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MEMORANDUM

TO:	Dick Hahn	DATE:	March 31, 2014
FROM:	Steve Wood	ESS PROJECT NO.:	L149-000
SUBJECT:	PSNH Asset Environmental Review		
COPY TO:	Dan Koehler		

PUBLIC SERVICE OF NEW HAMPSHIRE GENERATING ASSET ENVIRONMENTAL REVIEW

ESS has undertaken a high level review of environmental conditions for the Public Service of New Hampshire (PSNH) generating assets as part of the valuation of PSNH's generating assets and purchased power agreements for the New Hampshire Public Utilities Commission in support of LaCapra Associates, the lead consultant for the project.

The objective of the assessment was to generally identify known and potential environmental matters that could lead to substantial expenditures for future compliance i.e. the need for environmental controls or future liabilities potentially due to soil or groundwater conditions at the sites that could influence the cost of operations. The assessment was based on information as provided by PSNH through discussion and information requests and also through readily available information obtained by ESS from the New Hampshire Department of Environmental Services' (NHDES) website or Environmental Protection Agency website[1].

The review involved mainly the three largest assets: Merrimack, Newington, and Schiller Stations with the focus being three main areas of environmental concern: cooling water, air quality, and site assessment/conditions. ESS also reviewed the smaller peaking generating units located in Groveton (Lost Nation) and Tamworth (White Lake) with respect to air quality as well as the hydroelectric generating facilities with respect to water quality and discharge permit status.

1.0 BACKGROUND / METHODOLOGY

1.1 Cooling Water Assessment

One of the most significant pending potential requirements for existing electric generating units is the potential changes required to cooling water systems. The Clean Water Act Section 316(b) Rule, first promulgated in 1976, requires that the location, design, construction and capacity of cooling water intake structures (CWIS) reflect the best technology available (BTA) for minimizing adverse environmental impacts to fish and other aquatic organisms. Since 1976, the rule has been suspended and rewritten several times in a long and drawn out legal battle between utilities and environmental groups. The current draft of the Rule, published in April 2011 and set to be finalized sometime in early 2014, applies to existing power generating facilities and large manufacturing and industrial facilities that withdraw more than 2 million gallons per day (MGD) and use at least 25% of that water exclusively for cooling purposes. Based on available information, the Merrimack, Newington, and Schiller Stations are expected to be subject to the new Rule.

For an existing electric generating facility utilizing once through cooling; alternative cooling water system modifications may be possible that could provide meaningful environmental benefits at a lower overall

[1] http://des.nh.gov/onestop/index.htm; http://epa.gov/

cost than a full conversion to a closed loop cooling water system. These alternative approaches are very site specific and beyond the scope of this evaluation. EPA has not mandated conversion of all once through cooling water systems to closed cooling water systems and they are allowing each facility to provide a site specific and facility specific analysis of the costs and environmental benefits of alternative approaches to the full implementation of a closed cooling water system conversion. Further analysis and discussion with EPA would be necessary to ascertain if this approach would be acceptable by EPA for the PSNH generating Stations.

PSNH was asked by the EPA under the section 308 process to provide an engineering review of its existing generating facilities and to provide a cost analysis to implement a full conversion of these existing facilities to a closed loop cooling water system. Although no decision has been made to convert these facilities to a close loop cooling water system PSNH did undertake the required engineering and cost analysis to quantify the potential cost impact for a full conversion of each of the existing generating facilities to close loop cooling. ESS conducted a review of PSNH's cost estimates and a review of the costs developed by the EPA in its Technical Development Document for the Proposed Section 316(b) Phase II Existing Facilities Rule. U.S. EPA. March 2011 ("EPA 316(b) Technical Development Document") to develop an order of magnitude estimate of the overall cost to implement this technology.

1.2 Air Quality Assessment

PSNH's air permits require each operating station to be in full compliance with all applicable Federal and State emission and operating requirements. To assist in this review PSNH provided recent emission compliance reports for all five fossil-fuel generating assets (Merrimack, Newington, Schiller, White Lake, and Lost Nation), and air permits for each facility were obtained on New Hampshire Department of Environmental Services' (NHDES) website. ESS reviewed the PSNH annual emissions data, the current operating permits, and EPA regulatory compliance information to determine whether the PSNH assets were in compliance with current environmental regulatory requirements. ESS found PSNH operating assets to be in compliance with the requirements of the current operating air permits.

ESS also reviewed pending environmental emission regulations to identify those that have a potential to require a large capital investment or to otherwise require additional costs to operate.

1.2.1 FUTURE/PENDING AIR QUAILTY REQUIREMENTS

Greenhouse Gas Regulations

On December 7, 2009, EPA identified six key greenhouse gases (e.g. carbon dioxide and methane) and found that they constitute a threat to public health. On September 20, 2013, the EPA announced its first step in reducing carbon emissions by issuing proposed standards for new power plants and initiating a process to establish standards for existing power plants. EPA proposed a limit of 1,000 pounds of CO_2 per MWhr for new, reconstructed, or modified facilities. Therefore, these standards do not apply to the existing PSNH facilities, but may provide insight into the order of magnitude limitations the EPA may be considering for existing facilities.

The EPA has yet to propose any standards that would apply to the PSNH facilities for greenhouse gas emissions. EPA has suggested that a possible approach would be to give each State an emission "budget" or cap based on the mix of fuels used by electric generating units (EGUs) in the state to generate electricity in a base period. This is similar to an approach taken in the past with respect to NO_x emission regulation. PSNH has indicated they continue to monitor the status of EPA's thinking on establishing GHG standards.

Mercury and Air Toxics

On April 16, 2012 the Mercury and Air Toxic regulations under 40 CFR Parts 60 and 63 became effective, requiring the emission reductions of certain toxic air pollutants with a compliance date of April 16, 2015. The regulation applies to new and existing coal and oil-fired facilities. The pollutants for which emission limits have been established for coal and oil-fired plants are: filterable particulate matter (PM), hydrogen chloride (HCl), mercury (Hg), and hydrogen fluoride (HF). Merrimack, Schiller and Newington stations meet the size threshold to fall under these requirements, but Tamworth and Groveton do not.

