127 FERC ¶ 62,158
UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

TransCanada Hydro Northeast, Inc. Project No. 1904-065

# ORDER APPROVING PLAN TO MONITOR EFFECTIVENESS OF DOWNSTREAM FISH PASSAGE PURSUANT TO ARTICLE 403

(Issued May 27, 2009)

1. On April 23, 2009, TransCanada Hydro Northeast, Inc. (TransCanada, licensee) filed its Study Plan to Monitor the Emigration of Radio Tagged Atlantic Salmon Smolts at the Vernon Hydroelectric Project, Spring 2009. This plan was filed pursuant to revised article 403 of the license for the Vernon Project.[1] The project is located on the Connecticut River, in Cheshire County, New Hampshire and Windham County, Vermont.

## BACKGROUND

2. Revised article 403 required the licensee to file for Commission approval a plan and schedule to monitor the effectiveness of the project's downstream fish passage facilities to assure passage past the project by downstream migrating Atlantic salmon and American shad. The plan was required to include measures to assess the effectiveness of the project's downstream passage facilities and/or assess fish survival through the project turbines. The licensee was also required to prepare the plan and schedule following consultation with the U.S. Fish and Wildlife Service (FWS), the Vermont Department of Fish and Wildlife (VTF&W), and the New Hampshire Fish and Game Department (NHF&G) (agencies). Upon Commission approval, the licensee would implement the plan.

3. On February 12, 1993, the Commission approved the licensee's fish passage plan.[2] Downstream fish passage has been provided at the project since 1995. The facilities consist of a "fishpipe", located in two old turbine bays between units 4 and 5, having a 350 cubic feet per second (cfs) discharge capacity and a second smaller "fishtube" at the west end of the powerhouse having a 50 cfs discharge capacity. In addition, a 156 foot-long louver array extends from the log boom pier no. 1 to the entrance of the primary fishpipe.

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[1] See ordering paragraph (N) and condition E-7 of Appendix A of the Order Amending License, issued July 28, 2006 (116 FERC ¶62,078).

[2] 62 FERC ¶ 62, 097 (1993).

The purpose of the louver guidance wall is to direct downstream migrating fish that enter the forebay from mid-river and from the east shoreline into the fishpipe. The louver was designed to assist fish migration after the license was amended in 1992 to add two 14 MW units[3] but these units were never installed. The fishtube functions as a secondary passage for fish that are not intercepted by the louver array and that enter the western end of the forebay.

4. Turbine and fishway survival radio telemetry studies were conducted in 1995-1996 to develop estimates of total project survival for downstream migrating salmon smolts, which included assessment of the passage efficiency of the louver array, fishpipe and the west fishtube for emigrating salmon smolts. These downstream passage studies demonstrated that overall project survival (for salmon smolts) was estimated to be higher than 95 percent in 1996. The result of the studies were filed with the Commission and by letter order dated February 27, 1998, the Commission agreed that the studies showed that the existing passage facilities and low rate of turbine mortality adequately protect downstream migrating anadromous fish and waived further evaluation at that time. The letter did note that should redevelopment of the project begin, downstream fish passage effectiveness studies would still be required.

5. On March 1, 2006, TransCanada filed an application for amendment of its license to replace four existing 2.0 megawatt (MW) turbine/generator units with four new 4.0 MW units generating units. The amendment was approved by order issued July 28, 2006.[4]

6. In study plans filed on January 18 and April 21, 2008, the licensee stated that the purpose was to provide a monitoring approach and schedule to ensure safe and efficient downstream passage of anadromous fish subsequent to the installation and operation of the new units, which are Kaplan turbines, at the project. The licensee cited the past downstream fish passage studies and believed that overall project survival would remain high after installation of the new units. As outlined in the April 21, 2008 plan the licensee conducted a turbine survival study of the new units at Vernon during the period May 19 and May 22, 2008. Since the new units are identical, the licensee expected the effects of turbine passage to be similar; therefore only one unit was tested (unit 8). The study was performed under two discharge scenarios. The first was 1250 cfs, representing the lowest flow the units would likely function in, and second was 1600 cfs, representing the most efficient turbine operation. The turbine survival study was designed to determine survival and condition of salmon smolts after passage through the new axial flow five-blade

[3] 59 FERC¶ 62, 267 (1992)

4 116 FERC ¶62,078 (2006

propeller turbines. The results of the study showed that the one-hour survival ranged between 94 percent and 98 percent while the 49-hour survival ranged from 89 percent to 92 percent, depending on turbine flow. As a result of the lower than expected survivability results, the licensee and agencies concluded that a comprehensive assessment of downstream passage for emigrating Atlantic salmon smolts would be needed.

PROPOSED PLAN

7. The licensee proposes to assess route selection, louver guidance efficiency and bypass (fishpipe and west fishtube) passage effectiveness for emigrating Atlantic salmon smolts similar to the 1995 and 1996 studies, but with the new units active. The licensee would use a radio telemetry evaluation, citing its appropriateness for Vernon. Hatchery reared salmon smolts will be obtained from the FWS's Pittsford National Hatchery in Pittsford, VT. A sample size of 150 test fish is proposed as an appropriate number to provide a statistically valid study. Six groups of radio tagged smolts will be released approximately one-mile upstream of the Vernon dam so that movement and passage can be monitored. The study design is based on the availability of three passage routes: fishpipe, west fishtube and turbines. If river flow necessitates spill, attempts will be made to delay release of the test fish until spill subsides to maximize numbers of smolts exposed to the louver. Turbine operation, if possible, will follow an on-line order of Unit 10, then 5 through 8, 9, then units 4 through 1; offline will follow the reverse order. This operating protocol is meant to maximize the flow field along the louver. Six radio monitoring stations will be installed at the project. Steps will be followed prior to the release of fish to insure that valid signals are received and recorded at each monitoring location. The licensee proposes to use six monitoring stations with station number six used to confirm passage of tagged smolts past Vernon station.

8. Monitoring stations and holding facilities will be deployed in mid to late April, 2009, with the smolts being transferred to the holding facilities from the hatchery in early May. Depending on water temperature and spill status, smolts will be tagged and released during May and if needed, June. A draft report of the results will be sent to the agencies by September 15, 2009. Pending agency review, the licensee will file the results of the monitoring with the Commission by December 31, 2009.

