Water Quality Management at the Consumers Energy Hydro Projects

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Welcome and Introductions

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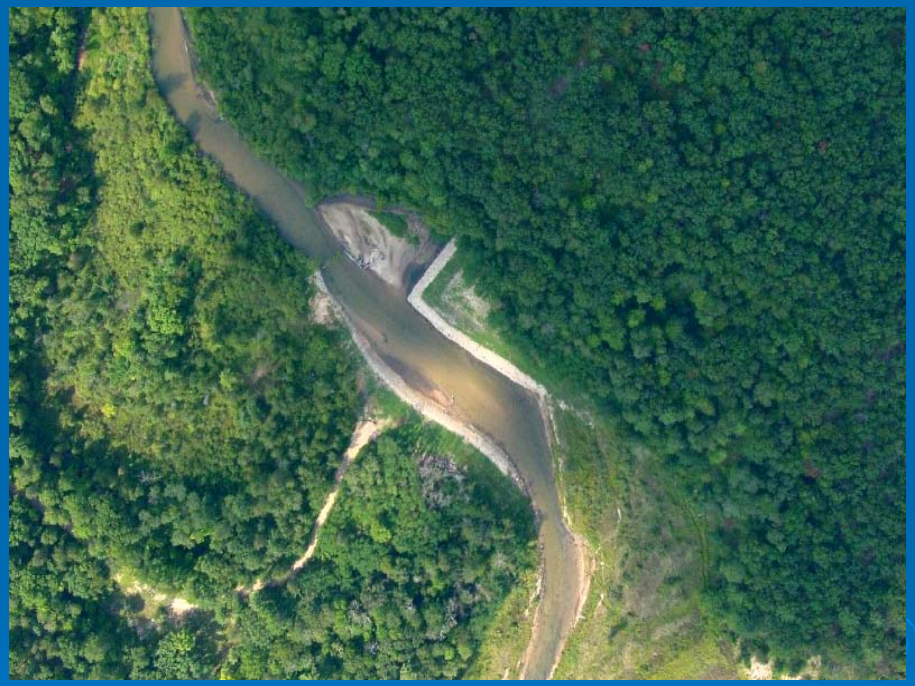
Tonight's Objective

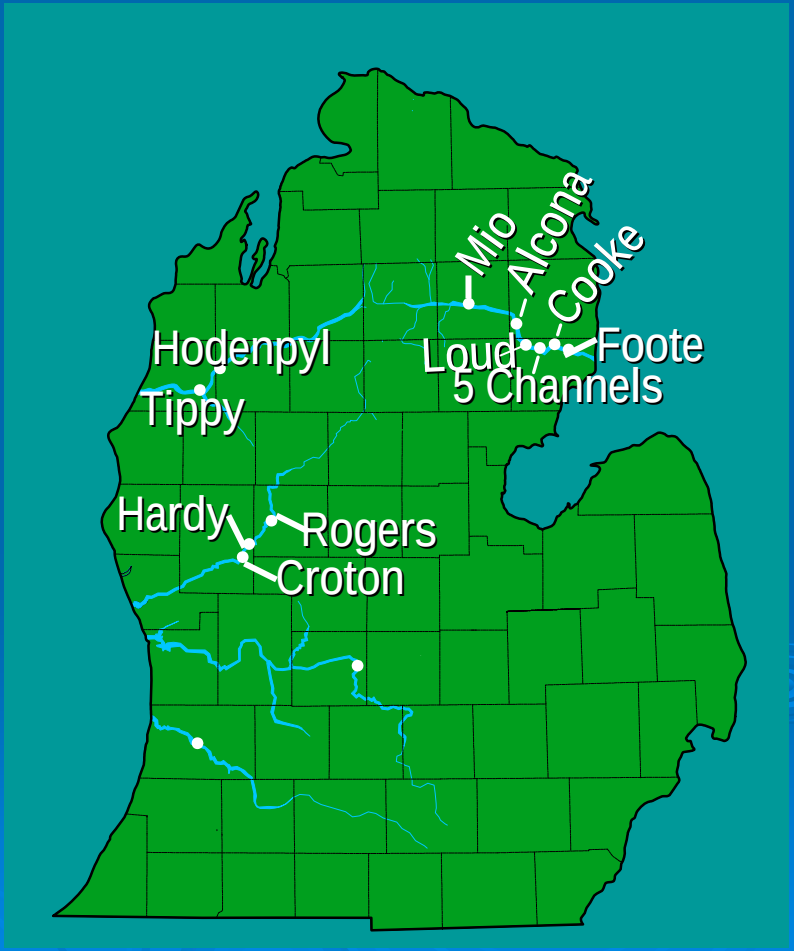
- Review Federal Energy Regulatory Commission (FERC) Water Quality license provisions
  - 401 Certification
- Discuss Consumers Energy's plans to fulfill those provisions
- Cover progress to date and future plans
- Answer your questions