PSNH has indicated that they are currently preparing for compliance with the mercury MATS regulation and provided a matrix in response to an information request, summarizing a number of options that are being considered and are developing cost estimates. A review of the information confirms PSNH is aware of the MATS compliance issues and have compliance options in development at each facility.

Best Available Retrofit Technology

New Hampshire's Best Available Retrofit Technology (BART) rule was finalized on January 8, 2011 and the EPA approved the NH Department of Environmental Services (NHDES) regional haze State Implementation Plan on August 22, 2012. Merrimack Station Unit 2 and Newington Station Unit 1 were identified by NHDES as facilities that needed to perform a BART Analysis to determine whether emissions were well controlled, and whether retrofit measures or additional work practices should be required to reduce emissions below current levels to improve visibility. According to PSNH, both Merrimack and Newington Station have worked with NHDES to determine what controls and work practices would be appropriate to reduce emissions and meet the state's regional haze goals while continuing to maintain operational flexibility and that Merrimack has been deemed to meet the requirements. EPA published approval of the New Hampshire State Implementation Plan in the Federal Register on August 22, 2012 incorporating regulation Env-A 2300 Mitigation of Regional Haze and PSNH Merrimack Station Temporary Permit TP-0008 Flue Gas Desulfurization System.

1.3 Site Assessment/ Conditions Assessment

ESS completed a limited assessment of environmental conditions for three of PSNH's power stations: Merrimack, Newington, and Schiller. The objective of the assessment was to generally identify known and potential environmental conditions of concern (particularly related to soil and groundwater) at the facilities and evaluate the short and long-term environmental liabilities associated with such condition(s). Based on discussions with PSNH, no overall ASTM or other method Phase 1 environmental site assessment has been conducted for the these facilities recently. This is not uncommon as there was no reason to undertake this type of evaluation at this time.[2] The assessment conducted by ESS was based on limited and readily available information provided by the PSNH in response to information requests and through information obtained from the NHDES website[3,4].

[2] For instance these type of assessments are typically associated with a property transfer or financing which is not the case for the PSNH facilities.

[3] http://des.nh.gov/onestop/index.htm

[4] The assessment of short and long-term environmental liabilities is solely based on ESS' review and interpretation of limited information and should not be considered a thorough and detailed liability evaluation of current and/or past contamination issues. Any monetary values presented herein for environmental liabilities: are purely estimates; do not consider other site-related environmental matters (i.e., wastewater, hazardous waste management, potentially hazardous building materials, air quality, etc.); are based on numerous assumptions; and are subject to change based on ESS' receipt and review of additional and pertinent site-specific information.

2.0 SUMMARY OF ASSESSMENT RESULTS

2.1 Merrimack Power Station

The Merrimack Station facility in Bow, New Hampshire is the largest generating station in the PSNH portfolio. The facility is a fossil fuel-fired electricity generating facility with a total output capacity of 440 MW. The facility operates on intermediate duty, which means is brought online when customer demand reaches a moderate level. The facility is comprised on two utility boilers, two combustion turbines operating as load shaving units, an emergency generator, and an emergency boiler. The two utility boilers (Unit 1, 110 MW and Unit 2, 330 MW) primarily burn bituminous coal; the two combustion turbines primarily burn No. 1 fuel oil or JP-4; the emergency generators burn No. 2 fuel oil or diesel fuel, and the emergency boiler burns No. 2 fuel oil or low sulfur diesel fuel. The two utility boilers ignite with No. 2 fuel oil.

The facility is located along the western bank of the Merrimack River and occupies approximately 150 acres of a 231-acre parcel of industrial-zoned land. The PSNH-Merrimack Station facility generally includes the following: an administrative office building, a power generation building, air pollution control equipment including a wet flue gas desulfurization system (scrubber), a coal yard storage and handling area, limestone and gypsum storage, truck washing facility, two combustion turbine structures, a jet fuel storage area, chemical unloading and storage areas, warehouses, a transmission substation, slag settling ponds, wastewater treatment facilities, and a cooling water discharge canal. The Merrimack Power Station reportedly has forty-two aboveground storage tanks (ASTs) currently in-use (containing either diesel, jet fuel, No. 2 fuel oil, transformer oil, gasoline, and used oil); two ASTs that are out-of-use; and seven ASTs that have been removed or dismantled (contained diesel, No. 6 fuel oil, No. 2 fuel oil, used oil, gasoline, and transformer oil); and twelve underground storage tanks (USTs) that were permanently closed (contained gasoline, No. 6 fuel oil, No 2 fuel oil, and used/waste oil).

2.1.1 Water Quality Assessment

A Draft NPDES permit for the Merrimack Station Permit Number: NH0001465 was issued for review and comment on and remains under review by EPA.PSNH are currently waiting for EPA's response to comments on the draft permit and a final permit.

