ANTI-DEGRADATION STUDIES FOR NPDES DISCHARGES FROM NEW GAS FIRED COMBINED CYCLES POWER PLANTS

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Introduction

Federal regulations require states to develop and adopt policies to protect existing in stream water quality and water uses. Wastewater discharges from new sources that could result in lowering of existing water quality must be evaluated as part of the National Pollutant Discharge Elimination System (NPDES) permit application process. These requirements are identified in very general terms under Title 40 of the Code of Federal Regulations (CFR) Part 131.12 Anti-Degradation Policy. However, this policy statement provides no guidance for implementation. Many states have adopted this policy but are still in various stages of development of the evaluation process. Timing of anti-degradation implementation procedures is especially of concern for new sources since the viability of a project is directly linked to funding mechanisms.

The intent of this paper is to provide an approach for addressing anti-degradation as part of the NPDES permit application process for new gas-fired combined cycles power plants. The approach was recently used to address anti-degradation in support of new combined-cycle power plants in two different states.

This paper presents federal and state anti-degradation policies and an example approach for addressing anti-degradation.

Overview

This section is based on information provided in the United States Environmental Protection Agency (EPA) Water Quality Standards Handbook, Second Edition, EPA, Office of Water, August 1994.

History

Anti-degradation was originally based on the intent and goals of the Clean Water Act (CWA), specifically the clause "...restore and maintain the chemical, physical and biological integrity of the Nation's waters" (section 101(a)) and the provision of 303(a) that made water quality standards under previous law the "starting point" for CWA water quality requirements. Anti-degradation was explicitly incorporated in the CWA through:

- A 1987 amendment codified in section 303(d)(B) of the CWA requiring satisfaction of anti-degradation requirements before making certain changes in NPDES permits; and

- The 1990 Great Lakes Critical Programs Act codified in CWA section 118(c)(2) requiring EPA to publish the Great Lakes water quality guidance including anti-degradation policies and implementation procedures. This guidance is codified as 40 CFR 132, Water Quality Guidance for the Great Lakes System (current regulation promulgated since April 23, 1998).

The first federal anti-degradation policy statement was released on February 8, 1968 by the Secretary of the U.S. Department of the Interior. It was included in the EPA's first Water Quality Standards Regulation 40 CFR 130.17 dated November 28, 1973. It was re-promulgated into the current regulation, which was published on November 8, 1983 and is included in the Current Water Quality Standards Regulations (40 CFR 131) as 40 CFR 131.12.

Summary of the Federal Anti-Degradation Policy

The current 1983 federal anti-degradation regulation (40 CFR 131.12) states:

(a) The State shall develop and adopt a statewide anti-degradation policy and identify the methods for implementing such policy pursuant to this subpart. The anti-degradation policy and implementation methods shall, at a minimum, be consistent with the following:

(1) *Existing in stream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected.*

This section, 131.12(a)(1), or "Tier 1," protecting "existing uses," requires the protection of existing uses and the level of water quality necessary to protect those uses with the intent of improving water quality and upgrading uses over time.[1] This section provides a minimum level of protection to all waters of the United States. However, it is most pertinent to waters having beneficial uses that are less stringent than section 131.12(a)(2) goals outlined below. As an example, if the water quality exceeds the existing use but is not sufficient to support a higher use, then the goals of this section would allow water quality to be lowered, such as from a new discharge source, as long as the existing use is maintained and downstream water quality standards are not affected.

(2) *Where the quality of the waters exceed levels necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water, that quality shall be maintained and protected*

[1] Each state is required to specify appropriate water uses to be achieved and protected and the appropriate criteria for uses of their state waters, pursuant to 40 CFR 131.10. Examples of appropriate use designations include use of water for public water supplies, protection and propagation of fish, shellfish, wildlife, recreation in and on the water, agricultural, and industrial.

unless the State finds, after full satisfaction of the intergovernmental coordination and public participation provisions of the State's continuing planning process, that allowing lower water quality is necessary to accommodate important economic or social development in the area in which the waters are located. In allowing such degradation or lower water quality, the State shall assure water quality adequate to protect existing uses fully. Further, the State shall assure that there shall be achieved the highest statutory and regulatory requirements for all new and existing point sources and all cost-effective and reasonable best management practices for nonpoint source control.