CONSULTATION/COMMENTS

9. On February 6, 2009, following the distribution of a draft of the report to the agencies, a Fishery Agency Consultation meeting was held with the agencies, as well as staff from the Massachusetts Department of Fish and Wildlife and the Commission's

regional office. The licensee then provided a record of the minutes of the meeting to attendees for review. The FWS commented that the phrase in the report "instream minimum flow" should be revised since other units were also operating and therefore there was more flow in the river. FWS also questioned why a flow of 1800 cfs was not tested. Finally FWS thought that calculating an overall project passage survival values using results of previous passage route section studies was not valid because the passage route may have been altered by the new units. The FWS then commented in an email communication dated April 29, 2009, noting that the upstream fishway is a possible egress route for smolt, which could be operational during the May-June smolt emigration period and may be a candidate for monitoring and that the tested unit operation should be done in a way that the licensee proposes to operate them. VTF&W commented that the report include an injury rate for fish that were considered alive after 48 hours and that the passage route selection study should be replicated with the new units, then combine the data for an overall project passage survival estimate.

10. The licensee addressed the comments from FWS by clarifying the instream minimum flow phrase, removing the calculation of passage survival using previous study results and noting that there were not enough fish to test flows in the 1800 cfs category. In responses to FWS' email comments, the licensee proposed to facilitate the monitoring of passage through the upstream fishway if possible and clarified the operational sequence of the units.

11. In its response to comments from VTF&W, the licensee modified the report to include the injury rate for fish that were alive after 48 hours and agreed to conduct a passage route selection study using radio telemetry, including monitoring the spill section of the dam.

DISCUSSION

12. The purpose of the study plan is to determine route selection, louver guidance efficiency and bypass passage effectiveness for emigrating Atlantic salmon smolts in accordance with the requirements of article 403 of the Vernon project license. With the four new units installed and operational, the licensee conducted a turbine survival study of the new units during the period May 19 and May 22, 2008. As a result of the lower than expected survivability results, a comprehensive study plan was developed in consultation with the resource agencies. The licensee will perform the study this spring and the plan outlines a schedule for providing the results to the agencies with adequate time for review and comment as well as submission of a final report to the Commission. The licensee's plan for monitoring downstream fish passage at the Vernon project provides a sufficient

method for assessing impacts on emigrating Atlantic salmon smolts and should be approved as modified by paragraph B.

The Director orders:

(A) TransCanada Hydro Northeast, Inc.'s (licensee) Study Plan to Monitor the Emigration of Radio Tagged Atlantic Salmon Smolts at the Vernon Hydroelectric Project, Spring 2009, filed on April 23, 2009, is approved, as modified by paragraph B.

(B) The licensee shall implement the studies approved in paragraph (A) during spring 2009, and shall file a final report with the Commission by December 31, 2009. The report shall include evidence of consultation with the U.S. Fish and Wildlife Service, the Vermont Department of Fish and Wildlife, and the New Hampshire Fish and Game Department and their comments on the draft report. If the results indicate excessive turbine mortality and/or that further evaluation of passage efficiency or changes to project operation or structures are needed to improve downstream fish passage, the licensee shall also file recommendations for such with the Commission, after consultation with the agencies. Based on the report, the Commission reserves the right to require modifications to project facilities and operations.

(C) Unless otherwise directed in this order otherwise, the licensee shall file an original and seven copies of any filing required by this order with:

The Secretary
Federal Energy Regulatory Commission
Mail Code: DHAC, PJ-12.3
888 First Street, NE
Washington, D.C. 20426

(D) This order constitutes final agency action. Requests for a rehearing by the Commission may be filed within 30 days of the date of issuance of this order, pursuant to 18 C.F.R. § 385.713.

George H. Taylor
Chief, Biological Resources Branch
Division of Hydropower Administration
and Compliance

# Downstream Fish Passage Monitoring Plan

Vernon Hydroelectric Project
FERC Project No. 1904

December 2007

TransCanada Hydro Northeast Inc.
4 Park Street
Concord, NH  03301

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# 1.0 INTRODUCTION

This Downstream Fish Passage Monitoring Plan (the Plan) is being submitted by TransCanada Hydro Northeast Inc. (TransCanada) to New Hampshire Department of Environmental Services (NHDES or DES), US Fish and Wildlife Service, Vermont Department of Fish and Wildlife, and New Hampshire Fish and Game Department for review; and to NHDES and the Federal Energy Regulatory Commission (FERC) for approval, in accordance with:

- Condition E-7 of the New Hampshire Clean Water Act Section 401 Water Quality Certificate issued on July 3, 2006; and

- Article 403 of the Federal Energy Regulatory Commission (FERC) Order amending the FERC License for the Vernon Hydroelectric Project, FERC No. 1904 (the Project) issued on July 28, 2006.

Condition E-7 of the New Hampshire Water Quality Certificate states:

> *"The Applicant shall address downstream fish passage at the Vernon Hydroelectric Project in accordance with fish passage provisions described in the Strategic Plan for the Restoration of Atlantic Salmon to the Connecticut River (Strategic Plan), revised July 1, 1998, or subsequent revisions, as approved by CRASC. The Applicant shall consult DES regarding the downstream fish passage studies, which were agreed-to by the Applicant and U.S. Fish and Wildlife Service (USFWS)."*

Article 403 of the FERC Order states:

> *"The licensee…shall file for Commission approval a plan and schedule to monitor the effectiveness of the downstream fish passage facilities to assure passage past the project by downstream migrating Atlantic salmon and American shad. The plan shall include measures to assess the effectiveness of the project's downstream passage facilities and/or assess fish survival through the project turbines.*
>
> *The licensee shall prepare the plan and schedule following consultation with the U.S. Fish and Wildlife Service, the Vermont Department of Fish and Wildlife, and the New Hampshire Fish and Game Department. The licensee shall include with the plan documentation of consultation and copies of comments and recommendations on the completed plan after it has been prepared and provided to the agencies, and specific descriptions of how the agencies' comments are accommodated by the plan. The licensee shall allow a minimum of 30 days for the agencies to comment and make recommendations prior to filing the plan with the Commission. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons, based on project-specific information. The Commission reserves the right to require changes to the plan or schedule. Upon Commission approval, the licensee shall implement the*

*plan according to the approved schedule, including any changes to the plan or schedule required by the Commission."*