In accordance with the proposed new 316b Rule, the conversion of the existing facility to a closed loop cooling water system would be a major engineering and construction undertaking involving significant planning, associated downtime for the existing unit and results in an overall decrease in the thermal performance of each facility involved. ESS reviewed the PSNH cost estimates developed in the following report [Response to United States Environmental Protection Agency CWA 308 Letter PSNH Merrimack Station Units 1 & 2; November, 2007] and compared these costs to the range of costs identified by EPA in its 316b Development Document for electric generating stations representative of the PSNH facilities. The PSNH cost estimates are costs reflective for the years in which the PSNH reports were completed and as a result these costs would need to be escalated to the year that any conversion of these facilities to closed loop cooling would occur. Costs associated with such conversion fall into several categories; Capital/construction costs, operation and maintenance, lost generation during construction, parasitic electric use and other losses associated with the new system and operational losses mainly due to decrease in efficiency. The table below summarizes the major expenditures associated with the full conversion of the existing facility to a closed loop cooling water system.[5]

[5] Cost assume the installation of and SPX hybrid closed cooling system

Merrimack Generating Station					
			MW (*MWhr*)	**$/MW**	**2014 Dollars***
Construction Cost Estimate					
	Station (Unit #1 and #2)				$68,020,460
		Unit #1			$25,749,740
		Unit #2			$48,771,590
Operation & Maintenance					
	Unit #1				
		Year 1 - 5			$96,260
		Year 6 - 15			$138,880
		Year 16-30			$266,840
	Unit #2				
		Year 1 - 5			$240,530
		Year 6 - 15			347,250
		Year 16-30			$667,160
Lost Capacity During Construction (MWhr)					
	Unit #1		60,480	$37	$2,237,800
	Unit #2		176,400	$37	$6,526,800
Parasitic Loss (MW)					
	Unit #1		*1.56*	$72	$983,900
	Unit #2		*5.14*	$72	$3,241,900
Operation Loss (MW)					
	Unit #1		*0.16*	$72	$100,900
	Unit #2		*2.82*	$72	$1,778,600

* Original values presented in 2007 dollars. Escalated to 2014 dollar using 2% per year.

The site specific costs presented above are reasonable based on the EPA 316(b) Technical Development Document, which provided a representative cost estimate for a closed cycle retrofit of a 350 MW plant with an intake flow of 200,000 gpm. The EPA estimated capital cost[6] for the representative retrofit was between $35,000,000 and $92,000,000 depending on the difficulty, with an estimated average level of difficulty being approximately $59,000,000. The estimated O&M cost for operating a retrofit closed cycle cooling system was $3,600,000. As described earlier, given the age of the PSNH generating facilities, the relatively low water withdrawals and other factors, it may be possible that an alternative to a full cooling water system conversion to closed cycle would be acceptable to EPA. Since the final 316(b) Rule has yet to be issued and the cost benefit of the required capital investment yet to be weighed by EPA, the costs developed for this generating facility should be considered only as a future potential and worst cast estimate.

2.1.2 Air Quality Assessment

NHDES performed an annual Title V Compliance Certification Review on May 18, 2013 and determined the facility to be in complete compliance with the Title V Operating Permit emission limits and operating conditions. Additionally, all recent stack test reports indicate compliance with applicable limits.

PSNH made a major capital investment in Merrimack Station in 2011, and it is reported to be effective in reducing SO_2 and Hg emissions and will be of value in meeting the Mercury and Air Toxics Standard (MATS). Based on industry experience with similar wet scrubbing technology, the wet

[6] Original values in the EPA report were presented in 2009 dollars. Escalated to 2014 dollar using 2% per year.

scrubbers already installed at the Merrimack Station should also be effective in controlling other MATS pollutants (HCl, HF, and PM). PSNH will need to demonstrate this by performing additional emissions testing to demonstrate the effectiveness of the existing emission controls. Therefore, PSNH should be able to avoid additional major capital investment to meet the MATS requirements at this facility although some small level of investment may be required to address these additional pollutants.

PSNH provided a matrix of options being considered to comply with MATS regulations monitoring requirements at Merrimack Station. In order to demonstrate compliance with the Mercury standard, PSNH anticipates one-time capital expenditures of $150,000 - $320,000 and operating costs of $12,000-$15,000 per year. HCL and particulate matter (PM) monitoring could be conducted as part of ongoing quarterly stack testing at no additional capital cost but approximately $60,000 annual in operating costs, however PSNH suggested this approach may be challenging because of timing i.e. the ability to meet the testing windows since there are no grace period provided for in the event operational or other matters preclude the ability to conduct the test. If stack testing is found to be ineffective for monitoring HCL and PM, alternative options are estimated to range from a low of $15k annually for 3 years to a high of $250,000 (total for HCL and PM). The operating costs to monitor HCL and PM (not including stack testing) ranges from $15,000 every 3 years after initial year to as much as $60,000 per year (total from HCL and PM).

Based on this analysis, the total cost to PSNH to comply with the MATS regulation is between $150,000 and $570,000 in capital cost and $12,000 to $75,000 per year in operating costs. An evaluation of the effectiveness of the controls identified by PSNH and the associated cost/benefit of each is beyond the scope of this evaluation. PSNH must be in compliance by April 16, 2015.

With regard to potential future limits on greenhouse gas emissions, the use of coal as a fuel source at the Merrimack facility which is carbon intensive (as compared to gas or even oil) may require additional operating cost as the program will most likely involve the trading of available “allowances”. Additional gas burning capability may also be an option which may require capital investments. Another option could be to reduce operations i.e. capacity factor which would impact revenues. At this time, given the uncertainty of the proposed GHG emission requirement, it is not possible to definitely assign a future cost.

2.1.3 Site Assessment/ Conditions Assessment

A fly ash landfill is situated on the property within an abandoned sand and gravel operation area. The landfill was originally unlined and began operations circa 1975 at which time fly ash, dewatered wastewater treatment sludge, slag, and ash pond dredging material were disposed of. Aluminum oxide blasting grit and asphalt pavement was also reported permitted (1980) to be disposed of the landfill. In November 1980, NHDES order PSNH to discontinue the disposal of semi-liquid, oil ash-based sludge and only allowed disposal of fly ash in the landfill. In 1981, ~2,000 cubic yards of oil ash sludge and vanadium content was removed from the landfill. In 1986, the landfill was upgraded with a synthetic rubber liner. The landfill was also equipped with a central leachate collection system with a 4,000-gallon underground storage tank (UST) and a pump house for the removal of leachate and subsequent treatment at the on-site treatment plant. Groundwater monitoring, in accordance with a Groundwater Release Detection Permit, has occurred around the landfill since circa 1985 through present.