Section 131.12(a)(2), or "Tier 2," applies to waters whose quality exceeds that necessary to protect the section 101(a)(2) goals of the Clean Water Act.[2] In this case, water quality may not be lowered to less than the level necessary to fully protect the "fishable/swimmable" uses and other existing uses and may be lowered even to those levels only after following all the bulleted provisions provided below. These Tier 2 waters are classified as "high-quality" waters. High quality waters are those waters that exceed water quality necessary to protect the section 101(a)(2) goals of the CWA, regardless of use designation. To meet the intent of section 101(a)(2) of the CWA, not all parameters need to be better quality than the State's ambient criteria for the water to be deemed a "high-quality water." In order to obtain a new NPDES permit to discharge to "high-quality waters," there must be acceptance of an anti-degradation demonstration under 131.12(a)(2) consisting of:

- A finding that the new source proposing the discharge is necessary to accommodate important economic or social development in the area in which the waters are located;
- Full satisfaction of all intergovernmental coordination and public participation in the permitting process; and
- Assurance that the highest statutory and regulatory requirements for point sources, including new source performance standards, and best management practices for nonpoint source pollutant controls are achieved.

This anti-degradation demonstration would be triggered by any action that would result in the lowering of water quality in a high-quality water, including new discharges or expansion of existing facilities, independent if it can be shown that the lowering of water quality would maintain an existing use designation.[3]

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[2] Section 101(a)(2) states the following: "It is the national goal that wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved by July 1, 1983".

[3] This differs from 131.12(a)(1) goals where lowering of water quality would be allowed without anti-degradation demonstration if existing use for that water body is maintained.

(3) Where high quality waters constitute an outstanding National resource, such as waters of National and State parks and wildlife refuges and waters of exceptional recreational or ecological significance, that water quality shall be maintained and protected.

Section 131.12(a)(3), or "Tier 3," applies to waters designated as outstanding national resource waters (ONRW).[4] Meeting the intent of this section, States may only allow some limited activities which result in temporary and short-term changes in water quality, but changes in water quality should not impact existing uses or alter the essential character or special use that makes the water an ONRW. An example of an activity that would cause a temporary and short-term change in water quality is harvesting of trees near streams that are designated as ONRW. Based on the goals of this section, a discharge from a new source could not lower water quality resulting in alteration of the ONRW characterization. As an example, a water designated as an ONRW for trout fishing would still be safe for trout fishing for the discharge to be allowed.

(4) In those cases where potential water quality impairment associated with a thermal discharge is involved, the anti-degradation policy and implementing method shall be consistent with section 316 of the CWA.

This section is intended to coordinate the requirements and procedures of the anti-degradation policy with those established in the CWA for setting thermal discharge limitations. Limitations developed under section 316 take precedence over other requirements of the CWA.[5]

In summary, the current federal anti-degradation policy is specified in 40 CFR 131.12. It provides requirements that States must adopt for protection of existing uses for all waters of the United States. It outlines requirements for protection of three levels of use attainability: Tier 1, Tier 2, and Tier 3 waters.[6] As intended by section 101(a)(2) of the CWA, wherever attainable, an interim goal of water quality that provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved. This results in a national goal for all waters to be a minimum level of Tier 2 use attainability. Therefore, most new dischargers would be required to perform an anti-degradation demonstration as part of their NPDES permit application.

[4] EPA has recently accepted a State-driven concept identified as Tier 2 ½. Tier 2 ½ is an application of the anti-degradation policy that has implementation requirements that are more stringent than for "Tier 2", but somewhat less stringent than the prohibition against any lowering of water quality (with the exception of temporary or short-term activities) in "Tier 3".

[5] An anti-degradation demonstration, which includes a review of best-available control technology, is inherently required for control of temperature pursuant to section 316 requirements. As an example, the implementation of a cooling tower in conjunction with a diffuser is assumed to best-available-control technology for control of temperature.

[6] Please note that Tier 3 is the highest level of water-quality that can be achieved.

Summary of State Anti-Degradation Policy

Each state must develop their own statewide anti-degradation policies regarding water quality standards and establish procedures for its implementation through the water quality management process. The State anti-degradation policy and implementation procedures must be consistent with the components detailed in 40 CFR 131.12, though each state may interpret the policy differently, such as classifying all waters of the State as Tier 2 "high-quality" waters instead of distinguishing between Tier 1 and Tier 2 (EPA, 1988).

States have been recently re-evaluating their policies and implementation procedures for anti-degradation because:

1. The federal government ruled Pennsylvania's anti-degradation policies unacceptable because their definitions of Tier 1, 2, and 3 waters were not as stringent as the intent of the federal anti-degradation policy. Hence, anti-degradation implementation procedures were also inadequate since they were designed to meet less stringent regulations.

2. Environmental groups have been threatening to sue states that do not have anti-degradation implementation regulations in place (ie. West Virginia and Alabama each received a "notice of intent to sue"). It is difficult for the states to show that they are implementing anti-degradation if they do not have procedures in place.

