UNITED STATES DISTRICT COURT
DISTRICT OF MAINE

FRIENDS OF MERRYMEETING BAY and
ENVIRONMENT MAINE,

Plaintiffs,

v.

NEXTERA ENERGY RESOURCES, LLC;
NEXTERA ENERGY MAINE OPERATING
SERVICES, LLC; FPL ENERGY MAINE
HYDRO, LLC; and THE MERIMIL LIMITED
PARTNERSHIP,

Defendants.

C.A. No. 11-cv-38-GZS

DECLARATION OF RANDY BAILEY

My Education, Qualifications, and Relevant Professional Experience

1. I am the owner and principal senior fishery scientist of my own aquatic resource consulting firm, Bailey Environmental. My office is located at 18294 S. Scotts Lane, Oregon City, OR.

2. I have a B.S. in Natural Resources Management, with an emphasis in Fish and Wildlife Management, from California Polytechnic State University, and an M.S. in Wildlife Management, with an emphasis in Fisheries Science, from Virginia Polytechnic Institute and State University. I am a Fellow Emeritus of the American Institute of Fishery Research Biologists, and am a Life Member of the American Fisheries Society, where I have held various offices and committee memberships over the past 40 years.

3. I have 21 years of experience as a fishery biologist in various positions with the

Federal government, including nine years as the Chief of the Fisheries Division in the Alaska Regional Office of the U.S. Fish and Wildlife Service. In addition, I have 16 years of fishery biology consulting experience specializing in Endangered Species Act ("ESA") issues, where my work has involved the evaluation of the impacts of human development on aquatic ecosystems, and the evaluation of scientific studies, reports, and environmental documents related to ESA compliance.

4. During my years of federal service, I was involved in numerous projects regarding ESA-listed fish species. My work with these projects included evaluating the impacts of resource development on listed species, planning and implementing habitat restoration projects for anadromous salmonids in the western United States, and designing and managing field studies on the life histories of Pacific salmon and other cold water fish species common to the west and Alaska. In my last federal position, I served as the Fish and Wildlife Program Manager for the Portland, Oregon, District of the U.S. Army Corps of Engineers. In this capacity, I was responsible for providing funding and program oversight for fish passage operations, involving numerous ESA-listed fish species, at 11 hydroelectric dams: three main-stem Columbia River dams and eight dams on four tributaries to the Willamette River in Oregon. In this position, I was responsible for the updating and modernization of four fish-trapping facilities on the four Willamette River tributaries and their associated "trap and truck" programs for ESA-listed winter steelhead and spring Chinook salmon. I also was responsible for interagency coordination regarding the development and implementation of an ESA Section 7 consultation for the operation of eight dams in the Willamette River watershed, including provision for fish passage over the eight dams, and management of six associated genetics conservation hatchery programs.

5. In my consulting business, I have specialized in dealing with issues related to ESA-listed fish species for various clients. I have helped clients with a Section 7 consultation on Southern California steelhead trout; provided technical review of various ESA documents, including biological opinions, recovery plans, and ecosystem restoration programs; provided policy recommendations on ESA issues; assisted in the development of the biological assessment for a consultation on operations of the California State Water Project (SWP) and the federal Central Valley Project (CVP); developed a portion of new water quality standards for the Sacramento/San Joaquin Delta; and provided technical review of over $500 million of habitat restoration projects for ESA-listed salmon and steelhead in Central California. I have developed or co-developed two ecosystem restoration plans aimed at protecting or improving conditions for listed species: one for two tributary watersheds to the Sacramento River, and one for the impacts of SWP and CVP operations with an estimated cost of approximately $5 billion. I believe that my experience with Pacific salmon and steelhead are directly applicable to Atlantic salmon, since these species have very similar life histories and habitat requirements.

My Prior Written Opinion

6. On January 16, 2012, I submitted a single written opinion in this case and in three companion cases partially consolidated with this case before this Court. In that opinion I addressed the four hydroelectric projects at issue in this case (the Weston, Shawmut, Lockwood, and Brunswick projects, collectively referred to in this document as the "NextEra dams") as well as the neighboring Hydro Kennebec, Worumbo, and Pejepscot projects. That opinion, which also appends a copy of my curriculum vitae, is attached here as Exhibit 1. On March 16, 2012, I submitted a supplemental opinion in this case addressing the draft Habitat Conservation Plan for Atlantic Salmon for the NextEra dams. That supplemental opinion is attached here as Exhibit 2.

I have been informed that NextEra has recently sold its interest in these projects, but I will use the "NextEra" designation herein for the sake of consistency.

My Evaluation of the Kennebec and Androscoggin Rivers

7. To date, I have conducted four inspections of the Androscoggin and Kennebec watersheds in and adjacent to the four dams at issue in this case, and in and adjacent to the Hydro Kennebec, Worumbo, and Pejepscot projects. I have toured the Androscoggin watershed for many miles upstream of Lisbon Falls, Maine, by helicopter, and I have toured the Sandy River watershed and that portion of the Kennebec River downstream of its confluence with the Sandy River, also by helicopter. In addition, I have examined fish habitat conditions on the ground in both of these watersheds. In my opinion, the habitat conditions and general hydrology of these watersheds are very similar to the many stream systems in Northern California, Nevada, Oregon, and South Central and Southwestern Alaska on which I have worked over the past 35+ years.

Background on the Four NextEra Dams

8. In this declaration I address the effects on Atlantic salmon of the four NextEra hydroelectric projects: Brunswick on the Androscoggin River and Weston, Shawmut, and Lockwood on the Kennebec River. I inspected the Brunswick and Lockwood projects on October 5, 2011, by viewing these projects from public access points at or near the projects. On December 8, 2011, I was provided a formal tour of all four NextEra dams. During this tour, I was accompanied by a former National Marine Fisheries Service fish passage engineer who is a colleague of mine. At each project, NextEra management and individual project staff showed us the physical structure of the project, gave an explanation of how the project generally operates, showed us the internal components of the powerhouse, showed and permitted us to examine the fish bypass facilities, and permitted us to ask questions of them about the project and its

operation. The fish passage engineer and I spent considerable time during this visit discussing the problems and potential ways to improve passage conditions for Atlantic salmon passing each project. This discussion helped inform my analysis of these issues, but the opinions expressed herein are based on my own analysis.

9. In evaluating these hydroelectric projects, I also reviewed: (a) numerous documents regarding one or more of the projects prepared by the owners and/or operators (for which I will use the shorthand term "NextEra"), by consultants hired by NextEra, and by various governmental agencies, including, among others, the National Marine Fisheries Service (NMFS), the U.S. Fish and Wildlife Service (USFWS); and the Maine Department of Marine Resources (MDMR); and (b) the scientific and professional literature on the effects of hydroelectric projects on migrating fish. I refer to a number of these documents in the text of this declaration, and I list those in an alphabetical compilation of references at the end of this declaration. I have also listed the primary documents I consulted in my evaluation of these projects through the date of my January 2012 written opinion at the end of that opinion (Exhibit 1).

10. Each NextEra project consists of several basic components that influence fish passage and survival. Each project, because it raises the water surface elevation, creates an impoundment or reservoir upstream of the dam. Each dam has an overflow spillway section and/or a gated spillway used to pass flows not routed through the project turbines or fish bypass. ("Taintor" and "bascule" gates are two types of gates used to control water flow at hydroelectric projects.)

11. Each project contains one or two powerhouses which contain one or more turbines that generate electricity. Shawmut and Lockwood have a canal upstream of the turbines (known as a "forebay canal") in which water flows toward the turbine intakes. Weston and Brunswick

do not have a forebay canal, and water to the turbines is supplied directly from the upstream impoundment.

12. Each project also has a downstream "bypass," which is a location where a portion of the water flow available to be passed through a turbine is "bypassed" and not allowed to flow into the turbine intake. When installed as a fish bypass, the intent is to provide fish a route past the dam without having to pass through a project turbine.

13. Each of the NextEra projects contains "Francis" type and/or "Kaplan" type turbines. Francis type turbines generally operate at higher rotations per minute (rpm) and have more blades (also called vanes or buckets), typically 10-16, but varying by application, than Kaplan type turbines. Kaplan type turbines (which include "propeller" turbines) usually contain from three to five blades, and usually are larger in diameter than the Francis turbines at NextEra's dams.

14. The three NextEra dams on the Kennebec River, Weston (River Mile [RM] 83.5), Shawmut (RM 70), and Lockwood (RM 63), are the fourth, third, and first dams, respectively, on the main stem of the Kennebec River. The Hydro Kennebec project (RM 64), which is owned by Brookfield Power, is located between Shawmut and Lockwood on the Kennebec and is the second dam on the river's main stem. The three NextEra dams (and Hydro Kennebec) are located downstream from the Sandy River watershed, a Kennebec River tributary which contains the overwhelming majority of spawning habitat currently available for adult Atlantic salmon returning to the Kennebec River. The MDMR transports those returning adult Atlantic salmon captured at the Lockwood fish trapping facility to the Sandy River and releases them in selected areas to spawn naturally. The MDMR also currently plants hundreds of thousands of fertilized Atlantic salmon eggs annually in the Sandy River and selected tributaries. MDMR 2011b in

Section 6 at 7. Atlantic salmon smolts and kelts (post-spawning adults) emigrating from the Sandy River need to survive passage through or over the Weston, Shawmut, Hydro Kennebec, and Lockwood projects in order to successfully complete their emigration (i.e., downstream movement) though Merrymeeting Bay to the Atlantic Ocean.

15. The fourth of these NextEra dams, the Brunswick Project, is the first dam upstream of Merrymeeting Bay on the main stem of the Androscoggin River. Returning adult Atlantic salmon trapped at Brunswick are passed upstream via a modern pool and weir design fish ladder. The next two hydroelectric projects upstream of Brunswick are the Pejepscot and Worumbo projects. These two projects pass adult Atlantic salmon by means of a fish trapping facility on the downstream side of the dam and a vertical fish lift, which lifts adult fish up and allows them to swim into the impoundment upstream of the dam. Passage data compiled by the operators of the Worumbo project and MDMR indicate that some percentage of adult Atlantic salmon passed upstream at Brunswick also make their way upstream past Pejepscot and Worumbo. The amount and geographic distribution of suitable spawning habitat in the Androscoggin River main stem, downstream of Lisbon Falls Dam, and its tributaries have been inadequately documented. Data from MDMR collected at the Brunswick fish trapping facility show a significant percentage of the adult Atlantic salmon captured are wild-origin, which indicates that they originated in the Androscoggin River or its tributaries. MDMR 2011a; MDMR 2012, Table 1. The MDMR has stated that spawning is occurring in the Androscoggin River and/or its tributaries, and has identified the Little River tributary, which is upstream of the Pejepscot Project, as containing spawning and rearing habitat. MDMR 2012; Brown 2010, Topsham 00582. A few thousand Atlantic salmon fry (early juveniles) have been stocked in the Little River every year for the past several years. Miller Hydro Group 2011 at 23. Smolts and kelts coming downstream from

spawning grounds upstream of Worumbo have to survive passage through or over the Worumbo, Pejepscot, and Brunswick projects and those emanating from the Little River have to survive passage through or over Pejepscot and Brunswick in order to successfully emigrate to Merrymeeting Bay and the Atlantic Ocean.

