NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

In the Matter of a Renewal and Modification of a State Pollutant Discharge Elimination System ("SPDES") Permit Pursuant to article 17 of the Environmental Conservation Law And Title 6 of the Official Compilation of Codes, Rules and Regulations of the State of New York parts 704 and 750 *et seq.* by Entergy Nuclear Indian Point 2, LLC and Entergy Nuclear Indian Point 3, LLC, Permittee,	**DEC # 3-5522-00011/00004** **SPDES # NY-0004472**
-and-	
In the Matter of the Application by Entergy Nuclear Indian Point 2, LLC, Entergy Nuclear Indian Point 3, LLC, and Entergy Nuclear Operations, Inc. for a Certificate Pursuant to §401 of the Federal Clean Water Act.	**DEC # 3-5522-00011/00030** **DEC # 3-5522-00011/00031**

SECOND SUPPLEMENTAL DIRECT TESTIMONY OF DR. PETER A. HENDERSON REGARDING ENTERGY'S PROPOSED CYLINDRICAL WEDGE-WIRE SCREENS, ON BEHALF OF INTERVENORS, RIVERKEEPER, INC., SCENIC HUDSON, INC., AND NATURAL RESOURCES DEFENSE COUNCIL, INC.

A. Background and Experience

Q. Please state your name, business address and occupation.

My name is Dr. Peter Alan Henderson. My business address is Pisces Conservation Ltd., IRC House, The Square, Pennington, Lymington, Hampshire, SO45 1BW, United Kingdom. I am a Director of Pisces Conservation Ltd. where I work as an ecological and fisheries consultant. I specialise in the ecological effects of large industrial plants, and power stations in particular. I am also a Senior Research Associate at the Department of Zoology, University of Oxford, England, where I lecture in population dynamics and marine ecology.

Q. Have you previously submitted testimony in this proceeding?

Yes. I submitted pre-filed direct testimony on the subject of Entergy's proposed cylindrical wedgewire (CWW) screen array on July 22, 2011, pre-filed rebuttal testimony on September 30, 2011, and supplemental direct testimony on May 30, 2012. My education, professional background and qualifications are all discussed in my previous testimony, and my full

curriculum vitae, which generally reflects my background and experience, is presently in evidence as **Riverkeeper Exhibit 1**. An updated curriculum vitae is submitted with this testimony as **Riverkeeper Exhibit 1A.** This testimony provides additional information on particular aspects of my background and experience with specific regard to the issues addressed herein.

Q. Please explain what issues are addressed in your testimony herein.

As I pointed out in my July 22, 2011 CWW screen direct testimony, a full assessment of the benefits of CWW screens must take into account all their negative ecological impacts.[1] Impacts from the placement of the proposed CWW screen arrays on the bed of the Hudson River would occur during both construction and operation, and include disturbance to the riverbed, impacts to the benthic ecosystem and increased turbidity and pollution in the water column.[2] As I pointed out in my September 30, 2011 CWW screen rebuttal testimony, Entergy's analysis does not address short- and long-term impacts associated with the installation and operation of CWW screens in the Hudson River.[3] As I also pointed out in my May 30, 2012 Supplemental CWW Direct testimony, the full extent and variety of impacts associated with the construction and operation of Entergy's proposed CWW screens cannot be reasonably ascertained based on the information and analyses which Entergy has provided.[4] Although Entergy has submitted another report on its CWW screen proposal (*Environmental Report, New York State Environmental Quality Review Act, in Support of the Draft SEIS for a State Pollutant Discharge Elimination System (SPDES) Permit (No. NY-0004472), Entergy Nuclear Indian Point 2, LLC and Entergy Nuclear Indian Point 3, LLC,* Mar. 29, 2013, TRC Environmental Corporation, hereinafter the "TRC Report"), the TRC Report does not identify or evaluate the full range and nature of the adverse environmental impacts associated with the installation and operation of Entergy's proposed CWW screen array in the Hudson River.

[1] Tr. 2371:18-22 to 2372:1-4 (Henderson Direct).

