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Review of Water Quality Standards, Permit Limitations, and Variances for Thermal Discharges at Power Plants

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The EPA Project Coordinator for this study was Mary Reiley, (202) 260-9456.

NOTICE

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TABLE OF CONTENTS

REVIEW OF WATER QUALITY STANDARDS, PERMIT LIMITATIONS, AND VARIANCES FOR THERMAL DISCHARGES AT POWER PLANTS

EXECUTIVE SUMMARY

This report provides an overview of issues relating to thermal effluent discharges, limitations, and variances. The report also highlights the environmental impacts of thermal effluents, methods to mitigate the impacts, and recommended EPA actions to address thermal issues.

Thermal discharges are defined as pollutants by the Clean Water Act (CWA) and are subject to effluent limitations. If the discharger can show that effluent limitations derived from applicable State water quality standards (WQS) are more stringent than necessary to ensure protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on the body of water to which the discharge occurs (i.e., meets the variance criteria), EPA or State may adjust the permit limitations to a less stringent level.

This adjustment is called a "Section 316(a) variance" and is included in the National Pollutant Discharge Elimination System (NPDES) permit (or State equivalent) that the facility receives from the permitting authority. EPA draft guidance for issuing these variances is provided in the 1977 *Section 316(a) Technical Guidance Manual*; however, this guidance has never been finalized by EPA. Some EPA Regions, however, have developed their own guidance.

The actual thermal limitations and monitoring requirements with which the facility must comply are specified in the permit. Permit limitations for thermal discharges may be established as a maximum temperature at the point of discharge (POD), maximum rate of temperature increase at the POD, and temperature difference between a sample taken at the POD and a sample taken upstream of the POD (i.e., ambient water temperature). Discharge temperature limitations in the permit are calculated by considering a specified mixing zone in which the thermal effluent is expected to be assimilated by the receiving water. In many cases, heat load is commonly limited, but discharge temperature, although monitored, may not be limited.

WQS requirements for thermal discharges and the related mixing zone requirements vary widely from State to State. Preliminary reviews by EPA indicated that approximately one third of the 580 power plants in the U.S. have been granted a Section 316(a) variance from WQS. EPA's review also revealed that the EPA has little information readily available on the thermal limitations that have been granted.

Based on these findings, EPA determined that further evaluation was needed. In August 1989, EPA's Office of Wastewater Enforcement and Compliance (OWEC) initiated this study of the CWA Section 316(a) variances for thermal limitations for power plants discharging thermal effluent. This study was conducted in the following four stages:

- Prepared a compendium of State WQS
- Compiled a matrix of NPDES permit limitations and State WQS
- Developed a list of facilities recommended for review in depth

- Conducted data reviews and site visits, including site visits to, and a file review of, Brunner Island Power Plant; a review of facility operation and discharge data at selected facilities; and interviews with selected State, EPA Regional, and facility staff.

The first two stages resulted in separate reports, which are summarized here. The information gathered and findings for the remaining stages are included in this report.

I. Impact of Thermal Effluent

Information provided by the EPA Regions and permitted facilities did not reveal widespread environmental problems resulting from the discharge of thermal effluent from power plants.[1] Isolated cases where substantial degradation occurred were most often the result of administrative error on the part of the permitting agency (e.g., inappropriate permit limitations) rather than facility noncompliance with permit limitations. Fish kills caused by "cold shock" (sudden drop in temperature in the thermal plume during winter months) and excessive temperatures are two acute impacts that were identified at some facilities in this study. In some of these cases, facilities with Section 316(a) variances had high temperature discharges, which caused fish kills. It has been documented that certain thermal discharges have a chronic effect on the populations of different aquatic species in certain water bodies (e.g., reduced diversity, change in species mix, health effects) as well as adverse impacts on surrounding flora and fauna.

To support variance requests and permit reissuance, facilities conduct environmental studies of varying scope and depth. In some cases, these studies are required in the permit. In addition, facilities may employ a variety of procedures to reduce the impact of thermal discharges. Many of these procedures also may be required in permits. These are discussed in Section II below.

II. Shutdown Procedures and Control Mechanisms to Reduce Impact on the Environment

Power plants shut down under a variety of circumstances, including decreased power needs, periodic maintenance, and emergencies. Shutdown procedures are generally designed to protect equipment and address health and safety concerns. Although not the primary purpose, many of these procedures protect fish from cold shock by preventing sudden drops in discharge water temperature. This study identified few facilities that have procedures for a controlled shutdown specifically designed to reduce the potential for cold shock. One facility that does have such procedures is Brunner Island, which uses a "fish comfort system" designed to ensure temperature drops of no greater than 10° F per hour in the discharge channel during unit shutdown.

A wide variety of control mechanisms are used, other than controlled shutdowns, to reduce the impact of thermal effluents on the environment. These mechanisms range from cooling towers that cool the effluent to physical barriers that keep fish out of discharge channels where the fish are at greatest risk from exposure to temperature fluctuations and maximum temperatures. Control mechanisms that are designed to prevent environmental degradation due

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[1] Note: Regions may not be apprised of problems because violation evaluation in the Permit Compliance System and on the Quarterly Non-Compliance Reports (QNCRs) may not necessarily meet the thresholds for reporting and/or enforcement action.

to thermal effluent may vary to accommodate seasonal temperature changes. These control mechanisms either reduce the water temperature at discharge and/or help reduce water temperatures outside the mixing zone. Mechanisms include: cooling towers, cooling ponds, submerged pipes, and multiport diffusers. Control mechanisms that are used to keep fish out of discharge channels include: screens, nets, barriers, water jets, and vertical bars. These mechanisms vary in effectiveness.

III. Environmental Studies Performed to Support Variances

Studies to support initial Section 316(a) variances may be quite extensive and involve collection of facility operating data, environmental data, and biological data, as well as mathematical or physical modelling. However, at the time of permit reissuance, the amount of data required to support a variance is usually less unless a change has occurred in: facility operating conditions, the discharges that interact with the thermal discharge, or in the biotic community of the receiving water.

Biosampling and environmental monitoring help ensure that the environmental integrity of a water body is maintained. Some permits require monitoring on a periodic basis, others have no requirements for monitoring or biosampling. In cases where the permit does not specify monitoring requirements, changes in water quality (most typically improvements) may go undetected unless the facility personnel perform monitoring on their own or a State or federal agency monitors that part of the waterway. Improvements in water quality may change the parameters under which a variance may be considered for reissuance.

IV. Key Findings

Key findings from this study to date are: 1) For the majority of facilities (some with variances, others without), impacts from thermal effluent have not been found to be large and/or permanent, although additional studies at some facilities are needed; 2) Most thermal issues are not related to intentional noncompliance on the part of the facility, but rather are administrative in nature on the part of EPA (e.g., there may be no permit provisions that ensure that variance criteria are met, no monitoring provisions are specified in the permit, and/or no permit requirements that protect fish at facilities where cold shock is likely to occur); 3) The lack of final guidance on Section 316(a) variances from EPA Headquarters has contributed to inconsistencies in permit requirements and the process by which variances are issued; 4) EPA is losing its institutional knowledge on thermal issues, thereby decreasing the EPA's ability to review permits.

The following recommendations reflect consideration of these findings and discussions with EPA staff from the Regions and Headquarters:

- Update the previously developed listing/summary of Section 316(a) and Section 316(b) status for power plants.

- Issue final guidance, formalize EPA policy, and develop permit language and enforcement checklists to ensure that Section 316(a) variances meet variance criteria.

- Provide training for EPA Regional and State permit writers.

- Identify States and EPA Regions that have established processes by which variances can effectively be issued and reissued (e.g., the Technical Advisory Committees in Region I) and share this information among the other States and EPA Regions through a national thermal guidance panel.

- Evaluate ways to increase the reporting to EPA and the public of thermal effluent violations from the States, including modifying the reporting protocols for the Permit Compliance System.

- Reconsider the establishment of technology-based new point source performance standards governing thermal discharges, for steam electric plants over the long-term.

In summary, OWEC believes that the Section 316(a) variance is a useful tool when appropriately and consistently applied. To promote consistency, OWEC is developing a training course for power plant permit writers and others involved in thermal effluent management. The pilot workshop is to be held in Region II in the second quarter of FY 1993. A guidance document also is under development and will be available in draft form by October 1993. The workshops and guidance document will address the first five recommendations made above. The sixth has been placed on the selection list for guidelines review, update, and reissuance.

REVIEW OF WATER QUALITY STANDARDS, PERMIT LIMITATIONS, AND VARIANCES FOR THERMAL DISCHARGES AT POWER PLANTS

1.0 INTRODUCTION TO THE REPORT

This report provides an overview of issues relating to thermal effluent discharges, limitations, and variances. The report also highlights environmental impacts of thermal effluent, methods to mitigate the impacts, and recommends EPA actions to address thermal issues.

The thermal component of any discharge is defined as a pollutant by the Clean Water Act (CWA) and is subject to technology-based or water quality-based effluent limitations, whichever is more stringent. Thermal discharges are of concern because they occasionally cause fish kills and have been known to cause other detrimental effects such as increased levels of parasitic and/or bacteriological infection and poor body condition in aquatic life, as well as reducing population size and species diversity. Thermal discharges may also have a detrimental impact on benthic flora and fauna in estuarine and marine areas. If the discharger can show that the effluent limitations calculated from State water quality standards (WQS) are more stringent than necessary to ensure protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on the body of water where the discharge is to occur, EPA or the State may adjust the effluent limitation to a less stringent level that still ensures such protection and propagation.

This adjustment is called a "Section 316(a) variance" and is included in the effluent discharge permit the facility receives from the State or EPA Region. Section 316(a) of the CWA allows dischargers such as power plants to apply for a variance from WQS to provide flexibility to ensure that thermal discharge limits are protective of a "balanced indigenous population" of aquatic life in and on our nation's waters, while balancing other environmental, social, and economic factors. These factors may include costs such as cooling towers, retention ponds, and protocols for facility operations for minimizing effluent temperatures and fluctuations. Other factors include: losses of electricity production capacity due to retrofitting of cooling towers; evaporative water losses caused by cooling towers; land use restrictions; energy requirements; solid waste disposal; clean air act compliance; and aesthetics. This variance provision for thermal effluent is particularly important to power plants because thermal effluent is such a significant part of their discharge. EPA draft guidance for issuing these variances was provided in the 1977 *Section 316(a) Technical Guidance Manual*; however, this guidance has never been finalized by EPA. Some EPA Regions, however, have developed their own guidance.

WQS for thermal limitations and the related mixing zone requirements vary from State to State. Preliminary reviews indicated that approximately one third of the 580 major power plants in the U.S. had been granted a Section 316(a) variance from those standards. Major facilities are defined by EPA to include NPDES permittees with an industrial rating of 80 or greater under the NPDES permit rating procedures. EPA selected facilities from this universe because permit, violation, and enforcement data are more likely to be reported by the States in EPA's Permit Compliance System (PCS) data base. The review also revealed that EPA had little information readily available on thermal limitations.