The Effect of These Hydroelectric Projects on Migrating Salmon

16. In my professional opinion, it is a scientific certainty that each of these projects has killed and injured (wounded) emigrating Atlantic salmon during each emigration period since the Atlantic salmon in these rivers were listed as endangered in 2009, and that each of these projects will kill and injure (wound) emigrating Atlantic salmon smolts during their 2013 emigration season. Further it is my opinion that the resultant loss of smolts will have an adverse effect on the Atlantic salmon populations in these rivers, and on the populations of the Merrymeeting Bay Salmon Habitat Recovery Unit and the Gulf of Maine Distinct Population Segment. A number of different factors were used to develop my opinions and conclusions in this declaration, and I discuss the primary such factors below. These factors include: 1) generally-accepted information about hydroelectric projects (¶¶ 18-24); 2) my inspections and evaluations of these facilities and the information known about the specific features of each of these facilities (Weston, ¶¶ 25-32; Shawmut, 33-40; Lockwood, 41-53; Brunswick, 54-63); 3) data and conclusions from empirical studies conducted at these facilities (¶¶ 64-91); 4) empirical studies of turbine mortality conducted at similar facilities (¶¶ 92-100, 111); and 5) the use of a well-known computer model to estimate turbine mortality, using site-specific inputs from NextEra’s turbines(¶¶ 92, 101-111). My examination and evaluation of these factors support my opinion that these hydroelectric projects are harming Atlantic salmon.

17. It is also my opinion that the adverse effects of these projects on this spring's Atlantic salmon smolt emigration could be substantially lessened by a cessation of turbine operation during the smolt emigration period, roughly April 15 through June 5, and that such a cessation of turbine operation during this period would be technologically feasible. I also discuss below how this could be accomplished (¶¶ 112-117).

(a) Generally-Accepted Information about Hydroelectric Projects

18. It is well-known that, unless a hydroelectric dam is equipped with one or more highly effective bypasses that allow close to 100% of the fish to pass safely, (i.e., without striking the projects' surfaces), or fish screens that essentially prevent juvenile fish from passing through the turbines, hydroelectric projects kill and injure some percentage of the fish passing downstream over or through the projects. Stone and Webster Environmental Services 1992, Winchell and Amaral 1997, Robson et. al. 2011, and Normandeau Associates, Inc. and FPL Energy Maine Hydro, LLC 2008d in Table 3-4. The extent of the injury and mortality to downstream migrating fish will vary with the specific features of the individual project, and with the specific features of the river in which that project operates. As discussed in more detail below, I have evaluated these specific project-related and riverine features with regard to the four NextEra dams.

19. Some emigrating fish, especially juveniles such as Atlantic salmon smolts, are harmed by hydroelectric projects even before reaching the projects themselves. Atlantic salmon smolts are adapted to moving downstream to the ocean via a flowing river channel. When they encounter a slower-moving impoundment created by the deepening of the water behind a dam, some smolts exhibit resultant behavioral changes, such as slowing their rate of downstream movement. This is significant, since spending more time en route increases the probability of

predation, which decreases the number of smolts that are able to make the journey out to the ocean. National Research Council, 2004 at 70; Fay 2006 et al. at 75, Holbrook et al. 2011 at 1255. Some smolts will feel compelled to actively swim downstream through slow-moving impoundments (rather than moving at their own pace), in order to meet their need to reach the estuary when growth and survival conditions are optimal. This additional physical demand tends to reduce their energy reserves, meaning that they reach the estuary in a less fit condition to begin the transition to salt water National Research Council, 2004 at 70, Kircheis and Liebich. 2007 at 57, McCormick et al. 2009 at 202. Moreover, the interaction between the slow-moving impoundment and the dam itself provides a well-known opportunity for predators to wait for the salmon near the dam's spillway or fish bypass. Some of the salmon lose their lives in this manner. Brookfield Power 2008, video image VI-3. Madison Paper Industries 2009 at 8. Madison Paper Industries 2010 at HK 9102.

20. At most hydroelectric projects, the most significant source of injury and mortality to emigrating fish is passing though the turbines. Fish passing through turbines are generally killed or injured because of one or a combination of three factors: a) being struck by one of the spinning blades in the turbine, b) being impinged between the outside edge of a blade and the wall surrounding the turbine, and c) being forced to experience the rapid changes in barometric pressure that occur as water passes through the turbine. Stone and Webster Environmental Services 1992 Section 4, Robson et al. 2011 at 31-32**.** Change in barometric pressure is likely not a significant factor at the four NextEra projects because their operations have a low hydraulic head. However, for reasons discussed in more detail below, the other two forms of turbine damage are significant causes of fish death (immediate and delayed) and injury at the NextEra dams. Atlantic salmon smolts that are injured or disoriented, but not killed directly, by turbine

blade strike or impingement are weakened by their injury, which increases their susceptibility to death or further injury from predators, and decreases the likelihood that they will successfully complete their emigration out to the Atlantic Ocean and successfully survive and thrive in marine conditions. National Research Council, 2004 at 70, Kircheis and Liebich. 2007 at 57, McCormick et al. 2009 at 202.

21. The four NextEra dams employ Kaplan type turbines (standard Kaplan or propeller), Francis type turbines, or a combination of both. While both types of turbines kill and injure emigrating fish, Francis turbines are more dangerous. Because Francis turbines generally have more blades, have a shorter distance between blades, and generally rotate at a higher rpm, there is a greater opportunity for fish passing through Francis turbines to be struck or impinged, and the incidence of fish mortality and injury thus is higher for Francis turbines than for Kaplan turbines. Stone and Webster Environmental Services 1992 Section 4.

22. As a general rule, the longer a fish is, the more likely it is to be struck or impinged by a turbine blade. National Marine Fisheries Service, 2012 at 53 Normandeau Associates, Inc. 2012a at 5; Stone and Webster Environmental Services 1992 Section 4. Robson et al. 2011 at 34. Accordingly, the mortality rate for adult Atlantic salmon passing through turbines is higher than the mortality rate for smolts. A differential mortality rate for longer fish is a significant issue for Atlantic salmon smolts as well. Experience has demonstrated that the larger smolts have a higher probability than smaller smolts of successfully migrating out to the ocean, of surviving and thriving in the marine environment, and of returning to the river to spawn as adults; larger-size smolts survive in the environment at a substantially higher rate. Fay 2006 et al. at 15**.** The fact that turbines kill and injure these larger smolts at a higher rate is especially detrimental to the recovery and survival of the species.

23. A percentage of the fish passing via spill, either through spillway gates or over the crest of dams (with or without flashboards installed), are killed, injured, and/or disoriented by striking project infrastructure (particularly glancing blows), striking the sill at the bottom of the dam on the downstream side, or by turbulence created by the amount of flow and the configuration of the downstream spillway. Robson et al. 2011 at 30-34. Normandeau 2012a at 4. As is discussed in more detail below, the extent of the injury and mortality to salmon smolts from passage by spill at the four NextEra dams varies with the design of the individual dams.

24. Although a well-designed bypass usually is the safest route of passage for salmon smolts migrating downstream past a hydroelectric project, bypasses also cause a certain amount of injury and mortality. Fish can be injured or killed in bypass systems due to the way the water entering the bypass system strikes hard objects in the bypass such as the walls or any associated infrastructure. Flow hydraulics in a bypass can also cause fish to be essentially trapped in the bypass or to become disoriented because of turbulent flow. This disorientation changes their behavior, and can attract predators that would not normally be attracted, resulting in death by predation. Madison Paper Industries 2009, Appendix C.; Robson et al. 2011 at 30-34. Normandeau 2012a at 4. In my professional experience, I have on numerous occasions seen predators (avian and aquatic) waiting near the upstream entrance to, or the downstream bypass outflow at, hydroelectric projects and feeding on either the fish attempting to find a route through the project or on the (often disoriented) fish that pass through the bypass. Predatory fishes such as striped bass, largemouth bass, smallmouth bass, brown trout and rainbow trout exist in the Kennebec and Androscoggin rivers and have been captured at the Brunswick and Lockwood project fish trapping facilities. NextEra™ Energy Maine Operating Services, LLC. 2011 at 10; Maine Department of Marine Resources 2011a at 11. A study done at the Hydro Kennebec

Project in 2008 found predators waiting for smaller fish at the upstream entrance to that project's fish bypass. Madison Paper Industries 2009 at 8.

(b) Specific Features of the NextEra Dams

(i) The Weston Project

25. The Weston Project (Weston) (RM 83.5) is the first hydroelectric project downstream of the Sandy River's confluence with the Kennebec River main stem and is located in Skowhegan, Maine. Normandeau 2012b. This project consists of two dams, one on either side of Weston Island. The North Channel dam is approximately 38 feet high and 530 feet wide, and contains no turbines. The South Channel dam is approximately 51 feet high and 391 feet wide, and contains a powerhouse with four Francis turbines. The impoundment behind the dam is approximately 930 acres and extends upstream approximately12.4 miles. The project hydraulic capacity (i.e., the total volume of water flowing through the turbines when they are all operating at maximum capacity) is approximately 6,700 cubic feet per second (cfs). Normandeau 2012b at 2-3.

26. Emigrating Atlantic salmon (smolts or kelts) approaching the Weston Project can potentially pass the project via one of three routes: 1) through the operating turbines, 2) via water spilling over the dam and/or through open gates or sluiceways spill, and 3) through a designated downstream bypass which is intended to provide fish an alternative route other than passing through an operating turbine. Normandeau Associates 2012c, at 4-5. When river flow is below the project's hydraulic capacity, the only downstream passage routes available for emigrating Atlantic salmon are through the operating turbines and/or a bypass sluice located adjacent to the Project's turbines.

27. Given the location of the powerhouse along the north bank of the South Channel, it is likely, based on my experience in observing salmon behavior, that fish moving along the north bank of the river would follow the north and east shoreline of Weston Island towards the project turbines. Under non-spill conditions the river flows in the South Channel where the powerhouse is located, with some minor spill occurring in the North Channel between flashboards and/or via leakage. This is the condition that existed during the 2012 radio telemetry study conducted by Normandeau Associates for NextEra, which is discussed in more detail below. Normandeau 2012c.

28. All four of the turbines at Weston are vertical Francis turbines. Two of these Francis turbines each have 13 buckets (blades) that rotate at 100 rpm. The other two each have 16 buckets (blades) that rotate at 100 rpm. Normandeau Associates, Inc. 2011h. Submission 00003964. Given the large number of blades on each of the turbines, the relative probability of blade strike or impingement of fish passing through an operating turbine of this type is high (e.g., fish passing through these turbines are more likely to be struck or impinged by a blade than a fish passing through a Kaplan type turbine). Stone and Webster Environmental Services (1992) Section 4.

29. A log sluice is used as the sole fish bypass at Weston. This sluice also serves the function of allowing debris to pass. Normandeau Associates 2012c, at 4-5. The sluice, which is approximately 18 foot wide by 14 foot deep, is located in the South channel portion; there is no bypass in the North Channel portion. In the fall of 2011, after the 2011 smolt emigration, NextEra installed a floating boom structure meant to help guide fish toward the sluice and away from the turbines. Richter (2012) at 145-146. Once installed, the boom experienced certain difficulties that likely diminished its functionality as a guidance device. Richter (2012) at 147.

30. Although the sluice has a capacity of 2,250 cfs, it is usually operated at a flow rate of 120 cfs (Personal communication with NextEra staff on the December 8, 2011 site visit). A flow rate of 120 cfs through the sluice is only 1.79% of the project's hydraulic capacity. Flow rate through a downstream bypass is important, especially in relationship to the project's hydraulic capacity, because bypass flow rate is one of the factors that helps determine the extent to which fish will be drawn away from the flow passing through the turbines and use the downstream bypass. In general, all other things being equal, the greater the flow to the bypass in proportion to the hydraulic capacity of a project, the more likely it is that fish will find and utilize the bypass instead of passing through the project's turbines. Normandeau 2012c at 26-27.