[2] Tr. 2371:18-22 to 2372:1-4 (Henderson Direct).

[3] Tr. 2407: 6-9 (Henderson Rebuttal).

[4] Henderson May 30, 2012 CWW II Direct at 3:26 to 4:13.

Q. Please describe your experience with assessing and minimizing the impacts of underwater construction projects.

I have worked for many years on the impacts of dredging and piling on marine and estuarine life. I worked as the fisheries advisor during the planning of two of the largest port construction projects taking place in Britain. For the London Gateway project, this included the effects of one of the largest dredging programs ever undertaken in Europe and the construction of a new port which required extensive piling and land reclamation. This dredging campaign had to consider the effects of the mobilization of contaminants held within the sediments of the Thames estuary. I have also advised on construction effects of numerous power plant projects that have included piling and dredging.

B. Summary of Testimony and Conclusions

Q. Dr. Henderson, what were you asked to do in preparing your testimony?

I was asked to update my evaluations of whether Entergy's proposed BTA alternative is consistent with the best usages of the Hudson River and minimizes adverse environmental impacts relating to water quality and aquatic resource impacts, including the loss of potential habitat associated with the space occupied by the cooling water intake structure and aquatic areas associated with construction operations.

I was asked to review Entergy's TRC Report and to evaluate whether the report supported their claims that CWW screens are an available alternative technology for Indian Point, in the light of the adverse environmental impacts which would be associated with the construction and operation of Entergy's proposed CWW screen array in the bed of the Hudson River. In particular, I was asked to analyze whether the construction of the CWW screens as proposed would minimize adverse environmental impacts, and to evaluate the impacts of the construction and operation of the proposed CWW screen array to the chemical, physical and biological parameters of Hudson River water quality.

Q. What are your summary conclusions with respect to Entergy's TRC Report?

I conclude that the construction and operational phase impacts of the CWW array on the benthos and other aquatic life have not been properly addressed. Because of a lack of ecological benthic survey data, it is not possible to assess the impact on the benthic community from the placement of the CWW array and associated structures. Further, dredging-related impacts to the benthic community and other aquatic life have not been adequately addressed because pivotal information has not been collected on the quality of the sediments and the presence of contaminants. It is standard practice to collect such data to ensure that harmful contaminants in the sediments are not liberated into the water. Finally, because some aspects of the design, such as the material from which the CWW screens will be constructed, have not been defined, it is not possible to evaluate their potential impact on aquatic life.

Q. Are there any limitations on your testimony which you need to identify at the outset?

My testimony is limited to some degree by the limited information which Entergy has provided. In particular, Entergy has not presented any studies, report or analysis with respect to the benthic community living in the area which will be impacted by the CWWS system installation area. In addition, I have seen no analysis of sediments in the area where dredging is planned, for contaminants such as heavy metals and anthropogenic organic chemicals that may be held in the sediments.

Q. What particular issues do you address?

In particular, I address the lack of information upon which the conclusions in the TRC Report, relating to aquatic impacts, are based. There is insufficient knowledge of the benthic community to ascertain the degree of ecological damage which will occur. No information is given on contaminant concentrations in the sediments, so the release of contaminants caused by dredging cannot be properly assessed. The design and construction of the proposed CWW screens have not been finalized, so the impacts they will cause cannot be adequately assessed.

Q. What are your conclusions regarding the impacts of Indian Point Generating Station as operating with open cycle cooling and cylindrical wedgewire screens?

As I have previously testified, Entergy's proposal will not minimize the adverse aquatic impacts of the cooling water intakes because the level of environmental protection offered by the proposed CWW array is below that available through the use of closed-cycle cooling.

Q. Please describe the ecological importance of benthic organisms.

Benthic organisms comprise a key component of both a healthy aquatic system, and of a habitat which is needed to support the survival and propagation of fish, shellfish and wildlife. Much of the recycling of detritus and bacterial decomposition is undertaken in the river bed. These bacteria are then consumed by worms and other invertebrates, which are in turn food for larger invertebrates such as crabs, and vertebrates such as small fish. Without a healthy benthos the fish community of the river would be greatly impoverished and less favorable for fish, shellfish and wildlife propagation and survival.