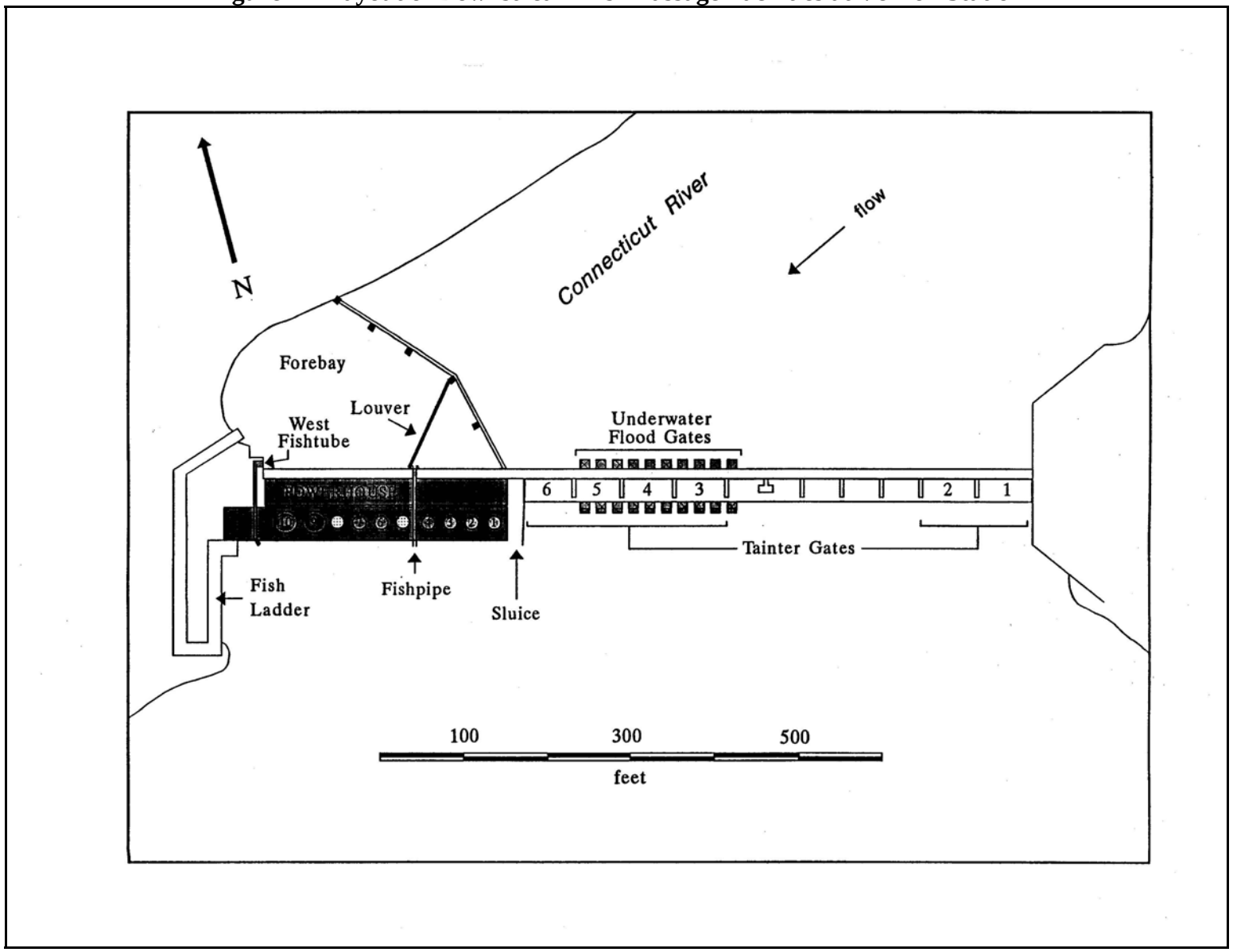
## 2.0 PURPOSE / BACKGROUND

The purpose of this Plan is to propose a downstream fish passage monitoring approach and implementation schedule to assure safe overall downstream passage of migrating Atlantic Salmon and American shad, subsequent to the installation and operation of four new 4.0 MW generating turbines at the Vernon Project.

As required by Article 403 of the Vernon Project's 1992 FERC License amendment, downstream fish passage facilities at the Project were completed in 1995. Those facilities include a "fishpipe" that discharges through one of two old exciter turbine waterways located between Units 4 and 5 (approximately midway through the powerhouse) having a 350 cubic feet per second (cfs) capacity; and a second smaller "fishtube" at the Vermont end of the powerhouse (West Fishtube) having a 50 cfs capacity. In addition, a 156-foot long louver array extends from log boom pier #1 (the third log boom pier from the Vermont shoreline) to the entrance of the fishpipe.

The louver array consists of stainless steel louver panels with vanes spaced 3 inches apart, extending to a depth of 15 feet at normal pond elevation. The purpose of the louver is to intercept and direct downstream migrating fish that enter the forebay from mid-river and from the east (New Hampshire) shoreline into the fishpipe. Radio-telemetry studies conducted at Vernon have shown that most of the fish approach the Project from mid-river and from the New Hampshire shoreline. The louver was designed in consideration of the two 14 MW turbines approved by the 1992 license amendment (the louver is to the east of the location for the new units and would intercept fish before entering the units). It is expected to function in the same manner with installation of the new four smaller generating turbines installed in the same general location. The West Fishtube functions as a secondary passage route for fish that are not intercepted by the louver array and that enter the western end of the forebay. Figure 1 illustrates the layout of downstream passage facilities.

**Figure 1 – Layout of Downstream Fish Passage Facilities at Vernon Station**



# 3.0 SUMMARY OF PREVIOUS STUDIES

Downstream passage studies conducted at the Vernon Project after installation of the downstream passage facilities have demonstrated that the passage facilities are effective in safely passing fish downstream; that turbine passage survival is high; and that overall safe passage through the Vernon Project is high for salmon smolts. The results of these studies are described in the following sections.

## 3.1 Assessment of the Louvers, Fishpipe, Fishtube, and Spill

Several studies on the effectiveness of downstream fish passage facilities were conducted at the Project in 1995 and 1996 by Normandeau Associates. These studies included assessment of the passage efficiency of the louver array, fishpipe, and fishtube for emigrating Atlantic salmon smolts, based on radio tagging of actively migrating smolts. Atlantic salmon smolts are the species of primary interest for downstream passage, although other anadromous species such as American shad also require safe downstream passage. All salmon smolts passing downstream from several upriver tributaries in Vermont and New Hampshire (which are heavily stocked with salmon fry), must pass through the Vernon Project.