31. In the spring of 2012, during a radio telemetry tracking study conducted by NextEra consultants Normandeau Associates, the flow to the sluice was variously kept at 2%, 4%, and 6% of the actual flow through the turbines. Normandeau 2012c at 26-27. During this study, 68.4% of smolts passing Weston used the bypass sluice with the flow set at 6% of turbine flow, 45.5% of smolts passing Weston used the bypass sluice with the flow set at 4% of turbine flow, and 43.8% of smolts passing Weston used the bypass sluice with the flow set at 2% of turbine low. Normandeau 2012c at 26-27. These results indicate that when the percentage of river flow sent through the bypass is lower (set at 2% to 4% of turbine flow), a majority of the Atlantic salmon smolts passing the project via the South channel (as all the smolts must do when there is no spill) will pass through the project's turbines, where a portion of them will be killed or injured. The percentage of emigrating smolts using the bypass sluice is significantly higher when the flow to the bypass is set at 6% of turbine flow, but a significant portion of the salmon smolts passing the project via the South channel will nonetheless pass through the project's turbines, and a portion

of these will be killed or injured by such passage. Stone and Webster Environmental Services 1992 Section 4; Winchell and Amaral 1997; Robson et al. 2011 at 34.

32. In addition to death or injury from turbine passage, some portion of downstream migrating smolts are killed or injured by spillway passage, passage through the sluice, by project-enhanced predation, and by the effects of the project's impoundment which, at over 12 miles in length, is substantial.

(ii) The Shawmut Project

33. The second hydroelectric project downstream of the Sandy River's confluence with the main stem Kennebec River is the Shawmut Project, which is located at approximately river mile 70, near the town of Fairfield, Maine. The Shawmut Project spans the entire width of the Kennebec, including a 1,135-foot long dam with an average height of about 22 feet, and an adjoining forebay section. The impoundment behind the project is approximately 1,310 acres and extends upstream approximately12 miles. The project hydraulic capacity is approximately 6,700 cfs. Normandeau 2012c at 5-6; Normandeau 2012d at 2

34. Emigrating Atlantic salmon approaching the Shawmut Project from upriver can potentially pass the project via one of three routes: via the turbines, via spill, and via the downstream bypass. Normandeau 2012c at 5. However, fish entering the forebay at Shawmut can pass via the turbines or the bypass, but not via spill, unless they swim back against the current to reach a point upstream of the forebay intake structure, which they are unlikely to do. When river flow is below the project hydraulic capacity, there is no spill, and the only two available passage routes are the turbines and the downstream bypass located in the forebay between the two powerhouses.

35. The Shawmut Project has two powerhouses, with a total of eight turbines. The first powerhouse contains Units 1-6, which are horizontal Francis turbines. The second powerhouse contains Units 7 and 8, which are horizontal fixed propeller turbines (a type of Kaplan turbine). Four of the Francis units at Shawmut have ten buckets (blades) each, which rotate at 200 rpm when generating electricity. The other two Francis units at Shawmut have turbine runners with 13 buckets each, which also rotate at 200 rpm when generating electricity. Normandeau Associates, Inc. 2011h. Submission 00003964. Given the large number of blades on each of these turbines and the high speed at which they rotate, the relative probability of blade strike or impingement is high (i.e., these turbines will cause blade strike or impingement more often than the average turbine).

36. The two propeller units at Shawmut have turbine runners with three blades each, which spin at 160 rpm when generating electricity. FPL Energy Maine Hydro, LLC and Merimil Limited Partnership 2013, Table 3.2.1. With fewer blades and relatively slower rotation, these turbines are likely to cause blade strike or impingement less often than the Francis turbines. However, the speed of rotation for these propeller turbines is still high, which increases the incidence of blade strike and impingement for salmon passing through these turbines.

37. The Shawmut Project has a 4 foot wide by 22 inch deep surface sluice located between the two powerhouses at the South end of the project's forebay, with a maximum flow capacity of 35 cfs, that serves as a fish bypass. There is no guidance boom at Shawmut. Normandeau 2012c at 5; Normandeau 2012d at 2. Given that the flow to this bypass is less than 1% of the project's hydraulic capacity of 6,700 cfs, this bypass likely passes only a small percentage of emigrating smolts. Reliance on this bypass alone, then, allows the great majority of the smolts entering the Shawmut forebay to pass through the turbines and be subjected to

higher levels of mortality and injury. It is my understanding from discussions with NextEra personnel that, prior to the 2012 Normandeau smolt study at the Shawmut Project, this 35 cfs sluice was used as the principal fish bypass mechanism at the project.

38. The Shawmut Project also has a 10 foot by 7 foot Taintor gate located at the south end of the forebay between the powerhouses. During the spring 2012 smolt study conducted by Normandeau Associates, the 35 cfs surface sluice was closed, and the Taintor gate was instead opened and set to constantly pass an estimated 600 cfs of river flow, and the flow through the Taintor gate ranged between 9% and 17% of total river flow during the course of the study. Normandeau 2012 at 2, 5. With this larger bypass route and corresponding increase in bypass flow available for fish, I would expect a higher percentage of smolts to pass the project via bypass flow than when the much smaller surface sluice (with a flow of only 0.52% of hydraulic capacity) is used as a bypass. The results of the 2012 Normandeau study support this conclusion, as 81.5% of the smolts passing Shawmut during that test reportedly passed via the bypass flow. Normandeau 2012 at 33. This level of bypass usage still allowed almost one fifth of the radio tagged smolts to pass through the turbines. A portion of the fish passing through these turbines will be killed or injured by such passage. Use of this much larger bypass flow would reduce injury and mortality to emigrating salmon if it were incorporated into the project's future operating regime.

39. It should be noted that the test conditions for the 2012 study may not have been indicative of normal operating conditions, because only the two propeller turbines were operating at 100% capacity during the period of the study. According to Normandeau, "Operation of the six Francis units varied with the lowest amount of operational time occurring at Unit 1 (located furthest upstream and away from the entrance to the downstream bypass)."

Normandeau 2012c at 13. In general, the reduced flow to the Francis turbines likely reduced the number of smolts passing through those turbines. This conclusion is supported by data on fish passage through Lockwood from the same study, which clearly demonstrate that the percentage of smolts passing through the Francis turbines increased when the number of turbines online increased to full station capacity, even though the percentage of bypass flow remained the same. Normandeau 2012c, Table 3 and Appendix Table A.

40. In addition to death or injury from turbine passage, some portion of downstream migrating smolts are killed or injured by spillway passage, passage through the sluice, by project-enhanced predation, and by the effects of the project's impoundment which, at over 12 miles in length, is substantial. However, given the height and shape of the spillway structure at Shawmut compared to that at Weston, I would expect the spillway mortality at Shawmut to be somewhat lower.

(c) The Lockwood Project

41. The fourth hydroelectric project downstream of the Sandy River's confluence with the main stem Kennebec River is the Lockwood Project, which is located at approximately river mile 63, in Waterville, Maine. Lockwood is approximately one mile downstream from the Hydro Kennebec Project, which is the third hydroelectric project downstream of the Sandy River on the Kennebec River. Normandeau 2012 at 6.

42. The Lockwood Project has an 875 foot long and up to 17 foot high dam with two spillway sections (with 15-inch flashboards) and a log sluice. The east spillway section begins on the east side of the river and extends approximately 225 feet in a westerly direction to a small island, and the west spillway section extends from the island another 650 feet in a southwesterly direction. There is an adjoining 160 foot long forebay section that contains two powerhouses on

the west side of the river, and a forebay canal that extends approximately 450 feet upstream of the entry to the turbines. Normandeau 2012c at 6. The dam creates an impoundment of approximately 81.5 acres that extends nearly upstream to the Hydro Kennebec Project. The project hydraulic capacity (the combined river flow through the turbines when they all are operating at full capacity) is approximately 5,600 cfs. Normandeau 2012c at 6.

43. Emigrating salmon approaching the Lockwood Project from upriver can potentially pass the project via one of three routes: via the turbines, via spill, and via a downstream bypass (one bypass sluice and two smaller sluice gates). Normandeau 2012c at 6. However, fish entering the forebay canal can pass via the turbines, the downstream bypass, or the fish trapping facility sluiceway (which is not used throughout the entire smolt or kelt emigration period), but not via spill, unless they swim back against the current to reach a point upstream of the forebay intake structure, which they are unlikely to do. Also, when river flow is below the project hydraulic capacity, there is no spill, and the only available passage routes during the entire smolt or kelt emigration period are the turbines and the downstream bypass.

44. One of the powerhouses at Lockwood contains six vertical Francis turbines, and each of the turbine runners in these Francis turbines has 15 blades, and rotates at 133 rpm when generating electricity. The second powerhouse at Lockwood has one horizontal Kaplan turbine with 5 blades that rotate at 144 rpm when generating electricity. Normandeau Associates, Inc. 2011h. Submission 00003964. Given the large number of blades on each of the Francis turbines and the fact that they each rotate slightly more than twice per second, the relative probability of blade strike or impingement is high. With its fewer blades and larger diameter, the Kaplan turbine at Lockwood is likely to cause blade strike or impingement less often than the Francis turbines. Normandeau Associates, Inc. 2011h. Submission 00003964. However, the speed of

rotation for this Kaplan turbine is relatively high, which increases the incidence of blade strike and impingement for salmon passing through this turbine.

45. From my observation of the physical layout of the Lockwood Project and my knowledge of salmon behavior, I believe it likely that Atlantic salmon emigrating downstream along the west bank of the Kennebec would move directly into the forebay canal and toward the project's turbines. The project contains three surface sluices in the forebay area through which fish can potentially pass and thus avoid the turbines. The primary fish bypass is a gated seven foot wide by nine foot deep sluice, located on the east side of the forebay near the first Francis turbine intake, that can pass approximately 340 cfs of river flow, which is approximately 6% of station hydraulic capacity, when the gate is fully open. It was installed in the project in 2009, along with a boom intended to guide fish toward that sluice. There are also two smaller sluices that are used to pass ice and debris through which fish can potentially pass: a six foot wide by 30 inch deep surface sluice between the two powerhouses, and another surface sluice, measuring approximately 7.5 feet wide by 16 inches deep, located above the project head works structure, with a manually adjustable fixed gate to control flow. Reportedly, these two additional sluices pass between 95 cfs and 110 cfs of river flow, depending on the headpond elevation and the adjustment to the fixed gate. Normandeau 2012c at 6.

46. The ineffectiveness of the two smaller sluices at passing salmon smolts was documented by Normandeau in a 2007 study, before the larger bypass sluice was installed. Using radio telemetry technology, Normandeau tracked the downstream passage routes of smolts released upstream. "For all radio-tagged Atlantic salmon smolts released into or entering the powerhouse canal, approximately 18% (8 of 45) passed via the surface sluice and the other 82%

(37 of 45) passed via the turbine units." Normandeau Associates, Inc. and FPL Energy Maine Hydro, LLC, 2008d at 7.

47. The effectiveness of the downstream bypass at passing Atlantic salmon smolts, with the fish guidance boom apparently fully intact and operating, was evaluated by Normandeau Associates in the spring of 2011. Using radio telemetry technology, Normandeau tracked the downstream passage routes of smolts released upstream. The study results reported for Lockwood incorporated smolts released immediately above Lockwood and smolts released above Hydro Kennebec as part of a companion study performed by Normandeau at that project during the same period. The antennas (radio signal receivers) that had been set up by Normandeau at Lockwood were able to detect radio tagged Atlantic salmon smolts that had been released at Hydro Kennebec and made their way downstream to Lockwood. Of all the radio-tagged smolts entering the forebay canal at Lockwood (from both the Lockwood and Hydro Kennebec release groups) for which definitive passage routes were determined, only 18.8% (12 out of 64) passed via one of the three sluices, while 81.2% (52 out of 64) passed via the turbines. Normandeau 2012f, Table 17.

48. The results of the 2011 study illustrate the importance of flow through the bypass. When all of the tags from both the Lockwood and Hydro Kennebec releases are evaluated, the downstream bypass effectiveness at Lockwood (i.e., the percentage of fish using the bypass) increased from 14.3% to 20.9% when the bypass flow was increased from 4% to 6% of station capacity. Normandeau Associates, Inc. 2012f at 15.