From 1981 through 1988, Preliminary Assessments and Hydrogeologic Investigations were performed (Dubois and King, Inc.) to determine groundwater impacts from leachate discharge from the fly ash landfill. A variety of constituents were initially detected in groundwater samples collected

(circa 1984 through 1988) from on-site monitoring. Up to thirteen off-site/private wells were also initially monitored (circa 1982 through 1985). Based on a January 1985 correspondence letter, NH Water Supply and Pollution Control Commission indicated that only one out of the thirteen off-Site residential wells were potentially impacted. The detected volatile organic compounds (VOCs) were believed to be associated with the solvent adhesive that was used to seal the synthetic rubber liner. More recent monitoring of groundwater on the site, as summarized below, has not shown the presence of the aforementioned constituents, with the exception of certain total and dissolved metals.

As stated above, Merrimack Station currently has a Groundwater Release Detection Permit (GWP-198400065-B-005) issued by NHDES for groundwater monitoring at the currently lined landfill. The most recent permit was issued in February 2012 and expires on February 2017. The groundwater monitoring system is comprised of five groundwater monitoring wells that are sampled semi-annually. According to a PSNH report to NHDES, dated May 15, 2013, entitled "Merrimack Station Coal Ash Landfill, Bow, NH; WMD Permit No. DPHS-SW-85012; DES #198400065, Project #9, "All of the groundwater results are consistent with those submitted in the past, and continue to demonstrate that the underlying aquifer is being fully protected".

There is an open NHDES case /release (Site No. 198400065) for the site associated with an oil release from a now closed in-place oil-water separator. In 2005, the facility closed a buried oil-water separator which had been replaced by a new unit installed within wastewater treatment facility building. During closure of the oil-water separator and subsequent environmental investigation activities in 2005 and 2006, petroleum-impacted soil was identified beneath a pipe which was used to transfer oil from the separator to a 3,000-gallon concrete collection sump. In-place closure of the oil-water separator and excavation of petroleum-impacted soil occurred in 2005 and early 2006. NHDES issued a Certificate of No Further Action to PSNH for the oil-water separator investigation and closure on December 13, 2006. In November of 2009, GZA was retained to observe and document the in-place closure of the 3,000-gallon concrete oil collection sump. On November 30, 2009, a 12-inch diameter opening was cut through the bottom of the oil collection sump to serve as a recovery point for free product from the soil adjacent to the sump. Based on March 2013 letter from PSNH to NHDES, no free-phase product was measureable and neither VOCs nor polyaromatic hydrocarbons (PAHs) were detected in the wells at concentrations exceeding the ambient groundwater quality standards (AGQS). NHDES approved the permanent closure of the sump (filling it with inert structural fill and capping with concrete). NHDES also approved quarterly monitoring of groundwater for dissolved metals (RCRA-8), pH and conductivity for the remainder of 2013. Monitoring groundwater quality for dissolved metals in groundwater appears to be on-going.

Short-term liabilities are considered current and on-going environmental activities to assess or remediate known releases of petroleum products or hazardous substances to the subsurface. Based on the information reviewed by ESS for Merrimack Station, the following short-term liabilities could include: (i) groundwater monitoring near a closed sump and oil-water separator for dissolved metals that exceed NHDES AGQS. ESS would anticipate that the annual costs for performing and reporting groundwater quality monitoring could be between $20,000 and $35,000. According to PSNH, an escrow account is maintained to ensure funding is available to close and perform long term monitoring of the landfill.

Long-term liabilities are considered environmental actions taken to address currently unknown or suspect contaminant conditions on the site. An example of a potential contaminant condition could include soil quality impacts from historical site operations (historic testing of soil quality appears limited based on the overall size of the property). With this scenario, future environmental actions include: comprehensive subsurface investigations (i.e. surface and subsurface soil testing), limited

soil removal actions; potential placement of an Activity Use Restriction (AUR), and all associated regulatory reporting. ESS would anticipate that the costs for these types of actions could be between $50,000 and $150,000. *Note – the long-term liabilities do not account for any large-scale redevelopment scenario that may involve significant earthwork and dewatering activities and associated management of potentially impacted soil or groundwater.*

2.2 Newington Power Station

The Newington Power Station is located just north of the Newington/Portsmouth NH town line at 165 Gosling Road in Portsmouth, New Hampshire. The facility has a total output capacity of 406 MW and is comprised of one utility boiler, two auxiliary boilers and one emergency generator. The one utility boiler is capable of burning either natural gas or No. 6 fuel oil or crude oil; the auxiliary boilers burn No. 2 fuel oil; and the emergency generator burns diesel. The facility is a peaking unit, which means it is brought online when customer demand reaches a high level.

The Newington station also reportedly consists of a former Mobil Oil bulk storage terminal (193 Gosling Road). Mobil developed the property as a bulk storage terminal circa 1943. Prior to 1940, the property was reportedly undeveloped. The facility reportedly has twenty-eight ASTs currently in-use (containing either No. 2 fuel oil, transformer oil, diesel, lubrication oil, used oil, No. 6 fuel oil); two ASTs that are out-of-use (contained No. 2 fuel oil, transformer oil); one 5,000-gallon No. 2 fuel oil UST that was permanently closed on June 5, 1987. The station began commercial operations in 1974.According to an April 2, 1984 document (entitled “On-Site Waste Disposal Systems”) received by the Division of Public Health Services, Bureau of Hazardous Waste from PSNH, on-site disposal of fly ash slurry reportedly occurred during 1976 and possibly circa 1975-1977.Two pits on the northwestern corner of the site were used for the fly ash disposal. This area was reportedly covered and is now used as equipment storage area (PSNH – 1982).

2.2.1 Water Quality Assessment

The Newington Station EPA NPDES Permit Number NH0001601 was issued on Sept 30, 1993 and expired on Oct 30, 1998. PSNH is currently waiting for a draft permit to be issued by EPA.