Based on these findings, EPA determined that further study was needed. In August 1989, EPA's Office of Wastewater Enforcement and Compliance (OWEC) initiated a review (this study) of the CWA Section 316 variances for thermal limitations for major electric power plants discharging thermal effluent. The goals of the review are to:

- Compile information on State thermal loading guidelines, standards, and limitations
- Compile NPDES permit information on all power plants having active discharges
- Prepare a listing of facilities with Section 316(a) variances that warrant in depth review based on certain criteria
- Conduct an in-depth analysis of selected facilities above
- Compare and analyze permit limitations, discharges, and standards of similar facilities.

EPA initiated a second study in April 1991 to examine in further detail issues identified during the initial data collection phase. In this second study, EPA conducted additional interviews with EPA Regional staff and facility staff. This report details the information collected to date from both studies, as well as further research and analysis of thermal limitations, study methodology, findings, and conclusions/recommendations. Future work may include site visits to other facilities, review of State files on specific facilities, and further research to respond to issues identified in this report.

2.0 STUDY METHODOLOGY

EPA's review of WQS, permit limitations, and thermal variances occurred in four stages. The first two stages resulted in separate reports, the *Compendium of State Water Quality Limits for Thermal Discharges and Mixing Zones* and the *Matrix of NPDES Permit Limits and State Water Quality Standards for Thermal Discharges from Major Power Plants*, which are summarized in Sections 2.1 and 2.2 . The remaining stages are included in their entirety in this report. The information collected from the site visits to Brunner Island is contained in Attachments A and B and summarized in the findings section of this report.

2.1 Compendium of State Water Quality Standards

As a first stage in compiling and analyzing information on thermal discharge limitations, EPA developed a compendium of State-approved WQS relating to thermal discharges and corresponding mixing zones. The compendium contains a summary of each State's WQS for thermal discharges and mixing zones, the issuance date of the thermal discharge WQS, and the State regulatory citation for the WQS.

To develop this compendium, EPA collected information on State WQS from the *Environment Reporter - State Water Laws* issued by the Bureau of National Affairs. In addition, EPA conducted interviews with personnel from State water resources departments and EPA's Criteria and Standards Division to ensure compilation of the most current regulations. EPA compiled this information into a document entitled *Compendium of State Water Quality Limits for Thermal Discharges and Mixing Zones.*

It should be noted that WQS in many States are not based on the extensive data and modern scientific theories that have become available since the standards originally were issued. Largely because of the availability of Section 316(a) of the CWA, which enables permittees to perform site-specific evaluations in lieu of applying WQS, many States have not chosen to update their thermal WQS with the new data and procedures that have become available since that time.

2.2 Matrix of NPDES Permit Limits and State Water Quality Standards

In the second stage, EPA prepared a report containing matrices of National Pollutant Discharge Elimination System (NPDES) permit limitations and State WQS for the 580 major power plants with active thermal discharges. The State WQS included in the matrices were summarized from the compendium to facilitate comparison with the NPDES permit limitations in the matrix. (Note: Comparing WQS and permit limitations does not indicate whether a variance is warranted or whether the permit limitations have been exceeded. Permit limitations and State WQS are measured differently and as a result cannot be compared directly. Instead, the WQS must be put into a formula that takes into account the amount of heat discharged, size of the thermal plume, amount of water discharged, and other variables. In addition, some facilities will have permit limitations that allow for the discharge of heated effluent in excess of State WQS (because those facilities have been "grandfathered" from complying with certain State WQS requirements). EPA obtained a majority of the information on the NPDES permit limitations from EPA's Permit Compliance System (PCS). The Utility Data Institute, EPA Headquarters' files, EPA Regional offices, and State water quality authorities provided additional information for the matrices.

The information collected on NPDES permit limitations and State WQS included:

- Facility permit number
- Facility name
- Receiving water
- Permit expiration date
- Design discharge flow
- Pipe schedule number
- Thermal parameter measured at the discharge point
- Minimum limitation for the associated thermal parameter
- Average limitation for the associated thermal parameter
- Maximum limitation for the associated thermal parameter
- Months limitation applies
- State water quality class
- Maximum increase above the ambient temperature
- Maximum temperature of receiving water
- Status of Section 316(a) variance
- Enforcement actions for thermal violations.

Not all of this information was available for each facility. From this facility-specific information, EPA selected facilities for further review, as discussed below.

2.3 Facilities Reviewed In Depth

EPA selected from a list of the 580 major facilities 33 that met at least one of the following criteria for more detailed review:

- Variance application or approval, but no thermal discharge limitations (according to PCS)
- High thermal discharge limitations
- History of noncompliance or citizen complaints.

In some cases, EPA also used as selection criteria evidence of fish kills and location of facilities on water bodies designated by the State as having high resource value or containing endangered species. For the 33 selected facilities, EPA then compiled the following information:

- Permit number
- Facility name
- Receiving water
- Name of contact
- Telephone number of contact
- Variance approval status
- Thermal discharge limitations
- High discharge limitations
- Enforcement actions.

This information is contained in Attachment C of this report. The next section presents the methodology used in collecting the information; the findings are summarized in Chapter 3.0.

2.4 Data Reviews and Site Visits

Discussions with EPA Regional, State, and facility staff provided the core of data on facility operations and discharges. In addition, EPA reviewed PCS and facility records to compare the actual discharges, permit limitations, State standards, and variances of several facilities, including Brunner Island.

EPA contacted several of the selected facilities from Section 2.3 to discuss operational data, facility type, compliance rate, and discharge information. EPA also researched and analyzed the permit limitations, discharges, and enforcement history of the six facilities discharging thermal effluent into the Susquehanna River. The Susquehanna River was selected because of its proximity to a facility that had a history of fish kill incidents. Moreover, some of these facilities are located in Pennsylvania, which has a different method for assessing mixing zones than other States.

In all, EPA gathered information about 39 major facilities relating to facility operations, discharges, permit limitations, State WQS, and variances. For specific facilities, EPA collected information on facility procedures for unit shutdown, the process by which the facility obtained its initial variance, studies to support renewal of the variance, environmental monitoring conducted by the facility, and the presence of any environmental problems. EPA also interviewed Regional and State staff on how variances are issued and reviewed by the States and Regions (in particular the Technical Advisory Committee in Region I). Other interviews, particularly in Region V, focused on facilities experiencing difficulty complying with State thermal WQS, while other discussions focused on issues relating to the Section 316(a) program and the CWA reauthorization.

In addition, EPA made two site visits to Pennsylvania Power and Light's (PP&L) Brunner Island facility in York County, Pennsylvania. The purpose of the site visits was to make preliminary determinations of the type of information to be collected during site visits to other facilities. These site visits consisted of a review of State files, a tour of the facility, discussions with facility environmental staff, and observation of biosampling at the facility. This information supplemented the review of State files on the enforcement history of the facility. The information compiled on the Brunner Island facility is integrated with the findings from discussions with staff at other facilities and the State.

3.0 STUDY FINDINGS

The results of the research and analysis of data on permits, State WQS, and variances, the impacts of thermal effluent, as well as information on specific facilities, are contained in this section.

3.1 Establishing Thermal Permit and Variance Limitations

The goal of the CWA as stated in Section 101 is to "restore and maintain the chemical, physical, and biological integrity of the nation's waters." A key objective is the eventual elimination of pollutants discharged into the waters of the U.S. A principal means to achieve that objective is a system to impose effluent limitations on, or to otherwise prevent, discharges of pollutants into any waters of the United States from any point source. The CWA's primary mechanism for imposing effluent limitations on pollutant discharges is a nationwide permit program established under Section 402 of the Act, NPDES. Each effluent limitation imposed on an NPDES permittee is generally developed using technology-based or water-quality-based standard methodology. Generally, technology-based limitations define a floor or minimum level of control and are applicable at the point of discharge. Technology-based limitations are established through either: 1) national effluent limitation guidelines developed by EPA, or 2) the permit writer's best professional judgement.

In addition to technology-based limitations, each permittee must comply with limitations derived from additional or more stringent WQS established by the State (and approved by EPA) to achieve or maintain the beneficial uses of a particular waterway. State WQS take precedence over any less stringent technology-based controls. These standards do not apply directly at the discharge pipe, but rather, are converted to discharge pipe limitations by the permit writer by determining the assimilative capacity of the stream and dividing it among the discharger's waste load allocation (WLA) to the stream.

In the case of the thermal component of a discharge, no national technology-based effluent limitation guidelines currently exist. As a result, thermal limitations must be developed based on WQS. WQS applicable to thermal discharges are generally set as a maximum temperature or maximum incremental temperature increase at a point outside of the mixing zone. (NB: the first effluent guidelines for the steam electric power industry did place technology-based controls on heat. EPA was quickly sued by the power industry and the courts remanded that provision to EPA. Since that time, no additional technology-based limits have been proposed or adopted for the thermal component of discharges.)

The actual thermal limitations and monitoring requirements with which the facility must comply are specified in the NPDES permit. The State or EPA permit writer may consult various guidance manuals to determine the validity of the proposed permit limitations. One of those manuals is the *Quality Criteria for Water 1986* (The Gold Book). The manual outlines methodologies for determining appropriate water quality criteria for all States. This manual is an attachment to the report entitled *Compendium of State Water Quality Standards.*

The concept of Section 316(a) varies significantly between States and between Regions. A State can write both WQS and mixing zone dimensions for thermal pollutants in such a way that virtually no power plant will need to apply for a Section 316(a) variance. In some States, plants in operation before a certain time have been grandfathered and are excused from performing a Section 316(a) demonstration. In other States, the requirements are more rigorous and even extend to industries other than steam electric power.

Permit limitations for thermal discharges may be established as a maximum temperature at the point of discharge (POD), a maximum incremental temperature increase at the POD, and/or the temperature difference between a sample taken at the POD and a sample taken at the plant intake or upstream of the POD. In most cases, heat load is commonly limited, but discharge temperature, though monitored, may not be limited. Compliance with mixing zone requirements is determined by in-stream thermal monitors or with mathematical models used to back calculate from the temperature at the POD to the expected temperature in the mixing zone as a result of the thermal discharge. The in-stream monitors that determine compliance with mixing zone requirements may be located as much as several miles downstream depending on the size of the mixing zone. The mathematical models consider such characteristics as the size of the waterway, the volume of the discharge, the stream bank configuration, mixing velocities, dilution ratio, and other hydrologic or physiographic characteristics. While each State has a specified mixing zone, each defines that mixing zone differently.