Table 1 below, presents the results of the 1995 and 1996 downstream passage effectiveness studies. These studies found that the guidance efficiency of the louver system improved from 42.1 percent in 1995 to 62.9 percent in 1996. The percentage of fish passing through the fishpipe showed a corresponding increase, from 23.7 to 41.2 percent, while the percentage through the West Fishtube decreased from 34.7 to 15.3 percent. The percentage of fish passing through the turbines also decreased from 34.7 to 19.8 percent, from 1995 to 1996. In 1996, more fish passed via the spillway, because river flows were higher, yet the louver guidance efficiency was also higher.

**Table 1**
**Downstream Fish Passage Effectiveness**
**Vernon Hydroelectric Project, 1995 and 1996**

| Measure of Effectiveness | 1995 | 1996 |
|---|---|---|
| Louver guidance efficiency (percent) | 42.1 | 62.9 |
| Percent through fishpipe | 23.7 | 41.2 |
| Percent through west fishtube | 34.7 | 15.3 |
| Percent through Units 9-10 | 24.3 | 15.3 |
| Percent through Units 1-4 | 10.4 | 3.5 |
| Percent through spillway | 0 | 23.5 |
| Percent passage via unknown route | 6.0 | 1.2 |

*Source: Normandeau Associates*

### 3.2 Downstream Survival Studies

Turbine and fishway survival studies were also conducted by Normandeau Associates in 1995 and 1996 to develop estimates of total Project survival for downstream migrating salmon smolts. Survival through the West Fishtube was 93.3 percent in 1995. Based on the migration routes that smolts used in 1996, the total estimated project survival was 95.5 percent. Estimated survival of smolts after 48 hours through Unit 10 was 94.9 percent and through Unit 4 (a smaller capacity unit) was 85.1 percent. Both generating units are Francis type turbines. Table 2 below summarizes the results of these studies.

**Table 2**
**Downstream Project Survival**
**Vernon Hydroelectric Project, 1995 and 1996**

| Migration Route | % Survival |
|---|---|
| Unit No. 4 at 75% gate opening | 85.1 |
| Unit No. 10 at 75% gate opening | 94.9 |
| Unit No. 10 at 100% gate opening | 100 |
| West Fishtube | 93.3 |
| Fishpipe | 97.5 |
| Flood, Tainter Gates | 97.7 |
| **TOTAL PROJECT [1]** | **95.5** |

*Source: Normandeau Associates*

### 3.3 Desktop Survival Study

To further address the potential for fish entrainment, a desktop evaluation of potential fish passage survival through the proposed new 4.0 MW turbines, which are Kaplan type turbines, was developed using the model developed by Franke et al. (1997) for a range of fish sizes from four to eighteen inches representing fish sizes for juvenile and adult shad and salmon smolts (Normandeau Associates, 2006).

In addition to fish size, variables used in the models, included:

- Turbine operating efficiency (85 and 90%);
- Fish entry point along the runner blade (10, 50, and 90 % of runner length); and
- Correlation factor (accounts for several factors such as strike that is non-injurious, fish in line with the blade may be carried around it by the 'bow wave', and other potential factors not related to blade strike - factors used were 0.1 and 0.15).

[1] 95.5% survival is a weighted estimate from proportional passage route selection data obtained from previous radio telemetry studies.

The model predicted survival for 4-inch fish (to represent juvenile shad) from 92 to 98 percent; for salmon smolt-sized fish (6 – 10 inches) from 79 to 97 percent; and for 12 to 18-inch fish (to represent adult shad) from 63 percent to 94 percent. The lower values are based on the more conservative estimates for all variables tested. The predicted survival rates fall within the range of empirical values observed in several field studies cited by Normandeau Associates (2006). They also show that survival decreases with increasing fish length, and that survival is generally higher at higher turbine efficiency.

# 4.0 RECOMMENDATIONS

## 4.1 Effects of New Turbines

The new 4.0 MW turbines are Kaplan type turbines, well known to pass fish more safely and at higher rates of survival than comparably sized Francis type units, like the four previous units that have been removed from Vernon. In addition, the four new turbines are very high-efficiency units with operating efficiencies well above 90% under normal operating conditions, which is likely to increase survival as well. Empirical values observed in several field studies of survival through a variety of Kaplan turbines (cited by Normandeau Associates, 2006) indicate that survival rates also increase with higher unit flows, with survival (even for larger fish) ranging from over 85% to 100% at flow levels expected for these new turbines.

Installation of the new 4.0 MW turbines also necessitates installation of new intake trash racks to keep leaves, tree branches and other river debris from entering the generator intakes. Racks with two-inch on-center spacing have been specified for the new turbines. The average approach velocity at the upstream face of the racks would be 2.4 feet per second (fps). There is no change between rack spacing between the four old generating units and the four new units. Thus, the potential for fish entrainment is low when considering bar spacing and flow velocities at the racks. Fish in the larger size groups (> 10”) would most likely be physically excluded from passage through the new units by the 2-inch-spaced trash racks, as they were from the 2-inch racks installed in front of the older units. A study from 1992 (Normandeau) found just over half the sample population of adult shad passed at night though Units 9 or 10 which have 4 inch O.C. bar spacing while the remainder utilized the fishpipe.

Overall, there is no indication that installation of the new high efficiency generating turbines would negatively affect fish survival during downstream passage relative to the pre-existing, nor to the previously authorized, conditions. Because overall Project survival (for salmon smolts) was estimated to be higher than 95 percent in 1996, we expect that overall Project survival will remain high after installation of the new units.

## 4.2 Downstream Monitoring Study Plan

As discussed in Section 3.0 above, the previous downstream passage studies demonstrated high (95%) overall safe passage through the Project. Those studies also

demonstrated that the vast majority of fish used the downstream passage facilities and only a minority (approximately 35% in 1995 and 19% in 1996) passed through Vernon's generating units. Therefore, the purpose of the additional monitoring study approach proposed here is limited to evaluating safe downstream passage only through the four new generating turbines.