In accordance with the proposed new 316b Rule, the conversion of the existing facility to a closed loop cooling water system would be a major engineering and construction undertaking involving significant planning, associated downtime for the existing unit and results in an overall decrease in the thermal performance of each facility involved. ESS reviewed the PSNH cost estimates developed in the following report [Response to United States Environmental Protection Agency CWA 308 Letter PSNH Newington Station; August, 2008] and compared these costs to the range of costs identified by EPA in its 316b Development Document for electric generating stations representative of the PSNH facilities. The PSNH cost estimates are costs reflective for the years in which the PSNH reports were completed and as a result these costs would need to be escalated to the year that any conversion of these facilities to closed loop cooling would occur. Cost associated with such conversion fall into several categories; Capital/construction costs, Operation and maintenance, Lost generation during construction, Parasitic electric use and other losses associated with the new system and Operational losses mainly due to decrease in efficiency. The table below summarizes the major expenditures associated with the full conversion of the existing facility to a closed loop cooling water system.[7]

[7] Costs assume the installation of an SPX hybrid closed cooling system.

Newington Generating Station					
			***MW* (MWhr)**	**$/MW**	**2014 Dollars***
Construction Cost Estimate					
	Unit #1				
		Unit #1 (seawater)			$85,706,700
		Unit #1 (graywater)			$76,737,160
Operation & Maintenance					
	Unit #1				
		Year 1 - 5			$253,950
		Year 6 - 15			$366,570
		Year 16-30 (seawater)			$726,940
		Year 16-30 (graywater)			$701,040
Lost Capacity During Construction (MWhr)					
	Unit #1	Scheduled when in economic reserve			
Parasitic Loss (MW)					
	Unit #1		*5.08*	$98	$4,361,100
Operation Efficiency Loss (MW)					
	Unit #1		*79.1*	$98	$67,906,000

* Original values presented in 2008 dollars. Escalated to 2014 dollar using 2% per year.

The site specific costs presented above are reasonable based on the EPA 316(b) Technical Development Document, which provided a representative cost estimate for a closed cycle retrofit of a 350 MW plant with an intake flow of 200,000 gpm. The estimated capital cost for the representative retrofit was between $35,000,000 and $92,000,000 depending on the difficulty, with an estimated average level of difficulty being approximately $59,000,000.The estimated O&M cost for operating a retrofit closed cycle cooling system was $3,160,000. As described earlier, given the age of the PSNH generating facilities, the relatively low water withdrawals and other factors, it may be possible that an alternative to a full cooling water system conversion to closed cycle would be acceptable to EPA. Since the final 316(b) Rule has yet to be issued and the cost benefit of the required capital investment yet to be weighed by EPA, the costs developed for this generating facility should be considered only as a future potential expense.

2.2.2 Air Quality Assessment

NHDES performed an annual Title V Compliance Certification Review on May 30, 2013 and determined the facility to be in complete compliance with the Title V Operating Permit emission limits and operating conditions. Additionally, all recent stack tests reports indicate compliance with applicable limits.

PSNH provided a matrix of options being considered to comply with MATS regulations at Newington Station. According to the regulation, a facility is exempt from the emission limits required by MATS if the facility operates with an annual capacity factor of <8% (based on a 2-year average). Based on information provided by PSNH, Newington Station has operating a capacity factor below 6% annually since 2009. Therefore, Newington Station may be exempt from the MATS regulations.

PSNH has also evaluated monitoring options to ensure compliance with MATS, in the event that the facility is not exempt for MATS in the future. The three criteria pollutants that are evaluated by PSNH are PM, HCL, and HF. All three constituents could be monitored as part of ongoing quarterly stack testing at no additional capital cost and $120,000 annual in operating costs; however PSNH suggested this approach may be challenging because of timing i.e. the ability to meet the testing

windows since there are no grace period provided for in the event operational or other matters preclude the ability to conduct the test. If stack testing is found to be ineffective, an alternative option at no cost to PSNH for HCL and HF (in capital cost or operating expense) would be to monitor the fuel moisture content and demonstrate compliance with a <1% standard, although this would not address PM. If neither option is acceptable, the capital expense to monitor HCL would be between $10,000 and $100,000, with operating expenses between $10,000 every 3 years after initial to $10,000 annually. The capital expense to monitor HF is $10,000 annually for 3 years to $100,000, with operating expenses between $10,000 every 3 years after initial to $10,000 per year. The capital expense to monitor PM is between $10,000 annually for 3 years to $100,000, with operating expenses between $10,000 every three years after initial to $35,000 every 3 years and $10,000 all other years.

Based on this analysis, the total cost to PSNH to comply with the MATS regulation at Newington is between $0 and $300,000 in capital cost and $30,000 to $120,000 per year in operating costs. An evaluation of the effectiveness of the controls identified by PSNH and the associated cost/benefit of each is beyond the scope of this evaluation. PSNH must be in compliance by April 16, 2015.

With regard to potential future limits on greenhouse gas emissions, Newington burns oil and natural gas and therefore less carbon intensive fuels.

Therefore, the approach at Newington may be less costly if the program adopted involves the trading of available “allowances”. Additional gas burning may also be an option which would not require capital investments. Another possibility is that because of the facilities low capacity factor, it may not be subject to any future GHG requirement. At this time, given the uncertainty of the proposed GHG emission requirement, it is not possible to definitely assign a future cost.

2.2.3 Site Assessment/ Conditions Assessment

Based on readily available information, it does not appear that the Newington Station property (excluding the former Mobil bulk storage terminal property) has any open cases with NHDES or EPA regarding petroleum product or hazardous substance releases to the subsurface (soil and groundwater) and there is no additional reference to the on-site disposal of oil fly ash at the Merrimack site as described above in Section 2.1.3.