Q. Please describe the aquatic habitat impacts which would be associated with the construction of Entergy's proposed CWW screen array.

There will be impacts caused by both construction and operation of the CWW screen array. Habitat loss and damage and the loss of benthic organisms will occur to the benthic community of the river in the area of installation. Dredging will increase suspended sediments (and the concentrations of any contaminants in the dredged material) in the water column, and dredged spoils, if not properly handled, stored and disposed of, may spread contamination to other aquatic areas outside the immediate area of impact. Construction activities will disturb aquatic life, and have the potential to interfere with the seasonal migrations of fish and other animals, for a number of years. Once construction is completed, continued disturbance to the local aquatic community will occur because of maintenance dredging, airburst cleaning and other maintenance activities.

C. Potential impacts during the construction of the CWW array

Q. Please summarize the construction phase aquatic impacts identified in the TRC Report.

These can be classified under the following 3 groups: (1) Underwater noise and disturbance generated by piling (discussed in TRC Report 4.5.1.1); (2) Dredging, pile driving, and other construction-related disturbances to water quality by increased sediment mobilisation, which increases turbidity and may lead to increased concentrations of contaminants such as heavy metals, PCBs and other compounds presently locked in the bottom sediments (discussed in TRC Report 4.5.1.2). Increased suspended solids can also reduce dissolved oxygen concentrations, and; (3) Disturbance to and destruction of benthic communities during construction. These relate to activities such as the burial of ABS pipes, impacts caused by the attachment of feet and anchors to the river bed and resettling of disturbed sediments, and the construction of a 168-foot long by 39-foot wide ABS building on piles, which would sit approximately 37 feet high and be located immediately seaward of the Unit 1 Wharf. *See* TRC Report at 2-7. The ABS building would result in additional habitat destruction and create permanently shaded conditions in the water beneath it.

Q. Does the TRC Report presents adequate data and information to address the three main areas of construction phase aquatic impacts described above?

No it does not.

Q. Please summarize the effects of underwater noise from pile driving on fish.

High levels of mortality have been found in fish exposed to 177 dB of sound, and the threshold for internal injuries to fish is around 160 dB. As a conservative measure, NOAA Fisheries and USFWS generally have used 150 dB RMS as the threshold for behavioral effects to ESA-listed fish species (Caltrans, 2009).

Underwater noise at levels below those causing physical harm may create disturbance to local populations, although some fish are known to rapidly acclimate to background noise. Some, such

as salmon, are only sensitive to low frequency sound and could not be made to react to frequencies above 380 Hz. This is at the lower end of sensitivity for birds and mammals, and indicates that salmon are able to sense low frequency vibrations, but do not hear in the human sense. They detect particle motion rather than pressure change. The lowest response threshold and presumably the frequency of greatest sensitivity is between 100 and 150 Hz. Above 150 Hz sensitivity rapidly declines.

Some species, such as flatfish, are even less sensitive than salmon, while others are more sensitive to low frequencies than salmon.

Pile driving may generate appreciable levels of noise, and the effects of noise during piling on migratory fish, particularly shad and striped bass, need to be considered. Noise levels close to the pile driver (within about 5m) can exceed the levels that will hurt or kill fish (peak quoted values 218 dB) (Caltrans, 2009). It has been calculated that noise levels 2 km from areas of piling can exceed 150 dB, which can be taken as the level at which fish will respond with avoidance reactions. There are thus clear needs to mitigate piling effects.

Q. How were the effects of underwater noise from pile driving on fish addressed in the TRC Report?

Section 4.5.1.1 of the TRC Report under fisheries gives a summary of our present knowledge of the potential impacts of noise on fish from pile driving, with which I broadly agree. There is however considerably less clarity as to the noise mitigation methods that would be undertaken. On p 4-19 it is stated "*Entergy would work closely with federal and state agencies to establish a construction window to minimize potential direct and indirect impacts to fish species that would also minimize the duration of overall construction timeframes. Since the magnitude of impacts is not only related to the size of the area impacted, but also the duration of impacts, it is important to complete the construction in a relatively rapid manner, which would be done.*" I could find no information as to how pile driving was to be undertaken to minimize the impact on fish.