The Vernon Units 5-8 turbine survival study will ascertain survival and condition of salmon smolts after passage through the new axial flow five-blade propeller turbine. A standard balloon-tag smolt study approach previously used at other TransCanada Projects and numerous other locations throughout the country will also be utilized at Vernon. HI-Z Turb'N tags (balloon tags) will be used to assess survival of smolts. The balloon tag-recapture methodology allows: 1) direct recapture of fish shortly after passage through the structure of interest, 2) provides detailed information on the extent and types of any structure inflicted injuries, 3) provides minimal or no modifications to project operations 5) employs a controlled experiment, resulting in an estimate of relative survival, so that experimental effects, if any, can be accounted for in estimating survival.

A proposed specific detailed study plan closely following the study performed in 2005 at TransCanada's McIndoes Dam, is provide in Appendix A. The final study plan will be developed following comment and consultation with state and federal resource agencies, prior to commencement of the study itself. The study plan specifies the number of tagged smolts, the methodology, test scenarios and a schedule for the field study, analysis and reporting. Following comments and consultation, it will be finalized prior to obtaining the requisite number of smolts. The study's fieldwork component is expected to be conducted in the spring of 2008 pending agency comments and the availability of smolts. The proposed implementation schedule is provided in Section 5.0 below.

## 5.0 IMPLEMENTATION SCHEDULE

The schedule for implementation of this Plan is contingent upon the availability of salmon smolts but otherwise could be conducted at any time after the new generating units are commissioned and become operational. Based on the current schedule for unit start-up, the study can most likely be conducted during the Spring 2008 migration season.

**Table 3**
**Implementation Schedule**

| Implementation Task | Targeted Date |
|---|---|
| Develop detailed balloon tag study plan and submit draft document to agencies | By February 15, 2008 |
| Consult with agencies to finalize study plan | By March 31, 2008 |
| Order smolts | Pending availability, prior to Spring migration season |
| Conduct tag study | 2008 Spring migration season |
| Analyze study data and results | Within 3 months of completion of field work |
| Submit study report to agencies for review | Before October 31, 2008 |
| Submit final study report to agencies and FERC | Before December 31, 2008 |

# APPENDIX A

# DETAILS OF PROPOSED TURBINE SURVIVAL STUDY

# PROPOSED TURBINE SURVIVAL STUDY PLAN

## 1.0 Test Unit and Conditions

Because each of the new Units 5-8 are identical, balloon-tagged salmon smolts will be introduced at the intakes of only one of the new generating turbines while operating under one of two flow conditions: minimum instream flow requirement (1250 cfs) or best efficiency flow (approximately 1600 cfs) at normal conditions. Turbine efficiencies for these flows are both above 90%. A final decision on flow variables and unit selection will be used will be made following consultation with agencies at the March consultation meeting.

Conventional thought is that low discharges (below the optimal operational point) may be more detrimental to fish because of increased turbulence and possibly cavitation in the turbine unit. These conditions can cause injuries and mortality if severe and fish interact with these [sometimes localized] conditions. Given that a low flow is more likely to cause more injury or mortality, a low flow will be tested first assuming river flow and other operational considerations will facilitate this approach. Approximately 150 tagged fish will be considered for use at the low discharge of approximately 1250 cfs. This presumes the new un-tested units can perform and would be called upon to run at this level if flows dictate such. The other flow would be at the anticipated best efficiency flow of approximately 1600 cfs.

The final choice will depend on what river flows are occurring during the week of the test and whether or not the suggested test flows can be maintained during the entire evaluation. A final decision will be made in the field based on consultation with the TransCanada Project Manager, our operations group and agency participants and observers onsite. We do not anticipate a significant difference between the lower flow (minimum flow) and best efficiency discharge level. One of the unique features of these new units is the broad efficiency range with turbine efficiencies above 90% for both of these flows.

If after about 50 fish, the initial survival of these fish is high and injuries are few, the low discharge test may be considered completed and the remainder of the sample would be released at the higher discharge, which is more typical of the operations of the units during spring emigration. If the survival at the low discharge is lower than expected (e.g., <90%), or injuries are prevalent, up to 150 fish will be tested at this discharge. More detail on the rationale for this approach is provided below under Section 5.0.

## 2.0 Source of Specimens

It is anticipated that CRASC will specify the hatchery source of juvenile Atlantic salmon to be utilized for the study. Fish will be held on site a minimum of 24 hours prior to any testing. Holding tanks will be continuously supplied with ambient river water. Treatment and control specimens will be taken randomly taken from the same group of fish to eliminate sample group bias.

## 3.0 Fish Tagging, Release and Recapture Procedures

Juvenile Atlantic salmon will be equipped with two un-inflated balloon tags and a miniature radio tag and passed through an operating turbine. The tags will buoy the fish to the surface after passage for recapture. Fish tagging, release, and recapture techniques will follow those used for other similar turbine survival investigations.

Fish will be anesthetized with MS 222, and equipped with two un-inflated balloon tags and a small radio tag. Balloon tags will be attached by stainless steel pins inserted through the musculature beneath the dorsal and adipose fins. The radio tag will be attached in combination with the balloon tag beneath the dorsal fin. Prior to release through the induction apparatus, fish will be allowed to recuperate from anesthesia. Fish will be placed individually into the induction holding tub, balloon tags activated, and then fish released. The inflation time of the balloon tags will be regulated to a certain extent by varying the temperature and amount of catalyst injected into each tag prior to release.

The induction apparatus consists of a 25-gallon holding basin attached to a 4 inch diameter hose. The release hose will be supplied with a continuous flow of river water, which ensures released fish move quickly to the desired release locations. Treatment group fish will be released in the upper part of the turbine intake at a point of commitment to passage. This release location will be where most naturally entrained fish typically pass.

A control group release pipe will be positioned downstream of the turbine discharge. The terminus of the control group release hose could be at or just below the water surface. By design, this release point controls for experimental factors and isolates the effects of the treatment variable (in this case, turbine passage).

After passage, tagged fish will be tracked by personnel in two boats using standard radio telemetry techniques to monitor the general location of tagged fish as they proceed down the tailrace. Tagged fish will be recaptured from the tailwater when buoyed to the surface by the inflated balloon tags. Upon recapture, balloon tags and the radio tag will be removed immediately. The juvenile salmon will be examined for injuries, and transferred in 5-gallon buckets to an on-shore holding tank to ascertain delayed effects (48-hour). These tanks will be located at a suitable site on the project and will be shielded and continuously supplied with ambient river water.

## 4.0 Classification of Recaptured Fish

Recaptured fish and recovery of dislodged inflated balloon tags will be classified as described below. Injuries and de-scaling will be evaluated immediately following recapture and categorized by extent and area of body affected.