Information in the 2008 Groundwater Management Plan Renewal Application (Roux Associates, Inc.) indicates the former Mobil Oil Terminal No. 28-075 is owned by PSNH and has on-going environmental monitoring of groundwater quality. Mobil ceased terminal operations at the Site circa 1994 and sold the property to Granite State Materials in 1994/1995. Mobil developed the property as a bulk storage terminal circa 1943. Prior to 1940, the property was reportedly undeveloped. Newington Power Station is located to the north and west of the former Mobil Oil Terminal. According to the 2006 Annual Monitoring Report Summary and Former Loading Rack Excavation Report, remedial activities at the site have included soil excavation, soil sampling, groundwater monitoring well installation and groundwater sampling and analysis. The 2008 Groundwater Management Plan Renewal Application also indicated that an oil-water separator existed (not closed) and previously discharged to the Piscataqua River and a non-operating soil vapor extraction (SVE) system was located in the southern portion of the Site and consisting of 13 wells and a horizontal trench.

On April 10, 2013, NHDES issued a Groundwater Management Permit (GWP-1991102013-N-004) to the PSNH to monitor the past discharge of petroleum at the former Mobil Oil Terminal 28-075. The permit expires on April 9, 2017. The groundwater monitoring system is comprised of eleven monitoring wells which are sampled annually for VOCs. The most recent groundwater quality results

(July 2013) showed that concentrations above AGQS. On October 25, 2013, NHDES provided a letter to PSNH indicating the following: (i) a periodic summary report is to be submitted in September 2015; (ii) the report shall include a review of the conceptual model and updated contaminant distribution maps; (iii) an analysis of contaminant distribution and recommendations for *remedial action* shall also be included in the report.

Short-term liabilities are considered current and on-going environmental activities to assess or remediate known releases of petroleum products or hazardous substances to the subsurface. Based on the information reviewed by ESS for the Newington Power Plant (including the former Mobil terminal property), the following short-term liabilities could include: (i) groundwater monitoring on the Mobil parcel for VOCs that exceed NHDES AGQS; and (ii) evaluation of remedial actions as part of the 2015 periodic summary report. ESS would anticipate that the annual costs for performing and reporting groundwater quality monitoring could be between $25,000 and $35,000.

Long-term liabilities are considered environmental actions taken to address currently unknown or suspect contaminant conditions on the site. For this site, long-term liabilities could include: (i) further remediation of VOCs in groundwater on the former Mobil terminal is likely(i.e., 2013 groundwater quality results showed certain VOCS well above AGQS, and (ii) potential soil impacted by historical site operations. With these conditions, future environmental actions could include: comprehensive subsurface investigations (i.e. surface and subsurface soil and groundwater testing), more aggressive remedial technologies for groundwater; soil removal actions; potential placement of an Activity Use Restriction (AUR), and all associated regulatory reporting. ESS would anticipate that the costs for these types of actions could be between $100,000 and $250,000. *Note – the long-term liabilities do not account for any large-scale redevelopment scenario that may involve significant earthwork and dewatering activities and associated management of potentially impacted soil or groundwater.*

2.3 Schiller Power Station

The Schiller Power Station is located at 400 Gosling Road in Portsmouth, New Hampshire. The facility has a total output capacity of 150 MW based on three 50 MW steam turbines, two of which are associated with boilers that can burn coal or No. 6 fuel oil and one boiler that was converted in 2006 to burn clean wood chips. The facility also includes one combustion turbine and an emergency generator. Schiller Station operates on intermediate duty, which means it is brought online when customer demand reaches a moderate level.

The facility is comprised of two parcels of land (approximately 79-acres). A railroad right-of-way for the Boston and Maine railroad separates the two parcels. The Piscataqua River forms the eastern boundary of the property. The approximately 2-acre closed, unlined solid waste landfill is located on the southeastern portion of the Schiller Station property. The landfill reported was used to dispose of a variety of materials including: brick, fly ash, insulation, oily substances, construction debris, and miscellaneous power plant debris (PSNH - July 1982).The closed landfill has since been redeveloped into a wood chip storage area for the Power Station. The Schiller Power Station has thirty-three ASTs currently in-use (containing diesel, No. 2 fuel oil, jet fuel, transformer oil, lubrication oil, and No. 6 fuel oil); two ASTs that are currently out-of-use; two ASTs that have been removed or dismantled (contained No. 6 fuel oil, transformer oil); one concrete UST that is closed (contained waste oil) and one 60,000-gallon No. 6 fuel oil UST that is currently active

2.3.1 Cooling Water Assessment

The Schiller Station EPA NPDES Permit Number NH0001473 was issued on October 11, 1990 and expired on October 11, 1995. PSNH is currently waiting for a draft permit to be issued by EPA.

In accordance with the proposed new 316b Rule, the conversion of the existing facility to a closed loop cooling water system would be a major engineering and construction undertaking involving significant planning, associated downtime for the existing unit and results in an overall decrease in the thermal performance of each facility involved. ESS reviewed the PSNH cost estimates developed in the following report [Response to United States Environmental Protection Agency CWA 308 Letter PSNH Schiller Station; October, 2008] and compared these costs to the range of costs identified by EPA in its 316b Development Document for electric generating stations representative of the PSNH facilities. The PSNH cost estimates are costs reflective for the years in which the PSNH reports were completed and as a result these costs would need to be escalated to the year that any conversion of these facilities to closed loop cooling would occur. Cost associated with such conversion fall into several categories; Capital/construction costs, Operation and maintenance, Lost generation during construction, Parasitic electric use and other losses associated with the new system and Operational losses mainly due to decrease in efficiency. The table below summarizes the major expenditures associated with the full conversion of the existing facility to a closed loop cooling water system.[8]

Schiller Generating Station					
			***MW* (MWhr)**	**$/MW**	**2014 Dollars***
Construction Cost Estimate					
	Station				
		Seawater			$60,338,200
		Graywater			$54,644,100
Operation & Maintenance					
	Station				
		Year 1 - 5			$184,690
		Year 6 - 15			$269,150
		Year 16-30 (seawater)			$408,000
		Year 16-30 (gray water)			$400,580
Lost Capacity During Construction (MWhr)					
	Unit #4		58,800	$53	$3,116,400
	Unit #5		58,800	$107	$6,291,600
	Unit #6		100,800	$53	$5,342,400
Parasitic Loss (MW)					
	Station		*2.76*	$98	$236,940
Operation Efficiency Loss (MW)					
	Station		*21.59*	$98	$18,535,000

* Original values presented in 2008 dollars. Escalated to 2014 dollar using 2% per year.