Concerns over the possibility of lawsuits related to total maximum daily loads (TMDLs) have added to the states' interest in anti-degradation policies and implementation procedures. Waters not meeting the states' Water Quality Standards are placed on the 303(d) list (section 303(d) of the CWA). By the fact of being on the 303(d) list, these waters are considered to be impaired. Public perception of allowing a new discharge to a 303(d) listed stream or river may be negative.

States are in various stages of developing procedures for addressing anti-degradation, though many are struggling with implementation strategies that would meet the intent of the federal regulation (Hakowski, 2000). In addition, EPA has left the decision to the State to allow limited lowering of water quality within a mixing zone, further complicating implementation procedures. In their initial discussions with the State before applying for a NPDES permit, a new discharger should include discussions regarding anti-degradation and mixing zones.[7]

[7] States currently are re-evaluating mixing zones. Some states are currently hesitant to grant a mixing zone to meet water quality standards.

The following section outlines one approach for addressing anti-degradation.

Anti-Degradation Approach Example

ABC Company is developing a combined-cycle power generation facility ("the Facility") along the Widen River near the Town of Appleton in Jane County.[8] The Facility will produce approximately 1,000 megawatts of electricity utilizing natural gas. Make-up and discharge will be via the Widen River.

ABC Company has prepared and submitted an NPDES permit application for discharge of process wastewaters into the Widen River. The Widen River is designated for full-contact recreation pursuant to the State Water Quality Regulations and is better water quality criteria for certain parameters for its designated use. As part of the NPDES permit application process, the State asked ABC to address anti-degradation.

ABC reviewed the applicable State regulations and ascertained the following:

- No State anti-degradation implementation procedures exist; and
- The State would allow mixing zones for discharges in certain circumstances, such as for chemicals that are technically or economically infeasible to treat.

Though no anti-degradation procedures exist, the anti-degradation objectives are stated in the State Water Quality regulations:

"Waters whose existing quality is better than the established standards will be maintained at high quality unless the Commissioner finds...that allowing lower water quality is necessary to accommodate important economic or social development in the area in which the waters are located."

Understanding the need to meet the intent of this regulation, ABC reviewed the procedures identified in 40 CFR 132, Appendix E – Great Lakes Water Quality Initiative Anti-Degradation Policy. The procedures identified include a performance of an anti-degradation demonstration for bio-accumulative chemicals of concern discharging to the Great Lakes System. The procedure includes:

- *A Pollution Prevention Alternatives Analysis.* An identification and comparison of pollution prevention alternatives or techniques that are

[8] The proposed Facility specifics (ie. company and river names, locations) have been changed.

available to eliminate or significantly reduce the extent of increased loading. Alternatives, which may include changes in production process technologies, materials, operations, procedures, or other discharge locations to reduce or eliminate the source of the pollutant, are evaluated for pollution reduction benefits, costs and other factors such as implementability and operability.

- *An Alternative or Enhanced Treatment Analysis.* An identification and comparison of alternative or enhanced treatment techniques that are available to minimize any lowering of water quality and the costs of such techniques relative to the cost of treatment necessary to achieve applicable effluent limitations. Alternatives are evaluated for treatment effectiveness, ease of implementation and operation, other factors (e.g., disposal of sludge generated by a potential process), and relative costs.

- *An Important Social or Economic Development Analysis.* An identification of area social or economic development and benefits that would be foregone if the Facility is not built. This includes evaluating the baseline economic evaluation, anticipated positive impacts, potential negative economic or social impacts to the community, and potential adverse environmental or public health impacts.

Though not specifically pertaining to the watershed encompassing the Widen River, ABC proposed this approach to performing the anti-degradation demonstration.

Performance of Anti-Degradation Demonstration

ABC performed an anti-degradation demonstration for each parameter or class of parameters anticipated to be present in the discharge as a result of cycling, chemical addition, or leaching (and therefore would cause a lowering of water quality).[9] A class of parameters is a group of parameters that can be addressed and/or treated using similar technologies or techniques. Parameters subjected to this analysis were grouped into the following classes: metals (i.e., copper, iron), inorganics (consisting of chloride, sulfate, TDS), cyanide, ammonia nitrogen, phenol (the only organic), and total residual chlorine.

[9] The proposed Water Quality Guidance for the Great Lakes System (April 16, 1993) proposes a test to ascertain if the resulting discharge would cause a lowering of water quality greater than "de minimis". Parameters that would be discharged to the water body in "de minimis" amounts would therefore not be subject to an anti-degradation demonstration. This language was removed from the final regulations, though if proposed, some states would allow a de minimis lowering of water quality.