49. The effectiveness of the downstream bypass sluices at Lockwood was again evaluated in the spring of 2012. Prior to this study, NextEra reportedly made changes to the fish guidance boom designed to improve its performance. Normandeau 2012 at 3. The 2012 radio

telemetry study, which was again performed by Normandeau, was conducted from May 22 through June 12. For the period of the study, the gate to the primary bypass sluice was adjusted in proportion to turbine flow, such that the flow to the bypass was maintained at 6% of actual flow through the project's turbines, and it was estimated that the flow to the bypass varied from 199 cfs to 336 cfs during the course of the study. Normandeau 2012 at 13.

50. Using radio telemetry technology, Normandeau tracked the downstream passage routes of smolts released upstream. (These included not only the smolts released above Weston, and those released above Lockwood, in the NextEra study, but also smolts released above Hydro Kennebec as part of a companion study performed by Normandeau during the same period.) Of all the radio-tagged smolts entering the forebay canal during the study, 66% (85 of 128) passed the project through the bypass, while 34% (43 of 128) passed through the turbines. Normandeau 2012c, Table 11. Of those smolts passing through the turbines, 49% were passed through the Kaplan turbine, and 51% were passed through one of the Francis turbines. Normandeau 2012c, Table 11.

51. It appears that maintaining the bypass at its maximum flow rate, and increasing the effectiveness of fish guidance technology, improves the effectiveness of the bypass as a means of keeping salmon out of the project's turbines. However, one third of the smolts entering the Lockwood forebay canal still passed through the project's turbines. A portion of the fish passing through the project's turbines will be killed or injured by such passage.

52. Test conditions for this study may not have been indicative of normal operating conditions at Lockwood, because only the Kaplan turbine was operating at or near 100% capacity during the period of the study. According to Normandeau, "Operation of the six Francis units varied with the lowest amount of operational time occurring at Unit 6 (located furthest

away from the entrance to the downstream bypass)." Normandeau 2012c at 13. Also, three of the six Francis turbines were off line for the first seven days after fish were being released starting on May 22, 201. Normandeau 2012c, Table 3. In general, having 50% of the Francis turbines offline during the first seven day of the study likely resulted in fewer smolts passing through the project's turbines than would have if all turbines had been fully online. As noted above, the percentage of smolts passing through the turbines increased when the number of turbines online increased to full station capacity, even though the percentage of bypass flow remained the same. Normandeau 2012c, Table 3 and Appendix Table A.

53. In addition to death or injury from turbine passage, some portion of emigrating smolts are killed or injured by spillway passage, passage through the sluice, by project-enhanced predation, and by the effects of the project's impoundment. The impoundment-related effects at Lockwood would be expected to be less significant than those at Weston and Shawmut, given smaller size of the impoundment. In addition, given the height and shape of the spillway structure at Lockwood compared to that at Weston, I would expect the spillway mortality at Lockwood to be somewhat lower.

(iv) The Brunswick Project

54. The Brunswick Project is the first hydroelectric project upstream of Merrymeeting Bay on the Androscoggin River; it is located at approximately river mile 6, at the junction of the towns of Brunswick and Topsham, Maine. The Brunswick Project spans the width of the Androscoggin, and includes a 605 foot long dam and an adjoining powerhouse section. The dam extends up to 40 feet high, and contains various spillway and Taintor gate sections. The impoundment created by the Brunswick Project is 4.5 miles long and encompasses 300 acres. The project hydraulic capacity (the combined river flow through the turbines when they all are

operating at full capacity) is approximately 7,800 cfs. Normandeau Associates, Inc. 2012e at 2.

55. Atlantic salmon adults returning to the Androscoggin River and passed upstream at the Brunswick Project are counted by MDMR, and the number is reported annually in an annual Brunswick Fishway Report prepared by MDMR. All of the smolts produced when these salmon spawn upstream of the Brunswick Project must successfully pass through or over the project to reach Merrymeeting Bay and the Atlantic Ocean.

56. Downstream migrating salmon approaching the Brunswick Project from upriver can potentially pass the project via one of three routes: via the turbines, via spill, and via the downstream bypass. Normandeau Associates, Inc. 2012e at 2.

57. The powerhouse structure at the Brunswick Project contains one vertical propeller turbine and two smaller horizontal propeller turbine. The vertical turbine has 5 blades, which rotate at 90 rpm when generating electricity. The two horizontal propeller turbines at Brunswick have 4 blades each, which rotate at roughly 211.8 rpm when generating electricity. Normandeau Associates, Inc. 2011h. Submission 00003964

58. There is one small downstream fish bypass at the Brunswick Project. The entrance to this bypass, which is located between the two powerhouse sections, is a grate covering the upstream end of an 18-inch pipe that leads down to the tailrace on the downstream side of the project. Normandeau Associates, Inc. 2012e at 2. The maximum flow to the bypass is approximately 60 cfs according to Brunswick Project personnel during our discussions on my December 8, 2011 site visit. A bypass flow of 60 cfs represents 0.8% of the station hydraulic capacity. There is no boom or other kind of guidance mechanism intended to guide fish toward the bypass pipe.

59. In my professional opinion, this bypass pipe is inadequate to prevent a significant

portion of downstream migrating salmon smolts from entering the project's turbines. It is quite small in surface area in comparison to the intakes to the project's turbines, and even when operated at maximum flow, the bypass flow is miniscule when compared to station hydraulic capacity. Furthermore, the entrance to the bypass pipe is located immediately adjacent to the intake to the vertical propeller turbine, which extends up to the water's surface, and just to the north of the twin intakes to the smaller horizontal turbines, which are approximately 20 feet below the surface. At a maximum bypass flow of 60 cfs, the bypass pipe is unlikely to be able to effectively "compete" for downstream migrating smolts with the flows to the larger turbine (which has a maximum flow of 5,075 cfs) or with the flows to the smaller turbines (which have a combined maximum flow of 2,672 cfs). That is, the fish that approach this portion of the project will tend to follow the flow, and will tend to go through the turbines rather than through the functionally inadequate bypass pipe.

60. The Brunswick Project bypass is also poorly positioned in relation to river flow and the likely path of downstream migrating salmon. The natural behavior of salmon when migrating downstream is to be oriented close to the shoreline. At this juncture in the river, the Androscoggin is flowing from west to east, and the smolts are likely to be traveling along the east bank. Thus, when they encounter the Brunswick Project, they will need to be able to work their way back across the eastern powerhouse section and the twin turbine intakes (and then to withstand the powerful surface flow to the larger turbine in the western powerhouse section) to be able to successfully locate and utilize the bypass pipe.

61. It is my professional opinion that, without an adequate downstream bypass system, the Brunswick Project presently passes a very large percentage of downstream migrating salmon smolts through the project's turbines, that this percentage increases during periods of low or no

spill, and that and a portion of the smolts passing through the turbines are killed or injured by such passage.

62. In addition to death or injury from turbine passage, some smaller portion of downstream migrating smolts are killed or injured by spillway passage, passage through the sluice, by project-enhanced predation, and by the effects of the project's impoundment. However, the impoundment-related effects at Brunswick would be expected to be less significant than those at Weston and Shawmut, given the smaller size of the impoundment, although at a length of 4.5 miles and an area of some 300 acres, the size of the Brunswick impoundment is still significant.

63. The river channel immediately downstream of the powerhouse tailrace appears deep and highly confined. This type of habitat is very conducive to harboring predators such as striped bass. Given the probability of fish being disoriented by passing through the turbines, it is my opinion that predation rates in this specific area of the Project are higher than other areas. In addition, the extensive bedrock ledges immediately downstream of the spillway section and the presence of a concrete sill along the downstream base of the spillway section provide low velocity habitat for potential predators, and I conclude that predation is elevated in this specific area as well, especially for salmon smolts that are disoriented by their passage over the spillway.

(c) Salmon Smolt Mortality Data from the Three Radio Telemetry Studies

64. The above-referenced radio telemetry studies of radio tagged Atlantic salmon smolts completed by Normandeau Associates at the Lockwood Project in 2007 and 2011 and at Weston, Shawmut, and Lockwood in 2012 (Normandeau 2012c) provide site-specific empirical data demonstrating that each of NextEra's Kennebec River projects kill emigrating Atlantic salmon smolts. In 2012, Normandeau Associates also conducted a concurrent study designed to

specifically assess mortality of Atlantic salmon smolts passing through the Hydro Kennebec project (Bernier 2012), which is located one mile upstream of the Lockwood Project. The four groups of radio tagged smolts that were released upstream of Hydro Kennebec in the Hydro Kennebec study were also tracked via the monitoring stations located at and downstream of Lockwood, and the results from those monitoring stations for those fish were included as part of the radio tagging study results for Lockwood in the NextEra study. The Hydro Kennebec study demonstrated that emigrating Atlantic salmon smolts are also killed by passing through Hydro Kennebec (Bernier 2012). Hydro Kennebec uses Kaplan turbines that are similar to the Kaplan turbine used at Lockwood.

65. The use of radio telemetry to track fish movements dates from the early 1970s, when radio tagged fish movements were monitored from either fixed antennas or via mobile tracking from a boat or vehicle adjacent to the water body. Winter 1996 at 555. The use of radio tagging to track fish movements is widely accepted in the fishery biology and management community. The scientific literature is replete with studies documenting, and relying on, the use of this technique. I have personally conducted and supervised an extensive two-year radio telemetry study on migratory salmonid fish species covering approximately 120 miles of river channel.

66. In a radio tagging study, fish are fitted with a radio transmitter, which can be attached externally, surgically implanted into the body cavity with an antenna trailing out through the incision, or inserted down the fish’s esophagus and into the stomach (with the antenna either left to trail out the fish’s mouth and down its side or threaded out through the gill arch and left to trail down its side). Once a fish is tagged, it is usually held in a tank to assess any mortality from the tagging operation, observe any abnormal behavior resulting from the

tagging procedure, assess whether the transmitter if functioning as intended, and determine whether there has been any shedding or regurgitation of the transmitter. Tags are set to transmit a signal at a fixed interval (two second intervals were used in the 2012 studies). Receivers pick up the radio signal, indicating the location of the tag. Monitoring radio signals can be accomplished using fixed locations, mobile ground tracking from a vehicle or boat, or from the air via helicopter or small fixed wing aircraft.

67. Tracking fish for successive time periods determines where and how fast a fish moves past a fixed point. In the case of mobile or aerial tracking, a time series of movements at the tracking interval is possible. The 2012 studies used fixed antenna locations to determine when a fish tagged upstream passed a particular point at some distance downstream from the original release location. The signal range for most radio telemetry studies of smolts is from hundreds of meters to more than a mile, depending on the particular tag. The manufacturer of the tags used in the 2012 studies stated to me that the range of these tags is “hundreds of meters.” The manufacturer also stated to me that this signal range would be reduced by about 75% if the tagged fish were eaten by a predator. Paul Wigglesworth, Lotek Manufacturing technical services representative, personal communication 2/13/13.

