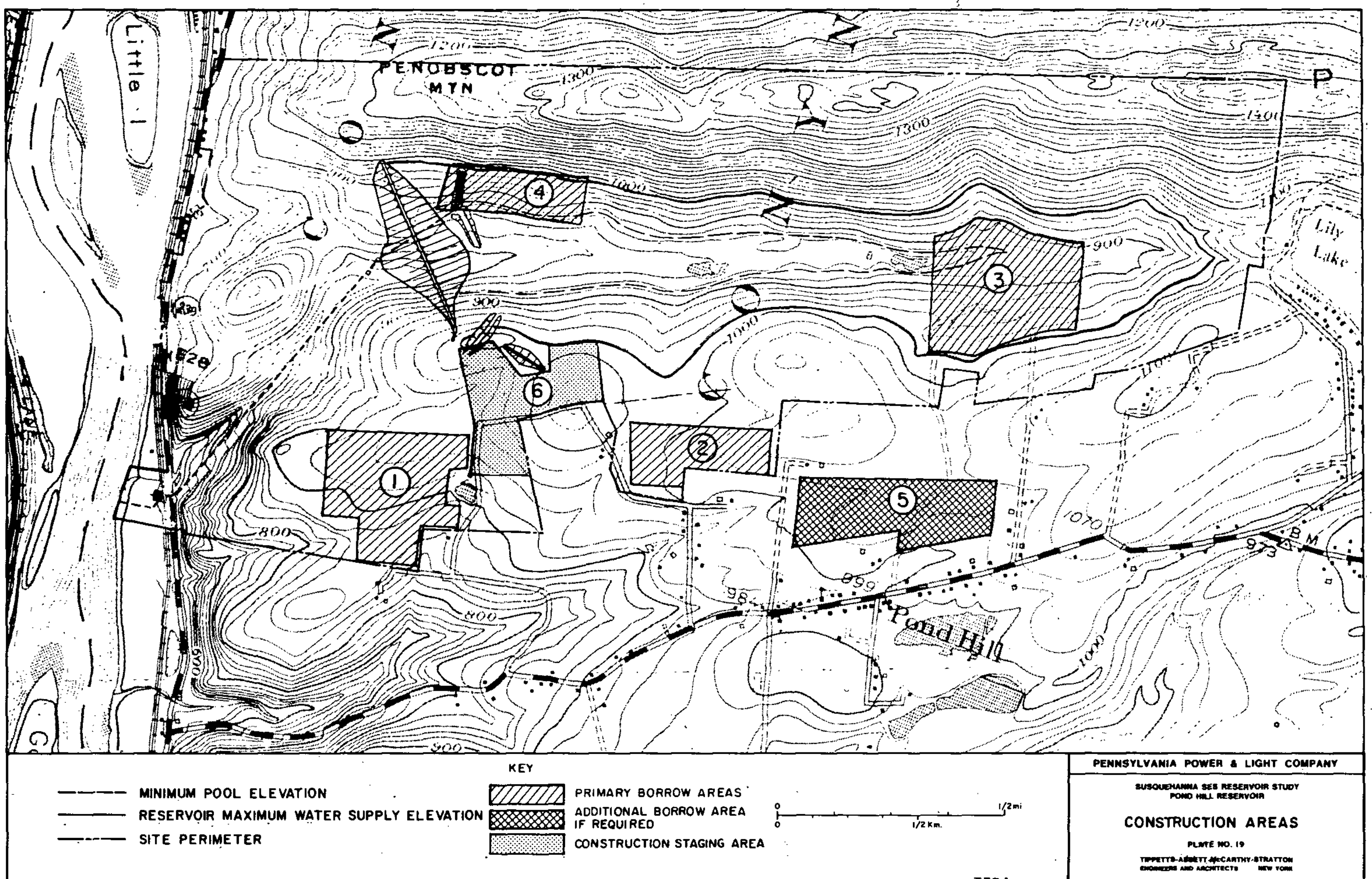
A.3.1.2 Spillway

An overflow-type of spillway located on the south abutment of the dam will be provided to release floodwaters when water levels exceed the 299-m MSL crest of the spillway (see Fig. A.3.2). Figure A.3.3 is a detailed schematic of this spillway. A 425-m concrete-lined chute will carry the overflow water from the spillway to the existing riverbed. A concrete structure will be used to dissipate most of the kinetic energy of the flow.

A.3.1.3 Inlet-Outlet Structure

This structure will be used to both control releases from the reservoir for conservation and compensation purposes, and to discharge pumped inflows into the reservoir.

This structure has been redesigned since the DES was issued in March 1980 (letter from M.N.W. Curtis, PP&L to Mr. B.J. Youngblood, NRC, 29 May 1980: this letter is on page B-47 of Appendix B). The new structure is shown schematically in Figure A.4.1; its location is given in Figure A.2.3). The new design calls for a vertical structure inside the reservoir, with exit ports 7.6, 17.0 and 39.9 m below the normal water surface.



TERA APERTURE CARD

Fig. A.3.1. Pond Hill Reservoir Construction Areas. (Source: Reference 1)

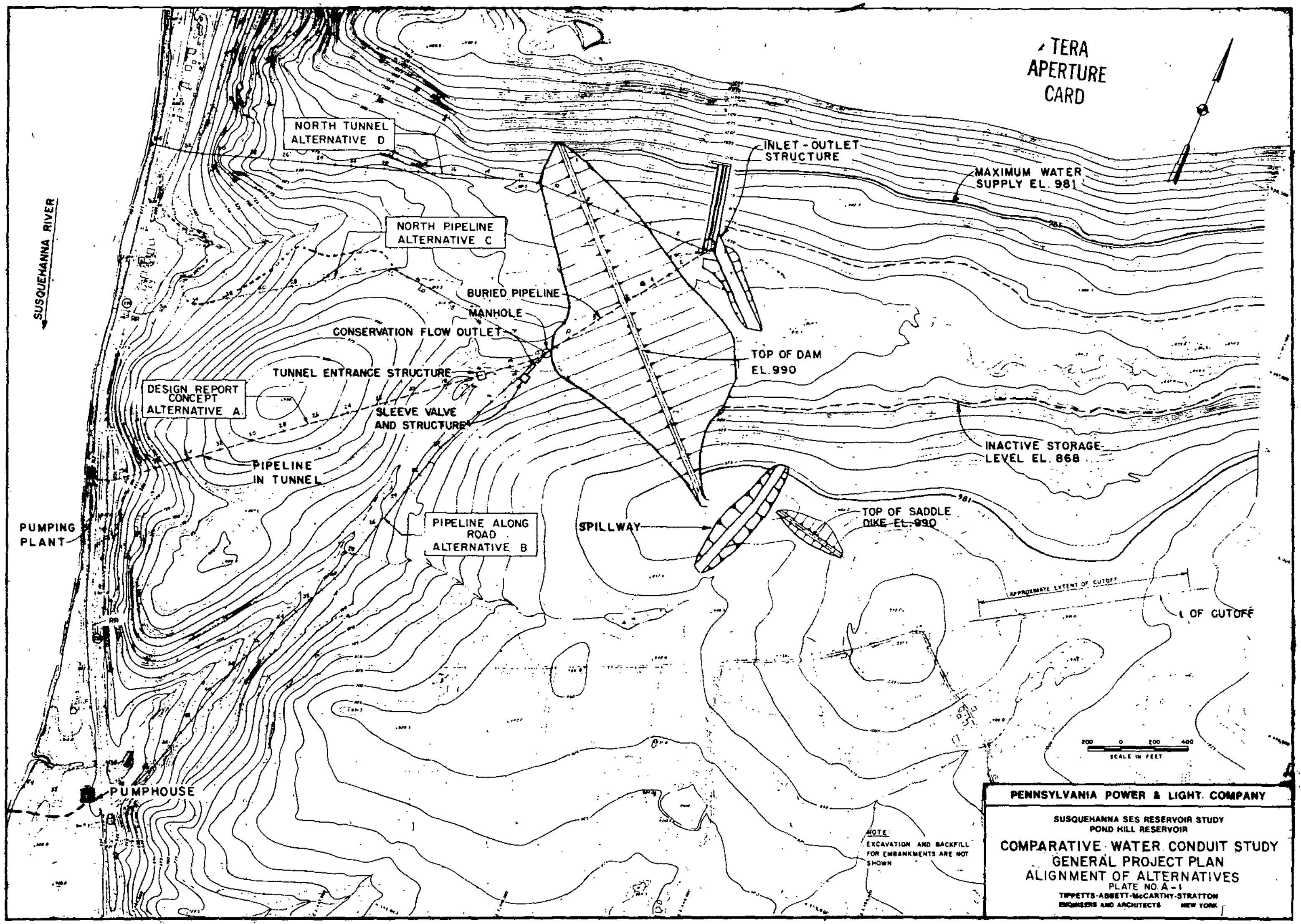


Fig. A.3.2. General Project Plan for Pond Hill Reservoir with Alignment of Alternatives. (Source: Reference 1)

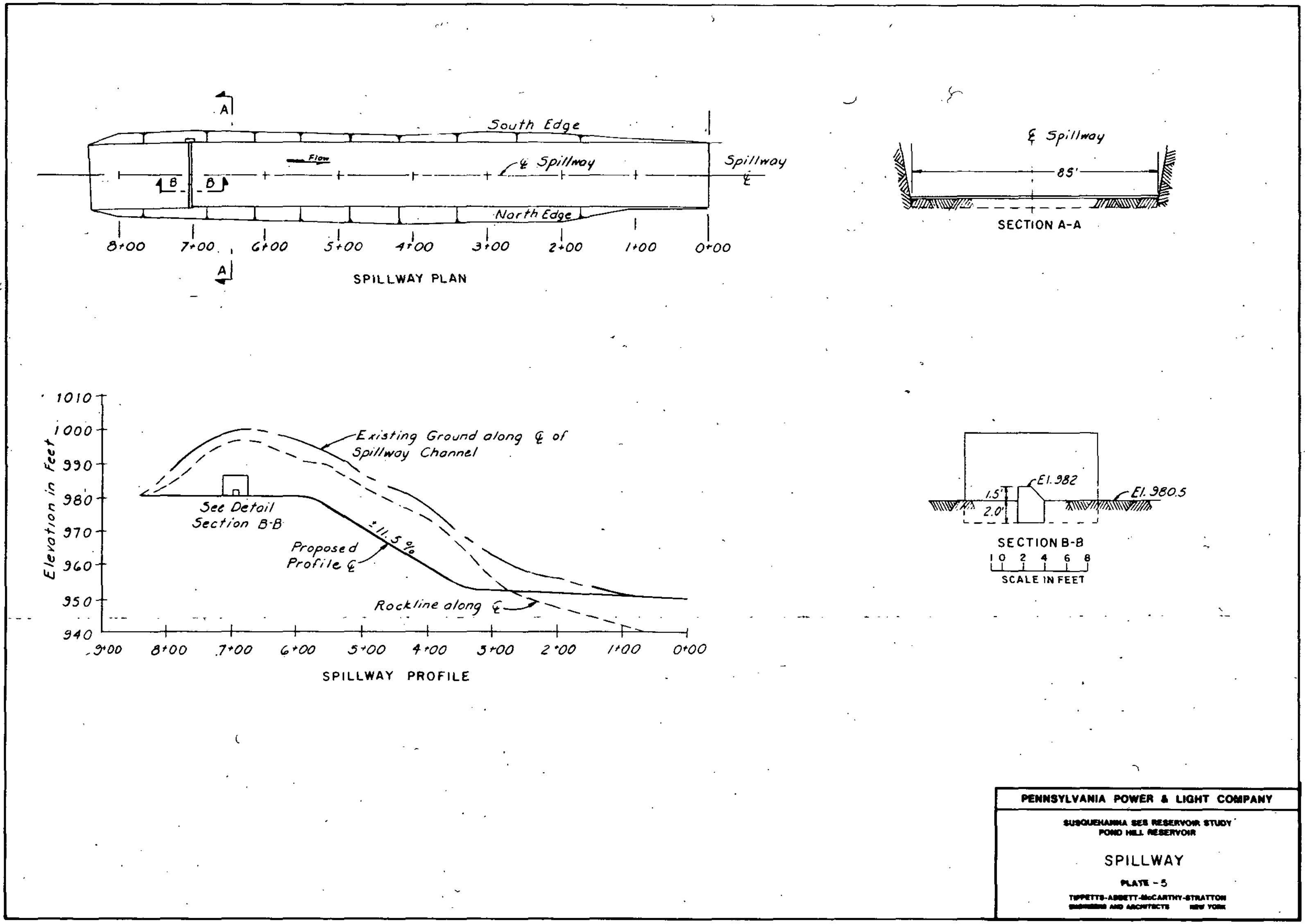


Fig. A.3.3. Detailed Schematic of Spillway Structure for Pond Hill Reservoir.

The concrete structure will be connected to the pumping plant by an underground pipeline (Fig. A.3.2, Alternative B). Pumped inflow will enter the reservoir at the base of the structure. Three outlet ports, each at a different level, will be used for compensation and conservation flows. The outlet port (or ports) used for a given release will be the one at which the temperature of the water in the reservoir most closely matches that of the Susquehanna River.

A.3.1.4 Water Conduit

A steel pipeline will be used to transport water between the pumping plant and the inlet-outlet structure (see Fig. A.3.2, Alternative B). The pipe will be capable of carrying 3.8 m^3/s of water from the pumps to the reservoir, and an average flow of 3.0 m^3/s for compensation releases. The maximum release flow will be 8.5 m^3/s. The pipe from the inlet-outlet structure to the pumping plant will have a diameter of 1.22 m. The pipeline will be constructed in a cut-and-cover trench along the proposed access road (see Fig. A.3.2).

A 0.61-m pipeline with a control valve will branch from the pipeline, near the downstream toe of the dam, to allow releases to Pond Hill Creek. The system will be able to release water at a rate of up to 0.57 m^3/s, a flow approximately equal to the capacity of the creek channel to carry water without flooding.

A.3.1.5 Pumping Plant and Intake Structure

The proposed pump station will be built adjacent to the railroad in an area outside the floodplain (see Figs. A.3.2 and A.3.4). The proposed intake will consist of two parallel steel pipes extending about 30 m into the river (see Fig. A.3.4). Although the final design of the intake structure has not been selected, screens similar to those manufactured by Johnson Screen Company or slotted steel pipes similar to those manufactured by Ranney Co., approximately 60 m of 0.6-m diameter screens, will be provided. The maximum approach velocity will be about 0.12 m/s. The pipe and screen low points will be about 0.6 m above river bottom; pipe tops will be about 1.2 m below water level at minimum pumping flows. Figure A.3.4 shows the contemplated configuration of the proposed pump station, intake structure, and the buried pipeline from the pumping plant to the intake screens. Compensation releases to the river would be through the screens. Three 1.25-m^3/s electrical driven pumps will be used to pump water into the reservoir.

A.3.1.6 Access Road

A new paved access road will be constructed from State Route 239 to the construction areas. The road will parallel the pipeline. The road will be approximately 1220 m long and 9 m wide; the area impacted by the construction of the road and pipeline will be about 2 ha. The use of this road will minimize construction traffic through the villages of Pond Hill and Lily Lake.

A.3.2 MODE OF OPERATION

A.3.2.1 Initial Filling of Reservoir

Most of the water required to fill the reservoir will come from the Susquehanna River, the remainder from drainage and precipitation. The applicant is committed to pumping only when river flow is greater than 85.4 m^3/s. The three pumps in the pumping plant are capable of delivering up to 3.8 m^3/s to the reservoir. Pumping at this rate, it would take 84 days to fill the reservoir.

A.3.2.2 Compensation Releases

During periods of low river flow, defined as the Q7-10 value of 22.7 m^3/s plus the actual consumptive use by SSES and dedicated compensation [18CFR803.61(c)(7)(i)], the applicant will be required to discharge water from the reservoir at the actual consumptive use rate. Consumptive water use of SSES will be determined by measuring the difference between the volume of water withdrawn from the river (primarily to replace that evaporated in the plant's cooling towers) and blowdown to the river.

The average rate of discharge from the reservoir will be 3.0 m^3/s; the active storage capacity of the dam will be such that this flow could be maintained for 106 days. The applicant estimates peak water consumptive use at about 1.8 m^3/s, and average use at 1.4 m^3/s.

Compensation water will be taken from one of the three outlet ports in the inlet-outlet structure, pass through the conduit, and be discharged into the Susquehanna River via the multislotted pipes. The outlet port selected would be the one at which the temperature in the reservoir most closely matches that of the river.

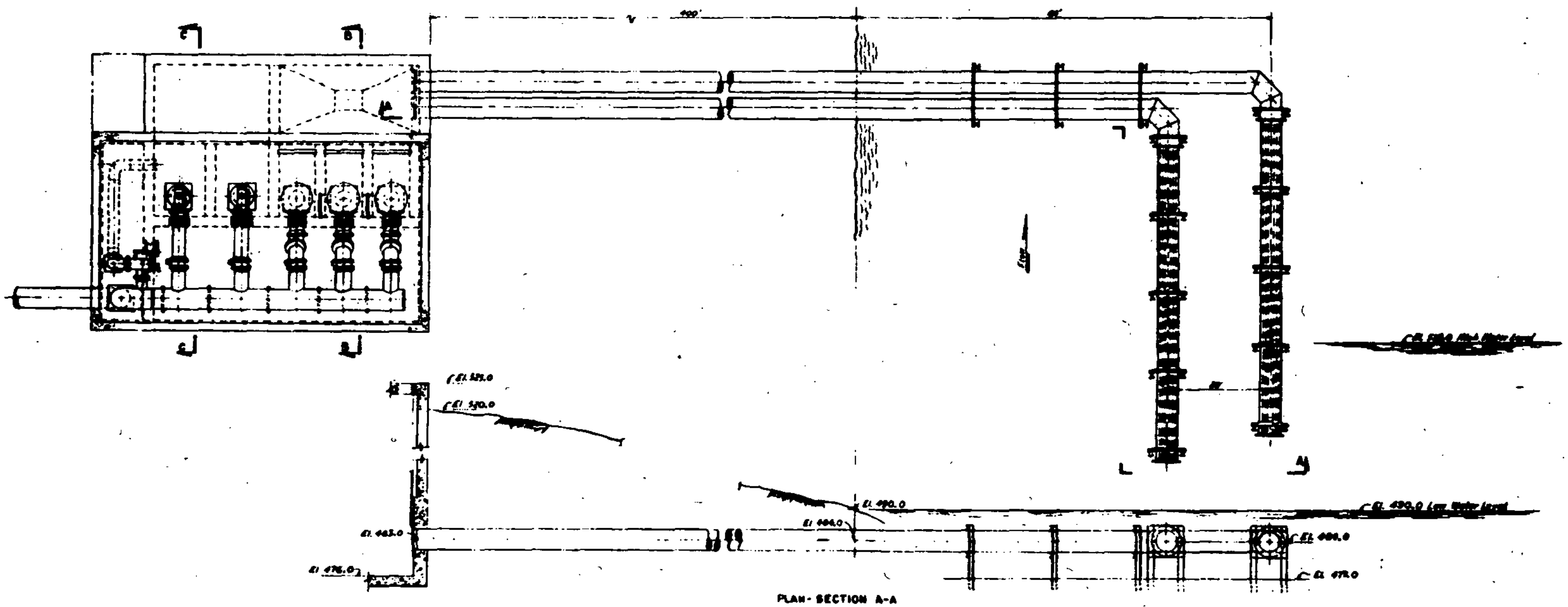


Fig. A.3.4. Proposed Intake for Pond Hill Reservoir (pumping station concept without traveling screens). (Source: Reference 1.)

A.3.2.3 Conservation Releases

The Pennsylvania Department of Environmental Resources requires that all new reservoirs provide a minimum release to maintain downstream flows. On streams without water-flow data, a value of 1.64 L/s per square kilometer of upstream drainage area is normally utilized by DER. Since the area upriver from the proposed dam is about 4.4 km^2, the applicant proposes a conservation release of at least 5.7 L/s. The release point for this discharge would be just west of the toe of the dam (see Fig. A.3.2).

Precipitation on the lake and drainage in excess of that required to keep the water level at 299 m would be discharged into Pond Hill Creek through the conservation-flow outlet (up to 0.57 m^3/s), over the spillway, or directly into the Susquehanna River via the conduit and the pumping plant.

A.3.2.4 Refilling the Reservoir

Additional water will be pumped into the reservoir whenever precipitation and drainage are insufficient to keep the pond full and replace losses due to seepage, evaporation, compensation, and conservation flows. As stated earlier, pumping will be permitted only with river flows in excess of 85.4 m^3/s.

A.3.3 RECREATION AREA

The applicant proposes to construct a recreation area so that the recreational potential of the reservoir may be utilized. The proposed facilities include a 30- to 50-car parking lot, a launching ramp for non-combustion-engine boats, and a system of trails for hiking and nature study (ER-OL, Appendix H, Section 4.2.8). Hunting will be permitted in season in the buffer areas around the reservoir. The Pennsylvania Fish Commission will be asked to stock the reservoir for sport fishing; the new aquatic habitat will be suitable for warmwater fishing.

A.3.4 ESTHETICS

A.3.4.1 Construction

The appearance of approximately 146 ha of land will be altered by construction and operation of the Pond Hill Reservoir. One hundred twenty-eight hectares of forested land will be inundated. Impoundment structures will convert about 16 ha from natural cover to built-up structures.

A.3.4.2 Operation

Since most of the buffer area surrounding the site will not be altered during construction, no appreciable changes in the esthetic quality of these areas will occur. The primary change in esthetic values will be the conversion of forested lands to a lake. None of the facilities will be visible from the settlements of Lilly Lake and Pond Hill, or from the roads leading to these communities. Since topographic features will screen the dam from view, the pumphouse will be the only structure visible from State Route 239.

Reference

1. Tippetts-Abbett-McCarthy-Stratton/Engineers and Architects, "Design Report: Pond Hill Reservoir," prepared for Pennsylvania Power & Light Company, February 1979.

A.4. ENVIRONMENTAL EFFECTS OF CONSTRUCTION AND OPERATION

A.4.1 IMPACTS ON LAND USE

Approximately 525 ha of land will be converted from present uses to land dedicated to a water storage project. Pond Hill Creek and most of the valley it drains will be permanently altered. About 146 ha of the site will be permanently altered by construction and operation of the reservoir; about 128 ha of presently wooded lands will be inundated and another 16 ha covered by impoundment structures, such as the dam, spillway, and inlet-outlet structure. The access road-pipeline corridors will occupy an additional 2 ha. Most of the areas disturbed by construction activities (about 51 ha) will be reclaimed and landscaped following construction; there will be only minor changes in land use in the remaining undisturbed areas of the site.

Farming on a controlled basis will be permitted to continue within the buffer area of the site.

The impacts of reservoir construction and operation on the terrestrial environment are discussed in Section A.4.3.1, those on the aquatic environment are discussed in Section A.4.3.2.

A.4.2 IMPACTS ON WATER USE

Construction

All effluents generated during the concrete batch plant operation will be collected in a holding pond. After the solids have settled out, the supernatant will be either recycled or discharged via a pipeline to Pond Hill Creek. With this treatment, the staff believes that the waste effluent disposal will meet PDER requirements for disposal of such waste.

A.4.3 ENVIRONMENTAL IMPACTS

A.4.3.1 Terrestrial

Construction Impacts

Construction plans for the proposed project have not yet been completely finalized. As currently reported by the applicant, the principal areas to be directly affected by construction activities are indicated in Figures A.2.2, A.2.3, A.3.1, and A.3.2; however, the use of some designated impact areas is qualified as follows. The location of the construction staging area, as well as facilities within the staging area, will be dependent on needs and requirements of the applicant's construction contractor. Also, borrow areas 3 and 4, located within the proposed impoundment area (see Fig. A.3.1), will be the principal sources of fill materials used in dam construction (ER-OL, Supp. Response to NRC Q. 17, 28 September 1979). To the extent that suitable core materials available at borrow area 3 are insufficient to complete the dam embankment, the required materials will be removed from either or both borrow areas 1 and 2. Although the need for additional materials is "not anticipated," the applicant has also identified borrow area 5 as a possible offsite source of core materials (ER-OL, Supp., Response to NRC Q. 17, 28 September 1979). Thus a total of about 45 ha of local land outside the impoundment area (borrow areas 1, 2, and 5) may be disturbed to acquire materials for dam construction (ER-OL, Supp. Response to NRC Q. 5, 28 September 1979).

The most obvious and extensive of the adverse construction impacts on the terrestrial environment will result from the destruction or alteration of local vegetation. Most of the vegetation to be affected during construction consists of forest and woodland. Merchantable wood products will be salvaged to the extent practicable (ER-OL, Appendix H, Sec. 4.3.2.5); however, the growth and growth potential of trees that have not yet attained merchantable size represent a loss of forest resources. The most significant loss of forest vegetation will occur within the proposed impoundment area and within the dam embankment and spillway sites (see Figs. A.2.2 and A.3.2), about 144 ha of total land area (ER-OL, Supp. Response to NRC Q. 1, 28 September 1979). Virtually all of this area will be cleared of woody vegetation prior to or during construction (ER-OL, Appendix H, Section 4.2.5.2); nearly 140 ha of mixed deciduous and coniferous-deciduous forest will be destroyed. Several small tracts of forest vegetation inside the perimeter of the impoundment area will be left intact to provide habitat for fish (ER-OL, Appendix H, Section 4.2.2.2).

The level of use and activity within the onsite construction staging area will be relatively intense, severely affecting the local vegetation. As noted previously, the size and location of the staging area are not yet resolved. However, given the area as indicated in Figure A.3.1, about 8 ha of forest and 6 ha of hayland and old field vegetation will be destroyed or disturbed. Also, the extent to which upland borrow areas (areas 1, 2, and 5; Fig. A.3.1) will be disturbed to acquire fill materials for dam construction has not been established (ER-OL, Supp., Response to NRC Q. 17, 28 September 1979). Assuming total utilization of all designated borrow areas, about 22 ha of forest and woodland, and a similar area of herbaceous vegetation will be destroyed. Some additional vegetation, primarily forest, will be disturbed in the vicinity of small construction sites, including those identified in Figure A.3.2; namely, the saddle dike and cutoff structure adjacent to the proposed impoundment, the pumping-plant site, and the narrow corridor (18 m wide) cleared for construction of water pipelines and the primary access road (Alternative B). About 2 ha of vegetation will be cleared from the common right-of-way required for pipeline and access-road construction; lesser areas will be affected at the other small construction sites.

The intensity and pattern of soil disturbance resulting from construction will closely correspond to impacts on the local vegetation as discussed. Soils of the proposed impoundment and dam sites will be committed, either totally disrupted during construction or inundated following construction. Land within these areas is unsuitable for cultivation, with the exception of isolated small tracts of Capability Class IV soils (see Sec. A.2.5.1.4).

About 29 ha of Class II soils (including prime farmland) occur within the construction staging and upland borrow areas (see Fig. A.3.1); the remaining land includes small tracts of Class III and IV soils and more extensive soils unsuited for cultivation (ER-OL, Appendix H, Fig. 3-13). These soils will be variously disturbed during construction; however, soil impacts will be mitigated as follows. The applicant will require that the construction contractor schedule project activities so as to minimize erosion potential. Further, work areas will be stripped of topsoil that, in turn, will be stockpiled and stabilized by establishing a temporary vegetative cover (ER-OL, Appendix H, Section 4.3.2.1). Reclamation of disturbed areas will entail establishing the approximate original contours, replacing topsoil, and providing suitable landscaping.

The applicant will also require the contractor to develop and submit an erosion and sediment control plan for the project site; this plan will be subject to review by appropriate agencies, including the Pennsylvania Department of Environmental Resources (ER-OL, Appendix H, Section 4.3.2.1). The plan will include details concerning practices to be employed, design specifications of control structure(s), and maintenance schedules to ensure effective erosion control. Given that the relatively marginal soils within the impoundment and dam sites will be disrupted or otherwise committed, the staff considers the foregoing provisions and requirements to be adequate precautions for conserving soil resources, provided that such measures are properly implemented. In view of the generally steep gradient of the proposed access road (see Fig. A.3.2), the staff recommends that culverts and water-spreader structures be installed at appropriate intervals to control the volume and velocity of runoff from the paved access road as well as runoff intercepted by the roadbed.

The applicant's commitment to landscaping certain disturbed areas will variously offset the adverse construction impacts on the local vegetation. Additionally, the established vegetation will partially offset losses of wildlife habitat incurred during land-clearing and construction activities. However, development of the dam and impoundment sites will preclude reclamation, thus more than two thirds (144 ha) of the total affected wildlife habitat will be severely altered during construction and will be unavailable for use by terrestrial wildlife during reservoir operation.

The extent and types of wildlife habitats affected during construction are implicit in the preceding discussion of impacts on the vegetation. Accordingly, the principal types to be affected will be forest and woodland habitats. Wildlife species strongly dependent on resources of these habitats include locally important game species such as whitetail deer, black bear, eastern red and gray squirrels, wild turkey, ruffed grouse, and American woodcock. Most of the locally occurring mammals utilize forest habitats to varying degrees. For example, the habitat preferences of the eastern cottontail includes brushy areas typical of forest - old field ecotones. However, representative areas of all major habitat types occurring onsite will be affected during construction; thus populations of all mammals identified in Section A.2.5.1.2 will probably be deprived of habitat to some extent. Characteristic habitat types of nongame birds as well as reported habitats of locally observed reptiles and amphibians are also indicated in Section A.2.5.1.2.

The alteration of habitats will be accompanied by a general migration of animals from the affected areas. The displaced animals will cause increased competition for habitat resources and space in adjacent habitats; the effects of this increased competition will be local and generally of short duration since habitat types similar to those onsite occur extensively throughout the surrounding area. However, all animals will not escape the impacted areas. Some of the less mobile animals, as well as juveniles of other species, will be impinged, buried, or otherwise destroyed during land-clearing and earth-moving activities. Any remaining animals will be subject to increased predation due to the removal of vegetative cover and to destruction of underground refuges. Some additional mortality will occur as the result of collisions with project-related traffic.

Construction noise and activity will also affect animal populations in areas not affected by construction. The applicant will require that noise emissions from construction equipment be in compliance with federal guidelines (OSHA, EPA) (ER-OL, Appendix H, Section 4.3.2.4). The intensity of blasting vibrations will also be controlled to the extent that local structures will not be affected. However, some of the more wary species, such as the wild turkey, will probably vacate the site during the construction period.

As noted, disturbed construction areas (with the exception of the proposed impoundment and dam sites) will be reclaimed if feasible, thus mitigating project impacts on wildlife. The applicant has further committed to improving wildlife habitat of the project site (see Sec. A.4.4.1). Pending final establishment of site boundaries, the applicant, in consultation with the Pennsylvania Fish and Game Commissions, will prepare a management plan for the site (ER-OL, Supp., Response to NRC Q. 15, 28 September 1979). Given proper implementation of a sound habitat management program, the staff believes the adverse construction impacts on wildlife can be offset to a substantial extent. The proposed reservoir will provide management opportunities not currently available.

Other construction impacts on the terrestrial environment include dust emissions from work areas and disturbed surfaces; however, the applicant will require the contractor to implement suitable dust control measures (ER-OL, Appendix H, Section 4.3.2.4). Slash materials and other combustible construction wastes will be burned in accord with applicable federal, state, and local regulations (ER-OL, Appendix H, Section 4.3.2.5). The disposition of waste effluents generated during batch plant operation will be in compliance with requirements of the Pennsylvania Department of Environmental Resources (ER-OL, Supp., Response to NRC Q. 6, 28 September 1979). The staff believes that adherence to the foregoing precautions will limit the anticipated impacts to acceptable levels.

Operational Impacts

The most significant operational impacts will occur with the initial filling of the reservoir, i.e., conversion of terrestrial habitats to an aquatic environment. Any residual soils and vegetation within the impoundment area will be inundated. Resident animals will either perish or be forced to migrate as the water level within the reservoir rises. Mortality will occur as animals seek temporary refuge on isolated islands created during initial filling of the reservoir, and as these islands are subsequently inundated. The number and kinds of animals that escape will be influenced by the swimming ability of the various species. The number of affected individuals will be relatively low since most will have been destroyed or displaced during land-clearing and construction activities.

Terrestrial habitat adjacent to the perimeter of the filled reservoir will be subject to disturbance due to wave action. However, the applicant proposes that "suitable ground cover of the slopes in the vicinity of the water line will be provided at all areas where sloughing may be a problem" (ER-OL, Supp. Response to NRC Q. 14, 28 September 1979). Thus, the onsite terrestrial habitat available to wildlife will be decreased by about 127 ha due to filling and operation of the reservoir. This loss of terrestrial habitat will to some extent be offset by the creation of a similar area of aquatic environment that will be used by both terrestrial and aquatic organisms. The future use of the reservoir by wildlife cannot be readily quantified. However, given the applicant's commitment to undertake a wildlife habitat improvement program, the staff does not believe that project related impacts will cause an unacceptable diminution in the overall wildlife productivity of the Pond Hill site.

Other impacts on the terrestrial environment directly attributable to reservoir operation will be of minor consequence. For example, vegetation within the utility right-of-way extending from the pumping-plant site to the reservoir (about 1.2 km) will be controlled. The applicant indicates that only chemicals approved by EPA will be used to control vegetation (ER-OL, Supp. Response to NRC Q. 15, 28 September 1979). Other human activities associated with routine operation and maintenance will generally result in negligible impacts on vegetation, soils, and terrestrial wildlife resources of the site. Operational noise levels will be relatively low; power units used for periodic refilling of the reservoir will consist of electric motors.

The applicant plans to allow public use of the site for specific recreational activities (ER-OL, Appendix H, Section 4.2.2.3). Such use will, however, be controlled to prevent degradation of the site resources (ER-OL, Appendix H, Section 4.3.3).

A.4.3.2 Aquatic

A.4.3.2.1 Pump House and Intake Screens

Construction

As presently proposed, the construction of the pump house will have minimal, if any, impact on either the water quality or the biota of the Susquehanna River. The applicant is committed to construction practices that minimize erosion and control sedimentation. The staff concludes that there will be no aquatic impacts to the two unnamed creeks bordering the proposed pump house on the north and south (see Fig. A.2.4).

Installation of the slotted-pipe or wedge-wire screen type of intake (see Sec. A.3.1.5) will result in loss of habitat, increased turbidity, and siltation. The staff concludes that the loss of habitat will be insignificant and that increases in turbidity and siltation will be temporary.

Operation

Operation of either a slotted-pipe or wedge-wire screen type of intake is expected to have minimal impact on the aquatic community of the Susquehanna River. The applicant did not indicate what the slot width would be; however, slot widths as small as 0.25 mm are suggested as a means of screening fine debris and preventing the entrainment of ichthyoplankton.[1] Impingement is purportedly minimized by the absence of a confining screenwell, which may entrap fish, and by the flushing action of ambient currents flowing around the cylindrical screen. To minimize impingement mortalities and to enhance the escape potential of organisms in the zone of influence of the intake flow, the entrance-slot velocity for cylindrical wedge-wire screen designs is generally taken as 12.2 cm/s or less.[2] As the proposed maximum approach velocity for the Pond Hill intake is 11.6 cm/s, the staff concludes that approach velocities should pose no problems.

A.4.3.2.2 Inundation and Operational Impacts

The rocky, shallow, fast-flowing stretch of Pond Hill Creek to be inundated will become a soft-bottomed, deep, slow-moving body of water. As a result, the aquatic biota will change from a lotic to a lentic community.

The effects of the reservoir on the water quality of lower Pond Hill Creek can be projected by comparing the water quality of the Susquehanna River with that of Pond Hill Creek. A comparison of the respective maximum, minimum, and average water-quality parameters is shown on Table A.4.1. The comparison shows that although some amelioration will take place in the reservoir, the water quality of lower Pond Hill Creek will be substantially lowered by the reservoir discharge.

The algae community in Pond Hill Creek consists of periphytic algae and diatoms that become free-floating only when detached during high flow. After inundation, conditions in the reservoir will permit the establishment of phytoplankton and zooplankton populations that will become the principal source of primary production. The reservoir will represent a significant ecosystem change from the present stream habitat, which relies upon the input of organic matter from the surrounding area as the chief source of primary production.

Productivity levels in Pond Hill Reservoir will depend, to a large extent, on the amount of nutrients available for the growth of phytoplankton. The Susquehanna River, which will be the main source of inflowing water for the reservoir, contains high nutrient concentrations year round (ER-OL, Section 4.2.3.2.2). To prevent the development of algal blooms and to control eutrophication, EPA has recommended that total phosphates as phosphorous should not exceed 0.050 mg/L in any stream at the point where it enters any lake or reservoir, nor 0.025 mg/L within the lake or reservoir.[3] Data gathered from 1972 to 1976 indicate that nearly all monthly and annual means of total phosphate levels in the river near SSES considerably exceeded these criteria (ER-OL, Section 4.2.3.2.2). Consequently, based on the total phosphate levels that would be expected in the inflowing water, the potential that eutrophic conditions will occur in Pond Hill Reservoir is relatively high.

The potential for high productivity (i.e., eutrophic conditions) during the first few years of impoundment will be enhanced, since the recently inundated terrestrial vegetation and soils will provide an additional large source of nutrients (ER-OL, Section 4.2.3.2.2). A reservoir becomes less productive over a period of time due to a decline in the quantities of land-supplied

Table A.4.1. Comparisons of Water Quality of Susquehanna River and Pond Hill Creek

Parameter[a]	Pond Hill Creek Mean	Pond Hill Creek Max.	Pond Hill Creek Min.	Susquehanna River Mean	Susquehanna River Max.	Susquehanna River Min.
Temperature (°C)	8.2	16.0	0.0	14.4	25.0	3.0
Dissolved oxygen	11.7	13.9	8.0	11.2	14.9	3.35
BOD	2.0	8.0	<0.5	2.2	5.0	<0.1
COD	8.9	18.0	3.4	13.0	25.0	5.0
pH (units)	7.1	7.6	6.65	7.6	8.6	7.2
Alkalinity as $CaCO_3$	9.2	23.0	<1.0	42.6	66.0	19.0
Total hardness as $CaCO_3$	19.0	24.0	14.0	105.9	167.0	66.1
Total dissolved solids	56.2	133.0	<0.5	171.4	290.0	67.2
Total suspended solids	16.4	120.0	<0.5	17.4	36.6	9.1
Turbidity (JTU)	2.6	5.5	0.7	1.2	16.0	5.1
Specific conductance (μmhos)	51.0	68.0	45.0	222.0	330.0	160.0
Color (CPU)	8.0	22.0	1.0	45.0	80.0	7.0
Sulphate as S	11.4	16.8	6.0	88.0	180.0	28.0
Ortho phosphate as P	0.02	0.06	<0.01	0.05	0.10	<0.01
Total phosphate as P	0.07	0.47	<0.01	0.2	8.84	0.04
Nitrate as N	0.14	0.33	0.01	0.72	1.0	0.43
Chloride	2.7	11.1	0.4	12.4	18.4	6.2
Total copper	0.03	0.06	<0.02	<0.02	0.02	<0.02
Total iron	0.66	3.11	0.20	2.5	4.7	1.63
Total manganese	0.05	0.21	<0.02	0.48	0.9	0.19
Coliform total MPN/100 mL	609.0	>2400.0	43.0	2007.0	72400.0	43.0
Coliform fecal MPN/100 mL	52.0	240.0	<3	412.0	1100.0	3.0
Fecal streptococci MPN/100 mL	4.0	20.0	<1	34.0	85.0	<1

[a]Units mg/L unless stated otherwise.

nutrients and organic matter and the loss of nutrients to bottom sediments.[3,4,5] Reservoirs act as traps for the nutrients, which adhere to clay particles and settle to the bottom. Once removed, nutrients are less likely to reach surface waters because thermal stratification and chemical conditions in the sediment hinder resuspension or dissolution. During spring and fall circulation of water in the reservoir, some of the nutrients are recycled to the surface for use by phytoplankton. However, once phosphorus reaches the bottom sediments, very little of it usually returns to the epilimnion (ER-OL, Section 4.2.3.2.2). With increasing age, productivity levels in the reservoir will, to a large extent, depend upon nutrients introduced by inflowing waters and brought to the surface during overturns.

Whenever water must be pumped from the river to meet storage requirements, nutrients in high concentrations will enter Pond Hill Reservoir. Consequently, although nutrients may be somewhat depleted in the reservoir as time passes, an additional supply will be provided during refilling operations. Data on Table A.4.2 indicate that very little pumping will be required during most years.

In general, Pond Hill Reservoir appears to have a relatively high potential for initial eutrophication, followed by a gradual decline in productivity levels as nutrients are lost to bottom sediments. This cyclic pattern may be repeated following periods of pumping to fill the reservoir.

Elevated concentrations of iron will enter the reservoir from the Susquehanna River (ER-OL, Section 3.2.3.2.2). Mean monthly levels of iron in the river ranged from 2.2 to 7.3 mg/L from 1972 to 1976. Most of the iron entering the proposed reservoir will be oxidized, forming precipitates that will subsequently settle to the bottom. Some of this iron will appear in the water column during spring and fall circulation, and in the hypolimnion if it becomes anaerobic;

Table A.4.2. Summary of Reservoir Operation Based on Historical Flow Records of the Susquehanna River at Wilkes-Barre[a]

	Drawdown				Refill	
Year	Period	Number of days	Minimum Level[b] (ft.)	Acres Exposed	Period	Number of days
1905-1907	No Operation					
1908	Sept. 17-28	12	935.0	12	Jan. 6-14	10
1909-1910	No Operation					
1911	Aug. 17-19	3	939.0	3	Sept. 1-3	3
1912	No Operation					
1913	Sept. 12	1				
	Sept. 16-17	2				
	Sept. 20	1	938.5	4	Oct. 21-23	4
1914-1938	No Operation					
1939	Aug. 26-31	6	937.5	6		
	Sept. 1-7	7				
	Sept. 10-24	15	927.5	28	Oct. 29-Nov. 19	24
1940	No Operation					
1941	Sept. 26-30	5	938.0	5	Nov. 9-13	
	Oct. 1-9	9	934.0	14	Dec. 24-29	12
1942-1952	No Operation					
1953	Sept. 1	1	939.8	2		
	Oct. 3-5	3	938.5	4	Nov. 23-25	4
1954	No Operation					
1955	July 31	1	939.8			
	Aug. 1	1				
	Aug. 3-10	8	936.0	9	Aug. 14-21	9
1956-1958	No Operation					
1959	Sept. 24-30	7	937.0	8	Oct. 9-14	6
1960-1961	No Operation					
1962	Aug. 3-6	4	938.5	4		
	Aug. 25-27	3	937.0	8		
	Aug. 31	1	936.6	8		
	Sept. 1-15	15	930.0	23		
	Sept. 20-27	8	926.0	32	Oct. 1-24	26
1963	Oct. 12-18	7	937.0	8		
	Oct. 20-31	12	931.5	20		
	Nov. 1-6	6	928.5	26	Nov. 29-Dec. 17	21
1964	-Critical Drought-					
	Aug. 8-11	4	937.5	5		
	Aug. 15-18	4	936.3	8		
	Aug. 20-21	2	935.3	11		
	Aug. 28-29	2	933.0	15		
	Sept. 3-30	28	919.0	45		
	Oct. 1-31	31	900.0	83	Dec. 28, 1964-Jan. 18, 1965	
	Nov. 1-25	25	878.0	127	Feb. 7-Apr. 12	86
1965	July 30-31	2	939.5	2	Sept. 26-27	2
1966-1975	No Operation					

[a]Does not include operations for maintenance purposes. Source: ER-OL, Vol. IV.

[b]To convert feet to meters, multiply by 0.305.

but, with the exception of iron chelated with organic matter, most of it will be oxidized and returned to the sediments as insoluble compounds. Since the iron will probably remain oxidized in bottom sediments, the dissolved iron concentration in the water column will be less than the 1.0 and 1.5 mg/L recommended for the protection of aquatic life.

Iron (by combination and precipitation) does not appear to have reduced phosphate levels nor severely limited phytoplankton productivity near SSES. Because iron concentrations in the Pond Hill Reservoir will decrease, and the levels recorded in the river at present do not appear to have seriously reduced primary production, the effects of iron on productivity in the Pond Hill Reservoir is not expected to be great.

Impacts on water quality from other substances entering the reservoir from the river should be insignificant, since the remaining parameters have been found to meet criteria recommended by DER and EPA. Fecal coliform levels in the river usually exceed standards acceptable for bathing waters. However, fecal pathogenic bacteria will survive for only a few days in the reservoir.[4]

Since the reservoir will be eutrophic, large growths or blooms of diatoms, green algae, and blue-green algae may seasonally occur in some years. However, extensive algal blooms would not be anticipated every year, since there will be a net loss of nutrient salts to the bottom sediments. Macrophytes, such as cattails and pondweeds, should appear in the shallow, inshore waters, but the amount of growth of macrophytes and periphytic algae in Pond Hill Reservoir will be limited, since much of the shoreline will be steep-sided. Mosses and liverworts, which are abundant in Pond Hill Creek, will be eliminated following inundation, since they require hard, unsilted substrates and continuously flowing water for survival.[5] Other periphyton will generally be confined to the littoral or inshore areas of the new reservoir, since growing conditions in the flooded stream channel will no longer be suitable. Iron deposits may also inhibit macrophyte development.

Following reservoir-pool formation, a thin layer of silt will accumulate on the bottom, and a fairly uniform benthic habitat will result throughout the new reservoir. Consequently, since quiet and riffle water habitats and a variety of substrates will be eliminated or covered over by silt, the diversity of benthic macroinvertebrates in the proposed reservoir should be less than that observed in Pond Hill Creek. Species composition will also change significantly. The Pond Hill Creek macroinvertebrates, which require a running-water habitat (stoneflies, caddisflies, and most mayflies), will not survive in the impoundment; those capable of adjusting to quieter waters and/or preferring soft substrates (oligochaete worms, snails, dragonflies, and midge larvae) will become more abundant in the reservoir. However, benthic macroinvertebrates may be further limited by iron deposits on the bottom and/or low dissolved oxygen levels in the hypolimnion. Thus, only the more tolerant macroinvertebrate forms would be expected to inhabit the bottom of the lake. Midge larvae (Chironomidae) will probably dominate the reservoir benthos, since they survive at very low oxygen levels and were found to be abundant in sections of the Susquehanna River in which heavy iron deposits were observed.

Pond Hill Creek is very small and presently supports a limited fish population comprised chiefly of minnows. No endangered or rare fish species inhabit the stream, nor are there any permanent game fish populations present.

A number of factors will affect the type of fish community that will develop in the reservoir. The fish species presently found in Pond Hill Creek, which prefer and/or require running-water habitats, are not expected to occur in the proposed reservoir. These include blacknose dace and creek chubs. On the other hand, golden shiner and fathead minnows, along with bluegills, largemouth bass, and other species inhabiting the small ponds adjacent to the stream may become abundant in the new reservoir.

Low dissolved oxygen and chemically-reduced substances released from bottom sediments may create an unfavorable habitat in the hypolimnion during late summer for many fish species. However, oxygen levels in the epilimnion should remain sufficiently high to support warmwater fishes (ER-OL, Section 4.2.3.3.2).

Iron levels near the intake site have been consistently higher than the 1.0 and 1.5 mg/L criteria. However, a total of forty-two fish species have been found to inhabit this section of the river. Apparently the ambient iron concentrations in the river are not directly toxic to these species. Nor do growth or spawning success seem to have been adversely affected. Consequently, most of the fish species, including a number of game fish, inhabiting the Susquehanna River near the intake site would be relatively unaffected by the iron levels in the reservoir. Possible detrimental effects of iron on the fish in the reservoir should be further reduced by the fact that iron concentrations will be lower than those usually found in the river.

Periodic drawdowns should have no major detrimental effects on fish or other aquatic life in the reservoir. Drawdowns generally will be infrequent and will expose a relatively small amount of the lake bottom; an extensive drawdown of the reservoir would be anticipated only once in about 71 years. All drawdowns would be expected to occur during the late summer and fall months.

The staff also concludes that evaporation rates will have insignificant effects on spawning habitat. The applicant's anticipated evaporation rates are presented in Table A.4.3.

In general, the proposed reservoir would be a suitable habitat for many warmwater game fish; these could include pickerel, muskellunge, catfish, bluegill (and other sunfish), crappie, smallmouth bass, largemouth bass, yellow perch, and walleye, all of which presently occur in the Susquehanna River near the intake site. These fish will be introduced and maintained by a fishery management program (ER-OL, Section 4.2.3.3.2). A number of these species would probably establish permanent populations in the reservoir.

Table A.4.3. Anticipated Evaporation Rated on a Monthly Basis for the Pond Hill Reservoir[a]

Month	Evaporation (cm)	Month	Evaporation (cm)
January	0.0	July	1.9
February	0.0	August	1.7
March	0.0	September	1.2
April	1.3	October	0.8
May	1.7	November	0.6
June	1.8	December	0.0

[a]Source: Response to NRC Question 23, 12 October 1979.

A.4.3.2.3 Discharge System

Construction Impacts

Since the discharge system, as presently proposed, will be contained within the same structure as the intake (see Fig. A.3.3), impacts associated with construction of the discharge will be the same as those discussed for the intake system (see Sec. A.4.4.2.1.1).

Operational Impacts

The applicant indicates that the quality and temperature of water discharged from the reservoir into the downstream section of Pond Hill Creek and the Susquehanna River will be controlled by the multilevel inlet-outlet structure (ER-OL, Sec. 4.3.1). The outlet ports for compensation releases in the revised inlet-outlet structure (Fig. A.4.1) will be at the 291.4, 282.0, and 259.1 m levels. The applicant has performed new thermal modeling analyses for the reservoir, using the schedule of compensation releases that would be required for 1964 drought conditions and the two sets of meteorological data, 1964 and 1975 (PP&L Comment letter, 29 May 1980; Letter 17 of Appendix B). The results of these calculations are given in the above comment letter.

The staff has not verified the applicant's calculations but does agree with their conclusion that, under most conditions, the compensation releases will be from the epilimnion layer, minimizing the potential for cold shock in the Susquehanna River. However, in the unusual event that the water level in the reservoir is below that of Outlet No. 2 (282.0 m) (the minimum pool level is 264.4 m), compensation water would be pumped through the outlet at 259.1 m and would be hypolimnetic water. Thus, a potential for cold shock remains. However, the staff believes that the multi-slotted discharge will enhance dilution and thus mitigate the effect to some degree.

In addition to extreme temperature changes, nutrient concentrations in the discharge may be higher than presently expected, depending on from what portion of the hypolimnion the water is withdrawn. The deeper the water, the higher the concentrations. An exception would be during turnover, when the concentrations would be more uniformly distributed.

Iron levels in the discharge water may be high, especially if release coincides with overturns. In addition, since the reservoir may be eutrophic, large amounts of organic matter may appear in discharges. High iron and organic-matter concentrations in the discharges should have little impact on the Susquehanna River, since compensation releases will be infrequent and usually small in volume.