The anti-degradation demonstration included:

- A Pollution Prevention Alternatives Analysis
- An Alternative or Enhanced Treatment Analysis
- A Social/Economic Development Analysis

Pollution Prevention Alternatives Analysis

ABC performed a pollution prevention alternatives analysis to address parameters expected to be present as a result of chemical addition, either from process chemicals or from leaching. Other parameters that would be present solely as a result of being present in the intake water are not amenable to reduction through pollution prevention measures. Table 1 presents the results of the pollution prevention alternatives analysis. Following the intent of 40 CFR 132, Appendix E, ABC used the following criteria to evaluate pollution prevention alternatives:

Effectiveness. This criterion addresses the effectiveness of the proposed alternative in reducing the parameter concentration in the discharge and/or its impact on the receiving water.

Implementability/Operability, Environmental, and Other Factors. This criterion addresses a host of issues that are important for comparison including the technical feasibility of the implementation and operation of the alternative, the impact with respect to environmental issues (such as the potential generation of a hazardous sludge), and other factors (such as quantity of equipment necessary for implementation).

Relative Cost. This criterion includes both capital and operating costs and provides a qualitative comparison to the baseline of not implementing any pollution prevention alternatives.

Table 1 Conceptual Level Pollution Prevention Alternatives Analysis
ABC Generation Facility
Jane County

Alternative	Description	Effectiveness (1)	Implementability/ Operability, Environmental	Relative Cost (2)	Selected or Rejected (3)
Implementation of No Additional Pollution Prevention Measures	Materials are chosen without regard to content of metals or processes.	Not effective. Metals will be present in discharge as a result of leaching from materials and from cycling of pollutants in the river water intake.	Equipment life reduced and maintenance costs increased without use of corrosion control chemicals.	No cost. Baseline for comparison	Rejected
Minimization of Materials Containing Copper, Iron, and Zinc Metals	Alternate materials are used to the extent practical. The largest contribution of metals to the plant discharge normally comes from the circulating water system due primarily to the large cooling water recirculating flow rate. Two components comprise the largest amount of wetted surface in this system, the cooling tower and the steam condenser. The cooling tower and condenser will utilize, to the extent practical, other materials in the construction.	Effectiveness proportional in part to amount of non-metallic material implemented. Estimates of discharge concentrations based on use of these materials.	Some materials containing the subject metals are still required based on their properties (ie. more resistant to temperature fluctuations/limitations; compatibility issues with varying water chemistries).	Moderately high capital cost since non-metallic materials are generally more expensive. Moderately low operating costs.	Selected
Corrosion Control Measures for Materials Containing Copper, Iron, and Zinc Metals	Water chemistry is controlled to limit corrosion of wetted surfaces of metallic materials. Water chemistry control will include pH adjustment and the addition of corrosion inhibitors as appropriate based on the operating temperatures and materials of construction for each particular system.	If implemented appropriately, corrosion control is effective in minimizing corrosion and degradation of wetted surfaces, thereby increasing equipment life and reducing maintenance and discharge of metals. May increase discharged TDS and other parameters.	Corrosion control would minimize leaching of metals to process water, but not eliminate it.	Minimal, since moderately high operating costs will be offset somewhat by lower maintenance costs due to increased equipment life and reduction in maintenance.	Selected
Management Practices for Pollution Prevention	Pollution prevention practices include practices that may reduce discharges to Widen River, such as automatic control of chemical addition, implementation of spill prevention measures.	Effective, but added benefit anticipated to be minimal due to small percentage as compared to overall discharge.	None identified.	Relatively low capital and operating costs.	Selected
Discharge to POTW	Discharge will be diverted to POTW for disposal.	Effective since no discharge to Widen River, though POTW probably not designed for treatment of metals or inorganics.	Jane County's POTW most likely can not handle large discharge flows. In addition, there may be environmental impacts associated with construction of pipeline.	Very high capital costs for construction of conveyance pipe; anticipated high operating cost due to sewer fees.	Rejected
Discharge Diffuser Installation	Submerged multi-port diffuser is installed to reduce resulting impact of discharges to receiving waters of Widen River.	Effective in reducing impacts with respect to concentration to receiving water but not in reducing mass loading. Provides compliance with water quality criteria outside acute mixing zone.	None identified.	Moderately high capital cost. No operating cost	Selected

Notes: (1) Effectiveness with respect to reduction of metals to Widen River.
(2) Qualitative comparison to baseline of not implementing any pollution prevention alternatives.
(3) Alternatives identified as selected will be incorporated into design and/or operation.

ABC evaluated the following pollution prevention alternatives:

- Implementation of No Additional Pollution Prevention Measures
- Minimization of Materials Containing Copper, Iron, and Zinc Metals
- Implementation of Corrosion Control Measures for Materials Containing Copper, Iron, and Zinc Metals
- Implementation of Management Practices for Prevention of Pollution (applicable to all parameters present as a result of chemical addition)
- Discharge to POTW
- Installation of Discharge Diffuser (applicable to all parameters present as a result of chemical addition).