Former Stronach Dam site
Pine River Arm – Tippy Pond

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



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Article 404 Funding Provisions

- 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

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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

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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

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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

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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

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Independent Agency Review

- 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

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Manistee and Au Sable
Projects of Interest

Hodenpyl

Tippy

Mio

Alcona

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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

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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

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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

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Model Calibration

- 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

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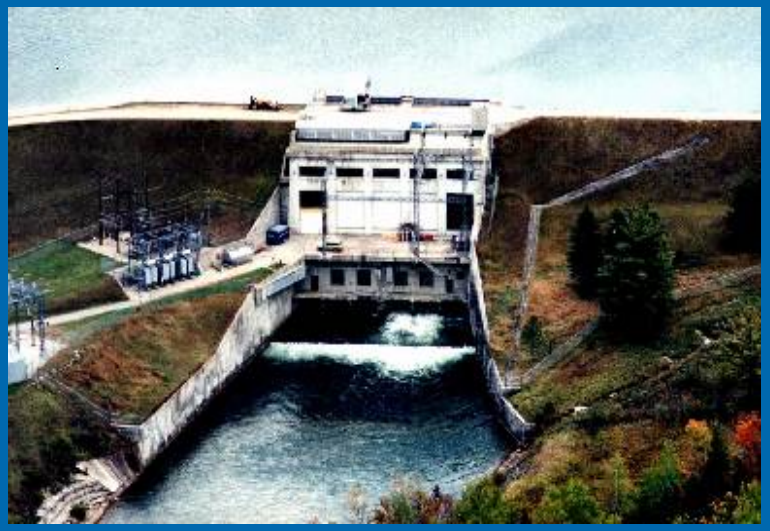
The Spill Gate Problem



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

- 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

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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

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Demonstration Modeling Run

Hodenpyl Model Runs

- Results indicate that about a 1°C (1.8^{o}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

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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