An exception to the mixing zone approach is that used by the Commonwealth of Pennsylvania. Pennsylvania does not specify or consider mixing zones in setting thermal discharge limitations. Instead, an instantaneous complete mix of the thermal discharge with the receiving stream is assumed. Therefore, the "mixing zone" actually is the entire stream, allowing for a greater dilution of the discharged thermal effluent. According to the Pennsylvania Department of Environmental Resources (PA DER), thermal discharge limitations established in individual facility permits are often more stringent to offset the benefits of whole stream dilution (this study did not attempt to verify this assertion). Generally, the effluent thermal limitations in Pennsylvania are based upon an allowable heat rejection rate and are expressed in terms of BTU's (British Thermal Units) per hour. The basic theory underlying this principle is that the heat gained by the stream is equivalent to the heat lost by the discharge. The maximum allowable or actual discharge temperature then is calculated based upon the equation of the heat rejection rate.[2] Variations in the equation account for cases where stream flow is augmented, or where the stream and intake temperatures differ. Pennsylvania has determined temperature variations and limitations on a site-specific basis for every body of water in the Commonwealth. Detailed calculations, equations, and examples are outlined in the PA DER's *Staff Guidance for Implementation of Temperature Criteria*, dated October 3, 1989. This document is an attachment to the EPA report entitled *Matrix of NPDES Permit Limits and State Water Quality Standards.*

3.2 Impact of Thermal Effluent

Thermal discharges can impact aquatic life in several ways. Either cold shock (a sudden decrease in water temperature) or high temperature discharges may cause high fish mortality rates due to the inability of different cold-blooded species to adapt to certain changes in temperature. In addition, increases in ambient temperatures may lead to changes in the population of certain aquatic species. Higher temperatures may also adversely affect plants and benthic organisms that are exposed to the thermal plume. The majority of facilities contacted did

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[2] $T_d = (Q_1 / Q_d)(T_2 - T_1) + T_1$, where T_d is the maximum allowable or actual discharge temperature, Q_1 is the design stream flow, Q_d is the anticipated or actual discharge flow, T_2 is the maximum allowable downstream temperature, and T_1 is the intake temperature. The design stream flow and temperature are established to represent a worst-case scenario and are based on low flow and median temperature conditions.

not report any significant environmental problems as a result of thermal effluent. Discussions with State staff and a review of PCS data revealed some problems relating to fish kills and permit violations, however.

Several facility staff mentioned recreational benefits enjoyed by fishermen who take advantage of the higher concentrations of fish found in thermal plumes in fall, winter, and early spring. Any adverse effects to the fish, they believe, would be reported by the fishermen. Only one of the facilities contacted has received citizen complaints regarding thermal effluent. In addition, temperate waters are well suited for commercial fish operations; some State and/or federal agencies utilize waters near power plants for fish stocks or hatcheries.

The following section documents some of the problems that were identified in this study from conversations with staff in the EPA Regions and at facilities, and from site visits. However, the absence of adverse impacts at most of the selected plants in this study provides the basis for a conclusion that there is only a small likelihood of significant thermal impacts occurring at the nation's power plants operating under Section 316(a) variances.

3.2.1 Impact of Cold Shock

One of the most acute forms of environmental impacts from thermal effluent is "cold shock," which results in fish kills. Cold shock to fish results from sudden drops in temperature in a thermal plume, usually during winter months. Typically, cold shock occurs during a unit or facility shutdown when the thermal effluent is replaced by a rapid discharge of unheated water. Certain species of fish less than 1 year old are especially susceptible to a sudden drop in temperature over 5° F. The fish kills appear to occur only in winter due to the physiology and location of fish during these months. During the coldest water periods, sudden temperature drops are more likely to cause death in most fish species than during warmer ambient temperatures (spring and fall) when higher temperature drops can be tolerated. Furthermore, the comfort range of the fish is such that in the warmest months, fish congregate in the deeper, cooler waters, and during the winter they are attracted to and stay within the thermal plume. Accordingly, fish are more likely to be present in the plume and therefore affected by thermal fluctuations during the winter months.

Cold shock is most likely to occur at facilities that:

- Are located in cold climates (northeast and northwest) or mountainous regions.
- Have "once through cooling" and do not have any form of supplemental heat dissipation or rapid effluent mixing device (i.e., cooling ponds or multiport diffusers) to reduce the change in temperature (ΔT). These facilities are more likely to have a thermal plume with a significantly higher temperature than that of the ambient water.
- Have one or two operating units, where shutdown of one unit has a significant effect on the total discharge.
- Have older units, which are more likely than newer units to be used only intermittently during peak loading, and are shutdown on weekends, holidays, and during periods of lessened demand. The more shutdowns a facility has, the

greater the number of occasions where cold shock may occur as a result of temperature fluctuations in the thermal plume.

Only one facility in the study reported fish kills attributable to cold shock in the last 2 years. This facility experienced fish kills due to "cold shock" in December 1985, January 1988, January 1990, and January 1991. The 1991 fish kill occurred during a controlled shutdown of the largest of three units. At the time of the controlled shutdown, one of the remaining two units was already out of service. As a result of both unit shutdowns, the amount of heated discharge entering the channel was significantly reduced. The drop in water temperature killed 500 fish. In January 1990, one unit was brought out of service in a controlled shutdown to $^{1}/_{3}$ of the unit's output. The "fish comfort system" activated and reduced the flow from the facility to avoid a sudden pass through of unheated river water. However, at $^{1}/_{3}$ load, the temperature differential across the unit was too great to continue with a controlled shutdown without critical damage to the facility, and the staff removed the comfort control system from operation. The shutdown of the unit resulted in a 30° F increase in the discharge channel over an hour as flows from the other two units overran the first unit's decreased discharge. A sudden drop in temperature (15° F in approximately 10 minutes) occurred in the channel when the comfort system was removed. Subsequently, unheated river water passed through the facility and into the discharge channel. The facility staff interviewed believe the fish kill was a result of the sudden decrease in temperature and not the initial increase.

A January 1988 fish kill due to a "cold shock" resulted from decreased flow from the facility during shutdown of one unit and the undertow of the river water back up the discharge channel. This resulted in a 29° F drop over 10 minutes in the channel, killing 180 fish. At this facility, there are no controls preventing fish from entering the discharge channel, thus exposing the fish to the potential variations of temperature.

The facility staff attributed the December 1985 fish kill to a drop in power load; the staff attempted to maintain a 5 megawatt per minute drop in load, but ended with a 6 megawatt per minute drop. The target drop rate was based on the staff's experience that a 5 megawatt per minute drop rate maintains less than a 10° F drop per hour. The facility staff believes it is possible that the ambient river temperature being lower than expected (in addition to the greater drop) was a factor in the large decrease in temperature. Adjustments in procedures were to include a check of ambient river temperature and adjust the rate drop accordingly.

The staff reported that controlled shutdowns are preferred over a "trip" (i.e., an automatic emergency shutdown of the unit) for safety and environmental reasons. On a "trip," the temperature in the discharge channel actually increases because of the influence of the discharges from the two other units.

3.2.2 Impact of Excessive Temperatures

High temperature thermal discharges can cause fish kills and other detrimental impacts to the aquatic environment. Some facilities reported that they have experienced heat-related fish kills. Many of these fish kills were isolated incidents and not indicative of a chronic problem. Facilities with once through cooling and no supplemental heat dissipation facilities are more likely to discharge high temperature thermal effluent than are those facilities that employ cooling ponds, cooling towers, diffusers, or recycle the water back through the facility after cooling.

EPA Regions have identified facilities where ongoing problems exist or existed and where fish kills have been reported in great numbers due to excessive temperatures. According to Region V files, one station in Indiana heated the West Fork of the White River to 108° F, resulting in an extensive fish and mollusk kill downstream. Four Ohio facilities heated their respective streams to higher than 100° F several miles downstream. Files show one of the four facilities increased river temperatures to 110° F in the summer of 1988, resulting in a major fish kill of approximately 2 million fish. At the time of these fish kills, all four facilities were in compliance with their permits; none of the permits had maximum temperature limitations. Rather, limitations were based on the maximum heat rejection rate for the facility.[3] In effect, these facilities can heat the river to facility capacity. In practice, as river flow rates reach summer minimum or drought condition minimum flows, power plants generally must reduce their operations, because the volume of cooling water available in the river and/or high intake water temperatures make operating the plant at full capacity impossible. EPA has since imposed thermal limitations that require the facility to meet maximum State WQS on a fully mixed basis. There are ongoing permit limitation negotiations with several Region V facilities.

In addition to fish kills, high temperature discharges can adversely impact the aquatic environment in several ways including: 1) damage to benthic grasses and fauna; 2) loss of spawning areas; 3) bank-to-bank thermal plumes preventing fish migration; and 4) loss of eggs, larvae, and planktonic organisms in riverine thermal plumes. For example, the thermal plume from a Region IV facility adversely affected approximately 3000 acres of the receiving bay area. Within this 3000 acres, at least 1100 acres of seagrass and attached macroalgal communities were destroyed because of excessive temperatures. In addition, major components of locally indigenous fish and invertebrate species are excluded from the thermally-impacted area.

3.2.3 Changes in Population of Certain Fish Species

More commonly, high temperature discharges cause chronic, health related problems to aquatic life. For example, thermal discharge at certain power plants may affect indigenous fish populations by reducing the presence and number of cold-water species, while increasing the abundance of warm-water species. A report entitled *Changes in the Fish Community of the Wabash River Following Power Plant Start Up: Projected and Observed* and studies by Region V in Indiana suggest that changes in fish population are occurring in some water bodies where there are variances to the WQS in the permit. These variances allow facilities to exceed the maximum 5° ΔT criteria included in most State WQS. More studies may be needed to identify the long-term effects of exceeding the WQS at specific sites.

3.2.4 Entrainment and Impingement

Many facilities have installed mechanisms to reduce environmental damage caused from entrainment and impingement. Entrainment refers to smaller organisms (e.g., phytoplankton, fish eggs, larvae) that are passed through the facility with the cooling water and are subjected to pumps, antifouling agents, condensers, and other physical, chemical, or thermal related causes of damage. Impingement refers to larger organisms such as fish that enter the cooling water intake system and then are trapped on screens. Although this study does not address environmental damage caused by entrainment and impingement, it is important to note that at some facilities a trade off exists between discharge temperature and impingement. Often, the

[3] These variances are appropriate for many other facilities since the facility may discharge into an ocean, a Great Lake, or a large river with a strong current thereby minimizing any effect on water quality.

more water that is drawn from the water source through the condensers to lower effluent temperatures, the more aquatic organisms die from entrainment and impingement.