Table 1 provides additional descriptions, compares features, and quantifies costs for each alternative.

Alternative or Enhanced Treatment Analysis

The alternative or enhanced treatment technologies analyses were developed for all parameters. These included metals, inorganics, cyanide, and total residual chlorine.[10]

Following the intent of 40 CFR 132 Appendix E ABC used the following criteria to evaluate technologies:

Effectiveness. This criterion addresses the treatment effectiveness of the proposed alternative in reducing the parameter concentration in the discharge or its impact on the receiving water. This assessment also considers the degree of treatment the technology can provide.

Implementability/Operability, Environmental, and Other Factors. This criterion is similar to that described for the pollution prevention alternatives analysis.

Relative Cost. This criterion includes both capital and operating costs and provides a qualitative comparison to baseline of not implementing any alternative or enhanced technologies.

[10] As previously noted, an anti-degradation demonstration is required for all parameters if de minimis approach not recognized.

ABC determined the Water Quality Criteria (WQC) for each parameter to ascertain treatment level required. The WQC was either obtained from the State Water Quality Regulations or from the EPA Recommended Water Quality Criteria publication dated April 1999. From the review, ABC ascertained that the lowest criteria to meet was for mercury at a concentration of 0.012 micrograms per liter. As such, ABC focused on treatment technologies for metals that could potentially treat to this level. ABC used available references for their review.

For metals, the primary technologies analyzed were:

- Implementation of No Additional Treatment
- Precipitation/Coagulation/Clarification with Sludge Dewatering/Disposal
- Ion Exchange with Regenerant Disposal
- Adsorption Processes with Disposal or Regeneration
- Membrane Processes with Concentrate Disposal
- Evaporation with Sludge Disposal

For the inorganics, the primary technologies selected were:

- None
- Softening/Coagulation/Clarification with Sludge Dewatering/Disposal
- Ion Exchange with Regenerant Disposal
- Membrane Processes with Concentrate Disposal
- Evaporation with Sludge Disposal

For cyanide, the primary technologies selected were:

- Implementation of No Additional Treatment
- Alkaline Chlorination
- Electrolytic Decomposition
- Ozonation
- Evaporation with Sludge Disposal

No additional analysis for total residual chlorine was performed because ABC already planned to implement the common industry control practice of chlorination and dechlorination at the Facility and will comply with New Source Performance Standards (40 CFR 423.15). Tables 2, 3, and 4 discuss and compare the alternative or enhanced treatment technologies for metals, inorganics, and cyanide, respectively.

Table 2 Conceptual Level Alternative or Enhanced Treatment Technologies Analysis for Metals
ABC Generation Facility
Jane County

Technology	Description	Effectiveness (1)	Implementability/Operability, Environmental	Relative Cost (2)	Selected or Rejected (3)
Implementation of No Additional Treatment	No treatment control implemented. If corrosion control and material minimization implemented, addition of metals from process would be minimized. Other metals present in discharge solely as result of being in intake water. Alternative assumes submerged multi-port diffuser would be implemented.	No treatment implemented.	Not applicable.	No cost. Baseline for comparison.	Selected
Precipitation/ Coagulation/ Clarification with Sludge Dewatering/Disposal	Treatment technology includes precipitation or co-precipitation of dissolved metal, coagulation, clarification via clarifier or filter, and subsequent sludge dewatering and sludge disposal. May involve some additional upfront treatment, such as oxidation of iron to its ferric state via chlorine or aeration.	Technology only effective for iron. Technology less effective for other metals.	Technology requires extensive solids, dewatering, and sludge handling equipment in addition to the water treatment equipment. Generation and subsequent disposal of sludge may be classified as hazardous for some metals, thereby adding cost and complexity for disposal.	Very high capital costs due to high flow rates. High operating costs due to high chemical costs and sludge disposal.	Rejected
Ion Exchange with Regenerant Disposal	Treatment technology involves removal of metals via ion exchange resins. Resins are backwashed and subsequent regenerant is disposed as a liquid or is further de-watered and disposed as sludge.	Technology less effective for high influent concentrations of metals; not effective for some metals (mercury) in meeting low State/USEPA limiting criteria.	Large regenerant volume, up to about 10% of influent flow, needs to be managed and/or disposed. Technology may require solids handling as described above.	Very high capital costs due to high flow rates. High operating costs due to regenerant chemicals and regenerant waste disposal.	Rejected
Adsorption Processes with Disposal or Regeneration	Treatment technology involves adsorption via activated carbon or some other adsorbable media. Once spent, adsorption media is either disposed or re-generated.	Technology only effective for organic metals, such as mercury. Technology less effective for inorganic forms of metals.	Technology requires disposal of spent adsorption media. If regenerated, then treatment effectiveness is reduced with re-use. Spent adsorption media may be classified as hazardous, thereby adding cost and complexity to disposal.	Very high capital costs due to high flow rates. High operating costs associated with spent adsorption media disposal/ regeneration/replacement.	Rejected
Membrane Processes with Concentrate Disposal	Treatment technologies involve concentration of stream via membrane technologies (ultrafiltration, nano filtration, reverse osmosis) for subsequent disposal. May include further de-watering of concentrate for subsequent disposal as sludge.	Technology less effective for high influent concentrations of metals; not effective for some metals (mercury) in meeting low State/ USEPA limiting criteria.	Large concentrate volume, up to about 30% of influent flow, needs to be managed and/or disposed. Technology may require solids handling as described for precipitation.	Very high capital costs due to high flow rates. High operating costs due to energy requirements, membrane cleaning and replacement, and concentrate disposal.	Rejected
Evaporation with Sludge Disposal	Treatment technology involves the removal of metals via the evaporation of effluent stream. Sludge would then be disposed.	Effective since entire stream is being addressed.	Extremely high energy requirements. Sludge may be classified as hazardous. Requires complex operating requirements.	Very high capital costs and extremely high operating costs due to materials of construction, energy requirements, and sludge disposal.	Rejected