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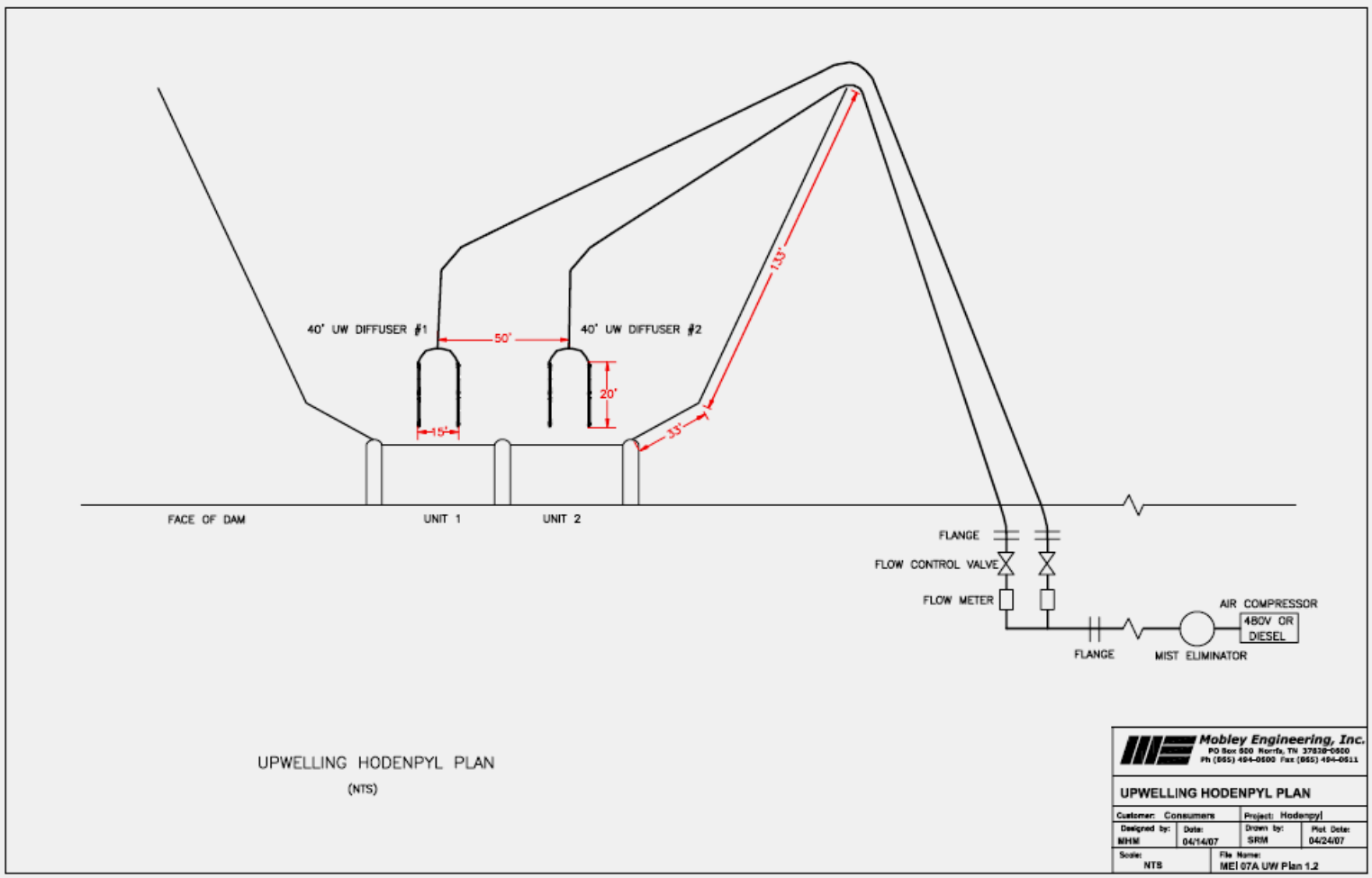
Hodenpyl Upwelling System



