Michigan Department of Natural Resources
Recommended Review Criteria
And Study Guidance
For the Federal Energy Regulatory Commission
Licensing Process
2001

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MICHIGAN DEPARTMENT OF NATURAL RESOURCES RECOMMENDED
REVIEW CRITERIA AND STUDY GUIDANCE
FOR THE FEDERAL ENERGY REGULATORY COMMISSION LICENSING PROCESS
August 9, 2001

The following are Michigan Department of Natural Resources (MDNR) review criteria, data needs and study guidelines for the Federal Energy Regulatory Commission (FERC) licensing process. These guidelines are intended to facilitate the FERC licensing and re-licensing process by informing licensees of MDNR positions and by detailing studies that will fulfill and facilitate this process. These criteria and study guidelines are not binding on the applicant and are intended to be used in conjunction with applicable FERC licensing statutes, rules and regulations. These criteria and guidelines were developed in 1986, and revised in 1988, 1989, 1990, 1991, 1992, 1994, 1996, 1998, and 2001.

MDNR Positions

1) Plant Operation

A) Daily Operation

i) Facilities with Riverine Tailwaters - We will recommend to FERC that the project(s) be operated as a run-of-river project (instantaneous inflow equals instantaneous outflow). The project will be limited to pond levels fluctuating $\leq$ 3" over the entire year.

ii) Facilities with Reservoir Tailwaters - We may recommend that FERC allow some minimal peaking operations with site-specific minimum flow and ramping rate requirements.

B) Operational Verification

We will recommend that data to verify the operation of the plant be provided and funded by the licensee. This will be accomplished using continuous gage stations on the reservoir to determine instantaneous headwater elevation, and continuous gage stations below the reservoir to determine instantaneous tailwater elevation. To provide independent data on project operation, we will recommend that the licensee fund the installation and maintenance of the appropriate number of USGS gages in the vicinity of the project. We may also recommend to FERC additional site-specific needs on a case by case basis.

2) Habitat

A) Comparative Aquatic Habitat Studies

We will recommend to FERC that all facilities with riverine tailwaters that choose not to operate their facilities as run-of-river operations conduct the following studies:

- Instream Flow Incremental Methodology (IFIM) studies on downstream river reaches for a comparative analysis of aquatic habitat under the proposed project operation(s) to Run-of-river project operation
- Habitat Evaluation Procedures (HEP) studies on the reservoir to compare reservoir habitat under the proposed project operation(s) to run-of-river project operation

These studies are to assure that the appropriate amount of data is collected for an analysis of all operating scenarios. However, we will recommend run-of-river operation to FERC in our final comments, at all facilities.

3) Fisheries

A) Fish Passage

We will recommend to FERC that appropriately designed, constructed, and operated fish passage facilities (for anadromous or other migratory fish species) be provided at all FERC projects. The recommendations for fish passage will consist either of fish passage facility construction and operation by the FERC licensee, or for dam removal. These recommendations will include time frames that may range from immediate to future implementation depending upon the management goals for the river system. MDNR may recommend that an escrow account be established to provide funds for the fish passage facility design and construction.

Fish passage is to be provided to: 1) regain access to spawning areas; 2) allow for the establishment of self-sustaining fish stocks; and 3) establish "special" fisheries of either state-wide or regional importance. In addition to upstream passage, downstream protection will be required at all projects.

B) Turbine and Spillway Entrainment and Mortality

We will recommend to FERC that the project be operated in a manner such that the entrainment and subsequent turbine and spillway mortality of fish will be minimized. To meet this request, the project can either immediately install protective devices to prevent entrainment and mortality or may decide to determine via studies the extent of the problem. The results of all studies and protective devices will be evaluated to determine minimum mitigation measures and effectiveness.

4) Wildlife

We will recommend to FERC that all projects maintain and enhance wildlife resources found on their lands and develop plans to implement wildlife management.

4) Recreation

We will recommend to FERC that all project lands be open to public access. Project lands shall include boat launching facilities on the reservoir, fishing access sites and related facilities on the tailwater area, a safe marked canoe portage around the dam, and other facilities which MDNR views as necessary to optimize recreation on the project. All facilities should conform to the Americans with Disabilities Act (ADA).

All new recreation facilities should be constructed and maintained by the project. If public recreation facilities exist on the project, MDNR will recommend to FERC that the licensee provide maintenance funds or actual maintenance for those sites. If only private or leased facilities exist, MDNR will recommend to FERC that the licensee purchase the land and associated facilities. If this cannot be accomplished, MDNR will recommend that the licensee either purchase easements of lands or provide for free access to the project. The licensee always has the option to purchase and operate outright any recreational facility that is intends to use to satisfy FERC requirements. All recreational facilities used to meet FERC licensing requirements should be free of charge for public use.

6) Water Quality

Prior to development of a 401 water quality certification, we will recommend to FERC that flows for the facility, in addition to minimum flow, be maintained to alleviate any water quality problems that may be identified as having an adverse effect on restoring and maintaining productive aquatic resources.

The conditions that are established in the Section 401 certificate should govern the project operation in respect to water quality.

7) Mitigation Plan

We recommend to FERC that the project develop a mitigation plan to alleviate any adverse impacts and compensate for the loss of riverine habitat caused by plant operation. This plan should include a continuous

program of analyzing and monitoring all planning, construction, and operational activities with respect to adverse impacts on the river ecosystem. We will also recommend that the project implement all measures necessary to correct any harmful effects identified during this ongoing monitoring program as a result of the licensees constructing, rehabilitating, operating, and maintaining of the project.

Overview of Project Information and Impact Data Needs

1) Plant Operation and Engineering
   A) Present plant design of all facilities
   B) Daily operation and maintenance records
   D) Plant hydraulic characteristics

2) Fisheries (Aquatic) Habitat
- A) Hydrographic maps of the reservoir and the tailwater areas, to include 500 meters downstream of the project
- B) An aquatic habitat inventory, may include IFIM and HEP studies if required by the proposed project
- C) A determination of the impact of plant operation on habitat availability and quality

3) Fisheries Data
- A) Fisheries community inventory of the riverine and pond areas, to include endangered, threatened, and sensitive species
- B) The adequacy of the any existing fish passage facility
- C) The impact of plant operations on the existing fish passage structure
- D) If the project proposes to study the facility entrainment/mortality problem, a two-stage study plan should be used to examine the extent of the problem: 1) A reconnaissance study to determine the gross extent of facility entrainment and mortality, which should include turbines and spillways; and 2) If necessary, a more intensive study to keenly determine facility entrainment and mortality of fish. Our guidelines for these studies are attached.
- E) Aquatic habitat management plans should be included

4) Wildlife (Terrestrial) Habitat
- A) Terrestrial and wetland habitat inventory
- B) Determination of the impact of plant operation on habitat availability and quality
- C) Forest management plans of the project area
- D) Topographical maps which show all project lands

7) Wildlife
- A) Wildlife community inventory of the riverine and pond areas, including endangered/threatened and sensitive species
- B) Wildlife management plans in the project area, as determined by MDNR personnel

5) Recreation
- A) Inventory of recreational facilities in the project area, including written descriptions and maps/diagrams of locations, for MDNR evaluation of adequacy

6) Water Quality

A) All NPDES permits, Act 307, and Super Fund sites in the drainage basin should be identified
B) All water management models and plans should be detailed
C) The impact of the proposed project operation on water quality should be determined

Project Operation and Engineering Information

Project Design Information

1) The present plant design for all facilities should include the following details:
   A) Plant engineering designs
   B) Type, number, kW, blade number, RPM, and design of turbines
   C) Elevation, peripheral velocity, and diameter of the runners

D) Minimum and maximum blade clearance between runner and wicket gates for Francis Type Units, and runner and the ring for Kaplan Type Units
E) Cavitation at the plant
F) Project map which includes all lands, roads (including condition), and right of ways
G) An updated turbine output-water use and spillway/gate rating curves for all project components

Daily Operation and Maintenance Records

1) The present daily operation of facilities should include :
   A) kW
   B) Wicket gate openings
   C) Efficiency
   D) Hours of use of each unit
   E) Bypass gate openings for the previous and current year, as well as low, normal, and high water years
   F) Use mean, min and max daily data for kW, wicket gate openings, efficiency, each unit's hours of use and openings of bypass gates to calculate weekly mean values, and mean weekly min and max values.