3.3 Shutdown and Load Reduction Procedures and Control Mechanisms at Facilities

Facility or unit shutdowns or load reductions often occur for facility or unit maintenance, reduction in energy demand, or exceedance of discharge temperatures. "Shutdown" refers to bringing a unit(s) offline (i.e., ceasing energy production). "Load reduction" refers to decreasing energy production.

An EPA review in August 1989 found that many facilities are not required by permit to have facility or unit shutdown procedures to eliminate or reduce risk of cold shock to aquatic life. However, a wide variety of control mechanisms to reduce the impact of thermal effluent on the environment are used, from cooling towers and cooling ponds that cool the effluent to physical barriers that keep fish out of discharge channels (where the fish are at greatest risk from temperature fluctuations). Control mechanisms that are designed to prevent environmental degradation due to thermal effluent may vary to accommodate for seasonal temperature changes. These control mechanisms reduce the water temperature at discharge and/or help reduce water temperatures within and outside of the mixing zone. Mechanisms include: cooling towers, cooling ponds, discharge pipes, and multiport diffusers. Control mechanisms that are used to keep fish out of discharge channels include: screens, nets, barriers, water jets, and vertical bars. These mechanisms vary in effectiveness.

3.3.1 Shutdown Procedures to Prevent Cold Shock

Most facilities have some type of shutdown procedures in which operating units gradually are brought offline as the power level is reduced. These procedures, however, normally reflect health and safety concerns related to protecting facility equipment, rather than preventing cold shock to fish. Efforts to reduce the risk of cold shock may be hampered, in some instances, by load reduction procedures that are required to meet air quality standards.

Some power plants operate only part time in order to supplement regional energy production during periodic high energy demand, resulting in occasional shutdowns. Fish that congregate in the facility's thermal plume during winter months may be susceptible to cold shock during these shutdowns. At this time, there are no national permit requirements or guidance on shutdown procedures to address the potential problem of cold shock. To help assess the impact of facilities operating part time, Region V has proposed special conditions in the permit of a facility that is prone to cold shock. The Region has suggested that the permit contain a "Special Condition" requiring the permittee to conduct an evaluation of the potential for cold shock to fish in the thermal plume. The evaluation would include winter fish sampling and a summary of winter operating conditions for the past 4 years. The summary would include daily average and maximum ΔT and discharge temperatures. After two years, a minimum discharge temperature of 36° F would be required when intake temperatures are below 36° F unless the evaluation documents the absence of cold shock potential. At one Region I nuclear facility, the permit requires gradual temperature decreases to protect marine life from cold shock. As characteristic of most nuclear plants, these controlled temperature decreases are not used in the event of a reactor emergency shutdown, because in those situations, the objective is to avoid core damage. Loss of adequate cooling water, such as would be caused by failure of cooling water condenser pumps or clogging of intake screens, might require an emergency reactor shutdown. Region IV requires all Section 316(a) demonstrations to address potential "cold kills" and assure adequate procedural controls.

In 1983, Brunner Island installed a fish comfort system in response to frequent fish kills. The comfort system allows for controlled temperature decreases of 10° F per hour during unit shutdown. Since then, fish kills have occurred less frequently and with less severity, but a problem still exists. The problem of cold shock at Brunner Island may be related to the disproportionate amount of water discharged from one unit relative to the combined discharges of two other units. In response to this problem, Brunner Island prepared a report examining each of the seven fish kills between 1983 and 1991 attributable to cold shock. Recommendations from the study include: 1) install a control modification to the discharge channel valve system on units one and two to achieve more control over discharge temperature; 2) conduct an annual check of the fish comfort system on unit three; 3) revise unit three control shutdown procedures so that the facility can better ensure a 10° F drop per hour; and 4) install temperature monitoring equipment on two units.

For most facilities, shutdown procedures related to cold shock are not needed. Procedures are not needed at facilities that discharge directly into a lake or large waterway where a rapid mixing of effluent occurs. For example, at a Lake Michigan facility, a year-long study performed in conjunction with the State determined that wind and current affected water temperature more than the thermal discharge. In the case of internally driven shutdowns, the risk of cold shock also is low for a facility that has three or more units, because a single unit shutdown will only result in a moderate and endurable drop in temperature in the thermal discharge. However, grid-affected unit trips likely will impact all the units at a given site, causing a larger impact in thermal discharge. The risk of cold shock and the related need for facility procedures is also low for facilities that operate in climates that are warm year-round. The risks of cold shock are also likely to be minimal at facilities with a history of winter outages that have not caused fish kills. Because cold shock appears to be very site-specific, such actual historic data offers the best evidence possible that the likelihood of cold shock is minimal.

Cold shock may, however, become more of an issue as facilities age and are used only intermittently to supplement peak power demands, or retooling extends their useful life. An important consideration, however, is that fish populations (and certainly less mobile species) are less likely to congregate in a thermal plume that is intermittent, as opposed to a plume that is continuous. Moreover, older plants generally are smaller than newer plants, and thus they produce a smaller plume. All of these factors must be considered in evaluating cold shock potential.

3.3.2 Control Mechanisms to Prevent Damage from Thermal Discharge

Power plants employ a variety of techniques that use water to cool their condensers. Many facilities have installed heat dissipation systems to minimize the impact of thermal discharge on the environment; others use operating procedures (such as the shutdown procedures described previously) to reduce the impact on the environment.

Typically a once through cooling process does not cool the water prior to discharge, rather it involves drawing in water, running it once through the facility, and directly discharging the water in one uninterrupted flow. Power plants prefer using once through cooling because it costs less than mechanisms that cool the water prior to discharge. Once through cooling is appropriate for certain facilities, but when used alone, it poses the greatest threat to aquatic life for both cold shock and thermal shock.

Cooling towers and cooling ponds are effective in lowering the temperature of the water after it is has passed through the condensers, prior to discharge. Depending on the facility, the cooled water is either recycled through the facility to be used again or periodically discharged to the receiving body. Cooling towers generally require the use of antifouling agents, which may have their own water quality issues. Salt water complicates any circulating water system, whether it is once-through or closed cycle, but this added complexity does not preclude the use of cooling towers. In addition, cooling towers may cause significant water loss due to evaporation.

Cooling or retention ponds are large reservoirs where water is stored after passing through the facility, allowing time for the water to cool prior to being recycled or discharged. Cooling ponds require approximately one acre per megawatt and may not be feasible for high megawatt facilities with a small plant site area. The acreage required for cooling ponds or reservoirs varies according to geographic location. Facilities located in arid climates may require more acreage per megawatt.

Some facilities locate their discharge pipes or multiport diffusers offshore or in the center and/or at the bottom of a river or lake to minimize the impact of the thermal discharge. The risk of fish kills from cold shock or excessive temperature is minimized when diffusers are used, as a function of water velocity and diffusion. Diffusers are equipped with nozzles or small diameter ports that blast water at a high velocity. The velocity is great enough that fish cannot swim against it; fish are unable to enter or rest in the high velocity zone. By the time velocities are reduced, diffusion has eliminated large temperature differentials, and there is little risk of cold shock or thermal shock to fish and other aquatic organisms.

The use of these control mechanisms may vary to accommodate for seasonal temperature changes. For example, some facilities only utilize their cooling towers or cooling ponds during summer months to reduce the discharge temperature and flow during critical ambient temperature periods. In addition, during very hot periods, some facilities reduce the amount of electricity generated which results in reduced temperature of the thermal effluent (as long as the same amount of water is run through the plant).

3.3.3 Control Mechanisms that Keep Fish Out of the Discharge Channel

Several facilities supplied information on control mechanisms used to keep fish out of the discharge channel. Mechanisms include: screens, barriers, water jets, and vertical bars. The appropriateness and effectiveness of the control mechanisms vary, and little data were available from the facilities to evaluate these methods. Screens vary in size and are used to physically keep fish out of the channel. Vertical bars keep larger, adult fish out of the channel. High velocity water jets keep fish out of the channel because the fish cannot swim against a rapid water flow. Discharge channels differ in terms of length (from a few yards to over 3 miles), depth, width, construction, and the temperature of water being discharged into them. Some facilities also stated that there were no mechanisms used to keep fish out of discharge channels, and that these channels are subsequently used for fishing by sportsmen during cold ambient temperature periods. Fish can make their way into the discharge channel by swimming through pipes, over fences, and a variety of other means. Subsequent heated effluent or change in discharge temperature can cause fish kills in the discharge channel.

For example, during the spring of 1991, a nuclear facility had an incident where 4,000 fish were killed in the discharge channel despite control mechanisms. Normally a wall blocks fish from entering the channel and discharge pipes maintain a water velocity that restricts access through the pipes. There are, however, occasions when the water velocity through the discharge pipes is reduced, and fish can swim up the pipes into the channel. In addition, during periods of high river flow, fish may be able to swim over the wall.

3.4 Environmental Studies Performed to Support Section 316(a) Variances

Environmental monitoring and studies provide data to both the facility and the permitting agency on the health and numbers of aquatic life near the facility. This data may be used to demonstrate that the facility meets Section 316(a) variance criteria under its current permit, that permit requirements need to be modified, or that a variance would not protect the environment.

This section describes some of the parameters that some initial studies for Section 316(a) variances monitored and discusses the extent to which facilities continue to monitor the biotic community. This section also discusses the environmental studies and monitoring that facilities seeking to renew their variances may be required to conduct.

3.4.1 Initial Section 316(a) Variance Studies

Facilities that have applied for Section 316(a) variances are often required to engage in extensive studies and data collection to demonstrate that facility operations under the requested variance will assure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on the body of water into which the facility discharges. Guidance for conducting and evaluating these studies is provided by the permitting agency. Several EPA documents exist to assist a facility in preparing its Section 316 demonstration, including the draft *Interagency Section 316(a) Technical Guidance Manual*. EPA, however, has not finalized this draft guidance. In absence of national guidance, some EPA Regions have developed their own informal guides to Section 316 demonstrations, which describe the types of information an applicant will need to submit to be considered for a variance.

Typically, information must be gathered on physical, thermal, and biological characteristics of the receiving water, including information on plankton, plants, macroinvertebrates, and fish. The specific types of information and sampling methodologies are determined on a case-by-case basis. For example, general requirements for a Section 316(a) demonstration for facilities that will use "once-through" cooling water systems differ from the requirements for "recycling" cooling water systems (cooling towers, spray ponds, or cooling ponds) because of varying impacts on the environment.

An applicant is entitled to a variance so long as the overall existence of balanced, indigenous population of aquatic organisms results from operation of the facility in its existing configuration. The permitting agency will establish permit limitations that are protective of the water and its inhabitants and consistent with the conditions of the Section 316(a) demonstration. Each permit is unique, based on the particular circumstances of that facility and the receiving water body. For example, the Brunner Island discharge results in the loss of spawning habitat for some fish. According to the facility staff, Brunner Island maintains a variance because the water body is still able to sustain a very large amount of spawning habitat for affected species along other parts of the waterway.