68. Radio tagging studies can be used to document acute (immediate) mortality or delayed mortality that occurs because of an injury that is caused by a fish passing through a dam’s infrastructure (i.e., operating turbines or downstream bypasses) or passing via spill through a gate or over the overflow section of the dam. If a radio tag that passes over or through a dam becomes stationary after passing the dam, the generally-accepted conclusion in the fishery biology profession is that the fish suffered acute mortality as a result of such passage. Radio tagging studies can be specifically designed to assess dam-related mortality through the use of

paired releases (i.e. upstream of the dam and downstream of the dam releases), which allow comparison of the percentage of fish passing a common fixed point downstream of the dam (the assessment point) for each release group. Differences in the percentages of fish passing the assessment point from the downstream release versus the upstream release are considered quantifiable and scientifically defensible measures of dam related mortality. An example of this paired-release methodology is the 2012 Hydro Kennebec study. Bernier 2012. Studies that do not have a paired downstream release group, such as the 2007, 2011, and 2012 studies of NextEra's Kennebec River dams, may also be used to draw scientifically defensible conclusions regarding acute mortality, because the presence of a stationary radio tag downstream of the dam is a strong and scientifically defensible indicator of acute mortality. The distance a tag may travel downstream before becoming stationary depends on the water velocity, the amount of turbulence in the water, the size of the fish, and the weight of the tag used in the study. On the other hand, some tagged fish detected passing the downstream assessment point may in fact die shortly after passing that location due to injuries suffered during dam passage that were not severe enough to cause acute mortality. This circumstance is referred to as delayed mortality, and it will not be detected in a radio telemetry study unless there is adequate monitoring further downstream. In some tests, other factors such as tag regurgitation, tag failure, or natural predation may also cause a tag to become stationary and/or to be undetected downstream. I evaluate these factors below with regard to the 2011 and 2012 NextEra studies.

(i) The 2007 Radio Telemetry Study at Lockwood

69. Normandeau Associates conducted an Atlantic salmon smolt downstream passage study at the Lockwood Project on behalf of NextEra in the spring of 2007, before the completion of the third sluiceway (bypass) in the power canal in 2009. In this study, radio tagged smolts

were released above the project and their routes were traced using manual receivers employed in vehicle and boat surveys. Normandeau Associates, Inc. and FPL Energy Maine Hydro, LLC. 2008d Study Results at 5.

70. A total of 37 radio-tagged smolts passed through the Lockwood turbines during this study. Normandeau Associates, Inc. and FPL Energy Maine Hydro, LLC, 2008d at 7. Of these 37, five "became stationary after passage at Lockwood and were assumed dead." Four of these five had passed through the Kaplan turbine, and one had passed through one of the Francis turbines. Normandeau Associates, Inc. and FPL Energy Maine Hydro, LLC. 2008d, Study Results at 5. As summarized in the study report: "Immediate survival of the Atlantic salmon smolts that passed through the turbine units was 86% (32 of 37). This data is similar to numerous other turbine passage studies throughout the country (Normandeau et. al.) that suggest that turbine passage survival for salmon smolts can be in that range." Normandeau Associates, Inc. and FPL Energy Maine Hydro, LLC, 2008d at 7.

71. In a report to the Federal Energy Regulatory Commission regarding the 2007 study, NextEra confirmed that "14% of the smolts [known to have passed through the turbines] were subject to turbine mortality." FPL Energy Maine Hydro, LLC. 2008a at 6. In response to questions and comments from the MDMR, NextEra confirmed that this study had measured only immediate, and not delayed, mortality, but that "the data is nonetheless valid within the limits of the study." FPL Energy Maine 2008b.

72. All of the entities involved in conducting and reviewing the study results concluded that the stationary tags represented acute mortality of Atlantic salmon smolts after passage through the project's turbines. As noted, this is consistent with standard practice within the profession, and it is my professional opinion, based on the data, that these stationary tags did

indicate immediate turbine passage mortalities. It is also noteworthy that intensive downstream monitoring of tag location, via both vehicle and boat mobile tracking, was necessary to locate the stationary tags. Although one of the mortalities became stationary in the Lockwood tailrace, the rest did not settle to the bottom of the river and become stationary for as much as a mile downstream of the project. Normandeau Associates, Inc. and FPL Energy Maine Hydro, LLC. 2008d study results at 5.

(ii) The 2011 Radio Telemetry Study at Lockwood

73. Normandeau conducted another Atlantic salmon smolt downstream passage study at the Lockwood Project on behalf of NextEra, also using radio telemetry technology, in the spring of 2011. In this study, downstream passage routes were tracked for radio-tagged smolts released into the power canal (forebay canal) and upstream of the project.

74. Before the study began, a group of 20 fish was tagged and then held and monitored for tag regurgitation and any effects of tagging on fish mortality. Three of these fish regurgitated their tags within one hour, and three additional fish were then tagged and monitored with the remaining 17. Of this group, only one of 20 of the fish had regurgitated its tag after 72 hours, and no mortalities were recorded 72 hours after tagging. Based on the results of this test, all fish used in the study were held for at least four hours post-tagging, so that they could be monitored for any signs of regurgitation, before being released into the water for tracking. Normandeau Associates, Inc. 2011c at 7.

75. Normandeau's draft and final study report states: "Of the 62 smolts that passed [the project] from [releases 4 and 5 upstream of the Lockwood Project] four were determined during manual tracking efforts to be stationary downstream of the Project (likely mortality, predation, or regurgitated tags), and three were not detected by manual tracking or at monitoring station 6

(located approximately 1.75 miles downstream of Lockwood)." Normandeau Associates, Inc. 2011c at 14. Normandeau Associates, Inc. 2012f at 14. I conclude that it is most likely that these seven fish were killed by passage through the project. If any of these fish had been eaten by a predator, their tag likely would not have remained stationary, but would have moved as the predator moved, and likely would have been detected. Moreover, the level of natural mortality (including natural predation) is low (0.002% per kilometer [NMFS 2012 at 37, 60, based upon Penobscot River data]), which would indicate that any death by predation during the study likely was associated with disorientation of the smolt as a result of passage through the project, and thus would be considered a project-related mortality. During a NextEra ESA Habitat Conservation Plan meeting on April 26, 2011, Rick Simmons of Normandeau Associates and Gail Wippelhauser of MDMR indicated that they did not believe that striped bass would be a problem with respect to Atlantic salmon smolts during the study, because of water temperature. NextEra Technical Advisory Committee 2011 at EA Sub 00004923. Given the efforts taken by Normandeau to ensure against tag regurgitation during the study, regurgitation is also not a likely reason for the stationary or undetected smolt tags. Since most of the tag regurgitation observed before the commencement of the study occurred within one hour, Normandeau's practice of holding all of the study fish for at least four hours after tag insertion made regurgitation during the study unlikely.

76. According to the final study report, a total of 58 radio-tagged smolts were recorded as passing the project through one of the turbines during the 2011 study, and nine of these (17.3%) were undetected at the downstream monitoring station. Normandeau 2012f, Tables 6 and 8-16. The report lists "mortality or tag regurgitation" as the "presumed disposition" of six of these nine fish, and lists "unknown" for the other three. Normandeau 2012f, Table 7. For the

reasons discussed in the previous paragraph, I believe that turbine-related mortality is the most likely explanation for these undetected tags. In other words, it is likely that these fish suffered immediate mortality because of turbine blade strike or impingement, that they dropped out of the water column before reaching the monitoring station, and that they were thus undetected at that monitoring station. It should be noted that, during the 2007 study discussed above, a more extensive manual search effort, which included the use of boats and vehicles to search from the river's surface, proved necessary to locate submerged and stationary tags.

(iii) The 2012 Radio Telemetry Study at Weston, Shawmut, and Lockwood

77. In 2012 a bypass effectiveness study was conducted at the Weston, Shawmut, and Lockwood projects using radio telemetry as the evaluation method. Normandeau 2012c. Downstream passage effectiveness was evaluated at Weston, Shawmut, and Lockwood by releasing five groups of tagged smolts upstream of Weston (the "Weston release groups") and tracking their passage route through each project, tracking the time and date of their passage past each project, and documenting any tags that were not detected at the next downstream fixed receiving antenna location. In addition, two groups of fish were released into the tailrace downstream of Hydro Kennebec, approximately one mile upstream of Lockwood, as part of a concurrent study at Hydro Kennebec, and their passage was tracked past Lockwood (the "Lockwood release groups"). Finally, the concurrent study at Hydro Kennebec provided four additional radio tagged Atlantic salmon smolt releases above Hydro Kennebec (the "Hydro Kennebec release groups"), and downstream passage of these fish past Lockwood was also tracked. Normandeau 2012c, Table 11.

78. Kennebec River flow was less than station capacity at Weston for the time period when fish were released and passed the Project, although two fish did pass via leakage at some

location on the dam. River flows at Shawmut were generally less than station capacity during the period of fish passage. Shawmut did spill on May 30, 2012, but none of the fish passing the project on that day did so by spill (all five passed through the bypass). There was also spill at Shawmut from June 2 through 5, with spill increasing over this period, and one fish did pass via spill on June 5, 2012, when the project was spilling over 50,000 cfs. Normandeau 2012c, Appendix Table A and Table 2. The Lockwood Project had a number of damaged flashboards and did spill some water during the test period. Also, the Lockwood Project experienced flows in excess of station capacity on May 30, 2012, and June 3-11, 2012. During these periods when flow exceeded station capacity, 12 fish passed Lockwood, with one passing via spill, four passing through the downstream bypass, and seven passing through the turbines. During the remainder of the test period, 12 fish passed Lockwood via spill.

79. Summary results from the Weston releases provide a clear and comprehensive picture of what happens to Atlantic salmon smolts when they pass through the Weston, Shawmut, Hydro Kennebec, and Lockwood Projects. The detailed data are not yet available for the 2012 Hydro Kennebec study, but the effects of Hydro Kennebec are reflected in the data for fish reaching the upstream side of the Lockwood Project. Summary data from 2012 Hydro Kennebec study will be discussed later in this declaration. Of the 120 radio tagged smolts released upstream of Weston, passage was determined for 111, with the remainder not passing the dam. Of the 111 tagged smolts passing the dam, only 81 (73%) were detected at the receiver 5.5 miles downstream of Weston. Of these 81, two passed via dam leakage, 19 passed via unknown routes (mostly non-detects due to a power to equipment failure during release group 3), 35 passed through the bypass, and 25 passed through the operating turbines. Of the 30 tagged smolts that were not detected at the downstream receiver, 14 passed via turbines, 13 via the

bypass, and three via an unknown route. In total, 35.9% (14 of 39) of the tagged smolts passing through the turbines at Weston failed to reach the downstream monitoring location, and 27.1% (13 of 48) of the tagged smolts passing through the bypass failed to reach the downstream monitor. These two percentages indicate a high rate of mortality for tagged fish passing through Weston. Normandeau 2012c, Tables 6 and 12-15. Sixteen of the 81 fish detected at the Weston downstream receiver failed to reach the Shawmut Project, an additional seven miles downstream. In total, only 65 (58.6%) of the original 111 fish passing through Weston reached the upstream side of the Shawmut Project, a river distance of about 13.5 miles. Normandeau 2012c, Tables 6 and 12-15.

80. Of the 65 remaining tagged smolts that reached the Shawmut Project, fifty eight were detected at the receiver located 1.1 miles downstream of Shawmut. This represents 52.8% of the original 111 passing through Weston. Passage routes were determined for all 65 smolts reaching Shawmut. Bypass flows at Shawmut were maintained at 600 cfs, which ranged from 9% to 17% of station flow, and most of the fish passed Shawmut during the time period when bypass flows were in the 12% to 17% range. Normandeau 2012c, Table 2. One fish passed via spill, 53 of 65 (81.5%) passed through the bypass, and 11 of 65 (16.9%) passed through the operating turbines. However, these results may be somewhat skewed, since three of the six Francis turbines at Shawmut were not operating during the majority of the passage time period, and 19 of the 65 fish passing Shawmut did so on May 27 and 28, 2012 when four of the six Francis turbines were not operating. Also, the powerhouse containing the two propeller turbines is located in the southwestern corner of the forebay. The high bypass flows of 9 to 17% of station capacity (normal bypass flows are less than 2% of station capacity), combined with the number of Francis turbines being off line, and the location of the propeller turbine powerhouse,

may make these results atypical for "normal" operations at the Shawmut Project since, with the Francis turbines off line and the propeller turbines located in the southwest corner of the forebay, emigrating smolts were influenced by the large percentage of bypass flow before they could come under the influence of turbine flow.