2) A record for the last 5 years of plant outages and length of outages

3) Any plans for plant operation automation, construction, major maintenance, or plant retirement

4) An estimation of the longevity of the existing facilities including powerhouse(s), penstock(s), reservoir(s) capacity, dam(s)

5) All dam safety reports should be summarized and made available to MDNR.

Project Hydrology Information

1) The daily fluctuation in the tailwater, any by-passed side channels, and reservoir should be reported for the previous year as well as normal, high and low water years. This should be reported in terms of discharge and elevation using mean, minimum, and maximum daily data to calculate weekly mean values, and mean weekly minimum and maximum values.

2) Monthly flow duration curves should be estimated for the river "without" plant operation and "with" plant operation for the assessment of minimum flow needs.

3) The operational compliance plan for all project operating conditions needs to thorough and should include continuous (at least an hourly basis) monitoring water level gages in the reservoirs, headwater and tailwater areas. Specifications for all gaging equipment should be completely described and submitted along with the provisions to provide for both the establishment and maintenance of a new continuous monitoring USGS gage or the maintenance of one existing continuous monitoring USGS gaging at each operating facility of the project. Plans should also include procedures for calibration and maintenance of gages. All other site-specific needs as determined by MDNR should also be documented in the compliance plan.

Fisheries (Aquatic) Habitat Information

Study Area

1. To include all reservoirs and stream reaches (including tributaries) from one-quarter mile above the high water level of the uppermost reservoir on the system to the downstream site of no project influence, as defined as follows:

   A. Mainstem of the St. Joseph River- From a point one-quarter of a mile upstream of the normal high water mark of the Mottville Impoundment

downstream to the normal high water mark of the Elkhart Dam in Elkhart, Indiana on the St. Joseph River. If the project has acceptable data that indicates that project influence zone is less than the recommended zone, the zone may be adjusted to reflect these changes in influence zone boundary, after consultation with and concurrence from the MDNR.

Hydrographic Maps

1. Hydrographic maps of the reservoir, any de-watered river reach, and the tailwater areas (to include 500 meters downstream of the facility) are required of all sites with transects every 10 meters. If recent existing maps are available, data verification studies can be substituted for mapping with MDNR concurrence. Additional FERC study justification is in Appendix 1.

   Maps should delineate the following habitat inventory data:

   A. Reservoirs - Predominant substrate (as classified using the Modified Wentworth Scale) and emergent and submergent plant beds (classified by dominant plant species complex) should be mapped on the hydrographic maps at all water levels. Other structure items such as logs, log complexes, and rock piles should also be denoted on the reservoir map.

   B. Tailwater areas - Predominant substrate (as classified using the Modified Wentworth Scale) and emergent and submergent plant beds (classified by dominant plant species complex) should be mapped on the hydrographic maps at all water levels. Other structure items such as logs, log complexes, and rock piles should also be denoted on the tailwater map.

   C. Other Project Impacted River Reaches - Predominant substrate, aquatic vegetation, and approximate mean depths should be indicated on river maps for all water levels.

Aquatic Habitat Inventory

1. Comparative Riverine Habitat Studies - Comparative riverine habitat studies will be recommended at all sites with riverine tailwaters that will not be operated as run-of-river facilities and that have no by-passed river reaches. The objective of this study is to compare resource impacts of the proposed project operation(s) to run-of-river operations. IFIM studies will be recommended at all sites unless another methodology is accepted by the MDNR. Additional study justification is in Appendix 2.

   The following guidelines should be followed in development of an IFIM study plan:

A) The IFIM study plan will require close agency coordination on the following items:

i. Study Purpose

ii. Study Boundaries - The IFIM study boundaries should include all riverine tailwaters to the next lake or impoundment. In addition, we recommend that a pre-study be conducted determine the extent of downstream water fluctuations from each hydroelectric facility operations. This will be used to delineate modeling boundaries on the river.

iii. Time Constraints –on dates for critical decisions and field studies.

iv. Specific Study Objectives - Concurrence with MDNR needs to occur on the type of study and expected results. We suggest the following as an objective statement:

The objective of this study is to determine the optimal flow regime from the hydroelectric facility to protect and enhance the aquatic resources of the river system. The IFIM study should provide recommendations that, at a minimum, protect the instantaneous needs of the aquatic community and provide data on the habitat usability of the river system(s) under a number of alternative operational schemes, including the proposed peaking operation and the strict run-of-river (instantaneous inflow equals instantaneous outflow) modes.

v. Target Species - We need to discuss the target species desired and come to an agreement on those species.

vi. Methodology - After agreeing upon the target species, we need to determine what habitat suitability criteria are available, which curves will be used, if any modifications are needed, and what data is needed. Decisions will also need to be made jointly on which models will be used in the study. We recommend that the attached two-flow analysis guidelines be followed to examine peaking impacts (Appendix 3).

vii. Hydrologic Baseline - After compilation of all available data on the river system, we need to jointly discuss and determine the "base" hydrologic conditions for present conditions.

viii. Stream Segmentation and Study Area Selection - We need to scope the river system and determine the logical study boundaries for each segment from a macro and microhabitat perspective. We need to

determine and agree where microhabitat and macrohabitat measures are to be taken.

B) We recommend that the IFIM scoping document be organized in the following manner:

i. Introduction - To include:
- Purpose of the study
- Study objectives
- Existing management objectives for each section of river
- Important background data
- Existing flow agreements

ii. Study Plan - To include:
- general approach
- Study area and reaches with detailed maps and reasoning

iii. Study Tasks - To include:
- Study area reconnaissance and macrohabitat segmentation
- Habitat characterization and reach selections
- Hydraulic data acquisition (includes transect selection and placement procedures with maps, candidate transect location, measurement methods and materials which include target measurement discharges, anticipated logistics and field activities schedule, acquisition and handling of field data)
- Hydraulic modeling approach (includes microhabitat simulations, evaluation species/life species and suitability criteria, models used and two flow analysis technique)
- Data analysis and reporting (includes model output composites and report preparation)

iv. Study Schedule

v. Study Plan Agreement

2. Comparative Reservoir Level Fluctuation Studies - Comparative Reservoir level fluctuation and habitat studies will be recommended at all sites that are not to be operated as run-of-river facilities. The study objective is to compare resource impacts of the proposed project operation(s) to run-of-river operations. Habitat Evaluation Procedures (HEP) methodology, to predict changes in fish community structure based on habitat changes, will be recommended at all sites unless another methodology is accepted by the MDNR. Additional justification is attached as Appendix 2.