3.4.2 Studies to Support Reissuance of Section 316(a) Variance

The Section 316(a) variance terminates when the permit expires. Although facilities engage in a great deal of research and data collection to initially acquire a variance, the amount of data required by the permitting authority to support reissuance of the variance at the time of permit reissuance usually is minimal. The permittee only needs to provide a basis for that reissuance. The basis could be as simple as: 1) there have been (and will be) no changes to thermal discharges from the facility or to plant operating conditions; 2) there are no changes to facility discharges that could interact with the permittee's thermal discharges; and 3) there are no changes (to permittee's knowledge) to the biotic community of the receiving water body. For many facilities, there is no need to perform additional reissuance studies, because no changes have occurred, and a reissuance is reasonable.

For certain facilities, however, continued reissuance studies may be warranted. For example, if the waterway to which the facility discharges undergoes an improvement in water quality or a return of anadromous fish, additional studies may be needed. As the water quality improves along many of the nation's waters (e.g., the Ohio River), the process for Section 316(a) variances may need to include studies on facility impact to the waterway. Several questions would need to be addressed by the permit writer prior to reissuance: 1) How do facilities or EPA Regions gather data on improved water quality? 2) What criteria need to be met to determine if additional testing is required for variance renewal? 3) Does the current biological data of a water body get compared to baseline data such as dissolved oxygen? 4) How should changes in water quality affect a facility's permit?

In addition, many variances initially were granted, and permit limitations established, based on modelling data. Actual field data from environmental studies may later indicate that the: 1) actual plant operation results in discharges that do not meet the permit limitations that were based on the modelled Section 316(a) demonstration; and/or 2) permit limitations are inadequate to ensure the protection and propagation of a balanced, indigenous population. Moreover, studies may be needed to support the reissuance of a variance where significant environmental degradation has occurred, as in the case of two of the four Ohio facilities mentioned in Section 3.2.2 of this report.

3.4.3 Environmental Monitoring

Some permits require a facility to engage in environmental monitoring, other permits have no such requirements. Moreover, sampling protocols currently are determined on a case-by-case basis, with little formal guidance from Headquarters or some EPA Regions.

Region I Technical Advisory Committees (TAC) develop and review site specific sampling and monitoring requirements for permitted facilities. One nuclear facility participates in an Environmental Surveillance and Monitoring Program, the purpose of which is to determine whether the operation of the facility results in measurable effects on the marine ecology and to evaluate the significance of any observed effects. If significant effects are detected, the facility must take steps to correct the situation. Similar programs were required in other EPA Regions for virtually all nuclear power plants.

In cases where permits do not require the facility to engage in environmental monitoring, changes in water quality may go undetected unless facility personnel perform monitoring on their own initiative or a State or federal agency monitors that part of the waterway. In these cases, some facilities will monitor more extensively than others. For example, one Maryland facility is completing a 10-year quantitative study of its effect on fin fish population and other biota. This extensive study is contrasted by the studies performed at a facility in Region III where biosampling procedures for fish could have been more rigorous.

Region V is considering recommending that future Ohio permits contain a special condition requiring in-stream biological monitoring for facilities with Section 316(a) variances that do not require compliance with all State thermal WQS criteria. Ohio EPA also has established fish sampling protocols including suggested procedures for electro-netting fish.

3.5 EPA Procedures for Issuing and Reissuing Permits

Each EPA Region differs in the level of expertise, guidance, and institutionalized procedures that are used in the permitting process. Region I has established the most formalized system to issue and renew variances through the TACs. Region IV also has a TAC in place for a Florida nuclear facility. One issue that all of the Regions share is that as a result of retirement, attrition, and transfer, EPA is losing its institutional knowledge on thermal issues and consequently the ability to adequately review permits. One way to ensure consistency and preserve institutional knowledge is through Headquarters guidance.

3.5.1 Advisory Committees

Some Regions and States report using TACs when developing permits. As mentioned above, Region I forms TACs to oversee the process by which variances are issued to facilities. The Committees were established to augment expertise within EPA and to shepherd utilities through the Section 316(a) process. Committee members represent key biological regulatory agencies (e.g., U.S. Fish and Wildlife Service, the State fish and game agencies, marine fisheries agencies, and outside experts). Power plants also are represented on the Committee. This review process, described below, has been well received by industry and regulators. To date, no variance decisions in Region I have been challenged by the permittees.

When a facility requests a variance, the EPA Region and the respective State convene an advisory committee, which remains in place until the facility undergoes verification testing. The facility provides the committee with a broad overview of facility operations and details of any problems that may arise as a result of the facility's operations. Baseline biological data are collected for 1 to 3 years before the facility goes on line so that any potential problems can be addressed at an early stage.

There appear to be no other arrangements that are as institutionalized as the TAC, although other advisory groups exist. For example, the Maryland Department of Natural Resources has a power plant research program that makes technical recommendations regarding the environmental effects of a facility's operations. While this program was not specifically established to deal with thermal issues, that has been one of its primary functions for at least the past 15 years.

3.5.2 Lack of Institutional Knowledge

EPA personnel familiar with permitting and compliance issues relating to thermal effluent and power plants, including national technical experts are retiring or otherwise leaving EPA. As a result, EPA may need to take actions to ensure continued expertise on power plants, thermal effluent, mathematical models, and other thermal issues. In one instance, Region V had objected to the original Section 316(a) request made by a facility, but after the Region's power plant expert left EPA, the Region lacked the expertise to support its permit objection, and the State granted the Section 316(a) variance. The facility in question later caused a large fish kill due to the high temperature discharge. Since that time, the permit limitations have been changed.

Currently, there is little guidance on permit preparation or conducting environmental studies and monitoring to support variance reissuance at the federal level. This potentially could result in poorly written permits, or lack of compliance oversight for thermal discharges. The loss of expertise on thermal effluent impacts will be mitigated somewhat in the future by the almost exclusive use of closed cycle cooling for new plants in certain EPA Regions; however, permit reissuance of older plants will still require some expertise on thermal discharges.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Key findings from this study to date are: 1) For the majority of facilities, impacts from thermal effluent have not been found to be large and/or permanent, although additional studies at some facilities are needed; 2) Most thermal issues are not related to noncompliance on the part of the facility, but rather are administrative in nature on the part of EPA (e.g., there are no permit provisions that ensure that variance criteria are met, no monitoring provisions are specified in the permit, and/or no permit requirements that protect fish at facilities where cold shock is likely to occur); 3) The lack of final guidance on Section 316(a) variances from EPA Headquarters has contributed to inconsistencies in permit requirements and the process by which variances are issued; and 4) EPA is losing its institutional knowledge on thermal issues, impacting EPA's ability to adequately review and prepare permits.

The following recommendations reflect consideration of these findings and discussions with EPA staff from the Regions and Headquarters:

- Update the previously developed listing/summary of Sections 316(a) and 316(b) status for NPDES permittees.

- Issue final guidance, formalize EPA policy, and develop generic permit language and enforcement checklists to ensure that 316(a) variances fully meet variance criteria.

- Provide training on thermal variances for EPA Regions and authorized States.

- Identify States and EPA Regions that have established processes by which variances can effectively be issued and reissued (e.g., the TACs in Region I) and share this information among the other States and EPA Regions.

- Evaluate ways to increase the reporting to EPA and the public of thermal effluent violations from the States, including modifying the reporting protocols for the Permit Compliance System.

- Reconsider the long-term establishment of technology-based new point source performance standards governing thermal discharges, for steam electric plants.

EPA guidance should address the need for maximum discharge temperature limitations for some permits, maximum ΔT in discharge temperatures over time, and ongoing biosampling and environmental studies. In addition, permit guidance should address the need for and feasibility of temperature monitoring requirements at various points in the waterway and/or requirements for periodic thermal surveys to ensure accuracy of thermal plume models. Guidance also needs to be developed on cold shock, especially for older peak power facilities, which operate part time. Cold shock guidance may include parameters for controlled temperature decreases during unit shutdown and control mechanisms to restrict fish from the discharge channel.

In summary, OWEC believes that the Section 316(a) variance is a useful tool when appropriately and consistently applied. To promote consistency, OWEC is developing a training course for power plant permit writers and others involved in thermal effluent management. The pilot workshop is to be held in Region II in the second quarter of FY 1993. A guidance document also is under development and will be available in draft form by October 1993. The workshops and guidance document will address the first five recommendations made above. The sixth has been placed on selection list for guidelines review, update, and reissuance.

Additional recommendations for EPA guidance relate to clarifying EPA's interpretation of the CWA. Specifically whether and how Section 316(a) variances should consider impingement and entrainment factors. Permits Division staff also believe that a clearer interpretation of what "cost reasonableness" level is intended for Section 316(b) would be helpful.

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Attachment A

BRUNNER ISLAND REVIEW

Description of the Plant and its Operations

Brunner Island Power Plant is a coal fired steam electric station located at Brunner Island, York County, Pennsylvania. It is operated by Pennsylvania Power and Light (PP&L). The Brunner Island facility takes in approximately 744 million gallons per day of water from the Susquehanna River. The river water is pumped to the condenser through tubing to cool steam coming out of the turbines. The water is chlorinated prior to use to remove contaminants (e.g., algae, dissolved solids) and to reduce fouling of the facility mechanisms by algae and deposits. The condensed steam is recirculated; the heated water is returned to the Susquehanna. The schematic on the following page details the processes at a coal fired electric plant.

The facility consists of three units, Units 1, 2, and 3, built in 1958, 1961, and 1969, respectively. The Brunner Island facility is typical of many older facilities in that it uses "once through cooling," which means the river water is pumped in to the condenser cool the turbines, then pumped out as soon as cooling is completed. The facility returns the water to its source, unlike other facilities that discharge water after cooling into a water body different from the source. By discharging to the source, the facility avoids many of the problems that could occur otherwise (e.g., augmented flow, introduction of non-indigenous species, draw down of source water body).

