Water Quality Management at the Consumers Energy Hydro Projects
Welcome and Introductions

Consumers Energy Representatives:

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Tonight’s Objective

  - 401 Certification
- Discuss Consumers Energy’s plans to fulfill those provisions
- Cover progress to date and future plans
- Answer your questions
FERC Water Quality Article

- Article 404 of the FERC licenses required filing of water quality limits plans for 11 hydros
  - Au Sable – 6 Hydros
  - Manistee – 2 Hydros
  - Muskegon – 3 Hydros
- These articles incorporate water quality standards included in the state issued - federal Clean Water Act 401 certificate
Consumers contracted with US Geological Survey (USGS) to install upstream and downstream continuous temperature and dissolved oxygen monitoring stations at the hydros.

- Capital cost for gauges was about $600,000 (1992 $s)
- Annual operating cost, currently about $250,000

Consumers also agreed to fund capital costs in the amount of $1.75 million (1992 $s).

- To study, plan, design and construct water quality enhancements for the 11 dams.
Article 404 Studies

- Consumers developed study plans for the Au Sable, Manistee, Muskegon hydros
  - Consulted with Resource Agencies (MDNR, USFS, USF&WS) and Michigan Hydro Relicensing Coalition (MHRC)
  - Plans were designed to evaluate water temperature and dissolved oxygen
- Consumers filed the plans with FERC in January 1995
  - FERC approved those plans in February 1995
Approved Study Plans

- Collect three years of temperature / D O data
- Evaluate the data to determine if the water quality limits are being attained
- Evaluate potential enhancement techniques
- Issuing two two-part study reports
  - Water Quality Limits Evaluation
  - Water Quality Enhancements Evaluation
- Consult with the Agencies / MHRC on the results
- Implement reasonable and prudent enhancements
Study Completion

- Following review and consultation of draft reports with the Agencies / MHRC, the Manistee and Au Sable Reports were filed with FERC June 2002.

- The Muskegon Report was filed November 2006.
  - Delay in Muskegon filing due mostly to:
    - USGS instrument installation upstream of Rogers Dam was delayed until the Big Rapids Dam removal was completed.
    - Desire on Consumers’ part to include turbine venting tests conducted at Hardy for Dissolved Oxygen enhancement.
Manistee and Au Sable Results

- Dissolved Oxygen concentrations downstream of the Projects were generally very good
  - DO less than 7 mg/l license limit were occasionally seen
    - Typically they occurred at night and were of short duration
- Temperature limits were exceeded
  - Exceedences were infrequent when 401 certification exceptions were applied
  - They tended to occur in July / August and increased from upstream to downstream
- Profile data indicates that limited amounts of cooler water exists in the deeper parts of some ponds
  - The cooler water typically had lower DO concentrations
Resource Agencies / MHRC indicated that while they have concerns with the occasional low DO values, their primary concern is with the summer temperatures in the tailwaters.

They recommended water temperature enhancement measures be evaluated for Hodenpyl and Tippy on the Manistee, and for Mio and Alcona on the Au Sable.

- These projects each have major downstream river segments, as opposed to impoundments immediately downstream.
Manistee and Au Sable Projects of Interest

Hodenpyl

Tippy

Mio

Alcona
Manistee and Au Sable Water Quality Mitigation

- Consumers and Agencies did not agree on the potential for successful temperature mitigation.
- To help resolve the issues, Consumers and the Agencies developed a proposal to further evaluate water temperature enhancement at Hodenpyl.
  - Hodenpyl was selected because it is the deepest of the four reservoirs with the greatest cold water potential.
  - The evaluation was to be conducted by developing a computer model of the Hodenpyl Pond based on the US Army Corps of Engineers CE-QUAL-W2 computer model.
  - The proposal was submitted to the FERC in September 2002 and approved in January 2003.
Hodenpyl CE-QUAL-W2 Model

- Data collection from April to October 2003
  - Continuous pond & discharge
    - Temperature
    - Dissolved oxygen
  - Periodic chemical and biological samples
  - On-site weather data
    - Wind
    - Temperature
    - Solar

- Hodenpyl Pond Bathymetry (bottom contours)
- Estimates of leakage through plant spill tubes
- Project run-of-river operational data
Model Calibration

- Calibrating the model is critical
  - The model results must match the actual field data collected under a given set of weather conditions
  - Otherwise you can’t be confident in the model’s projections

- Initial model results were reviewed in June 2004 by Consumers and the Agencies / MHRC
  - Concluded that the colder ground water contribution to the reservoir was not adequately accounted for in the model
  - MDNR and USFS representatives undertook a tributary assessment to estimate surface water contribution
    - These input volumes were then used to calculate groundwater input
  - Investigation into how to redistribute the groundwater and surface water inputs to the model was initiated
Meetings were held in late 2005 and early 2006 to review options for how to treat groundwater inputs in the model.

- Determined that groundwater is equal to about 75% of the flow difference between the USGS gauges at Sherman (near M-37) and Mesick (below the plant).