System consists of an air compressor, air supply pipe and an underwater diffuser

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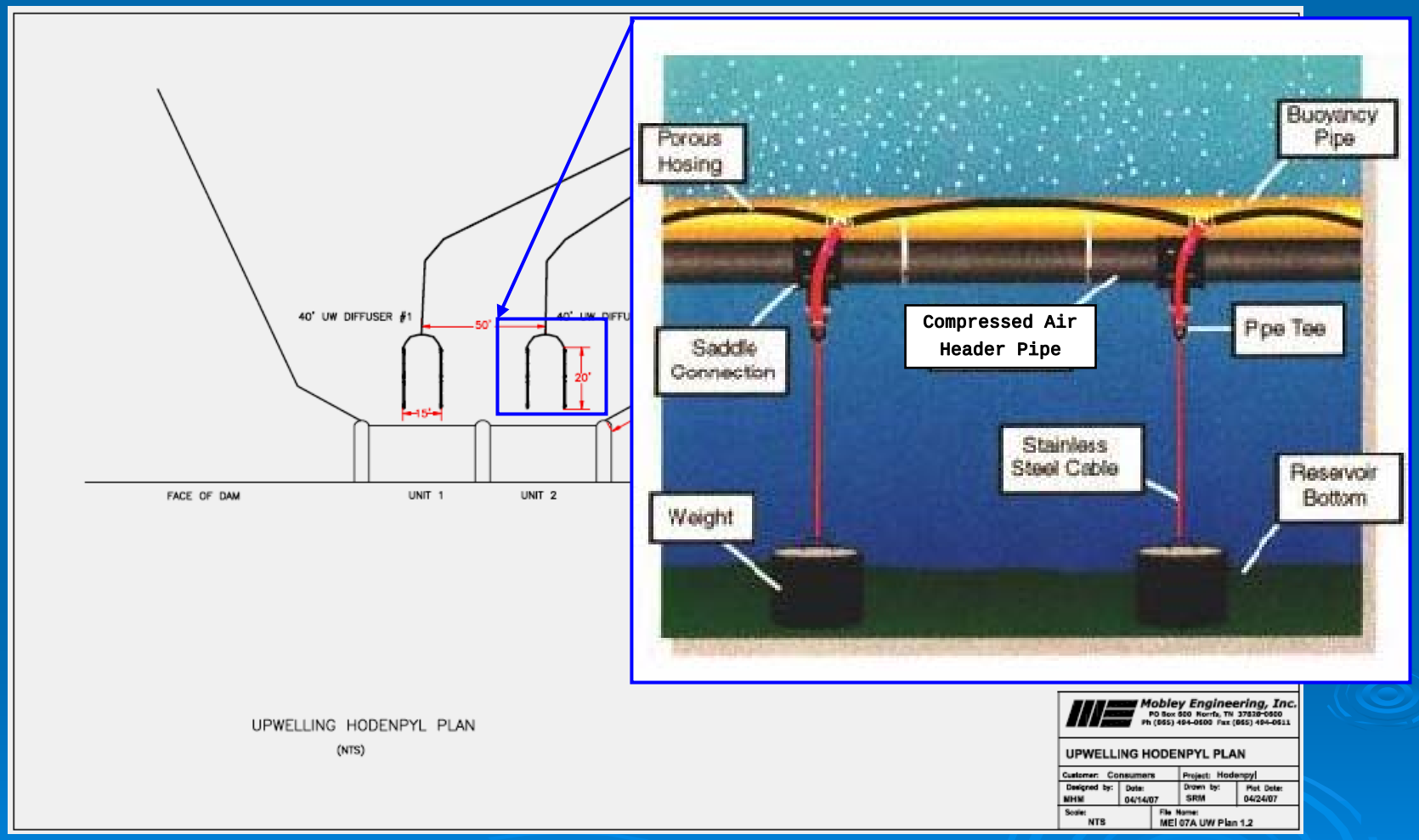
Hodenpyl Upwelling System