Q. Please describe typical mitigation methods for reducing the impacts of pile driving on fish.

There are a range of options, not all of which may be appropriate at any particular locality. Generally, percussive piling needs to be minimized. Possibly applicable approaches are listed below.

1. Avoidance of piling during the seasonal migration of fish such as shad, and when young, vulnerable, life stages are present.
2. Gradual ramping-up of sound ("pile tapping") to scare fish away before sound levels reach lethal levels.
3. Non-metallic pad between the hammer and the driving helmet of the pile driver.
4. Initial driving by a 'silent method' e.g. hydraulic pressing or vibration.
5. Percussive driving for only a limited number of hours per day.

Q. Please summarize why the release of contaminants during dredging is important.

The sediments in estuaries are often contaminated with chemicals released from industrial process, water runoff and sewage waste. Many chemicals have an affinity for the fine particles found in marine sediment, and if present can potentially be remobilized by dredging, when they may enter the estuarine food chain. Remobilized heavy metals and organic compounds in sufficient concentration may cause acute toxicity to juvenile fish, and other aquatic life. Many of these compounds are also concentrated moving up the food chain, generating greater concentrations in top predators such as striped bass. Specifically, with respect to the Hudson River, contamination of sediments with PCBs is a known problem.

Q. Does the TRC Report adequately address the release of contaminants during dredging?

On p 2-14 of the TRC Report we have the following statement on the important issue of the presence of contaminants in the sediment: "*Past testing of spoils from the Hudson River performed by IPEC (and the Riverkeeper [Gobler 2008]) has not revealed the presence of elevated levels of hazardous contaminants, such as polychlorinated biphenyls ("PCBs") or radionuclides.*"

This statement indicates that recent sediment testing for the purpose of the proposed dredge has not been undertaken. Furthermore as pointed out in **Entergy Exhibit 170,** *IPEC CWW Dredging Step 2 – Draft White Paper Proposed Methods of Dredging To Be Used For The Removal of Anticipated Contaminated Soils*, January 2012, ENERCON 2012 Report: *"however, it is unknown if ongoing dredging by GE or Hurricane Irene flood waters may have deposited contaminants near Indian Point."* Since that report, Hurricane Sandy has also passed through the area. This conclusion is reinforced by the statement on p 4-1 of the TRC Report that "*dredged material disposal sites. . .cannot be determined until materials are tested and evaluated for contaminants.*"

However there is an implication that contaminants are present, because on p 4-19 it states that: "*Also, such sediments would be removed from the River for disposal, resulting in a net reduction in contamination.*" Further, on page 2-12 of the TRC Report it is stated that "*Of the total excavated volume (after application of the expansion factor), it is conservatively estimated that 25,000 yd^3 may require special handling and/or treatment (ENERCON 2012b).*" The possibility that contaminants are present is again noted on page 4-19 of the TRC Report: "*Contaminants, if present, may be redistributed locally, but installation of the CWWSs would add no contaminants.*"

I conclude that the absence of a survey of river bottom sediments for contaminants means that the risks of environmental harm from contaminant release have not been adequately addressed. I am unable to judge, for example, if fish eggs and larvae will be poisoned if they enter the dredging plume in areas of high sediment contamination, or what effect the resuspension of any dredged contaminants would have on the concentrations of such contaminants in the water column.

As the TRC Report explains, the Hudson River is listed as impaired for fish consumption, and NYSDEC lists the source of the impairment as "contaminated sediment." TRC Report at 3-10, citing NYSDEC 2013. "*Substances of potential concern include mercury, dioxins/furans, polycyclic aromatic hydrocarbons ("PAHs"), pesticides and other heavy metals.*" *Id.*

Q. Why do you believe that the TRC Report does not adequately address construction phase impacts on the benthic community?