3. By-passed River Channel Minimum Flow Studies - On all projects that have by-passed river channels, we recommend that minimum flow studies be conducted on all by-passed river channels. IFIM studies will be recommended at all sites unless another methodology is accepted by the MDNR. Additional justification is attached as Appendix 2.

4. All aquatic habitat management plans should be identified

Fisheries

Aquatic Species Inventory

1. For all aquatic species, subdivide the systems by reservoirs and streams. Identify the relative abundance and species composition of each system using all available data sources which should include MDNR Fisheries, Michigan Department of Environmental Quality (MDEQ) Surface Water Quality Division, U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency, Scientific Publications, and Universities. If acceptable survey data is unavailable, the necessary surveys will be conducted according to MDNR standards.

Threatened, Endangered, and Sensitive Species

1. Species to include all Federally listed, proposed, candidate, endangered, or threatened species. The list should also include Federal species of

management concern, State-listed endangered or threatened species, and State species of special concern

Attached are lists of these species for the State of Michigan and a list of threatened/endangered/sensitive species found in each county

2. For all species, determine whether they are present and map their location if possible. If existing surveys are unavailable, new surveys should be conducted according to MDNR standards. Surveys should be limited to identifying those species likely to occur within the available habitat types.

Upstream Fish Passage Device Inventory and Guidelines

1. All currently installed fish passage devices, both upstream and downstream, should be documented with operational designs included.

2. The current use of all upstream and downstream fish passage facility should be described and include the fish species and number using the facility for all years that data are available.

3. The current project impact on any upstream or downstream fish passage facility should be documented. Additional studies on the adequacy of the facility may be required on a site-specific basis.

4. Fish passage designs, which should include upstream and downstream passage as well as prevention of turbine entrainment, will be recommended at some facilities as elected by MDNR. All passage designs should be developed using the fish species of interest as determined by MDNR.

Downstream Fish Passage Guidelines

1. We will recommend to FERC that plant operation minimize entrainment and subsequent turbine and spillway mortality of fish. The project can either immediately install protective devices to prevent entrainment and mortality or decide to determine entrainment and mortality via studies. We will recommend that all protective devices be evaluated for their effectiveness along with minimum mitigation for any fish losses.

2. We recommend that the any turbine entrainment and mortality study follow the attached MDNR guidelines (Appendix 4). Additional justification for this study is provided in Appendix 5.

Wildlife (Terrestrial) Habitat Information

Study Area

1. For terrestrial species and associated habitat, include all lands within the project boundaries and influence zone.

2. For wetland and aquatic species, include reservoirs and stream reaches from one-quarter mile above the high water level of the uppermost reservoir on the system to the downstream site of no project influence, as defined as follows:

    A. Mainstem of the St. Joseph River - From a point one-quarter of a mile upstream of the normal high water mark of the Mottville Impoundment downstream to the normal high water mark on the Mottvile Dam at Elkhart, Indiana on the St. Joseph River. If the project has acceptable data that indicates that project influence zone is less than the recommended zone, the zone may be adjusted to reflect these changes in influence zone boundary, after consultation with and concurrence from the MDNR.

3) For fish-eating birds including, but not limited to bald eagles, ospreys, herons, and other colonial nesting birds, incorporate an area of one mile on either side of the stream reaches and reservoirs defined under item 2.A.

Terrestrial Habitat Inventory

1. Collect and map terrestrial habitat data using MDNR approved classification systems. Provide percentage and acreage of each habitat type in the application

2. Collect and map wetland habitat data using USFWS mapping system (Cowardin et al.). Provide percentage and acreage of each wetland type in the application

2. Identify all forest management plans and terrestrial management plans

Shoreline Management Plan

1. Create a detailed shoreline management plan for licensee-owned lands and easements abutting project waters (within 1000 feet of the high water elevation for lakes and within 300 feet of the high water elevation for streams) that are determined to be needed for project-related purposes, such as providing public access for recreation or protecting sensitive, unique, or scenic areas. The plan shall include, but need not be limited to:

   (1) a description of those lands covered by the plan including a drawing or map showing their location relative to project facilities or project waters (those lands shall be included within the project boundary);

   (2) for each parcel of shoreline covered by the plan, a description of how the land will be managed and used;

   (3) a critical habitat inventory of the shoreline;

   (4) development of strategies and methods to educate property owners and reservoir users about the beneficial values of shoreline vegetation and shallow water habitats;

   (5) a discussion of how the plan addresses the following considerations: selection of lands that are largely undisturbed and free from any observable past alterations that may have impaired their ability to provide the necessary protection and enhancement of wildlife and plant species; selection of additional lands to provide additional buffering capacity against adjacent land disturbances in ecologically

sensitive areas; and selection of lands that would protect existing upper-canopy trees and their suitability for raptor use;

(6) development standards which include a setback of 200 feet from ordinary high water mark for all structures except piers, boat hoists, and boathouses; shoreline vegetation removal in the 35 foot strip adjacent to the ordinary high water mark will be limited; no more than 30 feet in any 100 feet may be clear cut (clear cut zone is limited to 10 feet in width); only 30% of the vegetation between 35 and 75 feet of the ordinary high water mark may be removed; and require that land uses be screened as viewed from the water and that the scenic beauty of the shoreline be maintained

(7) an implementation schedule.

The licensee shall prepare the plan after consultation with the Michigan Department of Natural Resources (MDNR), the U.S. Fish and Wildlife Service (USFWS), and the Wisconsin Department of Natural Resources (WDNR) and U.S. Forest Service (USFS) where applicable.

Wildlife

Wildlife Species Inventory

1. For wetland and aquatic species, subdivide the reservoirs and stream reaches into segments. Identify the relative abundance (common, uncommon, absent) of species in each area. Species should include water birds (seasonal designations will be needed for migratory use), marsh birds and the following mammals: otter, mink, muskrat and beaver. In particular, efforts should be made to determine the number of furbearers, water birds, and marsh birds breeding in the project influence zone and the nest or den locations. All existing data bases maintained by MDNR, WDNR (where applicable), USFWS, EPA, Michigan Breeding Bird Atlas, and universities should be examined and data compiled for this section. If no surveys exist, then field surveys should be conducted according to MDNR standards.

2. The following information may be recommended to evaluate timber management or other changes proposed to terrestrial habitat depending upon the project characteristics:

   a) The relative abundance of the following management indicator species: black throated green warbler, chestnut-sided warbler, eastern bluebird, pileated woodpecker, ruffed grouse, and white-tailed deer

b) The relative abundance of owls and raptors not previously identified as threatened or sensitive

Threatened, Endangered and Sensitive Species

1. Species to include all Federally listed, proposed, candidate, endangered, or threatened species. The list should also include Federal species of management concern, State-listed endangered or threatened species, and State species of special concern

   Attached are lists of these species for the State of Michigan and a list of threatened/endangered/sensitive species found in each county

2. For all species, determine whether they are present and map their location if possible. If existing surveys are unavailable, new surveys should be conducted during the reproductive season (e.g., nesting, flowering) appropriate to each species. Surveys should be limited to identifying those species likely to occur within the available habitat types.