Notes: (1) Treatment effectiveness with respect to reduction of metals to limiting State/USEPA criteria.
(2) Qualitative comparison to baseline of not implementing any alternative or enhanced treatment alternatives.
(3) Alternatives identified as selected will be incorporated into design and/or operation

**Table 3 Conceptual Level Alternative or Enhanced Treatment Technologies Analysis for Inorganics
ABC Generation Facility
Jane County**

Technology	Description	Effectiveness (1)	Implementability/Operability, Environmental	Relative Cost (2)	Selected or Rejected (3)
None	No treatment control implemented. Inorganics present as a result of chemical addition and present in intake water. This alternative also assumes that the submerged multi-port diffuser would be implemented.	No treatment implemented.	Not applicable.	No cost. Baseline for comparison.	Selected
Softening/ Coagulation/ Clarification with Sludge Dewatering and Disposal	Treatment technology includes softening of inorganics, coagulation, clarification via clarifier or filter, and subsequent sludge dewatering and sludge disposal.	Technology only effective for TDS attributed to hardness. Technology not effective for some inorganics in meeting low State/USEPA limiting criteria.	Technology requires extensive solids dewatering and sludge handling equipment in addition to the water treatment equipment.	Very high capital costs due to high flow rates. High operating costs due to high chemical costs and sludge disposal.	Rejected
Ion Exchange with Regenerant Disposal	Treatment technology involves removal of inorganics via ion exchange resins. Resins are backwashed and subsequent regenerant is disposed, either as a liquid or is further de-watered and disposed as sludge (ultrafiltration, reverse osmosis).	Not effective for TDS, since treatment generally involves replacement, not removal, of ions contributing to TDS. Technology less effective for other inorganics in meeting low State/USEPA limiting criteria	Large regenerant volume, up to about 10% of influent flow, needs to be managed and/or disposed. Technology may require solids handling as described above.	Very high capital costs due to high flow rates. High operating costs due to regenerant chemicals and regenerant waste disposal.	Rejected
Membrane Processes with Concentrate Disposal	Treatment technologies involve concentration of stream via membrane technologies (ultrafiltration, nanofiltration, reverse osmosis) for subsequent disposal. May include further de-watering of concentrate for subsequent disposal as sludge.	Technology less effective for high influent concentrations of inorganics. Technology not effective for some organics in meeting low State/USEPA limiting criteria.	Large concentrate volume, up to about 30% of influent flow, needs to be managed and/or disposed. Technology may require solids handling as described for precipitation.	Very high capital costs due to high flow rates. High operating costs due to energy requirements, membrane cleaning and replacement, and concentrate disposal.	Rejected
Evaporation with Sludge Disposal	Treatment technology involves the removal of inorganics via the evaporation of effluent stream. Sludge would then be disposed.	Effective since entire stream is being addressed.	Extremely high energy requirements. Requires complex operating requirements.	Very high capital costs and extremely high operating costs due to materials of construction, energy requirements, and sludge disposal.	Rejected

Notes: (1) Treatment effectiveness with respect to reduction of inorganics to limiting State/USEPA criteria.
(2) Qualitative comparison to baseline of not implementing any alternative or enhanced treatment alternatives.
(3) Alternatives identified as selected will be incorporated into design and/or operation