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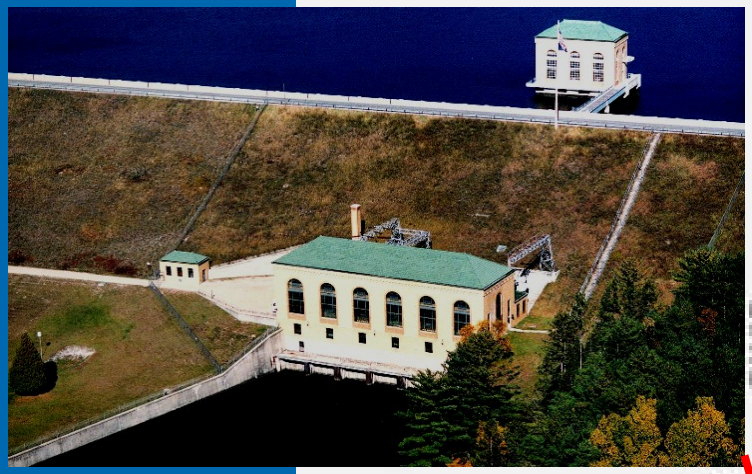
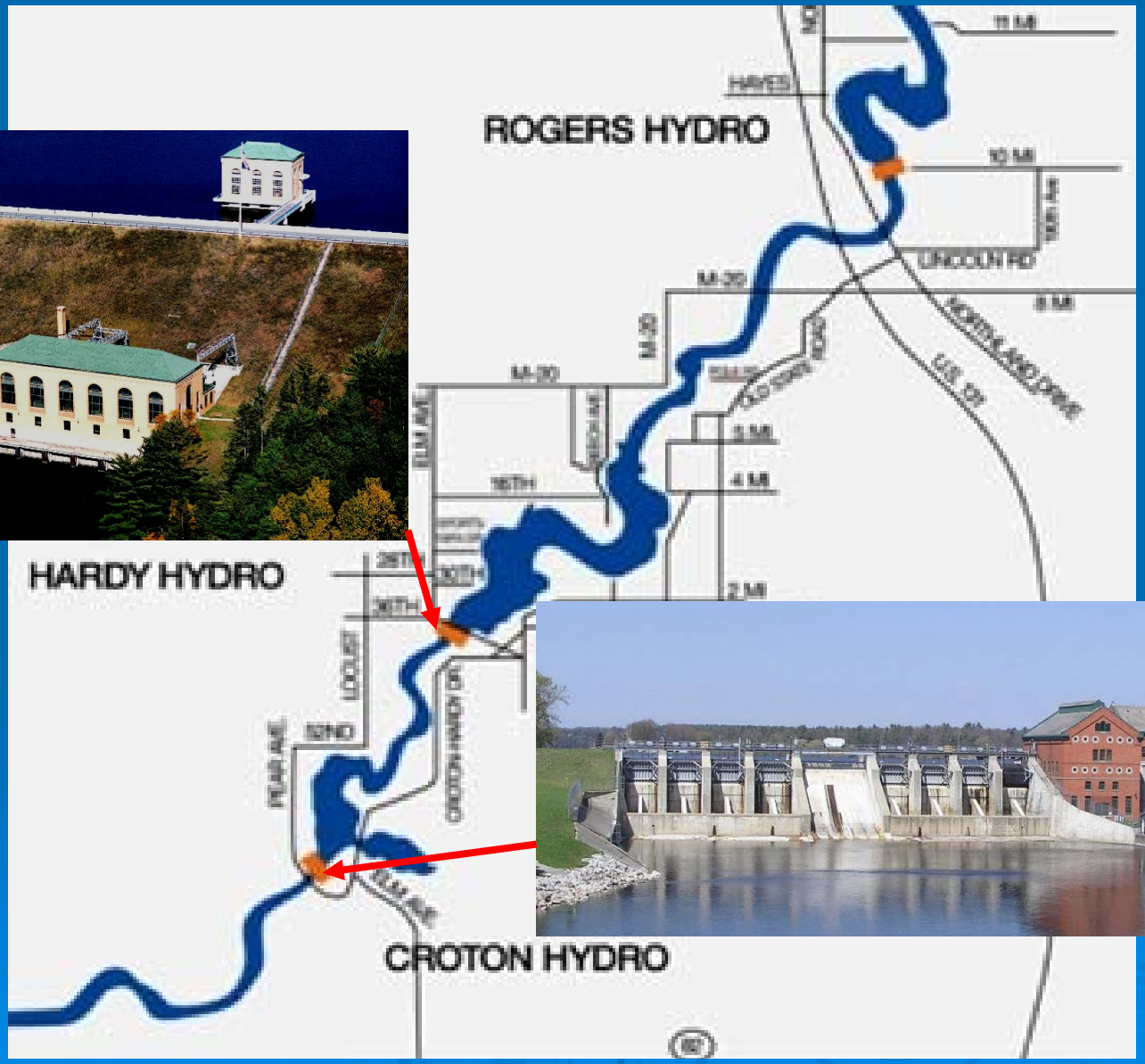
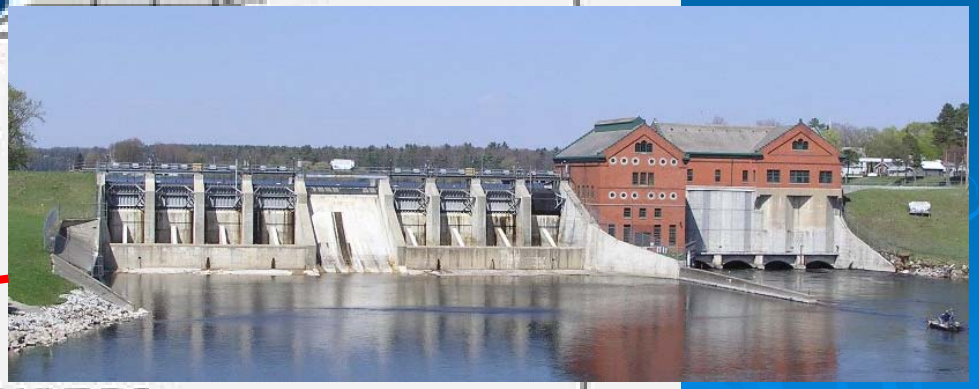
Muskegon River Projects