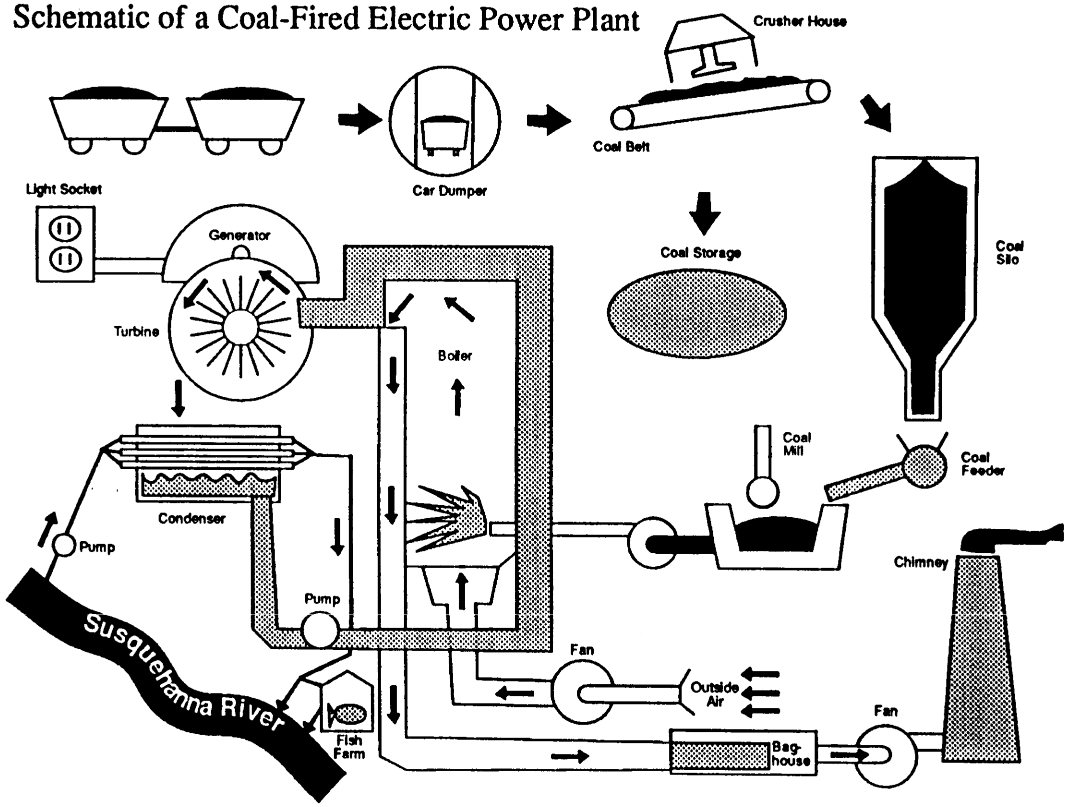
During shutdowns the amount of water entering and leaving the condenser is restricted. The residence time of the water in the condenser is thus longer to ensure the cooling water will remain at a more constant temperature even though the plant is generating less heat. This is the Thermal Shock Prevention System, or "fish comfort system," used to avoid sudden or large fluctuations of temperature in the discharge channel.

If the temperature differential across the condenser becomes too great, plant equipment can be damaged. Under these circumstances, the fish comfort system is removed resulting in increased draw of river water into the condenser and discharge of unheated water into the channel. The unheated water may serve to greatly decrease the temperature of the water in the channel/river interface. The discharge channel at Brunner Island, unlike other facilities in the review, does not have controls to prevent fish from entering or amassing at the channel/river junction (where the fish are at greater risk to temperature fluctuations and high temperatures).

Units 1, 2, and 3 share a common discharge channel. Because Unit 3 produces as much discharge as Units 1 and 2 combined, the reduced flow from Unit 3 during shutdown allows the flows from Units 1 and 2 to fill the entire channel. The cross over causes the remaining flow on the Unit 3 side of the channel to equilibrate to the temperature of the crossover flow. The equilibration could be either an increase or decrease in temperature on the Unit 3 side of the channel depending on the direction of the temperature differentials between the two discharges. Thus, a shutdown of Unit 3 can have a significantly higher impact on the receiving stream than the removal of either Units 1 or 2 alone.

Brunner Island (PP&L), PA Site Visit

Schematic of a Coal-Fired Electric Power Plant



Facility File Review

The Brunner Island facility file review consisted of examining PP&L's facility history file kept by the PA DER in Harrisburg, Pennsylvania, and documents on file at EPA. Documents reviewed included Discharge Monitoring Reports (DMRs), violation reports, enforcement action files, and inspection reports. There have been citizen complaints about river water temperatures downstream from the Brunner Island plant, including one in August 1989. Reportedly, the water a great distance from the power plant had at times been hot enough to prevent wading, and several dead fish had been observed.

The file review revealed that Brunner Island Power Plant had no DMR violations of its thermal limitations in the last 2 years. Further review of permit and discharge information has shown the plant to be in compliance with the thermal limitation, which is expressed as a heat rejection rate in the facility's permit. The current rejection heat permit limitation was established as part of a Section 316(a) thermal variance in 1977. It is unclear whether PP&L was required to submit operating data to support continuation of the variance at the time of permit reissuance; the permit expires September 30, 1990, but has been extended to 1992. The permit for Brunner Island facility sets a limit on the BTU per hour the plant may discharge. The permit also requires the facility to monitor its discharge temperatures. There are no limitations per se on the maximum and minimum temperatures that may be discharged, or the deviation in temperature from the ambient water temperature. (There also is no requirement that the facility conduct biosampling, although it has since 1981.)

The permit limitation of 6,960 x 10^6 BTU per hour for the facility is more than double the rate that EPA calculated (2,690 x 10^6 BTU/hour) based on the Pennsylvania WQS. The commonwealth's WQS equates to not more than a 5° F rise above ambient temperature measured above the intake pump on the lowest 7 days (continuous) flow in 10 years. For the Susquehanna River, this is 2,400 cubic feet per second (i.e., 7Q10 of 2400 CFS). The heat rejection rates reported at the facility for April and May 1989 were 6,290 x 10^6 BTU per hour and 6,225 x 10^6 BTU per hour respectively. While these rates are within the permit limitation, they far exceed those that the Pennsylvania WQS have dictated.

The commonwealth files contained reports of two fish kills, one each in January 1990 and January 1988. (There were reports of other incidents unrelated to thermal loadings (i.e., sulfuric acid spill, oil spills)). On file were the inspection reports detailing the follow-up inspections due to the fish kills as well as the recommended and performed enforcement activity. As a result of the January 1990 fish kill in which several hundred fish died, the commonwealth imposed a fine of $1,000. (The fish that died included a few hundred gizzard shad, numerous sunfish, and a few carp, catfish, crappie, and fall fish). In the January 1988 fish kill, approximately 180 fish died. At that time, the commonwealth issued a letter of agreement without penalty to the facility.

Commonwealth files also indicate that there were two fish kills in 1985. During the first, in November 1985, two to three thousand gizzard shad died. The facility agreed to a $100 voluntary civil settlement. PA DER made no assessment against the facility. The second fish kill occurred in December 1985. The facility staff attributed the second fish kill to a controlled shut down of the plant initiated due to a tube leak.

Fish Kills

The Brunner Island facility staff provided additional information on the fish kills. The January 1990 fish kill was due to a boiler tube failure in Unit 3. Unit 3 was brought out of service in a controlled shutdown to one-third of the unit's output. The "fish comfort system" kicked-in and reduced the flow from the plant to avoid a sudden pass through of unheated river water. However, at one-third load, the temperature differential across Unit 3 was too great to continue with a controlled shutdown without critical damage to the plant, and the staff removed the comfort control system from operation. Subsequently, unheated river water passed through the plant and into the discharge channel.

The shutdown of Unit 3 resulted in a 30° F increase over an hour in the discharge channel as flows from Units 1 and 2 overran the Unit 3 decreased discharge. A sudden drop in temperature (15°F in approximately 10 minutes) occurred in the channel when the comfort system was removed. The facility staff interviewed suspected the fish kill to be from the sudden decrease in temperature, and not the initial increase.

According to facility staff, the January 1988 fish kill was due to a "cold shock" as a result of decreased flow from the plant during shutdown of Unit 3 and the undertow of the river water back up the discharge channel. This resulted in a 29° F drop over 10 minutes in the channel. A total of 180 fish were counted as dead, including several carp, bass, red horse suckers, and blue gills. One researcher noted an increase in the diversity of fish species, and an increase in carp, and attributed this in part to the elimination of Talapia (an introduced species of fish that had been intentionally removed). As noted earlier, there are no controls preventing fish from entering the discharge channel, thus exposing the fish to the potential variations of temperature.

The staff attributed the December 1985 fish kill to a tube leak in the reheater section on Unit 3. They attempted to maintain a 5 megawatt per minute drop in load, but ended with a 6 megawatt per minute drop. The target drop rate was based on their experience that a 5 megawatt per minute drop rate maintains less than a 10° F drop. The facility staff reported that the ambient river temperature being lower than expected (in addition to the greater drop) possibly was a factor in the large decrease in temperature. Adjustments in procedures were to include a check of ambient river temperature and adjust the rate drop accordingly. (It is not clear how this was factored into the 1988 and 1990 fish kills).

The staff said controlled shutdowns are preferred over a "trip" (i.e., an automatic emergency shutdown of the unit) for safety and environmental reasons. On a "trip" the temperature in the discharge channel actually increases because of the influence of the discharges from Units 1 and 2. The facility has had an average shutdown rate of 13 per year. There were six shutdowns in November and December of 1985 due to tube leaks.

When EPA asked why fish kills appear to occur only in winter, the facility staff explained that the fish are not present at the outfall in the warm months. The comfort range of the fish is such that in the spring, summer, and fall months, they congregate in the deeper, cooler waters of the river and during the winter stay within the thermal plume. Accordingly, there are no fish present to be affected by thermal fluctuations in the warmer months.

In addition, there appears to be a correlation between fish kills and Unit 3 problems. Because Unit 3 discharges as much effluent as Units 1 and 2 combined, a problem with Unit 3 causes a greater impact than a shutdown of either of the other two units.

At the time of this site visit, there had been no recent fish kills, and there were no signs of problems. A second site visit, later in August, allowed EPA to take a closer look at the environmental impacts. These are discussed in the next sections.

Biosampling (see schematic, page A-6)

Every August, in coordination with PA DER staff, the Brunner Island facility environmental staff samples for aquatic life impacts. Late August is selected because it is assumed to be the worst case scenario (i.e., lowest water level and the hottest water). The staff sampled at eight locations, including above the intake, at the POD, and 2 ½ miles below the POD. Sampling is conducted for fish, macroinvertebrate larval and nymph stages, and water quality (dissolved oxygen, temperature, conductivity, and pH). The sampling has occurred every year since 1981. The study results and data are available from the plant.

The biosampling is important because, in addition to fish kills, thermal discharges have been known to cause other detrimental effects to fish such as: increased levels of infections and poor body condition, reduced population size, and reduced species diversity. Without biosampling, nonlethal effects of thermal discharges cannot be adequately assessed.

EPA participated in the August 1990 biosampling of two of the eight sampling locations. The first was on the Susquehanna River about 5 ½ miles downstream from the thermal discharge on the east side of the river opposite the thermal plume (Station 6). The second was at the junction of the thermal discharge channel with the Susquehanna River (Station 3). Results of the sampling are described below.