Table 4 Conceptual Level Alternative or Enhanced Treatment Technologies Analysis for Cyanide
ABC Generation Facility
Jane County

Technology	Description	Effectiveness (1)	Implementability/Operability, Environmental	Relative Cost (2)	Selected or Rejected (3)
Implementation of No Additional Treatment	No treatment control implemented. Cyanide present in the discharge as a result of solely being present in intake water. This alternative also assumes that the submerged multi-port diffuser would be implemented.	No treatment implemented.	Not applicable.	No cost. Baseline for comparison.	Selected
Alkaline Chlorination	Treatment technology involves oxidation of cyanide to carbon dioxide and nitrogen via chlorination. Destruction by chlorination may be accomplished either by direct addition of sodium hypochlorite or by addition of chlorine gas plus sodium hydroxide.	Technology not very effective.	Technology requires use of chemicals or gases that are difficult to handle with respect to safety. Decreased TDS in treated effluent.	Very high capital costs due to high flow rates. High operating costs due to high chemical costs.	Rejected
Electrolytic Decomposition	Treatment technology involves destruction of cyanide via anodic electrolysis.	Not effective for dilute cyanide-containing waste streams (< 45,000 mg/L cyanide)	Very high energy requirements. Requires complex operating requirements.	Very high capital costs due to high flow rates. High operating costs due to energy requirements.	Rejected
Ozonation	Treatment technology consists of oxidation of cyanide via ozonation.	Effectiveness dependent on initial concentrations, presence of other constituents, and treatment objectives.	Very high energy requirements.	Very high capital costs due to high flow rates. High operating costs due to energy requirements.	Rejected
Evaporation with Sludge Disposal	Treatment technology involves the removal of inorganics via the evaporation of effluent stream. Sludge would then be disposed.	Effective since entire stream is being addressed.	Very high energy requirements. Requires complex operating requirements. Sludge may be hazardous due to concentration of cyanide, thereby adding cost and complexity to disposal.	Very high capital costs and extremely high operating costs due to materials of construction, energy requirements, and sludge disposal.	Rejected

Notes: (1) Treatment effectiveness with respect to reduction of cyanide to limiting State criteria.
(2) Qualitative comparison to baseline of not implementing any alternative or enhanced treatment alternatives.
(3) Alternatives identified as selected will be incorporated into design and/or operation.

Social/Economic Development Analysis

The social/economic analysis consisted of an identification of the economic and social benefits and impacts that would occur in the local area if the proposed facility were built. This included a baseline economic analysis (Table 5), a social/economic benefits analysis (Table 6), and an analysis of the potential environmental or public health impacts (Table 7).

Baseline Economic Analysis

As shown on Table 5, the unemployment rate and the percent of the population below the poverty level are significantly higher than, and the average household income is significantly lower than, that of the State and the United States as a whole.

Table 5 Conceptual Level Baseline Economic analysis
ABC Generation Facility
Jane County

Parameter	Jane County	State	United States
Population	37,910	2,768,619	274,518,599
Unemployment Rate	5.3% (1996)	5.1% (1996-1998, 3-yr average)	4.2%
Average Household Income	$17,196 (1997)	$29,120 (1998)	$35,492
Percent of Population Below Poverty Level	30.8%. (1997)	17.6 %. (1998)	12.7% (1998)

Notes: Information was obtained from the U.S Census Bureau and is representative of the year 1999 unless noted

Social/Economic Benefits Analysis

The construction and operation of the proposed Facility would provide significant economic benefit to Jane County. As shown on Table 6, the anticipated benefits to Jane County include an estimated construction payroll of over $20 million and peak employment of 600 workers. Operation of the Facility will result in approximately 25 permanent professional staff with a budgeted annual payroll of over $2 million. Annual property tax payments will include over $1 million. In addition to these direct economic benefits, local economic stimulus will result from local purchases of material, equipment, and services to support construction and the influx of a large labor force. All of these benefits will result with minimal or no burden on existing infrastructure (schools, roads, government services).

Table 6 Conceptual Level Social/Economic Benefits
ABC Generation Facility
Jane County

Parameter	Impact of Plant Construction	Impact of Plant Operation
Employment	500 (peak employment)	25
Payroll	over $20,000,000 (2-year construction period)	over $1,000,000 per year
Increased Tax Revenue	NA	$1,000,000 per year
Increased Production/ Efficiency	NA	1,000 MW of generation capacity
Environmental, Public Health, Social or Economic Impacts	See Table 7	

NA = Not applicable.

Potential Environmental/Public Health Impacts Analysis

As shown on Table 7, ABC anticipates no adverse environmental or public health impacts associated with the construction of the proposed Facility.