The report identifies many of the impacts that will occur, and focuses primarily on the impacts of dredging. It is concluded that because of the "small" area to be dredged (5.2 acres), and the nature of the benthic community present, there will be a rapid recovery from any initial harm. On p 4-19 of the TRC Report, we are informed that benthic organisms will recover quickly from the disturbance caused by dredging: "*Thus, benthic invertebrate populations occurring at the site of the construction work could be reasonably expected to recover in a timeframe of one to two years...* ."

It is my opinion that this conclusion cannot be supported without a survey of the benthic community present. Benthic communities can possess complex inter-relationships between species that take a long time to develop. This is the case in shellfish beds and biogenic reefs, where biodiversity can be high and easily degraded by man. It is standard practice, prior to undertaking river or seabed works, to identify the benthic communities present to ensure no species or communities of high ecological value will be impacted. The report presents no recent information on the benthic community in the vicinity of the proposed works. It is possible that the area actually holds a number of different communities at different depths and on different substrates. It is assumed in the report that it comprises a benthic community which can quickly recover, without any information presented on the actual species comprising this community. Further, if contaminants are present and redistributed by the dredging, information on the species present would be required to determine the likely level and extent of the impact, because species differ in their sensitivity. Moreover, while the TRC Report contains no explanation as to how long before benthic organisms could be expected to re-colonize acres of riverbed covered by marine mattresses and rip-rap, it does acknowledge at pages 4-22 to 4-23 that roughly one acre of the altered river bed would be unlikely to re-establish functioning benthic habitat. Finally, I can find no discussion as to any benthic habitat impacts which would result from installation of the pile-supported ABS building the permanent shading of the shoreline riverbed beneath the pile-supported ABS building.

C. Potential impacts during the operation of the CWW array

Q. Please summarize the operational phase aquatic impacts identified in the TRC Report.

The TRC Report identifies no operational impacts associated with the installation of the CWW array. A summary of the conclusions is presented in Table E8-1 (pES-9). The impact on water quality and the benthic community is assumed to be limited to the construction period. The TRC Report considers operational impacts on the aquatic ecology to be beneficial, because it assumes that CWW screens will result in the elimination of fish impingement mortality and the reduction in entrainment.

Q. Do you believe the TRC Report has adequately addressed long-term operational impacts of the CWW array?

No I do not.

Q. Please summarize the areas that you consider have not been addressed.

These can be considered under 4 headings. (1) The loss and alteration of soft substrate benthic habitat where the CWW array, riprap and marine mattresses are placed, and where water currents may change. (2) Long-term impacts of maintenance dredging. (3) Effects associated with biofouling control and the potential leaching of copper from the CWW screen alloy. (4) Noise and disturbance caused by airburst cleaning.

Q. Do you consider that the loss and alteration of aquatic habitat under and around the CWW array has been adequately addressed in the TRC Report?

No I do not. As shown in Table 1 (**Entergy Exhibit 171**-RTC-12-002 IP Volume Area), which is reproduced below, an appreciable area of riverbed will be altered and replaced with modified habitat. There is no analysis of the loss of habitat, or the effects of its replacement with hard substrate such as riprap and with marine mattresses. This is important as it will change the nature of the local benthic community. Further, there will be changes to water flow and currents caused by the extraction of water from the bottom of the river. These will inevitably change the ecology

of the benthos in the vicinity of the CWW array. The nature and magnitude of these changes to the benthos are not considered, and the magnitude cannot be ascertained based on the limited information which Entergy has presented.