Bald Eagle Information

1. Map both active and inactive nest sites

2. Identify available habitat (described as relatively undisturbed areas with super-canopy trees)

3. Identify potential habitat areas within project boundaries, this will include areas where timber management could be used to develop appropriate habitat

4. Conduct a winter survey to determine over-wintering use and roost sites

5. Conduct a nest watch program during breeding seasons on at least two active nest sites per river system in order to determine the following information:
   - Extent of human disturbance to nest (identified by distance to nest site)
   - Food base (species and relative abundance)
   - Foraging locations on the reservoir or river systems
   - Roost sites, especially those used for foraging

6. For all other nest sites, including inactive nests, determine the extent of human disturbance by analyzing distances to roads, trails, rights of way, and other human activities

Recreation Information

Study Area

1. To include all reservoirs and stream reaches (including tributaries) from one-quarter mile above the high water level of the uppermost reservoir on the system to the downstream site of no project influence, as defined as follows:

   A. Mainstem of the St. Joseph River- From a point one-quarter of a mile upstream of the normal high water mark of the Mottville Impoundment downstream to the normal high water mark of the Elkhart Dam in Elkhart, Indiana on the St. Joseph River. If the project has acceptable data that indicates that project influence zone is less than the recommended zone, the zone may be adjusted to reflect these changes in influence zone boundary, after consultation with and concurrence from the MDNR.

2. Project county areas for certain sections of the off-site inventory. The county(s) of interest for this project are as follows: Ionia County

Data Needs

1) For the above project area, the following information is needed for each recreation site (developed and undeveloped):

   a) Map location

b) Map key should indicate:
   1) Type of facility (see list below)
   2) Provider of facility (State, Company, Pvt.)
   3) Size of facility (area, capacity)
   4) Level of use (heavy, light)
   5) Condition of site

c) Summary table of facility type, condition, and provider

d) Non-company facilities in the project boundary and their relationship (if any) to the company

e) Commercial operators in the project boundary (e.g., liveries, bait shops, campgrounds serving the project area) and their name, location, size, etc.

2) A general description of relevant off-site recreation facilities within the county or counties where the project is located, along with a table of numerical totals of facilities and a description of major off site facilities. This description is for the purpose of examining overall recreational use, availability of similar recreational opportunities, and recreational experience demand of the facility influence zone.

3) Identify any recreation plans that the licensee has written for the project.

4) Identify and summarize all existing data on recreational resources in the project influence area. Data sources include MDNR, Wisconsin Department of Natural Resources (WDNR) where applicable, U.S. Fish and Wildlife Service (USFWS), U.S. Environmental Protection Agency (EPA), local governments, and universities.

5) A study will need to be conducted to determine the present and future use of all recreation facilities.

<u>Recreation Facility Type Categories</u>
Shore fishing site
Fishing dock or pier
Boat launch with ramp
Carry-in small boat access
Canoe portage
Beach for swimming or sunbathing
Trail (ORV, hiking, horse, fishing, other)
ORV/snowmobile area
Picnic sites

Campsites
Playgrounds
General use site (use for a variety of purposes)
Support facilities (rest rooms, fish cleaning stations etc.)
Other

APPENDIX 1. MDNR Justification for Mapping Studies

The following is the Michigan Department of Natural Resources (MDNR) justification for the recommended habitat mapping and hydrographic study at your facilities. This document fulfills the requirement of Subpart B, Section 16.8 (i)-(vi) of the recently adopted FERC rules governing resource agency recommendations for necessary studies and information relating to a recommendation for the comparative habitat study.

Data Recommended For Analysis of Issue by MDNR

1. Provide quantitative data that documents the extent of each habitat type in the tailwater and the reservoir. If the above information is not available, then the applicant should arrange to collect the information.

Determination Basis of Resource Issue

Hydropower operations impact our water resources by: 1) altering normal stream flows for generating purposes; 2) de-watering river channels by diversion or peaking operations; and 3) fluctuating reservoir levels for either peaking operations or for storage purposes. All of the above project could be found at your project. The impacts of hydro operations that potentially could exist at your facility include the flushing of riverine reaches by generating with flood flows during the peak power periods and de-watering of riverine reaches at other periods. The de-watering of riverine habitat reduces the algae and aquatic plant life which are important as food for aquatic insects and which provide important fish nursery areas. Further, it reduces fish growth and survival by reducing available habitat and stranding fish, and changes the benthic invertebrate community to smaller, less useful, fish foods. The fluctuations cause

downstream erosion and sedimentation that destroys fish habitat and can disrupt fish migratory patterns. In addition, hydro operations cause reservoir fluctuations that de-water and disrupt fisheries habitat, which could be up to 3 foot on a daily basis, in the same fashion as the tailwater habitats.

MDNR needs quantitative habitat data to examine the severity and extent of habitat loss under any proposed operational mode. Without a baseline map of depth contours and habitat types in the impoundments and tailwaters, it is impossible for our agency to determine the impacts of the present or proposed operational modes. These maps will provide the background data for recommendations on operations at the projects that will adequately protect this river system.

Fisheries Goals and Objectives

MDNR's overall aquatic habitat protection goal is:

> To minimize and mitigate the negative impacts of hydroelectric facilities by operating these projects in a fashion that offers aquatic resources and users near natural riverine and reservoir conditions, protects and maintains aquatic environments and fish communities and rehabilitates those now degraded.

1) Riverine tailwater facilities to be operated in a run-of-river mode

2) Reservoir tailwater facilities to be operated with minimal tailwater and headwater fluctuation

3) Bypassed and/or diverted river facilities to be operated in a manner which maintains healthy aquatic resources of the river

The St. Joseph River system is a significant coolwater fishery in Southern Michigan. The fisheries resource includes important populations of largemouth bass, smallmouth bass, northern pike, walleye, bluegills, yellow perch, black crappie, rock bass, channel catfish, suckers (including redhorse) and bullheads. The habitat availability could be limited by the operational mode of either the Mottville Project.

Our specific fisheries habitat goal at your facility is to protect and enhance the coolwater fish communities in the St. Joseph River and its tributaries by maximizing and stabilizing available aquatic habitat. In our agency's professional opinion, this is best accomplished by recommending run-of-river-operating conditions. Run-of-river is defined as instantaneous inflow to the project impoundment equals instantaneous outflow downstream of the project tailwater.

Study Methodology Appropriateness

The recommended study methodologies for predominant habitat types inventory and hydrographic maps of the impoundment and tailwater are essential. This baseline data will allow MDNR the opportunity to examine the impacts of water development and to recommend further study plans if necessary. This standard baseline information will also produce documentation of habitat types and depth contours that are needed to analyze the impacts of hydro projects.

Study Data Utilization

This study will provide initial data on the potential availability of fish habitat under a range of operating modes. This information will serve as qualifying data for our recommendations regarding IFIM and HEP study designs, if necessary. Ultimately, this data will allow for the determination of the operational mode under which the Mottville Project will best protect the aquatic environment.

Our goals of protection and enhancement of the coolwater fish community call for the prevention of resource damage from hydroelectric generation and the optimal long term maintenance of the St. Joseph River fish community by maximizing and stabilizing the amount of available aquatic habitat. These data would provide the necessary background data to make the appropriate project operation recommendations to protect aquatic habitat in this river system.