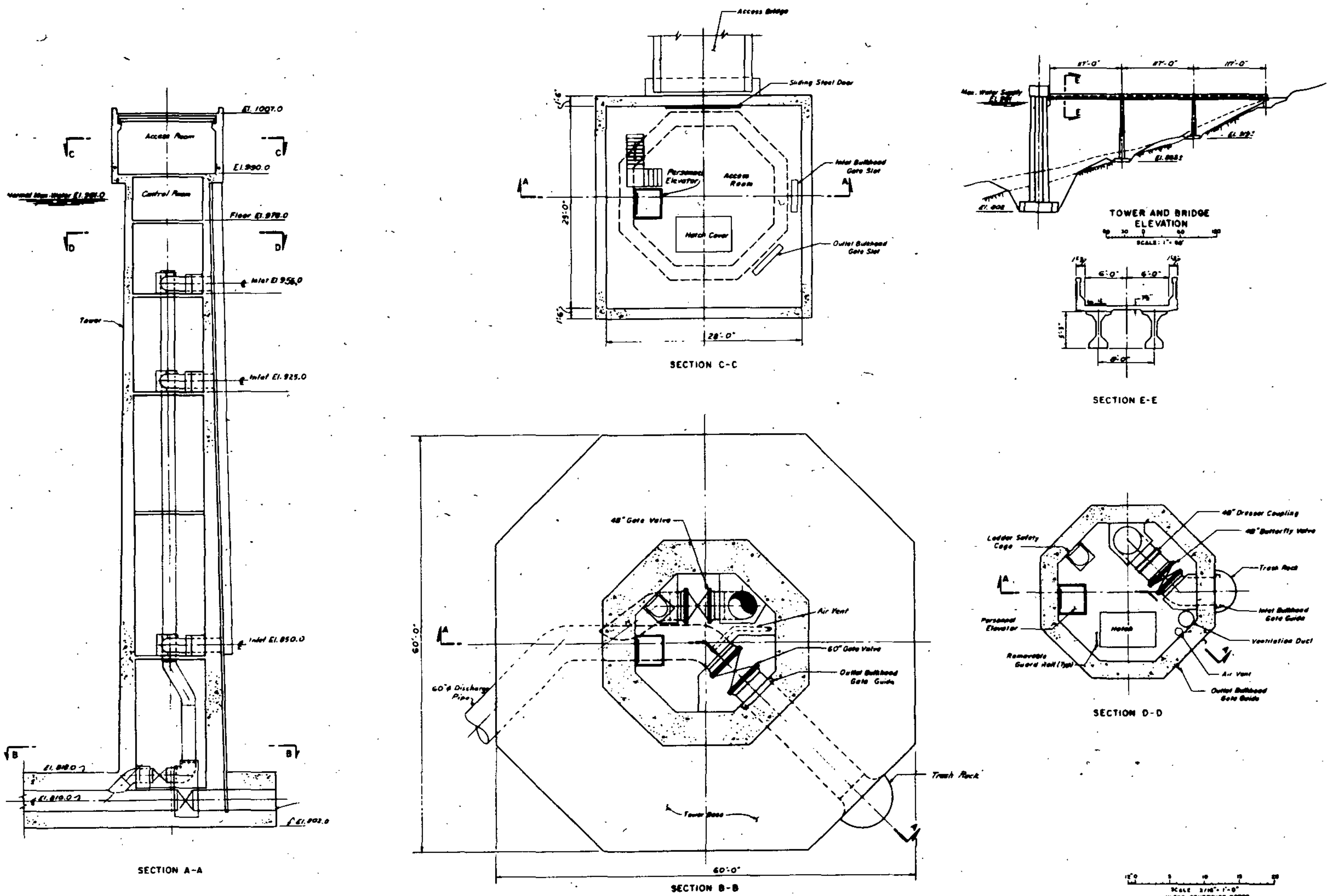


Fig. A.4.1. Inlet-Outlet Structure.

Dissolved oxygen concentrations vary inversely with reservoir depth. Anoxic conditions may exist in the deeper parts of the hypolimnion. Obviously the discharge of anoxic water to either Pond Hill Creek or the Susquehanna River would be adverse, with the effects being localized.

A conservation release of 5.7 L/s will be maintained for the remaining section of Pond Hill Creek below the dam. Most of the time, however, the downstream releases will exceed this rate due to natural runoff in the watershed. Although there should be a sufficient quantity of water to support the existing aquatic life in the stream, the quality of the downstream release water may be detrimental to some of the stream organisms. But iron levels in the release water may exceed the recommended criteria, particularly during reservoir overturns. This could result in the deposition or iron precipitates on the stream substrate, which in turn, could limit periphyton and macroinvertebrate communities to iron-tolerant species.

The average release velocity through the screens will be about 0.4 ft. per second (0.9 cm/s) (measured 1 foot from the screens) and the screens will be about 2 ft. (0.6 m) above the riverbed. Any scour that may result from compensation releases will be localized and temporary. The staff concludes that monitoring benthos in the vicinity of the discharge is not necessary.

A.4.3.3 Atmospheric

Converting 128 ha of mixed woodland/field vegetative cover to water will have minimal impact on the atmosphere. The thermal inertia of the stored water will moderate air temperatures slightly. In fall and early winter, light steam fog will occasionally form over the water and move a few tens of meters inland before evaporating. Since there is no heat load on the reservoir, the frequency and density of the steam fog will be similar to that of other small lakes in the area.

Equipment used in construction will comply with the criteria established by OSHA and EPA for noise and exhaust emissions. The applicant will require the contractor to employ dust control measures (ER-OL, Appendix H, pp. 4-87).

A.4.4 HYDROLOGIC IMPACTS

A.4.4.1 Construction

Stripping of vegetation from the area to be inundated and from other areas will increase the runoff coefficient, resulting in higher peak flows in Pond Hill Creek. However, since this effect will be temporary (the dam, when complete, will provide flood control for the remaining section of the stream) and since there are no residences that can be affected by the higher streamflows, the staff concludes that the impact will be minimal.

The major hydrologic impact of the construction of the dam will be to convert a natural stream, Pond Hill Creek, into a reservoir and a stream whose maximum and minimum flows will be controlled. The hydrologic aspects of the stream before construction are discussed in Section A.2.3.2. The upper portion of that stream will be replaced by a reservoir with a normal, or full-pool, elevation of 299 m MSL. This reservoir would cover 128 ha and contain approximately 30×10^6 m^3 of water. The maximum depth during normal pool operation would be about 67 m; the average depth would be 23.3 m.

The applicant used the Hydrologic Engineering Center (HEC) Water Quality Model to simulate the thermal behavior of the reservoir. The model results are sensitive to calibration constants that can only be determined by field measurements. For the Pond Hill thermal simulation, the vertical eddy diffusion coefficients were estimated by comparison with similar lakes and reservoirs. Although the analysis was performed for the smaller reservoir originally proposed by the applicant, the results are useful in that they provide a general description that should be representative of the proposed reservoir's thermal characteristics.

The HEC model predicted that the proposed reservoir would be thermally stratified during the summer with turnovers and mixing in early spring and late fall. A relatively stable thermocline was predicted to form in late April and remain throughout the rest of the spring, summer, and early fall (through October). The model predicted an epilimnion (upper layer) approximately 4.6 to 6.1 m thick with summer temperatures between 20° and 25°C. Temperatures in the hypolimnion (lower layer) were predicted to range from 5° to 10°C.

The proposed location of the pumping station is adjacent to the railroad in an area outside the 1% chance (100-year) floodplain as shown in Figure A.2.5. Pipelines connecting the pumping plant to the submerged intake and discharge will be buried in the floodplain. The applicant is committed to restore the land surface in the floodplain after completion of construction. The staff concludes that there is no practicable alternative to the construction of this section of pipeline in the floodplain and that the hydrologic impacts would be minimal.

A.4.4.2 Operation

A.4.4.2.1 Water Supply

The Pond Hill Reservoir was proposed to provide replacement for Susquehanna River water consumed by the Susquehanna Steam Electric Station during periods of low flow as defined in 18 CFR 803. The low-flow criterion is the seven-year, ten-day (Q7-10) low flow of the Susquehanna River plus the consumptive water use of the power plant. At Wilkes-Barre, the Q7-10 is estimated to be 22.7 m^3/s. Thus, the requirement for replacement of consumed water becomes effective whenever the river flow at Wilkes-Barre is below 22.7 m^3/s plus the plant's actual measured consumptive use. Average plant consumptive use is estimated to be 1.4 m^3/s, with the maximum estimated to be 1.8 m^3/s. Therefore, water replacement may be required when flow at Wilkes-Barre is below 24.5 m^3/s.

The reservoir was designed to be able to supply the required replacement water to the Susquehanna River during a recurrence of the drought of record, August to November 1964. The effects of precipitation onto and evaporation from the reservoir during the drought, although minor, were included. During this drought, flow at Wilkes-Barre was below 24.1 m^3/s on 106 days, including one period of 84 continuous days. There was only one additional day when the flow was below 24.5 m^3/s. If it were assumed that the maximum consumptive use occurred on that day, the conclusions would not change significantly. At normal full pool, the reservoir will contain approximately 29.7×10^6 m^3 of water with approximately 27.1×10^6 m^3 available for release. If released at an average rate of 1.4 m^3/s, the estimated average plant consumptive use, there will be enough water for more than 220 days without refilling the reservoir. The applicant has assumed a higher release rate of about 2.9 m^3/s. At this rate, the reservoir's available storage would be used up in about 106 days, the number of days for which replacement water would be required during a repeat of the drought of record.

At the assumed average release rate of 2.9 m^3/s, an average of 1.4 m^3/s would be needed for replacement of plant water consumption and 1.5 m^3/s would be available for other uses such as sales to other water users to supply compensation releases. During times of greater plant water consumption, the water available for other purposes would be reduced. At the maximum estimated plant consumption rate of 1.8 m^3/s, approximately 1.1 m^3/s would be available for other uses as described above.

The design rate at which the reservoir could be refilled with water from the Susquehanna River is 3.7 m^3/s. At this rate, it would take approximately 84 days to refill the reservoir. However, the applicant has stated that refilling will not occur at times when the flow in the Susquehanna River is below 85.0 m^3/s. Even with this restriction, it is almost certain that the reservoir would be refilled prior to the next low flow.

A.4.4.2.2 Pond Hill Creek

The operation of the Pond Hill Reservoir will change the character of the remaining portion of Pond Hill Creek, primarily during periods of high and low flow. Most of the time, with the reservoir full, surface flow into, or rainfall onto, the reservoir will be released through the spillway. This flow will be directed to the remaining lower portion of Pond Hill Creek. The replacement of approximately 39% of the upper drainage area of the stream with a reservoir will increase the flow at the spillway during moderate storms. However, during severe storms, the discharge will be limited by the cross-sectional area of the spillway. The excess inflow to the reservoir will be accommodated by a rise in water level.

The applicant analyzed the system response during a 1% chance flood (100-year recurrence flood). The analysis indicated that under natural conditions the peak stream discharge would be about 49.7 m^3/s. The calculated peak inflow (overland flow into and rainfall onto) to the reservoir was estimated to be about 60.8 m^3/s. However, the peak discharge through the spillway was calculated to be only 0.84 m^3/s. The reservoir, therefore, will serve to considerably attenuate the effects of the flood on the downstream portion of the stream.

Normally, with the reservoir at full-pool elevation of 299 m MSL, all inflow to the upper portion of the watershed will pass to the lower portion of the stream via the spillway. The applicant has stated, however, that a minimum flow of 5.7 L/s will be maintained. A section of pipeline, connected to the reservoir-to-pumping plant pipeline immediately downstream of the dam will be used for this purpose. The release point will be between the toe of the dam and the spillway discharge location. The choice of 5 L/s for the minimum flow is based upon the methodology used by DER to estimate the seven-day, ten-year low flow on ungauged streams. Since the natural streamflow probably ceases during drought periods, the proposed conservation release represents a change in the hydrology of the downstream portion of the stream.

A.4.4.2.3 Hydrologic Design of Dam

Since failure of the dam would not result in radioactive releases nor effect the reactor site, the staff did not perform a detailed evaluation of the dam's hydrologic design. The staff did, however, review the hydrologic criteria used and compared these with criteria used for (radiologically) safety-related dams.

The applicant's hydrologic design criteria is a flood series consisting of the 6-hr Probable Maximum Flood (PMF) followed, 48 hr later, by a lesser "Recurrent Flood." Staff's criteria require a PMF preceded by 40 percent of the PMF. In addition, the criteria result in a PMF more severe than that calculated by the applicant. However, the applicant's design flood series, while not as severe as the staff's, is an extremely severe flood event.

The applicant originally proposed a 3-m wide spillway with a crest elevation at 299 m MSL. The maximum reservoir level resulting from this design flood was calculated by the applicant as 300.19 m MSL, 1.18 m above the spillway crest and 1.56 m below the crest of the dam. The staff concluded, however, that its more severe design flood would result in overtopping of the dam. This was due primarily to the fact that the relatively narrow spillway was incapable of passing more than a small fraction of the postulated inflow to the reservoir.

The applicant has recently revised the proposed design of the spillway. The new design calls for the spillway to be 25.91 m wide with a crest elevation at 299.31 m MSL. The 0.30-m difference between the crest elevation and the normal full-pool reservoir elevation will provide additional flood storage.

The applicant routed its design flood through the reservoir with the revised spillway, assuming the initial water level to be at the spillway crest; i.e., no flood storage below the crest available. The maximum reservoir level calculated was 300.21 m MSL, 0.9 m above the spillway crest and 1.54 m below the dam crest.

The applicant also routed the staff's more severe design flood series through the reservoir. The calculated maximum reservoir level was 300.42 m MSL, 1.11 m above the spillway crest and 1.33 m below the crest of the dam.

The applicant's calculations indicate, therefore, that the dam can meet the hydrologic design criteria staff requires for (radiologically) safety-related dams.

A.4.4.2.4 Groundwater Effects

Filling of the reservoir will alter the groundwater conditions within the drainage area of the upper portion of Pond Hill Creek. The groundwater level should rise to at least the level of the reservoir at its perimeter. Since groundwater levels in the ridge north of the reservoir are clearly well above the reservoir level, there should be no effect on the groundwater regime north of the Pond Hill Creek drainage area. The limited information available on the groundwater conditions on the ridge south of the reservoir indicate that groundwater levels are also above the proposed water level in the reservoir. In addition, the applicant has proposed a saddle dam and an impervious cutoff section along the two lowest sections of that ridge. The staff, therefore, concludes that groundwater levels south of the ridge should not be affected by the reservoir.

A.4.5 SOCIOECONOMIC IMPACTS

The following is an assessment of the potential socioeconomic impacts of the construction and operation of the Pond Hill Reservoir on local communities in Luzerne County. Direct and indirect changes to the sociocultural systems of local communities are expected to be a result of the construction work force and related activities and of the presence of a lake in a previously wooded, rural area.

A.4.5.1 Demography

The peak construction work force will contain 125 individuals with 85% (106) of the workers expected to be commuters and 15% (19) in-migrating workers (Response to NRC Question 26). The applicant estimates that fewer than five of the expected in-migrants will bring their families; assuming two children per family, an additional ten school-aged children are expected as a result of this project (Response to NRC Q. 26).

Because of the short duration (two years) of construction and concurrent phasedown of construction at the Susquehanna Plant, the staff believes that induced service personnel will not result from the nineteen additional workers and their families moving into the local area. If these in-migrants are dispersed throughout the impact area, their additional service demands should be met by current staff and facilities.

A.4.5.2 Settlement Pattern

A.4.5.2.1 Housing

Specific information on the housing type and location preferred by the in-migrants is not available. The applicant states that workers at the Pond Hill site are expected to make arrangements for temporary housing--motels, boarding houses--and return home on weekends (Response to NRC Q. 26).

Available housing in communities close to the project area, such as Pond Hill, Mocanaqua, and Shickshinny, is virtually nonexistent. However, the applicant believes that some transient housing would be available in Wilkes-Barre or Nanticoke and additional housing is expected to become available in the Berwick-Bloomsburg area as the SSES work force is reduced.

However, factors such as local scenic qualities, recreational opportunities, gasoline prices, cost of living, etc., may attract more than the projected number of in-migrants. They and their families might choose to seek housing in the immediate area during some parts of the year rather than to commute from larger service centers. In such an event, housing competition may occur.

Operation of this project may also produce a secondary effect on local housing patterns because of the land-use changes brought about by the reservoir. Some residential development may take place in the areas surrounding the reservoir and buffer area. The applicant has provided estimates of the maximum and minimum number of residential development units that may be constructed, 35 and 140 units, respectively.[6] However, future development will depend on a combination of sociocultural factors, including the perceived attractiveness of the area, goals and values of the individuals wanting to build, local planning goals, availability of private land, and attitudes of local landowners.

A.4.5.2.2 Transportation

The construction and operation of the Pond Hill reservoir will impact local transportation systems. During construction, Route 239 and, to a lesser extent, LR 40120 will be affected by increased use for transport of construction-related equipment and materials and commuting workers.[6] In order to minimize traffic impacts in Pond Hill, the applicant will build a new access road to the reservoir site (Response to NRC Q. 8, part b). In addition, Route 239 will be affected by the construction of the pump station, when traffic will temporarily be reduced to one lane. The applicant has studied the cumulative effect of the Pond Hill and SSES projects and concludes that an additional police officer will be needed to facilitate traffic flow so as to avoid major transportation impacts.[6]

During operation, increased traffic volumes are anticipated on township roads because of the recreational facilities that will be available at the reservoir.[6] And, although the construction of a new access road to the site will lessen some of the impacts, the specific magnitude of these increases and their specific locations are not known at this time.

The applicant is committed to cooperation with the local townships to repair roads damaged due to reservoir construction activities.

A.4.5.2.3 Recreation

The applicant has summarized the outdoor recreational areas by owner and acreage for the general region and Conyngham Township (Reference 6, Tables 3.2.8-1 through 3.2.8-3). Forecasts of state recreational demands show a need for more facilities in almost all outdoor recreational activities. The staff believes that some of the projected recreational needs will be met by the Pond Hill Reservoir and associated facilities described in Section 3.3. The Pennsylvania Fish Commission will be asked to stock the lake for warmwater sport fishing. The recreational potential created by these facilities is estimated to be from 7,300 to 10,000 visitor-days per year, not including visitations related to hunting or winter sports.[6]

The applicant has defined five recreational development objectives in order to maintain the ecological characteristics and remote setting of the site and to minimize impacts of operation on the local communities while providing facilities that meet their perceived needs.[1] The staff notes that these objectives were considered in the designs for recreational use and project maintenance particularly to avoid greater use of the site than its intended design capacity.

A.4.5.3 Impacts to the Social System

The applicant states that short- and long-term impacts to the cohesion of local communities near the reservoir site are not expected (Reference 6, Sec. 4.2.4.7). The staff believes that direct impacts to social institutions or cohesion will not be severe because of the small work force and projected number of in-migrants and because the project area does not physically divide a community or separate communities. Potential effects on lifestyle; values; beliefs; and solidarity of local groups, neighborhoods, and communities would be due to indirect operational impacts of induced development. Such impacts could begin during construction. The potential for developmental impacts to the local settlement system were discussed in Section 4.6.2.1 of Reference 6.

A.4.5.4 Social Services

Because of the small work force, short duration of the project, and expectation of few in-migrants, impacts to most kinds of social services are not expected. However, impacts associated with increased traffic may require traffic-control personnel in some local areas.

A.4.5.5 Impacts to the Political System

Direct impacts to the political organization of local communities are not expected. Should indirect impacts occur, such as induced development, planning decisions, increased personnel, financing and zoning, consideration may be required.

A.4.5.6 Impacts to the Economic System

Although the economic impacts of the construction phase of the project will be small, they are expected to be beneficial to the region and to some local businesses. The applicant states that construction cost (50% in materials) will have a multiplier effect on the regional economy.[6] Moreover, many construction materials and equipment may be purchased within Luzerne County; additional spending may result as these industries increase their purchases from other industries and hire more labor.[6]

A.4.6 IMPACTS TO CULTURAL RESOURCES

Archeological investigations at the Pond Hill Reservoir site, limited to the area within the high water mark of the reservoir and a nearby section of the Susquehanna floodplain, disclosed negligible archeological materials.[7]

References

1. "Johnson Screens in Surface Water Intake Systems," Bulletin 1S577. Johnson Division of United Oil Products, Inc. St. Paul, MN, 1977.

2. J. B. Canon et al., "Fish Protection at Steam-Electric Power Plants: Alternative Screening Devices," Prepared for USNRC, Division of Site Safety and Environmental Analysis, under Interagency Agreement DOE 40-544-75 and the USEPA, Region II, Water Facilities, Branch-Energy & Thermal Wastes Section, Water Division, July 1979.

3. "Quality Criteria for Water," U.S. Environmental Protection Agency, Washington, D.C., 1976.

4. E. T. Chanlett, Environmental Protection, New York: McGraw-Hill, 1973.

5. H. B. N. Hynes, The Ecology of Running Water, Toronto: University of Toronto Press, 1972.

6. Tippetts-Abbett-McCarthy-Stratten/Engineers and Architects, "Design Report: Pond Hill Reservoir," prepared for Pennsylvania Power & Light Company, 1979.

7. Commonwealth Associates, "Archeological Investigations at the Susquehanna Steam Electric Station: the Pond Hill Reservoir Site," prepared for PP&L, 1981.

A.5. ALTERNATIVES, NEED FOR FACILITY, AND BENEFIT-COST ANALYSIS

A.5.1 ALTERNATIVES TO CONSTRUCTING A WATER STORAGE RESERVOIR

The applicant has given consideration to two alternative procedures that would not require the construction of an offstream water storage reservoir and would comply with the requirements of the Susquehanna River Basin Commission:

1. Not operate the Susquehanna Steam Electric Station whenever flow in the Susquehanna River fell below the consecutive seven-day low flow expected to occur every ten years (the Q7-10 value).

2. Purchase makeup water from existing reservoirs.

The applicant has submitted the following documents in support of analysis of alternatives:

1. Appendix H, Section 2 to the Environmental Report for SSES.

2. "Assessment of Sites for an Augmentation Reservoir for the Susquehanna Steam Electric Station," Tippetts-Abbett-McCarthy-Stratton, August 1977.

3. Letters from N. W. Curtis, PP&L, to D. E. Sells, NRC, 12 October and 13 November, 1979. Item 3 contains the applicant's response to staff questions on alternatives.

A.5.1.1 No Action Alternative--"River Following"

The applicant could meet SRBC requirements by choosing not to operate SSES during specific periods of low river flow. This mode of operation, called "river following," would require the generation of replacement electrical power from other units within the PP&L or PJM power system, or the purchase of power from other utilities.

Based on the critical flow value, 24.1 m^3/s, the river-following mode of operation would have required the shutdown of SSES for 106 days in 1964, the year of record low flow in the river.

The use of the river-following option would, in some years, require several additional shutdowns and startups of the SSES reactors, and also of the generating units providing the replacement electrical power. This cycling of units would add to maintenance costs and efforts and would probably decrease plant and system reliability.

A.5.1.2 Use of Existing Reservoirs

The applicant has examined the potential for purchasing the required volume of replacement water from an existing (or under-construction) reservoir, including those owned by the Pennsylvania Gas and Water Company (PGW), the U.S. Army Corps of Engineers (COE), and the Soil Conservation Service. Expansion of PGW's Nesbitt Reservoir to hold the required volume of water would entail the construction of a new 64-m high dam and a long refilling pipeline from either the Lackawanna or Susquehanna River. Estimated costs of expanding the Nesbitt Dam would be greater than that of constructing the Pond Hill Reservoir. The staff agrees with the applicant that, due to higher costs and potential for delays, the use of PGW's water storage facilities is not to be preferred over the Pond Hill Reservoir.

COE has two dams under construction in Tioga County, Pennsylvania. The applicant has sent to COE a request to purchase compensation water flow from the Cowanesque Reservoir, scheduled for completion in 1982 (ER-OL, Appendix H). COE has also indicated that congressional action may be required to make water storage an authorized use of the water in Cowanesque Lake (PP&L response to NRC questions). No firm cost values can be assigned to the use of COE-stored water.

A.5.1.3 Summary

The staff agrees with the applicant that the river-following alternative, while a viable one, is less desirable than the construction of Pond Hill Reservoir. The staff also agrees with the applicant that there is the potential for long delays in obtaining the required compensation releases from Cowanesque Lake, making the second option less desirable than the construction of Pond Hill Reservoir.

A.5.2 ALTERNATIVE SITES

The applicant has identified twelve potential alternate locations for the Pond Hill Reservoir (ER-OL, Appendix H, Section 2.4). This analysis is based on a usable water storage requirement of 11.7×10^6 m^3, the volume of water that would be required for a compensation flow of 1.42 m^3/s for 96 days.

The thirteen sites (selected and 12 alternates) were selected in part from a 1970 Susquehanna River Basin Study Coordinating Committee study. In 1977, an engineering consulting firm identified and investigated the technical, economic, and environmental characteristics of each site (Reference 1 and ER-OL, Appendix H, Section 4.2). TAMS's analysis of the 12 alternate sites was based primarily on reconnaissance-level information.

The applicant subjectively rated each site on the basis of eleven environmental engineering factors: number of residential units within the site; number of residential units below the proposed dam site; amount and type of agricultural activity affected; agricultural capability classification of soils within site; length of stream inundated; quality of the affected stream's fishery; water quality of the reservoir's water source (this would directly affect the reservoir's potential water quality); potential impact on pumping source (with particular emphasis on proportion of total flow to be pumped and on fishery quality); a qualitative judgment of the wildlife habitat within the site relative to the other sites studied; length and type of water conduit (i.e., pipeline or tunnel) and character of area that would be traversed by a pipeline; and area exposed by maximum drawdown (directly related to the size and shape of the reservoir).

Factors such as topography, hydrology, geology, and estimated cost of construction were also evolved. Construction impacts, except for the water conduit pipe and route, were considered to be similar for all sites. This analysis showed that the Pond Hill site would be the preferred site.

The staff has reviewed the applicant's site selection procedures and concludes that the methodology used by the applicant is satisfactory and that none of the alternate sites is environmentally obviously superior to Pond Hill Creek. The staff's judgment is based in part on visits to the Pond Hill area and to four alternate sites.

A.5.3 BENEFIT-COST ANALYSIS

A.5.3.1 No Action Alternative--"River Following"

Based on historical river flow, the river flow will be lower than the critical level on an average of 3.3 days per year (ER-OL, Appendix H, Section 1). Under the river-following alternative, the applicant would have to buy replacement energy to make up for the loss of generation due to the shutdown of SSES. The applicant estimated the average annual energy requirement for four days of shutdown (including that for start-up time) to be between 160,000 MWh and 170,000 MWh (response to NRC Q. 33, 12 October 1979). The energy range is due to the difference in length of start-up time associated with cold or hot reactor shutdown conditions. If an equal probability of hot or cold shutdown condition is assumed, the average annual energy requirement, as per the applicant's estimate, would be 165,000 MWh. Staff's estimate of energy loss during the four-day period, assuming 70% capacity factor, is 146,000 MWh. The applicant's and the staff's thirty-year present worth of the average annual replacement energy cost are 117.8 and 104.2 million dollars, respectively (Table A.5.1). In order to make a fairer comparison for benefit-cost purposes, it is important to subtract the cost of operating SSES from the replacement energy cost. It should be noted, however, that there are some advantages (such as improved systems reliability) of operating SSES over and above the difference between replacement energy costs and SSES operating cost.

The applicant's and staff's thirty-year estimate of present worth of the average annual replacement energy cost at the incremental price are 64.3 and 56.9 million dollars, respectively (Tables A.5.1 and A.5.2). The staff's estimate of present value of average annual replacement energy cost falls between $41 million for the best-case (average annual shutdown of three days) and $192 million for the worst-case (average annual shutdown of fourteen days). The probability of shutdown of less than or equal to 3 days and 14 days are 86.1 and 99.1%, respectively (Table A.5.3).

Table A.5.1. Thirty-year Present Worth of the Average Annual Replacement Energy Cost

	Applicant[a]	Staff	Pond Hill Reservoir Cost[b] w/o tax	Pond Hill Reservoir Cost[b] w/tax
Annual 4-day energy loss (MWh)	165,000	146,000	--	--
30-year present worth at incremental price (M$)[a]	64.3	56.9	48.7	62.3
30-year present worth at replacement price (MS)	117.8	104.2	49.5	63.1

[a]Response to NRC Question 33, 12 October 1979.

[b]Letter from L.E. Schroder, PP&L, to R. Prasad, ANL, 19 November 1979.

Table A.5.2. Staff Estimates of Replacement Energy Cost at the Incremental Price

Year	Replacement Price (mills/kWh)	Nuclear Gen. Price (mills/kWh)	Price Growth (%)	Incremental Price (mills/kWh)
1978	25	--	--	--
1980	35	13.0	--	--
1983	35	15.90	6.96	19.1
1985	40	18.20	6.9	21.8
1990	65	29.5	10.19	35.5
1995	100	45.5	8.99	54.6
1995-over	--	--	5.0	--

Table A.5.3. Shutdown Probabilities[a]

Days	% Probability of Generation Loss	Annual Average Day Loss	Present Worth ($ million) At Replacement Price	Present Worth ($ million) At Incremental Price
0	83.00	--	--	--
≤3	86.00	3	75.6	41.2
≤4	89.00	4	100.7	55.0
≤7	90.00	7	176.3	96.2
≤14	94.00	14	352.6	192.4
≤31	99.0	31	780.8	426.1
96	1.0	96	2418.1	1319.8

[a]Source: ER-OL, Vol. 4, pp. 1-4, Table 1.3.2-1.

A.5.3.2 Use of Existing Reservoirs

The applicant has explored the potential for using water supply storage in an existing storage facility to augment the river flow during the low riverflow period to keep SSES operating. Among the projects considered, the applicant, in consultation with COE, found the Cowanesque project to be the most suitable from the point of view of timeliness and availability of water supply storage. But in their recent response they have pointed out many uncertainties regarding the availability of water storage due to congressional approval requirements and the Susquehanna River Basin Commission's comment that Cowanesque Lake cannot presently be considered as a timely alternative for supplying makeup water for SSES (applicant's response to NRC Q. 39, 12 October 1979). The applicant estimates the approximate cost of this alternative to be $12 million over a 30-year period. The staff does not have sufficient information to substantiate the cost.

A.5.3.3 Pond Hill Reservoir

The third alternative considered was the building of a reservoir; this would assure a source of low-flow compensation. The applicant has proposed to build Pond Hill Reservoir for water supply storage. The overall cost of the project is estimated by the applicant as $47 million (in 1983 dollars). The applicant has assumed that the only cost associated with the Pond Hill Reservoir will be the electricity cost of pumping water into the reservoir. They estimate a yearly capacity cost of $40,300 and 2417 MWh (3357 kWh × 30 days × 24 hours of electricity) (personal communication, L. E. Schroder, PP&L, to R. Prasad, ANL, 19 November 1979). The present values of this alternative, over 30 years, are $48.7 and $49.5 million, including incremental and replacement price of electricity. On a purely economic benefit-cost analysis, which treats the tax cost as the transfer payment, these would be the costs of the project. If the property tax (in Pennsylvania the public utility realty tax is 3% of value) were treated as an added project cost, the staff's estimate of $63 million present value of the project would be very close to the replacement energy cost under the river-following alternative. One can also look at the property tax of $1.41 million as a compensation (benefit) for the environmental cost (undetermined) to the community.

A.5.3.4 Discussion and Conclusions

The cost of the river-following alternative is very dependent upon the probability of the occurrence of period length (number of days) of low river flow. From the analysis, it appears that, if low river flow were to occur at an annual average of four days, the cost of the Pond Hill Reservoir alternative would be very close to the replacement cost of electricity under the river-following alternative. But, if the annual average period of low river flow were 25 days (4% probability), the energy replacement cost could be as high as $344 million.

The best economic alternative would appear to be the use-an-existing-reservoir alternative. Based on the information available, Cowanesque appears to be the most economic among all alternative reservoirs, given that concerned authorities grant the use of water for flow compensation.

The river-following alternative took into account only the cost of replacement energy; it did not consider the effect of SSES shutdown on system reliability. The effect of shutdown on reserve margin is shown in Table A.5.4. PP&L's projected reserve margin without Susquehanna after year 1985 is significantly lower than its historical margin since 1973. PJM's reserve margin without SSES is projected to be approximately 25%, which is acceptable for the reliable operation of the interchange. PP&L, being a winter-peaking system, is able to operate with a reserve margin of 5%. PP&L could provide reliable service to its customers even during a short interval of shutdown of SSES.

A.5.4 EVALUATION OF UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION

A.5.4.1 Land

The 525-ha site will be removed from current uses and dedicated to reservoir uses for the life of the project.

The development of the Pond Hill dam and impoundment sites will result in a long-term commitment of about 146 ha of land area. About 16 ha of this area will be altered during construction of the dam embankment, the spillway, and the overflow channel; 128 ha will be inundated following construction. About 2 ha will be used for the development of ancillary impoundment structures, water pipelines, pumping plant, service facilities, and highway access. Virtually all of the areas to be committed are presently forested land.

Table A.5.4. Effect of Shutdown on Reserve Margin[a]

Projected	PJM/PP&L Reserve Margin 1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
With Susquehanna										
PJM	34	33	34	30	30	31	30	31	29	27
PP&L	29	44	58	53	48	46	42	35	33	30
Without Susquehanna										
PJM	37	30	29	25	25	27	26	27	25	23
PP&L	29	26	23	18	15	13	10	4	2	1
Historical	**1970**	**1971**	**1972**	**1973**	**1974**	**1975**	**1976**	**1977**	**1978**	**1979**
PJM	13	21	22	16	28	39	42	38	40	35
PP&L	1	6	14	34	30	39	27	48	39	35

[a]*Response to NRC Question 35, 12 October 1979.*

Other principal land areas that will be disrupted or otherwise adversely affected during project construction include a construction staging site and upland tracts excavated to acquire core material for dam construction. An estimated 14 ha of land will be used for construction staging. The areas affected by borrowing activities will be dependent on the amount of core materials available at the various sites; a total of about 45 ha of upland terrain has been designated as primary and reserve source areas for borrow materials. There will be less land available for hunting and hiking.

A.5.4.2 Water

A 128-ha lake will be created in an area now forested. About 2.3 km of Pond Hill Creek will be destroyed and inundated. The lower 1.3-km stretch of Pond Hill Creek will be converted from a free-flowing stream to a regulated one with a minimum flow of 5.7 L/s. Water quality in the lower reaches will be degraded during construction (erosion) and operation of the reservoir.

A.5.4.3 Air

Once the reservoir has been completed, there will be a very minor increase in the frequency of steam fog in the area. Air quality in the construction areas will be decreased during the construction period due to fugitive dust and emissions from construction equipment.

A.5.4.4 Terrestrial Ecology

Construction

Assuming total utilization of all designated borrow areas, about 195 ha of vegetation and, therefore, wildlife habitat will be destroyed or disturbed during land-clearing and construction activities. More than 80% of the vegetation to be affected consists of forest communities. Site reclamation will entail landscaping about 25% of the denuded area, partially mitigating losses of vegetation and wildlife habitat. Some individuals of the less mobile wildlife species will be destroyed during construction; other species will vacate the disturbed areas. The displaced animals will cause increased competition for habitat resources in adjacent areas; however, the consequences will probably be minor in nature and of short duration since habitat conditions similar to those onsite occur extensively in the surrounding area.

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Operational

The principal impacts resulting from project operation will occur with the initial filling of the reservoir. Residual vegetation will be inundated. Some additional wildlife will perish by drowning or be displaced from the impoundment site. The end effect of reservoir filling will be the conversion of about 128 ha of terrestrial habitat into an aquatic environment.

A.5.4.5 Aquatic Ecology

About 2.3 km of aquatic habitat along Pond Hill Creek, a healthy, unpolluted, natural stream, will be converted from that of a free-flowing small stream to that of a stagnant reservoir. The reservoir will support a much larger fish population than the area presently supports. There will be some loss of fish and other aquatic life in the Susquehanna River due to impingement and entrainment during periods when water is pumped into the reservoir; these losses are expected to be minimal.

Reference

1. Tippetts-Abbett-McCarthy-Stratton/Engineers and Architests, "Design Report: Pond Hill Reservoir," prepared for Pennsylvania Power & Light Company, February 1979.

APPENDIX 1

Letter from U.S. Fish and Wildlife Service re federally proposed endangered and threatened species in Pennsylvania

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
One Gateway Center, Suite 700
NEWTON CORNER, MASSACHUSETTS 02158

IN REPLY REFER TO:

William H. Regan, Jr., Chief
U.S. Nuclear Regulatory Commission
Environmental Projects Branch 2
Division of Site Safety and Environmental Analysis
Washington, D.C. 20555

Dear Mr. Regan:

This responds to your May 23, 1979, request for information on the presence of Federally listed or proposed endangered or threatened species within the impact area of the proposed 230 acre reservoir to be operated in conjunction with the Susquehanna Steam Electric Station near Berwick, Pennsylvania.

Except for occasional transient individuals, no Federally listed or proposed species under our jurisdiction are known to exist in the project impact area. Therefore, no Biological Assessment or further Section 7 consultation is required with the Fish and Wildlife Service (FWS). Should project plans change, or if additional information on listed or proposed species becomes available, this determination may be reconsidered.

This response relates only to endangered species under our jurisdiction. It does not address any other FWS concern or concerns of the National Marine Fisheries Service (NMFS). As the shortnose sturgeon (Acipenser brevirostrum) is under NMFS jurisdiction and may inhabit the project impact area, contact should be made with Mr. Robert Lippson, National Marine Fisheries Service, Oxford Laboratory, Railroad Avenue, Oxford, Maryland 21654, Telephone No. (301) 226-5771.

Lists of Federally listed and proposed endangered and threatened species in Pennsylvania are enclosed for your information. Thank you for your interest in endangered species. Please contact us if we can be of further assistance.

Sincerely yours,

Howard N. Larsen
Regional Director

C002 ES 1/1

Enclosure

FEDERALLY PROPOSED ENDANGERED AND THREATENED SPECIES IN PENNSYLVANIA

Common Name	Scientific Name	Proposed Status	Distribution
Fishes:			
None			
Reptiles:			
None			
Birds:			
None			
Mammals:			
None			
Mollusks:			
None			
Plants:			
Waterweed, Schweinitz's	Elodea schweinitzii	E	Northampton (Bethlehem Area) County
Bullrush (Unnamed)	Scirpus ancistrochaetus	E	Lackawanna, Lehigh, Clinton, Blair Counties
Pogonia, small whorled	Isotria medeoloides	E	Green, Centre, Monroe, Montgomery, Philadelphia, Berks Chester Counties
Mouse-ear Chickweed, (Unnamed)	Cerastium arvense var. villosissimum	E	Chester, Lancaster Counties
Globeflower, Spreading	Trollius laxus	E	Centre, Erie, Bucks Lawrence, Monroe, Northampton, Lehigh Counties

ENDANGERED AND THREATENED SPECIES
IN PENNSYLVANIA

Common Name	Scientific Name	Status	Distribution
FISHES:			
Cisco longjaw	Coregonus alpenae	E	Lake Erie - probably extinct
Pike, blue	Stizostedion vitreum glaucum	E	Deep water of Lake Erie probably extinct
Sturgeon, shortnose*	Acipenser brevirostrum	E	Delaware River and other Atlantic coastal river
REPTILES:			
None			
BIRDS:			
Eagle, bald	Haliaeetus leucocephalus	E	Entire state
Falcon, American peregrine	Falco peregrinus anatum	E	Entire state - re-establishment to former breeding range in progress
Falcon, Arctic peregrine	Falco peregrinus tundrius	E	Entire state migratory - no nesting
MAMMALS:			
Bat, Indiana	Myotis sodalis	E	Entire state
Cougar, eastern	Felis concolor cougar	E	Entire state - probably extinct
MOLLUSKS:			
None			
PLANTS:			
None			

*Principal responsibility for this species is vested with the National Marine Fisheries Service.

APPENDIX 2

ARCHEOLOGICAL SURVEY PLAN FOR THE POND HILL RESERVOIR SITE

Prepared for

PENNSYLVANIA POWER & LIGHT

by

Curtis E. Larsen, Archeologist,
Commonwealth Associates, Inc.
Jackson, Michigan

31 October 1979

INTRODUCTION

The Pond Hill Reservoir Site is a project allied to the construction of the Susquehanna Steam Electric Station near Berwick, Pennsylvania. The purpose of the reservoir is to compensate for water which will be withdrawn from the Susquehanna River by the cooling process for the power plant. Because of differential cooling rates, approximately two-thirds of the water will be lost by evaporation. PP&L is required to augment water lost by the Susquehanna River, especially during low flow periods. The proposed reservoir will meet these requirements by storing river water in the reservoir which can be released to the river during periods of low flow.

The reservoir will be located on a small tributary stream on the east bank of the Susquehanna. This stream is locally referred to as Catfish Creek, but is unnamed on the Nanticoke 7.5 minute USGS quadrangle. The site is approximately seven miles northeast of the Borough of Berwick and one mile south of the village of Mocanaqua. The valley of Catfish Creek is oriented east-west. The reservoir will be created by constructing a dam across the mouth of the valley about one mile upstream from the confluence of Catfish Creek with the Susquehanna. The valley is undeveloped and in places is heavily wooded. The entire area to be included within the reservoir is approximately 150 acres, however the entire area to be affected by the PP&L project is 1300 acres. This total includes both of the valley sides and the upland surfaces of the adjacent ridges. In addition to the reservoir, some of these adjacent areas will provide borrow material for various construction activities others will be used as staging areas for heavy equipment. Because much of the entire 1300 acres will be disturbed in some way, it will be necessary to take an inventory of any historic or archeological resources which may be impacted by the proposed construction. Such assessments are to be made pursuant to 36CFR800, Section 106 of the National Historic Preservation Act of 1966 as amended (16USC470), by Executive Order 11593, May 13, 1971 "Protection and Enhancement of the Cultural Environment," and by the President's Memorandum on Environmental Quality and Water Resources Management, July 12, 1978. This legislation outlines Federal Agency responsibilities with regard to National Register elibible properties and provides for the protection and enhancement of such properties.

To meet these directives, it is necessary to inventory the cultural resources of the project area prior to construction activities. This will require an adequate literature search to determine past historic uses of the area as well as to ascertain the presence of previously recorded archeological sites within the project boundaries. In addition, an on ground survey must be conducted to insure that archeological resources are not endangered by the proposed project. To satisfy these requirements, a plan for survey and literature search must be devised which satisfies the licensing requirements of the Nuclear Regulatory Commission with the participation of the State Historic Preservation Officer acting through the Pennsylvania Archeological Commission. The following plan is submitted to assist PP&L with these requirements.

<u>Cultural Resource Inventory Plan</u>

The cultural resource inventory of the Pond Hill Reservoir Site will consist of two concurrent investigations. The first of these will involve a literature and archival search to determine whether previous historic or prehistoric sites have been recorded for the project area. This will involve a canvass of the records of the State Historic Preservation Officer as well as a visit to the Luzerne County Courthouse in Wilkes-Barre. Should this research identify any previously recorded sites, each of these will be relocated in the field for future testing, if necessary. In addition to records' searches or published references, our staff will investigate the oral histories of the project area through interviews in the communities of Pond Hill, Mocanaqua, and Wapwallopen.

On the ground archeological survey will consist of a thorough canvass of the project area. At the present time, at least seventy-five percent of the valley of Catfish Creek is wooded. Areas of exposed soils are only present along cleared roads installed during test boring operations. Only a few cultivated fields exist within the area. These are located on upland surfaces near the village of Pond Hill. These too are overgrown. Because of difficulties in surface visibility, it will be necessary to shovel test the entire area to verify the presence or absence of archeological evidence. Our survey program will combine the necessary shovel testing with surface examination where possible, along a series of walked transects across the project area.

The site will be canvassed by walking compass-oriented transects at 30 m intervals across the site. At 30 m intervals, along the transect, a shovel test pit will be excavated to examine the soil beneath the surface debris or vegetation. Each pit will be no larger than 25 cm x 25 cm nor deeper than 25 cm. The soils removed from each pit will be carefully disaggregated and examined for artifacts. Should any indication of an archeological site be encountered, the area will be flagged with survey tape and labeled in a coding system which will allow a site to be identified only by persons with direct responsibilities for archeological resources. This will prevent unauthorized persons from damaging sites. Any sites discovered will then be located on existing base maps. These will supply the client with the necessary site information to plan for the protection or mitigation of cultural resources that may be threatened by the project construction.

The potential incidence of rock-shelters is a major concern for archeological investigation along the Susquehanna River. More specifically, these are overhanging rock ledges which may have offered shelter to past human groups. At the Pond Hill Site, the northern valley slopes display the bedrock configuration for rock-shelter formation. Because of this potential for rock-shelters, the northern valley slopes must be given special attention. The best method for approaching this problem is to locate the outcrop patterns of the pertinent resistant sandstone beds along the valley sides. Then, linear traverses will be made along the base of any such outcrops. Should characteristic overhanging ledges be found, shovel test pits will be excavated below them to check for archeological evidence. Once again, if evidence is found, each site will be flagged and located on base maps.

Analysis and Report

Following field survey and literature search, any archeological collections will be analyzed and described. The results of our survey will then be presented in a written report setting forth our research strategy, methodology and the results of our fieldwork. Should archeological sites be encountered during this survey, recommendations will be made regarding the testing of these sites to ascertain their eligibility for inclusion on the National Register of Historic Places. These recommendations will consist of a Phase II testing program with man-hour estimates for investigating the pertinent sites by hand excavation.

A draft report for the on-ground survey work presented here, will be submitted to PP&L in the spring of 1980. Following client comments, if any, Commonwealth will prepare a final report in the required number of copies for agency review and PP&L record purposes.

APPENDIX B. COMMENTS ON THE DRAFT ENVRIONMENTAL STATEMENTS (June 1979 and March 1980)*

* Comments on Supplement No. 2 to the Draft Environmental Statement published in March 1981 are contained in Section 6.1.6 of this Final Environmental Statement.

COMMENTS ON THE DRAFT ENVIRONMENTAL STATEMENT

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
(21) 596-1672

1950
August 14, 1979

Mr. William H. Regan, Jr.
Environmental Projects Branch 2
Division of Site Safety and
Environmental Analysis
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Refer to: Docket No. 50-387, 50-388
Draft Environmental Statement
Operation of Susquehanna Steam
Electric Station, PA

Dear Mr. Regan:

Our Milwaukee Office has forwarded this Statement to us for review and comment, as National Forest lands are not involved.

The proposed use of 2,4,5-T as a weed control agent in rights-of-way is illegal following the emergency order by EPA suspending use of 2,4,5-T on forests rights-of-way, and pastures (Federal Register Vol. 44, page 15874, March 15, 1979). We believe a discussion of alternative weed-control methods should be included in the Final Statement. Formulations of ammonium sulfamate, dicamba or bromacil could be considered.

Discussion of the coal and uranium fuel cycles should include the indirect effect of mining on the landscape. This effect is becoming more severe as the more productive sites are exhausted and more digging is needed for every ton of fuel.

Thank you for the opportunity to review and comment on this Statement.

Sincerely,

DALE O. VANDENBURG
Staff Director
Environmental Quality Evaluation

C002 ES10

7908210409

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Box 985 Federal Square Station, Harrisburg, Pennsylvania 17108

August 20, 1979

U. S. Nuclear Regulatory Commission
Wasington, D. C. 20555
Attention: Director
Division of Site Safety
and Environmental Analysis

Gentlemen:

This is to comment on the Draft EIS for the Susquehanna Steam Electric Station, Units 1 and 2, Pennsylvania. The document has been reviewed for items within the expertise of the Soil Conservation Service. We feel that two items should be added to the statement.

1. Sediment and erosion control for the land disturbed at the plant site and transmission line location should be discussed in regard to the regulations implementing Section 102 of the Pennsylvania Clean Streams Act and the Pennsylvania Department of Environmental Resources requirements.

2. The project's impacts on prime agricultural lands and farmlands of statewide importance should be displayed.

All other items of concern to the Soil Conservation Service have been adequately addressed.

Graham T. Munkittrick
State Conservationist

cc:
R. M. Davis, Administrator, SCS, Washington, DC
Cletus J. Gillman, Director, NTSC, SCS, Broomall, PA
Director, Office of Federal Activities, U.S. EPA, Room 537 West Tower, Waterside Mall, 401 W Street SW, Washington, DC 20460 (5 copies)

C002 ES10

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8005200437

UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Productivity, Technology, and Innovation
Washington, D.C. 20230
(202) 377-4335

P

May 13, 1980

Mr. Donald E. Sells
Acting Branch Chief
Environmental Projects Branch 2
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Sells:

This is in reference to your draft environmental impact statement entitled, "Susquehanna Steam Electric Station, Units 1 and 2, Pennsylvania Power and Light Company, Allegheny Electric Cooperative, Inc." The enclosed comment from the National Oceanic and Atmospheric Administration is forwarded for your consideration.

Thank you for giving us an opportunity to provide this comment, which we hope will be of assistance to you. We would appreciate receiving ten copies of the final statement.

Sincerely,

Bruce R. Barrett

Bruce R. Barrett
Acting Director, Office
of Environmental Affairs

Enclosure Memo from: Robert B. Rollins
National Ocean Survey
NOAA

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SURVEY
Rockville, Md. 20852

APR [illegible] 1980

OA/C52x6:JLR

Rec'd PP/EC
30 APR 1980

TO: PP/EC - Joyce M. Wood

FROM: OA/C5 - Robert B. Rollins

SUBJECT: DEIS #8004.01 - Susquehanna Steam Electric Station Units 1 and 2 (Supplement)

The subject statement has been reviewed within the areas of the National Ocean Survey's (NOS) responsibility and expertise, and in terms of the impact of the proposed action on NOS activities and projects.

Geodetic control survey monuments may be located in the proposed project area. If there is any planned activity which will disturb or destroy these monuments, NOS requires not less than 90 days' notification in advance of such activity in order to plan for their relocation. NOS recommends that funding for this project includes the cost of any relocation required for NOS monuments.

MEMORANDUM

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
FOOD AND DRUG ADMINISTRATION

TO : Director
Division of Site Safety and Environmental Analysis
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

DATE: May 20, 1980

FROM : Consultant (HFX-4)
Bureau of Radiological Health

SUBJECT: Draft Supplement to Draft Environmental Statement, NUREG-0564, March 1980

The Draft Supplement to the Draft Environmental Statement, NUREG-0564, March 1980 has been reviewed by the Bureau of Radiological Health, Food and Drug Administration. We previously commented on March 9, 1973 (copy attached) on the radiological health and safety aspects of the Draft Environmental Impact Statement (DEIS) related to the operations - Susquehanna Steam Electric Station, Units 1 and 2. This draft supplement to the DEIS is limited to a description of the environmental impacts of construction and operation of a water storage reservoir in the Pond Hill Creek drainage basin. We have no applicable comments.

Thank you for the opportunity of reviewing this draft statement.

Charles L. Weaver

Enclosure

cc:
Dr. K. Taylor (HFV-2)

REGION III
Curtis Building
6th. and Walnut Streets
Philadelphia, Pennsylvania 19106

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
PHILADELPHIA AREA OFFICE
CURTIS BUILDING, 625 WALNUT STREET
PHILADELPHIA, PENNSYLVANIA 19106

July 31, 1979

IN REPLY REFER TO:
3.2SS

Mr. Paul Leech
Environmental Project Manager
Environmental Project Branch 2
Division of Site Safety and
Environmental Analysis
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Leech:

Subject: Draft Environmental Impact Statement
Susquehanna Steam Electric Station, Units 1 and 2

We have completed our evaluation of the subject Draft Environmental Impact Statement, dated June 1979, and have no substantive comments to offer relative to the subject proposal. Further, and to the best of our knowledge, the proposed project does not directly affect any projects sponsored by this Department.

Sincerely,

James R. Treadwell
Environmental Clearance Officer

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

79/632

SEP 10 1979

Mr. William H. Regan, Jr.
Chief, Environmental Projects
Branch 2
Division of Site Safety and
Environmental Analysis
Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Regan:

The draft environmental statement for Susquehanna Steam Electric Station (SSES) Units 1 and 2 has been reviewed by this Department and we have the following comments. The comments are organized by page number in the document.

Page 2-28 and Page 4-33

We are concerned that the draft statement does not adequately address archeological and historic concerns. There appears to be a need for further investigation of significant properties in the area and identification of their relationship to the project. This applies to properties already on the National Register and any potential properties in the area but not yet evaluated.