Table 1

CWW Screen System Constructed Area						
Zone	**Item**	**Area**		**Qty**	**Total Area**	
1	Risers	20	ft^2	144	2,827	ft^2
	Plenum Box (minus risers)	2,190	ft^2	12	26,276	ft^2
	Marine Mattress	20,298	ft^2	1	20,298	ft^2
	Rip-Rap/Backfill	5,531	ft^2	2	11,062	ft^2
2	Transition Box	1,759	ft^2	4	7,038	ft^2
	Rip-Rap	1,700	ft^2	2	3,400	ft^2
3	Marine Mattress	33,417	ft^2	2	66,834	ft^2
4	Marine Mattress, Unit 2	38,179	ft^2	1	38,179	ft^2
	Marine Mattress, Unit 3	41,737	ft^2	1	41,737	ft^2
5	Intake Ducts	1,335	ft^2	4	5,339	ft^2
TOTAL					**222,990**	**ft^2**
					24,777	**yd^2**
					5.12	**acre**

Q. Do you consider that the impact of maintenance dredging has been adequately addressed in the TRC Report?

No I do not. Maintenance dredging is discussed in section 4.5.2.4. of the TRC Report. It states: "*Periodic dredging may be required around the CWWS array, as well as in front of the shoreline intake bypass system, to prevent excess sediment accumulation.*" The conclusion appears to be that dredging is presently undertaken, and will be undertaken in the future, so there is a SMALL effect. However, present dredging is limited to an area in front of Unit 2 and 3 intake structures. Maintenance dredging in the future will be over a more extensive area of river bed, as it may be

required around the CWWS array. No clear information is given on the extent or nature of this dredging activity. That maintenance dredging is anticipated indicates that the view that the benthic soft substrate community will quickly recover is untrue, as it will be subjected to continued intermittent disturbance over the life of the intake. As a result, the loss of benthic habitat would be permanent.

Q. Please summarize your concerns relating to biofouling control.

On p. ES-4 of the TRC Report we are informed of the possible use of copper-nickel alloy for the construction of the CWWS array: "*Use of alternative construction materials (i.e., various grades of stainless steel, copper-nickel alloys, etc.) depending on waterbody characteristics at the deployment site. In particular, wedgewire fabricated with copper-nickel alloys have proven to be effective in controlling the potential for biofouling of the screen surface and internal screen components.*" This statement indicates that no decision has been made on the alloy.[5] This information is required before an adequate assessment of the impacts can be made. Copper-nickel alloys may leach small amounts of copper into the water.

To give some idea of the scale of the issue we have made the following calculations:

The report *Evaluation of Zebra Mussel Resistant Materials of Construction, for Intake Screens & Assemblies, March 9, 1994,* **(Entergy Exhibit 58)** indicates that concentrations of copper at typical intake flow rates would be estimated at about 0.0005 parts per million (Table 6 of the above report). This is well below the level at which acute toxicity is likely to occur to the majority of aquatic life; however, it will represent a considerable annual input of copper into the system. Further, it is presumably the toxicity of the copper that gives these cupro-nickel alloys their anti-fouling properties.

The proposed maximum flow is 2.5 billion gallons per day, which equals 9.4625×10^9 litres per day. This gives a daily release of about 4,700 grams of copper per day, assuming a concentration

[5] I understand from Riverkeeper's counsel that Riverkeeper has determined through the discovery process that Entergy itself does not have information on the particulars of the composition of the CWW screen alloy which Entergy proposes to utilize for the CWW screens at Indian Point.

of 0.0005 parts per million. This is approximately 1.725 tonnes of copper per year released into the Hudson River via the heated water discharge. So if the plant would run for 20 years there would be a total loading of up to 34 tonnes of copper in the sediment bioaccumulation.

These calculations are only illustrative, as they are based on freshwater leaching rates. The site of the CWWs has a range of salinities, and this would potentially affect the rate of leaching, but without more information on the composition of the alloy, further estimates cannot be made.

Q. Please summarize your concerns relating to airburst screen cleaning.

The regular airburst cleaning of the screens will create an intermittent, but regular, disturbance to the water column. The effect this will have on fish and other aquatic life is unclear and has not been assessed. It is possible that foraging fish will be scared by, or even attracted by, the disturbance, which may create considerable underwater noise. More information on this impact is required.

Q. Does this conclude your direct testimony?

Yes.

Updated Biblography

California Department of Transportation (Caltrans), 2009. Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish (Final), *available at* http://www.dot.ca.gov/hq/env/bio/files/Guidance_Manual_2_09.pdf.

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