Conclusions

Based on the evaluation, ABC proposed to the State to implement the following pollution prevention alternatives:

- Minimization of Materials Containing Copper, Iron, and Zinc Metals Including the Use of Titanium Condenser Tubes
- Implementation of Corrosion Control Measures
- Implementation of Management Practices for Prevention of Pollution
- Installation of Discharge Diffuser.

Implementation of these pollution prevention alternatives would greatly limit the addition of metals to the process and subsequent discharge to the Widen River. Implementation of management practices for prevention of pollution will minimize the discharge of all chemicals added to the process. Installation of a discharge diffuser will provide efficient mixing and reduction of in-stream concentrations, thereby minimizing the impacts of discharges on the receiving water quality. Additional treatment would not be justifiable given the high flows and low concentrations present in the process waters.

Table 7 Conceptual Level Potential Environmental/Public Health Impacts
ABC Generation Facility
Jane County

Impact Identification	Discussion
Lowering of water quality	The Widen River is expected to maintain its current water quality given the low volume of effluent for discharge from the Facility and the proposed effluent quality.
Endangered or threatened species	In March, 2000, a representative of J&A Consulting Services surveyed ABC's proposed project site including its proposed discharge site in the Widen River. For the river in the vicinity of the project site, the consultant's report noted no records of federal or state listed species. The consultant's survey of the property, including areas within the river, found no evidence of any state or federally listed species. Consequently, ABC anticipates no impacts to endangered or threatened species due to the construction or operation of the proposed Facility.
Risk to human health due to new or increased concentrations of carcinogens or bioaccumulative compounds	ABC anticipates no increased risk to human health due to new or increased concentrations of carcinogens or bioaccumulative compounds. Based on a review of available analyses, there are only two such compounds that have been detected in the river (arsenic and mercury), neither of which will be added due to operation of the Facility, though concentrations may increase locally within mixing zone. No other carcinogenic or bioaccumulative compound is anticipated to be present in the discharge.
Characteristics of the receiving water body that are unique or rare within the local area or state	The Widen River in the vicinity of the proposed discharge location possesses no unique or rare characteristics within Jane County or the State. The Widen River is designated for recreation pursuant to the State Water Quality Regulations.
Downstream drinking water supply	No downstream usage of the Widen River for the supply of drinking water has been identified.
Government or private sponsored conservation projects for improved water quality or enhanced recreational opportunities on the Widen River in the local area	No government or private sponsored conservation projects were identified for the Widen River near the proposed discharge location.
All other environmental permits the applicant has applied or will apply for	In support of the construction of the Facility, ABC has or is in the process of obtaining State Air Pollution Control Permit which includes PSD review, an Acid Rain Permit, an NPDES permit with stormwater coverage (this application), a Permit to Divert or Withdraw for Beneficial Use the Public Waters of the State. and authorization from the Corps of Engineers to use certain Nationwide Permits. Prior to the start of construction, ABC and its construction contractor will obtain coverage from the State under the State General Permit for Stormwater Associated with Construction Activities. Upon commercial operation of the Facility, ABC will apply for a Title V (Part 70) Air Operation permit.

Finally, the ABC evaluation showed the State that the Facility provides economic benefits to Jane County and results in no adverse environmental or public health impacts.

Summary and Discussion

In summary, the current federal anti-degradation policy as specified in 40 CFR 131.12 provides requirements that States must adopt for protection of existing uses for all waters of the United States.. It outlines requirements for protection of three levels of use attainability: Tier 1, Tier 2, and Tier 3 waters. As intended by section 101(a)(2) of the CWA, it is the national goal that all waters obtain a minimum level of Tier 2 use attainability. Therefore, most new dischargers would be required to perform an anti-degradation demonstration as part of their NPDES permit application.

Each state must develop their own statewide anti-degradation policies regarding water quality standards and establish procedures for its implementation through the water quality management process and must be consistent with the components detailed in 40 CFR 131.12, though each state may interpret the policy differently. States are in various stages of developing procedures for addressing anti-degradation, though most are struggling with implementation strategies that would meet the intent of the federal regulation. EPA has also left the decision to the State for allowing limited lowering of water quality within a mixing zone, further complicating implementation procedures. At a minimum, in initial discussions with a state, a new discharger should also include discussions regarding approaches for addressing anti-degradation and mixing zones.

The implementation procedure presented in this paper is one approach that was submitted as part of NPDES permit applications for combined-cycle power generation facilities proposed to be constructed in two different states. One state is anticipated to accept the anti-degradation demonstration as meeting the requirements of the State anti-degradation objectives and issue a draft permit that would include an allowance for a mixing zone via the installation of an engineered diffuser. The other state, however, is presently reluctant to allow any lowering of water quality, even within a mixing zone.

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