On page 4-33, the draft states that "given the present inadequacies regarding cultural resource inventory and data, the staff cannot make a determination to the effect that the plant's operation will have no adverse effects on cultural resources that may be eligible for inclusion in the National Register. However, it is unlikely that the plant's operation will affect resources that are currently listed in the National Register (located in excess of 16 km from the plant property) . . ." The draft is unclear regarding the impact the plant and transmission corridors will have on properties close to the project site. Of particular concern are McClintock Hall, the Denison House, and Catlin Hall.

We urge the NRC to undertake a complete archeological and historic survey of the area in accordance with the requirements of 36 CFR 800 and Executive Order 11593. Names of persons qualified to undertake this survey may be obtained by contacting the State

Historic Preservation Officer (SHPO) for Pennsylvania, Edward Weintraub, Executive Director, Historical Museum Commission, P.O. Box 1026, Harrisburg, PA 17120. Results of the survey should be included in the final document. Also in consultation with the SHPO the NRC should determine if any of those properties identified in the survey are eligible for listing in the National Register. If they are determined to be eligible, the procedures and process of 36 CFR 800.4 and 5 must be followed to completion.

Page 3-8

Sulfuric acid will be used to control scale formation. As noted in the statement the system will be operated at a positive saturation index to minimize the addition of acid. Without this control on acid usage, the discharge could carry over four times the sulfate concentration of the receiving waters. This could aggravate an already stressed situation since the Susquehanna exhibits high and variable sulfate concentrations.

In the same manner that alternative levels of acid addition have been discussed, we suggest that alternate methods of scale and corrosion control should be looked at. The final statement should present an environmental evaluation of such methods as organic or hydrochloric acids or mechanical means.

Page 4-9

Since the intake structures for this plant have been constructed, the final statement should discuss what sampling program is proposed and when it would be implemented to determine levels of entrainment and impingement, during all expected flow conditions, of Susquehanna River fish and aquatic invertebrates. Further, the final statement should include a discussion of the possible actions the licensees will take to modify the project to protect such aquatic resources in the event significant adverse impacts occur from entrainment, impingement, or streamflow diversion for consumptive use (50 cfs average).

Page 4-12

The staff concludes that no adverse environmental impacts, other than atmospheric plumes and snowfall, will occur as a result of the operation of the cooling towers at the SSES. The licensees propose to construct a reservoir (Pond Hill) to provide makeup water during low flow conditions in the Susquehanna River. The final statement should be revised to indicate some adverse environmental impact will occur with the operation of the cooling towers and related reservoir. Construction of the dam and reservoir will destroy terrestrial wildlife habitat and reservoir filling operations will impact Susquehanna River aquatic invertebrate and fish populations through impingement, entrainment, streamflow regulation, and consumptive use of such flows.

Page 5-2

We agree with the staff that the applicant should monitor groundwater both upgradient and downgradient on a monthly basis. We note that the potential for radionuclide contamination of groundwater is implied on page D-1 of Appendix D (item 1.6); however, figure 4.1 (p. 4-13) does not indicate groundwater as an exposure pathway to humans.

Page 6-4

The conclusion that "the environmental risks due to radiological accidents are exceedingly small and need not be considered further" ignores the probability and the consequences of core-melt accidents (p. 6-4, par. 1). As was explained in the environmental statement for the Palo Verde Nuclear Station (NUREG-0522, 1979), this "realistic analysis" is based on procedures in the Proposed Annex to Appendix D, 10 CFR Part 50, which specifically exclude the evaluation of core-melt accidents. Environmental damages resulting from a core-melt accident can be devastatingly severe and conclusions concerning environmental risks that ignore these accidents must be questioned. We believe that site-specific evaluations of the full range of potential accidents should be a part of the site selection process for nuclear power stations.

The section on Postulated Accidents Involving Radioactive Materials enumerates "Several of the more significant findings" of the Lewis Report (p. 6-3). The three findings summarized exclude the final finding of that report:

> There have been instances in which WASH-1400 has been misused as a vehicle to judge the acceptability of reactor risks. In other cases it may have been used prematurely as an estimate of the absolute risk of reactor accidents without full realization of the wide band of uncertainties involved. Such use should be discouraged. (NUREG/CR-0400, p. x).

A footnote to table 6.2 states that "These calculations do not take into consideration the experience gained from the accident at the Three Mile Island site on March 28, 1979" (p. 6-3, footnote A). However, this provides no guidance on the possible magnitude or even the direction of the errors that may exist in the radiological consequences that are shown in the table. The largest

estimated dose to population in a 50-mile radius from any accident shown in the table is 37 man-rem. Until such time as the table can be revised, it might be helpful to note that the estimated dose to the population within a 50-mile radius of the Three Mile Island site was calculated to be 3,300 man-rem (NUREG-0558), p. 2, par. 2). The populations within that radius are not greatly different for the two sites, being 2,164,000 people in the case of the Three Mile Island site and projected to be 1,517,123 people within 50 miles of Susquehanna Steam Electric Station in the year 1980 (ER, table 2.1-8).

Page B-5

Table B.2 (page B-4) shows that 1,236 acres of forest and farmland will be required as rights-of-way for construction of a new transmission line system. The forested area could be managed effectively for wildlife if preferred vegetation and cover for grazing wildlife species were planted. Their feeding activities would help control revegetation of nuisance woody vegetation and reduce the need for clearing and herbicide applications. We recommend that Appendix B discuss the possibility of using plantings recommended by the Pennsylvania Game Commission for all forested areas cleared during transmission line construction.

We hope these comments will assist the preparation of the final.

Sincerely,

Larry E. Meierotto
Assistant SECRETARY

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

ER 80/284

MAY 2 9 1980

Mr. Donald E. Sells
Acting Branch Chief
Environmental Projects Branch 2
Division of Site Safety and
Environmental Analysis
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Sells:

The Department of the Interior has reviewed the draft supplement to the environmental impact statement related to the operation of the Susquehanna Steam Electric Station, Units 1 and 2, Luzerne County, Pennsylvania. We have the following comments.

We find that the supplement adequately describes existing fish and wildlife resources and impacts on those resources from construction of the proposed impoundment. Provided that the Pennsylvania Power and Light Company implements the management plans to be submitted by the applicant in consultation with the Pennsylvania Fish and Game Commissions (page 4-3 of the draft supplement), we have no objection to construction of the project as proposed.

We recommend that the following be stipulated in any operating license issued by the Nuclear Regulatory Commission for this project.

> "That the Licensee implements the fish and wildlife management plan to be developed in consultation with the Pennsylvania Fish Commission, the Pennsylvania Game Commission, and the U.S. Fish and Wildlife Service."

The proposed spillway capacity was found by the NRC staff to be insufficient to pass a probable maximum flood. The dam would be overtopped in such a flood and might fail (p. 4-11, item 4.4.2.3). The applicant's spillway design flood, based on the 6-hour probable maximum precipitation, apparently was calculated without consideration of the effects of potential antecedent storm runoff. Although the drainage area above the dam is small, the amount of water

to be stored as well as the dam's height are significant and, as indicated, failure could lead to loss of life (p. 4-11, par. 8). The spillway design flood should be reevaluated.

Item 3(1) on page ii of the Summary and Conclusions section states that certain lands will be converted to recreational uses. No discussion is given, however, to the possible environmental effects of this proposed action. Also, there is no mention of a need to survey this land to identify and evaluate cultural resources that may be impacted. At the request of the NRC, the Interagency Archeological Service Atlanta Office prepared a survey plan and cost estimate for a proposed recreational area along the Susquehanna River. This was provided to NRC on December 19, 1979. The NRC should reference the requirement to survey the proposed recreational areas as well as the proposed Pond Hill Reservoir Site.

The discussion of Impacts to Cultural Resources (p. 4-14), should recommend an appropriate management program to be developed only for those sites that meet National Register of Historic Places criteria. Identification and evaluation studies and management programs must be developed in accordance with 36 CFR 800, including consultation with the State Historic Preservation Officer (SHPO). For Pennsylvania, the SHPO is Edward Weintraub, Executive Director, Historical Museum Commission, P.O. Box 1026, Harrisburg, Pennsylvania 17120.

The Archeological Survey Plan for the Pond Hill Reservoir Site (Appendix B) does not clearly indicate whether the acreage to be surveyed under the Commonwealth Associate, Inc. proposal is the approximately 150 acres within the reservoir, or would cover the approximately 1300 acres of the entire project area. All areas to be affected, including transmission line corridors, borrow areas, and recreation facilities, should be surveyed to insure that all cultural resources that may be affected by the undertaking are identified.

Commonwealth Associates proposes that transects spaced at 30 meter intervals will be walked, but does not justify why a 30 meter interval was chosen. This may be sufficient for uplands and slopes but not sufficient in other areas such as terraces. There is no indication of what the interval for shovel testing will be along the transects. Also, testing to a depth of 25 centimeters may be inadequate depending on the depth of the plow zone or fill. We suggest that shovel tests be taken to a depth approximately 20 centimeters below the plow zone or fill, and to search below cultural deposits.

We hope these comments will be of assistance to you.

Sincerely,

James H. Rathlesberger
Special Assistant to
Assistant SECRETARY

U.S. DEPARTMENT OF TRANSPORTATION
REGIONAL REPRESENTATIVE OF THE SECRETARY
434 WALNUT STREET
PHILADELPHIA, PENNSYLVANIA 19106

August 9, 1979

MEMORANDUM TO: U.S. Nuclear Regulatory Commission
Washington, D.C. 20555
Attn: Director, Division of Site Safety and Environmental Analysis

SUBJECT: Draft Environmental Impact Statement - Susquehanna Steam Electric Station, Units 1 & 2

We have reviewed the subject draft EIS and offer the following comments.

From a transportation point of view, the statement did not discuss the impacts to existing highways in the area by traffic traveling to and from the plant. The transportation of nuclear fuels and the crossing of highways with power transmission lines has been mentioned. While there should be no significant impacts, the statement could answer the following questions:

1. Have the access points been designated and coordinated with the Pennsylvania Department of Transportation?

2. Would the travel trips by the 400 employees affect the level of traffic service on the existing highways?

We appreciate the opportunity to comment on this document.

Sally H. Cooper
Regional Representative
of the Secretary

8005070522

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DEPARTMENT OF TRANSPORTATION
REGIONAL REPRESENTATIVE OF THE SECRETARY
434 WALNUT STREET
PHILADELPHIA, PENNSYLVANIA 19106

REGION III

April 28, 1980

Donald E. Sells
Acting Branch Chief
Environmental Projects Branch 2
Divison of Site Safety & Environmental Analysis
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

RE: Draft Supplement to the DEIS related to the operation of the Susquehanna Steam Electric Station, Units 1 & 2
Docket Nos.: 50-387 and 50-388

The draft supplement to the DEIS covering the proposed construction of the Pond Hill Creek storage reservoir for the Susquehanna Steam Electric Station has adequately addressed the probable impacts to highway facilities. However, the supplement still lacks evidence of coordination with the Pennsylvania Department of Transportation. Since the pump station construction will affect Route 239 (pg. 4-12) and an access road will be added for the reservoir construction, we repeat our comment of August 9, 1979, recommending coordination with PA DOT.

Sally H. Cooper
Regional Representative
of the Secretary

SPEED LIMIT 55
It's a law we can live with.

R.D. #1, Box 4
Winfield, Pa. 17889
August 29, 1979

Mr. Daniel Muller, Director
Division of Site Saftey and
Environmental Analysis
Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Muller:

Thank you for the opportunity to comment on the "Draft Environmental Statement related to Operation of Susquehanna Steam Electric Station, Units 1 and 2 Pennsylvania Power and Light Company, Allegheny Electric Cooperative, Inc." Dockets Nos. 50-387, and 50-388, June 1979. Since no suspense date was mentioned in the document, it can be assumed that comments are still being accepted.

My comments will be very brief due to the limited amount of time available to review the document. Despite being published in June, not all of the public in the area affected by the plant were made aware of the document. Efforts by local environmental groups to alert the public, such as myself, were successful, but that did not occur until mid August. The apparent efforts of the NRC were the minimum that is required to do in order to seek input. This symbolizes NRC's attitude in the entire "public input" process- do the minimum required just to satisfy a section of the law. The public be damned for the convenience of the NRC and utilities. Hopefully this attitude will not carry over into the operation and regulation of a nuclear power plant.

Reguarding the document itself, it is unconscionable that an environmental inpact statement on a nuclear power plant published after April 1979, does not include specific analysis of the potential similar problems as occured at the Three Mile Island nuclear facility. Plant design differences aside, there are many generic issues such as emergency prepardness that should be factored into the impact of SESS. Emergency prepardness for an 80 km radius area costs a lot of money and time, and such costs should be factored into any cost/benifit discussion of SESS. The impact on the residents of the TMI area(16km,not just the 8km under study) of radiation exposure, stress and its related effects, and other health consequences should be carefully evaluated before SESS is permitted to continue in the licensing procedure.

General comments on specific sections of the document are as follows. On page 4-2, the possible effects of low river flow and excess river flow (floods) make one concerned about the assumptions used to draw the conclusion that the plant would need to be shut down only four days per year. An adequate water supply is crucial to reactor saftey, therefore the assumptions should be more fully explained.

Table 4.12 on page 4-21 indicates that the nearest sport fishing location is 24 hr. transit time away. Fishermen can be found at most points along the river from 0.1 hr. away on to the Chesepeak. Perhaps the problem is definitional.

The statements in Section 4 which state that radioactive releases, both occupationally and environmentally, will have no significant environmental impact are misleading when one considers that the effects of low level radiation are unknown. Groups such as the National Academy of Sciences hesitate to place acceptable low dose limits on human health effects.

Table 6.2 should be revised to reflect the experiences gained from TMI. Class 9 postulated accidents should be considered in calculating the costs and benifits of the plant to the people in the area. Their chance may be small in the NRC's opinion, but the consequences are real and the price must be paid if a class 8 or 9 accident occurs.

Section 7 "Need for Plant" fails to document the need for the plant other than to provide excess capacity. The reserve margin far exceeds recommended levels. The projections probably fail to consider recent shifts to conservation and selected solar hot water projects due to the high costs of electricity. Such trends, including residential winterization, will continue as the costs of electricity increase. Therefore, building a plant to provide increasing excess capacity escapes logic. The need for the plant is not documented by this analysis.

Section 8.41 "Health Effects", comparing nuclear and coal fired plants failed to include, as previously mentioned, the effects of a class 9 accident. We now realize after TMI, that serious accidents are in fact a possibility and should be considered.

The tables in Section 8 dealing with the effects of coal versus nuclear plants presumably used coal in the general sense. The SESS is located near the heart of the anthracite coal region. Anthracite, because it is a cleaner burning coal, has been exempted from many EPA air pollution regulations. Since this is the coal that should be used at SESS, it is the coal that should be used in any comparative studies.

Section 8.4.4 mentions that there have been no serious accidents in a nuclear plant with which to study morbibity and mortality. As mentioned previously, TMI has taken the first painful step towards this experience. That experience should be carefully studied before the nuclear process continues.

Section 8.5 fails to take into consideration a reported recent GAO study indicating that DOE may be off by as much as twenty percent in their estimates because of production losses and the declining quality of the ore were not considered. This section should be revised in light of the GAO report.

Section 8.6 "Decomissioning" is treated lightly considering the tremendous impact a non functioning radioactive plant can have on the environment. Storage for thousands of years with unproven technologies deserves more consideration in an environmental impact statement. Along with decomissioning, waste storage and disposal deserve more detailed analysis as the have a direct impach to the health of the people in the area.

In conclusion, the need for the plant versus the impact of the plant does not justify that any further work be done at SESS. When need is documented, and the alternatives for northeast Pennsylvania better examined (conservation, solar projects, biomass, small hydro projects, etc.) then a better and more complete environmental impact statement should be prepared. At that point in time, and not before, nuclear power should be considered as an alternative.

Thank you.

Sincerely,

Thomas R. Duck

cc: Senator Schweiker
Senator Heinz
Representative Flood
Representative Ertel

economic development council of northeastern pennsylvania
proximity to market . . . a competitive edge.
Northeast Megalopolis

August 27, 1979

Mr. Paul Stewart, Manager
Consumer & Community Affairs
Pennsylvania Power & Light Co.
344 South Poplar Street
Hazleton, Pennsylvania 18201

Dear Paul:

At the most recent meeting of the Policy Committee of EDCNP, a recommendation was made to defer action on the Nuclear Regulatory Commission's Draft Environmental Statement related to operation of the Susquehanna Steam Electric Station, Units 1 and 2, published June 1979, pending the receipt of a response to this letter. The Executive Committee confirmed this action at the August 23, 1979 meeting.

As you know, the PNRS Committee and staff spent considerable time evaluating the findings of the Draft Environmental Statement, at least those sections which the Council felt some competency to review and comment.

With respect to the review and comment, the Council's Policy Committee and Executive Committee requests additional background and the latest status report on the following elements which were noted in the Draft Environmental Statement:

1. With respect to water withdrawal from the Susquehanna River or with respect to a new water related project such as construction of a reservoir, please outline what actions will be taken to meet all water related needs relative to the Nuclear Power Facility at Berwick. The Council's Executive Committee is vitally concerned that the water related facility concerning the operation of the Nuclear Power Facility be on line at the time that the facility is officially opened.

2. The Draft Environmental Statement notes that flood plain consideration has been taken into account at least as far as the 100 year flood plain is concerned. Since the Pennsylvania Department of Community Affairs has noted that flood plain mapping may now be available for sections of the general area relative to the Nuclear Power Facility, the Council would appreciate the latest information being analyzed by PP&L concerning the impact of any potential flooding which may some time occur. Flood plain analysis for flooding substantially

VIVIAN P. EDWARDS, PRESIDENT
HOWARD J. GROSSMAN, EXECUTIVE DIRECTOR

above the 100 year flood plain level would also be appreciated, if such analysis has been accomplished.

3. The Draft Environmental Statement notes special consideration for the Berwick Hospital. The Policy and Executive Committees believe that other hospitals should be involved in evacuation or emergency plans and would appreciate any details you might be able to supply concerning plans involving hospital facilities other than Berwick.

4. The Draft Environmental Statement notes that a Safety Evaluation Report (SER) is in the process of being prepared. The Council would like the opportunity of obtaining this document when available and would also appreciate your outlining the schedule for completion.

The Council has other elements which it would like to bring to the attention of the Nuclear Regulatory Commission concerning economic affects of the Susquehanna Steam Electric Station, Units 1 and 2, but the above four elements represent some of the major factors for which the Policy and Executive Committees would appreciate a response.

Please feel free to contact me if you need any further background concerning this request. In order to expedite the Review and Comment process, it would be helpful to receive some type of response by September 15, 1979.

Yours truly,

Howard

Howard J. Grossman
Executive Director

HJG:mjc

economic development council of northeastern pennsylvania
proximity to market . . . a competitive edge.

September 26, 1979

Mr. Donald E. Sells, Acting Branch Chief
Environmental Projects Branch 2
Division of Site Safety and
Environmental Analysis
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Sells:

This letter is being sent to you to formally notify you that the Executive Committee of the Economic Development Council of Northeastern Pennsylvania (EDCNP), at its regularly scheduled meeting on September 20, 1979, affirmatively reviewed the Nuclear Regulatory Commission's draft environmental statement relative to the operation of the Susquehanna Steam Electronic Station, Units 1 and 2. Attached you will find several attachments which outline the Council's A-95 review process, its major comments on this draft environmental statement, and other related correspondence which the Council utilized in arriving at its conclusion on this proposal.

The Council trusts the attached material will help you finalize a decision on this matter. If additional clarification is desired, please contact me at your earliest convenience.

Yours truly,

Howard J. Grossman
Executive Director

HJG:sma

Attachments

CC: Rick Heiss, A-95 State Clearinghouse
Luzerne County Planning Commission
Lackawanna County Planning Commission
SEDA-COG
Paul Stewart, PP&L
File

VIVIAN P. EDWARDS, PRESIDENT
HOWARD J. GROSSMAN, EXECUTIVE DIRECTOR
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PNRS REVIEW OF THE
DRAFT ENVIRONMENTAL STATEMENT
RELATED TO THE
SUSQUEHANNA STEAM ELECTRIC STATION, UNITS 1 & 2
BY THE
ECONOMIC DEVELOPMENT COUNCIL OF NORTHEASTERN PENNSYLVANIA (EDCNP)

Background

On June 28, 1979, the EDCNP received a copy of the Draft Environmental Statement (EIS) on the Susquehanna Steam Electric Station, Units 1 & 2 from the U.S. Nuclear Regulatory Commission.

Upon receiving this EIS, the EDCNP notified the following agencies that it had the report; they could review the report in its offices during regular working hours; and they had until August 12, 1979, to forward their comments on the report to the EDCNP.

1. Lackawanna County Planning Commission
2. Schuylkill County Planning Commission
3. Monroe County Planning Commission
4. Susquehanna Economic Development Association Council of Governments (SEDA-COG)

The EDCNP's Deputy Director orally told the Executive Director of the Luzerne-Lackawanna Environmental Council (Lu-Lac) that the EDCNP had the report and that it could be reviewed in our office. The Council did not notify the Luzerne County Planning Commission since it was its understanding, based upon the cover letter it received from the NRC, that the Luzerne County Planning Commission received a copy of the report in the mail.

Upon receiving the report, the Council's staff immediately began to review the report. While this review was taking place, the staff also reviewed various A-95 reports and circulars to ascertain how such an EIS should be reviewed and its purviews under the A-95 Process. The staff, also, contacted the State Clearinghouse and the National Association of Regional Councils (NARC) to ascertain if any other agencies had performed similar reviews; and also, to alert them of our proposed actions. They both told us that they believed we were one of the first regional agencies, to the best of their knowledge, to review an environmental impact statement for a nuclear power plant under the A-95 System and believed we were going about it in a responsible way.

The staff, realizing this review was on a potential controversial project, brought the matter before the Council's Policy Committee for policy guidance. The Policy Committee told the Executive Director that the staff should handle the project like any other important PNRS project generated in the region.

As such, the staff, in addition to reviewing the draft EIS, also read for background information, the following publications in addition to the Draft EIS:

(1) The Final Report on a Study of the Effectiveness of A-95 Procedures and Their Administration with Regard to HUD Programs, dated March 1979 by Peat, Marwick, Mitchell & Co.

(2) Effects of Nuclear Power Plants on Community Growth and Residential Property Values by H.B. Gamble, R. H. Downing, and O.H. Sauerlender, dated November 15, 1978, for the U.S. Nuclear Regulatory Commission.

(3) A Review and Study of the Environmental Impact and Socio-Economic Impact of the Proposed Philadelphia Electric Company Limerick Generating Station Units 1 and 2 by the University City Science Center for the Montgomery County Planning Commission, dated March 14, 1974.

(4) Areas Around Nuclear Facilities Should Be Better Prepared for Radiological Emergencies - A Report to Congress by the Comptroller General, dated March 30, 1979, and several other newspaper articles and speeches on this and related subjects.

In addition to reviewing these documents, the staff also talked to Jane Kenney, the Executive Director of the South Eastern New Hampshire Regional Planning Commission on its involvement in the siting, licensing, and monitoring of the "Seabrook Nuclear Power Plant."

The following comments on this EIS are a direct outgrowth of these reviews and conversations:

> The Council's staff did not believe it had sufficient time nor the breadth and level of expertise to review and comment on many of the technical aspects of the EIS and its attachments. However, the Council's staff believed it had sufficient expertise and time to comment on the following items which were discussed with the Council's PNRS Committee, its Policy Committee, its Executive Committee and Board of Directors.

Summary of EDCNP's Comments

General Comments on History of the Project (Chapter I)

This EIS is an update of previous reports filed with the Nuclear Regulatory Commission.

A Safety Evaluation Report (SER) will be issued after the review and approval of this EIS and PP&L's Final Safety Analysis Report (FSAR).

Therefore, many of the concerns which the Council and other citizen groups may have on safety related issues associated with this plant (especially in light of the Three Mile Island (TMI) Accident) will be evaluated and commented upon at a later date if the Council is involved in that SER review.

General Comments on the Site (Chapter II)

The EDCNP staff believes a considerable amount of data has been assembled and adequately analyzed relative to the site, the general environs (Luzerne County), and the various public facilities and utilities in the area.

However, there are some recent reports, events, and new institutional relationships which might be evaluated prior to the Units coming on line. These include:

(1) Several state hospitals (Nanticoke, Hazleton, Pittston, etc.) may be either phased out or merged under the NPW proposal. It might be prudent to initiate programs similar to the one currently being undertaken between PP&L and the Berwick Hospital with other hospitals in the area (for example, Geisinger or the newly proposed NPW complex in the Wilkes-Barre area which is currently under construction).

Furthermore, more detailed evacuation plans should probably be worked out with the various local County and State Civil Defense and Emergency Medical Services (EMS) Agencies. The recent report issued by the Office of the Controller entitled A Report to Congress - Areas Around Nuclear Facilities Should Be Better Prepared for Radiological Emergencies, March, 1979, should be reviewed to ascertain potential roles and responsibilities of various public and private agencies in these efforts.

Furthermore, the EDCNP believes the most recent Section 208 Comprehensive Water Quality Management Program (COWAMP) reports for the Lower Susquehanna River Basin should be evaluated in light of any potential impact the plant and its ancillary facilities will have on current water and sewerage facilities and other water matters.

Also, the Council believes more information on the plant's location relative to the flood plain should be explained in more detail. It is difficult to ascertain if any of the proposed facilities are in the 100 year flood plain and/or if the construction of the Tioga Hammond Dams will affect the site and facilities in question (i.e. the intake and sewage treatment plant). The staff realizes this topic is discussed in more detail in Chapter 4; but believes this item should be thoroughly coordinated with the Susquehanna River Basin Commission (SRBC).

Another item which needs attention is the preparation of a systematic survey of historic, ethnohistoric, and prehistoric cultural resources at the plant site and along the proposed transmission corridors. The Council believes a joint State - County - Utility study of these potential resources should be undertaken as soon as possible. Potential sources of funding might include: the Pennsylvania Historical & Museum Commission, the Pennsylvania Endowment for the Arts, the National Endowment of the Arts, the Appalachian Program, and possibly other local foundations. This program and any findings could conceivably become a part of the proposed recreation area and/or part of the programs of local colleges (Wilkes, Luzerne County Community College, Bloomsburg State College, and Bucknell.

General Comments on the Plant (Chapter III)

Based upon the data presented in the EIS, it appears the Susquehanna River Basin Commission will not permit PP&L to withdraw the necessary volume of water from the river during periods of low flow.

Apparently PP&L is considering the construction of a reservoir or an alternate water source. The Council trusts that this reservoir will be capable of not only supplying the water needs at the proposed plant, but also be of sufficient size to augment the flow of the river to insure an adequate water supply for the water intakes on the river for the Cities of Danville, Berwick, and Bloomsburg. The Council would appreciate receiving a copy of this report on the proposed reservoir from either the utility or NRC.

It, also, appears that the proposed river intake structure will only be .3 of a meter (approximately 1 foot) above the Standard Project Flood (SPF). The placement of this facility should be closely evaluated in light of the region's experience in 1972 during Tropical Storm Agnes and the amount of protection, if any, which the proposed Tioga Hammond Dam will have on an area this far downstream from the above mentioned dam. Also, the construction of the riprap at this site should be carefully evaluated in terms of the potential force of the "flood way" during a 100 year or greater flood.

General Comments on the Environmental Effects of Station Operation (Chapter IV)

The Council's staff believes more study is necessary on the impact of this facility on public expenditures for police, fire, and other special emergency equipment which may be needed not only in the immediate areas but also for backups in the event of a serious radiological accident.

Also, the NRC staff notes there might be additional land use impacts and that PP&L should take these items into consideration in its socio-economic monitoring programs, but the NRC staff does not point out who will have the responsibility to implement the anticipated programs which might be necessary to mitigate the effects relative to adverse land uses.

The Council encourages PP&L to finalize its replacement water plans as soon as possible and coordinate those plans with the Luzerne County Planning Commission, the EDCNP, the Pennsylvania Department of Environmental Resources (DER) and the SRBC.

The Council also believes the Luzerne County Planning Commission should submit an application to the U.S. Environmental Protection Agency under the Quiet Communities Program to secure the necessary funding to buy the noise monitoring equipment and to acquire the necessary expertise to develop a history of the noise level generated at and near the plant.

The Council also strongly encourages PP&L to perform the appropriate studies on the operation of the intake as currently styled and designed, since it appears it will have an adverse effect on the acquatic life within the vicinity of wing walls and riprap. These are crucial, since shad may be reintroduced in the lower reaches of the Susquehanna River and various fish ladders are being contemplated on some of the dams downstream from this proposed facility.

Also, it appears there are some inconsistencies in the evaluations on whether the shad will remain in the main channel or use the pool areas for resting. If the shad decide to rest in the pool near the intake, this may have significant negative results as they migrate up and down the river. In essence, the Council's staff believes the potential shad problem should be studied in more detail and solutions found as soon as possible to assist in the reintroduction of shad in the Susquehanna River.

The Council applauds PP&L for its proposed recreation centers around the plants, however, it wonders if PP&L also plans to permit public recreational use around its proposed low flow augmentation reservoir.

The Council again believes it is important to stress that the local communities should receive sufficient taxes or payments in lieu of taxes to cope with the increased level of services and manpower (police, fire, etc.) which will be required due to the impact of this facility. The Council believes the Luzerne County Planning Commission or Salem Township should submit an application to HUD or NRC to more fully ascertain these fiscal impacts and also to develop appropriate implementation strategies.

Also, the Council believes a survey of cultural resources (Indian relics, etc.) in the vicinity of the plant should be made as soon as possible in order to quantify the extent and value of these resources in the area of the plant.

The Council staff also found it interesting that approximately 80 percent of operational work force which was hired by November, 1978 were in-migrants rather than local workers. The Council believes PP&L should investigate the development of training/employment programs (for example, under PIC or OJT) with local CETA agencies such as the Luzerne County Human Resources Agency in order to encourage the hiring of more "local" people.

Although the total tax bill for the two Susquehanna units will be about $5.5 million very little of this will be distributed locally. ($55,000 to Luzerne County and $10,000 to Columbia County due to current state law.

The Council's staff believes some more equitable formula should be pursued, even if it means possible amendments to the Pennsylvania Public Realty Tax Law.

General Comments on the Environmental Monitoring of the Plant Site (Chapter V)

The Council's staff concurs with NRC findings and recommendations in this Chapter and strongly urges PP&L to expedite many of them (i.e., the noise monitoring program mentioned earlier).

General Comments on the Environmental Impact of Postulated Accidents (Chapter VI)

The Council's staff believes the current EIS is deficient in that it did not note the TMI accident. The Council staff believes that since an accident such as TMI is possible, it believes it would be prudent for PP&L and/or the NRC to develop a plan for a Class 9 failure at this facility, especially since an accident of this magnitude was not considered in this EIS.

Again, the Council's staff recommends that NRC and PP&L review the Office of the Controller's report and the other publications noted earlier on this subject.

General Comments on the Need for the Plant (Chapter VII)

The Council's staff found this Chapter very informative and generally concurs that there is a need for the plant even though some may question the need to have the plant since PP&L would still have a 24 percent reserve margin in the summer without it in 1985; and a 30 percent reserve margin in the winter without it. Although the margins are significantly above the 5 percent reserve margin assigned to PP&L as its responsibility in the PJM interconnection; it appears PP&L acted in good faith in the late 1960's and early 1970's when it made the decision to go ahead with the facility, since it was assigned a 20 percent reserve margin at that time. Also, PP&L expected considerably more growth in its service area and the interconnection at that time. Furthermore, it now appears the State and the interconnect are indeed fortunate that PP&L is a winter peaking utility and has this reserve margin in light of the potential closing down of GPU's Three Mile Island plant, and also, the increasing need for energy in the United States due to the OPEC oil crisis in 1973-74 and 1978-79.

Furthermore, the Council's staff believes this reserve margin is a plus in the region's attempts to revitalize the economy of the region which to date has experienced high unemployment rates and little economic growth and diversification.

In essence, the Council's staff believes the additional reserve margin which the Susquehanna plant will provide (47 percent reserve margin in winter and 29 percent reserve margin in summer) by 1985 is a plus to the economy of the State and our region.

General Comments on the Evaluation of this Proposed Action (Chapter VIII)

Anthracite did not appear to be considered as an alternative. It may be a more viable fuel in the future in that it is exempt from the most recent SO_2 requirements promulgated by EPA. Other data was very technical and out of the Council's staff expertise or not directly related to the EIS statement.

General Comments on the Benefit Cost Analysis (Chapter IX)

The Council's staff generally concurs with the "bottom line" of this Chapter and the Council's staff believes that it would be possible to operate the station with only minimal environmental impacts if the applicant (PP&L and Allegheny Electric Cooperative, Inc.) follow through with the recommendations noted by the NRC staff in the EIS and the comments of the EDCNP which are noted in this review.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
6TH AND WALNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

AUG 17 1979

Mr. Voss A. Moore
Assistant Director
Environmental Projects
Nuclear Regulatory Commission T-518
Washington, DC 20555

Dear Mr. Moore:

We have completed our review of the Draft Environmental Impact Statement concerning the Susquehanna Steam Electric Station, Units 1 and 2, Luzerne County, Pennsylvania.

On the basis of our review and concerns we have classified the document and proposal ER-2. This means we have environmental reservations concerning the project and we do not believe the impact statement has sufficient information to assess fully the environmental impact of the action. We have enclosed our comments.

The EPA classification and the date of our comments will be published in the Federal Register in accordance with our responsibility to inform the public of our review on proposed actions under Section 309 of the Clean Air Act.

Sincerely yours,

John R. Pomponio
Chief
EIS & Wetlands Review Section

Comments

Draft Environmental Impact Statement

Susquehanna Steam Electric Units 1 & 2

Luzerne County, Pennsylvania

Radiological Issues

Iodine

We request the NRC to explain the changes which allowed a five to seven fold increase in projected gaseous iodine releases (found by comparison of the Statements of 1973 and 1979) and to explain why the increases did not result in any substantial change in the associated doses to a child's thyroid. (For details, see the Draft Statement, page 4-16 versus page G-56, and 4-18 versus G-75, 77.)

In support of this request, it may be noted that our 1973 comments on projected gaseous iodine releases and associated doses were sharply critical, and we recommended the use of engineered iodine control systems and other design modifications to reduce iodine release such that the offsite dose to a child's thyroid did not exceed 5 millirem per year. Our comments are reproduced in the Draft Statement, pages G-151, 152. The 1973 response to those comments, shown on page G-123, item 11.13, stipulated use of design modifications, and referenced a revised radiological impact as described on page G-77, section 5.4.1. Even though section 5.4.1 noted the existence of uncertainties in the calculational model, and the dose impact has now been recalculated using new source-term calculations, per page 4-1, but the Statement does not contain any specific discussion of lessened impact per unit of iodine release. This discussion of lessened impact per unit of iodine release must be incorporated in the Final Environmental Impact Statement.

Reactor Accidents

The EPA has examined the NRC's assessment of accidents and their potential risks. The assessments were developed by NRC in the course of its engineering evaluation of reactor safety in the design of nuclear plants. Since these issues are common to all nuclear plants of a given type, EPA concurs with NRC's generic approach to accident risk evaluation. The NRC is expected to continue to ensure safety through siting, plant design and accident assessments in the licensing process on a case-by-case basis.

In 1972, the AEC initiated an effort to examine reactor safety and the resultant environmental consequences and risks on a more quantitative basis. The final report of this effort was issued in October 1975 by the U.S. Nuclear Regulatory Commission as the Reactor Safety Study, WASH-1400 (NUREG/75/014). The EPA's review of the study included in-house and contractual efforts, and our comments were released in a report in June 1976.

In July 1977 the NRC chartered the Risk Assessment Review Group to provide advice and information to the NRC on WASH-1400 in response to letters from Congressman Udall expressing misgivings about the report and in particular about the Executive Summary published with the report. The Risk Assessment Review Group issued its findings in September 1978 and the NRC accepted the findings during January 1979. The NRC also withdrew any explicit or implicit past endorsement of the Executive Summary, among other specific actions. EPA agrees with the NRC's position in this matter. We also concur with the NRC's continued support for the use of probabilistic risk assessments in regulatory decisionmaking, with the admonishment that such decisions be based on several factors encompassing social, technical and economic issues in addition to accident risk assessments.

The reactor accident at the Three Mile Island-2 reactor on March 28, 1979 has focused attention on the great need for a thorough reexamination of reactor safety. We are concerned about the effectiveness of the procedures by which reactor operating experience is translated into improved reactor designs or operational practices. We believe it incumbent on the NRC to carefully review its current procedures for identifying, assessing and acting on potential accident sequences as operating experience with reactors increases.

Consideration of accident scenarios should of course include Class 9 accidents, because their existence was demonstrated at TMI. The SSES statement does not consider such accidents. As SSES is on the Susquehanna, upstream from Three Mile Island, and 75 miles away, the statement should review the possible cumulative effects of a second Class 9 accident in central Pennsylvania.

Population Dose Commitments

We are encouraged that the NRC is now calculating annual population dose commitments to the U.S. population, which is a partial evaluation of the total potential environmental dose commitments (EDC) of H-3, Kr-85, C-14: iodines and "particulates." This is a big step toward evaluating the EDC, which we have urged for several years. However, it should be recognized that several of these radionuclides (particularly C-14 and Kr-85) will contribute to long-term population dose impacts on a world-wide basis, rather than just in the U.S. To the extent that this draft statement (1) has limited the EDC to the annual discharge of these radionuclides, (2) is based on the assumption of a population of constant size, and (3) assesses the doses during 50 years only following each release, it does not fully provide the total environmental impact. Assessment of the total impact would (1) incorporate the projected releases over the lifetime of the facility (rather than just the annual release), (2) extend to several generations beyond the period of release, (3) consider, at least qualitatively or generically, the world-wide influences on the total environmental impact or specify the limitations of the model used.

Fuel Cycle and Long-Term Dose Assessments

EPA is responsible for establishing generally applicable environmental radiation protection standards to limit unnecessary radiation exposures and radioactive materials in the general environment resulting from normal operations of facilities that are part of the uranium fuel cycle. The EPA has concluded that environmental radiation standards for nuclear power industry operations should take into account the total radiation dose to the population, the maximum individual dose, the risk of health effects attributable to these doses (including the future risks arising from the release of long-lived radionuclides to the environment), and the effectiveness and costs of effluent control technology. EPA's Uranium Fuel Cycle standards are expressed in terms of dose limits to individuals members of the general public and limits on quantities of certain long-lived radioactive materials released to the general environment.

A document entitled "Environmental Survey of the Uranium Fuel Cycle" (WASH-1248) was issued by AEC in conjunction with a regulation (10 CFR 50, Appendix D) for application in completing the cost-benefit analysis for individual light-water reactor environmental reviews (39 F.R. 14188). This document is used by NRC in draft environmental statements to assess the incremental environmental impacts that can be attributed to fuel cycle components which support nuclear power plants.

Recently the NRC decided to update the WASH-1248 survey. We believe this is a prudent step and commend the NRC on initiating this update. In providing comments to the NRC on this subject, dated November 14, 1978, we encouraged NRC to express environmental impacts in terms of potential consequences to human health, since for radioactive materials and ionizing radiation the most important impacts are those ultimately affecting human health. We believe that presentation of environmental impact in terms of human health impact fosters a better understanding of the radiation protection afforded the public.

A second major concern of EPA deals with the discharge and dispersal of long-lived radionuclides into the general environment. In the areas addressed in WASH-1248, there are several cases in which radioactive materials of long persistence are released into the environment. The resulting consequences may extend over many generations and constitute irreversible public health commitments. This long-term potential impact should be considered in any assessment on health impact. EPA has consistently found inadequate the NRC's estimates of population doses for these persistent radioactive materials. In particular, the NRC has generally limited their analyses to the population within 50 miles of a facility, or in rare cases, to the U.S. population and to doses committed for a 50-year period by an annual release. These limitations produce incomplete estimates of environmental impacts and underestimate the impact in some cases, such as from releases of tritium, krypton-85, carbon-14, technetium-99 and iodine-129. The total impact of these persistent radionuclides should be assessed, qualifying such estimates as appropriate to reflect the uncertainties. In this regard, we note that the Nuclear Energy Agency is addressing this approach in making assessments and that the NRC is represented in this effort.

Another major consideration in updating WASH-1248 is the health impact from radon-222 from the uranium mining and milling industry. Estimates made by EPA among others indicate that radon-222 contributes the greatest fraction of the total health impact from nuclear power generation. In preparing an updated WASH-1248, we believe NRC should:

a. Include the radon-222 contribution from both the uranium mining and milling industries.

b. Determine the health impact to larger populations than only the local population.

c. Recognize the persistent nature of the radon-222 precursors (Th-230 and Ra-226) by estimating the health impact for a period reflecting multi-generation times.

High-Level Waste Management

The techniques and procedures used to manage high-level radioactive wastes will have an impact on the environment. To a certain extent, these impacts can be directly related to the individual projects because the reprocessing of spent fuel from each new facility will contribute to the total waste. The AEC, on September 10, 1974, issued for comment a draft statement entitled "The Management of Commercial High-Level and Transuranium-Contaminated Radioactive Waste" (WASH-1539). In this regard, EPA provided extensive comments on WASH-1539 on November 21, 1974. Our major criticism was that the draft statement lacked a program for arriving at a satisfactory method of "ultimate" high-level waste disposal.

DOE issued a draft EIS, "Management of Commercially Generated Radioactive Waste," during April of 1979. EPA is conducting a comprehensive review of this EIS, and will submit comments to DOE upon completion of the review.

EPA is cooperating with both NRC and DOE to develop an environmentally acceptable program for radioactive waste management. In this regard, EPA has published proposed environmental radiation protection criteria for the management of all radioactive waste and will establish environmental radiation protection standards for high-level waste in 1979. We have concluded that the continued development of the Nation's nuclear power industry is acceptable from an environmental point during the period required to satisfactorily resolve the waste management question.

Transportation

In its earlier reviews of the environmental impacts of transportation of radioactive material, EPA agreed with AEC that many aspects of this program could best be treated on a generic basis. The NRC has codified this generic approach (40 F.R. 1005) by adding a table to its regulations (10 CFR Part 51) which summarizes the environmental impacts resulting from the transportation of radioactive materials to and from light-water reactors.

The impact value for routine transportation of radioactive materials has been set at a level which covers 90 percent of the reactors currently operating or under construction. The basis for the impact, or risk, of transportation accidents is not as clearly defined. At present, EPA, DOE and NRC are each attempting to more fully assess the radiological impact of transportation risks. The EPA will make known its views on any environmentally unacceptable conditions related to transportation. On the basis of present information, EPA believes that there is no undue risk of transportation accidents associated with the SSES.

Decommissioning

The NRC has published a proposed rulemaking of Decommissioning Criteria for Nuclear Facilities in the Federal Register on March 13, 1978. EPA comments were sent to NRC on July 5, 1978, dealing with the decommissioning issues.

In summary, we believe that one of the most important issues in the decommissioning of nuclear facilities is the development of standards for radiation exposure limits for materials, facilities and sites to be released for unrestricted use. We have included the development of such standards among our planned projects. The work will require a thorough study to provide the necessary information, including a cost-effectiveness analysis for various levels of decontamination.

The development of standards for decommissioning must, of course, include consideration of the many concurrent activities in radioactive waste management and radiological protection. EPA has developed proposed Criteria for Radioactive Waste for management of all radioactive wastes which will provide guidance for decommissioning standards. From the decommissioning view probably the *most important* criterion is that limiting reliance on institutional controls to a finite period. EPA believes that the use of institutional control to protect the public from retired nuclear facilities, until they can be decontaminated and decommissioned, should be limited at the most to 100 years and preferably less than 50 years. This includes nuclear reactors shut down and moth-balled or entombed for a period of time under protective storage. After the allowable institutional care period is over, the site will have to meet radioactive protection levels established for release for unrestricted use. We believe EPA's proposed criteria would be directly applicable, as above, to decommissioning of nuclear facilities and should be given serious consideration by the Nuclear Regulatory Commission (NRC).

The availability of adequate funds when the time to decommission arrives is *also* most important; it should be the responsibility of the NRC to assure that such provisions are made. We recognize the great complexity of providing funds for such activities at some time in the future, particularly where utilities are involved due to the controls imposed by State and local utility commissions. However, if it can be firmly established that the total cost of decommissioning in current dollars is a very small fraction of initial capital costs, provision of escrow funding may not be necessary. Therefore, we urge the NRC to conduct the necessary studies and assessments to determine unequivocally the costs of decommissioning and to compare such costs to initial capital costs. It is only through a definitive analysis, and perhaps through realistic demonstration, that this issue can be resolved.

Direct Radiation From Nitrogen-16

The assessment of the direct radiation from the nitrogen-16 is not discussed in sufficient detail to allow meaningful interpretation (see pages 4-16 to 4-21). For example, it is stated that the applicant calculated a direct radiation dose of 2.7 mrem/year per unit at 0.55km

south of the plant. It is also stated that Monte Carlo techniques were used to calculate direct radiation and skyshine dose rates on the order of 20 mrem/year per unity at a typical site boundary distance of 0.6km from the turbine building. It is noted that the direct radiation dose is not listed on Tables 4.9 and 4.10, that there are residences at 610 m and 756m from the plant, and that the SE sector with the residence at 610m also has a garden and meat animal at 644m. These factors could serve to maximize doses in these sectors and therefore should be more fully discussed in the final EIS.

Health Risk Conversion Factors

The health risk conversion factors listed on page 4-27 appear low and are inconsistent with the factors used in the Generic EIS on Uranium Milling (NUREG-0511). These values should be made consistent with those used in NUREG-0511.

Comments Relating to Water Quality

1. Page 2-12, Figure 2.3

Figure 2.3 depicts the Water Use Diagram for Susquehanna Units 1 and 2; however, a water balance cannot be calculated for many of the unit processes shown on the diagram due to insufficient information. For example, it is impossible to determine the makeup of the waste treatment discharge since the flow rates of the dimineralizer and raw water treatment plant discharges are not indicated.

For purposes of clarity and future permitting, a revised diagram should be submitted which clearly shows all discharge points and includes a complete water balance. This treatment scheme could also be better utilized if it were included in Section 3.2.4 entitled Chemical, Sanitary, and Other Waste Treatment.

Paragraph 2.3.4 relates that the Susquehanna at the plant site meets water quality standards for all parameters except iron. In describing the discharge, on pages 4.4 and the pages following, the impression is given that the discharge will degrade the river beyond water quality limits for several contaminants. Table 4-3 shows that the chloride ion is extraordinarily high. The quantity of the ion is not the major concern but its nature is, particularly when you consider the stoichiometry of the various ions that are on the list of the State's water quality parameters, those making up the effluent of the plant and those ions and compounds not included but may be present in the list of water quality parameters.

Figure 2-3 does not clearly illustrate whether the sewage treatment plant effluent is discharged into the Susquehanna River. The plant is not described in sufficient detail. The lack of design or operation mode does not give the necessary assurance that it will operate efficiently at 1/3 capacity without adverse impacts upon the river. Many treatment systems fail when they are not operated at capacity.

2. Page 2-17, Table 2.8

Table 2.8 lists specific Water Quality Criteria applicable to fecal coliform, total iron, manganese, dissolved oxygen, pH, and total dissolved solids but has not included the applicable criteria for temperature. Specific temperature criteria for zone 03.010, North Branch Susquehanna River, are as follows:

> Not more than a 5°F rise above ambient temperature or a maximum of 87°F, whichever is less; not to be changed by more than 2°F during any one hour period.
>
> This information can be found in Pennsylvania's Water Quality Criteria, Pennsylvania Code, Title 25, Part I, Environmental Resources, Chapter 93, Water Quality Criteria Amended September 16, 1976; Effective October 11, 1976.

3. Page 3-3, 3.2.2.2

Section 3.2.2.2 describes the intake structure which will be employed at the plant. A comparison of this intake and intake designs illustrated in EPA Document 660/2-73-016 Reviewing Environmental Impact Statements - Power Plant Cooling Systems Engineering Aspects shows the design of the plant's intake as generally unsatisfactory. The document states that travelling screens with continuous movement are preferred to those with intermittent movement. In addition, it is recommended that stationary louvers for fish by pass or collection and removal facilities should be provided in the Screenwell. These two modifications to the proposed intake structure at SSES should be considered in the final design, especially in light of the NRC staff's concern of adverse affects to the aquatic community within the immediate vicinity of the wing walls and associated rip-rap. It should also be noted that Section 316(b) of the Clean Water Act of 1977 requires the location design construction and capacity of cooling water intake structures reflect Best Available Technology for minimizing adverse environmental impact by July 1, 1984.

Table 3-1 reveals that the average annual intake from the river exceeds the maximum monthly intake. These figures are confusing and should be clarified.

4. Page 3-8, Section 3.2.4.1

The first paragraph of Section 3.2.4.1, Industrial Wastes, states that sulfuric acid added to the circulating water system is the major source of industrial chemical waste and of potential impact to the aquatic environment. This section does not discuss what measures or treatment the applicant has employed to eliminate or minimize this impact. This section should be expanded to address this point.

The second paragraph of this section states that wastes from raw water treatment will be discharged with roof drains, etc. to the holdup pond in the parking lot. No indication is made, however, if any additional treatment will take place in this pond. If so, any proposed treatment should be outlined. If not, the applicant will most likely have to clean out the pond as a result of the build up of suspended solids. In this case, the disposal of these solids should be addressed.

5. Page 4-6, Section 4.3.4

Section 4.3.4, EPA Effluent Guidelines and Limitations states the station shall achieve effluent limitations requiring the application of BPTCA according to P.L. 92-500. It should also be noted that amendments to this law (Clean Water Act of 1977, P.L. 95-217) will require the station to achieve effluent limitations which require the installation of Best Conventional Technology no later than July 1, 1984; Best Available Technology for non-conventional pollutants by July 1, 1984 or three years after limitations are established, whichever is later, but never later than July 1, 1987; and Best Available Technology for those 129 toxic pollutants which appeared at 43 Federal Register 4108 no later than July 1, 1984, as applicable.

6. Page 4-9

It is questionable as to the practicability of reintroducing shad to the river. Due to the number of dams between Conowingo and the Susquehanna Steam Electric site, it does not appear that this anadromous fish could survive. The cost of getting the migrating fish over the dams would be exorbitant and difficult to justify.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
6TH AND WALNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

MAY 30 1980

Director, Division of Site
Safety & Environmental Analysis
Attn: Mr. S. Singh Bajwa
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Bajwa:

Thank you for granting us a short extension on the deadline for submitting comments on the Draft Supplement to the Draft EIS related to operation of SSES, Units 1 and 2, specifically the Pond Hill Creek Reservoir.

Our comments are attached and if any questions arise in relation to them please contact us on FTS 597-7188.

Sincerely yours,

Robert S. Davis

Attachment

Below are comments on Draft Supplement EIS SSES for the Pond Hill Reservoir pumped storage facility. We believe an ER-2 rating is justified relative to this document. Please find attached a copy of our system for commenting on EIS's. The ER stands for Environmental Reservations and the 2 indicates Insufficient Information.

Information regarding floods and flooding is sparse. In addition, the map on page 2-7 does not adequately depict the Pond Hill Creek floodplain nor the Susquehanna River Floodplain. No doubt some changes will take place in these areas as a result of the project and such changes should be addressed.

With regard to flooding, our information does not agree with either the applicant's or the NRC's. Calculations based upon the maximum storm of recent years, i.e. hurricance Agnes, indicates a 686 mm precipitation event. It is our belief that this impoundment would be topped in such a storm and, depending upon dam construction, may wash out and compound the downstream damages due to flooding. In addition, thorough information should be presented regarding other effects of storms of lesser intensity so that a complete analysis can be made.