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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

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Muskegon River Water Quality

- 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)

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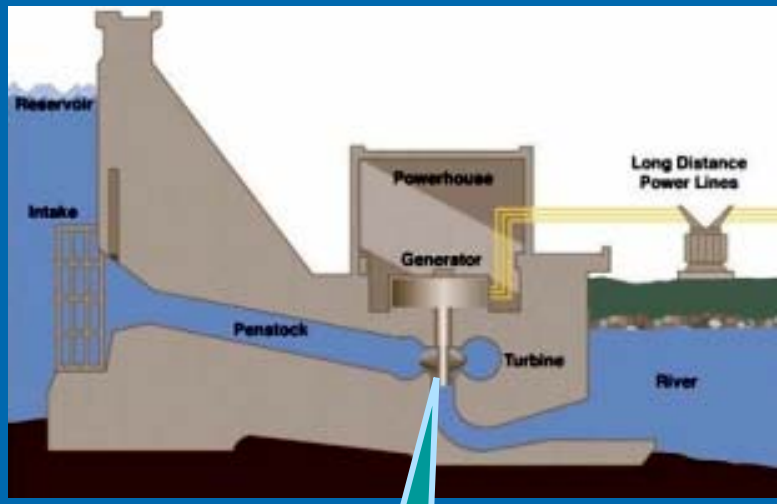
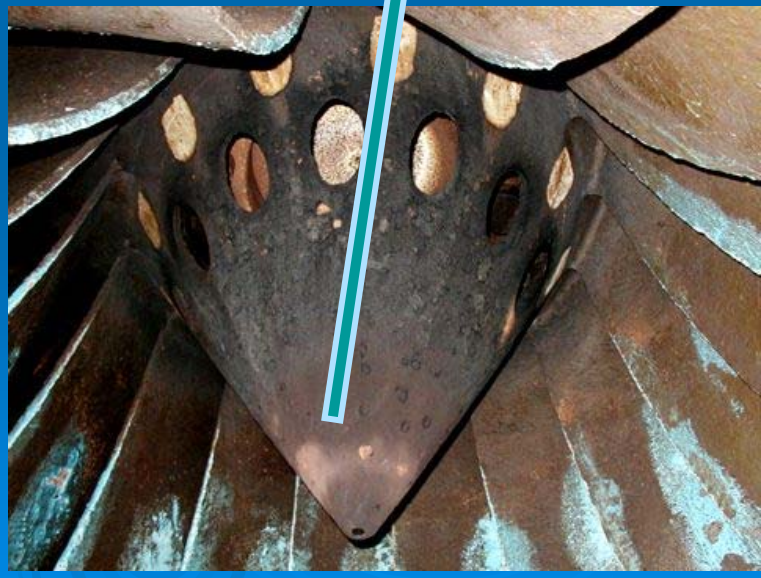
Dissolved Oxygen at Hardy

- 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





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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

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Hardy Test Results

Increased aeration from the turbine venting was visible in the tailwater

- 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

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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

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Au Sable River Water Quality

- 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

Summary

- 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

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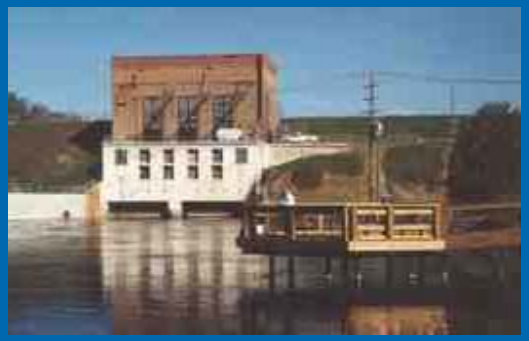

Thank You

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Hydro Generation