The post-passage status of each fish will be designated as: alive, dead, dislodged inflated tag(s) recaptured, unknown, or predation. The following criteria have been established to define these designations: (1) alive--recaptured alive and remaining so for 1 hour; (2) alive--fish does not surface but radio signals indicate movement patterns typical of emigrating

juveniles; (3) dead--recaptured dead or dead within 1 hour of release; (4) dead--only inflated tag(s) without fish are recovered and telemetric tracking, or the manner in which inflated tags surfaced, is not indicative of predation; (5) unknown--no fish or dislodged tags are recaptured, or radio signals are received only briefly, and the subsequent status cannot be ascertained; and (6) predation--fish are either observed being preyed upon, the predator is buoyed to the surface, distinctive bite marks are present on the recovered fish, or subsequent radio telemetric tracking indicates predation (e.g. rapid movements of tagged fish in and out of turbulent waters or sudden appearance of fully inflated tags).

Mortalities of recaptured fish occurring after 1 hour will be assigned as post-passage effects (48 hours). Specimens that die will be necropsied to evaluate the potential cause of death. Additionally, all specimens alive at 48 hours will be re-anesthetized and closely examined for injury and de-scaling. This re-examination of immobilized fish minimizes additional handling stress immediately upon recapture. Fish will be considered de-scaled if greater than 20% scale loss is detected on either side of the fish. Upon completion of the 48-hour assessment, live smolts will be released to the river and any dead fish will be disposed of as permits require.

## 5.0 Sample Size

We propose that the goal for the turbine survival probability be a precision level ($\varepsilon$) of $\leq \pm 0.05$, 90% of the time. It was explained above that tests will be conducted at two turbine discharge levels, and that the number of treatment group fish at the low discharge level could vary between 50 and approximately 150 (and as a complement, the number of fish tested at the higher discharge would vary correspondingly). The reason for the uncertainty in the sample size estimate is due to the precision of the point estimates as sample sizes vary. Achieving the stated precision goal will depend on the similarity between the point estimates at the low and high turbine discharge.

If the results of the two discharges are similar (within five percentage points), the low and high discharge samples will be pooled to obtain a single turbine passage survival estimate and the precision of that estimate will be reported. If the point estimates from the two turbine discharge levels differ by at least 6%, then the samples will not be pooled and point estimates and precision will be reported for each discharge level. If the data from the two discharge levels can be pooled and if results include 95% recapture, 95% control group survival, and 95% overall survival, precision would be <+5%. If 150 fish (50% of the total turbine treatment group) are tested at each of the two discharge levels and reported separately, the two point estimates would have lower precision than the goal. Under the assumptions of 95% recapture, 95% control group survival, and 90% overall survival, the precision about the estimate for a sample of 150 fish would be approximately <+7.5%.

If the previous cursory results from the radio telemetry study and the output from the mathematical model (i.e., survival is high, say >90% at low discharge) are reflected in the first 50 fish tested at low discharge, it may be advantageous to curtail this testing and go to the higher discharge for the remainder of the 300 treatment group fish because the higher level discharge will be more typical of what the unit is operated at and fish will more likely

be attracted to a higher discharge than a lower one for passage, thus more fish would likely pass at the higher discharge. The Study Consultant will use professional judgment to make a recommendation to TransCanada on sample size apportionment for the remainder of the tests.

## 6.0 Data Acquisition, Analysis and Reporting

Data including but not limited to release and recapture times, condition of fish and status after holding, hourly discharge flow, turbine/spill operation level will be recorded. To account for the disposition of all released fish, data results will be provided as described above. All dislodged inflated tags will be conservatively included with the dead fish. Analyses of the data will follow procedures utilized in other balloon tag studies. Upon completion of data analysis, a draft study report will be submitted to resource agencies for review and comment. A final report will then be prepared and submitted to agencies and FERC.

# APPENDIX B

# AGENCY COMMENTS

VERMONT

**State of Vermont**
**Fish & Wildlife Department**
100 Mineral Street, Suite 302
Springfield, VT 05156-3168
**www.vtfishandwildlife.com**

[phone] 802-885-8855
[fax] 802-885-8890
[tdd] 800-253-0191

*Agency of Natural Resources*
[direct line] 802-885-8829
jay.mcmenemy@state.vt.us

January 3, 2008

John L. Ragonese,
FERC License Manager
TransCanada; Northeast Hydro Region
4 Park Street
Concord, NH 03301

RE: Agency Draft of Downstream Fish Passage Monitoring Plan for Vernon, FERC No. 1904

Dear John,

VFW_1 I reviewed the above document that you sent December 3, 2007 via email. The proposal is merely to do a survival test of Atlantic salmon smolts through one of the new turbines, not to conduct a comprehensive evaluation of downstream fish passage under the new flow regime, as I understood was the plan based on previous discussions and the original license.

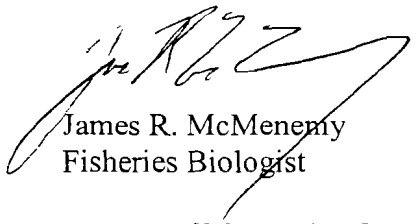
Installation of the new turbines will greatly increase hydraulic capacity while reducing frequency, duration, and volume of spill compared to past conditions including those studied in 1995 and 1996. Flow fluctuations will also presumably be greater when inflows are less than the new capacity. Future conditions with the new turbines operational will be very different than when downstream passage was previously evaluated.

The Vermont Department of Fish and Wildlife recommends that, in addition to the proposed turbine survival study, studies be conducted on Atlantic salmon smolts, and juvenile and adult American shad to assess timely guidance by the louver system to downstream passage routes under full generation conditions. Such studies should be conducted as soon as the new turbines are operational in the appropriate season for each species and life stage.

VFW_2 Salmon smolt studies, including the proposed turbine survival study, need to be conducted in the spring when salmon are physiologically smolts and are actively migrating, not in the fall as proposed. Salmon would not be smolts at that time and would not be expected to be migrating past the project then.

I look forward to further discussion of these studies at your proposed meeting later this winter.