The site specific costs presented above are reasonable based on the EPA 316(b) Technical Development Document, which provided a representative cost estimate for a closed cycle retrofit of a 350 MW plant with an intake flow of 200,000 gpm. The estimated capital cost for the representative retrofit was between $35,000,000 and $92,000,000 depending on the difficulty, with an estimated average level of difficulty being approximately $59,000,000.The estimated O&M cost for operating a retrofit closed cycle cooling system was $3,160,000. As described earlier, given the age of the PSNH generating facilities, the relatively low water withdrawals and other factors, it may be possible that an alternative to a full cooling water system conversion to closed cycle would be acceptable to EPA. Since the final 316(b) Rule has yet to be issued and the cost benefit of the required capital investment

[8] Costs assume the installation of an SPX hybrid closed cooling system.

yet to be weighed by EPA, the costs developed for this generating facility should be considered only as a future potential expense.

2.3.2 Air Quality Assessment

NHDES performed an annual Title V Compliance Certification Review on May 8, 2013 and determined the facility to be in complete compliance with the Title V Operating Permit emission limits and operating conditions. Additionally, all recent stack test reports indicate compliance with applicable limits.

PSNH provided a matrix of options being considered to comply with MATS regulations at Schiller Station. According to the regulation, a facility is exempt from the emission limits required by MATS if the facility operates with an annual capacity factor of <8% (based on a 2-year average). PSNH indicates that effectively eliminating coal from use at the facility and limiting the operation of the facility as required for the exemption is an option that presents no capital cost or operating expense, however this option would likely result in decreased operation of the station which would presumably have revenue implications. Alternatively, in order to comply with the MATS regulations, PSNH could install an activated carbon system to meet the mercury standard and a dry sorbent injection system to meet the HCL standard. The capital cost to install the activated carbon system is estimated to be approximately $300,000 with operating expenses of $12,000 annually plus materials costs (~$1/lb with a need for up to 100 lb/hr per unit). The capital cost for the dry sorbent injection system is estimated to be between $1,500,000 and $2,000,000 with material costs (~100-250/ton with a need for up to 5 tons/hr). If PSNH determines that limiting the operation of the Schiller facility or eliminating coal is uneconomical, the total cost to comply with the emission limits required in the MATS regulation could result in a capital cost between $1,800,000 and $2,300,000 and operating expenses that vary depending on the cost of materials required to operating the control systems.

PSNH has also evaluated monitoring options to ensure compliance with MATS, in the event that the facility is not exempt for MATS in the future. The three criteria pollutants that are evaluated by PSNH are PM, HCL, and mercury. All three constituents could be monitored as part of ongoing quarterly stack testing at no additional capital cost and $60,000 annual in operating costs, however PSNH suggested this approach may be challenging because of timing i.e. the ability to meet the testing windows since there are no grace period provided for in the event operational or other matters preclude the ability to conduct the test. If stack testing is not the preferred approach, the capital expense to monitor PM is between $8,000 annually for 3 years to $210,000 ($70,000 per unit), with operating expenses between $8,000 every three years after initial to $25,000 every 3 years and $8,000 all other years. The capital expense to monitor HCL would be between $0 and $210,000 ($70,000 per unit), with operating expenses between $0 and $7,000 annually. The capital expense to monitor mercury is $150,000 to $320,000, with operating expenses of $15,000 per year.

Based on this analysis, the total cost to PSNH to comply with the monitoring requirements of the MATS regulation at Schiller is between $0 and $740,000 in capital cost and variable operating costs depending on the method selected. An evaluation of the effectiveness of the controls identified by PSNH and the associated cost/benefit of each is beyond the scope of this evaluation. PSNH must be in compliance by April 16, 2015.

With regard to potential future limits on greenhouse gas emissions, the use of coal as a fuel source at the Schiller facility which is carbon intensive (as compared to gas or even oil) may require additional operating cost as the program will most likely involve the trading of available “allowances”. Additional gas burning capability may also be an option which may require capital investments. Another option could be to reduce operations i.e. capacity factor which would impact revenues. At this time, given

the uncertainty of the proposed GHG emission requirement, it is not possible to definitely assign a future cost.

2.3.3 Site Assessment/ Conditions Assessment

According to records maintained by PSNH and on-file with NHDES, waste was disposed in a former site landfill from about 1949 until 1979. Based on a February 28, 1980 inventory prepared by PSNH, the waste disposed at the site generally consisted of construction and building debris (wood, brick, plaster, metal, and concrete), shells, mud, seaweed, fly ash, rags and absorbent material (e.g. Speedi-dry) containing waste oil, household goods (furniture, washing machines, tires and car parts), boiler and pipe insulation (possibly containing asbestos) and 55-gallon steel drums. The closure of the landfill occurred between 1980 and 1981 and included the removal of suspected asbestos-containing materials, grading of the area, capping with at least two feet of soil and establishing vegetative cover. Landfill closure also included the installation of four groundwater monitoring wells in May 1980.