Final calibrations of the model proceeded on that basis.
The Spill Gate Problem

- Leakage of 375 cfs through the 6-spill gates
  - 168,000 gallons per minute
  - >24 million gallons per day
- The leakage drew cooler water continuously
  - Depleted cold water supply in spring and early summer when it wasn’t needed for outflow temperature enhancement
- The leakage needed to be controlled in order to manage the cold water supply

Hodenpyl has six submerged spill gates that lead to under-plant spill tubes
Spill Gate Replacement

- Consumers undertook a $1 million project in 2006 to replace the gates
- Spill gates 4, 5 and 6 for Unit #2 were completed November 2006
- Work to replace spill gates 1, 2 and 3 for Unit #1 is now in progress
- Modeling has proceeded assuming no spill gate leakage

Workers install one of the six new spill gates at Hodenpyl
Demonstration Modeling Run
Hodenpyl Model Runs

- Results indicate that about a 1°C (1.8°F) temperature relief might be achievable in outflow at specific times.
- A “mini-group” involving Consumers, the Water Quality / Modeling contractor and a Resource Agency liaison was formed to continue evaluation and develop a “cold water management strategy.”
- Based on the modeling results, an upwelling system has been designed for field testing in summer 2007.
Hodenpyl Upwelling System

- Fabrication, installation & testing scheduled to begin June 18, 2007
- Test results will be factored back into CE-QUAL-W2 model in order to better define the overall effects of upwelling
- Additional testing in late summer 2007
- Goal is to develop an operational strategy that optimizes the upwelling system
System consists of an air compressor, air supply pipe and an underwater diffuser
Hodenpyl Upwelling System

System consists of an air compressor, air supply pipe and an underwater diffuser.
Muskegon River Water Quality

- Limits evaluation indicated that:
  - Due to its deep intake, the Hardy outflow is cooler than the upstream Rogers outflow throughout the summer
  - Croton does not meet temperature and dissolved oxygen limits during the mid-summer period
  - Likewise, Hardy does not meet dissolved oxygen limits during the mid-summer period

- Mitigation Plan approved by FERC (April 2007) follows the Hodenpyl path of evaluating potential enhancements using the CE-QUAL-W2 model

- Lessons learned on Hodenpyl model will speed up Muskegon modeling
Consumers decided in January 2006 to proceed with data collection for the modeling even though FERC approval of the Mitigation Plan was still pending.

- Data collection was performed during summer 2006
- Hardy and Croton Ponds were included

**Water quality data**
- Continuous temperature and dissolved oxygen
- Periodic chemical and biological samples

**Weather data was also obtained**

**A tributary assessment was performed**
- Over 40 potential tributaries were identified

**Hardy inlet flow distribution was identified**

**Existing bathymetry (bottom contours)**
Dissolved Oxygen at Hardy

- Hardy’s deep intake provides cooler water throughout the summer, but that deeper water is lower in dissolved oxygen concentrations, causing lower DO outflows.
- Turbine venting to address DO at Hardy may help DO at Croton also.
Turbine Venting

- Summer of 2005 feasibility test conducted
  - DO uptake was favorable
- Consultant recommended installing baffles on the turbine to increase air induction and mixing
  - Baffles installed January 2006
- A turbine upgrade is also being investigated for Hardy
  - May be able to combine increased power output and better venting capability
Hardy Turbine Testing

- Turbine runner baffles field tested in late August 2006
- Air inducted through the 4” vacuum breaker lines with a control valve
- Outflow DO was then measured with the valve closed and then open at wicket gate settings from 40% through about 100%
- Venting decreased power output by about 0.5 MW
Hardy Test Results

- Enhancement ranged from 0.9 to 0.3 mg/l depending on gate setting
- Enhancement occurred at all gate settings tested
- At 80% gate (typical operation) enhancement was about 0.45 mg/l, DO increased from 4.65 to 5.1 mg/l (standard is 5.0 mg/l)
- At the USGS gage a short way downstream, DO generally increased up to 1.5 mg/l
Muskegon River Water Quality

- Data being incorporated in CE-QUAL-W2 for Hardy-Croton model
- Modeling will take place during 2007
  - Results to be filed with the FERC by December 31, 2007
  - Field testing of any temperature enhancement measures is expected in 2008
- Hardy turbine upgrade is being designed
  - Pending FERC approval, Consumers expects to proceed with the installation in 2008, with a design that improves power output (unit efficiency) accommodates more effective turbine venting
CE-QUAL-W2 modeling is also being pursued for the Au Sable plants.

Mio Pond will be the initial focus of the modeling.

Data collection similar to Hodenpyl and Croton-Hardy began June 1.
Consumers and the Agencies / MHRC have been working together to resolve the water quality issues for the Au Sable, Manistee and Muskegon hydros.

The CE-QUAL-W2 modeling process has been more time consuming than originally envisioned.

The Hodenpyl evaluation has resulted in testing of a potential temperature enhancement.

Lessons learned from the Hodenpyl modeling should speed up the Croton-Hardy modeling process.

Dissolved oxygen enhancement progress at Hardy is ongoing with the new turbine installation plans.