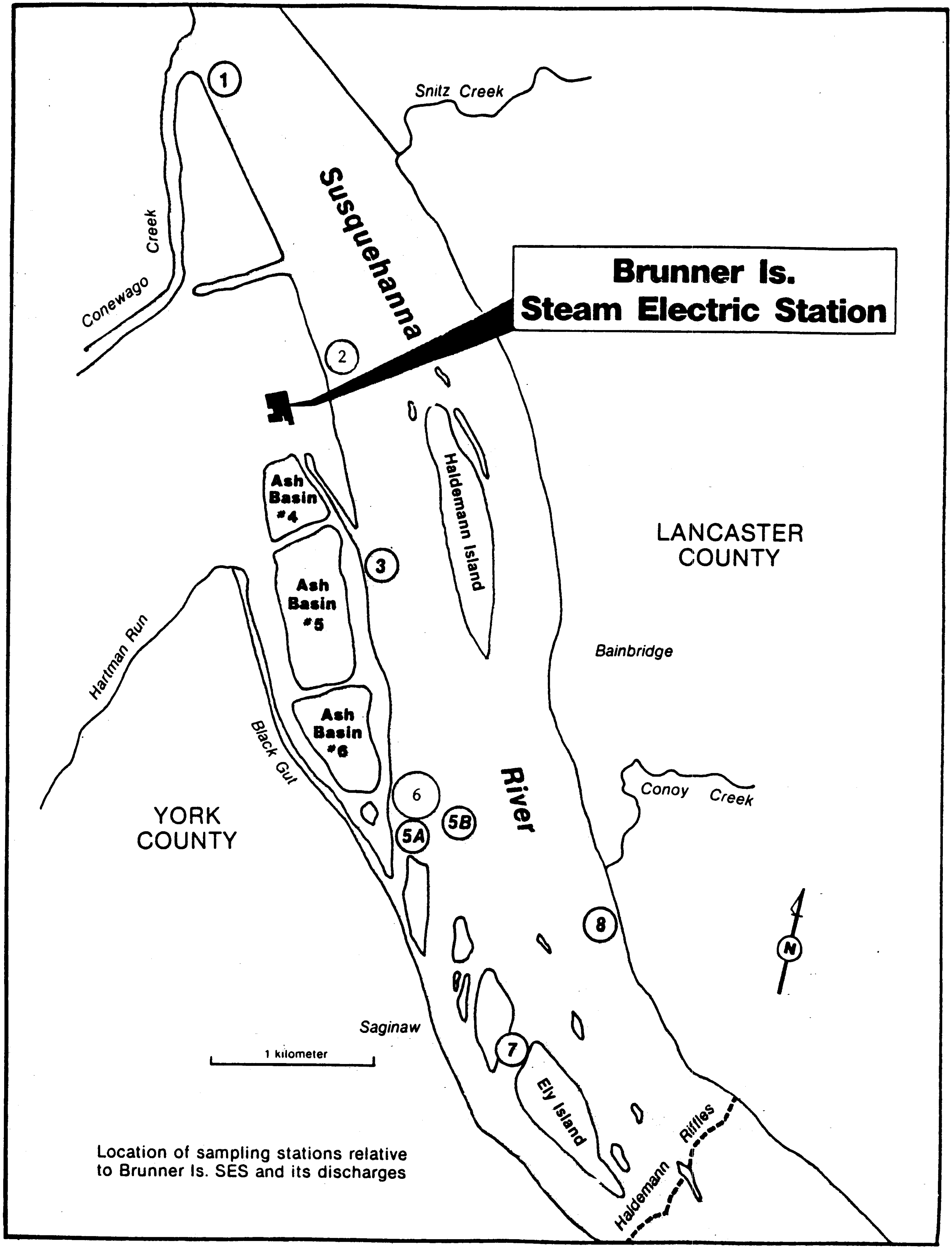
Station 6 Biosampling

The flow of the river on August 28, the day of the sampling, was about two feet above the normal August flow. This resulted in lower than normal numbers of fish caught in that part of the river. (Sampling conducted later in the week was closer to the expected numbers for August). The staff collected fish via electro-shock and netting procedures. The vast majority of the fish were two-inch long shiners, though the staff also caught a few channel catfish, carp, bass, and sunfish. The fish all appeared to be in good health with no obvious signs of disease or infection (i.e., no sores or lesions). For fish over two inches, the staff identified, measured, and weighed them in the field and returned them to the river (The weight and length of the fish are used to calculate body condition). The staff bottled and preserved the smaller fish for later identification.

Macroinvertebrates were collected by disturbing the substrate and collecting the wash in a small mesh seine. The macroinvertebrates collected were typically species found in past sampling (i.e., mayflies, caddisflies, mosquito larvae, hymenoptera). These samples were bottled and preserved for later identification and enumeration. The water temperature at Station 6 was 75° F.

Station 3 Biosampling

The fish collection at Station 3 was significantly different from that of Station 6. According to facility staff, Station 3 routinely demonstrates the lowest diversity and numbers of fish and macroinvertebrates as it is the most highly impacted by the thermal discharge of the eight sampling stations. The fish that were collected were almost exclusively shiners and mosquitofish, as well as a few small sunfish and bass. The staff did not catch any catfish or cod. Some of the fish were dead, though it could not be determined if they had died due to the thermal effluent or



Location of sampling stations relative to Brunner Is. SES and its discharges from entrainment through the plant's cooling water system. The large fish were identified, measured, weighed, and returned to the river. The smaller fish were bottled and preserved for later identification.

The macroinvertebrate sampling at Station 3 uncovered only two insects, both mayflies, one of which was dead. The samples were bottled and preserved for later identification and more thorough examination. The water temperature at Station 3 was 96° F. The rocks and sediments at this station were covered by a thick (0.5 cm) spongy and slick growth of algae. There also was some discolored foam near the shoreline. (The water in this area is fairly turbulent and foam would be expected.)

Conclusions on Biosampling

The sampling methods and locations are appropriate to meet the company's goals: Year-to-year comparison of river flows, locations of thermal plume, numbers and diversity of fish and macroinvertebrates, and fitness of fish. The sampling is not necessarily rigorous enough, however, to demonstrate "no adverse effects" or "irreparable harm" as no sampling of aquatic vegetation takes place, and fish and macroinvertebrate sampling is only performed once a year.

The fish from Station 6 were robust and in good health. Those from Station 3 did not appear as well off nor were there as many or in as great diversity. The difference in numbers is to be expected, given the hotter water temperatures; in the summer months, most fish seek the cooler, deeper regions of the river. The fish that were dead (Station 3) were not kept to determine the possible cause of death.

The macroinvertebrate population at Station 6 was significantly greater and more diverse than at Station 3. Station 3 has high turbulence, hotter temperatures, and algae growths that interfere with the development of macroinvertebrate populations.

Miscellaneous Observations

Facility staff was not aware of "hot pockets" in the receiving waters, but acknowledged the thermal plume extended downstream at least 6 miles, hugging the right bank (although it occasionally moved depending on flow and weather conditions). The staff members were not aware of thermal stress on the fish, although they indicated that other PP&L plants had thermal stress problems.

The staff members were questioned on how they believe the plant impacts the local and downstream environment and if they believe the York Haven Hydrological Plant and the Three Mile Island Nuclear Power Facility (both just up the river) may be causing impacts for which PP&L was or could be held accountable. The staff responded that the original impact analysis (performed in 1979 and 1980) of the variance required no impact more than 5 miles downstream and believe that depending on the river flow for the year, little or no impact was observed at 2 ½ miles downstream from the discharge point. They noted no visible drawdown of the river due to the plant's use of the water.

None of the staff believed the upstream facilities mentioned caused problems for which PP&L was or could be held responsible. They did mention that the York Hydrological Plant occasionally had an impact on PP&L's ability to draw from the river. When York restocks its reservoir, a drawdown is apparent. This impact is not severe and is temporary, as the reservoir capacity is very limited.

Attachment B

TRIP REPORT FOR MARY REILEY

BIOSAMPLING
PENNSYLVANIA POWER AND LIGHT
BRUNNER ISLAND STEAM ELECTRIC

AUGUST 12-16, 1991

Background: In response to a citizens complaint in the fall of 1989 that the heated effluent from the Pennsylvania Power and Light Co.'s (PP&L) Brunner Island Steam Electric Plant was too hot to wade in for fishing and that cooked crayfish could be found, OWEC launched an investigation into the thermal limits, variances, and mixing zones placed upon steam electric plants. One result of the investigation was a review of the Brunner Island compliance file at the Pennsylvania DER and an informational meeting with the plant's management.

During the meeting, Ed Davis and Bob Domermouth (of Brunner Island and PP&L respectively) spoke of the company's annual biosampling on the Susquehanna River to asses the effects of the thermal effluent on the river. Bob Domermouth invited me to join the sampling team last year and called this past spring to ask if I would like to participate again.

Lay of the Land: (see attached schematic in Appendix A, page A-6)

The Brunner Island facility is located about 10 miles north of York, PA. The segment of the river it discharges to is two miles wide and divided down the center by a chain of islands approximately five miles long. The chain separates the deeper channel on the east side of the river from the shallower on the west and effectively creates a barrier between the thermal plume and cool east waters should the plume extend towards the river's center. The river bottom is almost entirely bedrock, either outcroppings or covered in stones and heavy gravel; some slower moving areas are silty.

The river's water level was extremely low (not much over the 7Q10 which is 2400 cfs) providing a prime opportunity to investigate the effects of the thermal discharge under the low flow conditions anticipated at permit issuance. The plume extended across approximately two-thirds of the west side of the river for atleast four miles. Previous studies at extremely low flows found impact similar to those at station seven as much as five and one-half miles downstream.

Sampling Methods: (see attached schematic in Appendix A, page A-6)

There are eight sampling stations in the annual study: one is a reference station above the thermal discharge at Conewago Creek; two is also a reference station above the thermal discharge on the west bank of the river at the discharge from the facilities sanitary waste treatment pond; station three has the highest impact as it is located at the end of the thermal discharge channel; station six is the outfall of ashbasin six; stations 5A and 5B are on the west side of the river downstream from the thermal discharge, under normal flows this is an impacted area; station seven is between two islands located one-third of the way across the river, downstream from the thermal discharge and is mildly impacted; and station eight is on the east bank of the river, downstream from the thermal discharge but not impacted by the thermal dischage.

Water Quality

Water quality parameters were sampled for all stations: DO (range 6-10), pH (approx. 8), Temperature (range 26° - 42°C), Conductivity, metal and non-metal contaminants.

Vertebrates

Fish were collected at all sampling stations except station 6 (the outfall of ashbasin six, not a natural stream). Fish were captured using electroshock and nets. Collection started downstream of the sampling area and worked upstream.

