Water Conservation Plan

Electric Utilities Sector Plan

Michigan Chamber of Commerce

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Submitted by Barr Engineering Company

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1.0 Introduction

Public Act 35 of 2006 (PA 35 of 06) requires that each water use sector develop voluntary guidelines for generally accepted water management practices (GAMPs) or environmentally sound and economically feasible water conservation measures. The Act allows for such guidelines to be developed and adopted by an established statewide professional or trade association representing that sector.

In response to PA 35 of 2006, the Michigan Chamber of Commerce (Chamber) has developed this template for a Water Conservation Plan (Plan) to serve as a guide for the Electric Utilities sector.

The Chamber and its constituents recognize that the development of the voluntary guidelines as set forth in PA 35 of 2006, also meet the requirements of the Great Lakes Charter Annex Compact, and are consistent with the recommendations of the Groundwater Advisory Council. Specifically, Article 203 of the Proposed Compact (The Decision-Making Standard for Management of Withdrawals and Consumptive Uses within the Great Lakes - St. Lawrence River Basin Sustainable Water Resources Agreement), states:

> *"The withdrawal or consumptive use shall be implemented so as to incorporate environmentally sound and economically feasible water conservation measures."*

The Groundwater Conservation Advisory Council's February 6, 2006 Final Report to the Legislature provided several recommendations. Recommendation No. 10 of the Report states:

> *"Each water-use sector should develop its own sector-specific water management practice. These should be reviewed and evaluated by a closely related professional or trade association. Water users within each sector should be encouraged to adopt and implement the water-management practices specific to their sector."*

The guidelines set forth in this Plan exemplify environmentally sound and economically feasible water conservation measures through GAMPs.

2.0 Plan Objectives

This Utility Water Conservation Measure is being adopted by Michigan's Electric Utilities in response to Michigan P.A. 33 through 37 of 2006 and particularly P.A. 35, Section 32708a, which required "each water user's sector" to designate guidelines for water conservation GAMPs or environmentally sound and economically feasible water conservation measures within that sector.

The Electric Utilities sector has developed the following objectives to help define the strategy for implementing voluntary GAMPs for water conservation and improving water efficiency as part of this Plan. The objectives for this Plan include the following:

- Establish an understanding of current water use at the facility.
- Consider sector specific GAMPs, and document GAMPs either considered or implemented at the facility, as indicated by cost-benefit considerations that could reduce water withdrawal or consumption from the levels that would exist without conservation efforts.
- Maintain documentation related to implementation of the Plan.

Each of these objectives will be further discussed and outlined in the remainder of this document.

3.0 Characterization of Current Water Usage

An important component of a Water Conservation Plan is the characterization of a facility's current water usage. This includes characterizing how water flows through a facility or system, identifying what purpose the water plays within the system, identifying specific equipment that consumes and uses large quantities of water, identifying how water is discharged from the system, and identifying and quantifying, to the extent practicable, the cost considerations associated with the existing water usage.

3.1 Current Water Usage

The following elements provide a guideline for characterizing water usage as part of the Plan:

- Describe the source of water at the facility.
- Identify significant water use processes, sources operations and equipment and account for significant and losses.
- Describe water metering and water use tracking, if any.
- Describe leak detection and repair program, if any.
- Identify current reclamation and reuse of water, including how much water is consumed and not available for reuse.
- Identify how water is discharged.
- Identify and quantify, to the extent practicable, the cost parameters associated with water usage.

3.1.1 Description of Water Sources

Water sources for existing plants were established when the plant was constructed and for most, if not all, electrical generating facilities major changes to those sources is not possible. The existing sources are identified on NPDES Permit applications. The Electric Utilities sector will use information already available to identify water sources.

3.1.2 Significant Water Use Processes

Water processes at electrical generating facilities have been developed for most, if not all, facilities in Michigan in the form of a water flow diagram (also called water balance diagrams) that is part of NPDES Permit applications. As part of the Water Conservation Plan, utilities would review their water flow diagrams to determine if there are ways to further reduce water use.

3.1.3 Water Metering and Tracking

Water metering and tracking is already a part of most NPDES Permits for electrical generating facilities in Michigan. An assessment will be made to determine if the current flow metering and tracking equipment and procedures are adequate and upgraded where it is determined additional metering and tracking is needed for the Water Conservation Plan.

3.1.4 Leak Detection and Repair Programs

Leak detection and repair programs are a part of routine maintenance at electrical generating facilities. Leaks are usually indicative of worn or damaged equipment and the leaks could lead to further damage to the equipment or reduce efficiency of a process. As part of the Water Conservation Plan each facility will evaluate the current leak detection and repair program and determine if there is room for improvement.

3.1.5 Reclamation and Reuse

Reclamation and reuse of water has become a common practice in electrical generating facilities. Plant operators recognize that the water pollution control equipment installed to achieve compliance with NPDES Permit conditions has made the effluent water adequate for reuse. As part of the Electric Utility sector plan, facilities will reassess opportunities to use treated effluent rather than discharging it.