Groundwater quality monitoring around the landfill started circa 1980 and remains on-going. The wells are monitored annually. In the June 2016, NHDES also requested additional testing. The most recent round of groundwater monitoring was performed in June 2013. According to the July 31, 2013 Data Transmittal (Sanborn, Head & Associates, Inc.), manganese was the only constituent detected above AGQS. The next groundwater monitoring round is planned for June 2014,

The Newington Station Bulk Storage Containment Area is located at the Schiller Station. The Containment Area is roughly square with dimensions of approximately 540 feet by 540 feet and surrounds two ASTs, both of which are currently used to store No. 6 fuel oil for Newington Station. Each AST is 200 feet in diameter by approximately 56 feet tall with a capacity of approximately 280,000 barrels (about 11.7 million gallons). On July 14, 2011, PSNH personnel observed a discharge of apparent oily water in the area one of the ASTs. Subsequent remedial activities included the removal of approximately 101 tons of non-hazardous petroleum impacted soil from the initial oily-water release area near the AST, a cleaning and inspection of the interior of the AST, the repair of the corroded area in the sump in the floor of the AST, and soil sampling and analysis collected from beneath the sump. On August 19, 2013, NHDES issued a Certificate of No Further Action letter concluding that the site has been DES's closure criteria and that no additional investigation, remedial measures or groundwater monitoring will be required by NHDES for this site and requests that the groundwater monitoring wells be decommissioned.

Short-term liabilities are considered current and on-going environmental activities to assess or remediate known releases of petroleum products or hazardous substances to the subsurface. Based on the information reviewed by ESS for the Newington Power Plant (including the former Mobil terminal property), the following short-term liabilities could include: (i) groundwater monitoring on the Mobil parcel for VOCs that exceed NHDES AGQS; and (ii) evaluation of remedial actions as part of the 2015 periodic summary report. ESS would anticipate that the annual costs for performing and reporting groundwater quality monitoring could be between $20,000 and $30,000.

Long-term liabilities are considered environmental actions taken to address currently unknown or suspect contaminant conditions on the site. An example of a potential contaminant condition could include soil quality impacts from historical site operations (historic testing of soil quality appears limited based on the overall size of the property). With this scenario, future environmental actions include: comprehensive subsurface investigations (i.e. surface and subsurface soil testing), limited soil removal actions; potential placement of an Activity Use Restriction (AUR), and all associated regulatory reporting. ESS would anticipate that the costs for these types of actions could be between

$50,000 and $150,000. *Note – the long-term liabilities do not account for any large-scale redevelopment scenario that may involve significant earthwork and dewatering activities and associated management of potentially impacted soil or groundwater.*

2.4 Lost Nation Generating Station

The Lost Nation Generating Station is located at 1508 Lost Nation Road, Northumberland (also known as Groveton), New Hampshire. The primary source of emissions at the facility is a combustion turbine operating as a load shaving unit and a starter engine. Net power output is approximately 22 MW. Seasonal differences can vary as much as 5 MW.

2.4.1 Air Quality Assessment

NHDES performed an annual Title V Compliance Certification Review on May 30, 2013 and determined the facility to be in complete compliance with the Title V Operating Permit emission limits and operating conditions. Additionally, all recent stack tests reports indicate compliance with applicable limits.

The Lost Nation facility is below the threshold for MACT regulations (25 MW). PSNH has indicated that there has been no specific analysis conducted or reports prepared regarding possible future air regulatory requirements. This facility may also be below any future GHG requirements.

2.5 While Lake Generating Station

The White Lake Generating Station is located at 289 Maple Road in Tamworth, New Hampshire. The primary source of emissions at the facility is a combustion turbine operating as a load shaving unit. Net power output is approximately 20.4 MW. Seasonal differences can vary as much as 5 MW. In addition, the facility has a 121.7 hp emergency generator which is below permitting thresholds.

2.5.1 Air Quality Assessment

Based on available information, the facility appears to be in compliance with applicable air permit provisions.

The White Lakes facility is below the threshold for MACT regulations (25 MW). PSNH has indicated that there has been no specific analysis conducted or reports prepared regarding possible future air regulatory requirements. This facility may also be below any future GHG requirements.

2.6 Hydroelectric Generating Facilities

2.6.1 Water Quality Assessment

ESS reviewed the current NPDES permits provided by Public Service Company of New Hampshire in response to ESS 1-004. Six of the nine hydroelectric facilities were issued NPDES permits in 2010 under the Hydroelectric General Permit, which expires on December 7, 2014. Those facilities are:

- Amoskeag Hydro
- Ayers Island Hydo
- Eastman Falls Hydro
- Garvins Falls Hydro
- Gorham Hydro
- Hooksett Hydro

Two of the nine hydroelectric facilities (Jackman Hydro and Smith Hydro) were issued NPDES individual permits in May 2011 because operation of the facilities utilize an agent called TannerGas® and therefore do not qualify for the Hydroelectric General Permit. TannerGas® is authorized under the NPDES permit for each facility to prevent freezing and blockage of the air blowers and compressed air lines used to supply the aeration systems which prevent icing at the dam spillways and in the surge tanks during the winter months. The individual permits for these facilities expire in 2016.

All eight of the hydroelectric facilities identified above are required to perform routine quarterly monitoring of outfall discharges. Reports to the EPA must provide average monthly flow volumes and demonstrate compliance with discharge limits for pH as well as oil and grease concentrations from specifically identified outfalls.

The Eastman, Jackman, and Smith Hydro facilities discharge cooling water and are therefore required to monitor and report temperatures at the relevant outfalls. According to the NOI (available online) for the Eastman Hydro facility, the total cooling water discharge is approximately 29,000 gallons per day and therefore new EPA rules for cooling water intake structures (under Clean Water Act §316(b)) do not apply. Details on the discharge rates for cooling water at the Jackman and Smith facilities could not be identified but it is likely that §316(b) will not apply.

The Canaan Hydro facility does not have a current discharge permit. The Canaan facility is located on the Connecticut River, which defines the boundary between New Hampshire and Vermont in this area. Based on the location of the power generating equipment, the facility is under the jurisdiction of the Vermont Department of Environmental Conservation (DEC) with regard to water quality issues. PSNH is unaware of any requirement for a discharge permit from the Vermont DEC.