The flooding impact potentials as well as the floodplain effects may in themselves indicate that the impoundment should not be built; however, one other point should be more thoroughly presented. This is the frequency analysis of low flows that would interrupt the operation of the power station. In this context, the use of such terminology as "... in <u>some</u> years..." and "... require <u>several</u> shutdowns..." is too inspecific for adequate evaluation. The reasons for not using the river follow alternative, then, based upon information here, are inadequate.

Around the saddle from the "top of the ridge", where a dike is to be placed, is another saddle. *This second saddle appears to be within the same contour* lines as the "saddle" to be diked yet no mention is made either of its potential as an "accidental" spillway in times of severe flooding or of the necessity of a dike in this area. (Re. fig. 3.2, p 3-3). Furthermore, no mention is made of the severe flooding potential associated with the Lily Lake; a very low saddle between these two sites indicates a possible spill over into Pond Run watershed during severe storm periods.

The discussions on wildlife resources is acceptable, but shows some deficiencies with regard to periodicities exhibited by some animals. For example, it is stated with far too much assurance that the eastern cottontail is of minor importance. However, this animal is currently near or at the low point in its seven year cycle. (p 2-11). As the cottontail is a major component of the food web further decreases in its population may be significant.

The operational parameters discussed on pages 3-4 and 4-10 & 11 fail to describe adequately the frequency of intakes and releases and their effects on the reservoir itself and upon the Susquehanna River. For example, this reservoir may have multiple uses among them being recreation. The worst possible case should be described when the level is dropped to an extreme where such activities are curtailed. Also, during these low levels what will the effects be upon the Susquehanna at the point where reduced flows in the river are augmented by the maintenance from the reservoir?

During low flow periods, when the reservoir intake cannot be used, and the river must be augmented by flows from the impoundment, will evaporative losses be significant? Evaporative losses during hot weather are large. These losses coupled with drawdown may indicate a shorter useful storage capacity than is indicated in the document.

In sum, this supplementary document does not adequately discuss alternative measures other than providing flows from the river itself or other reservoirs. Alternative sites to the one presented here are given only cursory attention. Under the new CEQ guidelines, such documents as this are supposed to describe the decisionmaking process and not merely represent the most favorable arguments for choosing this alternative.

Environmental Impact of the Action

LO--Lack of Objections

EPA has no objections to the proposed action as described in the draft impact statement or suggests only minor changes in the proposed action.

ER--Environmental Reservations

EPA has reservations concerning the environmental effects of certain aspects of the proposed action. EPA believes that further study of suggested alternatives or modifications is required and has asked the originating Federal agency to reassess these aspects.

EU--Environmentally Unsatisfactory

EPA believes that the proposed action is unsatisfactory because of its potentially harmful effect on the environment. Furthermore, the Agency believes that the potential safeguards which might be utilized may not adequately protect the environment from hazards arising from this action. The Agency recommends that alternatives to the action be analyzed further (including the possibility of no action at all).

Adequacy of the Impact Statement

Category 1--Adequate

The draft impact statement adequately sets forth the environmental impact of the proposed project or action as well as alternatives reasonably available to the project or action.

Category 2--Insufficient information

EPA believes that the draft impact statement does not contain sufficient information to assess fully the environmental impact of the proposed project or action. However, from the information submitted, the Agency is able to make a preliminary determination of the impact on the environment. EPA has requested that the originator provide the information that was not included in the draft statement.

Category 3--Inadequate

EPA believes that the draft impact statement does not adequately assess the environmental impact of the proposed project or action, or that the statement inadequately analyzes reasonably available alternatives. The Agency has requested more information and analysis concerning the potential environmental hazards and has asked that substantial revision be made to the draft statement.

If a draft impact statement is assigned a Category 3, ordinarily no rating will be made of the project or action, since a basis does not generally exist on which to make such a determination.

Figure 3-1. Notification of EPA's Classification of Comments
Page 2 of 2

FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON, D.C. 20426

In Reply Refer To:

OEPR-ORB
Cooperative Studies
Draft Supplement to DEIS
Susquehanna Steam-Electric
Station Units 1 and 2

JUN 10 1980

Darrel G. Eisenhut, Director
Division of Licensing
Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Eisenhut:

This is in response to your recent request for comments on the draft supplement to the draft environmental impact statement for the Susquehanna Steam-Electric Station (SSES) Units 1 and 2, Pennsylvania.

The draft supplement addresses the subject of low flow augmentation required to supply water to the Susquehanna River to replace water consumptively used by the SSES during periods of very low streamflow. The average consumptive use at the SSES would be about 1.4 cubic meters per second or approximately 6 percent of the seven consecutive day, 10-year frequency low flow of 22.7 cubic meters per second at the Wilkes-Barre gage. When the discharge at the gage is below this level, Pennsylvania law prohibits water withdrawals from the river. This would result in SSES being shutdown for the duration of the streamflow deficiency.

The applicants, Pennsylvania Power and Light Company and the Allegheny Electric Cooperative, Inc., have studied two alternatives for providing low flow augmentation -- one, a new single-purpose reservoir and another, which would utilize storage from an existing reservoir. Another option would be to "river follow" or accept and accommodate the occasional shutdowns necessary during low streamflow. The applicants have recommended construction of the Pond Hill low flow augmentation reservoir. The proposed single-purpose reservoir would be located on a headwater tributary to the Susquehanna River, with insufficient natural streamflow for its intended purpose. Consequently, pumping energy amounting to about 2,417 megawatt-hours per year would be required to maintain its required inflow. This is equivalent to the amount of electricity that could be generated from using about 4,000 barrels of oil.

The report recognizes that the most economic alternative to augment low flows would be the modified operation of an existing upstream reservoir. However, we believe that the draft supplement did not adequately explore that opportunity, which appears to us to be the most practical alternative. The primary project

considered is the U.S. Army Corps of Engineers' Cowanesque project, presently under construction and scheduled for completion in June 1981. The report states that the Corps of Engineers pointed out uncertainties regarding the availability of storage due to the need for Congressional approval for reallocation of storage capacity, and according to the Susquehanna River Basin Commission, the Cowanesque project cannot be considered as a timely alternative. The report implies that the Pond Hill project could be designed, constructed, and placed in operation in less time than the Congress could effect changes in the Cowanesque project operations. We question this implication.

According to the Corps of Engineers, the pre-construction planning of the Cowanesque project included approximately 31,000 acre-feet of storage for water supply but it was not included as a project purpose due to lack of local support at the time. However, we have been informed by the Corps that a detailed $600,000 plus study is currently underway to determine the availability of storage in the Cowanesque project for supply make-up water for the Susquehanna Steam-Electric Station. This extensive study, initiated in March 1979, is scheduled for completion in early 1982.

Based on our review of the draft supplement report and consultation with the Corps of Engineers, it appears that the use of the Cowanesque project, now under construction, instead of the proposed Pond Hill project would: save an equivalent of 4,000 barrels of oil annually, avoid the environmental effects normally associated with dam construction, eliminate possible objections from local residents or property owners, increase benefits to recreation and fish and wildlife resources during low flow conditions, and perhaps provide the low flow regulation sooner than Pond Hill. Therefore, it appears to be in both the ratepayers' and taxpayers' interests to include storage in the Corps of Engineers' project (under construction) rather than build a new reservoir.

Sincerely,

William W. Lindsay, Director
Office of Electric Power Regulation

Thomas J. Halligan
P.O. Box 5
Scranton, Pa. 18501
August 18, 1979

Director
Div. Site Safety & Environmental Analysis
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Director:

Reference -- Draft Environmental Statement
NUREG--0564, June, 1979
Related to the operation of the
Berwick Atomic Power Plant
(Susquehanna Units 1 & 2)
NRC Docket Nos. 50-387/388

The following comments are submitted on behalf of the Citizens Against Nuclear Dangers, Berwick, Pennsylvania, interveners before the NRC Atomic Safety and Licensing Board in the above proceedings.

The Applicants, who are responsible for the preparation of the Draft Environmental Statement (DES), have failed to satisfy certain requirements of the National Environmental Policy Act (NEPA) and thereby place in jeopardy the validity of the DES in its present form.

The Applicants are attempting to circumvent NEPA be piecemealing their assessment of the Berwick atomic plant's overall impact on the human environment. The Applicants are preparing a separate DES for the so-called Pond Hill Flow Augmentation Reservoir, which is a transparent attempt to circumvent NEPA. The submission of a separate DES by Allegheny Electric on sections of the UHV transmission lines from Berwick is another example of piecemealing. The Applicants will know doubt, at some latter date, prepare other DES's, piecemealing such integral projects as the uranium fuel cycle, on-site storage, decommissioning of the atomic plant, and more.

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Recent decisions of the Federal Courts have held that the piecemealing of a major project, such as Berwick, for purposes of environmental assessment, is not permissible under NEPA. You are advised that the DES (NUREG--0564) cannot be considered a comprehensive assessment of Berwick unless and until it takes into account the cumulative effects of all related actions. In order to be acceptable, NUREG--0564 must address the impacts of the proposed "Flow Augmentation Reservoir" and all other projects inextricably linked to the Berwick atomic power plant, but which have not been included in the Applicants DES to date. These piecemealed projects may seem individually limited, but they are cumulatively significant! Piecemealing of a DES is illegal!

Failure on the part of the NRC to rectify this fundamental defect in the DES may invite a lawsuit in Federal District Court to halt the process of environmental review by the NRC until the Applicants comply with NEPA as it relates to piecemealing violations.

Yours truly
Thomas J. Halligan
Correspondent

Director,
Division of Site Safety and
Environmental Analysis,
Nuclear Regulatory Commission
Washington D.C. 20555

Aug. 11, 1979

Dear Director,

I would like to comment on the draft environmental statement concerning the nuclear Susquehanna Steam Electric Station, Luzerne County, Pennsylvania.

The booklet you sent me was very impressive. However it was equally unreadable.

I feel that we here in Pennsylvania already have too many nuclear power plants, contributing more and more radioactivity to the air and the Susquehanna river through normal operations let alone accidents like TMI. It's been said that any dose of radiation is an overdose, so I can't see how this new plant will contribute anything to our health and safety here in Pennsylvania.

Also considering the fact that the NRC as of now has no final plans for waste disposal, I don't feel that the on-site accumulation of these wastes will be beneficial to the residents of our state.

I strongly disapprove the issuance of any license to operate the Susquehanna plant until you have:

-a way to dispose the wastes safely

-can operate the plant without adding more low level radioactivity to our environment

-can be <u>sure</u> through independent studies that the effects of low level radiation emitted from the plant over the 30 to 40 year life span will not harm the public.

Sincerely,

Michael L. Hershey
626 N. Pine St.
Lancaster, Pa. 17603

Re: Mike Huntington
Rd #1
Hunlock Creek, Pa.
18621

8-19-79

Sirs,

I am writing in response to your request for my input on the Draft Environmental Statement for the Steam Electric Station at Berwick, Pa. Well, much as I have tried to plow through the voluminous information that it contains, the short amount of time that I have been allowed for this task makes me skeptical of the N.R.C.'s sinserity about being genuinely interested in my in-put. The advertisement of the availability of this report was made only approxiamately 1 1/2 months ago in our local paper

over

since it does take time to recieve one through the mail, the amount of time to assess this mass of data has been severly limited. I am not an expert on these matters and dealing with so much unfamiliar territory does not make for quick progress either. But just because I am not overly qualified in areas of Nuclear science or ecological balance does not mean that my opinions and observations are with out value. I live less than 10 air miles from this proposed facility and work practically within the shadow of it's cooling towers. I also used to live about 15 miles from T.M.I. but evacuated from there and did not feel very thrilled to returning to a town that gets a good portion of it's drinking water from the Susquehanna River

3

at a point below TMI. I don't want to have to leave my home <u>Ever</u> again because of fears of my safety due to Nuclear radiation! Since TMI, I have looked deep and hard into the area of nuclear power. I am convinced that we do not at the present time have the technology to deal with the requirements of infalibility that it demands. I am also of the opinion that the N.R.C. has failed in it's responsibility to look first after the better interests of the U.S. public. With specific reference to the Environmental statement mentioned, and the amount of it that I have had the time to study, I have several observations: P.P&L is basing it's cost benefit analysis on a 60% to 70% efficiency factor. Our

Generally, the performance of the nuclear industry has in fact been much much lower — "the cumulative to date capacity factor for all plants from the first year of operation through 1976 was 53.7 %. More over, the plants show a decline in performance as they get older. During the first two years of commercial operation, they average 54%, rise to an average of 63% during the next 6 years, and thereafter decline to an average of 39 %", ...

* The Silent Bomb
Peter Faulkner

P.P.+L is not telling the truth to their rate payers as to the true economics of this plant.

The Environmental Statement is also invalid due to a shocking lack of consideration of the events at Three Mile Island - I saw one footnote that regarded some data as pending! This is outrageous! T.M.I has not even been fully assessed, yet the

significance of any findings from this event seem to be regarded as having little relation to already established findings for this specific environmental statement. 3

Another major point that I contend in this report is the establishment of the uranium mining and milling necessary for this plant as having an "acceptable" impact upon the environment. Acceptable to whom I ask? The N.R.C. itself has been unable to disagree with Dr. Chauncey Kepford's findings that 1.2 million people per year will die in the future from the effects of radon gas emitted from the tailings produced just to fuel T.M.I. Now, surely the Susquehanna Steam Electric Station is going to require an equally substantial amount of fuel for its operation too.

are we to be asked to define as "acceptable" the premature deaths of another group of 1.2 million people per year in this situation too?!

Something not found in this report is very good coverage of alternatives — and their impact on the environment — to the S.S.E.S. No mention of solar energy, conservation, cogeneration, bio mass, etc. Coal was not treated fairly or totally. The benefits that a coal-fired S.S.E.S. would have on the local economy is vastly underrated.

Other points that I highly object too, which probably should be headed under the cost/benefit analysis, are the areas of waste disposal and insurance coverage. I resent being called upon as a U.S. tax payer to support P.P.&L, along with all of the other nuclear utilities, with responsibility for disposal of rad waste and absolutely unjust insurance limitations — also at my expence — under the Price Anderson act. If P.P.&L were held responsible — as they should be — for the permanant and safe disposal of the mill tailings, rad waste, and worn out reactor [when they are through with it] the economics would be alittle different. If they were only required to pay their own insurance — without unrealistic limitations such as 560 million ceilings on liability claims — the economics of this plant would be prohibitive. I do not want any part of subsidizing these aspects of the nuclear industry. They have created a false state of economy for the utilities and as a free citizen, I feel that my own freedom of choice has been trampled upon. The N.R.C has a dismal record of putting the Public's health, safety, and welfare ahead of the profit schemes of power utilities It is time for a turn around from this stance – past time! I charge you with the task of fulfilling the duties as public protectors that you have been established for.

In total opposition to Nuclear generated electricity

Michael J Huntington

---

803 North Street
Weatherly, PA 18255
August 8, 1979

Director, Division of Site Safety
and Environmental Analysis
Nuclear Regulatory Commission
Washington, D. C. 20555

Dear sirs:

We want to strongly protest your Draft Environmental Statement recommending that Pennsylvania Power & Light Co. be granted an operating license for the Berwick, PA. nuclear plant. In Section 6, "Environmental Impact of Postulated Accidents," you state that the environmental risk from a Class 9 accident need not be considered, because the probability of a major accident is far too low.

The low probability, as you are aware, did not prevent the accident from happening at Three Mile Island on March 28 in Harrisburg. That accident brought out the potential for human and mechanical error in any nuclear plant, no matter how carefully built, and we feel that no one should have to live with the fear of another accident. We advocate increased use of our own abundant Pennsylvania coal, and the development of synthetic and solar sources of energy to combat our energy crisis.

We have been active in the Hazleton Branch of the Susquehanna Alliance in protesting the licensing of the Berwick plant. We will continue to voice our concern. In speaking to others, we find that the majority of the people in our area are against the operation of the plant, unless it is converted to another source of energy.

Very truly yours,

Mr. and Mrs. Harold C. Jeppsen

In reference to the Susquehanna Nuclear Power plant owned by PP&L.

According to what I understand in the Environmental Statement related to PP&L, there is not such a great need for this plant. PP&L is only adding to their output energy not replacing what they are now using.

Radiation causes cancer. This is an accepted medical fact. The United States has a surplus of power plant, so why add the Berwick plant to the long list of environmental and health hazards of this country.

I feel you should stop using so bias and let some real concerned people draw up another environmental statement! You make it so complex for the average person to understand. No wonder most americans in our country know the real truth about nuclear power.

104 Davey Laboratory
Penn. State University
University Park
Pa., 16802

19 August 1979

Director, Division of Site Safety
and Environmental Analysis
U.S. Nuclear Regulatory Commission
Washington, D.C.
20555

Gentlemen:

Enclosed are my comments on the Draft Environmental Statement for the Susquehanna Steam Electric Station Units 1 and 2, NUREG-0564 (Docket Nos. 50-387 and 50-388). Please note that the information presented is my own and not necessarily the position of The Pennsylvania State University, which affiliation is given for identification purposes only.

My comments consist of one page of main text (beyond this page) and ten pages of appendix, which I would like to have considered in entirety.

Sincerely,

William A. Lochstet

Wm. A. Lochstet

The Long Term Health Consequences of
Susquehanna Steam Electric Station
by

William A. Lochstet
The Pennsylvania State University*
August 1979

The Nuclear Regulatory Commission has attempted to evaluate the health consequences of operation of the Susquehanna Steam Electric Station, Units 1 and 2 in its draft environmental statement NUREG - 0564.

The health consequences of radon-222 releases from the uranium fuel cycle are estimated for the first 1000 years in section 4.5.5. In evaluating the radon-222 emissions from the coal fuel cycle in section 8.4.4, (item #7 on page 8-10), the staff recognizes that the emissions continue for "millions of years". Neither approach is correct. Footnote 12 of NRDC v. USNRC, 547 F.2d 633 (1976) requires that the wastes be considered for their entire toxic life. Thus, the only proper evaluation is with no temporal cutoff. Such an evaluation is attached as an appendix to this statement ("Comments on NUREG - 0332"). This evaluation shows that the Staff has underestimated the health consequences of both the coal and uranium fuel cycles.

The NRC apparently justifies its allowing of health consequences by comparison with background (P. 4-27 to 4-28). This is totally irrelevant and contrary to NEPA. NEPA requires an evaluation of the benefits and all of the costs of the Federal action under consideration (Susquehanna 1 & 2). Background radiation is not a justified federal action. The harm caused by background cannot justify other harm. This improper comparison of costs to background is contrary to the decision in Calvert Cliffs Coordinating Committee v. USAEC, 449 F.2d 1109 ,1115 (1971).

* The opinions and calculations presented here are my own, and not necessarily those of The Pennsylvania State University. My affiliation is given here for identification purposes only.

Comments on NUREG-0332
by

Dr. William A. Lochstet
The Pennsylvania State University
November 1977

In the document NUREG-0332 (Draft), the NRC estimates the excess deaths per 0.8 gigawatt-year electric (GWy(e)) to be about 0.5 for an all nuclear economy and about 15 to 120 for the use of coal(Ref. 1). These estimates are much too small because they ignore the health effects due to the slow release of radon-222 resulting from the decay of radioactive components of the coal, uranium mill tailings, and of the tailings from the uranium enrichment process. If the health effects are estimated by the procedure used by the NRC, then the excess deaths are about 600,000 in the nuclear case and twentythousand for coal. The estimates presented here are all based on the production of 0.8 GWy(e).

Radon Produced by the Uranium Fuel Cycle

The production of 0.8 GWy of electricity by a LWR will require about 29 metric tons of enriched uranium for fuel. With uranium enrichment plants operating with a 0.2% tails assay, 146 metric tons of natural uranium will be required. In the absence of the LMFBR, 117 metric tons of depleted uranium would be left over. With a uranium mill which extracts 96% of the uranium from the ore (Ref. 2), a total of 90,000 metric tons of ore is mined, containing 152 metric tons of uranium. The uranium mill tailings will contain 2.6 kilograms of thorium-230 and 6 metric tons of uranium. As Pohl has pointed out (Ref.3) the thorium - 230 decays to radium - 226, which in turn decays to radon - 222. This process results in the generation of 3.9×10^8 curies of radon-222, with the time scale determined by the 8×10^4 year half life of thorium - 230.

The 6 metric tons of uranium contained in the mill tailings decay by several steps to radon - 222 thru thorium - 230. This process occurs on a time scale governed by the 4.5×10^9 year half life of uranium - 238, the major isotope present (99.3%). The total amount of radon - 222 which will result from this decay is 8.6×10^{11} curies.

The 117 metric tons of depleated uranium from the enrichment process is also mainly uranium - 238 which also decays. The decay of these enrichment tailings results in a total of 1.7×10^{13} curies of radon - 222. This is listed in Table 1, along with the other radon yields.

It is instructive to compare these quantities of activity to the activity of the fission products which result from the use of the fuel which they are associated with. The total fission product inventory resulting from 0.8GWy(e) with half lives of 25 years or more is about 10^7 curies. This is much less than any of the numbers in Table 1. We should be more careful with these tailings.

Radon Produced by the Coal Fuel Cycle

Item 2 i of Appendix A of NUREG-0332 (Ref. 1) assumes a 75% capacity factor, which for a 1000 MWe plant would produce only 0.75 GWy(e). A capacity factor of 80% will be used here. The production of 0.8 GWy(e) by a coal plant operating at 40% efficiency, using 12,000 BTU per pound coal would require 2.5 million short tons of coal. This is close to the value of 3 million tons suggested on page 9 of NUREG-0332 (Ref. 1).

There is great variability in the amount of uranium contained in coal. An analysis of coal samples at one TVA plant reported by the EPA (Ref. 4) indicates a range of almost a factor of ten in uranium content. Eisenbud and Petrow (Ref. 5) report a value of about 1 part per million. A recent survey by the USGS based on several hundred samples suggests that in the United States coal contains an average of 1.8 part per million of uranium(Ref. 6). Both values of 1.0 and 1.8 ppm will be used here. Thus 2.5 million tons of coal will contain between 2.3 and 4.1 thousand kilograms of uranium. Using the assumption of NUREG-0332 (Ref. 1) that there is 99% particulate removal from plant emissions, 1% of this uranium will be dispersed into the air and the remainder carted away as ashes for land burial. Table 1 indicates that with 1.0 ppm coal the uranium in the resulting ash will decay to a total of 3.2×10^{11} curies of radon - 222, while the stack emissions will lead to 3.2×10^{9} curies. For 1.8 ppm coal the values are 5.8×10^{11} curies from ash and 5.8×10^{9} curies from emissions.

Evaluation of the Health Effects

It is necessary to evaluate the number of deaths which result from the release of one curie of radon - 222. For the purpose of this evaluation the population and population distributions are assumed to remain at the present values. This should provide a good first estimate.

NUREG-0332 (Ref. 1) suggests that a release of 4,800 curies of radon - 222 from the mines (page 11) would result in 0.023 excess deaths (Table 1a, page 18). This provides a ratio of 4.8×10^{-6} deaths per curie. Data from Chapter IV of GESMO (Ref. 7) suggests a value of 1.7×10^{-6} deaths per curie as a lower limit. The value of 4.8×10^{-6} deaths per curie will be used here as the NRC estimate. It is understood that this is very approximate.

The EPA has evaluated the health effects of a model uranium mill tailings pile. They estimate a total of 200 health effects (Ref. 8, page 73) for a pile which emits at most 20,000 curies of radon - 222 for 100 years. The resulting estimate is 1.0×10^{-4} deathe per curie and will be used here as the EPA estimate.

Evaluation of Health Effects - Nuclear

At present, some recent uranium mill tailings piles have 2 feet of dirt covering. In this case the EPA estimate (Ref. 8) is that about 1/20 of the radon produced escapes into the air. This factor of 20 is listed in Table 1 and is used to find the effective releases. Thus the 3.9×10^{8} curies of radon which results from thorium in the mill tailings results in a release of 1.9×10^{7} curies into the atmosphere, which with the NRC estimate of 4.8×10^{-6} deathe per curie results in 90 deaths. With the EPA estimate 1900 deaths result. A similar treatment applied to 8.6×10^{11} curies of radon from the uranium in the mill tailings results in 200,000 dead for the NRC estimate and 4.3 million for the EPA estimate. It is here assumed that no future generation will see fit to take any better care of the mill tailings than is presently practiced.

The uranium enrichment tailings are presently located in the eastern part of the country. It is assumed that these are buried near their present locations. Radon will not escape so easily through wet soil. A reduction factor of 100 is used to estimate this effect. The accuracy of this estimate depends on the particulars of the burial which can only be projected. An additional factor of 2 is used to reduce the effect due to the fact that much of this radon would decay over the ocean rather than populated land areas. No compensation is taken for the greater population density near the point of release as compared to the uranium mill tailings piles of the western states. With this total reduction factor of 200 the NRC estimate is 400,000 dead while the EPA value is 8 million.

Evaluation of Health Effects - Coal

It is assumed that the ashes from the coal plants will be buried in a manner similar to the tailings from the uranium enrichment process. Thus a reduction factor of 200 is used in this case also. Again the higher population density is ignored.

The particulate which is released into the air by the coal plant is taken to contain 1% of the contained uranium. Since most such plants are in the eastern part of the country it is estimated that half will fall into the ocean rather than onto land. A second factor of 2 is used to reduce the effect of the resulting radon due to the fact that some of this radon will decay over ocean as with the radon from the uranium in the enrichment tailings. Again no compensation is taken for the greater population density near the point of release. This gives the total reduction factor of 4 shown in table 1.

With these reduction factors applied to the radon released by the ashes and emissions, in the two cases of 1.0 ppm and 1.8ppm uranium content coal, the health effects are calculated. These are shown in Table 1, and range from 7,700 dead from ashes and 3,800additional dead from airborn emissions for 1.0 ppm coal in the NRC estimate to 290,000dead from ashes and 140,000 dead from airborn releases in the case of 1.8 ppm coal in the EPA estimate.

Discussion

It is obviously very difficult to estimate with any precision how many health effects result from the release of a given curie of radon - 222 from some specific site in the west. The estimates presented here differ by a factor of 20. This might best be used as a range of expected deaths. The reduction factors used here are crude estimates in some cases, and could be improved upon. Changes in public policy could also change the manner in which this material is disposed, thus greatly changing these factors. In particular deep burial could practically eliminate the escape of radon to the atmosphere (Ref. 8).

It is important to compare Table 1 here with Table 1 of NUREG-0332 (Ref. 1), which shows 0.47 dead for the nuclear case and at most 120 dead for coal. These last numbers totally ignore the effects of long term radon emissions, which result in at least 100 times higher mortality. These long term effects are not only significant, but dominate the effect.

It is important to use Table 1 to compare the relative risk of the nuclear and coal option in their present forms. In this case deaths due to all causes considered in NUREG-0332 can be ignored as insignificant, since they are so small. The absolute number of deaths per curie released is irrelevant since it enters in both cases. The relative risk is determined solely by the quantities of radon - 222 generated and the reduction factors. Unless there is a clear decision to treat coal ashes differently from uranium enrichment tailings, the health effects from the tailings will be 50 times greater since there is

50 times more uranium there. The nuclear option remains more hazardous than coal unless the releases from all of the tailings piles can be reduced below the releases from the airborn particulates of the coal plant. This is not the present policy.

Additional Comment

There is a typographical error on page 25 of NUREG-0332. Reference #33 is listed there as being in volume 148 of Science, whereas it appears in volume 144.

Acknowledgment

The above comments were inspired by the 5 July 1977 testimony of Dr. Chauncey R. Kepford in the matter of the Three Mile Island Unit 2 (Docket No. 50-320) operating license entitled: " Health effects Comparison for Coal and Nuclear Power".

Table 1

Energy Source Excess Mortality per 0.8 GWy(e) due to Radon - 222 emissions

Origin of Radon	Radon Generated Curies	Reduction Factor	Deaths NRC	Deaths EPA
Nuclear				
Thorium in Mill Tails	$3.9x10^8$	20	90	1900
Uranium in Mill Tails	$8.6x10^{11}$	20	200,000	$4.3x10^6$
Uranium in Enrichment Tails	$1.7x10^{13}$	200	400,000	$8x10^6$
Coal 1.0 ppm U				
Ashes	$3.2x10^{11}$	200	7,700	$1.6x10^5$
Air Particulate	$3.2x10^9$	4	3,800	$8x10^4$
Coal 1.8 ppm U				
Ashes	$5.8x10^{11}$	200	14,000	$2.9x10^5$
Air Particulate	$5.8x10^9$	4	6,800	$1.4x10^5$

References

1 "Health Effects Attributable to Coal and Nuclear Fuel Cycle Alternatives" NUREG-0332,Draft, U.S. Nuclear Regulatory Commission (September 1977)

2 "Environmental Analysis of The Uranium Fuel Cycle, Part I - Fuel Supply" EPA-520/9-73-003-B, U.S. Environmental Protection Agency, (October 1973)

3 R.O. Pohl, "Health Effects of Radon - 222 from Uranium Mining" Search, 7(5),345-350 (August 1976)

4 P.H. Bedrosian, D.G. Easterly, and S.I. Cummings,"Radiological Survey Around Power Plants Using Fossil Fuel" EERL 71-3, U.S. Environmental Protection Agency, (July 1970)

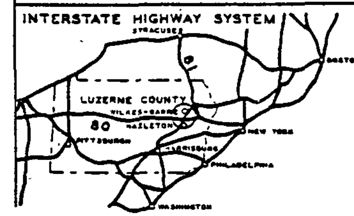
5 M. Eisenbud, and H.G. Petrow," Radioactivity in the Atmospheric Effluents of Power Plants that Use Fossil Fuels," Science 144,:288-289 (1964)

6 V.E. Swanson et al,"Collection, Chemical Analysis, and Evaluation of Coal Samples in 1975", Open-file report 76-468, U.S. Department of the Interior, Geological Survey, (1976)

7 "Final Generic Environmental Statement on the Use of Recycle Plutonium in Mixed Oxide Fuel in Light Water Cooled Reactors," NUREG-0002. U.S. Nuclear Regulatory Commission, (August 1976)

8 See Ref. 2

LUZERNE COUNTY PLANNING COMMISSION



EDWARD HEISELBERG
DIRECTOR OF PLANNING

DONALD J. SHYMANSKI
ZONING OFFICER

LUZERNE COUNTY COURT HOUSE
WILKES-BARRE, PENNSYLVANIA 18711
TELEPHONE: 825-2749
823-6161 EXT. 226 - 227

August 10, 1979

United States Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Director, Division of Site Safety and Environmental Analysis.

Gentlemen:

The Susquehanna Steam Electric Station is located in Luzerne County. The Draft Environmental Statement (NUREG-0564) of the U. S. Nuclear Regulatory Commission was reviewed by the Luzerne County Planning Commission on August 9, 1979, at its regular monthly meeting at which a quorum was present.

After due consideration, a motion was made, seconded, and unanimously carried to make two (2) recommendations to the U. S. Nuclear Regulatory Commission:

1. That an Emergency Evacuation Plan be completed by the Luzerne County Civil Defense Agency before the Susquehanna Steam Electric Station goes into operation; and

Page 2....
U. S. Nuclear Regulatory Commission
Washington, D. C.
August 10, 1979

2. If at all possible, to have an additional source of water available other than the Susquehanna River, and particularly Pond Hill Reservoir, before the Station goes into operation.

Yours truly,

Edward Heiselberg, Director of Planning
Luzerne County Planning Commission

EH/mss

cc: Nick Souchik, Luzerne County Civil Defense Agency
Susquehanna River Basin Commission
Senator Frank O'Connell
Nancy Snee
Pennsylvania Power and Light Company
Susquehanna Alliance

216 North Fifth Street
Apt. 2
Lewisburg, Pa. 17837
October 25, 1979

Mr. Daniel Muller
Director, Division of Site Safety and
Environmental Analysis
Office of Nuclear Reactor Regulation
United States Nuclear Regulatory Commission

Dear Mr. Muller:

The purpose of this letter is to express my comments on the Draft Environmental Statement related to the operation of the Susquehanna Steam Electric Station, Units I and 2, Docket Numbers 50-387 & 50-388.

I, In refering to figure 2.I, the map that is presented is of very poor quality and standards. There is no north orientation nor is there any distance scale presented. The map is blurred, and worst of all, the plant site is not shown. If you were to assume that north is pointing to the top of the map, then the two counties that shown are backwards. Colombia County is east of Luzerne County, and it is not the other way as they are incorrectly shown. Finally, after making these corrections, I recommend that a much larger base area be used so as to locate other areas of the state in relation to the plant site.

2, In refering to section 2.2.4.2, the amount of data presented on the capabilities of the nearby hospitals handling emergency situations that can occur with a nuclear facility is inadequate. There should be much more data presented on the qualifications of the hospitals in handling and treating radiological accidents and cases.

3) In refering again to section 2.2.4.2, the amount of data concerning police and fire protection is also inadequate. If an emergency situation should arise, such as a fire at the plant, are the local volunteer fire companies adequately trained to fight a fire at such a facility? Are the local volunteers trained to cope with an emergency that may envolve radiological precautions? Do they have the necessary equipment? These questions should be considered for the final statement.

4) In refering to section 2.2.6.I, the land-use categories for Luzerne County for developed land correctly add to 100%, but the land-use categories for developed land in Columbia County do not total 100%. This error should be checked and corrected.

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5) In refering to section 3.2.I, if the applicant is considering building an additional reservoir, then this should be included in the cost/benefit ratio. Also, if the plant must be shut down during periods of low flow, then this should be included in the cost/benefit ratio.

6) In refering to section 4.4.I.I, there is an area that does need attention. In paragraph six the applicant states that 330 grams of salt per hectare per month will be deposited. The staff believes that this will not cause an impact on local biota and soils because of the results of recent studies from the Chalk Point Power Plant in Maryland. I disagree with this assumption. Because the salt has no adverse results in Maryland does not mean that it will have no adverse effects in Pennsylvania. The fact that Maryland is close to the coast could mean that the flora there has adapted to the salt that naturally drifts in from oceanic breezes. I am sure that the species of flora along the coast are much more tolerant of brackish conditions than those species that are found near and around Berwick, Pennsylvania. I also believe that the soils along the coast are naturally brackish. Therefore, any small amount of extra salt imposed on those soils will be in the tolerable range of those coastal soils. However, adding appreciable amounts of salt to those types of soils that are not accustomed to salt will most certainly have adverse effects. In conclusion, I think that the assumption made on the results of the power plant in Maryland are misleading and do not apply to SSES. Therefore, this problem needs to be solved.

7) In refering to section 4.4.3, the assumptions made are not compatible with SSES. Again the assumption is that if there are no problems at one plant, then there will be no problems at the next. The assumption that little or no fogging or icing will occur at SSES is not valid. Berwick and surrounding areas along the Susquehanna River have always been known for being subject to fog conditions. The effects of the plumes will add to this natural phenomenon. The occurence of ground-base inversion layers, a common meteorlogical phenomenon in the ridge and valley province of Pennsylvania during the winter months, was not even mentioned. Should this occur with below-freezing temperatures, the consequences will be much icing of foilage, utility lines, highway surfaces (Route II), and any other surfaces. I cannot see how the applicant and the NRC can draw conclusions about the effects of the NDCT's at SSES from the results obtained in Europe. This section must also be corrected and further studied.

8) In refering to table 5.I, the frequency of monitoring has to be increased. The most frequent monitoring that table 5.I mentions is weekly. Giving the applicant the benefit of doubt, I assume that this will not be the complete schedule of the radiological monitoring. If this is not the complete monitoring schedule, then the complete schedule of frequencies and locations should be included in the final statement.

9) In refering to tables 6.I and 6.2, I find it very disturbing that the applicant and/or staff has not included the possibility of a class nine accident occuring. Since the draft was published after the accident at Three Mile Island, then the results should have been incorporated. Also included should be the psychological effects that TMI has had and the psychological effects that the SSES will have.

IO) In refering to tables 7.4 and 7.5, I find that the reserve margin with SSES in both cases is much too high. As a matter of fact these two tables show that the plant is really not needed.

II) In refering to section 8.6, I think that a decomissioning plan should be prepared before operation in the case of an emergency where time would be a factor in preparing one. In other words a plan should be ready should the event arise that it is needed. Also the cost that is stated for decomissioning seems quite low. Is the cost of decomissioning included in the cost/benefit ratio?

I2) In refering to figures 3-I, 3-2, and 3-3, one cannot give a critical evaluation of the planned routes of the transmission corridors when one cannot even read the maps. These maps are also of very poor quality for obvious reasons. (See comment I).

I think that these comments are very much worth consideration in preparation of the final environmental impact statement for the SSES. I would appreciate and welcome any reply to the above comments.

Sincerely,

Michael M. Molesevich

Michael M. Molesevich

Aug. 14, 1979

To Whom it may concern;

In response to the N.R.C. wanting comments relating to the operation of P.P.&L. Cos. Susquehanna nuclear power plant, to me nuclear power plants remind me of Russian Roulette, but instead of gambling on one life they gamble on millions of lives and anything in their way. Nuclear power plants up to now are not to be trusted or the people that (think) they are controlling them. It was proven at the 3 mile plant near Harrisburg that up to today they don't even know what to do with the radioactive water or waste. These nuclear plants also remind me of being handed a shrapnel grenade and being told to pull the pin and hold it not knowing if it is a dud or a live one.

Now to look at being power conservative and no need for nuclear power plants. In the past 15 to 20 years people thatmoved into the Back Mountain want street lights on every corner but want the taxpayer to pay for them, and not as it was years ago, if a light was seen to be needed by a barn or something the individual paid for it. The road I live on is about 3 miles long and not a public street lamp is on it. I think if you want country living then don't look for a street light on every corner or power pole. And then there is the automatic washers and dryers which some people use them every day. I don't think that is necessary especially when you think of the power that goes into the electric dryer, some exercise wouldn't hurt. Then there are some stores as I have seen having about 9 televisions turned on at one time, and enough lights turned on to use a microscope without its light on. This is only a few of the ways I see electrical power wasted.

Truely Yours,
Lou Moses
R.D.#3 Wyoming Pa. 18644

P.S. Please let me know if & when you receive this letter and your opinion of my comments

7908200 363

4D, Freeland Pa.
July 28, 1979

Division of Site Safety
& Environmental Analysis
Nuclear Regulatory Commission
Washington DC 20555

Attn: Director

In writing the inside address of this letter, I find that your divisional title is inappropriate. If you were, in fact, concerned with "site safety" & "Environmental Analysis" you could not possibly recommend PP&L be granted an operating license—even at a provisional level. (statement of NUREG-0564.)

Why is the NRC bothering to study the Three Mile Island accident, if licenses can be granted before the full impact of this accident is learned? It is indeed irresponsible for the NRC to continue business as usual pretending Three Mile Island never occurred.

Would you want a nuclear reactor in your back yard? And if they are indeed "safe"

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why do we need evacuation plans? If the only "safety" you can assure us of, is obtained by evacuating pregnant women & young children, you had better look again at your meaningless title which contains words like SAFETY & ENVIRONMENTAL ANALYSIS.

Sincerely,

Deborah Olsen

PP&L

TWO NORTH NINTH STREET, ALLENTOWN, PA. 18101 PHONE: (215) 821-5151

September 4, 1979

Mr. Donald E. Sells, Acting Branch Chief
Environmental Projects Branch 2
Division of Site Safety and Environmental Analysis
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

SUSQUEHANNA SES
COMMENTS ON DES
ER 100450 FILE 991-2
PLA- 396

DOCKET NOS. 50-387
AND 50-388

Dear Mr. Sells:

Attached are PP&L's comments on the Draft Environmental Statement issued by NRC in June, 1979.

Very truly yours,

N W Curtis

N. W. Curtis

JSF #587:5

Copy to:
Mr. Paul Leech
Mail Stop P522
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

7909070452

1. INTRODUCTION

1. Section 1.], pg. 1-1 - The issuance of a National Pollution Discharge Elimination System (NPDES) permit is a necessary prerequisite for the issuance of an operating license by the Nuclear Regulatory Commission. The permit was issued by the Pennsylvania Department of Environmental Resources on July 31, 1979.

2. THE SITE

1. Section 2.3.3, pg. 2-11 - Figure 2.3, Water Use Diagram has been revised per the NPDES permit. The parking area hold-up pond has been deleted (see revised Figure 2.3, attached)

2. Section 2.3.4.1, pg. 2-11 - On "line 1" - The monitoring schedule ranged from twice weekly to quarterly. On "line 2" - The monitoring by Ichthyological Associates since 1971 has been weekly instead of daily. Line 8 should read total iron "and fecal coliforms". Figures 2.5 and 2.6 are reversed.

3. Section 2.5.1.3, pg. 2-22 - Add to line 12; "An American peregrine falcon was observed in 1973.:

4. Section 2.4.2, pg. 2-11 - Local Meteorology

The statement is made that in 1973 data recovery for the joint frequency data at the 9.6 m level was "only about 70%." Applicant data show about 90%. This is based on the wind speed and direction from the 9.6 m level and the temperature differential between 91.7 m and 9.6 m as the primary system. If these temperature differential data were missing, the temperature differentials between 30.5 m and 9.6 were used.

The years 1974 and 1975 did have an unusually high occurrence of unstable conditions. These meteorological conditions are not fully understood. The data may not be representative of long term conditions but they are representative of conditions which occurred in 1974 and 1975, and therefore, Applicant believesit should not be deleted.

For the year 1976 the wind speed and direction data indicates a predominant wind flow from the west-southwest (13.50% of the time). A secondary flow occurred from the west 12.18% of the time. These figures differ slightly from those in the DES, although the directions are in agreement. The frequency of calms was 1.51% for 1976 at the 9.6 m level, rather than the 4.6% frequency shown in the DES.

3. THE PLANT

1. Section 3.2.4.1, pg. 3-8 - The parking area hold up pond has been deleted. See revised Figure 2.3 which is attached.

4. ENVIRONMENTAL EFFECTS OF STATION OPERATION

1. Section 4.3.1, pg. 4.2 - The effluent limitations, monitoring requirements, and other standard and special conditions of the Commonwealth of Pa. Water Quality Management Permit (No. 4076203) have been susperseded by the terms and the conditions of the NPDES Permit (No. PA-0047325). See part C, paragraph B of NPDES permit.

2. Section 4.3.3.3, pg. 4-5 - Inhibitors containing chromium will be used in the closed cooling loops.

3. Section 4.4.2.1, Pg. 4-9 - Although it is true that specific pool by pool comparisons have not been made, the applicant's consultant, Ichthyological Associates (IA), has compared water quality and aquatic organisms (species numbers and relative abundances) in the intake-discharge pool to that at sampling stations in pools up and downriver. A review of physiocochemical, algae, zooplankton, benthos, larval fish, and adult fish data presented in IA Annual Reports from 1972 through 1974 will show that ample comparisons have been made. Overall, the results reveal that aquatic life in the intake-discharge pool is not unique in comparison to other areas sampled with the exception that this pool is an extensive recovery zone caused by acid mine drainage pollution which enters at various locations upriver. For example, in 1974 Gale and Mohr (1976) sampled fish spawning sites about 6 km up- and downriver from the intake. They determined that "no species avoided polluted waters by spawning in the tributaries or in clean water below their mouths." They also found the most kinds of fish eggs in "shallow water with strong currents." Such areas are between river pools. Furthermore, in 1973 Tuttle (1974) sampled adult fishes with nearly equal effort at five stations. He captured about three times as many fish at Falls, a relatively clean water control station about 65 km upriver, than at the intake-discharge pool (SSES).

The term "pool" is perhaps somewhat misleading. The Susquehanna River during low water periods is not a series of pools that are isolated from one another by shallow riffle areas. Even during the lowest flows at which the Susquehanna SES will be permitted to operate, there will be ample flowage between the pools so that fish and other organisms can pass freely.

References

Gale, W. F. and H. W. Mohr, Jr. 1976. Fish spawning in a large Pennsylvania River receiving mine effluents. Proc. Pa. Acad. Sci. 50: 160-162.

Tuttle, L. R., Jr. 1974. Fishes. Pages 537-691 in, An ecological study of the North Branch Susquehanna River in the Vicinity of Berwick, Pennsylvania, Progress Report for the Period January-December 1973. Ichthyological Associates, Inc., Berwick, PA.

4. Section 4.4.2.1, pg. 4-10 - An entrainment and impingement program will be provided consistent with NPDES permit (No. PA-0047325) requirements.

The applicant has stated that impingement and entrainment will be "relatively small" because of unpublished studies done by Ichthyological Associates, Inc. at the Hunlock Steam Electric Station (Hunlock SES) in 1974-75 (Ichthyological Associates 1975). The Hunlock SES is a small, coal-fired station operated by the Luzerne Electric Division of the UGI Corporation, Kingston, Pennsylvania. It is located about 15 km upriver from the Susquehanna SES and utilizes a once through cooling system that draws about 245 m^3/min of water through two intake canals with velocities up to 0.23 m^3/s. Once each month, from May 1974 through April 1975, impingement samples were collected. Extrapolation of results from these limited samples showed that approximately 230 kg of fish flesh were impinged throughout the one-year period. It was therefore concluded that impingement losses of about 0.6 kg/day would have a negligible effect on the sport fishery of the Susquehanna River. Because the Susquehanna SES at maximum generation will withdraw only about 150 m^3/min, applicant concludes that impingement losses would be similar to those experienced at the Hunlock SES. Larval fish were also sampled at the Hunlock SES once per month in May, June and July, 1974 to evaluate entrainment. Mean densities of entrained larvae were always less than one larvae/m^3. This was concluded to be an acceptable loss because less than 5% of the river flow was drawn into the plant on the days sampled. It would not seem unreasonable to expect similar results at the Susquehanna SES. A copy of this report to be provided under separate cover.

References

Ichthyological Associates, Inc. 1975. Hunlock Steam Electric Station Ecological Study, Progress Report for the Period May 1974 through April 1975. Ichthyological Associates, Inc., Berwick, PA 107 pp.

5. Table 4.1 - This table contains several typographical errors. A copy of the table with corrections indicated will be forwarded under separate cover.

6. Table 4.5, pg. 4-16

Staff assumptions regarding Turbine Building releases do not allow credit for the leakoff collection system.

Staff assumptions regarding the off-gas system releases are significantly higher than the ER-OL estimates. It appears this is due to a failure to adjust the charcoal absorption factors for temperature.

Applicant believes that iodine releases should be reduced due to the use the leakoff collection system.

5. ENVIRONMENTAL MONITORING

1. Table 5.1, pg. 5.3 - This table has been updated to reflect changes in sampling locations and station nomenclature corrections. The lower limits of detection have also been revised per NUREG 0473. A copy of the table with corrections indicated will be forwarded under separate cover.

6. ENVIRONMENTAL IMPACT OF POSTULATED ACCIDENTS

No Comments

7. NEED FOR POWER

1. Section 7.1, pg. 7-1 - The present schedule for commercial operation of Unit 1 is July, 1981 and for Unit 2, October, 1982. Line 7 - 4970 MW is without UGI.

2. Section 7.3.2, pg. 7-2 - The annualized construction cost of $105 million is from FES-CP. The cost of the plant to PP&L in the ER-OL is forecast to be $1.9 billion. With an assumed 15% levelized annual carrying charge rate a carrying charge of $285 million per year results.

3. Table 7.4, page 7.5 appears to contain two errors. First, firm purchases are accounted for twice. Normally, these transactions are either added to total capacitors or subtracted from peak load. Since 76 MWe are included in total capacities, this amount should not be subtracted from the Winter Peak. Second, for years 1982 through 1985, only Unit 1 was subtracted from the total capacities to calculate reserves without Susquehanna. Unit 2 should also be deducted.

8. EVALUATION OF PROPOSED ACTION

1. Table 8.1 - The listing of nuclear fuel consumed in kg/day (12,000*) appears to be one order of magnitude too high.

9. BENEFIT-COST ANALYSIS

1. Section 9.4, pg. 9-1 - Economic Costs

The fuel cost for the first full year of operation should be $51 million as noted on Table CAB 1.2 of the ER-OL.

2. Table 9.1, pg. 9.2 - Benefit-Cost Summary

The energy and capacity in the Direct Benefits section are for the whole plant (2 units), however the Economic Costs are PP&L's share of the first year cost of Unit #1 only. The direct benefits and the economic costs should be stated on a consistent basis.

JSF #587:5

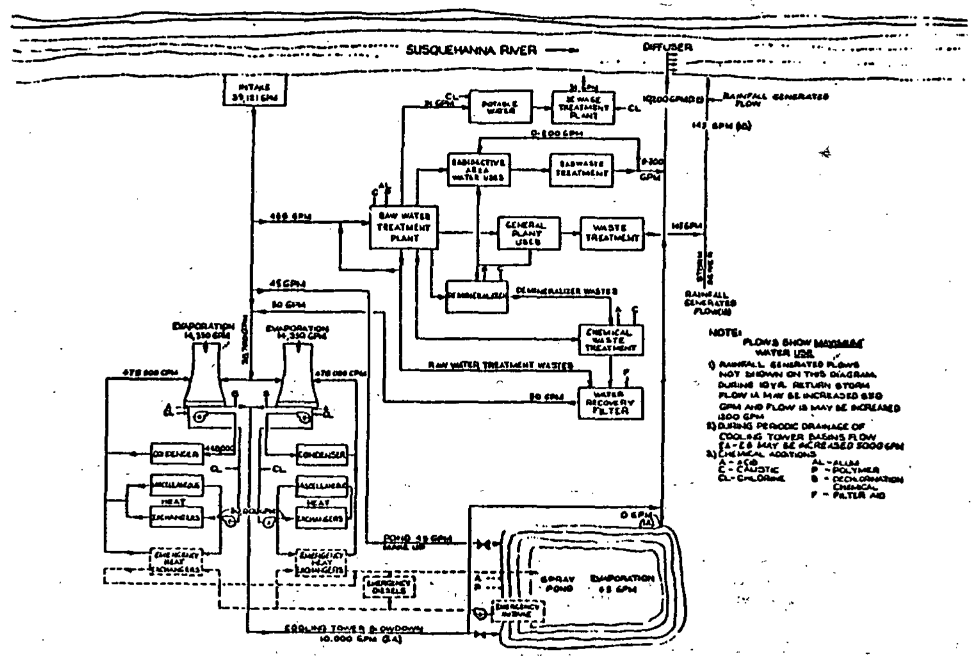

Fig. 2.3. Water Use Diagram for Susquehanna Units 1 and 2. From ER-OL, Fig. 3.3-1.

PP&L

344 SOUTH POPLAR STREET, HAZLETON, PA. 18201 PHONE: (717) 454-6641

September 10, 1979

Mr. Howard J. Grossman, Executive Director
Economic Development Council of
Northeastern Pennsylvania
P. O. Box 777
Avoca, Pennsylvania 18641

RECEIVED
SEP 12 A.M.
EDCNP

Dear Howard,

Your review of the Nuclear Regulatory Commission's Draft Environmental Statement (DES) is appreciated. In response to the questions raised in your August 27, 1979 letter, we offer the following:

1. As noted in the DES, the Susquehanna River is the source of water needed for the operation of Susquehanna SES. In 1976, the SRBC formulated regulations requiring flow augmentation by users of Susquehanna River water under certain conditions. To meet this requirement, PP&L proposed to build the Pond Hill Reservoir Project. An application for plan approval of the project was submitted to SRBC in March, 1979. The SRBC has not completed their review at this time.

   SRBC recognized that some projects were well underway when their regulations were issued and that augmentation facilities could not be built prior to operation of the user facility. The regulations provide flexibility in establishing an effective date for each facility consistent with reservoir approval and construction schedules. Provided that approvals are granted in a timely manner, PP&L expects to put the Pond Hill Project in service in 1983.

2. All the facilities in the flood plain related to operation of the Susquehanna SES are designed to withstand the 100-year flood and remain operational. Examples of such facilities are the transmission towers and the river water intake structure. The impact of flooding substantially above the 100-year flood level is primarily plant shutdown due to loss of operability of the river water intake. Since the plant elevation is approximately 150 feet above the river level, there would be no impact and, consequently, no hazard to the public.