APPENDIX 2. MDNR Justification for Comparative Habitat Studies

For those projects that propose peaking operation, the following is the Michigan Department of Natural Resources (MDNR) justification for the recommended comparative habitat studies using Instream Flow Incremental Methodology (IFIM) and Habitat Evaluation Procedures (HEP). This explanation fulfills the requirement of Subpart B, Section 16.8 (i)-(vi) of the recently adopted FERC rules governing resource agency recommendations for necessary studies and information relating to a recommendation for the comparative habitat study.

Data Recommended For Analysis of Issue by MDNR

1. Provide quantitative data that documents habitat availability in the tailwater and the reservoir under the proposed operational mode, run-of-river, and other operational modes. If the above information is not available, then the applicant should arrange to collect the information.

Determination Basis of Resource Issue

At a minimum, hydropower operations impact our water resources by: 1) altering normal stream flows for generating purposes; 2) de-watering river channels by diversion or peaking operations; and 3) fluctuating reservoir levels for either peaking operations or for storage purposes. The impacts of peaking and semi-peaking operations include the flushing of riverine reaches by generating with flood flows during the peak power periods and de-watering of riverine reaches at other periods. The de-watering of riverine habitat reduces the algae and aquatic plant life that are important as food for aquatic insects and provide important fish nursery areas. Further, it reduces fish growth and survival by reducing available habitat, stranding fish, and changing the benthic invertebrate community to smaller, less useful, fish foods. The fluctuations cause downstream erosion and sedimentation that destroy fish habitat and can disrupt fish migratory patterns. In addition, peaking operations cause reservoir and tailwater fluctuations (up to 3 foot per day), resulting in de-watered and disrupted fisheries habitat.

The resource agencies have requested that all hydro projects operate in a run-of-river mode, defined as instantaneous inflow equals instantaneous outflow, with essentially no pond elevation fluctuation. If you decide to operate your project in a peaking mode, the MDNR will need quantitative habitat data to examine the severity and extent of habitat loss under the proposed operational mode of semi-peaking. Both IFIM and HEP allow for meaningful comparisons of operational strategies and will provide the background data for recommendations on the operation of Mottville Project that will adequately protect this river system.

Fisheries Goals and Objectives

The Michigan Department of Natural Resources' overall aquatic habitat protection goal is:

> To minimize and mitigate the negative impacts of hydroelectric facilities by operating these projects in a fashion that offers aquatic resources and users near natural riverine and reservoir conditions, protects and maintains aquatic environments and fish communities and rehabilitates those now degraded.

1) Riverine tailwater facilities to be operated in a run-of-river mode

2) Reservoir tailwater facilities to be operated with minimal tailwater and headwater fluctuation

3) Bypassed and/or diverted river facilities to be operated in a manner which maintains healthy aquatic resources of the river

The St. Joseph River is a significant inland river fishery in Southern Michigan. The fisheries resource includes important populations of largemouth bass, smallmouth bass, northern pike, walleye, bluegill, yellow perch, black crappie, rock bass, channel catfish, suckers (including redhorse) and bullheads. The present habitat availability would be limited by any proposed peaking operational mode at the Mottville Project.

Our specific fisheries habitat goal at your facility is to protect and enhance the coolwater fish community in the St. Joseph River and its tributaries by maximizing and stabilizing available aquatic habitat. This is best accomplished by recommending run-of-river-operating conditions. Run-of-river is defined as instantaneous inflow to the project impoundment equals instantaneous outflow downstream of the project tailwater

Study Methodology Appropriateness

The recommended study methodologies IFIM and HEP are commonly used techniques to examine the impacts of water development. Both methodologies will produce documentation on habitat availability under a range of operational strategies that are needed to analyze the impacts of these facilities.

Study Data Utilization

This study will provide data on the potential availability of fish habitat under a range of operating modes that will provide for meaningful comparisons of the options available to the resource agencies and the city. These data will provide the basis for our recommendations on which operation of the Mottville Project will best protect the aquatic environment.

Our goals of protection and enhancement of the coolwater fish community would be furthered by the prevention of resource damage from hydroelectric generation and provide for the optimal long term maintenance of the St. Joseph River fish community by maximizing and stabilizing the amount of available aquatic habitat. This study would provide the necessary data to make the appropriate project operation recommendations to protect aquatic habitat in this river system.

APPENDIX 3. MDNR IFIM Two Flow Analysis Guidelines October 1990

Introduction

Peaking operations cause impacts at both the low and high flow events. Low flow events mainly limit habitat by reducing both stream depth (de-watering habitat and stranding organisms) and water velocity. High flow events mainly limit habitat by increasing velocities beyond that used by organisms. The use of optimal flows from HABTAT and/or HABTAV for benthos and fish habitat only addresses low flow impacts, thus two flow analysis is needed to examine operational impacts at low and high flows. The following guidelines are for two-flow peaking analysis as discussed in Milhous et al. (1989).

Recommended Analytical Methodology

The intent in this type of study is to: 1) determine the actual peaking impact when movements ranges are known or to bracket the peaking impact when the actual movement ranges for species in question is unknown; and 2) compare the peaking operation to run-of-river conditions. Run-of-river should be simulated using the average daily discharge at peaking operations. The bracketing should be done by documenting the most conservative and liberal estimate of peaking impacts from both life stage (the movement question) and study area perspectives (independence of study reach question).

Two approaches to handle movement concerns for individual life stages should be used and are dependent upon whether the life stage or species was classified as a mobile or non-mobile. Non-mobile life stages and species are benthos, spawning and fry. Juvenile and adult life stages are should be classified as mobile. Recreational activities should also be classified as mobile. These approaches follow the procedures in Milhous et al. (1989) and communications with Milhous and Bartholow (personal communication, 1990). These approaches are described below:

Non-mobile species and life stages. Peaking impacts on non-mobile life stages should be determined using the HABEF program. This program uses output files from HABTAT or HABTAV and examines WUA for each cell at

both the generation and base flow. The lowest WUA of the two flows is then assigned to the cell for the summation of WUA for the reach. This approach assumes that no migration or movement occurs between cells, a realistic assumption for the non-mobile life stages and species. Run-of-river WUA should be determined using HABTAT or HABTAV results for the particular flow of interest. WUA percentage loss estimates for both the reach and whole study area should be calculated by dividing the appropriate peaking WUA (as determined by HABEF) by the appropriate run-of-river WUA (as determined by HABTAT) at each possible peaking discharge and multiplying these figures by 100.

Mobile life stages. The impacts on mobile life stages with unknown home ranges should be determined using a combination of HABEF output and a comparison of whole reach generation and base flow WUA from HABTAT or HABTAV. The impacts should bracketed by presenting the results of the two extremes of movement which are: 1) no migration between cells or reaches as modeled by HABEF; and 2) complete migration through the entire reach as modeled by comparing HABTAT or HABTAV WUA results for generation and base flow for each case and using the minimum value of the two to represent the peaking impact. The actual impact has to be somewhere within this impact window between these two scenarios as it is unlikely that juvenile and adult fish will not move at all in response to changes in stage and flow, and it is equally unlikely that fish will travel through an entire reach multiple times per day in response to the changes in stage and flow.

The individual reach WUA estimate of peaking impacts that allows total movement within the reach should be determined using the minimum of generation and base flow WUA from HABTAT or HABTAV for a given reach. The no migration within a reach case WUA should be determined using HABEF output for a given reach as described above for the non-mobile species and life stages. Individual reach run-of-river WUA and percent loss for a individual reach should be determined as described above for the non-mobile species and life stages.