Sincerely,



James R. McMenemy
Fisheries Biologist

cc: Jeff Cueto, DEC
John Warner, USFWS
Ben Rizzo, USFWS
Jan Rowan, USFWS
Gabe Gries, NHFG
Paul Piszczek, NHDES
Eric Palmer, Fisheries Director

# APPENDIX C

# RESPONSE TO AGENCY COMMENTS

## Vernon Hydroelectric Project Downstream Fish Passage Monitoring Plan
## Responses to Agency Comments

**Agency Comment: VFW_1**

The proposal is merely to do a survival test of Atlantic salmon smolts through one of the new turbines, not to conduct a comprehensive evaluation of downstream fish passage under the new flow regime, as I understood was the plan based on previous discussions and the original license.

Installation of the new turbines will greatly increase hydraulic capacity while reducing frequency, duration, and volume of spill compared to past conditions including those studied in 1995 and 1996. Flow fluctuations will also presumably be greater when inflows are less than the new capacity. Future conditions with the new turbines operational will be very different than when downstream passage was previously evaluated.

The Vermont Department of Fish and Wildlife recommends that, in addition to the proposed turbine survival study, studies be conducted on Atlantic salmon smolts and juvenile and adult American shad to assess timely guidance by the louver system to downstream passage routes under full generation conditions. Such studies should be conducted as soon as the new turbines are operational in the appropriate season for each species and life stage.

**TransCanada Response to VFW_1:**

Article 403 of the License Amendment requires TransCanada to submit a plan to *"monitor the effectiveness of the downstream fish passage facilities to assure passage past the project by downstream migrating Atlantic salmon and American shad. The plan shall include measures to assess the effectiveness of the project's downstream passage facilities and/or assess fish survival through the project turbines"*. This is not a requirement for a comprehensive evaluation of downstream passage under a new flow regime. It is a requirement to monitor and assess whether or not Vernon Dam, with new units operating, provides effective passage for Atlantic salmon and American shad through either fish passage facilities **or** turbine passage.

We believe based upon prior studies performed in 1995 and 1996 that Vernon Dam under the operating conditions at that time that Vernon Dam did adequately and effectively passed salmon smolts. In its April 27, 2006 comment on the Amendment Application, the US Fish and Wildlife Service (FWS) stated, "*Subsequent to the construction of the passage facilities, several studies to evaluate the effectiveness of the new facilities were conducted under the existing turbine configuration. These studies generally indicated that passage past the project was acceptable under tested conditions.*" By letter order dated February 27, 1998, the Commission waived any additional downstream passage study requirements, since the completed studies had proved that the existing facilities adequately protected anadromous fish under tested conditions.

The above conclusions, reached under "tested conditions" with the "existing turbine configuration", were based upon the **combined results** of studies evaluating 1.) the effectiveness of the passage facilities, 2.) the louver guidance wall and 3.) **the survivability of turbine passage**. The louver guidance wall did not restrict a significant number of downstream migrants from the Unit 5-10 portion of the forebay and as many as 34% of fish passed through the units behind the louvered guidance wall (see Table 1 below). Over concerns regarding the numbers of fish choosing turbine passage over fish passage resulting in excessive fish mortality additional studies were performed to assess survivability through turbines and fish passage facilities. It was determined that little mortality resulted due to turbine passage, and thus adequacy and effective passage at Vernon was achieved under these conditions (see Table 2 below) .

TransCanada does not believe that operation of the new Units 5-8, when compared to the previous conditions tested, represents a fundamentally significant change that would reduce the adequacy of existing passage facilities. But it agreed with the FWS to perform an evaluation and there is a requirement under the License to conduct an assessment based upon the new operation. The most logical evaluation would be to continue where previous studies left off – evaluate turbine mortality through the new units. TransCanada does not agree that a comprehensive evaluation is warranted, particularly if it involves a re-evaluation of a guidance wall that already has been determined to be partially effective and results suggest as before, a subsequent evaluation of turbine mortality. It would seem more logical to simply evaluate turbine survivability of the new units since there is a reasonable chance fish will pass though the louvers and consider passage though the new units. If mortality through turbine passage is significant, then it may make sense to evaluate what portion of the out-migrating population chooses Unit 5-8 as the passage route.

**Table 1**
**Downstream Fish Passage Effectiveness**
**Vernon Hydroelectric Project, 1995 and 1996**

| Measure of Effectiveness | 1995 | 1996 |
|---|---|---|
| Louver guidance efficiency (percent) | 42.1 | 62.9 |
| Percent through fishpipe | 23.7 | 41.2 |
| Percent through West Fishtube | 34.7 | 15.3 |
| Percent through Units 9-10 | 24.3 | 15.3 |
| Percent through Units 1-4 | 10.4 | 3.5 |
| Percent through spillway | 0 | 23.5 |
| Percent passage via unknown route | 6.0 | 1.2 |

*Source: Normandeau Associates*

**Table 2**
**Downstream Project Survival**
**Vernon Hydroelectric Project, 1995 and 1996**

| Migration Route | % Survival |
|---|---|
| Unit No. 4 at 75% gate opening | 85.1 |
| Unit No. 10 at 75% gate opening | 94.9 |
| Unit No. 10 at 100% gate opening | 100 |
| West Fishtube | 93.3 |
| Fishpipe | 97.5 |
| Flood, Tainter Gates | 97.7 |
| **TOTAL PROJECT [1]** | **95.5** |

*Source: Normandeau Associates*

[1] 95.5% survival is a weighted estimate from proportional passage route selection data obtained from previous radio telemetry studies.

TransCanada believes that the most significant difference between "tested conditions… with existing facilities" and the new un-tested condition is the axial flow Kaplan units themselves and whether or not fish can survive passage through them. There is a reasonable expectation that these units will pass fish with high survivability. As part of the preparation for the license amendment application a desktop turbine survival estimate was performed for a 4MW Kaplan unit at an efficiency rating between 85%-90% (see Table 3). The best-case estimate assumes 90% efficiency and passing runner near blade tip. Worst case assumes 85% efficiency and passing the turbine near the blade hub. The new Vernon Units 5-8 are expected to operate above 90% efficiency between 650 and 1800 cfs discharge at 32 feet of head, representing most if not all of its normal operating range. As such, the estimates from the desktop estimate at 90% efficiency could reasonably represent the new Units 5-8 and may even be a conservative estimate.