3. PP&L has made arrangements with the Berwick Hospital for the treatment of injured persons who might also be radioactively contaminated. The Berwick Hospital is the nearest hospital to the Susquehanna plant and is the logical choice for this type of service.

   Other hospitals in the area must be considered in emergency planning, and to insure this, PP&L has been actively pursuing the formulation of adequate emergency plans with the Pennsylvania Emergency Management Agency, the Columbia and Luzerne County Civil Defense organizations and others. PP&L believes that area hospitals are addressed in the emergency plans developed by these agencies.

4. The Safety Evaluation Report (SER) is prepared and issued by NRC and is a necessary step prior to beginning public hearings on safety-related issues involving Susquehanna SES. The SER is unlikely to be issued before Spring, 1980. If you request a copy of the SER from NRC, they will forward it to you when it is issued.

If you require additional information, please feel free to contact me.

Very truly yours,

Paul R. Stewart

PP&L

May 29, 1980

Mr. B. J. Youngblood, Chief
Licensing Branch 1
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, DC 20555

SUSQUEHANNA SES
COMMENTS ON POND HILL DES
ER 100450 FILE 991
PLA-490

Docket Nos. 50-387
and 50-388

Dear Mr. Youngblood:

Attached are PP&L's comments on the Draft Supplement to the Draft Environmental Statement related to operation of the Susquehanna Steam Electric Station (NUREG-0564). If you have any questions on these comments, please contact W. E. Barberich (Phone 215-821-5833).

Very truly yours,

N W Curtis

N. W. Curtis

WEB:mg
1Q

Attachment

PENNSYLVANIA POWER & LIGHT COMPANY

SUSQUEHANNA SES
COMMENTS ON DRAFT ENVIRONMENT
STATEMENT (DES)

Summary and Conclusions

It is suggested that an additional item be added to the list of potential impacts, stating, as indicated in Section 4, that the project will have minimal impacts on the Susquehanna River.

Section 1 - Introduction

1) Section 1.1 Para. 3: Add "plus consumptive use" after "the Q7-10 value".

2) Section 1.2 Para. 3: The Applicant will also obtain necessary federal permits (Corps of Engineers, etc.)

Section 2 - The Site and Its Environs

1) Section 2.3.3: It should be noted that one property owner has developed a spring within the proposed project boundary, as a source of water during part of the year. This spring is in the vicinity of the innundated area and, depending on its exact location, may be innundated. This was shown as the spring on the south side of the reservoir on plate 17 of our November 17, 1979 response.

   Use of this spring as a water supply source would be discontinued after project completion.

2) Section 2.5.2.1 Para. 1: We are unaware of any sampling by DER in Pond Hill Creek. Sampling of Pond Hill Creek referenced in Appendix H was by consultants to PP&L. The reference to the ER-OL should probably be to Appendix H of the ER-OL. This reference should also be added on the footnotes to Tables 2.2, 2.3, 2.4 and 2.5.

3) Page 2-22, Reference 29: This reference is redundant to reference 24, which specified the date correctly.

Section 3 - Reservoir Description

1) Section 3.1 Para. 2: This paragraph should be clarified to indicate the 287 m (940 ft.) normal water surface project would have an active storage volume of 12.5 x 10^6 m^3 (10,100 Ac-ft.) and

a total storage volume of 16.0×10^6 m^3 (13,000 Ac-ft.). The higher, 299 m (981 ft.) MSL normal water surface project, would have an active storage volume of 27.1×10^6 m^3 (22,000 Ac-ft.) and a total storage volume of 29.7×10^6 m^3 (24,000 Ac-ft.). Based on a study of the optimum dam height, storage capacity of the site is topographically limited to a dam with a crest elevation of 310.9 m (1020 ft.) MSL, providing 38.5×10^6 m^3 (31,200 AC-ft.) total storage. This study indicated the most economical project would have a normal water surface elevation of 299 m (981 ft) MSL. The design for the project is being prepared based on this height of Dam.

2) Section 3.1 Para 3: The last sentence should be clarified to note that the drawings provided in the DES are for the larger project. Revised Plates A-1, 2, 5, 6, 17, 19, & Figure 3-2 showing the latest project concepts are attached.

3) Section 3.1.1 Para 2: The last sentence should be revised to state that the impervious subsurface cutoff will be required to prevent seepage thru the saddle rather than in the saddle.

4) Section 3.1.3: The project concept for the inlet-outlet structure has recently been revised from the inclined structure previously proposed to a conventional multi-port vertical tower. Three outlet ports will be provided, at Elev. 956, 925, 850 MSL. The attached Plate 6 shows the revised inlet-outlet structure concept.

6) Section 3.1.4 Para 1: The pipe will convey an average flow of 3.0 m^3 sec. (106 cfs) but will be capable of conveying higher flows. The two submerged discharge sleeve valves in the pump station will each be capable of discharging up to 150 cfs. This will be the limiting feature of the design.

7) Section 3.2.2 Para 2: Average annual water use of SSES during a repeat of the meteorological conditions occurring during the drought of record has been estimated at 52.5 cfs (1.5 m^3/sec) not 49.5 cfs (1.4 m^3/sec.).

8) Section 3.2.2 Para 3: We suggest that this section be retitled "Compensation Releases" and wherever the term "augmentation releases" appears in the report it be replaced by "compensation releases". The purpose of releases from Pond Hill Reservoir will be to provide compensation for water consumed by downstream users. The term augmentation releases may be misinterpreted to imply that the releases will be solely to increase flow in the river.

<u>Section 4 - Environmental Effects of Construction and Operation</u>

1) Section 4.3.1 Para 5: As significant volumes of fill material will be removed from the borrow areas, it will be impossible to reestablish the original contours; however, the areas will be regraded so that they will drain properly, topsoil will be replaced and suitable landscaping will be provided.

2) Section 4.3.1 Para 6: Drainage features such as culverts will be provided in the final design for the access road where necessary to control runoff from the road as well as runoff intercepted by the road.

3) Section 4.3.2.3 Para. 2: As indicated above, the inlet-outlet structure concept has been revised. The revised design will provide 3 outlet ports with the top outlet port of elev. 956 ft. (291.4m) MSL or 25 ft. (7.6m) below the normal water surface. Model data indicates that this port will be in the epilimnion, thereby eliminating the problems associated with the withdrawal of hypolimnitic water. Tables 1 & 2 (attached) show the results of temperature model studies of the revised inlet-outlet structure concept. These studies are based on meteorological conditions and stream temperatures occurring in 1964 and 1975 and assume 1964 release patterns.

4) Section 4.3.2.3 Para. 8: The average release velocity thru the screens will only be about 0.4 fps (0.9 cm/s) (measured 1 foot from the screens) and the screens will be about 2 ft. (0.6 m) above the river bed. It is, therefore, not believed any significant scour will result from compensation releases.

5) Section 4.4.2.2 Para 3: Minimum flow releases to Pond Hill Creek will be 5.7 L/s (0.2 cfs) and not 5 L/s (0.18 cfs).

6) Section 4.4.2.3: We are currently reviewing the design concept for the spillway, and will consider the NRC's comments in this review. As design approval for the project will rest with the Pennsylvania Department of Environmental Resources, the final spillway design will meet their criteria. We will inform the NRC of any revisions to the spillway concept.

<u>Section 5 - Alternatives, Need for Facility, and Benefit Analysis</u>

1) Section 5.1.3: In February, 1980 , the SRBC established July 1, 1984 as the deadline for compliance with the consumptive water make-up requirements (SRBC Regulations, Section 803.61).

2) Section 5.3.1 Para 1: The second sentence states that the applicant would have to purchase replacement power if Susquehanna were down due to low flow. This is not correct since, depending on PP&L/PJM conditions, it may be that "sales" would be lost rather than "purchases" needed. The sentence should read "Under the river following

alternative, the applicant would incur added costs because of the loss of generation due to the shutdown of SSES".

3) Section 5.3.1 Para 2: The 14 day shutdown probability appears inconsistent with Table 5.3.

4) Section 5.3.3: The cost reported here ($47 million) is for the smaller reservoir design. The cost is estimated to be $65 million (1983 dollars) for the larger reservoir assessed in the DES.

5) Section 5.3.4 Para 3: Since PP&L is a winter peaking system in the summer-peaking PJM power pool and since PP&L has favorable generation availability relative to PJM, the reserve margin without Susquehanna will exceed this reserve requirement for reliability through about 1986. However, should Susquehanna be shutdown because of low river flows, PP&L and PJM are both exposed to capacity reductions of other units on the Susquehanna River and other regional rivers for the same reason. In addition, because PJM currently has about 45% oil-fired capacity, the added exposure to low reserves due to fuel curtailment also exists.

6) Table 5.4: The 1980 PJM Reserve Margin <u>without</u> Susquehanna should be 34%.

1964 DATA
TABLE 1

POND HILL RESERVOIR DISCHARGE TEMPERATURE (°C)
3-PORT STRUCTURE

MONTH	AUGUST		SEPTEMBER			OCTOBER			NOVEMBER		
DAY	19	24	3	13	23	3	13	23	2	12	22
Temp. Effluent (°C)	19.6	20.6	21.5	16.7	17.8	15.8	13.4	11.8	10.8	10.2	9.0
Temp. River (°C)	26.0	24.0	22.0	20.0	18.0	17.0	15.0	13.0	11.0	9.0	8.0
Outlet Discharge (CFS)											
Outlet No. 1) El. 956	102	102	99	0	0	0	0	0	0	0	0
2) El. 925	0	0	0	99	99	102	102	0	0	0	0
3) El. 850	0	0	0	0	0	0	0	102	102	102	102

NOTE: Outflow rates of the model deviate from the specified 102 cfs flow in order to compensate for averaging techniques.

1975 DATA
TABLE 2

POND HILL RESERVOIR DISCHARGE TEMPERATURE (°C)
3-PORT STRUCTURE

MONTH	AUGUST		SEPTEMBER			OCTOBER			NOVEMBER		
DAY	19	24	3	13	23	3	13	23	2	12	22
Temp. Effluent (°C)	21.6	22.5	18.7	18.6	16.9	16.4	15.1	13.4	12.9	11.4	9.6
Temp. River (°C)	21.6	22.6	19.0	19.0	17.0	16.6	16.3	16.0	15.0	14.0	14.0
Outlet Discharge (CFS)											
Outlet No. 1) El. 956	91.8	96.8	75.3	0	0	0	0	0	0	0	0
2) El. 925	0	0	0	99	86.5	99.2	102	0	0	0	0
3) El. 850	15.2	10.2	23.7	0	12.5	2.8	0	102	102	102	102

NOTE: Outflow rates of the model deviate from the specified 102 cfs flow in order to compensate for averaging techniques.

PP&L

TWO NORTH NINTH STREET, ALLENTOWN, PA. 18101 PHONE: (215) 821-5151

NORMAN W. CURTIS
Vice President-Engineering & Construction-Nuclear
821-5381

January 7, 1980

Mr. B. J. Youngblood, Chief
Licensing Branch No. 1
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

SUSQUEHANNA STEAM ELECTRIC STATION
LOW RIVER FLOW OPERATIONS
ER 100450 FILE 841-2
PLA-592

Dear Mr. Youngblood:

The following information on Susquehanna operations during low river flow conditions was requested by Mr. Richard Stark:

> PP&L plans to replace water taken from the Susquehanna River during periods of low flow by utilizing water from either an existing reservoir or from the Pond Hill Reservoir to be constructed by PP&L. Should a low flow situation occur prior to the availability of a makeup water source, PP&L will comply with all SRBC directives regarding water withdrawal from the Susquehanna River.

If you require additional information, please call.

Very truly yours,

N W Curtis

N. W. Curtis
Vice President-Engineering & Construction-Nuclear

WEB:mks

8003270482 A

PENNSYLVANIA POWER & LIGHT COMPANY

Pennsylvania State Clearinghouse

PSC
Commonwealth of Pennsylvania

P.O. BOX 1323 — HARRISBURG, PA. 17120 — (717) 787-8046
783-3133

GOVERNOR'S OFFICE
OFFICE OF THE BUDGET

August 20, 1979

Director,
Division of Site Safety and
Environmental Analysis
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Sir:

The Pennsylvania State Clearinghouse has received from your office copies of the Draft Environmental Impact Statement related to the operation of Susquehanna Electric Station Units 1 and 2.

These copies have been transmitted for various State agencies for their review and comment.

Attached please find the comments of our Department of Environmental Resources relative to the above EIS.

Please consider these comments the official response of the State Clearinghouse. Additional comments received from State agencies will be transmitted to your office for response and inclusion in the Final EIS as appropriate.

Thank you for your cooperation.

Sincerely,

Richard A. Heiss

Richard A. Heiss,
Supervisor

ER-001 1-67 COMMONWEALTH OF PENNSYLVANIA

August 20, 1979

5-79-07-003

SUBJECT: Draft ES - Susquehanna Steam Electric Station Units 1 & 2 Operating Licenses

TO: Richard Heiss, Supervisor
Pennsylvania State Clearinghouse

FROM: CLIFFORD L. JONES
Secretary
Department of Environmental Resources

The Department feels the Draft Environmental Statement (ES) for the Susquehanna Steam Electric Station should include a more detailed discussion of several important concerns, especially in light of the recent accident at Three Mile Island: 1) the environmental consequences of a Class 9 nuclear accident, 2) contingencies for long-term storage of spent fuel, 3) routine radiation releases, 4) certain water quality aspects, and 5) impacts on fish populations.

(1) Nuclear Accident

Section 6.2 - Table 6.2 lists the radiological consequences of all postulated accidents. Since the consequences of the Three Mile Island (TMI) accident were greater than those listed and since the sequence of failures were more severe than analyzed as a design basis accident, it could be considered as a Class 9 accident. Therefore, this type of senario deserves more attention than a footnote in Table 6.2. A summary discussion of lessons learned from the TMI accident which are applicable to this plant should be included in the Final Environmental Statement (Operating Permit), with a more detailed discussion in the staff safety evaluation.

Table 5.1 - Section 5.3.6 states that the preoperational monitoring program delineated in Table 5.1 will be continued during the operational period. Based on experience gained as a result of the Three Mile Island accident, the number of direct radiation monitors (TLD's) would be totally inadequate for accident considerations.

The Draft ES should also evaluate the role and capability of state and local emergency management agencies in limiting the environmental health impacts of accidental radiation releases.

(2) Spent Fuel Storage

Section 4.5.5 - Radioactive Wastes - This section should be expanded to include contingencies for the long-term storage of spent fuel on site. This may be required if a decision has not been made on the final disposition of spent fuel after the plant has been operating for a few years.

(3) Radiation Releases

Section 4.5.2 - Direct Radiation - The direct radiation dose of 2.7 mrad/yr calculated by the applicant could be low by about an order of magnitude based on a more sophisticated type of analysis. If this is indeed the case, the site could exceed a liberal interpretation of 40 CFR 190. It would appear that these various models could be confirmed or refined by measurements taken near several of the operating boiling water reactors (BWR's).

Table 4.5 - It appears from this table of expected annual releases that about 18% of the Xe-133, 23% of the I-131 and about 5% of the Cs-137 is released through operation of the gland seal and mechanical vacuum pump. Since this is an untreated and unfiltered pathway, the routing of this effluent through the off gas treatment system, a seemingly simple design change, would significantly reduce the yearly routine station effluent. In addition, it has been the experience of other boiling water reactors in the Commonwealth having similar system arrangements, that the instantaneous technical specification limits have been exceeded by operating the mechanical vacuum pump following certain types of plant shutdowns.

Section 3.1 and 3.2.3 - Section 3.1 states that the applicant has modified the liquid, gaseous and solid radwaste treatment systems. Since these systems were described in some detail in the Final Environmental Statement (Construction Permit), the major design changes and their impacts should be described in more detail in this document. This is especially true of the gaseous radwaste treatment system which has changed from a cryogenic distillation system to one utilizing charcoal delay beds.

(4) Water Quality

The Draft ES is somewhat outdated with respect to the National Pollution Discharge Elimination System (NPDES) permit issued by Pennsylvania on July 31, 1979, the National Interim Drinking Water Standards for Specific Radionuclides and Recommended Water Quality Standards (Chapter 93) of the Pennsylvania Department of Environmental Resources. (Attached are the latest recommended standards which are expected to be adopted by the Environmental Quality Board on August 21, 1979).

The NPDES Permit issued by Pennsylvania limited iron to a maximum of 7 mg/l and an average of 4.6 mg/l. The Draft ES on page 4-5 at table 4.2 is not consistent with this permit requirement regarding the discharge.

The calculated radionuclide releases in liquid effluents is discussed in terms of dose commitments (pages 4-14, 4-15). The Department believes that the impact of radionuclide releases and resulting river quality concentrations should be compared to the National Drinking Water Standards.

The sulfate concentration in the river would be increased by approximately 10% to a value of 244 mg/l as a maximum which approaches the water quality standard of 250 mg/l. The Department would encourage that sulfuric acid be utilized such that the Saturation Index is a positive value, insofar as possible, to minimize sulfates in the discharge.

(5) Fish Population

The Department feels that additional studies are needed on entrainment and impingement relative to water intakes and that mitigative steps identified by the studies be followed.

The report indicates that turbulance caused by the jetted water from the discharge will scour the riverbed immediately downstream and that there may be some loss of spawning habitat. The Department believes that the effect of the discharge on macroinvertebrate should be evaluated.

Attachment

OFFICE BUDGET

Pennsylvania State Clearinghouse

P.O. BOX 1323 — HARRISBURG, PA. 17120 — (717) 787-2046
783-3133

Sept. 5, 1979

RE: PSCH# ʌ 57907003

APPLICANT: US Nuclear Regulatory Commission

PROJECT : DEIS – Susquehanna Electric Station Units 1 and 2

Dear Applicant:

Attached are additional comments concerning your State Clearinghouse submission referenced above.

Please include these comments with our correspondence to you dated August 20, 1979

Thank you for your cooperation.

Sincerely,

Marian L. Elby

Marian L. Elby,
Project Clearance Coordinator
Pennsylvania State Clearinghouse

Pennsylvania Clearinghouse
Governor's Budget Office
P.O. Box 1323
Harrisburg, PA 17120
717-787-8046

PSC SAI NO. 5 79 07 -003

FIRST STAGE REVIEW
Preapplication/Notification of Intent
AGENCY REVIEW COMMENTS

INSTRUCTIONS: To be completed by review agency and returned to State Clearinghouse. Check one or more appropriate boxes. Indicate comments below. Return copy 1, 2 and 3 to the State Clearinghouse. Retain copy 4 for your official records. Attach triplicate sheets if necessary.

PART I: Declaration of Interest

[ ] No Interest Declared — Complete Part V and return copy 1 and copy 2 to State Clearinghouse.

[ ] Interest Declared — Complete Parts II, III, IV and V and return copy 1 and copy 2 to State Clearinghouse.

PART II: Identification of Agency Review Criteria (Agency plans, programs, policies and/or laws)

We have reviewed Susquehanna Steam Electric Station's application for Nuclear Regulartory Commission. Our review is in accordance with Section 106 of the Historic Preservation Officer's role in the Advisory Council on Historic Preservation's procedures for the protection of historic properties.

PART III: COMMENTS (Include results of preliminary contact made with applicant and suggestions for improving project proposal)

This report adequately addresses cultural resources in the project area.

PART IV: Recommended State Clearinghouse Action (This action will not be honored by the State Clearinghouse unless Part II and Part III above have been completed)

[ ] Recommend Approval

[ ] Recommend Disapproval

[ ] Request the opportunity to review final application.

[ ] Request the opportunity to review environmental impact statement.

PART V: Certification	Authorized Agency Signature	Agency	Date
	WILLIAM HICKOK	PHMC	8-22-79

COPY 3. FEDERAL COPY—Return to Pennsylvania State Clearinghouse

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CA-301 12-67

COMMONWEALTH OF PENNSYLVANIA

August 21, 1979

SUBJECT: 5-79-07-003
Addendum to Comments on Draft EIS - Susquehanna Steam Electric Station

TO: Richard A. Heiss, Supervisor
Pennsylvania State Clearinghouse

FROM: CLIFFORD L. JONES
Secretary
Department of Environmental Resources

The following concern should be added to the Department's comments on this Draft Environmental Statement -

(6) Air Quality

The Draft ES should consider the possible system-wide effects of use of the Susquehanna Steam Electric Station as a new base-load facility. The Department would anticipate that one or more coal-fired stations in the system would consequently become peaking or stand-by facilities. This may cause increased emissions unless measures are taken to avoid more frequent cold start-ups. The effects on ambient air-quality of more-frequent start-ups at such stations should be studied.

Pennsylvania State Clearinghouse

Commonwealth of Pennsylvania
GOVERNOR'S OFFICE
OFFICE OF THE BUDGET

P.O. BOX 1323 – HARRISBURG, PA. 17120 – (717) 787-8046
783-3133

RE: PSC-SAI# 58004002

APPLICANT: Nuclear Regulatory Commission

PROJECT: DRAFT EIS - Susquehanna Steam Electric Station

LOCATION: Luzerne County

Enclosed with this letter please find the comments of the following State Agencies relative to the project identified above:

Department of Environmental Resources

Please consider these the comments of the Pennsylvania State Clearinghouse at this time.

Thank you for your cooperation.

Sincerely,

Anne G. Ketchum
Supervisor

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A

Donald E. Sells, Acting Branch Chief
Environmental Projects Branch 2
Division of Site Safety and Environmental Analysis
Nuclear Regulatory Commission
Washington, D.C. 20555

Secretary

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
P. O. Box 2063
Harrisburg, PA 17120

May 20, 1980

SUBJECT: Review and Evaluation of PSCH No.: 5-80-04-002
Draft Supplement to the DEIS - Susquehanna Steam Electric Station, Units 1 & 2, Pennsylvania Power and Light Company Allegheny Electric Cooperative, Luzerne County

TO: Richard Heiss, Supervisor
Pennsylvania State Clearinghouse

FROM: CLIFFORD L. JONES
Secretary of Environmental Resources

The Department has reviewed the draft supplement to the draft environmental impact statement as prepared by the Pennsylvania Power and Light Company for the proposed Pond Hill Reservoir. I believe our original comments on the Pond Hill project made in a letter to Robert Bielo, Executive Director, Susquehanna River Basin Commission, dated May 21, 1979, are still pertinent. I will restate them below.

The concept of constructing the reservoir appears to meet the regulations of the Department of Environmental Resources as related to dam safety (Chapter 105). The applicant should be informed of the need to submit an application for a permit to the Bureau of Dams and Waterway Management when final design plans and specifications have been completed.

The Department notes that although the plant is scheduled to begin operation in 1981, the inservice date for augmentation operation is 1983.

The Department notes that the Pennsylvania Fish Commission has not been included on the list of agencies for review of this proposal. The Department recommends that the Pennsylvania Fish Commission be given an opportunity to comment on this project.

DOCKET NUMBER PROD. & UTIL. FAC. 50-387,388

August 30, 1979

424 Laurel Drive
Hershey, PA 17033

Mr. Joseph M. Hendrie
Chairman
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Hendrie:

I note with much apprehension, that the NRC has recommended licensing of the Berwick Nuclear Plant on the Susquehanna River. You reassure us that "no significant environmental impacts are anticipated from normal operational releases of radioactive materials."

I find this statement to be both arrogant and misleading to the public. First, please define for me what "significant" means. Any low level radiation releases are significant as has been admitted and proven, even by the old AEC and the NRC's own studies. There is no safe level of radiation exposure. How can you say then that releases are of "no significance?"

Secondly, you "anticipate" no environmental impacts. May I remind you that Three Mile Island was not "anticipated" or planned for either. Where man is involved, there will never be a safe nuclear power plant. The nuclear way is an unforgiving way. Once the unanticipated happens, it stays with us for generations.

Thirdly, it is time to tell the public the truth regarding the "normal operational releases" from nuclear plants. How much "normal" radiation will be or is projected to be released by the Berwick plant, how much "normal" radiation is currently being released by the operating plants in this country, and who sets these, and how are these "normal" release ceiling levels set?

The current standards were initially set in order to justify atomic bomb testing. Those standards were kept in order to justify nuclear power plants because the nuclear industry and our government recognizes that no plant operates without "normal" releases of radiation.

Recognizing that the AEC, NRC, and other scientific studies have proven that there is no safe level of radiation exposure, negates the "normal" release standards currently used. Normal may be normal for a nuclear plant, but not for a clean environment and certainly not for the health and safety of the public.

Moreover, the boiling reactor cores at the Berwick plant are untried and unproven as to their overall safety and functioning. It does not matter how remote an accident of any kind may be, a chance is still there, especially with a new design. It only takes one accident to release dangerous radiation. The safety equipment and men at the Berwick plant are untried and unproven just as they were at TMI.

Lastly, let us use honest, straightforward language and tell the truth. "The temporary loss of habitat may have significant adverse impacts on the aquatic community in the vicinity of the site," really means that it would kill all fish and wildlife currently living near the site.

In summary, the Berwick plant is another threat to the Susquehanna River Valley, an added burden and danger not needed by the people of Central Pennsylvania. The plant, as a nuclear facility, should not be licensed and operated. It is not safe to the normal environment of the people in Central Pennsylvania.

It is incumbent on the NRC in its charge "to protect the health and safety of the public" to tell us the truth about the Berwick plant and the other nuclear power plants. Please inform me in whatever scientific or non-scientific terms you wish:

1. What is your definition of significant, and how was it arrived at?
2. On what basis do you calculate the "anticipated" occurrences? The Rasmussen Report has already been proven to be incorrect.
3. How do you define "normal"? Normal operational levels of radiation emission are quite different and separate from normal background levels of radiation already existing in the environment. Also, because of bomb testing and power plants the "normal" levels of background radiation have increased over the past 30 years.
4. What individuals, by name, set these "normal" levels?
5. How much "normal" radiation will be expected to be released in Berwick?
6. What are the NRC's recorded, documented levels of "normal" radiation releases from the operating plants in the United States?

Mr. Joseph M. Hendrie
August 30, 1979
Page 3

Thank you for your anticipated prompt response to the above.

Sincerely,

Warren L. Prelesnik

cc: Richard T. Kennedy, Commissioner
John F. Ahearne, Commissioner
Peter A. Bradford, Commissioner
Victor Gilinsky, Commissioner
Richard S. Schweiker
H. John Heinz, III
Allen E. Ertel
George W. Gekas
Rudolph Dininni
Stephen R. Reed
Pennsylvania Power & Light

SEDA - COUNCIL OF GOVERNMENTS
TIMBERHAVEN RD 1 • LEWISBURG PENNSYLVANIA 17837 • 717 524-4491

September 26, 1979

Mr. S. Singh Bajwa
Division of Site Safety and Environmental Analysis
Office of Nuclear Reactor Regulation
United States Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Bajwa:

SEDA-COG is the Areawide A-95 Clearinghouse for a ten-county region in Central Pennsylvania. Acting in its role of A-95 Clearinghouse, the staff of SEDA-COG has reviewed the Draft Environmental Statement related to operation of the Susquehanna Steam Electric Station (SSES), Units 1 and 2 (Docket No's. 50-387 and 50-388). SEDA-COG's interest is related to the proximity of the SSES to our region, and the potential impact of the SSES in the region. It is our contention that one major omission needs to be addressed in the environmental statement. According to the new regulations of the Council of Environmental Quality:

"(c) Agencies:

(1) Shall prepare supplement to either draft or final environmental statement if

* * *

(ii) There are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action and its impact. (43 Federal Register 55978, 1502.9 (c))"

The accident at the Three Mile Island nuclear facility certainly qualifies as a significant new circumstance. We believe it is imperative, therefore, that the environmental statement include an analysis of the natural and human environmental impacts associated with the TMI accident as a basis for evaluating potential impacts at the SSES, should an accident ever

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occur. The addition of this information will greatly strengthen the environmental statement, and will help reassure the public that Pennsylvania Power and Light Company and the Nuclear Regulatory Commission are thoroughly evaluating and mitigating the effects of any potential accident.

Sincerely,

Dennis E. Robinson

Dennis E. Robinson
Executive Director

DER/mw

Florence L. Shilly
Thompson, Pa. 18465

August 18, 1979

To
US Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, D.C.

Subject: Comments on the Draft Environmental Statement related to operation of Susquehanna Steam Electric Station Units 1 and 2 of Pennsylvania Power and Light Company and Allegheny Electric Cooperative, Inc. Nureg 0564

6.2 Postulated accidents Involving Radioactive Materials.

This section should be updated in the light of TMI-2 accident. Hypothetical sequences of failures more severe than Class 8 <u>should</u> be considered.

Since human frailty and fallibility cannot be eliminated the worst possible accident <u>is</u> a possibility, the unthinkable <u>could</u> happen! Therefore the environmental impact of a meltdown should be considered in the costs.

I object to the conclusion that "environmental risks due to postulated radiological accidents are exceedingly small and need not be considered further"

The NRC's own monitoring of radioactive fallout around TMI-2 out to 10 miles during the week of March 31 – April 7, 1979 and readings taken by Dr. Chauncey Kepford, upwind of the plant during that same time, indicate that the fallout did not diminish with the distance from the plant but in some instances (the N.E. sector, I believe) actually increased. Dr. Califano's calculation of projected deaths was based on a hypothetical model and not on the actual NRC data.

7.3.2 The staff concludes that economic considerations justify adding the Susquehanna facility in the scheduled time period.

The Susquehanna nuclear plant is economically uncompetitive with virtually any of the alternative sources of energy including conservation when life time full cost includes plant decommissioning, ultimate dismantling and site decontamination, interim spent fuel storage and subsequent

disposal, and radioactive waste management and disposal at all stages of the nuclear fuel cycle; and when government subsidies are counted in by the taxpayer for the Price-Anderson Act and Research and Development expenses.

4.5.5 Uranium Fuel Cycle Impacts
Radon-222
I refer you to the transcript of the TMI-2 Operating License Hearing July 5, 1977 page 2890 and the testimony of Dr. Chauncey Kepford and Dr. Reginald Gotchy. (*see over)

On September 20, 1977 Dr. Walter Jordan, a member of the NRC Atomic Safety and Licensing Board, submitted a memo to the Board pointing out that the number of curies (74.5) the NRC attributed to radon-222 was far too low, by a factor of 100,000. Met Ed's lawyer moved on December 19, 1977 that the ASLB disregard

* Using the NRC's own data and computer models developed by the US Environmental Protection Agency Dr. Hefford calculated that over the full detoxification period the radon gas (from mill tailings alone) would result in millions dying prematurely of cancer, leukemia and other radiation-related diseases.

Hefford's testimony and the Jordan memo on the grounds that radioactive emissions from Radon-222 are insignificant compared with radon contribution of natural back-ground radiation.

4.5.5 Page 4-28

"From the above analysis the staff concludes that both the dose commitments and health effects of the uranium fuel cycle are insignificant when compared with dose commitments and potential health effects to the U.S. population resulting from all natural back ground sources."

In rebuttal, Dr. Hefford pointed out that on the basis of NRC's own environmental health cost of $1000 per man-rem, Dr. Jordan's calculation of 10 million man rem exposure per reactor year translates into an environmental cost of $10 billion per reactor year. On a purely cost benefit basis Met. Ed. would have to sell TMI's electricity for $2.00 per kilowatt hour to show a comparative profit.

5

These costs would be the same for P.P.+L. as for Met. Ed. coming as they do from the mining and milling of uranium.

I also object to the argument that costs are negligible because they are less than naturally occurring costs. The naturally occurring costs are bad enough without adding to them.

Respectfully submitted
Florence L. Shelly
Thompson, Pa. 18465

August 20, 1979

Wm. H. Regan, Jr., Chief
Environmental Projects Branch 2
Division of Site Safety and
Environmental Analysis
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Regan:

I would like to thank you for sending me a copy of the "DRAFT ENVIRONMENTAL STATEMENT" of SSES. The following are my comments on same.

It is unbelievable that so much of the report is taken up by studies on the flora and fauna while the human aspect is almost completely ignored. It does tend to explain the treatment of those who do live within this area. According to the report we don't hardly exist. The report goes on to some length before Beach Haven is even mentioned. It gives the impression that this is a very sparsely populated area scarred from mining with a very high unemployment rate and greatly effected by the Agnes flood. PP&L saved the area by deciding to build their nuclear plant here. How much better off we would all have been if PP&L would have built their plant somewhere else.

So much space is devoted to the concern for the environment, but where was that concern when the site was cleared with trees bulldozed onto piles as high as houses and set afire to burn for weeks.

Missing from the report was the fact that much blasting would be necessary to prepare the site for the buildings. This omission could explain their reluctance to admit that damages resulted from this blasting effecting local properties. In order to resolve the situation it was necessary to go one step short of a court trial. The resulting aggravation, harrassment and stress on the property owners can never be measured.

Just to set the record straight, not that it will make any impact on the licensing of SSES, the following are the true facts concerning this area. This was a very beautiful, peaceful area before the start of construction of this nuclear power plant. We were experiencing a residential growth that was extending into the rural areas at a very fast pace. Some of the best agricultural areas were taken by the plant site. Naturally the agricultural activity has decreased because of the land taken out of productivity by the plant site. It is far from being the desolate area pictured in the report. Many homes are within a mile radius of the plant site and I am sure the number would be much greater in this area if it were not for the plant being here. Approximately twenty-one homes have been demolished by PP&L for the site. Our area consists of tree covered rolling hills and mountains interspersed with farm land. Except for sand and gravel excavation the only other scarring of the landscape has been done by PP&L with the cutting of power lines in all directions through our beautiful mountains. The mining referred to in the report is in the Wilkes-Barre area and is not visible here. There is no undermining of this area. The effects of Agnes was minimal in this area. In fact, I don't think there was one family in the Beach Haven, Berwick area that was displaced by the flood. (If they were effected, they have moved back into their homes.) Economically we were much better off before the start of construction of the PP&L plant. With the influx of workers and the high pay scale for union workers, the rents doubled and tripled. This area is now one of the most expensive places to reside. Very few residents of the Berwick area are employed at the plant site. The traffic from the commuting workers is very disruptive to local residents. As for the recreational area being developed by PP&L, it would not have been missed in my opinion. Before the acquisition of land by PP&L we had the best hunting and trapping area for many miles around.

In light of TMI we are most concerned about the possibility of an accident and the storage of spent fuel on the plant site. Our experience with PP&L makes us most apprehensive of any reports that would come from PP&L in case of an accident. I can't help but believe there would be no report if they thought an accident could be covered up. With the granting of a permit to store the spent fuel on the plant site is this area destined to become a dumping spot for nuclear waste? Recent reports of release of radioactivity into the environment from nuclear power plants across the United States and the "accidental" dumping of 200 gallons of radioactive water by the Oyster Creek nuclear plant, what can we expect here? How many accidents of this type can we expect during the life of this plant?

We, for one, are too close to the plant site for any errors. As you know our land borders the site to the south and southwest, with the closest cooling tower approximately 550' from our land. To date the government has done nothing to protect us or our property. Can we expect any protection from the government or are we the dispensible ones in the scheme of things?

Respectfully yours,
[signature]
Mrs. Stanley Skortz
RFD #1 Box 246
Berwick, Penna 18603

SIERRA CLUB
PENNSYLVANIA Chapter

REPLY TO: Thomas A. Drazdowski
Chairman, Northeastern Group
R.D.#2, Box 59B
Nicholson, PA. 18446
August 15, 1979

Director
Division of Site Safety and Environmental Analysis
Office of Nuclear Reactor Regulation
Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Sirs:

The Northeastern Group of the Sierra Club, which comprises Lackawanna, Luzerne, Susquehanna, Wayne, and Wyoming counties, is very concerned about the draft Environmental Statement for the PP&L Berwick Nuclear Plant. A preliminary review finds the report flawed and incomplete in the following:

1. Three Mile Island is only mentioned in a footnote that states it has not been considered.
2. Discussion of the health effects of radiation and radoactive waste disposal do not note the present controversy among scientists concerning risks, safe dosage, and waste disposal techniques.
3. The project site and transmission lines have not had a competent archeological survey.
4. The new transmission line will cross the gorge of the Lehigh River, a Pennsylvania Scenic River candidate.
5. Nuclear energy is compared to coal unfairly because the potentially enormous benefits of revitalizing the anthracite area are not calculated.

Please make these comments part of the official record. Thank you for your cooperation.

Sincerely,
[signature]
Thomas A. Drazdowski
Chairman
Northeastern Group

TD.

Susquehanna Alliance
PO Box 249
Lewisburg, Pa 17837

August 17, 1979

Daniel Muller
Director, Division of Site Safety and Environmental Analysis
Office of Nuclear Reactor Regulation
US Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr Muller,

In a letter to you, dated August 7, I requested an extension of the public comment period on behalf of the Susquehanna Alliance, for the Draft Environmental Statement related to the operation of Susquehanna Steam Electric Stations 1 and 2 (Docket Nos 50-387 and 50-388). I had indicated in that letter that the Susquehanna Alliance was undertaking a review of the statement and felt that an extension should be granted to allow time for inclusion of data now being collected on the causes and effects of the accident at Three Mile Island. Specifically, we felt that the period should be extended beyond October 25, 1979 at which time the President's Commission is expected to issue their final report. This extension would also allow time for wider public comment on the statement. We know of many citizens who only learned of the availability of the document during the past couple weeks and have not had sufficient time to obtain a copy and review it.

In a converstion on August 16 with Mr Leech, Project Manager, I learned that my letter had not yet been received and that it was unlikely that a decision would be made on the extension until after the initial deadline, August 21, had passed. I am therefore submitting to you a summary of the areas of concern that the Susquehanna Alliance has regarding the Draft Environmental Statement. We anticipate that your office will grant the requested extension and we will, during that time, continue our review and file more detailed explanations of our concerns. Here, then, are our initial comments:

1) Several comments in the statement with regard to the preservation of cultural resources cause concern. The staff indicates that there have been indications that cultural resources may exist on the plant site and on associated PP&L properties and that if they exist they might qualify for inclusion in the National Register. No systematic survey has been undertaken to determine if such sites exist yet the staff seems to feel strongly enough about the possible existence of such sites to include a warning in their summary that such sites could be damaged if no preventative measures are taken.

   Yet the staff does not require a cultural resource survey be undertaken to determine what sites may exist and will be (or have already been) damaged by the construction of the plant and

associated projects. The staff specifically mentions the recreational area near the river. It is our understanding that the applicant has recently begun construction there <u>without</u> a cultural resource survey having been completed. Guidelines based on the National Environmental Policy Act and established through the Council on Environmental Quality and the Advisory Council on Historical Preservation require not only the protection of properties listed in the National Register but also those eligible. Furthermore, if no systematic survey of the area has been completed, it must be initiated and the data submitted to the Office of Archaelogy and Historic Preservation for a determination of eligibility. We feel these actions should be undertaken immediately.

2) The discussion of the effects of the uranium fuel cycle appears to be incomplete. Table 4.14 does not list any value for the effect of Radon 222. The staff notes the absence of this figure and then proceeds to develop their own criteria for evaluating the effect of Radon. What they fail to mention is that this number was vacated from the table as the result of evidence produced during the hearings for the licensing of Three Mile Island Unit II in which Dr Chauncey Kepford, an intervenor, indicated that the value previously used was in error by an order of magnitude of well over 100,000. His calculations were based on the previous number used but extended over the full period during which Radon would be emitted to the atmosphere. This topic is still under consideration by the commission and their final report should be included in the environmental statement.

   The staff draws the conclusion that, dispite the extreme toxicity of high level wastes, there will be no environmental impact related to their storage in a Federal repository. This does not take into account the current controversy over whether or not a 100% safe repository can be found (or developed). There are reports from several government agencies indicating that no demonstrably safe method exists of disposing of these wastes. The damage done to the environment by leaks at the Hanford low level disposal site and the reprocessing plant at West Valley should be sufficient to raise suspicions about the feasibility of developing such a repository.

3) In the discussion of the potential radiological effects of accidents at the plant site there is only a footnote about the accident at Three Mile Island indicating "these calculations do not take into consideration the experience gained ... ". There are those that contend that the accident was in fact a class nine accident. To our knowledge no final ruling has been issued on this. Since the "improbable" series of events <u>did</u> happen at Three Mile Island, the effects of other "improbable" accidents should be considered. The full effects of this accident should be studied and included in any environmental impact accident issued in relation to the operation (or construction) of a nuclear plant.

4) The report does not fairly represent the growing controversy over the effects of low level radiation. Time after time the assumption is made that as long as the radiation contributed to the environment is sufficiently lower than normal background levels or is below existing federal standards, that the health effects will be minimal. This does not take into account the growing feeling among the scientific community that there is not a radiation level below which there are no ill effects. Mention should be made of the reports which indicate that continued exposure to even low levels of radiation can be damaging and those that propose that in light of recent studies, federal standards be lowered.

5) The report does not fairly treat the possibility of the use of an anthracite fired plant as an alternative. The use of such a plant in the midst of Pennsylvania's anthracite fields could have a tremendous beneficial impact on the area. The use of modern technology to mine the anthracite in the area would offer opportunities for the revitilization of an economically depressed area, relamation of lands previously surface mined and improvement of the water quality. The obvious benefits of lower taxes and more jobs should be weighed. In addition, the numbers used to illustrate the cost of operating a coal fired plant and the environmental impact of its operation should be based upon the operation of an anthracite fired plant.

The report does indicate that at the operating license stage, considerations of alternatives involves only the decision as to whether the plan should operate or not. However, as can be seen from the projected reserve margins shown in tables 7.4 and 7.5, the operation of the Susquehanna station as a nuclear plant will preclude the need for an anthracite facility for many years to come and will therefore preclude the possibility of the area receiving the benefits that would be associated with such a plant. A full discussion of this alternative should be included.

6) The benefit-cost analysis should, of course, be affected by all the above comments. In addition it is interesting to note the inclusion of a decommissioning cost of 59 million dollars. Is this an estimate based on a realistic plan for decommissioning? In light of the estimated $400 million to "clean up" Three Mile Island Unit II, it seems unrealistic to expect to be able to decommission two units for the stated price. An outline of the expected method of decommissioning should be included.

The benefit-cost analysis does not include any information with regards to the psychological effects on the residents of the area if the plant is allowed to operate. Surveys at a business located near the plant showed that 50% of the employees would quit their jobs if the plant was allowed to operate. Many area residents have already begun to make plans to leave the area. An analysis of these effects should be included.

The benefit-cost analysis also assumes that the production of 2100 MW of electrical energy is enough to offset the accumulated costs. This assumes that the additional capacity is needed. However, tables 7.4 and 7.5 seem to indicate that without the operation of the plant there would still be sufficient reserves to meet both the requirements of the interchange agreement and the recommendations of the Federal Economic Regulatory Commission. Therefore, the benefit of the additional power seems questionable.

7) In the July 23 Federal Register there was a notice that listed the Nuclear Regulatory Commission as one of those agencies that had not published proposed procedures to bring them in alignment with the new National Environmental Policy Act regulations adopted by the Council on Environmental Quality and effective July 30, 1979. It is our assumption, then, that this draft of the environmental statement may not follow these new regulations and we feel the commission should publish their proposed procedures and have them approved prior to releasing the final version of this report.

As we stated above, we are going to continue research on these topics. With the anticipated extension to the review period and the help of various local agencies we hope to more completely evaluate the draft environmental statement. In the wake of this country's worst nuclear accident it is, we feel, advantageous to provide as thorough an analysis as possible of the potential effects the operation of this plant could have on the environment.

Sincerely,

David Mann
for The Susquehanna Alliance

Susquehanna Alliance
P O Box 249
Lewisburg, Pa 17837

June 10, 1980

U S Nuclear Regulatory Commission
Washington, D.C. 20555
Att: Director, Division of Site Safety & Environmental Analysis

Dear Sir/Madam,

We are enclosing several documents which we hope will be of help in improving the quality of the Draft Environmental Statement and its Supplement which have been prepared in relation to the planned operation of the Susquehanna Steam-Electric Station Units 1 & 2 (Docket No's 50-387 and 50-388). On May 26 we requested and were granted a 15 day extension of time in which to submit these comments by Mr Singh Bajwa, the NRC Environmental Project Manager for the project.

The documents enclosed include 1) a summary of the reasons we feel the Draft Supplement to the Draft Environmental Impact Statement with regard to the Pond Hill Reservoir is inadequate and incomplete; 2) comments on the Draft Statement itself to supplement our comments submitted on August 17 which reinforce our belief that as an Environmental Impact Statement this document is inadequate and incomplete, and 3) a copy of a recent PP&L news release which bolsters our contention that an inadequate assessment of the need for the plant has been done.

We hope that these comments will be of value to the staff in continuing the process of fully and diligently evaluating the full range of impacts of the proposed operation of the Susquehanna Steam Electric Station. It is our opinion that in order to adequately address the areas of concern raised by us and other commenters, extensive revisions to the draft must be made. In this context we request that a second draft be issued and be made available for further public comment before the final EIS is adopted. Please let us know if this request will be honored.

Sincerely,

David Mann

Tony Sade

for the Susquehanna Alliance

COMMENTS ON DRAFT SUPPLEMENT TO DRAFT EIS FOR THE SUSQUEHANNA STEAM ELECTRIC STATION

1) One of the conclusions drawn by the Staff of the NRC's office of Nuclear Reactor Regulation and of paramount concern to residents of the vicinity is that construction of the "Pond Hill" water storage reservoir will have a significantly negative impact on water quality. In particular, the supplement states that nutrient levels, specifically phosphorous, "will considerably exceed" the criteria established by the Environmental Protection Agency for nutrient levels and thus "the potential that eutrophic conditions will occur in the Pond Hill reservoir is relatively high". Missing from the statement is a polution abatement or mitigation plan by the applicant. Until such a plan is included, this draft supplement is incomplete.

2) The safety analysis of the project is clearly insufficient, especially given the unpredictable nature of the Susquehanna River and its tributaries, and the fact that severe flooding has occured in the region twice within the last eight years as a result of extraordinarily heavy rains from tropical storms Agnes (1972) and Eloise (1975) in unprecedented concentrations. The maximum flood danger and impacts of overtopping the dam have not been adequately assessed, a rather glaring ommission in light of the NRC's mandate to protect the health and safety of the public. Specifically, the staff noted in section 4.4.2.3 that:

> If the dam were to be overtopped the staff believes that the dam could fail. The flooding that would result from failure of the dam would produce rapidly rising water elevations downstream of the dam site. The potential exists to trap and drown persons and wildlife in the downstream floodplain during such flooding (emphasis added). The potential for harm to persons using Route 239 and the railroad during such flooding also exists.

The issue of safety should be settled on the conservative side, with the maximum benefit to and protection of the public the overriding consideration. These hazards are not acceptable and a plan to mitigate these dangers should be included.

3) The report does not adequately address the consideration of alternatives to the construction of the Pond Hill Reservoir. The use of the Army Corp of Engineers Cowanesque Reservoir now under construction in Pennsylvania has not been fully explored, especially in light of the applicant's own admission that the costs of this alternative over a 30 year period would be $12 million (as compared with the $46-50 million cost of Pond Hill, $63 million if property taxes are treated as an additional project cost). In fact the Staff has concluded that:

> The best economic alternative would appear to be the use-an-existing-reservoir-alternative (emphasis added). Based on the information available, Cowanesque appears to be the most economic among all alternative reservoirs, given that concerned authorities grant the use of water for flow augmentation.

The Baltimore District Corps of Engineers is currently studying the feasibility of modifying the existing project to include water supply storage as a project purpose in addition to flood control and recreation. It is felt that this modification would increase the economic efficiency of the Cowanesque Lake Project. Preliminary findings indicate that this could be done without affecting the flood control capabilities, that substantial releases could be provided into the Susquehanna River during low stream flow periods and these releases would generally improve the riverine environment during naturally low streamflow periods. Rather than expend over $63 million on what may become a putrid, stinking lake at Pond Hill, the utility and the public would be better served by the applicant's aggressive investigation of the resources required to effectuate

SUPPLEMENT COMMENTS CONTINUED

the necessary approval for their use of the Cowanesque project.

In addition to the foregoing criticism regarding alternatives to the proposed project, the applicant and staff have not fairly treated the "No Action" or "River Following" alternative, whereby SSES would merely shut down during times of low flow in the Susquehanna River. Based on an average annual occurence of low flow of 4 days (a roughly 90% probability according to table 5.3) "the cost of Pond Hill Reservoir alternative would be very close to the replacement cost of electricity under the river following alternative". Given the excess capacity figures of both the applicant and the PJM interconnection, the staff concluded that "PP&L could provide reliable service to its customers even during a short interval of shut down of SSES". The attached press release from PP&L provides support for this statement.

4) The final area of comment in regard to this project concerns the impact of the project on the cultural resources of the area. Although the applicant is "committed to carry out an archeological survey" and certain preventative measures if resources are discovered, the applicant does not specify in sufficient detail what those measures will be and what, if any, action will be taken (including halting construction) if substantial resources are in fact discovered. This survey should be performed before an EIS is prepared and the results included. The applicant has illustrated in the construction undertaken at the recreation area near the plant that it has no regard for cultural resources. A repeat of this performance must not be allowed.

ADDITIONAL COMMENTS ON DRAFT ENVIRONMENTAL STATEMENT FOR SSES

1) The report does not adequately address the continuing and even escalating controversy regarding the health effects of continued exposure to low level radiation. In addition no mention is given to what has been dubbed the "Heidelberg Report" which has also been translated and printed by the NRC as "Radioecological Assessment of the Whyl Nuclear Power Plant". In studying existing data on the transfer factors to plant life (and ultimately human tissue) of certain radioactive isotopes emanating from operating nuclear power reactors, the authors of the report concluded that the NRC's judgments on how much plutonium, cesium, strontium, etc was picked up from the soil were "between 10 and 1,000 times to low". Even more outrageous than the error factor calculated by the W German scientists is their contention that the old AEC in an attempt to mollify critics of earlier nuclear policy, deliberately rigged the experiments to minimize the high transfer factors inherent in the isotopes. The steps include, but were not limited to:

a. pre-testing and selection of soils so as to choose those which absorbed the minimum amount of the isotope

b. adding radiotoxic substances to the soil shortly before harvesting, thereby avoiding realistic conditions, where plants would grow from seeds in the contaminated soil

c. cooking the soil in ovens to reduce the bacteriological effect upon the isotope and thus assure lower readings

The Heidelberg Report is the first time that independent scientists have examined the NRC's safety assurances about routine emmissions from operating plants. Although, in all fairness, it should be noted that the report may have come into the NRC's hands after or only shortly before the release of the Draft Environmental Statement for SSES, its conclusions warrant a thorough review of the issues raised, not only by the NRC, but by the applicant as well. The EIS must assess the <u>full range</u> of impact on the human environment before it can be considered complete.

2) It is interesting to note that in the Draft Supplement to the Draft EIS, the applicant promises that it is "committed to carry out an archaeological survey" and to take whatever preventative measures are necessary to protect cultural resources. The irony inherent in that position is that no such survey was undertaken or even alluded to for the original project itself, one that involves considerable more expense, area, and intensity of construction than the Pond Hill Reservoir. In addition, part of the plant's secondary construction involves establishment of a recreation area on the low-lying flatlands adjacent to the Susquehanna River, similar areas of which have proven to be archeological motherlodes of information on and relics of pre-existing indigenous populations. As the applicant itself notes in Appendix B to the Draft Supplement ...

> Such assessments (inventories of historic or archeological resources which may be impacted by the proposed construction are to be made pursuant to 36 CFR 800, Section 106 of the National Historic Preservation Act of 1966 as amended (16 USC 470). by Executive Order 11593, May 13, 1971, "Protection and Enhancement of the Cultural Environment", and by the President's Memorandum on Environmental Quality and Water Resources Management, July 12, '78.