When the actual home ranges are known and are not greater than the cross sectional distance of the transects, then HABTAM can be used as the best estimate of the peaking impact. Individual reach run-of-river WUA and percent loss for a individual reach should be determined as described above for the non-mobile species and life stages.

Literature Cited

Milhous, R.T., M.A. Updike, and D.M. Schnieder. 1989. Physical Habitat Simulation System Reference Manual - Version II. Instream Flow

Information Paper No. 26. U.S. Fish and Wildlife Service Biological Report 89 (16). v.p.

APPENDIX 4. MDNR Fish Entrainment and Turbine Mortality Study Plan Guidelines

Introduction

The Michigan Department of Natural Resources (MDNR) has determined that a study to quantify the magnitude of potential turbine-induced injury or mortality on the fishery resources is needed. The overall study has been broken down into two main components: monitoring fish entrainment and mortality rates and controlled turbine mortality experiments. The fish entrainment and mortality rate study (Phase 1) should be conducted initially. Based on the results of Phase 1 studies, the need for a more formalized turbine mortality study (Phase 2) will be determined. A phased approach to addressing the turbine mortality issue will preclude a potential applicant from conducting a, perhaps, unnecessary turbine mortality study. The MDNR may accept a potential applicant's proposal to conduct Phase 1 and Phase 2 studies concurrently, however. The MDNR may recommend that components of the studies be redone if the studies are not conducted as agreed to or if the results are not representative.

The potential applicant may opt to implement fish protective measures at the outset of after Phase 1 studies. In this case, the potential applicant will be required to conduct studies to develop appropriate mitigative measures. In all cases, licensees will be required to monitor the effectiveness of fish protective or mitigative measures once they are implemented. These studies will need to be coordinated with the MDNR.

The guidelines presented below identify the critical elements that must be included in a detailed plan of study developed by the potential applicant. Specific details, such as design of sampling equipment, sampling schedules, etc., will require coordination with the MDNR. The final study plan must be approved by the MDNR before studies are begun.

This document contains exact technical specifications that should be used to design an entrainment study. These specifications should be used in obtaining bid and study designs from consultants. These specifications are minimum specifications subject to discussion only when site-specific conditions warrant.

Phase 1 - Assessment of Fish Entrainment and Preliminary Mortality Rates

All entrainment studies should be designed to meet the following specific data objectives:

1. Estimates of the total number of each fish species (greater than one and a half inches) passing through the project during the study;

2. Estimates of the size distribution of fish entrained;

3. Estimates of the vertical and horizontal distribution of fish passing through the intake in one meter increments (pertains to hydroacoustic studies only);

4. Estimates of the daily and hourly fish passage numbers through each turbine.

When an applicant is requested to perform an entrainment study, the protocol should be as follows:

1. Agency study specifications (this document) are provided to the applicant. MDNR and applicants may hold initial meetings to clarify the design or address specific concerns. Applicants should use the agency specifications as basis for obtaining consultants bids or scopes of work.

2. Applicant or consultant perform proof-of-concept study (POC) to verify that the procedures, equipment, and analyses proposed by the consultant will, in fact, provide the information promised

3. MDNR and applicant meet to review POC study results and develop scope of work for the entrainment study

4. Applicant conducts the entrainment study according to an agency-approved scope of work

<u>Proof of Concept Study (POC)</u>

To verify that the proposed study design will provide the data required to evaluate entrainment, a "proof-of-concept" (POC) study is required. The purpose of the POC is to determine the appropriate methodology to use at the site to

determine entrainment. If hydro acoustics is proposed, then the POC should be designed to determine whether entrainment can be accurately estimated using this methodology and include tracking of live test fish. Ground truth netting should be used in the POC study to show an initial relationship between hydro acoustic sampling and tailwater netting. If a netting only study is proposed, the POC should show that entrainment can be accurately estimated using this method.

The POC study should be conducted for at least a two-week period to verify the applicability of the methodology selected. This study ***must*** be completed and reviewed by the MDNR prior to the initiation of the scope of work. Each POC study must specifically address all of the technical and design parameters that are listed below. The procedures to be used must be ***fully documented***.

A test-netting program must be conducted over a two-week period. This should include the installation and monitoring of the nets described below, a net efficiency study, and a visual evaluation by a SCUBA diver to confirm the adequacy of the net support system and that the tailrace area is free of any obstructions that could tear the net or effect net fishability. Any areas where the net seal is not sufficient, measures should be taken to prevent downstream infiltration of fish. In particular, the bottom seal should be examined because this is the area here infiltration problems usually occur.

The tailwater net efficiency study should include the introduction of at least 150 marked fish of various sizes and species into the turbine(s). A recapture rate of at least 70% of these fish is necessary to show that the nets are fishing properly. MDNR representatives should be notified prior to this test so they may observe and evaluate the operation.

Actual Entrainment Study

The following specific technical and design parameters must be incorporated into all studies. If site-specific conditions warrant the modification of these parameters, full justification and details of alternative methods must be provided to the MDNR. The MDNR must approve any deviation from the original plan of study prior to the start of the study.

If a hydro acoustic assessment is proposed:

1. Transducers should be placed so that at least 50% of the intake opening in all turbine bays are sampled. Each transducer should operate for a period of no less than thirty minutes every hour. Near and far field dead zones must be fully measured and accounted for in consideration of the 50%

coverage and vertical distribution requirements. Monitoring must be conducted 24 hours a day for at least one full year.

2. Single beam transducers should be used because they are less sensitive to noise and provide wide coverage. However, one dual beam transducer per site is needed to develop a target strength distribution and effective beam angle.

3. The pulse width used should be 0.5 milliseconds or less

4. A scientific echo sounder with a frequency of at least 400 kHz should be used

5. An accurate 40 log R Time Varied Gain (TVG) must be used to account for range-related signal loss

6. The echo signal processor-sampling rate must be no less than 15,000 samples/second

7. The pulse repetition rate must be 10-15 pulses per second to ensure that targets will be fully tracked

8. All transducers and equipment will be properly calibrated. The actual equipment used in the study must be calibrated using standard Naval Lab hydrophones before and after the study. If the study lasts more than one year, this calibration should be conducted annually. In situ calibration should be conducted at the start and end of the study as well as every three months during the study. This calibration consists of cable and transducer impedance measurements, TVG shape, and standard target return. All calibration measurements must be maintained and reported with the study results.

9. Studies must use the echo-counting analysis technique unless the proportion of multiple targets exceeds 5%. Echo integration techniques are not recommended and are rarely necessary.

10. All data extrapolations and calculations must use the effective beam width as measured at calibration based on the target strengths appropriate for the species and sizes of fish expected to be seen at that site. Calculations based on manufacturers nominal beam widths are not acceptable.

11. Instrument specifications must be provided to the MDNR and copies of all equipment manuals must be available upon request.

12. Target-tracking/recognition processing can be used to differentiate fish from noise and debris. All tracking parameters, including filters must be agreed on up front in the scope of the work. In situ field measurements of representative fish targets should be conducted as part of the POC study.

13. A direct fish-counting fish flux estimation procedure is recommended because it directly incorporates target tracking. However, a mean density analysis procedure may be used if acceptable target recognition adjustments can be incorporated. In situ field trials may be needed to determine the efficacy of the two methods.