3.1.6 Means of Discharging Water

The means of discharging water from electrical generating facilities has been established by the NPDES Permit and altering discharge locations or means is not usually an option.

4.0 Implementation of GAMPs for Water Conservation

Implementation of GAMPs for water conservation and improving water use efficiency are an important component of this Plan. This section outlines GAMPs for water conservation for the Electric Utilities sector.

The Electric Utilities sector considers water conservation to be either a reduction in water withdrawal or a reduction in consumptive uses. The Electric Utilities sector lays out an array of potential water conservation measures to assist each utility as it moves forward with its complying with both P.A. 33-37 and the Clean Water Act. The cost effectiveness of many of these measures is very site specific. For instance, some power plants are nearing their useful life limit and may be operated infrequently to provide peaking power on only the hottest days during the summer or coldest days during the winter. In such instances, it would be much more difficult to derive any monetary benefits associated with the use of more efficient equipment.

Cooling water is used in the generation of electricity to make the process more efficient. The more efficient generation of electricity reduces the amount of fuel (nuclear, coal, gas, or oil) needed to operate the plant, thereby reducing both air emissions, process wastewater discharges, and operating costs. For this water use, water conservation and energy efficiency should all be considered together with the non-consumptive nature of this use of water. See **Appendix A** – Once Through vs. Closed Cycle Cooling Systems. In addition, it is imperative that each power plant's goals for the water conservation program be harmonized with other programs, including the 316 program to reduce fish loss. See **Appendix B** – Tradeoffs, Alternatives, and the Path Forward.

Most other water uses at power plants are also generally non-consumptive uses. These other uses include steam generator make-up water, ash transport system, pump seal water, bearing cooling water, fire protection, and lawn watering. Drinking water and lawn watering are examples of consumptive uses at power plants that make up less than a fraction of one percent of the total water use.

A number of GAMPs generally applicable within the Electrical Utilities sector include:

- Create a leak detection and repair program with regular inspections of major water systems.
- Educate employees on techniques and benefits of water conservation.

- Identify the water quality, quantity, and temperature of major water uses throughout the facility to determine possible water recirculating or recycling opportunities (see Section 3.1 above).
- Update and calibrate as necessary, methods for calculating condenser thermal performance and acceptance criteria. Clean condensers as necessary to support above.
- Match, as close as practical, service water pumping rates of major water uses, to actual process needs to reduce excessive pumping.
- For major makeup water systems, consider the installation of a surge tank to prevent overflow and/or the installation of float-controlled valves on any makeup water lines.
- To the extent practical, consider turning off water to equipment that is not in use and during shutdowns using a solenoid valve to stop the water flow. Note that safety or reliability constraints may sometimes dictate that critical plant systems not be dependent upon manual shutdown procedures or the expected operation of a solenoid valve.
- Install high pressure, low-volume, nozzles on hoses and spray washers, where practical.
- Use fogging nozzles, mist eliminators or otherwise minimize unnecessary water losses in cooling towers.
- Investigate alternative raw water sources for major processes.
- Investigate variable-speed pumps for cooling water intake.
- Confirm that unnecessary cooling water pumps are not being operated during cooler seasons, within the limits of practicality (Note that at least two cooling water pumps are needed for normal operation to prevent catastrophic damage to the power plant in the event a single pump fails).
- At new facilities, consider configuring intake structures to receive cooler hypolimnion water from lakes and reservoirs.
- At new facilities investigate configuring condensers to double pass water during periods of low water temperature.
- A number of larger power plants that will remain operational for a long period of time, and are consequently able to amortize the costs of large capital improvements, have been able to justify the retrofitting of a new generation of more efficient, steam turbine blades. These are the blades which convert the steam energy from the boiler into mechanical energy (which is then converted into electrical energy by the generator). These upgrades allow those plants to transform more of the energy from the fuel into electrical energy and consequently transfer less energy to the condenser cooling water. The net result is less evaporative (consumptive) losses of water.
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5.0 Evaluation and Modification of the Plan

Upon implementation of this Water Conservation Plan, the Electric Utilities sector will maintain records regarding the measures taken to implement the water conservation plan. The re-evaluation step will be repeated each time there are changes made to a facility’s water flow diagram for the NPDES Permit.

Appendix A

Once Through vs. Closed Cycle Cooling Systems

Steam electric power plants use heat from combusting fossil fuels or reacting nuclear fuels to convert water inside a boiler into steam. The steam drives a turbine connected to a generator, and then the steam is condensed back to water as it exits the turbine shell in the condenser. The condensed steam is pumped back to the boiler and the cycle is repeated.

A condenser is a large heat exchanger in which cooling water passes inside of the tubes and the steam flows over the outside. The cooling water never comes in contact with the steam, only the heat is transmitted across the walls of pipes. This cooling process is referred to as “non-contact cooling.” Condensing the steam exiting the turbine shell forms a vacuum into which the steam is exhausted from the turbine, which makes the steam cycle more efficient, producing more electricity per unit of fuel. Cooling water can be provided by either once through or closed cycle systems.