The applicant should be required to conduct such an inventory in compliance with the above-cited legislation, regulations, and executive pronouncements, before construction continues and an operating license is granted. In addition a plan for mitigating the damage done by construction should be implemented.

3) The Staff and applicant's cost-benefit analysis do not adequately reflect the impact of a renewed anthracite industry on the region. In an analysis prepared recently for the Susquehanna Alliance entitled "Economic, Social, and Environmental Impacts of Renewed Mining in the Anthracite Region", it was found that a revitalization of this industry, especially one employing new open-pit mining technologies, could remove all economically extractable coal and restore presently unusable areas to productive land uses, improve water quality beyond the requirements of the Pennsylvania Clean Streams Law, create 1500 new jobs in mining and related industries, and stem the outmigration of young people from the area. All of this could be accomplished in the process of producing a fuel cost-competive (based on BTU equivalents) with those currently in use. Again we state our belief that the operation of SSES will preclude the need for such an industry and the loss of these benefits should be included in the cost-benefit analysis.

4) As with all other Environmental Impact Statements relating to the construction of nuclear power plants, the Staff and the utility concerned have dismissed out of hand the possiblity of a serious, or Class IX accident and the health effects of such a catastrophe on the local population. Although this omission will be addressed shortly in a summary of the President's Council on Environmental Quality's generic criticisms of the entire EIS process, it is especially glaring both in light of the recent events at TMI and SSES's proximity to that crippled reactor, where in the Staff's own estimation (made in conjunction with a proceeding dealing with the Salem plant) a Class IX accident did occur. A thorough review of the possibilities of such an occurrence at SSES should be made that is site-specific not only to the nature of the technology employed by the applicant in the construction of the plant and certain geographic and geologic features but which also throughly reviews, analyzes, and assesses the probability of success of a large-scale evacuation of area residents should such a measure be necessitated by extraordinary events at the site. If the NRC is to even begin to restore public confidence in its ability to safely regulate the nuclear industry, the attitude that "it can't happen here" must no longer be standard operating procedure.

5) In a recent letter to John Ahearne, Chairman of the NRC, Gus Speth of the President's Council on Environmental Quality outlined several generic deficiencies, which he characterized as "disturbing" in the NRC Impact Statement Process of nuclear power reactors.

The most damning of CEQ's criticisms was that the discussion of potential accidents and their environmental impacts in these impact statements was "perfunctory, remarkably standardized, and uninformative to the public". Speth found that despite wide variations in the size, location, and design of nuclear power plants that have been licensed by the NRC, "virtually every EIS contains essentially identical "boilerplate" language written in an unvarying format". The failure to consider the worst case, or Class IX accident is exemplified in the Statement prepared for the licensing of TMI Units I & II, where no consideration is given to the Class IX scenario. This omission looms quite large in view of the Staff's own view that such an accident did occur on March 28, 1979.

Speth also urges the Commission to "broaden its range of variables (e.g. radiation pathways) in determining accident's impacts, and expand its discussions in EIS's of the

impacts of nuclear accidents on human health, the natural environment, and local economies". Once again, this criticism seems to stem from the belief that EIS's as currently prepared are simply general regurgitations of pre-existing data and positions that bear limited if any relevance to particular and unique site-specific information. The inability to translate this information in non-technical terms easily comprehensible to the general public also meets with CEQ's disapproval.

Finally, Speth suggests that the NRC vigorously pursue the goal of fulfilling to the utmost extent the requirements of the National Environmental Protection Act and the "legitimate public interest in full disclosure of nuclear plant hazards" (emphasis added) in the obvious belief that such disclosure has not been a top priority of the NRC's agenda in preparing Environmental Impact Statements for the operation of nuclear power plants.

We believe it is the responsibility of the NRC to bring the EIS's they prepare within the guidelines set by CEQ. Until this is done for the draft EIS in question here, it remains wholly inadequate and incomplete.

Contact:

Source: Al Craven (215) 821-5510

An opportunity to own part of a nuclear power plant or a percentage of the electricity it will generate during the first several years after it begins operation has been offered in letters sent by Pennsylvania Power & Light Co. to electric utilities in Virginia, West Virginia, Ohio, New York, western Pennsylvania and New England. Similar letters had already been sent to the other companies in the Pennsylvania-New Jersey-Maryland Interconnection (PJM), of which PP&L is a member.

William Hecht, manager of System Planning for PP&L, said the company will be in a position to make a portion of the capacity or electric energy from its Susquehanna Steam Electric Station available, since the company's generating capacity will be greater than its obligations to the PJM power pool when the nuclear plant near Berwick begins operating. "The rate of growth for people's use of electricity has dropped considerably since we decided to build the plant," he explained.

—more—

So, he said, PP&L is offering first to sell part ownership interests in the plant and then, if more should be sold, portions of the electricity it will produce through the 1980s will be offered. He emphasized that, despite the sales of part ownership, PP&L will retain control of the plant and be responsible for its operation.

PP&L now has about a 40 percent generating capacity reserve. Assuming that the demand for electricity grows as PP&L expects it to, the company will have about a 43 percent reserve when the first generating unit at Susquehanna begins operation. PP&L's agreement with PJM is that it will maintain a reserve of at least 6 percent.

Allegheny Electric Cooperative Inc., a Harrisburg-based power supply cooperative, already owns 10 percent of the plant. Atlantic City Electric Co., a private utility serving customers in the Atlantic City and southern New Jersey area, has agreed to buy about 6 percent of Susquehanna's electrical output until 1991. The sales to Allegheny Electric and Atlantic City Electric total about 335,000 of Susquehanna's 2.1 million kilowatts.

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NUCLEAR

SUSQUEHANNA RIVER BASIN COMMISSION

1721 North Front Street Harrisburg, Pennsylvania 17102

From the Office of the Executive Director

August 30, 1979

Mr. William H. Regan, Jr., Chief
Environmental Projects Branch 2
Division of Site Safety and
Environmental Analysis
Nuclear Regulatory Commission
Washington, DC 20555

Re: Docket No. 50-387, 50-388

Dear Mr. Regan:

Reference is made to your letter dated June 22, 1979 transmitting the draft Environmental Statement for Susquehanna Steam Electric Station presently under construction by Pennsylvania Power and Light Company. The Commission staff has the following comments on this draft.

1. In section 3.2.1, page 3-1, it is stated that station water requirements have increased since the construction permit stage. Apparently the basis for this statement is the river intake flow shown in Table 3.1 which is shown as increasing by 0.45 cms (about 15 cfs). However, we cannot verify the 1972 figure shown in Table 3.1 nor can we determine the reason for the increased water withdrawals. Also, the text states that water withdrawal will be at a rate of 1.8 to 2.2 cms, but the table shows 2.45 cms. Please clarify the discrepancy and the reasons for increased water withdrawal. Also please clarify the text to indicate whether the increase pertains to water withdrawal or consumptive use.

2. In section 3.2.1, the discussion of the SRBC regulation is incorrect. The applicant will still be permitted to withdraw water during periods of low flow, but the amount of the consumptive use must be replaced. The proposed reservoir is not an alternative source of water but only a source of makeup water. The regulation is correctly stated in section 4.3.2.1 except that the third sentence should read, "The regulation requires replacement of consumptive use..."

3. It is stated on page iii and again in Table 3-1 that the maximum consumptive use is estimated to be 1.81 cms (63.9

cfs). The basis for that number is not clear, but it appears to be based on four years of climatic data collected at the site. If so, it may not be representative of actual worst evaporative conditions experienced at the site. The Commission's concern, from the viewpoint of water management, is the probability of maximum consumptive use, expected under the worst set of climatic conditions, occurring concurrently with low flow. The draft EIS statement has not addressed this concern. Also, the procedures and assumptions used in making the calculation of maximum and average consumptive use should be clearly stated.

4. It is stated on page iii that the river flow at which consumptive use must be replaced is 23.2 cms (819.0 cfs). This figure should be equal to the 7-day, 10-year low flow plus the consumptive use. Our analysis of 7-day average low flow frequency at Wilkes-Barre, based on the period of record 1900-76, shows that the 7-day, 10-year low flow is 800 cfs. The applicant has used the value of 770 cfs which is based on an analysis by USGS for the shorter period 1900-72. We believe our analysis is more correct by virtue of including additional record.

   Also, we believe that the consumptive use value used should be the maximum consumptive use, which is stated to be 64 cfs, rather than the average consumptive use used in your report. This is important in determining the storage required for consumptive loss makeup. The applicant has stated that they have computations showing that the design of the reservoir based on the 50 cfs average loss will provide adequate storage in a repeat of the 1964 drought of record. We have as yet not seen that data.

5. In section 3.2.2.3, page 3-8, the 7-day, 10-year low flow is identified as 23.2 cms (819.0 cfs). That appears to be inconsistent with the above comments, and with section 4.3.2.1, page 4-2 where the 7-day, 10-year low flow is stated as 21.8 cms (769.8 cfs).

6. The proposed intake structure may not meet the requirements of section 316(b) of PL 92-500. According to the Environmental Statement, the "embayment intake will remove more biomass than an alternative intake..." SRBC staff recommends that an intake structure be designed using best available technology before the plant is issued an operating license.

7. Staff is concerned about the effect of the consumptive withdrawal on aquatic habitat during prolonged periods of low flow. This concern should be addressed in the draft statement.

8. The post-operational monitoring programs do not include any provision for metering plant intake and discharge flows. We recommended to Pennsylvania DER that such flow meters be required in connection with approval of the encroachment permit for the intake and discharge structures, but these are not addressed in the Environmental Statement. We still believe that metering flows is an essential part of the environmental monitoring program.

Thank you for the opportunity to comment on this environmental statement.

Very truly yours,

Robert J. Bielo
Executive Director

8005070541

SUSQUEHANNA RIVER BASIN COMMISSION
1721 North Front Street Harrisburg, Pennsylvania 17102
From the Office of the Executive Director

April 30, 1980

Director
Division of Site Safety &
Environmental Analysis
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Re: Docket Nos. 50-387, 388

Dear Sir/Madam:

The following comments, prepared by the staff of this Commission, are in response to the "Draft Supplement to the Draft Environmental Statement" (NUREG-0564) relating to the Susquehanna Steam Electric Station. They focus primarily on clarification of positions attributed to the Commission and apparent errors of fact or methodology. The comments are keyed to the section numbers of the "Draft Supplement".

Section 3.1-Introduction

We believe that the second sentence of the second paragraph would more accurately reflect the circumstances if it read as follows: "In response to comments by the Pennsylvania Dept. of Environmental Resources and SRBC regarding the desirability of optimal development of the site to meet water supply needs in addition to those of the Susquehanna plant, the applicant submitted ...." Clearly, our comments have nothing to do with water conservation.

We note also that we have not seen copies of any of the correspondence referenced in the second paragraph.

Section 3.2.2-Augmentation Releases

There is a minor misstatement of the SRBC consumptive use make-up requirement. The first sentence refers to the "average consumptive use ... by SSES" in defining the low flow criterion, whereas the regulation specifies "the 7-day 10-year low flow plus the project's total consumptive use and dedicated augmentation." [18 CFR 803.61(c)(1)(i)] As we interpret the regulation, the appropriate value is the actual rather than the average consumptive use. This notion is stated correctly in Section 4.4.2.1. It should be corrected here.

Section 4.2-Impacts on Water Use

The last sentence refers to an application for a NPDES permit applicable to reservoir discharges. We are not aware of any such permits.

The section also concludes that "... the quality of the water discharged from the Pond Hill Reservoir will meet applicable DER and EPA criteria except for an occasional high level of iron." This conclusion should be reviewed in light of the comments relating to Section 4.3.2 below.

Section 4.3.2.2-Inundation & Operational Impacts

On page 4-5, it is stated, "... the potential that eutrophic conditions will occur in Pond Hill Reservoir is relatively high.", suggesting that water quality problems are quite likely. Later on that page it is stated, "... once phosphorus reaches the bottom sediments, very little of it usually returns to the epilimnion." The analysis concludes that productivity levels will decline over time as "... nutrients are lost to bottom sediments." We are less optimistic that such will be the case. If the bottom water becomes anoxic, which seems to be a distinct possibility, phosphorus and ammonia will be released from the sediments. During turnovers, these nutrients would be returned to the epilimnion.

Section 4.3.2.3-Discharge System

In the first paragraph under Operational Impacts, there is the statement, "... as presently designed, only hypolimnetic water will be withdrawn." The report then goes on to point out that if this is the case, the result will be cold shock to many of the organisms. The only way we can see that such a conclusion is possible is to assume that for the dam presently proposed the spacing and elevation of the inlet structures remain as planned for the original dam with top elevation at 950' msl. Do you know this to be the case? As recently as April 15, 1980, PP&L has reported to us that the project design has been revised to reflect the "full-size" reservoir (Elevation 990' msl top of dam). Further, that correspondence states that the inlet-outlet structure has been revised from inclined to a conventional multiport vertical tower structure. We assume that the applicant intends to adhere to its

design criteria of having multiple outlets "... so that releases can be made from the reservoir level where the water temperature most closely matches that of the Susquehanna River" (TAMS, "Design Report-Pond Hill Reservoir", February, 1979, p. 3-4).

We do note that the final paragraphs of the Section conclude that the release will cause cold shock, contain large amounts of organic materials, be high in iron, and may be anoxic. We have three comments with regard to these conclusions.

1. We find them difficult to reconcile with the assertion of Section 4.2 that all quality criteria, except for iron, will be met.

2. We cannot accept the conclusion that such releases "should have little impact on the Susquehanna River, since augmentation releases will be infrequent and usually small in volume" (p. 4-9). This argument seems to hang on a long time average concept. Under minimum daily flow of record conditions compensation releases would represent about 10% of the river flow. Moreover, the SRBC consumptive use requirements specify that, "The physical, chemical and biological quality of water used for compensation shall meet the quality purposes for [protection of public health; stream quality control; economic development; protection of fisheries; recreation; dilution and abatement of pollution,]" among others [18 CFR 803.61(b)(1) and (e)]. It isn't clear that this requirement will be met. Finally, it should be noted that our consumptive use regulations require compensation for water removed from the river and not returned to it. Augmentation carries the idea of increasing the flow above the amount available under natural flow conditions.

3. We feel that the applicant should more fully investigate water quality problems associated with the releases and present procedures for ameliorating them.

Section 4.4.1-Construction

We have reservations about certain of the parameters used in the temperature modeling. The original analysis by the applicants' consultant used 1975 climatic data to simulate the 1964 drawdown. We feel it would have been more appropriate to use 1964 climatic data. Moreover, we feel that the results are even less appropriate for the larger reservoir. It is our judgment that a new analysis should be made of the larger reservoir, using more appropriate parameters.

It is also stated that the pumping station lies outside the 100-year flood plain. We are unable to verify that statement because of the level of detail used in Figure 2.5. However, the pumping station clearly lies outside of the floodway.

Section 4.4.2.1-Water Supply

The second and third paragraphs contain statements that are incomplete and potentially misleading. The second paragraph ignores the fact that the larger reservoir is planned to meet not only the consumptive use requirements of SSES during periods of low flow but also similar needs by other downstream users who might contract for a portion of the Pond Hill Water Supply. To state without explanation that the applicant has assumed a release rate of 2.9 cms, as against its own needs of up to 1.8 cms, is unfair to the applicant, making it appear they are planning a release that bears no relation to their own needs.

"Other uses" are recognized in passing in the third paragraph. However, without any explanation as to the nature of these other uses, the discussion could leave the impression that they are somehow associated with the Susquehanna plant. Also, it would be more accurate to note that, based on the average consumptive use during the design drought, 1.5 cms will be needed by the SSES for replacement of consumed water and 1.4 cms will be available to other users. (A similar misstatement regarding the average consumptive use at SSES appears in the second paragraph.)

The last paragraph of the Section relates to the refilling of the reservoir. You state correctly that the planned operational procedure calls for no pumping from the river when river flow is below 85 cms (3,000 cfs). You should be aware that we have as yet unresolved concerns about possible environmental impacts of pumping at such a low level of river flow.

We assume that the refilling rate of 3.7 cms refers to the pumping capacity of the enlarged project. We have not seen these specifications.

Section 4.4.2.3-Hydrologic Design of Dam

We note with concern that the dam design does not meet NRC criteria and that your staff is concerned about potential overtopping. We feel that the design criteria problem is a matter for the Pa. Dept. of Environmental Resources and the applicant to resolve.

Section 5.1.2-Use of Existing Reservoirs

A statement in the second paragraph misconstrues this Commission's position regarding the use of existing reservoirs. The statement "SRBC's response to this request was that the Cowanesque Reservoir is not now a timely alternative," misinterprets the statement on p. 2-3, Appendix H of the Environmental Report - Operating License Stage. The applicant correctly summarized the comments of our April 17, 1978 letter which suggested that a restudy of all potential water supply uses, the impact of these uses on other project functions, and determination of the necessity for reauthorization be made. The applicant then drew its own conclusion that, "The SRBC comments indicate that Cowanesque Reservoir is not now a timely alternative." (Emphasis added) The draft supplement sets forth as the position of this Commission a conclusion reached by the applicant. (A copy of our April 17, 1978 letter to the Corps of Engineers is attached.)

Section 5.1.3-Summary

In recent months, we have been working closely with both the Corps of Engineers and Pa. Power & Light Co. to explore the use of the Cowanesque project and an expanded Pond Hill project (enlarged to approximately 22,000 acre-feet of active water supply storage) as complementary water supply sources to meet several needs in the basin, including SSES. The Corps has completed Stage I of its Cowanesque Lake Reformulation Study and expects to have the entire study completed by March, 1982. PP&L estimates at this time that with continued work on the Pond Hill project, the completion date for PP&L storage only is summer, 1983 and with maximum storage, summer 1984. As you are aware, PP&L has announced the in-service date for Unit 1 is now January, 1982 and January, 1983 for Unit 2. At its March, 1980 meeting, the Susquehanna River Basin Commission adopted July 1, 1984 as the date by which Peach Bottom Nuclear Generating Station, Three Mile Island Nuclear Generating Station, and Susquehanna Steam Electric Station must be in compliance with the consumptive water make-up requirements.

Section 5.2-Alternative Sites

The first paragraph specifies certain parameters relating to the usable water storage requirement in the Pond Hill Reservoir that are no longer relevant. In response to questions raised by our staff, PP&L estimated that the full load consumptive use at SSES will be 52.5 cfs (1.49 cms) based on the drought of record; the Q7-10 at the Wilkes-Barre gage is 800 cfs (24.06 cms); and the consumptive use make-up storage for the full load operation at SSES consuming 52.5 cfs for 106 days is 11,030 acre-feet.

PP&L stated further "that the Pond Hill Project, if intended solely for SSES flow compensation, will be constructed to provide an active storage of 11,600 acre-feet (11,030 acre-feet for SSES plus 570 acre-feet for losses and downstream conservation flow). (Letter from N. W. Curtis, PP&L, to R. J. Bielo, SRBC, September 4, 1979)

The first sentence of the second paragraph refers to "a 1970 SRBC study". The study in question is one made by the Susquehanna River Basin Study Coordinating Committee, an interagency task force made up of representatives from seven Federal departments and agencies and the three basin states. It was chaired by the Corps of Engineers. The report was completed and released several months before this Commission came into existence. The applicant cites the study correctly in the ER-OL, Appendix H, Section 2.4.

<u>Section 5.3.1-Benefit-Cost Analysis-No Action Alternative</u>

The benefit-cost analysis for the "river following" alternative developed in this section poses several problems. First, the analysis presented in Tables 5.1 and 5.2 is based on the assumption of a 4-day shutdown occurring every year. This is the average number of days the plant would be shutdown based upon the flow duration curve. The latter assumption implies that an average flow year will occur in each year of the life of the project. But hydrology doesn't work that way. The analysis should have been based upon the expected value of the present worth of the cost of plant shutdown for different flow sequences. The analysis displayed in Table 5.3 apparently utilizes more realistic representation of the flows.

Second, the calculations which produced the 160,000 MWH, 170,000 MWH, and 146,000 MWH values mentioned in the first paragraph of the section are not evident to us. We feel this should be clarified.

Third, the analysis assumes an equal probability of hot and cold shutdown. Our understanding of these terms is as follows:

a. Cold shutdown means the nuclear reaction is essentially stopped, and no heat is being generated;

b. Hot shutdown means that the reactor control rods have been inserted to stop the reaction but the reaction has not actually ceased, heat is still being generated, and both primary and secondary cooling loops are carrying away the heat. Under this circumstance, the consumptive loss would still be continuing for some time (until cold shutdown is obtained) and the consumptive use would be decaying from its value prior to the beginning of the shutdown.

The point is that if our understanding is correct, hot shutdown is <u>not</u> a viable alternative to consumptive loss make-up, because the consumptive loss continues until cold shutdown is reached. That further implies that in order to use the river follower method, cold shutdown would have to exist on the first day that the flow goes below Q7-10+C and hot shutdown would have had to start some considerable period of time prior to that date.

Finally, under the brief periods of shutdown postulated for the analysis, it is not obvious to us why there should be any significant savings in the costs of operating SSES. While we do not know the components of the "Nuclear Generating Price", surely they are not entirely variable operating costs. It appears that this aspect of the analysis needs to be reconsidered.

<u>Section 5.3.2-Use of Existing Reservoirs</u>

The matter of cost of water from the Cowanesque Lake project is not resolved and will not be for some time to come. This Commission is in the process of developing a water supply management program, one component of which is a water pricing plan. The presumption is that SRBC will serve as the wholesale vendor of any water supply storage developed in the basin. Until this entire matter is more fully developed, no one can make any meaningful estimates of the cost of obtaining water from existing reservoirs. Certainly it would not be correct at this point to apply either the prices or pricing scheme of the Delaware River Basin Commission to the Cowanesque Lake project.

<u>Section 5.3.3-Pond Hill Reservoir</u>

There is an error in the statement about the cost of electricity for pumping water into the reservoir. The annual pumping cost is the sum of a capacity charge and an energy charge. The 4,500 hp of pumping capacity is equivalent to 3,357 KW. Assuming a (mid-1978) capacity charge of $12/KW, the annual capacity charge is (3,357 KW x $12/KW) = $40,300. The energy charge, assuming 30 days of pumping, and an energy cost of $0.025 per KWH is 3,357 KW x 30 days x 24 hrs./day x $0.025/KWH = $60,400. Thus, the total annual pumping cost is ($60,400 + $40,300) = $100,700. (See TAMS Design Report, Pond Hill Reservoir, p. 7-2 and Figure 15.)

* * * * *

We appreciate the opportunity to comment on the Draft Supplement. We hope that our comments are helpful.

Very truly yours,

Robert J. Bielo
Executive Director

SUSQUEHANNA RIVER BASIN COMMISSION
1721 North Front Street • Harrisburg, Pennsylvania 17102

From the Office of the Executive Director

April 17, 1978

Colonel G. K. Withers
U.S. Dept. of the Army
Corps of Engineers
Baltimore District
P.O. Box 1715
Baltimore, Maryland 21203

Dear Colonel Withers:

Thank you for providing us with a copy of a request from PP&L asking your office to determine whether the use of the Cowanesque Reservoir's potential seasonal storage capability to meet Susquehanna Steam Electric Station's consumed water make-up needs would be compatible with Cowanesques' other functions and whether such use would be practicable and economically justified. We note from the PP&L request that if it is determined such storage and water use is permissible the company intends to seek a contract with the Corps for the use of Cowanesque water and to submit such contract to SRBC for approval.

I have polled the Commission alternates on the <u>study</u> proposal and would advise that the Commission recognizes the need for the company (PP&L) to explore various alternative measures to obtain make-up water to compensate for consumptive losses of water at its Susquehanna Steam Electric Station during certain periods of low stream flow. Further, the Commission recognizes a need to determine the potential for seasonal water supply storage in the Cowanesque Reservoir for uses other than as outlined by the company.

Essentially the Commission believes that any review of the storage capability of the Cowanesque Reservoir should include: a range of water supply and other water use storage alternatives at the site, a determination of the effects such alternatives would have on flood storage and other project uses, and a determination whether such alternatives would require reauthorization or could be accomplished under current project authorization and Corps' authority.

Col. G. K. Withers - 2 - April 17, 1978

The Commission also wishes to note that if as a result of the study a positive determination is made of the potential capability of Cowanesque Reservoir to meet the water storage needs outlined by PP&L in its request that such finding does not in any way prejudice future Commission action regarding allocation of water from this project.

We will look forward to your findings and will be pleased to cooperate in any way possible.

Very truly yours,

Robert J. Bielo
Executive Director

730 East Second Street
Bloomsburg, PA 17815
20 August 1979

Director, Division of Site Safety and
Environmental Analysis
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

The following comments concern the Draft Environmental Statement for PP&L's Susquehanna Steam Electric Station, Units 1 and 2.

I urge the denial of an operating License for the PP&L nuclear power plant for the following reasons:

1. Need

a. the projection of the PJM summer peak (Table 7.5) shows a 6+% increase: the national average is, in actuality, slightly over 2%, a more reasonable projection and one that decreases need, pushing back the drop in reserve over summer peak.

b. while needs of the PJM power grid are a main reason given for the need to build the PP&L nuclear power plant (SS 1 & 2), those needs can be bypassed and PP&L can sell direct to member companies (e.g., sales to GPU to replace TMI electricity). PP&L's growth alone, with a generating capacity in excess of 41% over peak demand (Table 7.4), does not show conclusive need for more generating capacity by 1981, especially if the strong conservation measures of the service area continue. In fact, if the need were real, PP&L would be obliged to conduct a crash program to build a coal/solid waste/solar (or what-have-you) plant, since the nuclear plant may very well not be in operation by then.

c. the statement that "additional reserve capacity above 20% may be desirable for a system with units which are large in relation to system size (as will be the case with ~~as~~ the Susquehanna facility in service)," (p. 7-5) rather than showing the need for the plant, shows that the plant, in fact, creates need.

2. Evaluation of the Proposed Action

In reaching the conclusion that the nuclear power cycle is less harmful to man than the coal cycle, insufficient attention was paid to the mounting evidence of the effects of low-level radiation; the unknown effects of radioactive waste disposal; and the reliability of evidence supplied almost entirely by the nuclear power industry. While measurable effects may, at present, point to the coal cycle as more harmful, the potential for harm renders the nuclear cycle the more destructive

3. Benefit-Cost Analysis

a. The benefit of 11.0 - 12.9 billion KWh of electric power to the PJM interchange is based on a not necessarily valid assumption of a plant capacity factor of 60-70%, when, in actuality, nuclear power plant performance averages less than 60%.

b. The addition of 1890 MW of generating capacity to the PJM interchange and 210 MW to the cooperative is listed as a benefit when, in reality, it might be construed as a cost since it may encourage additional electrical power use.

c. The "savings" of 75 million (1980 $) in production costs per unit per year can be challenged if total costs, including government subsidies of the nuclear power industry, are included. In more concrete terms, the "savings" would accrue only if radioactive waste disposal is not pro-rated into the costs, and if the plant operates at 60-70% efficiency, without accident, for its projected lifetime: there are no models that would lead to the belief that this will happen.

d. The conclusion that there are no significant socioeconomic costs to be expected from station operation does not give sufficent weight to the very real stress experienced since TMI by those living in a 20 mile radius of the plant--the constant feeling of living on the edge of a radioactive volcano will cost.

e. The economic costs are presented in absolute terms rather than as compared to <u>not</u> operating the plant. Calculations from sources other than the utility have not been taken fully into account: Komanoff, e.g., projects electricity generated from coal-fired plants as cheaper <u>now</u> than from nuclear--and the difference will increase.

In summary, I urge the Nuclear Regulatory Commission to deny an operating license to PP&L for Susquehann Steam (Nuclear) Electric Station, Units 1 and 2, because operating the nuclear plant will adversely affect me, as a PP&L consumer, economically, environmentally and emotionally, and because, the need for additional generating capacity having diminished, there is enough "lead time" to develop alternate energy sources (including the use of increased conservation and efficiency) to supply the electricity needed--in an economically, environmentally and emotionally acceptable manner.

Sincerely,

Florence L. Thompson

Florence Thompson (Mrs. L.F.)

SEP 4 1979

Louise P. Watson
RD 2 Box 59
Union Dale, Pa.
17470

U.S. Nuclear Regulatory Comm.
Office of Nuclear Reactor Regulation
Washington, D.C. 20555

DOCKET NUMBER
PROD. & UTIL. FAC. 50-387, 388

Dear Sir:

I have just received the Final Draft Environmental Statement for the Susquehanna Steam Electric Station at Berwick. It appears that much research and work has gone into the preparation of this statement. As an interested and concerned citizen living less than 30 miles from the plant, I have a few comments I would like to make.

There was quite a bit of data collected on fish and wildlife but there was none collected on humans - no health picture of the human population within 10 miles of the plant - before the start up of operation. I feel this should have been done - to have some comparison with data that might be taken a few years later, with respect to effects of radiation, etc., with normal operation of the plant and also in case of an accident such as at T.M.I.

We were informed, during a visit to the Berwick plant, that a reservoir is planned to be constructed across the river to make up for additional cooling water that will be needed, since the S.S.E.S. be restricted by the Susquehanna River Basin Commission,

Acknowledged by card 9/14

B-75

in the amount of water they can use from the river. We object to the additional destruction of habitat which would result.

On page 687, 6.2.2 in the Environmental Statement of June 1973, the staff comments "the applicant does not appear to have made arrangements for interchange of data as yet, with nearby radiological monitoring programs at Peach Bottom, TMI, Oyster Creek, Indian Point, Shoreham, Forked River, Newbold Island, Salem, or Limerick." In the revised Draft Statement of June 1979, this omission has not been corrected.

In the section 4.5.5 on Uranium Fuel Cycle Impacts, we object to the conclusion that "both the dose commitment and health effects of the uranium cycle are insignificant when compared with dose commitment and potential health effects to the U.S. population resulting from all the natural background sources." The effects are additive, and even the natural background sources are considered responsible for mutations cancer, and other diseases. Just because we must tolerate natural background sources, it does not follow that radiation from the uranium fuel cycle is harmless! It could be the "straw" that breaks the camel's back.

Thank you for allowing us private citizens to make comments.

Very truly yours,
Louise C. Watson
R.D. 2 Box 59
Spring Dale, Pa
18273

APPENDIX C. ENVIRONMENTAL ASSESSMENT BY THE DIVISION OF SITE SAFETY AND ENVIRONMENTAL ANALYSIS FOR PROPOSED MODIFICATIONS TO THE TRANSMISSION LINE SYSTEM, SUSQUEHANNA STEAM ELECTRIC STATION UNITS 1 AND 2 (PENNSYLVANIA POWER & LIGHT COMPANY CONSTRUCTION PERMIT NOS. CPPR-101 AND CPPR-102 DOCKET NOS. 50-387 AND 50-388)

C.1. INTRODUCTION

By letter received on 15 October 1975, the Pennsylvania Power & Light Company proposed changes in the transmission routes previously evaluated for the Susquehanna Steam Electric Station. The proposed changes involve:

a. Shortening of the Susquehanna-Lackawanna 500-kV line and resulting in the Susquehanna-Stanton 500 kV line.

b. Elimination of the Susquehanna-Frackville 500-kV line and replacement with a 500-kV line between SSES and Sunbury Substation and a 500-kV line between SSES and the Wescosville-Siegfried Substation.[1,2]

Additional details concerning these changes were provided in Amendments 4 and 5 to the SSES Environmental Report, construction permit stage, submitted on 26 February 1976 and 30 June 1976.

C.2. REASON FOR THE PROPOSED CHANGE

PP&L is a member of the Pennsylvania-New Jersey-Maryland (PJM) power pool. Prior to 1974, the reliability of the PJM bulk power transmission system was considered inadequate without the network addition of a 500-kV line from Lackawanna 500-kV substation to an existing 500-kV system in northern New Jersey. This line, which would have been jointly owned by PP&L and two other PJM utilities, was approximately 121 km long and was expected to be placed in service by 1982 to provide overall improvement in the reliability of the PJM bulk power network. This line was not analyzed in the Final Environmental Statement (June 1973). Based on the data provided by the applicant (ER-CP, Amendment No. 5) it appears that these 121-km transmission lines from Lackawanna to an existing system in northern New Jersey would be more environmentally sensitive than the proposed addition of 90 km of transmission lines. Sixty percent of the 121-km transmission lines was expected to pass through the Pocono Mountains. The staff did analyze the environmental impacts of the Lackawanna transmission line and related facilities that were to be constructed between the Susquehanna Nuclear Power Plant and the proposed Lackawanna Substation. In late 1974, modifications were made in the planned development of the PJM bulk power network due to changing patterns of load growth and capacity expansion of other companies. As a result, the proposed 121-km line was canceled. Without this line, the applicant has stated that a single contingency failure of the Susquehanna-Frackville 500-kV line would cause electrical instability of the Susquehanna generators and would necessitate restricting output of SSES. Therefore, in order to obtain an adequate level of reliability, the previously planned transmission system for SSES needs to be modified (ER-CP, Amendment No. 5, Sec. 3.9.1).

C.3. ENVIRONMENTAL IMPACT OF THE PROPOSED CHANGE

The staff's evaluation of the two proposed changes is as follows:

a. The staff analyzed the impacts associated with changes detailed in Amendment No. 4 (Susquehanna-Stanton 500-kV line) and it was concluded that modifications proposed in Amendment No. 4 are acceptable, as discussed in a letter to PP&L, dated March 8, 1976.[3]

b. The staff has analyzed the impacts associated with changes detailed in Amendment No. 5 (proposed Susquehanna-Sunbury and proposed Susquehanna-Siegfried 500-kV lines), and this evaluation is detailed below. The review included a helicopter overflight by the staff on September 3, 1976, of the proposed Susquehanna-Sunbury line and the proposed Susquehanna-Siegfried line. Alternative routes were also investigated.

Description of Line Routing and Transmission Corridor Environment

Two lines are being proposed to replace the Susquehanna-Frackville 500 kV. The Sunbury-Susquehanna 500-kV line, shown in Figure B.1, will terminate at the existing Sunbury 500-230 kV substation. This line is approximately 71 km long and proceeds in a southerly direction from SSES, crossing the Susquehanna River where it intersects with the existing Sunbury-Susquehanna 230-kV route. From this intersection, the route parallels this existing line before terminating at the Sunbury Substation. This line will cross parts of Columbia, Montour, and Northumberland counties. At a point 1.9 km south of Sunbury, the proposed line will again cross the Susquehanna River to the Sunbury Substation on the west bank in Snyder County.

The Susquehanna-Siegfried 500-kV line crosses approximately 87 km between SSES and the Siegfried Substation north of Northampton, Pennsylvania (Figure C.1). The line traverses parts of Columbia, Lucerne, Carbon, and Northampton counties.

Right-of-way data as supplied by the applicant are included in Tables C.1 and C.2.

The study areas for the Sunbury and Siegfried lines encompass characteristic steep forested ridges and valleys and gently rolling farmland. The proposed Sunbury-Susquehanna line routes would traverse approximately 55% crop and pasture lands and about 33% forested lands. The proposed Susquehanna-Siegfried line would occupy nearly 66% forest cover and 33% crop and pasture cover.

The forest cover is primarily comprised of a mixture of oaks and pines. In general, ridges and high plateaus are composed of scrub oak (*Quercus ilicifolia*), white oak (*Quercus alba*), red oak (*Quercus ruba*), pitch pine (*Linus rigida*), and short-leaf pine (*Pinus echinata*). Valleys are composed primarily of red, white, and chestnut oaks (*Quercus prinus*), white pine (*Pinus strobus*), hemlock (*Tsuga canadensis*), several types of birch (*Betula* spp.), red maple (*Acer rubrum*), and yellow poplar (*Liriodendron tulipifera*). The slopes contain a diverse mixture of hardwoods and conifers; oaks, red birch (*Betula nigra*), white pine, hemlock, pitch pine, and white ash (*Fraxinus americana*) are dominant species.

Dominant understory species include azalea and rhododendron (*Rhododendron* spp.), mountain laurel (*Kalmia latifolia*), blueberry (*Vaccinium* spp.), and willow (*Salix* spp.) (ER-CP, Amendment No. 5).

The applicant has listed a wide variety of terrestrial and aquatic fauna within the Sunbury and Siegfried study areas (ER-CP, Amendment No. 5). The staff and the applicant have consulted the Pennsylvania Game Commission, the Pennsylvania Department of Environmental Resources, and the U.S. Department of the Interior. Local resource agencies, such as Bloomburg State College, have individually determined that the proposed routes do not cross areas containing any known unique floral or faunal habitats or state forest natural areas and wild areas.[4]

Threatened and Endangered Species

The State of Pennsylvania lists no birds, mammals, or floral species as being threatened or endangered in the state. The Department of the Interior lists two endangered mammals and three endangered birds whose range encompass the study area.[5] These are the eastern cougar (*Felis concolor cougar*), Indiana bat (*Myotis sodalis*), arctic peregrine falcon (*Falco peregrinus tundrius*), American peregrine falcon (*Falco peregrinus anatum*), and bald eagle (*Haliacetus leucocephalus*).[6] The applicant indicates that no endangered or threatened mammals have been observed in the study area. Critical habitats have been identified for the Indiana bat.[7] No areas in Pennsylvania have been identified as critical habitats for this species. Peregrine falcons have been sighted at Hawk Mountain, south of the study area (ER-CP, Amendment No. 5). The bog turtle (*Climmys muhlenbergii*) is the only endangered herpetile listed on the Pennsylvania Fish Commission list whose range falls within the study area. The applicant indicates that two endangered and two rare fish are listed by the Pennsylvania Fish Commission as having ranges falling within the study area for the proposed transmission line (ER-CP, Amendment No. 5). The applicant has provided the staff with its construction specifications program and vegetative management program and, based upon the mitigative and construction measures detailed, it is the staff's position that any rare and endangered fish species that may inhabit the general area along the applicant's preferred routes will not be affected by construction of SSES transmission lines.

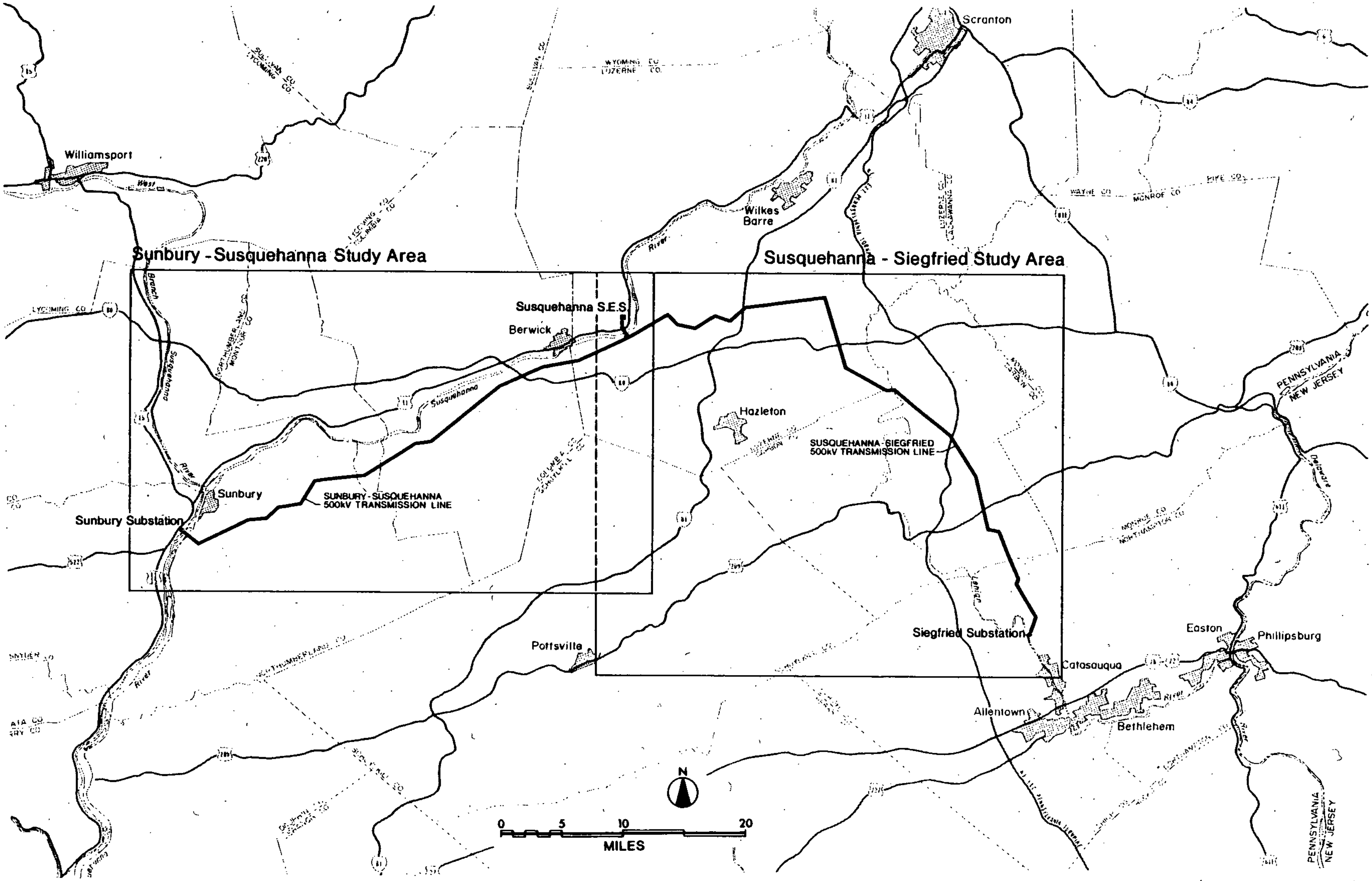


Fig. C.1. Susquehanna-Sunbury and Susquehanna-Siegfried Proposed Transmission Corridors.[1]

Table C.1. Right-of-way Data: Susquehanna-Sunbury Line[a]

Segment of Line	Length (ft)[b]	Required Width of Existing Line (ft)[b]	Required Width of New Config. (ft)[b]	Width of Additional ROW Required (ft)[b]	Area of Additional ROW Required (acres)[b]
Parallels existing Sunbury-Susquehanna 230 kV	222,600	150	325	175	894.3
Parallels proposed Susquehanna-Siegfried 500 kV	9,000	162.5[c]	325	162.5c	33.6
Total	231,600				927.9

[a]Source: ER-CP, Amendment No. 5, Table 3.9-A_1.

[b]Conversion factors:
ft to m, multiply by 0.3048.
acres to ha, multiply by 0.40469.

[c]With respect to the Sunbury line, the Siegfried line is considered to be existing and the required 325-ft right-of-way is equally divided between the two lines.

Table C.2. Right-of-way Data: Susquehanna-Siegfried Line[a]

Segment of Line	Length (ft)[b]	Required Width of Existing Line (ft)[b]	Required Width of New Config. (ft)[b]	Width of Additional ROW Required (ft)[b]	Area of Additional ROW Required (acres)[b]
Parallels proposed Sunbury-Susquehanna 500 kV	9,000	152.5[c]	325	162.5[c]	33.6
Parallels existing Sunbury-Susquehanna 230 kV	4,400	150	325	175	17.7
New right-of-way	184,400	0	200	200	846.6
Parallels existing East Palmerton-L. Harmony (outside of BWA[d] land)	32,800	100	300	200	150.6
Parallels existing (north) Siegfried Harwood 230 kV	20,000	150	325	175	80.3
Parallels existing (south) Siegfried Harwood 230 kV	27,000	150	300	150	93.0
Parallels existing East Palmerton-L. Harmony (within BWA[d] land)	6,400	100	200	100[c]	14.7
Total	284,000				1,236.5

[a]Source: ER-CP, Amendment No. 5, Table 3.9-A_2.

[b]Conversion factors:
ft to m, multiply by 0.3048.
acres to ha, multiply by 0.40469.

[c]With respect to the Siegfried line, the Sunbury line is considered to be existing and the required 325-ft right-of-way is equally divided between the two lines.

[d]BWA = Bethlehem Water Authority.

The applicant indicates that the only unique flora noted in the area, American chestnut (*Castenea dentata*), is not endangered and will not be affected by the proposed routes. The staff has investigated the possibility of existence of any critical habitat containing threatened or endangered floral species as proposed by the Department of the Interior.[8] No critical habitats have yet been determined for any proposed threatened or endangered floral species. The staff and the applicant, in response to staff questions (see Reference 24), have found no evidence that any threatened or endangered floral species are located along the proposed transmission routes.

Effects of Transmission Line Construction on Land Use and Impacts to the Land and Water

1. Land Use

The Sunbury-Susquehanna line crosses approximately 38 km of open land, predominantly utilized for crops or pastures. A small orchard will be traversed as well as 4.3 km of land classified as small farm woodlots (ER-CP, Amendment No. 5). The remaining portion of the route crosses 24.3 km of forest land and 2.6 km of state game lands. The applicant has submitted a detailed inventory of residential and commercial units; institutional and historic features; river, stream, railroad and major road crossings; as well as selected environmentally sensitive features such as wetlands, game and forest lands, etc., for each route.

The proposed Susquehanna-Siegfried line crosses 58.4 km of forest land, which includes state game land and state forest land. The line crosses a section of the Beltzville Reservoir in Beltzville State Park. At the crossing of the Lehigh River Gorge, the line will traverse 915 m of a proposed state park involving the crossing of an existing canoe trail and a proposed foot trail along an abandoned railroad right-of-way (ER-CP, Amendment No. 5). The line also crosses the Appalachian Trail at Blue Mountain while paralleling an existing 230-kV line. It is the staff's opinion that proposed paralleling 500-kV lines will not cause additional adverse impact to the Appalachian Trail. Approximately 25 km of agricultural land (29% of the total length) will be crossed by the proposed Siegfried-Susquehanna line.

2. Impacts

The staff's analysis of the originally proposed Susquehanna-Frackville 500-kV line in the FES-CP (Sec. 5.5.1) indicated that approximately 23.4 km of this route would traverse forested land requiring the alteration of 143 ha of forest cover. Approximately 14.8 km of agricultural land (79 ha) would also be temporarily impacted. Replacement of the Susquehanna-Frackville line with the Susquehanna-Sunbury and Susquehanna-Siegfried lines will result in an increase in both total forest and agricultural acreages required for new rights-of-way.

Impacts to the vegetative communities along the proposed paralleling Sunbury-Susquehanna line will be primarily limited to the selective removal of approximately 153 ha of forest cover along the proposed paralleling Sunbury-Susquehanna line. An additional 13.75 ha of state game lands will be disturbed, but the applicant will minimize impacts by preserving to the greatest extent possible all existing vegetation within rights-of-way limits except where removal is required for erection of line structures or installation of conductors (ER-CP, Amendment 5, Appendix I, Exhibit B, p. 11). In addition, the applicant indicates that planting and reseeding will be undertaken where required by the Pennsylvania Game Commission.

The applicant indicates that the Siegfried-Susquehanna proposed route would traverse 54.3 km of forest cover requiring 61 m of new right-of-way and 6.9 km of paralleling line requiring an average width of 52 m. The applicant estimates that the proposed Susquehanna-Siegfried right-of-way will impact 367 ha of forest land. Most of the land will be cleared by selective cutting, which will remove all trees except specified low-growing varieties (ER-CP, Amendment No. 5).

Impacts to animals along the corridor may take several forms. Most directly, some less mobile animals may be killed by construction equipment. Loss or partial alteration of habitat will result in the displacement of some faunal residences and may result in the loss of some animals.

Disturbance of fauna will temporarily result from increased human activity during construction. This type of impact is not expected to extend beyond the construction phase of the project.

Data on aquatic ecology, geology, and soil can be found in the ER-CP, Amendment No. 5. To reduce and minimize erosion and siltation problems the applicant has committed to detailed mitigative action specified in the ER: "Transmission Construction Specifications: Development of Erosion Control Plan for Line Construction" (ER-CP, Amendment No. 5, Appendix 1, Exhibit A) and "Vegetation Management" (ER-CP, Amendment No. 5, Appendix 1, Exhibits B and C).

Measures and Controls to Limit Adverse Effects During and From Construction

The applicant has submitted detailed erosion control plans (ER-CP, Amendment No. 5, Exhibit B) for staff review. It is the staff's conclusion that all actions outlined by the applicant will result in acceptable soil erosion control. The staff concurs with the applicant's plans to notify in advance the Soil Conservation Service (SCS) at the Conservation District of the county in which line construction activities will involve any earth-moving work. It is the staff's opinion that such contact with SCS will further reduce the possibility of serious erosion problems.

The applicant has selected two clearing methods, "selective" or "tailored" (ER-CP, Amendment No. 5, Appendix 1, Exhibit B), which the staff concludes will minimize construction impacts associated with more severe methods of clearing as well as reduce visual impacts. The applicant has provided a plan for corridor redress (ER-CP, Amendment No. 5, Appendix 1, Exhibits B and C). The staff has reviewed these plans and finds that they are acceptable as proposed; therefore, the staff does not recommend additional steps for redress.

The applicant states that no known archeological sites are crossed by either line and indicates that if any objects of possible archeological importance are unearthed, the Pennsylvania State Archeologist will be notified for an evaluation of the site.

Neither of the lines crosses or passes in the near vicinity of any registered historic site (ER-CP, Amendment No. 5, 3.9-13).

Effects of Transmission Line Operation on Land Use and on the Environment

The assessment of those impacts of station operation discussed in the FES-CP are still valid. Additional or new information is presented in this section.

1. Environmental Impact

Transmission line inspection and maintenance will not impact the involved ecosystems, especially since periodic inspections will be conducted by aircraft or on foot.

Use of hand clearing and selective spraying of herbicides are planned for routine maintenance. Chemical control of vegetation will conform to state and federal regulations and will be applied as directed by these authorities.

All chemicals, when used, will be applied by hand. The applicant has specified numerous precautions so that the possibility of chemical herbicides entering into water bodies will be remote. Herbicides will not be applied aerially (ER-CP, Amendment No. 5).

Ozone and other gaseous pollutants, such as nitrogen oxides, are formed as a result of ionization of air molecules that surround the cylindrical conductors used for transmitting electrical energy at high voltages. This ionization is caused by electrical discharge that is termed "corona." The degree of ionization depends on voltage, humidity, conductor diameter, surface roughness, and spacing between conductors. Calculations indicate that ozone production could be 45 times higher in foul than fair weather. Measurements at 765-kV lines show, however, that at ground level beneath the conductors the ozone concentration does not rise above ambient; furthermore, ground level concentration of ozone is the same on foul days as fair days, presumably because factors favoring increased production rates also favor increased destruction rates.[9,10] Recently, experiments were run over a one-year period in Jefferson County, Indiana, on 765-kV lines running over open, flat cornfields. When instruments were placed six meters downwind from the 765-kV conductors at conductor height, where corona-produced ozone concentration should be greatest, "no ozone attributable to the transmission lines was detectable during the test."[10] The natural increase in ozone concentration of 2 to 3 ppb for an increase of 30 m in elevation was observed.

The sensitivity of measuring instruments is about ±2 ppb; hence, increases in ozone concentration above ambient due to corona from 765-kV lines are within the sensitivities of measuring instruments.[11]

The national, primary air-quality standard for photochemical oxidants prescribes a level of 80 ppb as a maximum one-hour arithmetic mean not to be exceeded more than once per year. Susceptible plant species show damage symptoms from ozone exposure at concentrations as low as 30 ppb,[12,13] but over prolonged periods ozone is not considered injurious to vegetation, animals, or human beings unless concentrations exceed 50 ppb.[14] On the basis of these considerations, the staff concludes that ozone from SSES's 500-kV lines will be environmentally inconsequential.