**Table 3**
**Results from Desktop Turbine Survival Evaluation**

| OPERATING EFFICIENCY* | UNIT DISCHARGE TESTED | FISH ENTRY POINT (%r)** | CORRELATION FACTOR*** | Fish Length (in) 4 Juvenile. Shad | 6 Salmon Smolt | 8 Salmon Smolt | 10 Salmon Smolt | 12 Adult Shad | 18 Adult Shad |
|---|---|---|---|---|---|---|---|---|---|
| **90%** | **1600** | **90** | **0.1** | **94.6%** | **91.8%** | **89.0%** | **86.3%** | **83.6%** | **75.4%** |
| **90%** | **1600** | **50** | | **97.9%** | **96.9%** | **95.8%** | **94.8%** | **93.7%** | **90.6%** |
| **90%** | **1600** | **10** | | **98.0%** | **97.0%** | **96.0%** | **95.0%** | **94.0%** | **91.0%** |
| **90%** | **1600** | **90** | **0.15** | **91.9%** | **87.7%** | **83.5%** | **79.5%** | **75.4%** | **63.0%** |
| **90%** | **1600** | **50** | | **96.9%** | **95.3%** | **93.7%** | **92.2%** | **90.6%** | **85.9%** |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 90% | 1600 | 10 | | 97.0% | 95.5% | 94.0% | 92.5% | 91.0% | 86.5% |
| 85% | 1600 | 90 | 0.1 | 94.6% | 91.8% | 89.0% | 86.3% | 83.5% | 75.3% |
| 85% | 1600 | 50 | | 97.9% | 96.8% | 95.8% | 94.7% | 93.6% | 90.5% |
| 85% | 1600 | 10 | | 98.0% | 97.0% | 95.9% | 95.0% | 93.4% | 90.9% |
| 85% | 1600 | 90 | 0.15 | 91.9% | 87.7% | 83.5% | 79.4% | 75.3% | 63.0% |
| 85% | 1600 | 50 | | 96.9% | 95.2% | 93.6% | 92.1% | 90.5% | 85.7% |
| 85% | 1600 | 10 | | 97.0% | 95.4% | 93.9% | 92.4% | 90.9% | 86.4% |

*Source: Normandeau Associates*

The trash racks upstream of Units 5-8 continue to remain 2 inches on center which will match previous study conditions. Adult shad turbine passage though such racks seems unlikely should they choose to pass through the louver wall. Flow velocity at the trash racks is estimated to be about 2.4 feet per second and should serve to prevent entrainment.

TransCanada disagrees with the assessment that operational changes as a result of the new Units 5-8 will be detrimental to effectiveness of fish passage facilities. The effectiveness of the guidance wall under previous studies was certainly not optimal. The design of the guidance wall was based upon two14 MW units in operation with two 4.2 MW units for a combined maximum flow of 15,070 cfs operating behind the louvers, with Units 9 and 10 on as the priority units. Studies were conducted with only a maximum flow of 6,870 cfs possible since Units 5 and 8 were retired) possible. The maximum flow through Units 5-10 is 11,270 cfs. The wide high efficient operating range of the new Units 5-8 will result in more consistent use of these units over others with, smoother flow changes in comparison to previous units which were basically full on and full off. Higher priority operation f these units will draw water from the mid and east portions of the river and tend to shift flows closer to the louvered wall. Previous studies (1996 Normandeau) indicated that many of the fish in the forebay area behind the louver wall did so by entering forebay along the west bank portion of the river where there is no louver guidance wall. In addition, previously when flows exceeded 6,780 cfs, Units 1-4, which lie outside the guidance wall, were operated. With the new Units 5-8 in operation up to 11,270 cfs can pass the station behind the louver guidance wall before flows through Units 1-4 is required. This should reduce the frequency and potential for fish to pass through those units. As shown in Table 2, those units have reasonably high survival rates but lower than Units 9 and 10 and most likely lower than the new Units 5-8.

By maintaining the normal operation reservoir fluctuation range of between 220 and 218 feet in elevation in concert with the wide operating range of the new units, maximizing generation dictates station discharge will generally track with inflows and will not result in the greater flow fluctuations as suggested in VFW comments. The new units 5-8 will operate as the priority units except Unit 10 and possibly Unit 9 during fish ladder operation. However, due to their wider operating range of each unit (650-1800 cfs above 90% efficiency), the numbers of start-ups and stops will be reduced compared to all the other units including the old, now replaced Units 6-7.

Results from previous radio tagged studies (1996 Normandeau) suggest that fish passage is not delayed significantly at the project nor does it influence continued travel time to the next passage facility at Cabot Station. The radio tagging study from Spring 2005, in which the residence time before passage was determined for 173 radio tagged salmon smolts (some released above Vernon Dam and others from above Bellows Falls Dam). Residency times averaged 12 hours, with a median of median of 6 hours of at the dam. Of these smolts that were further detected on monitors downstream of Holyoke Dam (about 10%), all passes Holyoke Dam within 2-12 hours after leaving Vernon. This would suggest little affect on continued out-migration due to the residency period above Vernon. Since there was no clear distinguishing difference in residency times at Vernon among the various units and fish passage facilities, TransCanada believes the same variability is likely to continue with the new Units 5-8, and that this will not be a detriment to overall downstream passage.

**Therefore TransCanada believes that the most effective study to initiate at this time is a survivability study of Units 5-8 under various flow conditions as stated in this Plan. TransCanada feels we should proceed with turbine mortality evaluation of these units since fish will likely pass through the guidance wall and seek passage through a unit or through the West Fishtube. If the results indicate a high survival rate under normal operation, TransCanada would suggest that passage past the project would be acceptable, in keeping with previous conclusions as stated in the FWS 4-27-06 comment letter, passage past the project would be acceptable.**

**Agency Comment: VFW_2**

Salmon smolt studies, including the proposed turbine survival study, need to be conducted in the spring when salmon are physiologically smolts and are actively migrating, not in the fall as proposed. Salmon would not be smolts at that time and would not be expected to be migrating past the project then.

**TransCanada Response to VFW_2:**

TransCanada is not opposed to conducting a turbine survival test in spring 2008 presuming at least one of the Units 5-8 are fully operational. Commissioned operation of one or more of these units is anticipated to be the case, however at this time none of them are fully commissioned and tested. A revision to the Plan will indicate this response. It does not appear that ordering and securing balloon-tags is a problem for this schedule.

TransCanada also modified the deadline for the agency consultation meeting to March 31, 2008 in order to combine this consultation meeting with several others that need to occur in late winter or early spring. At this meeting we will discuss the study plan described in this document and produce detailed protocols as to numbers of fish, sources of fish, test scenarios, dates for conducting study and data collection requirements.