81. Only 43 (38.7%) of the original 111 tagged smolts passing Weston arrived immediately upstream of Lockwood. Normandeau 2012c, Table 11. Passage routes were determined for 42 of these 43 fish, with one fish remaining upstream of Lockwood at the time the study was ended. Of these 42 fish, four passed via spill, 25 passed through the downstream bypass, and 13 passed through the operating turbines. Normandeau 2012c, Table 11. In addition, 38 of the 40 tagged smolts in the Lockwood release groups (released into the tailrace downstream of Hydro Kennebec) were detected immediately upstream of Lockwood. Of these 38 fish, two remained upstream of the Project, 11 passed via spill, nine went through the downstream bypass, and 18 passed through the operating turbines. Normandeau 2012c, Table 11. In addition, 72 tagged smolts from the four Hydro Kennebec release groups (released upstream of the Hydro Kennebec Project) were detected immediately upstream of Lockwood. Passage routes were determined at Lockwood for all 72 of these tagged fish, with nine passing via spill, 51 passed through the downstream bypass, and 12 passed through the operating turbines. Normandeau 2012c, Table 11. Combining the results of the Weston releases that reached Lockwood and the releases upstream and downstream of the Hydro Kennebec Project that also reached Lockwood shows that 153 fish reached Lockwood, with 85 of 153 (55.6%) using the bypass for passage and 43 of 153 (28.1%) passing via the operating turbines. Normandeau 2012c, Table 11. During the majority of the time period when fish were passing the Lockwood Project, three of the six Francis turbines were essentially shut down. Once these

Francis turbines went back on line on May 29, 2012, the proportion of fish using the turbines for passage changed. Sixteen fish passed via the bypass or turbines after May 29, 2012. Of these 16 fish, seven (43.8%) passed through the downstream bypass and nine fish (56.2%) passed via the turbines. Normandeau 2012c, Table 3 and Appendix Table A. Of the 43 fish passing through the operating turbines at Lockwood, 22 passed through the Francis turbines, and six of those failed to reach the downstream receiver location approximately 1.75 miles downstream of Lockwood. Four of these six fish were not detected by manual tracking upstream of the downstream receiver location and apparently became stationary shortly downstream of the Project. The remaining two fish were located >0.1 mile downstream of the Project but did not pass the downstream receiver location.

82. Of the 43 tagged smolts passing through the operating turbines at Lockwood, 21 passed through the Kaplan turbine and seven of those failed to reach the downstream receiver location approximately 1.75 miles downstream of Lockwood. Five of these seven fish were detected by manual tracking between >0.1 and 1.0 miles downstream of the Project but were not detected at the downstream receiver location. The remaining two fish were not detected by manual tracking upstream of the downstream receiver location and apparently became stationary shortly downstream of the Project. Normandeau 2012c, Tables 9 and 11. Overall, it appears that 13 of the 43 (30.2%) tagged smolts passing through the Lockwood operating turbines suffered lethal injuries. Normandeau 2012c, Tables 9 and 11.

83. The Normandeau (2012c) study report, at page 35, lists seven factors that the authors believe may have contributed to the loss of tags between the various projects. These factors are:

- Immediate mortality from dam passage

- Delayed mortality from dam passage
- Predation
- Tag regurgitation
- Transmitter failure
- Low river flow, and
- Loss of migratory drive.

I discuss these factors below.

84. Expiration of the battery used in the radio tag releases is highly unlikely. This potential factor was identified as a possible reason for non-detection of two tags passing Lockwood. It was stated that: "Transmitters for both turbine-passed smolts were near or had exceeded the manufacturers warranted battery life of 15 days since their release upstream of the Weston Project". Normandeau 2012c at 15. According to the manufacturer of the tags, however, this statement is incorrect. The tags used for the Weston and Lockwood release groups were model NTC-3-2 nano tags manufactured by Lotek. According to Lotek's website (www.lotek.com) and a discussion with a Lotek representative (Paul Wigglesworth, Lotek Manufacturing technical services representative, personal communication 2/13/13) the warranted battery life for this specific tag is 30 days, with a calculated battery life of 39 days. The total duration of the Normandeau 2012c study was from May 22 to June 12, 2012, a period of 21 days. Mr. Wigglesworth also indicated that their tag failure rate is less than 0.5% based on some 45,000 tags sold. I conclude that expiration of the battery used in the radio tags or tag failure are not valid or justified reasons for the rate of non-detection of the radio tags at study receivers.

85. Predation is mentioned as another factor that could account for non-detection of tags at the various receivers. While some predation has been documented for radio tagged fish in

the past, it is unlikely that predation could account for the large losses of radio tagged fish experienced in this study. First, the water temperatures during the study period were less than 17.8^0 C. (64^0 F.) as recorded at Lockwood. Normandeau 2012c, Table 3. At such moderate water temperatures, it is unlikely that warmwater predators would be very active during the study period. Second, most of the fish that were released and passed at Weston did so at night. Many of the Weston released fish were recorded at Shawmut before dawn on the day after the late evening release at Weston. Normandeau 2012c, Appendix Table A. The known predators on Atlantic salmon smolts that reside in the Kennebec River are “ambush” predators in that they ambush prey as they move past the predator’s position in the stream. These predators detect prey by sight and thus are not generally active at night. Third, during a NextEra HCP meeting on April 26, 2011, Rick Simmons of Normandeau Associates and Gail Wippelhauser of MDMR indicated that they did not believe that striped bass would be a major problem with respect to Atlantic salmon smolts during the 2011 study at Lockwood. NextEra Technical Advisory Committee 2011 at EA Sub 00004923. Fourth, even if a fish had been consumed by a predator, the radio tag would in all likelihood continue to transmit with a reduced range. The range reduction would be about 75%, but the remaining range still could be 100 m or more, based on the tags having an original range of hundreds of meters. Paul Wigglesworth, Lotek Manufacturing technical services representative, personal communication 2/13/13. Based on the approximate locations of the Weston and Shawmut downstream receivers, an evaluation of Google Earth photos estimates the river width at these locations to be 150 to 200m across. Fifth, if a fish were consumed by a predator, it is likely that the tag would remain in motion and not become stationary. Sixth, it is highly unlikely that a predator population of sufficient size could be maintained in a river with a predation rate of approximately 3% of the available prey population per three day time period (as it would have to be if a significant percentage of the undetected tags here resulted from predation). Normandeau 2012c, Appendix Table A. Seventh, NMFS estimates the level of natural mortality, including predation, is low (0.002% per kilometer, based upon Penobscot River data). NMFS 2012 at 37, 60. Over the approximately 32 kilometers from Weston to the monitoring station downstream of Lockwood, this would represent a predation rate of less than 1% for the stretch of the Kennebec under study. Given the information, above I conclude that predation (natural and project-related) would likely account for only a small percentage (estimated 1-3% per dam at Weston, Shawmut, and Lockwood) of the non-detect tags recorded during this study.

86. Another potential factor identified as a reason for non-detection of tags is tag regurgitation. In the Normandeau (2012c) study, a group of 20 fish were held post tagging with no regurgitation of tags or mortality noted. However, since a test done on tagged smolts held prior to the 2011 study (Normandeau Associates, Inc. 2011c at 7, discussed above) had shown that 75% of regurgitated tags occurred within one hour, all fish in the 2012 study were held for a minimum of six hours before release. In addition, gastric bands were placed on the tags prior to insertion to reduce the probability of tags being regurgitated. Normandeau 2012c at 14. Also, if Normandeau personnel believed that tag regurgitation is a major problem, given the experience of Normandeau Associates at conduction radio tagging studies, it would seem that they would have chosen to surgically implant the radio tags instead of using esophageal implants. Given the empirical data above, I would estimate that tag regurgitation would likely account for no more than 2-3% of the undetected or stationary tags found in the 2012 study.

87. The loss of migratory drive as a reason for the non-detection rates seen in the 2012 radio tagging study, while technically possible, is in my opinion highly unlikely for several

reasons. First, tagged smolts were released one day after the last emigrating smolt was captured in the trapping program conducted on the Sandy River. This indicates that naturally produced fish were actively emigrating during the study period, and the tagged smolts can be expected to have been doing the same. Second, tagged fish in this portion of the Kennebec River are essentially only a day or two from reaching tidal influence and access to the Merrymeeting Bay estuary. In my opinion, fish that are this close to the ocean would not lose their migratory behavior. In fact, I would expect fish to increase their rate of downstream movement given the increasing trend in water temperature. Third, in past studies in the Kennebec, Normandeau has released tagged smolts into the river into the first week of June, without using loss of migratory desire as a reason for fish not being detected, and no rationale is offered as to why it should be an appreciable factor here. Normandeau 2012 at 35. I believe that loss of migratory behavior is a highly implausible factor to explain the high rate of non-detect tagged fish found in the 2012 study.

88. Finally, I believe it is not likely that low river flows could account for the large number of undetected radio tags. The lower flows would not be expected to affect the ability to track the tagged fish. Lower river flows would mean that the tag signal would have a greater range than if the tag were located in deeper water. In addition, lower flows would allow access to areas that would normally not be accessible by boat because of turbulence or water velocity conditions. It is possible that low flows could inhibit manual tracking from a boat, as Normandeau (2012c) suggests for manual tracking downstream of Lockwood. However, I note that manual tracking was accomplished by vehicle in the Normandeau 2011 Lockwood study over the same reach of river as surveyed in 2012. No explanation of why vehicle tracking was not attempted is given in the 2012 study. Also, tracking from a helicopter or small fixed-wing

aircraft was an option. Similarly, I can find no biological rationale indicating that low flows would have resulted in the high number of non-detect tags. Physiologically, the tagged fish were in a migratory mode (as evidenced by the number of fish that continued to emigrate during the 2012 study), water temperatures were rising in the river during the course of the study, and the photoperiod was increasing; all of these factors suggest that the fish were in a migratory state and river flow conditions would not have impeded their progress.

Overall Evaluation of 2012 Study Results

89. I agree with the authors the 2012 study report that "the design of this study was not appropriate to properly assess the whole station passage survival of smolts at or between the Weston, Shawmut or Lockwood Projects." Normandeau 2012c at 1. A paired-release methodology was not utilized, and differentiation between project-related and natural causes of mortality thus cannot be accurately quantified. Nonetheless, I believe that the data from this study are robust enough to provide strong evidence that significant mortality of the tagged Atlantic salmon smolts occurred as a result of passage at the Weston, Shawmut, and Lockwood projects during 2012.

90. I base this conclusion on four lines of logic. First, the stationary tags immediately downstream of each project are a definite indicator of dead fish. Even with only limited manual tracking in the tailrace at Weston, five stationary tags (4.5%) were recorded. At Shawmut, five tags (7.7%) of those passing were recorded as stationary within 1.1 miles downstream of the Project. The data from Lockwood are even more compelling. Of the 153 tags passing Lockwood (this total includes all three release groups), 20 (13.1%) were determined to be stationary. Normandeau lists passage-related mortality or tag regurgitation as potential causes for the stationary tags. Because, as discussed above, these are unlikely to be regurgitated tags, I

conclude that significant rates of project-related mortality are occurring based on the stationary tag data alone. Normandeau 2012c at 32-34. Second, the much larger percentage of tags that were not detected at subsequent downstream receiver locations are a strong indicator of mortality associated with passing through a dam via the operating turbines or the downstream bypass. Third, as discussed below, the empirical data (stationary and missing tags) from this study are consistent with empirical data gathered at other dams. Fourth, as set forth above, the other factors (beyond project-related harm) listed in the Normandeau (2012c) report as possible explanations for the rate of non-detects are not supported by a logical analysis of the data.