There is a possibility that electrical fields set up around transmission lines could affect persons in the field. Studies have been performed to determine the effects of electrostatic fields on humans.[15-18] These studies did not incorporate controls and are limited in both scope and time. For example, cases are known of adults who were unaffected by doses of agents that are teratological or lethal to the fetus or child, and lag times between dose and effect of 20 years or more are known. Since the above studies do not consider children, since children may play beneath the transmission lines, and since controlled studies of long duration have not been carried out, the long-term effect of high voltage transmission lines is currently unknown. However, the staff is not aware of any reported observable effects on humans resulting from exposure to electric fields radiated from high voltage power lines. The physiological effects reported by the Russians[16] were observed on maintenance workers in EHV substations, not on individuals below transmission lines. A recent Russian paper[19] stressed that present standards apply only to maintenance personnel working on electrical installations. Russian standards permitting higher voltage gradients for local populations and agricultural workers are currently being considered since these populations will be exposed only infrequently.

The applicant will install a phasing arrangement and increase structure height, if necessary, at highway crossings to limit the electrostatic field strength at ground level to 7.5 kV/m. Where the applicant predicted the worst potential gradients (11 kV/m on a single circuit and double circuit 500-kV corridor), a phasing arrangement that will result in a worst-case gradient no greater than 7.83 kV/m at 11.28 m ground clearance will be used. Significantly lower field gradients will exist at highway crossings where a 16.5-m clearance will be maintained (ER-CP, Amendment No. 5, Section 5.5.1.5 and Applicant's Response to Staff Questions of October 15 and November 18, 1976). Field gradient levels at the edge of rights-of-way will be on the order of 2.4 kV/m or less.

If these gradients occur, using the more conservative Russian study[16] intended for maintenance personnel, a person could spend three hours daily working beneath the lines without adverse effects. The general public is not expected to spend significant amounts of time in the transmission line right-of-way corridors.

Staff's literature survey indicates that adverse health effects on switchyard workers have been observed, but no such observations were reported from studies on transmission line workers and on individuals outside the switchyard environment exposed to voltage gradients well above 7.5 kV/m.

The staff has analyzed data on the effects of high voltage electric lines on plants and animals and has found no evidence to date indicating hazardous effects to plants or animals from present levels of fields generated from existing transmission line technology.[20]

In the absence of such observations, the staff believes that there should be no changes in the applicant's proposed design. A number of carefully designed studies of the biological effects of electric fields are currently underway and additional studies are planned. These research projects are being sponsored by Federal agencies, including NRC, to study the effects of transmission line voltage gradients along with long-term effects on the general population. The staff will keep abreast of these studies and of any guidelines resulting from them and will consider the impacts of the transmission line operation prior to or at the time of the Operating License stage review, taking into consideration any new information (Sec. 4.4.1.2).

Induced currents are unlikely to ignite fuel vapors, but currents capable of shocking people could be induced in vehicles without grounding straps. Any stationary structure with metal parts in and along the right-of-way will be limited to a maximum electrostatic short circuit current of 5 milliamperes (rms); any object not meeting this criterion will be grounded by the applicant, especially such objects as metal fences or rail lines that run parallel to the right-of-way. In such objects that are ungrounded, shock causing involuntary muscle reaction may occur, but no permanent physiological harm is likely.[21] The staff believes grounding measures will reduce the likelihood of shock to a level that is of no concern.

A transmission line design guideline pertaining to induced currents which the applicant plans to follow, and which the staff considers prudent, is that ground clearances should be maintained so that a maximum induced current of 5 milliamperes (rms) is not exceeded under conditions of maximum line sag when the largest anticipated truck, vehicle, or equipment under the line is short-circuited to ground (ER-CP, Amendment No. 5, Secs. 3.9.5.5 and 5.5.1.5).

The applicant estimates that foul-weather noise (maximum) produced at the edge of the right-of-way of a 500-kV line will be 59 dB(A) (ER-CP, Amendment No. 5, Sec. 5.5.1.2). However, these worst case conditions will not occur frequently and noise levels will diminish as soon as the conductors begin to dry. The applicant states, and the staff concurs, that the area traversed is very sparsely populated and, therefore, impact due to noise will be minimal.

The applicant addressed the potential impacts of transmission operation on radio and TV reception interference and indicates that investigation and correction of reception problems due to radio interferences will be done on an individual basis as each problem will be unique. Corona-produced television interference is not foreseen for those areas where good television reception is presently obtained during fair weather. There may be some foul-weather phenomena, but the applicant indicates that the low precipitation type television influence has been found to be less than two percent of foul-weather radio influence at a point 61 m from the outermost conductor; therefore, lines are not expected to cause any significant television disturbances (ER-CP, Amendment No. 5, Sec. 3.9.5.4).

2. Esthetic Impacts

Sunbury-Susquehanna will parallel an existing 230-kV transmission line for 67.9 km or 96% of its length. In addition, it is proposed that 2.7 km of the line (or the remaining 4%) will parallel the proposed Susquehanna-Siegfried 500-kV line. The staff believes that the paralleling nature of this route, as outlined by Federal guidelines,[22,23] will assure that all visual impacts will be on an acceptable level. In addition, it is the staff's opinion that the applicant's right-of-way clearing and maintenance practices will further aid in reducing any potential visual impact associated with both the Sunbury-Susquehanna line and Siegfried-Susquehanna line (ER-CP, Amendment No. 5, Appendix I, Exhibits B and C).

The Siegfried-Susquehanna line will cross several esthetically sensitive areas; namely, the Lehigh River Gorge crossing being considered for use as a state park and Beltzville Reservoir and State Park.

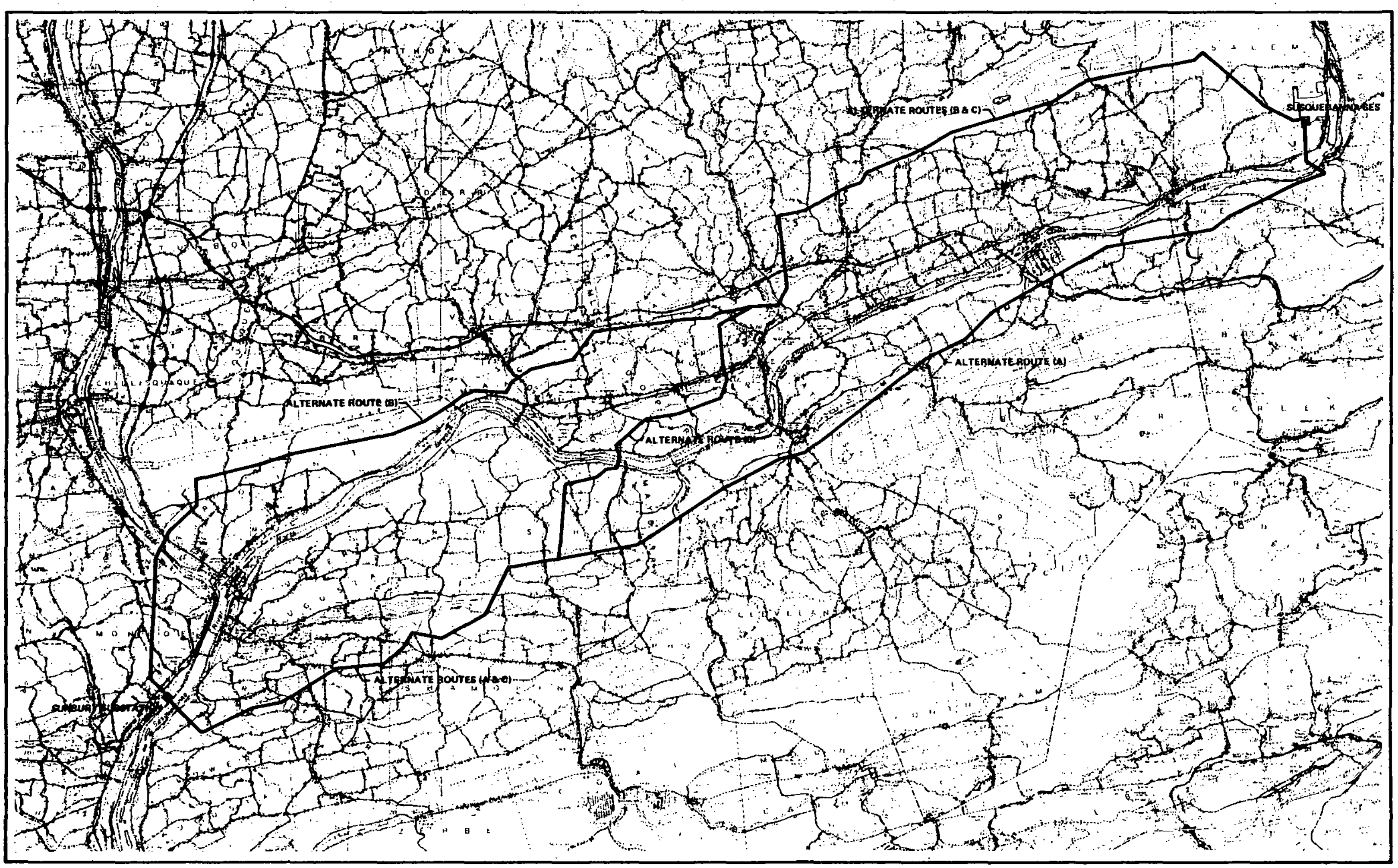
In both cases, the applicant is designing the line to minimize visual impacts. At the Lehigh River crossing, the tower structures will be set back from the gorge, being screened from the canoe run and hiking trail at the bottom of the gorge by the natural terrain. The applicant has received approval from the Pennsylvania Department of Environmental Resources for this crossing (Applicant's Response to Staff Questions, November 18, 1976). The applicant conducted a feasibility study regarding crossing of Beltzville Reservoir by using new double circuit tubular steel poles instead of existing 66-kV tower structure in front of scenic view. The study concluded, and the U.S. Corps of Engineers agreed, that such a combined crossing presents serious reliability problems. The staff believes that the parallel crossing will not create additional adverse visual impacts to the area. Based upon the implementation of the applicant's proposed mitigative measures, such as tailored clearing or feather cutting at improved road crossings, parks, peaks and ridges, and stream and river crossings (ER-CP, Amendment No. 5, Sec. 5.5.4.2.b and Appendix 1, Exhibit B), combined with the remote location of large portions of this route, making it unlikely that many people would be affected by it, the staff does not expect unacceptable esthetic impact along the Susquehanna-Siegfried proposed corridor.

Alternatives to the Proposed Routes

The applicant has considered a variety of alternative routes, analyzing both predicted minimum impact routes and minimum cost routes. Three routes were fully examined and compared for each line.

1. Sunbury-Susquehanna Line Alternatives

Two alternatives to the proposed Sunbury-Susquehanna route (Alternative Route A) are considered (Figure C.2). Alternative Route B leaves the Sunbury Substation in a northerly direction and crosses the west branch of the Susquehanna about 3.2 km above the confluence of the Susquehanna. It then proceeds eastward, paralleling the north branch of the Susquehanna, until it passes north of Berwick where it heads southeast to SSES. Alternative Route C parallels the applicant's preferred corridor out of Sunbury for approximately 20 km and then leads north, where it jointly crosses the north branch of the Susquehanna



Base Map: Commonwealth of Pennsylvania, Department of Transportation.

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Fig. C.2. Susquehanna-Sunbury Alternative Routes.

just east of Reeds Island (southeast of Danville) with an existing line. It proceeds in a basically northerly direction until it meets with Alternative Route B and then follows the Alternative B corridor into the plant.

It appears to the staff that the applicant has endeavored to utilize existing corridors wherever practical in selection of preferred and alternative routes for the Sunbury-Susquehanna corridor. The preferred route (Alternative A) parallels an existing line (a 230-kV Sunbury-Susquehanna line) for more than 67 km and the remaining 2.7 km will parallel the proposed Susquehanna-Siegfried 500-kV line. Interpretation of the available data indicates that all three alternatives recommended by the applicant are acceptable and that the applicant's preferred route would be the most environmentally acceptable in terms of fine tuning of environmental impact reduction due to extensive "paralleling."

2. Susquehanna-Siegfried Route Alternative

Figure C.3 shows the three routes examined for termination at the Siegfried Substation. Alternative B proceeds in a southeasterly direction from the plant, paralleling an existing 230-kV line for almost its entire length until it joins Alternative routes A, the preferred route, and C just north of the Siegfried Substation. Alternative Route C is similar to the preferred corridor except that it departs from the preferred corridor approximately 1.6 km northwest of the intersection of Interstates 80 and 81 and proceeds easterly until it rejoins Alternative A southwest of White Haven. According to the applicant, this route was originally investigated and selected as the prime connection to the Siegfried Substation, but a potential generating plant north of White Haven resulted in modification of Alternative C to form Alternative A. It is the staff's evaluation that there are few major differences between alternative routes A and C. The applicant's analysis (Table 10.9-A_2) indicates only marginal differences between alternatives A and C. The major difference is that Route C will approach more residential units than Route A. The applicant indicates that, from an environmental standpoint, Route B is more desirable. The staff's own analysis also concludes that the paralleling nature of Route B would cause a reduction in 68.3 ha of primary forest land needed for additional right-of-way. However, it appears to the staff that none of the corridors pass through any areas requiring unique siting constraints and that the additional acreage required for Alternative A will be an insignificant impact to the large inventory of forested lands in the region. The staff has assessed the applicant's proposed mitigative measures to insure minimal environmental impact and has concluded that these will reduce construction and operating impacts to an acceptable level.

The applicant has provided the staff with more detailed estimates of the length and land area requirements for the above alternatives (Table C.3). Alternative B requires less land area 68.3 ha than the applicant's preferred route (A). Land area requirements for alternatives A and C are judged by the staff to be of similar magnitude. However, Alternative C does approach approximately twice the number of residences (607) as alternatives A (359) and B (342). The staff concludes that based on this residential impact, Alternative C is not preferable to alternatives A or B. Therefore, the staff's environmental analysis of impacts associated with construction of the preferred route (A) and two alternative routes (B and C) indicates that 1) the applicant's preferred route is environmentally acceptable and 2) that selection of Alternative B would cause a slight reduction in terrestrial impacts primarily due to lower right-of-way land requirements.

Table C.3. Right-of-way Data for Alternative Analysis[a]

	Alternative		
	A	B	C
Length (km)	86.6	81.6	82.4
Area for total right-of-way (ha)	500.4	432.1	474.4

[a]Source: Applicant's Response to Staff Questions, November 18, 1976 (Reference No. 24).

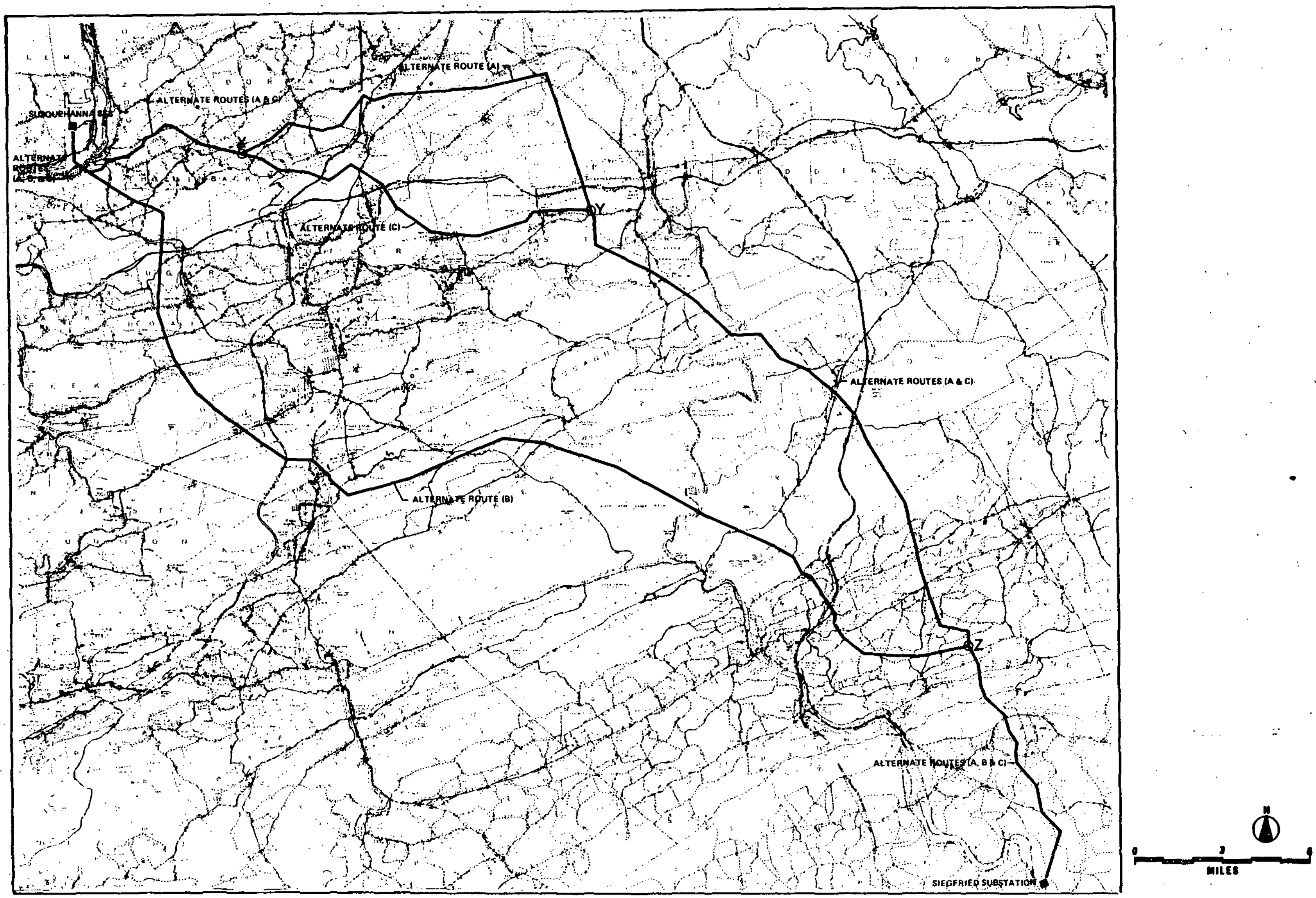

Fig. C.3. Susquehanna-Siegfried Alternative Routes.

The applicant has supplied data for the economic costs of the three alternatives.[24] Route A is estimated to cost $28,586.522; Route B is estimated to cost $29,273,095, and Route C is estimated to cost $28,346,991. Interpretation of the available data indicates that all three alternative routes for the Susquehanna-Siegfried line recommended by the applicant are acceptable. Alternative A provides an economic advantage over Alternative B, even though Alternative B would require 68.3 ha less land area to construct. The estimated construction cost for Alternative C is slightly lower than that for Alternative A; Alternative C would approach more residential units and does not appear to offer unique advantages over Alternative A. In conclusion, although Alternative A does not represent the minimum environmental path in the Susquehanna-Siegfried line, from an overall point of view it does offer the best compromise of economic and environmental considerations. Therefore, the applicant's selection of Route A is reasonable.

Unavoidable Adverse Environmental Impacts

1. Land

   Except for small land areas used for tower bases, land will be available for multiple use within the transmission line right-of-way.

2. Water

   No impacts on water are expected since extensive mitigative measures will be in effect at all water-body crossings.

3. Air

   Construction activities may cause some dust and emissions of particulates. However, with the applicant's mitigative measures, little air quality deterioration will occur. Little ozone should be produced during operation of the lines.

4. Noise

   No unacceptable noise levels are expected during construction and operation of SSES transmission lines.

C.4. CONCLUSIONS

On the basis of the foregoing analysis, the staff has determined that modifications proposed in Amendment No. 4 and 5 combined involve greater environmental impact primarily with respect to the increase in total line lengths from 116 km to 206 km. On a region-wide basis, however, the net environmental impact could be considered lessened, since the additional 90 km of lines are necessitated by the cancellation of a proposed 121-km long line.

The proposed transmission routes would pass through areas similar to the Susquehanna-Frackville lines; therefore, the environmental impact evaluation conducted in connection with the initial application still characterizes the nature of the impacts, and the extent of impacts associated with the proposed change has been analyzed in this assessment. The staff concludes that impacts associated with the newly proposed transmission routes are acceptable and not substantial.

Further, impacts of the proposed change in transmission lines discussed above are sufficiently small so that, when they are superimposed upon the other environmental impacts assessed with respect to construction of the plant, the changes in the overall environmental impact from construction of the plant are not significant. After considering the impacts attributable to the proposed changes, the staff concludes the overall cost-benefit balance previously developed in the FES-CP remain unaltered.

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APPENDIX D. NEPA POPULATION DOSE ASSESSMENT

Employing the same models used for individual doses, population dose commitments are calculated for all individuals living within 80 km of the facility (see Regulatory Guide 1.109, Rev. 1). In addition, population doses associated with the export of food crops produced within the 80-km region and the atmospheric and hydrospheric transport of the more mobile effluent species such as noble gases, tritium, and carbon-14 have been considered.

NOBLE GAS EFFLUENTS

For locations within 80 km of the reactor facility, exposures to these effluents are calculated using the atmosphere dispersion models in Regulatory Guide 1.111, Rev. 1., and the dose models described in Section 4.5 and Regulatory Guide 1.109, Rev. 1. Beyond 80 km, and until the effluent reaches the northeastern corner of the United States, it is assumed that all the noble gases are dispersed uniformly in the lowest 1000 m of the atmosphere. Decay in transit was also considered. Beyond this point, noble gases having a half-life greater than one year (e.g., Kr-85) were assumed to completely mix in the troposphere of the world with no removal mechanisms operating.

Transfer of tropospheric air between the northern and southern hemispheres, although inhibited by wind patterns in the equatorial region, is considered to yield a hemisphere average tropospheric residence time of about two years with respect to hemispheric mixing. Since this time constant is quite short with respect to the expected midpoint of plant life (15 yr), mixing in both hemispheres can be assumed for evaluations over the life of the nuclear facility. This additional population dose commitment to the U.S. population was also evaluated.

IODINES AND PARTICULATES RELEASED TO THE ATMOSPHERE

Effluent nuclides in this category deposit onto the ground as the effluent moves downwind; this continuously reduces the concentration remaining in the plume. Within 80 km of the facility, the deposition model in Regulatory Guide 1.111, Rev. 1, was used in conjunction with the dose models in Regulatory Guide 1.109, Rev. 1. Site-specific data concerning production, transport, and consumption of foods within 80 km of the reactor were used. Beyond 80 km, the deposition model was extended until no effluent remained in the plume. Excess food not consumed within the 80-km distance was accounted for, and additional food production and consumption representative of the eastern half of the country was assumed. Doses obtained in this manner were then assumed to be received by the number of individuals living within the direction sector and distance described. The population density in this sector is taken to be representative of the eastern United States, i.e., about 62 people per square km.

CARBON-14 AND TRITIUM RELEASED TO THE ATMOSPHERE

Carbon-14 and tritium were assumed to disperse without deposition in the same manner as krypton-85 over land. However, these nuclides do interact with the oceans. This causes the carbon-14 to be removed with an atmospheric residence time from four to six years, with the oceans being the major sink. From this, the equilibrium ratio of the carbon-14 to natural carbon in the atmosphere was determined. The same ratio was then assumed to exist in humans so that the dose received by the entire population of the United States could be estimated. Tritium was assumed to mix uniformly in the world's hydrosphere, which was assumed to include all the water in the atmosphere and in the upper 70 m of the oceans. With this model, the equilibrium ratio of tritium to hydrogen in the environment can be calculated. The same ratio was assumed to exist in humans and was used to calculate the population dose in the same manner as carbon-14.

LIQUID EFFLUENTS

Concentrations of effluents in the receiving water within 80 km of the facility were calculated in the same manner as described for the Appendix I calculations. No depletion of the nuclides present in the receiving water by deposition on the bottom of the Susquehanna River was assumed. The assumption that aquatic biota concentrate radioactivity in the same manner as was assumed for the Appendix I evaluation was also made. However, food consumption values appropriate for the average individual, rather than the maximum, were used. It was assumed that all the sport and commercial fish and shellfish caught within the 80-km area were eaten by the U.S. population.

Beyond 80 km, it was assumed that all liquid effluent nuclides, with the exception of tritium, have deposited on the sediments so they make no further contribution to population exposures. The tritium was assumed to mix uniformly in the world's hydrosphere and to result in an exposure to the U.S. population in the same manner as discussed for tritium in gaseous effluents.

APPENDIX E. EXPLANATION AND REFERENCES FOR BENEFIT-COST SUMMARY

Economic Impact of Plant Operation

Direct Benefits - The staff has evaluated the total direct benefit of the Susquehanna Nuclear Station production of baseload energy by calculating entire output of the facility at 60% capacity factor. Applicant owns 90% of the facility. Refer to Section 7.

Indirect Benefits - A small portion of the state tax is provided to the impacted local counties ($65,000). Refer to Sections 4.6.6.1 and 4.6.6.2.

Economic Costs - Operating costs: Supplied by applicant.

Decommissioning costs: The staff has estimated decommissioning costs in 1975 dollars at $59 million.

1. Deactivating the reactors
2. Decontaminating of process systems and areas of plant
3. Removing all nuclear fuel from the site for recovery of fuel materials and ultimate disposal of radioactive wastes
4. Sealing of building or portion of building containing activated process piping and components by means of blocking, bolting, or welding plates over openings, etc.
5. Dismantling and sealing of all gaseous and liquid waste systems and effluent lines
6. Maintaining some security and fire systems
7. Ultimate dismantling of station

Environmental Impact of Plant*

Item 1 - Impact on water

Item 1.1 - Consumption (nuclear station consumption): The amount of water consumed by the applicant for operation is estimated to average 1.4 m^3/s. This amounts to 26,000,000 m^3/yr at a 60% capacity factor.

Item 1.2 - Heat discharge to natural water body

1.2.1 - Cooling capacity of water body: J/hr rejected heat = 3.4×10^{11} (max)
1.2.2 - Aquatic biota: insignificant.
1.2.3 - Migratory fish: insignificant.

Item 1.3 - Chemical discharge to natural water body (Includes Items 1.3.1, 1.3.2, 1.3.3, and 1.3.4): chemicals will be discharged to the Susquehanna River. The 1,400,000 kg/yr chemical discharge is an annual average, mainly sulfate.

Item 1.4 - Radionuclide contamination of natural water body: See Sec. 4.5.

Item 1.5 - Chemical contamination of groundwater: see Item 1.3, above.

Item 1.6 - Radionuclide contamination of groundwater: See Sec. 4.5.

*The index numbers used in this and the next section correspond to those used in Table 9.1.

Item 1.7 - Raising/lowering of groundwater levels (Includes Items 1.7.1 and 1.7.2): no effect is expected.

Item 1.8 - Effects on natural water body of intake structure and condenser cooling systems: unknown.

1.8.1 - Primary producers and consumers: chemical discharges are discernible (Sec. 4.3.3).
1.8.2 - Fisheries: additional studies are warranted relative to the effect of construction and operation of the intake structure upon fish productivity.

Item 1.9 - Natural water drainage

1.9.1 - Flood control: no damage to station or immediate vicinity.
1.9.2 - Erosion control: no significant erosion is expected.

Item 2 - Impact on air

Item 2.1 - Chemical discharge to ambient air

2.1.1 - Air quality--chemical: no impact. Entries for CO, NO_x, and HC are non-zero because of operation of diesel equipment several hours per month.
2.1.2 - Air quality--odor: no impact.

Item 2.2 - Radionuclides discharged to ambient air

2.2.1 - Noble gases: See Sec. 4.5.

Item 2.3 - Fogging and icing: offsite icing may occur when the spray pond is operating (Sec. 4.4.1).

Item 2.4 - Salt discharge from cooling system

2.4.1 - People: see FES-CP, p. 3-41.
2.4.2 - Plants and soil: See ER-OL, p. 5.3-5.

Item 3 - Impacts on terrestrial systems

Item 3.1 - Station area: acceptable. See ER-OL, Section 3.1-5.

Item 3.2 - Bird impingement on station facilities: should be monitored. See Sec. 5.3.6.

Item 4 - Transmission line corridors

Item 4.1 - Right-of-way maintenance and inspection: See Sec. 4.5 and Appendix C.

Item 4.2 - Production of ozone, other gaseous pollutants: See Sec. 4.5 and Appendix C.

Item 4.3 - Audible noise: See Sec. 4.5 and Appendix C.

Item 4.4 - Radio and TV interference: See Sec. 4.5 and Appendix C.

Item 4.5 - Electrical field effects: See Sec. 4.5 and Appendix C.

Item 5 - Total body dose commitments to U.S. population general public, unrestricted area: See Sec. 4.5 and Appendix C.

Societal Impact of Plant

Item 1 - Operational fuel disposition

Item 1.1 - Fuel Transport: Ten truck shipments of new fuel plus 13 train shipments of radioactive spent fuel assemblies per year.

Item 1.2 - Fuel Storage: The staff assumes storage of new fuel to be provided for in plant design within the reactor building.

Item 1.3 - Waste Products: Onsite storage of spent fuel assemblies is normal and is assumed for SSES.

Item 2 - Labor: impacts anticipated due to high unemployment in area (see Section 4.6).

Item 3 - Historical and archeological sites: (see Sec. A.2.7).

Item 4 - Station operational noise: exceeds EPA standard but is to be monitored by applicant. Refer to Section 5.3.5.

Item 5 - Social costs: include social stresses, demand on public services, and housing.

Item 6 - Esthetics: acceptable. Refer to Section 4.4.1.1.

APPENDIX F. APPLICATION FOR NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT TO DISCHARGE TO STATE WATERS

NPDES Application No. PA-0047325

COMMONWEALTH OF PENNSYLVANIA

DEPARTMENT OF ENVIRONMENTAL RESOURCES

Bureau of Water Quality Management
Wilkes Barre Regional Office
90 East Union Street - 2nd Floor
Wilkes Barre, Pa. 18701
July 31, 1979

Industrial Waste
NPDES Permit No. PA-0047325
Pennsylvania Power & Light Company
Susquehanna Steam Electric
Salem Township
Luzerne County

RECEIVED
AUG 10 1979
ENVIR MGMT

Pennsylvania Power & Light Company
Susquehanna Steam Electric
c/oMr. John T. Kauffman
Executive Vice President, Operations
Two North Ninth Street
Allentown, Pa. 18101

Gentlemen:

The subject permit is enclosed.

Please study the permit carefully and direct any questions to this office. Our telephone number is (717) 826-2553.

Very truly yours,

Lawrence A. Pawlush

Lawrence A. Pawlush
Regional Water Quality Manager

LAP:JPL:hp

Enclosures - NPDES Permit
NPDES Discharge Monitoring Report
DMR Instructions

cc: File
Program Services
Richard L. Constrisciano
Environmental Engineer
Water Enforcement Branch
Pennsylvania Section 3EN22
U.S. Environmental Protection Agency
Sixth & Walnut Streets
Philadelphia, Pa. 19106

ER-BWQ-15.1 9/78

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF WATER QUALITY MANAGEMENT

WATER QUALITY MANAGEMENT PERMIT - PART I

AUTHORIZATION TO DISCHARGE UNDER THE
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

PERMIT NO. PA-0047325

In compliance with the provisions of the Clean Water Act, 33 U.S.C. 1251 et. seq. (the "Act") and Pennsylvania's Clean Streams Law, as amended, 35 P.S. Section 691.1 et. seq.,

Pennsylvania Power & Light Company
Susquehanna Steam Electric
c/o Mr. John T. Kauffman, Exec. Vice President, Operations
Two North Ninth Street
Allentown, Pa. 18101

is authorized to discharge from a facility located at

Salem Township
Luzerne County

to receiving waters named

North Branch of Susquehanna River

in accordance with effluent limitations, monitoring requirements and other conditions set forth in Parts A, B, and C hereof.

This permit shall become effective on July 31, 1979.

This permit and the authorization to discharge shall expire at midnight, September 30, 1980.

The authority granted by this permit is subject to the following further qualifications:

1. If there is a conflict between the application, its supporting documents and/or amendments and the standard or special conditions, the standard or special conditions shall apply.

2. Failure to comply with the rules and regulations of the Department or with the terms or conditions of this permit shall void the authority to discharge given to the permittee by this permit.

PERMIT ISSUED BY Lawrence A. Pawlush

DATE July 31, 1979 TITLE Regional Water Quality Manager

7909140339

(DRAFT - 4/26/79) PA-0047325

1. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS, OUTFALL 041, LAT 41° 05' 35", LONG 76° 07' 48"
WHICH RECEIVES WASTE FROM: cooling tower blowdown.

During the period beginning July 31, 1979 and lasting through September 30, 1980, the permittee is authorized to discharge.

Such discharges shall be limited, and monitored by the permittee, as specified below:

Effluent Characteristic	Discharge Limitations*					Monitoring Requirements	
	kg/day (lbs/day)		Other Units (Specify) (Mg/1)				
	Daily Avg.	Daily Max.	Daily Avg.	Daily Max.	Instantaneous Max.	Measurement Frequency	Sample Type
Flow-m³/Day (MGD) 54,504-m³/Day (14.4 mgd)						Daily	Recorded
Free Available Chlorine ***	0.91(2)	2.27(5)	0.2	0.5		(When being added) Daily	Grab
Total Suspended Solids			N.A.	200 **		Daily	Grab
Total Iron			N.A.	7.0 **		Weekly	Grab

*** Neither free available chlorine nor total residual chlorine may be discharged from any unit for more than two hours in any one day and not more than one unit in any plant may discharge free available or total residual chlorine at any one time unless the utility can demonstrate to the regional administrator or state that the units in the particular location cannot operate at or below this level of chlorination.

The pH shall not be less than 6.0 standard units, not greater than 9.0 standard units and shall be monitored daily, grab.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): at outfall 041 - cooling tower blowdown.

*Unless otherwise indicated, these are gross discharge limitations.

** Effluent quality need not exceed the quality of the raw water supply (background conditions of the North Branch Susquehanna River).

(DRAFT - 4/26/79) PA-0047325

1. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS, OUTFALL 042, LAT 41°05' 34", LONG 76° 08' 45"
WHICH RECEIVES WASTE FROM: the service and administration building, diesel-generator building, diesel fuel unloading pad and some transformer pad sumps. (S/A LOW VOLUME WASTE)
During the period beginning July 31, 1979 and lasting through September 30, 1980, the permittee is authorized to discharge.

Such discharges shall be limited, and monitored by the permittee, as specified below:

Effluent Characteristic	Discharge Limitations*					Monitoring Requirements	
	kg/day (lbs/day)		Other Units (Specify) (Mg/l)				
	Daily Avg.	Daily Max.	Daily Avg.	Daily Max.	Instantaneous Max.	Measurement Frequency	Sample Type
Flow-m^3/Day (MGD) 87.06-m^3/Day (.023 mgd)						Daily	Pump rate or weir
Total Suspended Solids	2.61(5.75)	8.7(19.18)	30	100		1/month	Grab
Oil & Grease	1.31(2.88)	1.74(3.84)	15	20		1/month	Grab

The pH shall not be less than 6.0 standard units, not greater than 9.0 standard units and shall be monitored when first discharging, bimonthly, grab.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): outfall 042.

*Unless otherwise indicated, these are gross discharge limitations.

1. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS, OUTFALL 043, LAT 41° 05' 33", LONG 76° 08' 51"
WHICH RECEIVES WASTE FROM: Unit 1 turbine building outside areas (Unit 1 - Low Volume Waste Basin)

During the period beginning July 31, 1979 and lasting through September 30, 1980, the permittee is authorized to discharge.

Such discharges shall be limited, and monitored by the permittee, as specified below:

Effluent Characteristic	Discharge Limitations*					Monitoring Requirements	
	kg/day (lbs/day)		Other Units (Specify) (Mg/1)				
	Daily Avg.	Daily Max.	Daily Avg.	Daily Max.	Instantaneous Max.	Measurement Frequency	Sample Type
Flow-m^3/Day (MGD)							
87.06-m^3/Day(.023 mgd)						Daily	Pump rate or weir
Total Suspended Solids	2.61(5.75)	8.7(19.18)	30	100		1/month	Grab
Oil & Grease	1.31(2.88)	1.74(3.84)	15	20		1/month	Grab

The pH shall not be less than 6.0 standard units, not greater than 9.0 standard units and shall be monitored when first discharging, bimonthly, grab.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): outfall 043.

*Unless otherwise indicated, these are gross discharge limitations.

1. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS, OUTFALL 044, LAT 41° 05' 28", LONG 76° 08' 51"
WHICH RECEIVES WASTE FROM: Unit 2 turbine building outside areas. (Unit 2 - Low Volume Waste Basin)

During the period beginning July 31, 1979 and lasting through September 30, 1980, the permittee is authorized to discharge.

Such discharges shall be limited, and monitored by the permittee, as specified below:

Effluent Characteristic	Discharge Limitations*					Monitoring Requirements	
	kg/day (lbs/day)		Other Units (Specify) (Mg/1)				
	Daily Avg.	Daily Max.	Daily Avg.	Daily Max.	Instantaneous Max.	Measurement Frequency	Sample Type
Flow-m^3/Day (MGD) 87.06-m^3/Day (.023 mgd)						Daily	Pump rate or weir
Total Suspended Solids	2.61(5.75)	8.7(19.18)	30	100		1/month	Grab
Oil & Grease	1.31(2.88)	1.74(3.84)	15	20		1/month	Grab

The pH shall not be less than 6.0 standard units, not greater than 9.0 standard units and shall be monitored when first discharging, bimonthly, grab.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): at outfall 044.

*Unless otherwise indicated, these are gross discharge limitations.

(DRAFT - 4/26/79) PA-0047325

1. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS, OUTFALL 046, LAT 41° 05' 29" LONG 76° 08' 54"
WHICH RECEIVES WASTE FROM: acid unloading pad.

During the period beginning July 31, 1979 and lasting through September 30, 1980, the permittee is authorized to discharge:

Such discharges shall be limited, and monitored by the permittee, as specified below:

Effluent Characteristic	Discharge Limitations*					Monitoring Requirements	
	kg/day (lbs/day)		Other Units (Specify) (Mg/l)				
	Daily Avg.	Daily Max.	Daily Avg.	Daily Max.	Instantaneous Max.	Measurement Frequency	Sample Type
Flow-m^3/Day (MGD)							
11.94-m^3/Day (.033 mgd)						(When discharging)	Estimate
Total Suspended Solids	0.34(0.75)	1.13(2.5)	30	100		1/month	Grab
Oil & Grease	0.17(0.38)	0.23(0.5)	15	20		1/month	Grab

The pH shall not be less than 6.0 standard units, not greater than 9.0 standard units and shall be monitored when first discharging, bimonthly, grab.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): Point Source 046 - acid unloading pad sump discharge.

*Unless otherwise indicated, these are gross discharge limitations.

1. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS, OUTFALL 047, LAT 41° 05' 32", LONG 76° 08' 48"
WHICH RECEIVES WASTE FROM: Unit 1 Condensate Storage Tank Area

During the period beginning July 31, 1979 and lasting through September 30, 1980, the permittee is authorized to discharge.

Such discharges shall be limited, and monitored by the permittee, as specified below:

Effluent Characteristic	Discharge Limitations*					Monitoring Requirements	
	kg/day (lbs/day)		Other Units (Specify)				
	Daily Avg.	Daily Max.	Daily Avg.	Daily Max.	Instantaneous Max.	Measurement Frequency	Sample Type
Flow-m^3/Day (MGD)							
90.84-m^3/Day(.024 mgd)							

This permit authorizes the discharge of rain water from Point Source 047 that collects in the diked area surrounding the Unit 1, Condensate Storage Tank. Any discharge other than storm water requires prior approval from the state and U.S. Environmental Protection Agency. Therefore, fire protection water that is pumped into the condensate storage tank for storage requires this prior approval before discharge to the storm sewer.

The pH shall not be less than standard units, not greater than standard units and shall be monitored

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s):

*Unless otherwise indicated, these are gross discharge limitations.

1. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS, OUTFALL 048, LAT 41° 05' 27", LONG 76° 08' 48"
WHICH RECEIVES WASTE FROM: Unit 2 Condensate Storage Tank.

During the period beginning July 31, 1979 and lasting through September 30, 1980, the permittee is authorized to discharge.

Such discharges shall be limited, and monitored by the permittee, as specified below:

Effluent Characteristic	Discharge Limitations*					Monitoring Requirements	
	kg/day (lbs/day)		Other Units (Specify)				
	Daily Avg.	Daily Max.	Daily Avg.	Daily Max.	Instantaneous Max.	Measurement Frequency	Sample Type
Flow-m^3/Day (MGD)							
71.91-m^3/Day(.019 mgd)							

This permit authorizes the discharge of rain water from point source 048 that collects in the diked area surrounding the Unit 2, Condensate Storage Tank. Any discharge other than storm water requires prior approval from the state and U.S. Environmental Protection Agency. Therefore, fire protection water that is pumped to the condensate storage tank requires this prior approval before discharge to the storm sewer.

The pH shall not be less than standard units, not greater than standard units and shall be monitored

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s):

*Unless otherwise indicated, these are gross discharge limitations.

PART A

2. MONITORING AND REPORTING

a. Representative Sampling

Samples and measurements taken as required herein shall be representative of the volume and nature of the monitored discharge.

b. Reporting

Monitoring results obtained during the previous month shall be summarized for that month and reported on a Discharge Monitoring Report Form (EPA No. T-40), postmarked no later than the 28th day of the month following the completed reporting period. The first report is due on SEP 29 1979 Duplicate signed copies of these and all other reports required herein, shall be submitted to the Department and the EPA Regional Administrator at the following addresses:

Commonwealth of Pennsylvania
Department of Environmental Resources
Bureau of Water Quality Management
Wilkes Barre Regional Office
90 East Union Street - 2nd Floor
Wilkes Barre, Pa. 18701

Permits Administration Section
Enforcement Division
U.S. Environmental Protection Agency
Region III
6th and Walnut Streets
Philadelphia, PA 19106

c. Definitions

(1) The "daily average" discharge means the total discharge by weight during a calendar month divided by the number of days in the month that the production or commercial facility was operating. Where less than daily sampling is required by this permit, the daily average discharge shall be determined by the summation of all the measured daily discharges by weight divided by the number of days during the calendar month when the measurements were made.

(2) The "daily maximum" discharge means the total discharge by weight during any calendar day.

(3) The "daily average" concentration means the arithmetic average of all the daily determinations of concentration made during a calendar month. Daily determinations of concentration made using a composite sample shall be the concentration of the composite sample. When grab samples are used, the daily determination of concentration shall be the arithmetic average of all the samples collected during that calendar day.

(4) The "daily maximum" concentration means the daily determination of concentration for any calendar day.

(5) The "instantaneous maximum" concentration means the concentration not to be exceeded at any time in any grab sample.

(6) Composite Sample - A combination of individual samples obtained at regular intervals over a time period. Either the volume of each individual sample is proportional to discharge flow rates or the sampling interval (for constant volume samples) is proportional to the flow rates over the time period used to produce the composite. The maximum time period between individual samples shall be two hours.

(7) Grab Sample - An individual sample collected in less than 15 minutes.

(8) "i-s", = immersion stabilization - a calibrated device which is immersed in the effluent stream until the reading is stabilized.

(9) The "daily average" temperature means the arithmetic mean of temperature measurements made on an hourly basis, or the mean value plot of the record of a continuous automated temperature recording instrument, either during a calendar month, or during the operating month if flows are of a shorter duration.

(10) The "daily maximum" temperature means the highest arithmetic mean of the temperatures observed for any two (2) consecutive hours during a 24-hour day, or during the operating day if flows are of shorter duration.

(11) "Measured Flow" - Any method of liquid volume measurement the accuracy of which has been previously demonstrated in engineering practice, or for which a realtionship to absolute volume has been obtained.

(12) "At outfall XXX" - A sampling location in outfall line XXX downstream from the last addition point or as otherwise specified.

(13) Estimate - To be based on a technical evaluation of the sources contributing to the discharge including, but not limited to, pump capabilities, water meters and batch discharge volumes.

(14) Non-contact cooling water means the water that is contained in a leak-free system, i.e. no contact with any gas, liquid, or solid other than the container for transport; the water shall have no net poundage addition of any pollutant over intake water levels.

(15) The term "cyanide A" shall mean cyanide amenable to chlorination.

d. Test Procedures

Test procedures for the analysis of pollutants shall conform to regulations published pursuant to Section 304(h) of the Act, under which such procedures may be required.

e. Recording of Results

For each measurement or sample taken pursuant to the requirements of this permit, the permittee shall record the following information:

(1) The exact place, date, and time of sampling.

(2) The dates the analyses were performed.

(3) The person(s) who performed the analyses.

(4) The analytical techniques or methods used.

(5) The results of all required analyses.

f. Additional Monitoring by Permittee

If the permittee monitors any pollutant at the location(s) designated herein more frequently than required by this permit, using approved analytical methods as specified above, the results of such monitoring shall be included in the calculation and reporting of the values required in the Discharge Monitoring Report Form (EPA No. T-40). Such increased frequency shall also be indicated.

g. Records Retention

All records and information resulting from the monitoring activities required by this permit, including all records of analyses performed and calibration and maintenance of instrumentation and recordings from continuous monitoring instrumentation, shall be retained for a minimum of three (3) years, or longer if requested by the Department or the EPA Regional Administrator.

PART B

1. MANAGEMENT REQUIREMENTS

a. Change in Discharge

All discharges authorized herein shall be consistent with the terms and conditions of this permit. The discharge of any pollutant identified in this permit more frequently than or at a level in excess of that authorized shall constitute a violation of the permit. Any anticipated facility expansions, production increases, or process modifications which will result in new, different, or increased discharges of pollutants must be reported by submission of a new NPDES application or, if such changes will not violate the effluent limitations specified in this permit, by notice to the Department of such changes. Following such notice, the permit may be modified to specify and limit any pollutants not previously limited.

b. Noncompliance Notification

If, for any reason, the permittee does not comply with or will be unable to comply with any effluent limitation specified in this permit, the permittee shall provide the Department and the EPA Regional Administrator with the following information, in writing, within five (5) days of becoming aware of such condition:

(1) A description of the discharge and cause of noncompliance; and

(2) The period of noncompliance, including exact dates and times; or, if not corrected, the anticipated time the noncompliance is expected to continue, and steps being taken to reduce, eliminate and prevent recurrence of the noncomplying discharge.

c. Facilities Operation

The permittee shall, at all times, maintain in good working order and operate as efficiently as possible, all treatment or control facilities or systems installed or used by the permittee to achieve compliance with the terms and conditions of this permit.

d. Adverse Impact

The permittee shall take all reasonable steps to minimize any adverse impact to navigable waters resulting from noncompliance with any effluent limitations specified in this permit, including such accelerated or additional monitoring as necessary to determine the nature and impact of the noncomplying discharge.

e. Bypassing

Any diversion from or bypass of facilities used to maintain compliance with the terms and conditions of this permit is prohibited. Where malfunctions, breakdowns, or other unforeseen events cause a disruption of these facilities, the permittee shall first make an effort to halt, reduce, or otherwise control production so that a discharge in excess of the effluent limitations does not occur.

In the event that diversion or bypassing occurs to prevent loss of life or severe property damage, or where excessive storm drainage or runoff would damage these facilities, the permittee shall promptly notify the Department and the EPA Regional Administrator, orally and in writing, of each such diversion or bypass, together with a full and complete explanation of the event as noted in Par. 1.b(1) and 1.b(2) above.

f. Removed Substances

Solids, sludges, filter backwash, or other pollutants removed in the course of treatment or control of wastewaters shall be disposed of in a manner such as to prevent any pollutant from such materials from entering navigable waters.

g. Power Failures

In order to maintain compliance with the effluent limitations and prohibitions of this permit, the permittee shall either:

(1) In accordance with the Schedule of Compliance contained in Part A.3, provide an alternative power source sufficient to operate the wastewater control facilities;

or, if such alternative power source is not in existence, and no date for its implementation appears in Part A.3,

(2) Halt, reduce or otherwise control production and/or all discharges upon the reduction, loss, or failure of the primary source of power to the wastewater control facilities.

2. RESPONSIBILITIES

a. Right of Entry

The permittee shall allow the head of the Department, the EPA Regional Administrator, and/or their authorized representatives, upon the presentation of credentials:

(1) To enter upon the permittee's premises where an effluent source is located or in which any records are required to be kept under the terms and conditions of this permit; and

(2) At reasonable times to have access to and copy any records required to be kept under the terms and conditions of this permit; to inspect any monitoring equipment or monitoring method required in this permit; and to sample any discharge of pollutants.

b. Transfer of Ownership or Control

In the event of any change in control or ownership of facilities from which the authorized discharges emanate, the permittee shall notify the succeeding owner or controller of the existence of this permit by letter, a copy of which shall be forwarded to the Department and to the EPA Regional Administrator.

c. Availability of Reports

Except for data determined to be confidential under 25 Pa. Code, Section 92.63, all reports prepared in accordance with the terms of this permit shall be available for public inspection at the offices of the Department and the EPA Regional Administrator. As required by the Act, effluent data shall not be considered confidential. Knowingly making any false statement on any such report may result in the imposition of criminal penalites as provided for in Section 309 of the Act or applicable State law.

d. Permit Modification

After notice and opportunity for a hearing, this permit may be modified, suspended, or revoked in whole or in part during its term for cause including, but not limited to, the following:

(1) Violation of any terms or conditions of this permit;

(2) Obtaining this permit by misrepresentation or failure to disclose fully all relevant facts; or

(3) A change in any condition that requires either a temporary or permanent reduction or elimination of the authorized discharge.

(4) A change in applicable water quality standards or treatment requirements.

e. Toxic Pollutants

Notwithstanding Part B.2.d above, if a toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is established under Section 307(a) of the Act for a toxic pollutant which is present in the discharge, and such standard or prohibition is more stringent than any limitation for such pollutant in this permit, then this permit shall be revised or modified in accordance with the toxic effluent standard or prohibition and the permittee so notified.

f. Civil and Criminal Liability

Nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance.

g. Oil and Hazardous Substance Liability

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee is or may be subject under Section 311 of the Act.

h. Property Rights

The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State or local laws or regulations.

i. Other Laws

Nothing herein contained shall be construed to be an intent on the part of the Department to approve any act made or to be made by the permittee inconsistent with the permittee's lawful powers or with existing laws of the Commonwealth regulating industrial wastes and the practice of professional engineering, nor shall this permit be construed to sanction any act otherwise forbidden by any of the laws of the Commonwealth of Pennsylvania or of the United States.

j. Severability

The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

PART C

OTHER REQUIREMENTS

SPECIAL CONDITIONS

A. This permit shall be modified, or alternatively, revoked and reissued, to comply with any applicable effluent standard or limitation issued or approved under Sections 301(b)(2)(C), and (D), 304(b)(2), and 307(a)(2) of the Clean Water Act, if the effluent standard or limitation so issued or approved:

(1) Contains different conditions or is otherwise more stringent than any effluent limitation in the permit; or,

(2) Controls any pollutant not limited in the permit.

The permit as modified or reissued under this paragraph shall also contain any other requirements of the Act then applicable.

B. Effluent limitations, monitoring requirements, and other standard and special conditions which relate to the discharge of pollutants authorized by this permit and which are contained in Water Quality Management Permit No. 4076203, issued on May 24, 1977, are superseded by the terms and conditions of this permit, unless specifically noted otherwise herein.

C. Six months after effective date, the permittee shall submit to the Regional Administrator and the state permitting authority a specific study program for monitoring impingement and intrainment effects at the plant intakes. The weight, and length frequency distribution of different fish species impinged, as well as estimating the number of eggs, larvae and plankton entrained. Operating data such as intake velocity, flow, temperature, etc. at the time of sampling should also be reported. A final report will be submitted upon completion of the study.

D. The pH of all discharges, except cne through cooling water, shall be within the range of 6.0 to 9.0.

E. There shall be no discharge of polychlorinated biphenyl compounds such as those commonly used for transformer fluid.

F. Neither free available chlorine, nor total residual chlorine, may be discharged from any unit for more than two hours in any one day and not more than one unit in any plant may discharge free available, or total residual, chlorine at any one time unless the utility can demonstrate to the regional administrator or state permitting authority that the units in the particular location cannot operate at or below this level of chlorination.