14. Target strength distributions and length relationships used to develop length distributions and effective beam width calculations must be fully documented. In situ lab measurements of batches of representative species and size fish should be conducted as part of the POC study. Correct all-aspect equations should be used where appropriate.

15. Site-specific noise levels must be adequately measured and mapped for each turbine bay. This should be conducted as part of the POC study. These should be incorporated into transducer placement plans and detection level estimates. The minimum effective detection threshold should be a signal return corresponding to a fish 1.5" in length.

16. All data extrapolation procedures must be fully documented prior to study initiation and use statistically valid procedures.

17. All hydro acoustics sampling must be accompanied by an appropriate level of tailwater netting (see below) to determine size ranges and species composition of fish seen in the hydro acoustics.

18. Hydro acoustics entrainment estimates must be correlated to net catch. Discrepancies suggest a design or configuration deficiency and should be addressed prior to study start. Calculations must be done at a minimum on a monthly basis with analysis of hourly counts on the time step, so those problems can be detected and corrected. These calculations should be included in the bimonthly reports.

Criteria for netting:

1. If a netting only study is proposed, at least 72 hours of netting at each unit should be done each week during the ice-free period (April-October). During winter months (November-March), 72 hours of sampling should be conducted on a biweekly basis assuming safe sampling conditions exist. If netting is done to ground truth hydroacoustics, a minimum of 24 hours

should be done each week, April-October, and 24 hours biweekly, November-March. Sampling effort should be stratified on a weekly basis to make sure there is adequate coverage of all time periods.

2. The recovery net(s) should be constructed of dark colored (to minimize fish avoidance) 1/4 inch bar mesh, knotless nylon, with a removable live box attached to the cod end of the net. A fyke net should be incorporated into the net, near the live box, to prevent escapement. The effects of the recovery net(s) and live box on the mortality or injury of fish must be determined through suitably designed experiments. Divers should inspect all nets to ensure nets are fishing according to specifications. Nets should be appropriately marked immediately following inspection so that proper placement can be gauged each time the net is installed.

3. The recovery net(s) should sample the entire turbine discharge. A marked fish study should be conducted to determine the capture efficiency of the recovery net(s) and to obtain preliminary turbine mortality estimates. The capture efficiency of the net(s) must be quantified by releasing known lot sizes of marked live and dead fish at the intake. At least two capture efficiency/turbine mortality bouts should be done in addition the bout conducted during the POC study. Species should be determined in consultation with the MDNR. The capture efficiency of the recovery net(s) must be based on the release and subsequent recovery of marked live and dead fish. Preliminary estimates of turbine mortality will be based on the release of marked live fish; live fish used in the preliminary turbine mortality study may be used concurrently as part of the study to quantify capture efficiency of the recovery net(s). The two size classes of each species, juvenile and adult, as defined in consultation with the MDNR, should be used. Three groups of fish of each species and size group are needed for these studies: 1) a control group of 10 fish per species and size class to examine handling and marking mortality, 2) a net control group of 10 fish per species and size class to examine net mortality, and 3) a test group of 50 fish per species and size class to examine turbine passage and net efficiency. Fish may be of hatchery, wild, or commercial catch origin.

   Suitably designed assemblies to introduce live and dead fish at the turbine intake must be used. Fish must be released at an appropriate location within the intake chamber to ensure entrainment of all released fish.

   All fish used in the marked fish studies should be held for a minimum of 48 hours to determine latent mortality.

4. If more than one operational turbine unit exists, selection of the units to be sampled should be done through consultation with the MDNR, but with the overall goal of estimating entrainment to ± 10%.

5. Installed nets should be flushed before the tests begin to remove as many "resident" fish as possible from the draft tube/tailwater area.

6. The species, size, and condition (live, dead, or injured) of all captured fish should be recorded. A randomly selected 10 percent of all fish used in the marked fish studies should be examined for internal injuries. Voucher samples of each species captured should be preserved so that MDNR can verify species identifications.

For all studies:

1. Environmental variables - data that should be recorded during the collection of each sample include a total river discharge (in cubic feet per second), percent gate opening (load level) and discharge (in cfs) of each sampled unit and of other operational turbine units, water temperature, dissolved oxygen, and transparency (Secchi disk), and other variables as identified by the MDNR. Also a velocity vs. depth profile to include vertical and horizontal velocity profiles should be obtained from directly upstream of the trash racks during low, average, and high water discharges.

2. Data analysis - a description of all statistical tests proposed for data analyses, including assumptions and how such assumptions will be addressed, significance levels, confidence levels, etc. must be provided and approved by the MDNR prior to study initiation.

3. Reports

   A. Written progress reports should be provided to the MDNR on a bimonthly basis throughout the study period, and should include a description of any intentional or unintentional deviations from the approved study plan.

   B. Reports should contain the following data:

      1. Hydro acoustic data

         a. Amount of time sampled by day and explanations of any down time in sampling
         b. Total daily fish passage
         c. Daily fish passage by hour

d. Fish passage by location in the water column and across the intake structure
e. Fish passage by size

2. Netting data

a. Amount of time sampled by day and explanation of any down time in sampling
b. All fish data should be broken down by species and should include numbers and size (length)
c. Data should be presented to on an hourly, daily, monthly and annual basis, and by net location.
d. All fish with external and internal turbine passage damage should be documented

3. Environmental and Plant Parameters

a. Daily mean and hourly river flow in cubic feet per second (cfs)
b. Daily mean and hourly river temperature (°F) and dissolved oxygen (mg/l)
c. Daily mean and hourly headwater level
d. An hourly description of plant operation (units operating, each unit's discharge, % gate opening and Kw)
e. A daily summary of weather

C. A final study report is to be submitted to the MDNR within three (3) months after completion of the study.

D. The MDNR will provide written comments within three (3) months after receipt of the final report and will include any recommendations for further study, i.e., Phase 2, or for the need of appropriate fish exclusion or mitigative measures.

Phase 2 Study- Assessment of Turbine Mortality and Injury to Fish

This study is designed to develop intensive data on actual turbine-induced injury and mortality, based on the release and recovery of known lot sizes of marked test and control fish. Phase 2 studies are needed to more accurately quantify the occurrence and extent of turbine-related impacts to entrained fish.

1. Fish species of concern - target species and sizes to be studied will be determined through further consultation with the MDNR.

2. Sampling equipment

   A. Suitably designed assemblies to introduce test and control fish at the turbine intake and discharge must be used. Test fish must be released at an appropriate location within the intake chamber to ensure entrainment of all released fish.

   B. Total recovery net(s), if used, are to be located in the tailrace(s) as described above.

   C. Ichthyoplankton sampling equipment details will be provided by the MDNR if ichthyoplankton studies are deemed necessary.

3. Sampling protocol

   A. Fish injury and mortality experiments should be appropriately frequency as determined through consultation with the MDNR. In addition, the experimental design should include provisions for adequate sample sizes and an adequate number of replicates. Experiments should be conducted over the full range of normal project operating conditions, e.g., peak and off-peak.

   B. Live test and control fish selected from the same lot of fish should be acclimated to the project water for at least 24 hours. A third group of fish not subjected to the test and control procedures, selected from the same lot of control fish, should be held separately in holding cages in the tailrace to permit an assessment of non-test impacts.