Once through cooling systems withdraw water from a river, lake, Great Lake, or ocean, pumps it through the condenser, and then returns all of this water to the water body. Closed cycle cooling systems circulate water first through the steam condenser and then circulate that water through a cooling tower where the heat collected from the steam is dissipated to the atmosphere by evaporative cooling. An amount of water equal to the amount evaporated must be made-up to the closed cycle system to replace the water lost or consumed by the evaporative process. As water is continually cycled through the cooling towers, evaporation causes the salt concentration of the cooling water to increase. A small amount of the water must be returned to the source water body and more freshwater must also be added to the circulated system to control salinity, also called “dissolved solids.”

A typical 1,000 MW new coal-fired power plant might circulate a 1,000 MGD of water per day through its condensers. If that plant were fitted with a once-through cooling system, it would withdraw the entire 1,000 MGD daily from a nearby water body and a tiny fraction approximately 0.5% or 5 MGD of the discharged water would eventually be evaporated in the receiving water body. The cooling water is discharged back to the source water body. Some of the heat is released to the environment (i.e., receiving water body) by convection, which is the simple transfer of heat from one surface to another without any evaporation. About half of the heat loss is accomplished through evaporative cooling off of the heated surface of the cooling water plume in the receiving water body. The exact ratio of how much heat is transferred via convection and how much by evaporation is complex and dependent on wind speed, wind and water temperature, humidity and whether a diffuser is used to promote rapid mixing. In general, something less than half of the heat is dissipated through evaporation and the rest through convection. This evaporation is the incremental amount of evaporation that occurs above and beyond the natural evaporation. It is the result of the surface temperature of the water body being raised.

If that plant were fitted with a cooling tower, it would continuously withdraw only about 20 MGD of water as makeup water to its closed cycle cooling system, but it would evaporate about 13 to 15 MGD of water from its cooling towers. This evaporated water may return to the watershed as precipitation. The above numbers are approximations. The actual rates of withdrawals are dependent upon season, the temperature of the receiving water body, and various plant design parameters. Additionally, the cooling water requirements for a nuclear fueled boiler are somewhat higher.

Regardless of the fuel and the plant design, however, a once through plant will always withdraw more water, but evaporate (or consume) less water than a closed cycle cooling plant. There are other trade offs between these two plant designs that are discussed below.

Appendix B

Tradeoffs, Alternatives and the Path Forward

Cooling systems are designed to make the production of electricity more efficient. They are also designed to limit the impact of a water intake and discharge on fish. In this context, the design must also consider the conservation of water.

Once Through Cooling vs. Closed Cycle Cooling

Once through cooling systems withdraw large quantities of water and, absent the use of innovative designs and locations, will have greater potential impacts on a fishery. Adult and juvenile fish can be impinged on a power plant's intake screens and fish eggs and larvae that are small enough to pass through the intake screens can be damaged as they pass through the power plant's cooling water system. There are a number of ways to mitigate these impacts. In some instances, intakes can be located in locations where there are fewer fish. In other instances, intakes can be angled relative to river flows, so as to deflect rather than impinge fish. Additionally, velocities across the intake screens can be designed to be so low as to allow fish to swim away. Lastly, new technologies are being pursued to further minimize the impacts on a fishery.

Against these potentials problems, once cooling systems offer two large advantages, relative to closed cycle systems. They minimize consumptive (evaporative) losses and they make power plants more energy efficient. Consumptive (evaporative) losses are minimized because about half the heat dissipated to the environment from such systems is dissipated by convection and less by evaporation. The energy efficiency of the plant is increased because large amounts of power are not needed to operate cooling towers and the condensers operate more efficiently at the lower temperature ranges associated with once through cooling.

Closed cycle cooling systems have been installed where cooling water availability was limited or thermal discharge limits were an issue. Also, closed cycle systems may be installed on water bodies where fish friendly intakes for a once through cooling system are too costly to install or locate.

Future Regulations will Influence Designs and Implementation Schedules

Section 316(b) of the Clean Water Act requires electric generating facilities to minimize adverse environmental impact to fish and shell fish from cooling water intakes. The EPA is in the process of promulgating new guidelines for the use of cooling water at power plants. These new guidelines, once written, will be used by states to determine whether existing cooling systems need to be retrofitted. Previous EPA guidance on 316(b) compliance embodied the concept of a “baseline year.” Previous EPA guidance also contained the concept that a redesign of a cooling system needed to consider achieving a certain percentage reduction in fish losses. Any new EPA rule is quite likely to consider the same concepts and only credit intake modifications done after a “baseline year.”

It is imperative that each power plant's goals for the water conservation program be harmonized with the goals of the 316 program to reduce fish losses. Water conservation goals, as stated earlier, are to reduce either water use or water consumption (i.e. water evaporation). It is also imperative that any modification to a cooling system, required by a state or federal agency, be consistent with both programs, and that it receives credit under both programs. In moving forward with water conservation initiatives, the utility industry will be working with the state to assure that any new practices are recognized and credited under both programs.