G. The discharges shall not cause a rise in the stream temperature of more than 5° F. above the ambient, or a maximum of 87° F. whichever is less; not to be changed by more than 2° F. during any one hour period.

H. All limitations and monitoring requirements for liquid radioactive waste discharges shall be in accordance with the Atomic Energy Commission regulations as set forth in 10 CFR, Part 20 and 10 CFR, Part 50. The conditions that would be specified in this permit would in no way supersede the mandatory requirements for operation of nuclear power plants imposed by the Atomic Energy Commission.

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
DISCHARGE MONITORING REPORT

Form Approved
OMB NO. 158-R0073

Pennsylvania Power & Light Company
Susquehanna Steam Electric
c/o Mr. John T. Kauffman
Executive Vice President, Operations
Two North Ninth Street
Allentown, Pa. 18101

Salem Township
Luzerne County

(2-3) ST	(4-16) PERMIT NUMBER	(17-19) DIS	SIC	LATITUDE	LONGITUDE
	PA-0047325			41°05'35"	76°07'48"

POINT SOURCE (041)

REPORTING PERIOD: FROM (20-21) YEAR (22-23) MO (24-25) DAY TO (26-27) YEAR (28-29) MO (30-31) DAY

INSTRUCTIONS

1. Provide dates for period covered by this report in spaces marked "REPORTING PERIOD".
2. Enter reported minimum, average and maximum values under "QUANTITY" and "CONCENTRATION" in the units specified for each parameter as appropriate. Do not enter values in boxes containing asterisks. "AVERAGE" is average computed over actual time discharge is operating. "MAXIMUM" and "MINIMUM" are extreme values observed during the reporting period.
3. Specify the number of analyzed samples that exceed the maximum *(and/or minimum as appropriate)* permit conditions in the columns labeled "No. Ex." If none, enter "O".
4. Specify frequency of analysis for each parameter as No. analyses/No. days. *(e.g., "3/7" is equivalent to 3 analyses performed every 7 days.)* If continuous enter "CONT."
5. Specify sample type (*"grab" or "___ hr. composite"*) as applicable. *If frequency was continuous,* enter "NA".
6. Appropriate signature is required on bottom of this form.

(32-37) PARAMETER		QUANTITY (3 card only) (38-45) MINIMUM	(46-53) AVERAGE	(54-61) MAXIMUM	UNITS	(62-63) NO. EX	CONCENTRATION (4 card only) (38-45) MINIMUM	(46-53) AVERAGE	(54-61) MAXIMUM	UNITS	(62-63) NO. EX	(64-68) FREQUENCY OF ANALYSIS	(69-70) SAMPLE TYPE
Flow	REPORTED												
	PERMIT CONDITION		14.4		Mgd.								
Free Available Chlorine	REPORTED				Lbs/ Day								
	PERMIT CONDITION		2	5				0.2	0.5	Mg/1			
Total Suspended Solids	REPORTED												
	PERMIT CONDITION								200	Mg/1			
Total Iron	REPORTED												
	PERMIT CONDITION								7.0	Mg/1			
pH	REPORTED				Std. Units								
	PERMIT CONDITION	6.0		9.0									
	REPORTED												
	PERMIT CONDITION												
	REPORTED												
	PERMIT CONDITION												
	REPORTED												
	PERMIT CONDITION												

NAME OF PRINCIPAL EXECUTIVE OFFICER	TITLE OF THE OFFICER	DATE	*I certify that I am familiar with the information contained in this report and that to the best of my knowledge and belief such information is true, complete, and accurate.*	
LAST FIRST MI	TITLE	YEAR MO DAY		SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT

T-40 (6-74)

PAGE OF

ORIGINAL

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

DISCHARGE MONITORING REPORT

Form Approved
OMB NO. 158-R0073

Pennsylvania Power & Light Company
Susquehanna Steam Electric
c/o Mr. John T. Kauffman
Executive Vice President, Operations
Two North Ninth Street
Allentown, Pa. 18101

Salem Township
Luzerne County

ST (2-3)	PERMIT NUMBER (4-10)	DIS (17-19)	SIC	LATITUDE	LONGITUDE
	PA-0047325			41°05'34"	76°08'45"

POINT SOURCE (042)

REPORTING PERIOD: FROM (20-21) YEAR | (22-23) MO | (24-25) DAY TO (26-27) YEAR | (28-29) MO | (30-31) DAY

INSTRUCTIONS

1. Provide dates for period covered by this report in spaces marked "REPORTING PERIOD".
2. Enter reported minimum, average and maximum values under "QUANTITY" and "CONCENTRATION" in the units specified for each parameter as appropriate. Do not enter values in boxes containing asterisks. "AVERAGE" is average computed over actual time discharge is operating. "MAXIMUM" and "MINIMUM" are extreme values observed during the reporting period.
3. Specify the number of analyzed samples that exceed the maximum (and/or minimum as appropriate) permit conditions in the columns labeled "No. Ex." If none, enter "O".
4. Specify frequency of analysis for each parameter as No. analyses/No. days. (e.g., "3/7" is equivalent to 3 analyses performed every 7 days.) If continuous enter "CONT."
5. Specify sample type ("grab" or "___ hr. composite") as applicable. If frequency was continuous, enter "NA".
6. Appropriate signature is required on bottom of this form.

PARAMETER (32-37)		QUANTITY (3 card only) MINIMUM (38-45)	AVERAGE (46-53)	MAXIMUM (54-61)	UNITS	NO. EX (62-63)	CONCENTRATION (4 card only) MINIMUM (38-45)	AVERAGE (46-53)	MAXIMUM (54-61)	UNITS	NO. EX (62-63)	FREQUENCY OF ANALYSIS (64-68)	SAMPLE TYPE (69-70)
Flow	REPORTED				Gpd								
	PERMIT CONDITION			23,000									
Total Suspended Solids	REPORTED				Lbs/Day					Mg/l			
	PERMIT CONDITION		5.75	19.18				30	100				
Oil & Grease	REPORTED				Lbs/Day					Mg/l			
	PERMIT CONDITION		2.88	3.84				15	20				
pH	REPORTED				Std. Units								
	PERMIT CONDITION	6.0		9.0									
	REPORTED												
	PERMIT CONDITION												
	REPORTED												
	PERMIT CONDITION												
	REPORTED												
	PERMIT CONDITION												
	REPORTED												
	PERMIT CONDITION												

NAME OF PRINCIPAL EXECUTIVE OFFICER	TITLE OF THE OFFICER	DATE		
LAST FIRST MI	TITLE	YEAR MO DAY	*I certify that I am familiar with the information contained in this report and that to the best of my knowledge and belief such information is true, complete, and accurate.*	SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT

T-40 (4-74)

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ORIGINAL

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
DISCHARGE MONITORING REPORT

Form Approved
OMB NO. 158-R0073

Pennsylvania Power & Light Company
Susquehanna Steam Electric
c/o Mr. John T. Kauffman
Executive Vice President, Operations
Two North Ninth Street
Allentown, Pa. 18101

Salem Township
Luzerne County

ST	PERMIT NUMBER	DIS	SIC	LATITUDE	LONGITUDE
	PA-0047325			41°05'33"	76°08'51"

POINT SOURCE (043)

REPORTING PERIOD: FROM YEAR MO DAY TO YEAR MO DAY

INSTRUCTIONS

1. Provide dates for period covered by this report in spaces marked "REPORTING PERIOD".
2. Enter reported minimum, average and maximum values under "QUANTITY" and "CONCENTRATION" in the units specified for each parameter as appropriate. Do not enter values in boxes containing asterisks. "AVERAGE" is average computed over actual time discharge is operating. "MAXIMUM" and "MINIMUM" are extreme values observed during the reporting period.
3. Specify the number of analyzed samples that exceed the maximum (and/or minimum as appropriate) permit conditions in the columns labeled "No. Ex." If none, enter "O".
4. Specify frequency of analysis for each parameter as No. analyses/No. days. (e.g., "3/7" is equivalent to 3 analyses performed every 7 days.) If continuous enter "CONT."
5. Specify sample type ("grab" or "___ hr. composite") as applicable. If frequency was continuous, enter "NA".
6. Appropriate signature is required on bottom of this form.

PARAMETER		QUANTITY MINIMUM	QUANTITY AVERAGE	QUANTITY MAXIMUM	UNITS	NO. EX	CONCENTRATION MINIMUM	CONCENTRATION AVERAGE	CONCENTRATION MAXIMUM	UNITS	NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
Flow	REPORTED												
	PERMIT CONDITION			23,000	Gpd								
Total Suspended Solids	REPORTED				Lbs/ Day								
	PERMIT CONDITION		5.75	19.18				30	100	Mg/1			
Oil & Grease	REPORTED				Lbs/ Day								
	PERMIT CONDITION		2.88	3.84				15	20	Mg/1			
pH	REPORTED				Std. Units								
	PERMIT CONDITION	6.0		9.0									
	REPORTED												
	PERMIT CONDITION												
	REPORTED												
	PERMIT CONDITION												
	REPORTED												
	PERMIT CONDITION												
	REPORTED												
	PERMIT CONDITION												

NAME OF PRINCIPAL EXECUTIVE OFFICER	TITLE OF THE OFFICER	DATE		
LAST FIRST MI	TITLE	YEAR	MO	DAY

I certify that I am familiar with the information contained in this report and that to the best of my knowledge and belief such information is true, complete, and accurate.

SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT

T-40 (4-74)

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ORIGINAL

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

DISCHARGE MONITORING REPORT

Form Approved
OMB NO. 158-R0073

Pennsylvania Power & Light Company
Susquehanna Steam Electric
c/o Mr. John T. Kauffman
Executive Vice President, Operations
Two North Ninth Street
Allentown, Pa. 18101

Salem Township
Luzerne County

ST	PERMIT NUMBER	DIS	SIC	LATITUDE	LONGITUDE
	PA-0047325			41°05'28"	76°08'51"

POINT SOURCE (044)

REPORTING PERIOD FROM | YEAR | MO | DAY | TO | YEAR | MO | DAY |

INSTRUCTIONS

1. Provide dates for period covered by this report in spaces marked "REPORTING PERIOD".
2. Enter reported minimum, average and maximum values under "QUANTITY" and "CONCENTRATION" in the units specified for each parameter as appropriate. Do not enter values in boxes containing asterisks. "AVERAGE" is average computed over actual time discharge is operating. "MAXIMUM" and "MINIMUM" are extreme values observed during the reporting period.
3. Specify the number of analyzed samples that exceed the maximum *(and/or minimum as appropriate)* permit conditions in the columns labeled "No. Ex." If none, enter "O".
4. *Specify frequency of analysis for each parameter as* No. analyses/No. days. *(e.g., "3/7" is equivalent to 3 analyses performed every 7 days.)* If continuous enter "CONT."
5. Specify sample type (*"grab"* or *"— hr. composite"*) as applicable. If frequency was continuous, enter "NA".
6. Appropriate signature is required on bottom of this form.

PARAMETER		QUANTITY (3 card only) MINIMUM	AVERAGE	MAXIMUM	UNITS	NO. EX	CONCENTRATION (4 card only) MINIMUM	AVERAGE	MAXIMUM	UNITS	NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
Flow	REPORTED												
	PERMIT CONDITION			23,000	Gpd								
Total Suspended Solids	REPORTED												
	PERMIT CONDITION		5.75	19.18	Lbs/ Day			30	100	Mg/1			
Oil & Grease	REPORTED												
	PERMIT CONDITION		2.88	3.84	Lbs/ Day			15	20	Mg/1			
pH	REPORTED												
	PERMIT CONDITION	6.0		9.0	Std. Units								
	REPORTED												
	PERMIT CONDITION												
	REPORTED												
	PERMIT CONDITION												
	REPORTED												
	PERMIT CONDITION												
	REPORTED												
	PERMIT CONDITION												

NAME OF PRINCIPAL EXECUTIVE OFFICER	TITLE OF THE OFFICER	DATE		
LAST FIRST MI	TITLE	YEAR	MO	DAY

I certify that I am familiar with the information contained in this report and that to the best of my knowledge and belief such information is true, complete, and accurate.

SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT

T-40 (4-74)

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ORIGINAL

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
DISCHARGE MONITORING REPORT

Form Approved
OMB NO. 158-R0073

Pennsylvania Power & Light Company
Susquehanna Steam Electric
c/o Mr. John T. Kauffman
Executive Vice President, Operations
Two North Ninth Street
Allentown, Pa. 18101

Salem Township
Luzerne County

ST	PERMIT NUMBER	DIS	SIC	LATITUDE	LONGITUDE
	PA-0047325			41°05'29"	76°08'54"

POINT SOURCE (046)

REPORTING PERIOD FROM YEAR | MO | DAY TO YEAR | MO | DAY

INSTRUCTIONS

1. Provide dates for period covered by this report in spaces marked "REPORTING PERIOD".
2. Enter reported minimum, average and maximum values under "QUANTITY" and "CONCENTRATION" in the units specified for each parameter as appropriate. Do not enter values in boxes containing asterisks. "AVERAGE" is average computed over actual time discharge is operating. "MAXIMUM" and "MINIMUM" are extreme values observed during the reporting period.
3. Specify the number of analyzed samples that exceed the maximum (and/or minimum as appropriate) permit conditions in the columns labeled "No. Ex." If none, enter "O".
4. Specify frequency of analysis for each parameter as No. analyses/No. days. (e.g., "3/7" is equivalent to 3 analyses performed every 7 days.) If continuous enter "CONT."
5. Specify sample type ("grab" or "— hr. composite") as applicable. If frequency was continuous, enter "NA".
6. Appropriate signature is required on bottom of this form.

PARAMETER		QUANTITY MINIMUM	QUANTITY AVERAGE	QUANTITY MAXIMUM	UNITS	NO. EX	CONCENTRATION MINIMUM	CONCENTRATION AVERAGE	CONCENTRATION MAXIMUM	UNITS	NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
Flow	REPORTED												
	PERMIT CONDITION			3,155	Gpd								
Total Suspended Solids	REPORTED												
	PERMIT CONDITION		0.75	2.5	Lbs/ Day			30	100	Mg/1			
Oil & Grease	REPORTED												
	PERMIT CONDITION		0.38	0.5	Lbs/ Day			15	20	Mg/1			
pH	REPORTED												
	PERMIT CONDITION	6.0		9.0	Std. Units								
	REPORTED												
	PERMIT CONDITION												
	REPORTED												
	PERMIT CONDITION												
	REPORTED												
	PERMIT CONDITION												
	REPORTED												
	PERMIT CONDITION												

NAME OF PRINCIPAL EXECUTIVE OFFICER	TITLE OF THE OFFICER	DATE		
LAST FIRST MI	TITLE	YEAR MO DAY	*I certify that I am familiar with the information contained in this report and that to the best of my knowledge and belief such information is true, complete, and accurate.*	SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT

T-40 (4-74)

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ORIGINAL

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

DISCHARGE MONITORING REPORT

Form Approved
OMB NO. 158-R0073

Pennsylvania Power & Light Company
Susquehanna Steam Electric
c/o Mr. John T. Kauffman
Executive Vice President, Operations
Two North Ninth Street
Allentown, Pa. 18101

Salem Township
Luzerne County

ST	PERMIT NUMBER	DIS	SIC	LATITUDE	LONGITUDE
	PA-0047325			41°05'32"	76°08'48"

POINT SOURCE (047)

REPORTING PERIOD FROM | YEAR | MO | DAY | TO | YEAR | MO | DAY |

INSTRUCTIONS

1. Provide dates for period covered by this report in spaces marked "REPORTING PERIOD".
2. Enter reported minimum, average and maximum values under "QUANTITY" and "CONCENTRATION" in the units specified for each parameter as *appropriate. Do not* enter values in boxes containing asterisks. "AVERAGE" is average computed over actual time discharge is operating. "MAXIMUM" and "MINIMUM" are extreme values observed during the reporting period.
3. Specify the number of analyzed samples that exceed the maximum *(and/or minimum as appropriate)* permit conditions in the columns labeled "No. Ex." If none, enter "O".
4. Specify frequency of analysis for each parameter *as* No. *analyses/No. days. (e.g., "3/7" is equivalent to 3 analyses performed every 7 days.)* If continuous enter "CONT."
5. Specify sample type *("grab" or "__ hr. composite")* as applicable. If frequency was continuous, enter "NA".
6. Appropriate signature is required on bottom of this form.

PARAMETER		QUANTITY (3 card only) MINIMUM	AVERAGE	MAXIMUM	UNITS	NO. EX	CONCENTRATION (4 card only) MINIMUM	AVERAGE	MAXIMUM	UNITS	NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
Flow	REPORTED												
	PERMIT CONDITION			24,000	Gpd								
	REPORTED												
	PERMIT CONDITION												
	REPORTED												
	PERMIT CONDITION												
	REPORTED												
	PERMIT CONDITION												
	REPORTED												
	PERMIT CONDITION												
	REPORTED												
	PERMIT CONDITION												
	REPORTED												
	PERMIT CONDITION												

NAME OF PRINCIPAL EXECUTIVE OFFICER	TITLE OF THE OFFICER	DATE	I certify that I am familiar with the information contained in this report and that to the best of my knowledge and belief such information is true, complete, and accurate.	SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT
LAST FIRST MI	TITLE	YEAR MO DAY		

T-40 (4-74)

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ORIGINAL

F-24

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

DISCHARGE MONITORING REPORT

Form Approved
OMB NO. 158-R0073

Pennsylvania Power & Light Company
Susquehanna Steam Electric
c/o Mr. John T. Kauffman
Executive Vice President, Operations
Two North Ninth Street
Allentown, Pa. 18101

Salem Township
Luzerne County

ST	PERMIT NUMBER	DIS	SIC	LATITUDE	LONGITUDE
	PA-0047325			41°05'27"	76°08'48"

POINT SOURCE (048)

REPORTING PERIOD FROM | YEAR | MO | DAY | TO | YEAR | MO | DAY |

INSTRUCTIONS

1. Provide dates for period covered by this report in spaces marked "REPORTING PERIOD".
2. Enter reported minimum, average and maximum values under "QUANTITY" and "CONCENTRATION" in the units specified for each parameter as appropriate. Do not enter values in boxes containing asterisks. "AVERAGE" is average computed over actual time discharge is operating. "MAXIMUM" and "MINIMUM" are extreme values observed during the reporting period.
3. Specify the number of analyzed samples that exceed the maximum *(and/or minimum as appropriate)* permit conditions in the columns labeled "No. Ex." If none, enter "O".
4. Specify frequency of analysis for each parameter as No. analyses/No. days. *(e.g., "3/7" is equivalent to 3 analyses performed every 7 days.)* If continuous enter "CONT."
5. Specify sample type (*"grab" or "__ hr. composite"*) as applicable. If frequency was continuous, enter "NA".
6. Appropriate signature is required on bottom of this form.

PARAMETER		QUANTITY (3 card only) MINIMUM	AVERAGE	MAXIMUM	UNITS	NO. EX	CONCENTRATION (4 card only) MINIMUM	AVERAGE	MAXIMUM	UNITS	NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
Flow	REPORTED												
	PERMIT CONDITION			19,000	Gpd								
	REPORTED												
	PERMIT CONDITION												
	REPORTED												
	PERMIT CONDITION												
	REPORTED												
	PERMIT CONDITION												
	REPORTED												
	PERMIT CONDITION												
	REPORTED												
	PERMIT CONDITION												
	REPORTED												
	PERMIT CONDITION												
	REPORTED												
	PERMIT CONDITION												

NAME OF PRINCIPAL EXECUTIVE OFFICER	TITLE OF THE OFFICER	DATE			
LAST FIRST MI	TITLE	YEAR	MO	DAY	*I certify that I am familiar with the information contained in this report and that to the best of my knowledge and belief such information is true, complete, and accurate.*

SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT

T-40 (4-74)

PAGE OF

ORIGINAL

F-25

Additional Instructions for Utilizing
The
National Pollutant Discharge Elimination System
DISCHARGE MONITORING REPORT (T-40)

The attached originals of the NPDES Discharge Monitoring Report (T-40), have been provided to you as a master. The permit establishes specific effluent monitoring and reporting requirements and these values are repeated on the original Discharge Monitoring Report provided for you. The "N/A" placed in the permit condition block of the Discharge Monitoring Report indicates one of two things: (1) that the parameter is monitored but no limitations are imposed, and the pertinent value must be reported, or (2) that the parameter is limited elsewhere on the Discharge Monitoring Report, and the value should be reported if it is available.

Your reports are to be submitted by utilizing copies of the attached forms. Do not write on or send the attached originals, but rather (1) make copies of them, (2) fill out the copies as appropriate, (3) make the necessary copies of the completed (filled out) form, and (4) submit these copies to the appropriate EPA and State offices as provided in the permit.

<u>Proposed Method for Preparing DMR Form T-40's</u>

1. Use N/A in the "permit condition" block when the parameter does not have a corresponding permit limitation or when the parameter is limited by a concentration value but a reported quantity value may be useful. Also, it should be used in the minimum and average blocks when there are no corresponding limitations.

2. Use **** in both the "permit condition" and the "reported" block when both the permit has no limitations and no monitoring requirements and the value, if reported would be either useless or incorrect. (eg. - a reported Flow in concentration area of the DMR)

3. Do not leave any "permit condition" blocks blank.

4. All permit conditions including parameters required to be monitored only should be filled in as appropriate.

5. The parameter pH should be limited in the concentration area of the DMR since it is a measure of the concentration of hydrogen ions.

Through use of the "N/A" the permittee has the option of reporting a value. In cases where the parameter is monitored but no limitations are imposed, the value must be reported. In cases where the parameter is limited in the concentration portion of the DMR, the use of the "N/A" in the quantity portion will allow the permittee to report the quantity value if it is available. Also, unlimited minimum and average values may be reported if they are available.

Through use of the "****" the unnecessary values which are sometimes reported will be eliminated.

Copies to:

S.J.Berger	TW2
R.J.Shovlin	N4
G.H.Gockley	A3-3
W.E.Barberich	N4
J.S.Fields	A3-3
S.H.Cantone	N4
R.P.Janoso	A3-3
R.A.Webster	Susq. SES
J.P.Mahony	Susq. SES
R.H.Featenby	Susq. SES

April 9, 1980

Jim Ulanowski

SUSQUEHANNA SES IMPINGEMENT/ENTRAINMENT
File 100450 012

Dear Mr. Ulanowski:

During our meeting of March 4, 1980 at Wilkes Barre we discussed our submittal of January 9, 1980 regarding Special Condition C of our NPDES Permit #0047325. Our submittal included a predictive model to satisfy this condition. During this meeting you requested that PP&L submit a program for confirmation of predicted organism entrainment values. You also concurred with our conclusion that impingement losses would be negligible and that further monitoring would not be required. Accordingly, we are submitting a proposed verification program for entrainment values for fish larvae which we feel certain will verify our predictive model. This program is as follows:

I. Sampling Frequency -

Fish larvae will be sampled at the intake bay at which two pumps are operating:*

1. Three times per 24 hour day (including daylight and nighttime) at approximately 8 hour intervals).**
2. Approximately five minutes duration per replicate.
3. Two sample days per month.

II. Sampling Level -

Samples will be withdrawn at two levels

1. Near the botton of the skimmer wall.
2. Near the botton of the intake aperture.

*There are two bays with two full capacity pumps per bay. Normal two unit station operation requires three of these four pumps to operate. These tests will be conducted with three pumps operating.

**Current plans are to conduct sampling at 0200, 1400, 2200 hrs.

Page 2

III. Sample Volume -

- A calibrated volume delivery pump with a discharge collection filter will be used which delivers approximately 500 gallons per minute. Since the sample will be of about 5 minutes duration, each sample volume will be about 2500 gallons.

IV. Identification -

- Fish larvae collected will be identified to the lowest feasible taxon.

V. Program Duration -

- This program will be conducted for a period of three months during the spawning season which at the Susq. SES is May, June and July.

VI. Reporting -

We will supply you copies of the draft report upon review and completion.

Final results will be reported to you as an addendum to our routine annual report which is completed prior to May 1st of the year following data collection. Copies will be supplied to your office after preparation.

Although you suggested a sampling frequency of four hours rather than the eight hour frequency described above, we have determined that this cannot be accomplished without significant adverse impact on the intake pumps. Since the cooling towers will not be in operation during this sampling period there will be no evaporation and the intake rate will exceed the blowdown rate. As a result it will be necessary to cycle these pumps on and off to permit blowdown of water accumulated in the cooling tower basins between sampling periods. These pumps are designed for continuous operation and a limited number of cycles are permitted. We have therefore proposed a eight hour interval between sampling periods.

You suggested also in our meeting that we should consider sampling at bottom, middle and surface levels. We cannot at this time determine a practical method for sampling at three different levels. We have determined however from our data on existing river concentrations of fish larvae that these organisms tend to group at either the bottom or surface level. We consider that there will be no loss of confidence in verification of the program with the described sampling.

Since this is not normal operational mode as described in our NPDES permit and application we also request your approval for this pumping and release concept.

Page 3

We trust that this verification program as described will serve to verify our initial program submittal of January 9, 1980. We request your approval of this program as described at your earliest convenience since we fully intend to proceed during May of 1980.

If you have any questions please do not hesitate to call me at 215-281-4785.

Very truly yours,

Michael R. Buring

MRB:NLF
MRB#]03:6

Copies to:
Ed Kupski PA DER Wilkes Barre
Paul Swerdon PA DER Wilkes Barre

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
P.O. Box 2063
Harrisburg, Pennsylvania 17120
(717) 787-9614

April 29, 1980

Mr. Michael R. Buring
Pennsylvania Power and Light Company
2 North 9th Street
Allentown, PA 18101

Dear Mr. Buring:

Ed Kupsky, myself, and Jim LaBuy, U.S. EPA have reviewed your proposed impingement/entrainment study plan for the Susquehanna Steam Electric Station as contained in your letter dated April 9, 1980. We find the proposal to be acceptable.

Paul Swerdon, Facilities Engineer, Wilkes-Barre Office, has approved your request for the pumping and release operational mode.

Sincerely,

James T. Ulanoski

James T. Ulanoski
Aquatic Biology Section
Division of Water Quality

APPENDIX H. ASSUMPTIONS RELATED TO ESTIMATES OF FUEL-CYCLE HEALTH EFFECTS

The following important assumptions were used to evaluate fuel-cycle health effects.

1. The Uranium Fuel Cycle[1]

   a. For mine and mill emissions it was assumed that population density in the United States varies from 4.3 persons per square kilometer in the west to 93 persons per square kilometer in the east, all uniformly distributed. For all other facilities, density was assumed to be 93 persons per square kilometer. Most of the calculated health effects would occur outside the 80-km radius of the plant. The mortality rate for the U.S. population is about 2,000,000 per year from all causes.

   b. A "box" atmospheric dispersion model was used; vertical dispersion was limited to 1000 m, wind speed to 2 m/s, and deposition velocity to 1 cm/s for all particulates except those resulting from decay of noble gases (including radon-222 daughters, for which a velocity of 0.3 cm/s was assumed.

   c. The dose commitment from one year of operation for each type of fuel-cycle facility was calculated. This dose commitment represents the sum of the 50-year dose commitments from one year of operation and each of the subsequent 99 years (i.e., a 100-year environmental dose commitment). In the case of radon-222, the health effects estimates are based on the estimated 100-year dose commitments for the radon-222 releases each year per reference reactor year for periods up to 1000 years. In the case of carbon-14, the environmental dose commitment was extended to encompass environmental dose commitments of 100 to 1000 years.

   d. Radioactive materials were not considered to be removed from food chains except by radioactive decay. Only in the case of carbon-14 was an environmental sink assumed to be acting on biological availability.

   e. Krypton-85 and carbon-14 not removed from the plume in the United States were assumed to mix uniformly in the world's atmosphere. Tritium was assumed to be mixed uniformly in the world's circulating water volume.

   f. Resuspensions of deposited particulates was considered.

   g. Bioaccumulation of radioactivity in food chains was considered (generally upper-bound estimates).

   h. An 80% capacity factor was assumed.

2. The Coal Fuel Cycle[2-4]

   Because the major impact of the coal fuel cycle results from power-plant emissions, only the critical assumptions concerning emissions will be discussed:

   a. Actual population distributions within 80 km of several nuclear plant sites were used; the average population of 3.8 million people experiences about a 25,000 per year mortality rate from all causes.

   b. Actual meteorological data from the same plants, to calculate inhalation exposures to sulfates out to 80 km, were used.

   c. A 1000-ft stack for emissions was assumed.

   d. Use of 3%-sulfur coal with 12% ash and 28 MJ/kg (eastern coal) for an upper-bound estimate of health effects was assumed; use of 0.4%-sulfur coal with 3% ash and 28 MJ/kg (eastern coal) for a lower-bound estimate was assumed.

   e. A removal of 99% particulates from plant emissions was assumed.

f. A 10%-per-hour oxidation rate for conversion of sulfur oxides to sulfates was assumed.

g. The dose-response relationships of Lave and Seskin,[5] Winkelstein et al.,[6] and others[2,3,7] were used to calculate excess mortality and morbidity;[2] adjustments were made for fractions of sulfates in the total suspended particulates.

h. Resuspension of deposited particulates was not directly considered, although deposition was.

i. A 75% capacity factor was assumed.

References

1. U.S. Nuclear Regulatory Commission, "Final Generic Environmental Statement on the Use of Recycle Plutonium in Mixed Oxide Fuel in Light Water Cooled Reactors," NUREG-0002, August 1976.

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Appendix I. List of Preparers

The following personnel of the Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, D.C., participated in the preparation of the Final Environmental Statement:

R. M. Stark	Project Manager
G. E. Gears	Environmental Review Coordinator, Terrestrial Ecology
S. Acharya	Accidents
S. Baker	Accidents
E. Branagan	Radiological Assessment
L. Bykoski	Socioeconomics; Cultural Resources
S. Chestnut	Emergency Preparedness
A. Chu	Accidents
R. Codell	Accidents
M. Fliegel	Hydrology, Floodplains Effects, Accidents
R. Gotchy	Accidents
C. Hinson	Radiological Assessment
J. Lehr	Water Quality
J. Levine	Meteorology
J. Lewis	Accidents
C. Miller	Effluent-treatment Systems
J. Minns	Radiological Assessment
D. Nash	Accidents
L. O'Reilly	Radiological Assessment
A. Sinisgalli	Accidents, Demography
M. Taylor	Accidents
A. Toalston	Accidents

The following personnel of the Division of Environmental Impact Studies of Argonne National Laboratory, Argonne, Illinois, participated in the preparation of the Final Environmental Statement.

J. E. Carson	Project Leader, Air Quality, Cooling Tower
S. Curtis	Socioeconomics and Cultural Resources
R. Freeman	Aquatic Ecology
E. Hugo	Copy Editor
J. Milsted	Non-radioactive Waste Discharges
D. Ness	Terrestrial Ecology
R. Prasad	Need for Power and Benefit-Cost Analysis
S. Tsai	Thermal Discharges
F. Vaslow	Water Quality

APPENDIX J

REBASELINING OF THE RSS RESULTS FOR BWRs

The results of the Reactor Safety Study (RSS) have been updated. The update was done largely to incorporate results of research and development conducted after the October 1975 publication of the RSS and to provide a baseline against which the risk associated with various LWRs could be consistently compared.

Primarily, the rebaselined RSS results reflect use of advanced modeling of the processes involved in meltdown accidents, i.e., the MARCH computer code modeling for transient and LOCA initiated sequences and the CORRAL code used for calculating magnitudes of release accompanying various accident sequences. These codes* have led to a capability to predict the transient and small LOCA initiated sequences that is considerably advanced beyond what existed at the time the Reactor Safety Study was completed. The advanced accident process models (MARCH and CORRAL) produced some changes in our estimates of the release magnitudes from various accident sequences in WASH-1400. These changes primarily involved release magnitudes for the iodine, cesium and tellurium families of isotopes. In general, a decrease in the iodines was predicted for many of the dominant accident sequences while some increases in the release magnitudes for the cesium and tellurium isotopes were predicted.

Entailed in this rebaselining effort was the evaluation of individual dominant accident sequences as we understand them to evolve rather than the technique of grouping large numbers of accident sequences into encompassing, but synthetic, release categories as was done in WASH-1400. The rebaselining of the RSS also eliminated the "smoothing technique" that was criticized in the report by the Risk Assessment Review Group (sometimes known as the Lewis Report; NUREG/CR-0400).

In both of the RSS designs (PWR and BWR), the likelihood of an accident sequence leading to the occurrence of a steam explosion (α) in the reactor vessel was decreased. This was done to reflect both experimental and calculational indications that such explosions are unlikely to occur in those sequences involving small size LOCAs and transients because of the high pressures and temperatures expected to exist within the reactor coolant system during these scenarios. Furthermore, if such as explosion were to occur, there are indications that it would be unlikely to produce as much energy and the massive missile-caused breach of containment as was postulated in WASH-1400.

For rebaselining of the RSS BWR design, the sequence $TC\gamma'$ (described later) was explicitly included into the rebaselining results. The accident processes associated with the TC sequence had been erroneously calculated in WASH-1400. In general, the rebaselined results led to slightly increased health impacts being predicted for the RSS BWR design. This is believed to be largely attributable to the inclusion of $TC\gamma'$.

*It should be noted that the MARCH code was used on a number of scenarios in connection with the TMI-2 recovery efforts and for post-TMI-2 investigations to explore possible alternative scenarios that TMI-2 could have experienced.

In summary, the rebaselining of the RSS results led to small overall differences from the predictions in WASH-1400. It should be recognized that these small differences due to the rebaselining efforts are likely to be far outweighed by the uncertainties associated with such analyses.

The accident sequences identified in the rebaselining effort which are expected to dominate risk of the RSS-BWR design are briefly described below. These sequences are assumed to represent the approximate accident risks from the Susquehanna BWR design.

Each of the accident sequences is designated by a string of identification characters in the same manner as in the RSS (See the table of these symbols in page H-4). Each character represents a failure in one or more of the important plant systems or features. For example, in sequences having a γ' at the end of the string, it means a particular failure mode (overpressure) of the containment structure (and a rupture location) where a release of radioactivity takes place directly to the atmosphere from the primary containment. In the sequence having a γ at the end of the string, the containment failure mode is again by overpressure but this time, the rupture location is such that the release takes place into the reactor building (secondary containment) before discharging to the environment. In this latter (γ) case, the overall magnitude of radioactivity release is somewhat diminished by the deposition and plateout processes that take place within the reactor building.

<u>TCγ' and TCγ</u>

These sequences involve a transient event requiring shutdown of the reactor while at full power, followed by a failure to make the reactor subcritical (i.e., terminate power generation by the core). The containment is assumed to be isolated by these events; then, one or the other of the following chain of events is assumed to happen:

(a) High pressure coolant injection system would succeed for some time in providing makeup water to the core in sufficient quantity to cope with the rate of coolant loss through relief and safety valves to the suppression pool of the containment. During this time, the core power level varies, but causes substantial energy to be directed into the suppression pool; this energy is in excess of what the containment and containment heat removal systems are designed to cope with. Ultimately, in about 1-1/3 hours, the containment is estimated to fail by overpressure and it is assumed that this rather severe structural failure of the containment would disable the high pressure coolant makeup system. Over a period of roughly 1-1/2 hours after breach of containment, it is assumed the core would melt. This has been estimated to be one of the more dominant sequences in terms of accident risks to the public.

(b) A variant to the above sequence is one where the high pressure coolant injection system fails somewhat earlier and prior to containment overpressure failure. In this case, the earlier melt could result in a reduced magnitude of release because some of the fission products discharged to the suppression pool, via the safety and relief valves, could be more effectively retained if the pool remained subcooled. The overall accident consequences would be somewhat reduced in this earlier melt sequence but ultimately, the processes accompanying melt (e.g., noncondensibles, steam, and steam pressure pulses during reactor vessel melt-through) could cause overpressure failure (γ or γ') of the containment.

$TW\gamma'$ and $TW\gamma$

The TW sequence involves a transient where the reactor has been shut down and containment has been isolated from its normal heat sink (i.e., the power conversion system). In this sequence, the failure to transfer decay heat from the core and containment to an ultimate sink could ultimately cause overpressure failure of containment. Overpressure failure of containment would take many, many hours, allowing for repair or other emergency actions to be accomplished; but, should this sequence occur, it is assumed that the rather severe structural failure of containment would disable the systems (e.g., HPI, RCIC) providing coolant makeup to the reactor core. (In the RSS design, the service water system which conveys heat from the containment via RHR system to the ultimate sink was found to be the dominant failure contribution in the TW sequence.) After breach of containment, the core is assumed to melt.

[$TQUV\gamma'$, $AE\gamma'$, $S_1E\gamma'$, $S_2E\gamma'$] and [$TQUV\gamma$, $AE\gamma$, $S_1E\gamma$, $S_2E\gamma$]

Each of the accident sequences shown grouped into the two bracketed categories above are estimated to have quite similar consequence outcomes and these would be somewhat smaller than the $TC\gamma',\gamma$ and $TW\gamma'$ sequences described above. In essence, these sequences, which are characterized as in the RSS, involve failure to deliver makeup coolant to the core after a LOCA or a shutdown transient event requiring such coolant makeup. The core is assumed to melt down and the melt processes ultimately cause overpressure failure of containment (either γ' or γ). The overall risk from these sequences is expected to be dominated by the higher frequency initiating events (i.e., the small LOCA (S_2) and shutdown transients (T)).

KEY TO BWR ACCIDENT SEQUENCE SYMBOLS

A - Rupture of reactor coolant boundary with an equivalent diameter of greater than six inches.

B - Failure of electric power to ESFs.

C - Failure of the reactor protection system.

D - Failure of vapor suppression.

E - Failure of emergency core cooling injection.

F - Failure of emergency core cooling functionability.

G - Failure of containment isolation to limit leakage to less than 100 volume per cent per day.

H - Failure of core spray recirculation system.

I - Failure of low pressure recirculation system.

J - Failure of high pressure service water system.

M - Failure of safety/relief valves to open.

P - Failure of safety/relief valves to reclose after opening.

Q - Failure of normal feedwater system to provide core make-up water.

S_1 - Small pipe break with an equivalent diameter of about 2"-6".

S_2 - Small pipe break with an equivalent diameter of about 1/2"-2".

T - Transient event.

U - Failure of HPCI or RCIC to provide core make-up water.

V - Failure of low pressure ECCS to provide core make-up water.

W - Failure to remove residual core heat.

α - Containment failure due to steam explosion in vessel.

β - Containment failure due to steam explosion in containment.

γ - Containment failure due to overpressure - release through reactor building.

γ' - Containment failure due to overpressure - release direct to atmosphere.

δ - Containment isolation failure in drywell.

ϵ - Containment isolation failure in wetwell.

ζ - Containment leakage greater than 2400 volume per cent per day.

η - Reactor building isolation failure.

θ - Standby gas treatment system failure.

APPENDIX K

EVACUATION MODEL

"Evacuation," used in the context of offsite emergency response in the event of substantial amount of radioactivity release to the atmosphere in a reactor accident, denotes an early and expeditious movement of people to avoid exposure to the passing radioactive cloud and/or to acute ground contamination in the wake of the cloud passage. It should be distinguished from "relocation" which denotes a post-accident response to reduce exposure from long-term ground contamination. The Reactor Safety Study[1] (RSS) consequence model contains provision for incorporating radiological consequence reduction benefits of public evacuation. Benefits of a properly planned and expeditiously carried out public evacuation would be well manifested in reduction of acute health effects associated with early exposure; namely, in number of cases of acute fatality and acute radiation sickness which would require hospitalization. The evacuation model originally used in the RSS consequence model is described in WASH-1400[1] as well as in NUREG-0340.[2] However, the evacuation model which has been used herein is a modified version[3] of the RSS model and is, to a certain extent, site emergency planning oriented. The modified version is briefly outlined below:

The model utilizes a circular area with a specified radius (such as a 10 mile plume exposure pathway Emergency Planning Zone (EPZ)), with the reactor at the center. It is assumed that people living within portions of this area would evacuate if an accident should occur involving imminent or actual release of significant quantities of radioactivity to the atmosphere.

Significant atmospheric releases of radioactivity would in general be preceded by one or more hours of warning time (postulated as the time interval between the awareness of impending core melt and the beginning of the release of radioactivity from the containment building). For the purpose of calculation of radiological exposure, the model assumes that all people who live in a fan-shaped area (fanning out from the reactor), within the circular zone with the down-wind direction as its median - i.e., those people who would potentially be under the radioactive cloud that would develop following the release - would leave their residences after lapse of a specified amount of delay time* and then evacuate. The delay time is reckoned from the beginning of the warning time and is recognized as the sum of the time required by the reactor operators to notify the responsible authorities, time required by the authorities to interpret the data, decide to evacuate, and direct the people to evacuate, and time required for the people to mobilize and get underway.

While leaving the area, the model assumes that each evacuee would move radially out and in the downwind direction with an average effective speed* (obtained by dividing the zone radius by the average time taken to clear the zone after the delay time) over a fixed distance* from the evacuee's starting point.

*Assumed to be of a constant value which would be the same for all evacuees.

This distance is selected to be 15 miles (which is 5 miles more than the 10-mile plume exposure pathway EPZ radius). After reaching the end of the travel distance the evacuee is assumed to receive no further radiation exposure. (An important assumption incorporated in the RSS consequence model is that if the calculated ground dose to the total marrow over a 7-day period would exceed 200 rems in the regions beyond the evacuation zone, then this high dose rate would be detected by actual field measurements following the accident and people from those regions would be relocated immediately. Therefore, the model limits the period for ground-dose calculation to only 24 hours for those regions. When no evacuation at all is assumed, this manner of ground-dose calculations applies to all regions, beginning from the reactor's location. CRAC code implements this feature irrespective of the evacuation model used.)

The model incorporates a finite length of the radioactive cloud in the downwind direction which would be determined by the product of the duration over which the atmospheric release would take place and the average windspeed during the release. It is assumed that the front and the back of the cloud formed would move with an equal speed which would be the same as the prevailing windspeed; therefore, its length would remain constant at its initial value. At any time after the release, the concentration of radioactivity is assumed to be uniform over the length of the cloud. If the delay time would be less than the warning time, then all evacuees would have a head-start, i.e., the cloud would be trailing behind the evacuees initially. On the other hand, if the delay time would be more than the warning time, then depending on initial locations of the evacuees there are possibilities that (a) an evacuee will still have a head-start, or (b) the cloud would be already overhead when an evacuee starts out to leave, or (c) an evacuee would be initially trailing behind the cloud. However, this initial picture of cloud-people disposition would change as the evacuees travel depending on the relative speed and positions between the cloud and people. It may become possible that the cloud and an evacuee would overtake one another zero, or one or more number of times before the evacuee would reach his or her destination. In the model, the radial position of an evacuating person, while stationary or in transit, is compared to the front and the back of the cloud as a function of time to determine a realistic period of exposure to airborne radionuclides. The model calculates the time periods during which people are exposed to radionuclides on the ground while they are stationary and while they are evacuating. Because radionuclides would be deposited continually from the cloud as it passed a given location, a person while under the cloud would be exposed to ground contamination less concentrated than if the cloud had completely passed. To account for this, at least in part, the revised model assumes that persons are exposed to the total ground contamination concentration, calculated to exist after complete passage of the cloud, when completely passed by the cloud; to one half the calculated concentration when anywhere under the cloud; and to no concentration when in front of the cloud. The model provides for use of different values of the shielding protection factors for exposure from airborne radioactivity and contaminated ground, and the breathing rates for stationary and moving evacuees during delay and transit periods.

It is realistic to expect that authorities would evacuate persons at distances from the site where exposures above the threshold for causing acute fatalities could occur regardless of the plume exposure pathway EPZ distance. Figure I-1 illustrates the reduction in acute fatalities that can occur by extending evacuation to a larger distance such as 15 mi, from the Susquehanna site. Calculation shows that if the evacuation distance is increased to 20 mi, there would be no acute fatalities at all probability levels for this site. Also illustrated in Figure I-1 is a pessimistic case for which no early evacuation is assumed and all persons are assumed to be exposed for the first 24 hours following an accident and are then relocated.

The model has the same provision for calculation of the economic cost associated with implementation of evacuation as in the orginal RSS model. For this purpose, the model assumes that for atmospheric releases of durations three hours or less, all people living within a circular area of 5-mile radius centered at the reactor plus all people within a 45° angular sector within the plume exposure pathway EPZ and centered on the downwind direction would evacuate and temporarily relocate. However, if the duration of release would exceed three hours the cost of evacuation is based on the assumption that all people within the entire plume exposure pathway EPZ would evacuate and temporarily relocate. For either of these situations, the cost of evacuation and relocation is assumed to be $125 (1980 dollar) per person which includes cost of food, and temporary sheltering for a period of one week.

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3. "A Model of Public Evacuation for Atmospheric Radiological Releases," SAND78-0092, June 1978.

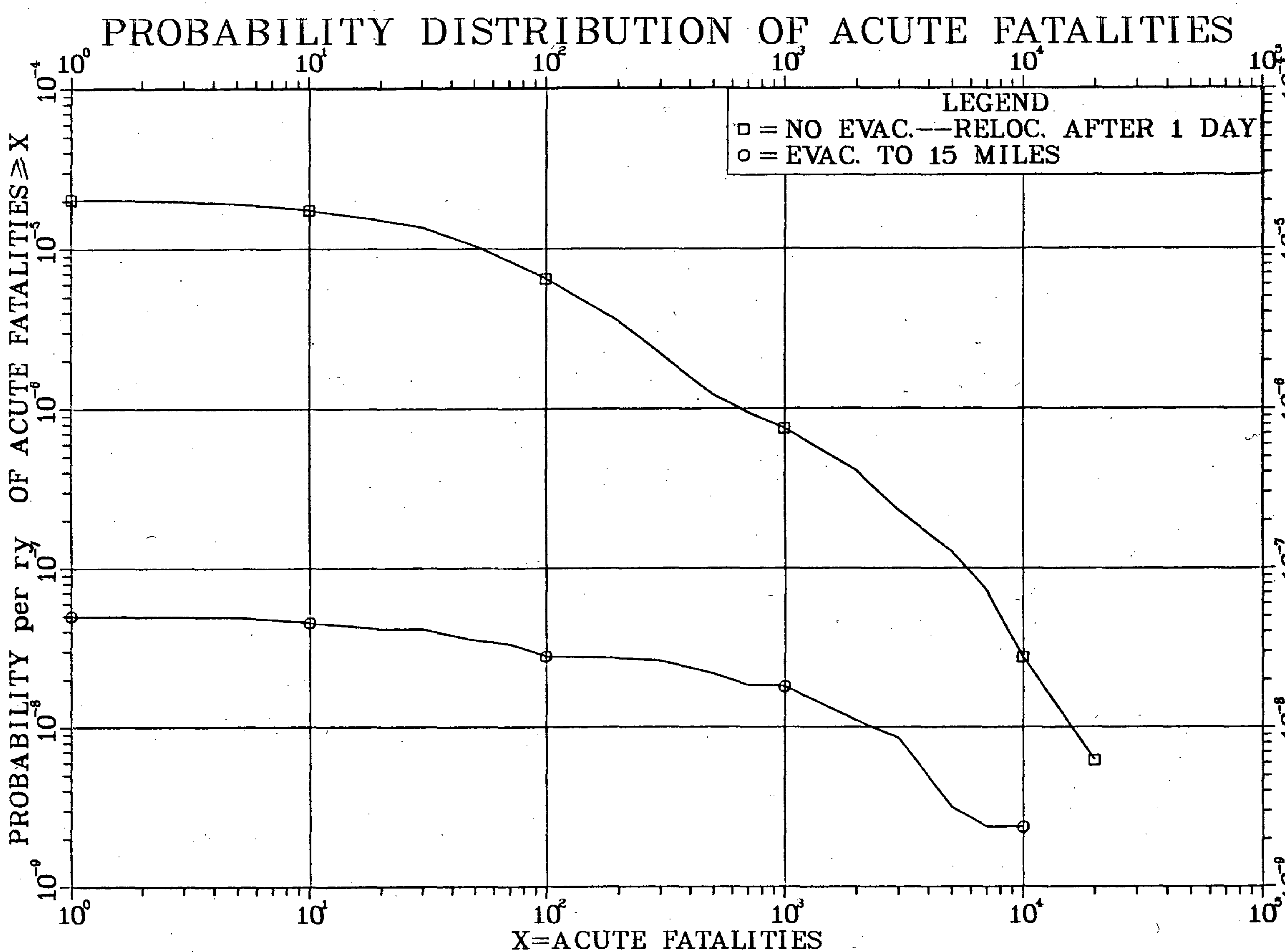

Fig. K-1

NOTE 1: For evacuation to 20 miles, no acute fatality is predicted.

NOTE 2: Please see section 6.1.4.7 for discussion of uncertainties in risk estimates.

NRC FORM 335
(7-77)

U.S. NUCLEAR REGULATORY COMMISSION

BIBLIOGRAPHIC DATA SHEET

1. REPORT NUMBER *(Assigned by DDC)*	NUREG-0564
4. TITLE AND SUBTITLE *(Add Volume No., if appropriate)*	Final Environmental Statement Related to the Operation of Susquehanna Steam Electric Station, Units 1 and 2
2. *(Leave blank)*	
3. RECIPIENT'S ACCESSION NO.	
7. AUTHOR(S)	
5. DATE REPORT COMPLETED	MONTH: June; YEAR: 1981
DATE REPORT ISSUED	MONTH: June; YEAR: 1981
9. PERFORMING ORGANIZATION NAME AND MAILING ADDRESS *(Include Zip Code)*	Office of Nuclear Reactor Regulation U. S. Nuclear Regulatory Commission Washington, DC 20555
6. *(Leave blank)*	
8. *(Leave blank)*	
12. SPONSORING ORGANIZATION NAME AND MAILING ADDRESS *(Include Zip Code)*	Same as 9 above
10. PROJECT/TASK/WORK UNIT NO.	
11. CONTRACT NO.	
13. TYPE OF REPORT	
PERIOD COVERED *(Inclusive dates)*	
15. SUPPLEMENTARY NOTES	Pertains to Docket Nos. 50-387 and 50-388
14. *(Leave blank)*	

16. ABSTRACT *(200 words or less)*

A Final Environmental Statement has been prepared that contains the second assessment of the environmental impact associated with operation of the Susquehanna Steam Electric Station pursuant to the guidelines of the National Environmental Policy Act of 1969 (NEPA) and 10 CFR Part 51 of the Commission's Regulations. The station would be operated by the Pennsylvania Power and Light Company and Allegheny Electric Cooperative, Inc. at a site on Susquehanna River in Luzerne County, Pennsylvania. The facility will employ two pressurized water reactors to produce 3293 megawatts thermal per unit. A steam turbine generator will use this heat to provide 1050 megawatts electric per unit. The staff assessed the terrestrial, aquatic, radiological, social, and economic benefits and costs associated with station operation, considered station accidents, their likelihood of occurrence, and their consequences; and also updated the discussion of need for power based on information available in 1980. The staff concludes that the station's engineered safety features provide for protection of the environment; that operation of the station will be less expensive than any other generation alternative; that the benefits of increased availability of electric power outweigh the environmental and economic costs created by the station; and that the action called for is the issuance of operating licenses for Units 1 and 2.

17. KEY WORDS AND DOCUMENT ANALYSIS	
17a. DESCRIPTORS	
17b. IDENTIFIERS/OPEN-ENDED TERMS	
18. AVAILABILITY STATEMENT	Unlimited
19. SECURITY CLASS *(This report)*	Unclassified
20. SECURITY CLASS *(This page)*	Unclassified
21. NO. OF PAGES	
22. PRICE	S

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

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