   C. The effects of the fish introduction assemblies, the recovery net(s), and fish marking techniques (e.g., fin clipping, dye immersion) on the injury and mortality of test and control fish must be determined.

   D. The condition of captured fish should be categorized according to the following criteria.

      * Live with no visible external injury

* Live with obvious external injury
* Dead with no visible external injury
* Dead with obvious external injury

Live test and control fish (with and without apparent external injury) recovered from the recovery net(s) should be held 48 hours in suitably designed holding cages secured in the tailrace to determine latent mortality of fish. Fish should be segregated by species and size to minimize stress and predation.

E. The number, species, condition, and size of all fish released and recovered in each trial must be recorded.

4. Environmental variables - see above

5. Data analysis - see above

6. Reports - see above. The MDNR will provide written comments within three (3) months after receipt of the final report and will include any recommendations for the need for appropriate fish exclusion or mitigative measures.

APPENDIX 5. MDNR Turbine Entrainment and Mortality Study Justification

The following is the Michigan Department of Natural Resources (MDNR) justification for the recommended turbine entrainment and mortality study at your facility. This document fulfills the requirement of Subpart B, Section 16.8 (i)-(vi)

of the recently adopted FERC rules governing resource agency recommendations for necessary studies and information relating to a recommendation for a standard turbine mortality/entrainment study.

Data Recommended For Analysis of Issue by MDNR

1. Provide quantitative estimates of the number, species composition and size distribution of fish being entrained at the project; or acceptable quantitative estimates of the above parameters from a comparable project; or acceptable quantitative evidence that installed protective devices are preventing fish entrainment.

2. Provide quantitative estimates of the mortality rate of fish being entrained at the project and the source of the mortality (turbine mortality, impingement on intake screens, etc.); or acceptable quantitative estimates of the above parameters from a comparable project; or acceptable quantitative evidence that installed protective devices are preventing fish mortalities.

   If the above information is not available, then the applicant should arrange to collect the information using recommended survey procedures provided by the MDNR.

Determination Basis of Resource Issue

Numerous studies have been conducted to determine the extent of fish entrainment at hydroelectric projects nationwide with many of them summarized in Eicher et al. 1987. Unfortunately, most of these studies have been conducted at West Coast facilities and deal with migrating salmonid smolts. A number of entrainment studies have also been done on the east coast, targeting on anadromous species such as shad, striped bass, alewife, blueback herring and Atlantic salmon. These studies have shown that mortalities can be significant and range between 5-90% per facility. Very few entrainment studies have been done in the Midwest, where the hydroelectric facilities and their design, fish community composition and fish sizes are very different from those examined in the literature. Thus, little is known concerning turbine entrainment and mortality in the Midwest.

In the past, many fisheries biologists felt that the fish species indicative of Midwestern rivers were fairly sedentary and did not move long distances. These "resident" fish have recently been found to move long distances putting themselves at risk from turbine mortality. Studies by WDNR personnel on walleye in the Mississippi River, smallmouth bass in the Embarrass River, and channel catfish in the lower Wisconsin River all have shown movement of each of these species in excess of 30 miles over one year. In addition, studies on the

threatened lake sturgeon in the Menominee River by Tom Thuemler have shown yearly movements of at least 20 miles with some radio tagged fish moving through hydroelectric facilities.

Summaries of the few recent entrainment studies on Midwestern rivers have shown large amounts of movement through hydroelectric facilities. The Morrow Dam Study, using tailwater netting, on the Kalamazoo River in Michigan estimated 45,987 fish passing the facility consisting of 21 species, ranging in size form 1.8 to 32.4 inches, in 6.5 months of sampling. Hydro acoustic studies at the Park Mill facility on the Menominee River showed daily movements of from 216 to 10,017 fish and hydro acoustic/netting studies at the Vanceburg hydroelectric plant on the Ohio River estimated hourly movement at from 282 to 6,000 fish.

The magnitude of resident Midwestern fish movements, available Midwestern data on entrainment, and the wide range of known fish mortalities has lead us to determine that turbine entrainment and mortality occurs at our facilities. Legally, all fish are property of the State of Michigan, under Public Act 165 of 1929 and any fish killed by any non-legal means are to be compensated for. Therefore, we are requesting a turbine entrainment and mortality study be conducted at your facility to determine the nature and degree of mortality, and to determine the necessary mitigation for those losses.

Fisheries Goals and Objectives

The overall Michigan Department of Natural Resources' goal on hydroelectric facility entrainment and mortality is:

> To minimize and mitigate for the loss of fish at every hydroelectric facility from either turbine or spillway passage to protect and maintain fish communities, and rehabilitate those now degraded.

The St. Joseph River is a significant inland river fishery in Southern Michigan. The fisheries resource includes important populations of largemouth bass, smallmouth bass, northern pike, walleye, bluegill, yellow perch, black crappie, rock bass, channel catfish, suckers (including redhorse) and bullheads. Our fisheries goal in respect to entrainment and mortality at your facilities is to protect and enhance the coolwater fish community in the St. Joseph River and its tributaries by minimizing and mitigating for fish losses from hydroelectric facility entrainment and mortality.

Study Methodology Appropriateness

In order to adequately determine turbine entrainment and mortality a direct sampling system is needed. The joint agency, MDNR, WDNR and the U.S. Fish

and Wildlife Service, sampling guidelines use a two-phase approach. Phase I is designed to determine entrainment and to estimate the magnitude of mortality. If mortality is found to be a problem then more detailed mortality studies are recommended as part of Phase II. Our hope and intent is that most of the studies should stop at Phase I, instead of requiring both phases to be done at once.
This overall methodology is preferable and less costly than trying to determine whole system effects. Whole system effects would require detailed and long-term population dynamics of each member of the fish community. Turbine entrainment and mortality data would still need to be collected and compared to natural mortality and year class strengths. By using just direct sampling techniques, mitigative measures can be more easily determined, and the very large and costly sampling effort can be avoided. This overall methodology also follows the methodology the State of Michigan uses to determine mitigation for fish kills. For example, if farmer X kills fish in drain A, we require direct compensation for those fish killed not a river system wide impact statement as these fish are property of the State of Michigan killed in an illegal method. We view turbine mortality as a chronic fish kill situation.

This overall methodology has been used before in numerous turbine mortality studies including Morrow Pond, Park Mill and Vanceburg studies. The actual methodologies recommended, hydro acoustics and tailwater netting, are commonly used as can be seen in the review by Eicher et al. (1987).

Study Data Utilization

This study will provide data on the numbers entrained and the mortality of each member of the fish community of the St. Joseph River and its tributaries at your hydroelectric facility. These data will then be converted to a mitigation value by either a lost angler day determination or some other acceptable technique. These mitigation values will be used to determine if the problem is severe enough to require screening, which is always an alternative to the study, or some other mitigation to replace the lost resource value.

Our goals of protection and enhancement of the coolwater fish community would be furthered by the replacement of lost resource values from hydroelectric generation if the losses are not severe enough to warrant protective devices or the complete exclusion of fish, by protective devices, if the losses are significant. Thus, no net loss of the fisheries resource value would occur in either case because of the results of this study.

Literature Cited

Eicher, G.J., M.C. Bell, C.J. Campbell, R.E. Craven and M.A. Wert. 1987. Turbine Related Fish Mortality: Review and Evaluation of Studies. Electric Power Research Institute Report No. AP-5480.