91. As discussed directly below, there is a significant body of literature that summarizes various studies on mortality rates of fish passing through hydropower turbines. These data demonstrate that all three types of turbines in operation at the NextEra projects: 1) Francis turbines used at Weston, Shawmut, and Lockwood, 2) a standard Kaplan turbine used at Lockwood, and 3) propeller turbines used at Shawmut and Brunswick cause significant immediate and delayed mortality for fish the size of Atlantic salmon smolts in the Kennebec and Androscoggin rivers. The Francis turbines, especially, are capable of causing considerable mortality, and the significant smolt losses downstream of Weston (which uses only Francis turbines) are consistent with the empirical data. Given that, as discussed previously, this study was conducted while the bypass flows at all of these facilities were enhanced and the Francis turbines at Weston, Shawmut, and Lockwood were partially off-line, it is likely that mortality caused by these projects was more pronounced during previous operational periods.

(d) NextEra’s Turbine Mortality Estimates

92. NextEra and its consultants estimated turbine mortality for each of the turbines at these four projects using two different methodologies: applying empirical data generated from

mortality studies conducted at other hydroelectric projects, and applying a computer model designed to calculate the incidence of turbine blade strike. While each of these is a reliable method for estimating mortality when applied correctly, NextEra and its consultants used assumptions in applying these methodologies that largely tended to understate mortality. Thus, as explained below, it is my opinion that these estimates should be considered a "lower-bound" of actual turbine mortality at these NextEra projects.

(i) Estimates Based on Empirical Data from Mark and Recapture Studies Performed at Other Dams

93. A common and well-accepted method for evaluating mortality and injury at hydroelectric projects is to conduct what is known as "mark and recapture" studies. In such studies, a certain number of test fish are: tagged; released above the hydroelectric project into a downstream passage route (turbine, bypass, spillway, etc.); collected after passing through that route and held for a specified period of time; and then examined for mortality and injury. To account for any injury or mortality that may be caused by the handling of the test fish, a representative group of "control" fish are also tagged, but are held in a holding tank rather than being released to pass through the passage route under consideration. The control group is held for the same period of time as the recaptured test group, and the control fish are then also examined for mortality and injury. In general, the incidence of injury and mortality to the control group is subtracted from the incidence of injury and mortality to the test group to yield the calculated injury and mortality rate attributable to the passage route under consideration. Mark and recapture studies are well-accepted among fisheries biologists as a means of estimating mortality, injury, and movement of salmon and other fish. I have personally conducted and supervised the performance of mark and recapture studies involving salmonids and other fish.

94. Historically, the passage route most commonly studied via mark and recapture studies at hydroelectric projects in the United States has been passage through turbines. This is because turbines are known to usually be the most dangerous route of passage at hydroelectric projects. A large database of the results and specific methodologies of a great number of mark and recapture studies performed on turbines at hydroelectric projects throughout the country has been compiled by the Electrical Power Research Institute ("EPRI"), and has been published in two documents that are available in an electronic format. Stone and Webster Environmental Services (1992) Sections 3 and 4, Winchell and Amaral (1997). This database is commonly used by fisheries biologists as a means of estimating mortality and other injury to salmon and other fish passing through turbines at hydroelectric projects, and it is considered a reliable source of information within the profession. Franke et al. (1997) in Tables 4.2.1 to 4.2.4 contains the results of a number of turbine passage survival rate studies. Robson et al. (2011), at 31-34, also contains a less extensive summary of dam related mortality studies using mark and recapture techniques.

95. Information from the Winchell and Amaral (1997) database, and from similar mark and recapture studies done more recently, is commonly used by fisheries biologists as a means of estimating mortality and other injury to salmon and other fish from passage through turbines at hydroelectric projects at which no mark and recapture studies have been done. (The underlying data used in Stone and Webster Environmental Services are currently only available in hard copy.) When used properly, comparisons of similar turbine types, turbine runner diameter, comparable fish lengths, and a sufficiently robust number of comparable studies, a reasonable estimate of turbine mortality can be developed using these empirical data. This practice is well-accepted, and considered reliable, within the profession. Indeed, one of the primary purposes for

the compiling of this data base was to enable such estimates to be performed. Winchell and Amaral (1997). In my professional career, I have used the Winchell and Amaral (1997) database for this purpose, and have made conservation biology decisions based on likely mortality and injury rates at hydroelectric projects derived from proper use of this data base and from similarly reliable mark and recapture studies done more recently. The NMFS has accepted this methodology as a means of determining the existence and the degree of "take" of fish that are listed under the Endangered Species Act, so long as the mark and recapture studies on which the estimates are based evaluated injury and delayed mortality, and not just immediate mortality, from turbine passage. In fact, NMFS relied upon information from the Winchell and Amaral (1997) database to support their recent biological opinion on hydropower operations at the Hydro Kennebec Project on the Kennebec River.

96. There at least four primary reasons why proper use of the Winchell and Amaral (1997) database, alone or in conjunction with scientifically defensible mark and recapture studies completed since that database was published in 1997, is considered a reliable methodology for determining injury and mortality rates. First, although there are differences in specific operational practices among different hydroelectric projects, the injury and mortality rates resulting from a particular type and size of turbine fall within a reasonably defined range across a wide variety of locales and operating practices. The types and sizes of turbines used at the NextEra dams are represented within the database. Second, because the database was relatively comprehensive at the time of its creation and contains detailed information about the tests performed and the size, specifications, and operational characteristics of the turbines tested, a trained biologist is able to select the group of study results that is most likely to reflect the turbines at the hydroelectric project for which the injury and mortality estimate is being

developed. Third, the number of test fish groups represented in the database allows evaluation of multiple data points, gathered at multiple locations, which tends to provide scientific reliability to the conclusions reached. Fourth, the published literature from other individual studies that are not included in the Winchell and Amaral (1997) database show results generally consistent with those in the database.

97. NextEra and its consultants, Normandeau Associates, utilized data from the EPRI database and from mark and recapture studies done by Normandeau at other locations to estimate turbine injury and mortality to Atlantic salmon smolts from each of the turbines at each of the four NextEra dams under consideration here. Normandeau 2012a various pages; Normandeau 2012b various pages; Normandeau 2012d various pages; and Normandeau 2012e various pages. I believe these estimates understate actual mortality at these turbines, based on three reasons.

98. First, it appears that only one of the empirical studies used by NextEra and its consultants evaluated 72-hour turbine mortality, and NextEra states that its turbine mortality estimates from empirical data are for 48-hour mortality. A 48-hour mortality estimate does not capture the delayed mortality that occurs more than 48 hours after turbine passage. Further, NextEra's estimates to not include the additional turbine-related mortality that occurs due to predation to fish that are injured or disoriented (but not killed) by turbine passage. Such fish display abnormal behavior that attracts predators.

99. Second, NextEra and its consultants used median river flows in calculating their “whole station survival” estimates. The use of median flows automatically allocates a portion of river flow to spill over the dam and fails to account for low flow conditions, such as occurred during the 2012 smolt migration season, during which all of the emigrating Atlantic salmon, both smolts and kelts, have to pass through project turbines or downstream bypasses. Normandeau

(2012c) documents the low flow conditions present on the Kennebec River in late May and early June of 2012, and (as discussed above) the radio telemetry study conducted during that period showed much higher rates of smolt mortality than predicted by NextEra from the empirical data. A more detailed discussion of the river flow data relevant to each of the NextEra projects is found in my January 16, 2012, written report, attached here as Exhibit 1.

100. Third, NextEra and its consultants used comparisons to studies that included tests on fish shorter in length (110-220 mm (4.3 to 8.66 inches)) than would be expected to be seen in Atlantic salmon smolts from the Kennebec River. Field data gathered by USFWS on Atlantic salmon "pre-smolts" (fish that have not yet reached full smoltification) from Togus Stream, a lower Kennebec River tributary, showed pre-smolts ranging from 152 to 277 mm (5.98 to 10.9 inches) in length in early winter. (U.S. Fish and Wildlife Service, 1996, unpublished data previously provided to NextEra). Comparisons to empirical turbine mortality studies using shorter fish tended to understate NextEra's turbine mortality estimates.

(ii) Computer Modeling Based on the Operational Characteristics of the NextEra Dams

101. In addition, NextEra and its consultants used information from a modeling study on advanced turbine design, Franke, et al. (1997), to generate survival and mortality estimates at NextEra dams. Normandeau 2012a various pages; Normandeau 2012b various pages; Normandeau 2012d various pages; and Normandeau 2012e various pages. This study is referred to as the "Franke model" in this declaration. The Franke model is well-known in the field as a means of estimating mortality from standard Kaplan turbines, and it does have applicability to propeller-type Kaplan turbines as well. When used as intended, the Franke model can produce results that are reasonable estimates of turbine passage survival that are consistent with empirical data.

102. In my opinion, however, use of the Franke model is not as reliable a method for calculating turbine mortality as is the use of empirical data from appropriate studies found in the EPRI database and other empirical studies that have been conducted since the EPRI database was published in 1997. There are a number of inputs used in the Franke model, including certain operating parameters of the turbines under analysis. However, a key parameter used in the model that has a significant influence on the passage survival estimate generated is a "strike mortality correlation factor" (designated by Franke as "lambda"). Franke et al. (1997) at 97. It is easiest to think of lambda as a "fudge factor" introduced into the model to bring the model's predicted survival estimate in line with the empirical data used to calibrate the model. The Franke model was developed for Kaplan turbines, and initial model calibration indicated that a lambda value of 0.2 provided the best fit of the empirical data for Kaplan turbines. Franke et al. (1997) at 97-98 and Figure 4.4.3-6 at 104. However, there is significant "scatter" in the data presented in this portion of the Franke study, and while a lambda of 0.2 appears to be the dominant value in the data, this is by no means definitive, and some of the data suggest that a higher lambda may be appropriate for Kaplan turbines. However, subsequent testing of the model on a large Kaplan turbine at Wanapum Dam on the Columbia River found that a lambda of 0.2 appeared to overstate turbine mortality for this turbine under some conditions. Thus, as stated in the Franke study, "As this seems unrealistic, a value of lambda equal to 0.1 was *arbitrarily chosen* for the strike equation and leading edge strike mortality was recalculated**."** (Emphasis added). Changing the lambda value from 0.2 to 0.1 *increases* the model's predicted turbine survival, thus *decreasing* the projected mortality. The underlying issue, which can be seen from the data plots in the Franke study, is that no single "correlation factor" will permit the model to be accurate in all circumstances, which thus indicates the underlying limitations of the

model. For this reason, I believe use of the Franke model tends to be less reliable than reliance on empirical data.

103. Further, it is my opinion that NextEra and its consultants have used the Franke model inappropriately in some respects, resulting in overall turbine passage survival estimates that are significantly higher (with corresponding mortality estimates that are significantly lower) than actual performance. As discussed, NextEra employs three types of turbines at these dams: a standard Kaplan turbine at Lockwood, Francis turbines at Weston, Shawmut, and Lockwood, and propeller turbines at Shawmut and Brunswick. For all of these turbines, NextEra and its consultants ran the Franke model using a lambda of 0.1, and again at a lambda of 0.2, and then averaged the results to produce the mortality estimate. Normandeau 2012a, Tables 12 and 13; Normandeau 2012b, Table 11; Normandeau 2012d Tables 12 and 13; and Normandeau 2012e, Table 11. In my opinion, this posed differing problems, depending on the type of turbine.

104. The most troublesome issue is the use of the Franke model to predict mortality from the 16 Francis turbines in use at Weston, Shawmut, and Lockwood. The Franke model was based on data generated from standard Kaplan turbines, and not on the propeller or Francis type turbines used by NextEra. Franke et al. (1997) at 97. As the Franke study notes, the use of the model developed from Kaplan data to predict mortality from Francis turbines is problematic:

> "The Francis turbine data is more extensive than the Kaplan data. It encompasses a greater range of turbine sizes, thus leading to a greater range of the variable N L / D [N L/D is a non dimensional parameter that incorporates: N is the number of blades in the turbine; L is the length of a fish; and D is the diameter of the turbine runner]. The specific speed range is also large. The accuracy of the Francis turbine strike (BZE) equations is believed to decrease as specific speed increases. It also appears that the credibility of the turbine operating data is not as high as the Kaplan data. In spite of this, all available data (Table 4.2.4) was used to evaluate the strike prediction formula. The correlation coefficient, lambda, was reevaluated for Francis turbines. Figure 4.4.10-1 [in Franke et al. (1997)] shows considerable scatter for the calculation of lambda for each survival data point. A value of lambda equal to 0.2 was chosen, based on Kaplan turbine results and on *the absence of a reliable estimation method*."