Recreational species and those more than four centimeters in length were weighed, measured, examined for external peculiarities, and released. Those fish less than four centimeters were preserved for later identification and examination (primarily shiners).
Examples of fish caught and environment (not all inclusive):

Cooler Waters	Warmer Waters
Quill-Back	Shiners
Yellow Carp	Sunfish (Redbreast, Green)
Catfish (Yellow, Brown, Channel)	Catfish (Yellow, Brown)
Bass (Rock, Large/Smallmouth)	Smallmouth Bass
Sunfish (Redbreast, Green)	Common Carp
Gizzard Shad	
Minnows	
Shiners	
Suckers	
Pumpkinseed	

The most significant difference between the cooler and warmer water was the numbers of fish collected rather than the types. Colder waters had significantly more fish than warmer waters. Station three had few if any fish present. Station 5B and 7 also had significantly lower numbers than did the reference stations and station 5A which received reverse flow.

Invertebrates

Macroinvertebrates (insect larvae, pupae, worms, chironomids, bivalves, snails, beatles, etc.) were collected at all stations but station six. The macroinvertebrates were captured in the riffle areas by kicking up the substrate and collecting the loose substrate and organisms in a fine mesh dipnet placed immediately downstream of the disturbed area. All invertebrates were preserved for later enumeration and identification. Depth and flow for the riffle areas sampled were recorded using a universal wading rod.

Examples of macroinvertebrates collected and environment (not all inclusive):

Cooler Waters	Warmer Waters
Riffle Beatles	Dominated by Chironomids
Mayfly Larvae	Riffle Beatles
Bivalves	Water Pennies
Snails	
Chironomids	
Water Pennies	

As with the fish sampling, the macroinvertibrates collected from the benthos demonstrated significant differences in numbers of organisms, particularly station three where again all but nothing was collected. The most significant difference between impact and reference stations was the dominance of the impacted stations by chironomids and only a few token representatives of the other species.

Field Evaluation:

The final report of this years sampling will not be available for several months. Field observations lead me to believe that the impact of Brunner Island Steam Electric's thermal discharge on the Susquehanna River is local and not irreparable. If the plant were to shut down today, the lateral and upstream migration of organisms into the previously impacted area would be relatively quick. This is exemplified in stations 5A and 5B.

During normal flow years stations 5A and 5B are thermally impacted. This year the river flow was extremely low allowing a split flow of cold water from ash basin six; half of the flow traveled back upstream through station 5A and hugging the west side of station 5B. The fish and macroinvertebrate populations in these areas were very different from last year. Though the invertebrate population was still dominated by chironomids, a strong showing of less tolerant species was present. The areas also supported the cooler fish species.

There is little to nothing present at station three, the end of the thermal discharge channel, all life has vacated for the summer to cooler climates (sounds like August in D.C.).

Potential Concerns not Investigated:

There is a possibility that some species, i.e. bass, are spawning just upstream from the PP&L plant and below the York Haven Hydroelectric plant (there is a dam at this point with no passage for fish). The eggs may float downstream and be caught either in the cool water intake or in the plants thermal plume. The effect of this (if there is any) on potential recruitment of these species is unknown.

Other:

Brunner Island had a cold shock kill this past January 1991. It was not a large kill, approx. 200 fish, but it has prompted the facility to take further procedural and potentially technological steps to eliminated the cold shock kills. The facility recently completed a study of all fish kills that have occurred at the plant since 1977. The results demonstrate that since the fish comfort system was put in place on Unit 3 the number, frequency, and severity of fish kills has dropped significantly. The facility has since adopted some additional protective procedures and is considering installing a comfort system for both Units 1 and 2 as well. The station anticipates these measures will eliminate all future kills excepting those that result from severe emergency shutdowns. Bob Domermouth will send me a copy of their study and new procedures.

Attachment C
Facilities Reviewed In Depth (from Section 2.3)*

Permit #	Facility Name	Receiving Water	Contact Person	Telephone #(s)	Thermal Discharge Limits ** (Y/N)	Discharge Limits Above 100° F (Y/N)	History of Noncompliance or Complaints (Y/N)
CT0003093	N.E. Utilities (Norwalk Harbor)	Long Island Sound	Mr. R.A. Reckert, V.P. Mr. Nicholas Lanzalotta	(203) 665-5315 (203) 665-5657	Y	Y	N
CT0003115	N.E. Utilities (Montville Station)	Thames River	Mr. R.A. Reckert, V.P. Mr. Nicholas Lanzalotta	(203) 665-5315 (203) 665-5657	Y	Y	N
CT0003263	Millstone Nuclear Power Station	Long Island Sound	Mr. R.A. Reckert, V.P. Mr. Nicholas Lanzalotta Dr. Bill Renfro	(203) 665-5315 (203) 665-5657	Y	Y	N
CT0003883	Middletown Station	Connecticut River	Mr. R.A. Reckert, V.P. Mr. Nicholas Lanzalotta	(203) 665-5315 (203) 665-5657	Y	Y	N
MA0003557	Boston Ed-#1 Pilgrim Plt	Cape Cod Bay	Mr. Robert Anderson, Biologist	(617) 849-8935	Y	Y	N
MA0005339	Holyoke Water-Mt Tom Station	Connecticut River	Mr. R.A. Reckert, V.P. Mr. Nicholas Lanzalotta	(203) 665-5315 (203) 665-5657	Y	Y	N
ME0000272	Central ME Power-Yarmouth	Casco Bay	Mr. Jim Wazlaw, Dir. Env. Comp.	(207) 623-3521	Y	Y	N
ME0002569	Maine Yankee Atomic Power Co.	Montsweag Bay (Bailey Cove)	Mr. David Sturniolo, Principal Engineer	(207) 882-6321 Ext. 5189	Y	Y	N
NH0020338	P.S.Co. of NH-Seabrook	Atlantic Ocean	Mr. Ken Dow, Env. Scientist	(508) 779-6711 Ext. 2634	Y	N	N
NJ0005550	Oyster Creek Nuclear	South Br. Forked River	Mr. James Vouglitios, Mgr. Env. Ctrl.	(609) 971-4021	Y	Y (T^{0} diluted)	N
NY0001015	Nine Mile Point Nuclear Station	Lake Ontario	Mr. Hugh Flanagan, Mgr. Env. Protec.	(315) 349-2428	Y	Y	N
NY0005924	Far Rockaway Power Station	Mott Basin	Mr. Madison Milhous, Mgr. Env. Dept. Mr. Chris Gross	(516) 391-6133 (516) 391-6097	Y	Y	N

* All facilities have approved or applications under review for 316(a) variances
** According to the Permit Compliance System (8/90)

Attachment C
Facilities Reviewed (from Section 2.3)* (continued)

Permit #	Facility Name	Receiving Water	Contact Person	Telephone #(s)	Thermal Discharge Limits ** (Y/N)	Discharge Limits Above 100° F (Y/N)	History of Noncompliance or Complaints (Y/N)
PA0008281	PP&L Brunner Island	Susquehanna River	Mr. Bob Domermuth Env. Mgr.	(215) 770-4849	N	N	N
MD0001511	Baltimore Gas and Electric Co.	Salt Peter Crk.	Mr. Jerry Warner, Senior Engineer Ms. Melissa Wieland	(410) 787-5379 (410) 787-5114	Y	Y	N
MD0002399	BG&E Calvert Cliffs	Chesapeake Bay	Mr. Jerry Warner, Senior Engineer Ms. Melissa Wieland	(410) 787-5379 (410) 787-5114	N	N (not numerical)	N
MD0002658	PEPCO Chalk Point Gen. Station	Patuxent River	Mr. David Bailey, Mgr. Water Quality	(202) 331-6533	N	N	N
IL0002224	Commonwealth Edison, Dresden	Illinois River	Mr. Jeff Smith, Supervisor, Water Quality	(312) 294-4450 Ext. 4435	N	N	N
IN0000132	NIPSCO, Bailey Generating Station	Lake Michigan	Mr. Charles Kern, Dir. of Env. Affairs	(219) 647-4938	N	N	N
MI0001686	Deco-St. Clair Plant	St. Clair and Belle Rivers	Mr. Art Heidrich, Admin. Env. Protection	(313) 237-7021	N (variance not required, facility is grandfathered)	N	N
MI0004464	Lansing BWL-Eckert Station	Grand River	Ms. Gail Peterson, Env. Engineer	(517) 371-6366	N	N	N
MN0000892	NSP-Riverside Plant	Mississippi River	Mr. Jim Bodensteiner, Reg. Analyst	(612) 330-5972	Y	N	N
MN0002011	Ottertail Power Co.	Ottertail River	Mr. Terry Graumann, Env. Engineer	(218) 739-8407	N	N	N

* All facilities have approved or applications under review for 316(a) variances
** According to the Permit Compliance System (8/90)

Attachment C
Facilities Reviewed (from Section 2.3)* (continued)

Permit #	Facility Name	Receiving Water	Contact Person	Telephone #(s)	Thermal Discharge Limits ** (Y/N)	Discharge Limits Above 100° F (Y/N)	History of Noncompliance or Complaints (Y/N)
MN0004006	NSP-Prairie Island Plant	Mississippi River	Mr. Jim Bodensteiner, Reg. Analyst	(612) 330-5972	Y	N	N
OH0001112	Clev. Elec. Illuminating Co.	Lake Erie	Mr. Al Gephart	(216) 447-3202	N	N	Y
OH0001121	Elec. Ill. Ashtabula	Lake Erie	Mr. Al Gephart	(216) 447-3202	N	N	Y
OH0009261	Dayton Power & Light Co.	Great Miami River	Mr. Dave Duwel, Mgr. Env. Mgmt Mr. Scott Arentson	(513) 227-2564 (513) 227-2147	N	N	Y
WI0001589	Wis. Power & Light Edgewater	Lake Michigan	Mr. Tom Hunt, Env. Scientist Mr. Ken Koele, Plant Manager	(608) 252-3237 (608) 252-3237	N	N	N
MO0000043	UE-Rush Island Power Plant	Mississippi River	Mr. Michael Bollinger, Super. Engineer Mr. Frank Putz	(314) 554-3652	N renewal (variance not requested)	N	N
NE0000418	OPPD Fort Calhoun Station	Missouri River	Mr. Bill Neal, Mgr. Env. Affairs	(402) 636-2302	Y	Y	N
NE0111635	OPPD Nebr. City Station	Missouri River	Mr. Bill Neal, Mgr. Env. Affairs	(402) 636-2302	Y	Y	N
MT0000396	Montana Power Co.-Bird/Corett	Yellowstone River	Mr. Jim Stilwell, Env. Engineer	(406) 723-5421 Ext. 3360	Y	Y	N
WY0003115	Dave Johnston Plant	North Pletle River	Mr. Alan Dugan, Env. Engineer	(307) 436-3712	N	N	N

* All facilities have approved or applications under review for 316(a) variances
** According to the Permit Compliance System (8/90)