Franke et al. (1997) at 136 and Figure 4.4.10-1 at 137 (Emphasis added). Two points are noteworthy here: (1) as the Franke study acknowledges, the modeling results for Francis turbines are based on lambda values derived for Kaplan turbines, and thus are not a "reliable estimation method" for Francis turbines; and (2) an examination of the referenced Figure 4.4.10-1 in the Franke study shows that the estimates of lambda for Francis turbines, based on empirical data, range from 0.0 to *over 2.0*. As the lambda value increases, so does the predicted turbine mortality. The Franke study acknowledges the implications of this issue: "Due to the generally smaller size and larger number of blades of Francis turbines, the nondimensional length parameter [N L/D] is an order of magnitude larger than for Kaplan turbines. *It is presumed therefore, that fish survival would be significantly lower [for Francis turbines]*." Franke et al. 1997 at 136 (Emphasis added).

105. NextEra's use of a lambda between 0.1 and 0.2 for the Francis turbines, then, likely "significantly" understated actual mortality. For example, a predicted survival rate of 90% for Francis turbines changes to 80% when the lambda changes from 0.1 to 0.2. Normandeau 2012a, Tables 12 and 13; Normandeau 2012b, Table 11; Normandeau 2012d Tables 12 and 13; and Normandeau 2012e, Table 11. In fact, examination of the Francis turbine data in Figure 4.4.10-2 in the Franke study shows that even at a lambda factor of 0.2, the model output overestimates turbine passage survival (and thus *understates* mortality) consistently by 20-50% or more (i.e., the survival ratio between measured survival and predicted survival is less than one fairly consistently). Franke et al. (1997) at 137.

106. NextEra's use of a lambda of between 0.1 and 0.2 for the four propeller turbines at Shawmut and Brunswick is problematic for different reasons. Although propeller turbines are a type of Kaplan turbines, the propeller turbine does not have a gap between the turbine hub and

the inside edge/end of the blade. The Franke study did examine data from propeller turbines, and recommended that, if the model was to be used with a propeller turbine, a lambda value of 0.1 (or slightly higher) be used. Franke et al. at 134 and Figure 4.4.9-1 at 135. Thus, although a correlation factor above 0.1 may be appropriate for propeller turbines, use of a factor as high as 0.2 is not. Accordingly, averaging the model runs for lambda values of 0.1 and 0.2 likely tended to overstate the mortality estimates for the propeller turbines.

107. The only one of the NextEra turbines for which the Franke model is directly applicable is the single Kaplan at Lockwood. As discussed, there is no reliable scientific basis for the use of a lambda of 0.1 with Kaplan turbines. Thus, averaging the model runs for lambda values of 0.1 and 0.2 likely underestimated the mortality estimates for the Lockwood Kaplan. The effect of a change from 0.2 to 0.1 on predicted mortality is significant for Kaplan turbines (i.e., predicted survival is markedly increased, and predicted mortality accordingly reduced), but the extent of the difference depends on the assumption of where the fish is located within the turbine. Normandeau 2012a, Tables 12 and 13.

108. Three other factors in NextEra's Franke model calculations also tend to systematically understate turbine mortality. First, one of the key inputs to the Franke model is the length of fish assumed to be passing through the turbines. The NextEra modeling effort assumed fish of from five to nine inches (127 to 229 mm) in length. However, field data gathered by USFWS on Atlantic salmon "pre-smolts" (fish that have not yet reached full smoltification) from Togus Stream, a lower Kennebec River tributary, showed pre-smolts ranging from 152 to 277 mm (5.98 to 10.9 inches) in length in early winter. (U.S. Fish and Wildlife Service, 1996, unpublished data previously provided to NextEra). Inclusion of additional model runs at 10 and 11-inch fish lengths as inputs (as these empirical data suggest is

appropriate) would have yielded higher overall mortality projections. This is confirmed by an analysis and discussion presented in Normandeau 2012a, at 5.

109. Second, NextEra and its consultants averaged the model-predicted turbine survival rates across all the different fish lengths, thus artificially reducing predicted mortality rates for the larger smolts whose survival will be most important to the survival of the species.

110. Third, NextEra and its consultants used median river flows in calculating their "whole station survival" estimates. As discussed above, the use of median flows automatically allocates a portion of river flow to spill over the dam and fails to account for low flow conditions. As discussed, Normandeau (2012c) documents the low flow conditions present on the Kennebec River in late May and early June of 2012, and the radio telemetry study conducted during that period showed much higher rates of smolt mortality than predicted by NextEra's Franke model estimates.

(iii) Implications of the NextEra Estimates

111. Even with these factors tending to dampen the estimated level of mortality, NextEra's turbine mortality estimates from the EPRI database, other applicable studies, and the Franke model show what I consider to be significant mortality at each of the turbines at each of these four projects. Given the large body of empirical evidence in the EPRI database and other studies that turbines of the type used by NextEra do kill fish, and given that the Franke model was developed to model known characteristics of the interaction between (Kaplan) turbine blades and swimming fish, this is to be expected. Indeed, it is not conceivable that any population of smolts could experience turbine passage at these dams without significant injury, and it would not be scientifically defensible to expect that they could. To conclude otherwise would fly in the face of all of the relevant scientific study results, and would defy common sense.

Gauging the Timing of the 2013 Smolt Emigration

112. If the turbines at the four NextEra projects are to be taken out of operation in order to reduce the mortality and injury to Atlantic salmon smolts and kelts emigrating down the Kennebec and Androscoggin rivers during the 2013 emigration period, there needs to be a practical method for determining the beginning date and the ending date of this period. Below I discuss two practical options for making such a determination. One relies on the use of start and end dates derived from general conditions and experience, and the other relies on specific information that would be gathered from the rivers this spring.

113. Water temperature and photoperiod (the relationship of light to dark periods over a 24-hour day) have been shown to be critical factors in triggering "smoltification" in Atlantic salmon, and these same two factors are critical in determining when the period of smolt migration will end. Atlantic salmon smolts are known to begin the smoltification process at water temperatures as low as 5^{o} C., while others suggest $8\text{-}12^{o}$ C, with a generally accepted trigger point of about 10^{o} C. Kircheis and Liebich 2007 at 47. Data indicate that Atlantic salmon parr enter a maintenance and survival strategy when water temperatures exceed 19^{o} C. Kircheis and Liebich 2007 at 42. Since smoltification increases the physiological demands on a fish, I believe that smolts would be highly stressed at this temperature and survival to the ocean would be minimal. Thus, Atlantic salmon smolt emigration is likely to have ended by the time the water temperature reaches this level.

114. In any particular location, photoperiod is determined by the time of year. Since there are limited data available for the emigration time period for Atlantic salmon smolts in the Kennebec and Androscoggin River; I have used emigration timing for the Sheepscot River as a surrogate. U.S. Atlantic Salmon Assessment Committee 2011, Figures 5.4.5 and 5.4.6. Data

from these figures indicate that in 2010 the first Atlantic salmon smolts were captured beginning about April 12 of that year. I believe these data are applicable since the locations where Atlantic salmon currently reside in the Kennebec and Androscoggin are at a similar latitude as the Sheepscot River and likely have a similar water temperature regime, but no data are available to me to confirm this later assumption.

115. The precise beginning and end dates of the smolt emigration period in the Kennebec and Androscoggin Rivers will vary with specific annual conditions (principally water temperature and photoperiod, as discussed), but these data suggest that a reasonable assumption is that smolt emigration in both rivers will begin in mid-April, that the majority of the smolts will emigrate in May, and that the last of the smolts will do so in late May or early June, depending primarily on the water temperature. In general, the colder the temperature, the later the emigration will extend. Given this, I believe that using an assumed start date of April 15 and an assumed end date of June 5 would capture the emigration of the great majority of the smolts in these rivers. Most of these smolts will travel by night, but a significant portion will travel during the day as well.

116. Alternatively, information could be gathered for each river this spring to provide a more specific beginning and ending date for the period of turbine closure. The best information for the three Kennebec River dams would come from the results of properly designed and implemented smolt trapping program in the Sandy River. MDMR has experience in conducting such a trapping program in the Sandy River, and it is my suggestion that the trapping be conducted or supervised by MDMR. Using such a program, the period of turbine closure would be determined by the first and last smolt to be captured in the Sandy River. Assuming that the trapping location would be within about five miles of the Sandy/Kennebec confluence, the

turbines at the three Kennebec River dams would be taken off line within 12 hours after the first capture of an Atlantic salmon smolt in the Sandy River trap. The turbines would remain off line until after the last smolt was captured by the trapping program, and would come back on according to the following schedule: 1) Weston – last capture + 36 hours, 2) Shawmut – last capture + 48 hours, and 3) Lockwood – last capture + 60 hours. This schedule would allow the smolts a reasonable time to pass the projects before resumption of turbine operation. If a smolt trapping program is used as the trigger for operational restrictions, it is critical that the full time period in which smolts are emigrating is covered by the operational guidance. There is a tendency to "clip" the ends of the curve describing the time period of smolt emigration since relatively few smolts would be expected to be captured at the beginning or at the end of the emigration period. However, for salmon populations clipping the ends of the catch distribution can be highly detrimental to the genetic diversity of the Atlantic salmon population. The "ends" of the curve can and most likely do represent subpopulations of the overall Atlantic salmon population in the Sandy River. Fish that start emigrating early are from an area or tributary where water temperatures are warmer overall and thus the fish reaches a physiological state earlier in the year which triggers emigration. Fish emigrating later in the spring are most likely from an area or specific tributary which has a colder water temperature regime, thus they emigrate later in the year. Both of these situations contribute to the genetic diversity of the population and contribute to the overall population stability.

117. The best information for the Brunswick dams would also come from the results of properly designed and implemented smolt trapping program. To my knowledge, a smolt trapping program has not been conducted for the Androscoggin River, and implementing such a program for that river would present certain logistical challenges. Nonetheless, the requisite

screw traps are available, and it would be entirely possible to conduct a smolt trapping program (again, supervised by MDMR) for the Androscoggin. Another alternative to using the "fixed" beginning and ending dates described above would be to rely on measured water temperature. I would recommend using the water temperature at Lisbon Falls, ME, which is at the upstream edge of Atlantic salmon smolt distribution in the Androscoggin. Daily measurements would be taken beginning on April 1, and the turbines at the Brunswick Project would be taken off-line when the measured temperature exceeded 9.0^{o} C, which would be an indication that the smolt emigration is imminent. The turbines would remain off line until the measured water temperature exceeded 19.0^{o} C or on June 5, whichever comes first, as this would be an indication that the smolt emigration is at an end. Given MDMR's experience with the Androscoggin, it is my recommendation that the temperature measurements be done under the supervision of, and according to criteria specified by, MDMR.

I declare under penalty of perjury that the foregoing is true and correct.

Dated: March 13, 2013

<u>/s/Randy E. Bailey</u>
Randy E. Bailey

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CERTIFICATE OF SERVICE

I hereby certify that on the 14th day of March, 2013, I electronically filed the above *DECLARATION OF RANDY BAILEY* on behalf of the above-named Plaintiffs, with the Clerk of Court, using the CM/ECF system, which will send notification of such filings to all other counsel of record.

/s/ Rachel Gore Freed
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