UNITED STATES DISTRICT COURT
DISTRICT OF NEW HAMPSHIRE

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SIERRA CLUB, INC. and CONSERVATION LAW FOUNDATION, INC.,

Civil Action No.: 1:19-cv-216-JL

Plaintiffs,

v.

GRANITE SHORE POWER LLC; GSP MERRIMACK LLC; and PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE d/b/a EVERSOURCE ENERGY,

Defendants.

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DECLARATION OF MATTHEW HODGE

I, MATTHEW HODGE, declare as follows:

1. This declaration is submitted in connection with Plaintiffs' opposition to the Motion for Partial Summary Judgment filed by Granite Shore Power LLC and GSP Merrimack LLC (collectively "GSP" or "Defendants") relating to Count V of the Complaint in this lawsuit.

2. I am a professional water resources engineer based in Massachusetts. I am the founder and owner of Hodge.WaterResources, LLC, where we specialize in numerical modeling of surface water and groundwater resources. Our clients include consulting firms, law firms, private developers, and universities. We provide technical expertise for National Pollutant Discharge Elimination System (NPDES) permitting and other hydrodynamic and water quality studies. A true and accurate copy of my resume is annexed hereto.

3. I have 12 years of professional experience focused on hydrodynamics, hydrology,

and water quality. I have a Bachelor of Science Degree in Civil and Environmental Engineering from the University of South Carolina, a Master of Engineering Degree in Civil and Environmental Engineering from the Massachusetts Institute of Technology (MIT), and a Master of Science in Technology and Policy, also from MIT.

4. I have reviewed Defendants' Motion (Doc. 45), the Tillotson Affidavit (Doc. 45-3), and the annual reports attached to the Tillotson Affidavit (Doc. 45-4).

5. I am also familiar with the 1992 NPDES Permit (no. NH0001465) for the Merrimack Station and annual reports submitted to the U.S. Environmental Protection Agency (US EPA) and other agencies by the Station's former owner, Public Service of New Hampshire (PSNH).

6. PSNH and GSP's annual reports to EPA consist of daily statistical summaries (i.e., daily maximum, daily minimum, and daily average) for temperature, dissolved oxygen, and pH recorded at monitoring locations in the Merrimack River designated as "N-10," "N-5," "S-0," and "S-4."

7. The Tillotson Affidavit states that PSNH and GSP collected readings from continuous monitoring probes at 15-minute intervals (96 readings per day).

8. I have reviewed and am familiar with files produced by the Defendants to the Plaintiffs in this lawsuit containing the 15-minute data collected from the monitoring probes from 1992 through 2019. I have focused mainly on the data collected by GSP in 2018 and 2019.

9. I understand that the 15-minute data are the actual readings of temperature, dissolved oxygen, and pH that PSNH or GSP recorded at the monitoring locations and used to prepare the daily statistical summaries they submitted to EPA in the annual reports.

10. As I explain in more detail below, review of the daily statistical summaries alone

would make it difficult for a regulator or other interested party to understand the effect of Merrimack Station's thermal discharge on water quality conditions in the Merrimack River and to identify permit violations. Review of the 15-minute data is necessary to make such evaluation properly.

11. Below I discuss four topics of potential interest to a regulator: (1) the duration of adverse water quality conditions; (2) the rate of change of water quality conditions; (3) the relationship of water quality conditions between monitoring stations; and (4) the cause of water quality standard exceedances.

12. In addition to the four topics I discuss here, there may be other ways in which the daily statistical summaries obscure important information that is apparent from the 15-minute data. If I testify on this subject at trial or in a hearing, I would like to reserve the right to discuss such additional topics at that time.

Duration of Adverse Water Quality Conditions

13. One way in which the daily statistical summaries hinder evaluation of the Station's effect in the river is by obscuring the duration of adverse water quality conditions.

14. The harm caused to an aquatic organism by adverse environmental conditions is a function of the dose and the duration of the organism's exposure to the adverse conditions (Ji, 2008, 212).[1]

15. Daily statistical summaries make it difficult for a reviewer to understand the duration of exposure. As an example, consider the maximum protective temperature threshold of 29.5° C developed by the US EPA for American Shad Larva in Hooksett Pool between June 16 and

[1] I am not an expert in biology, but the application of my expertise leads me to be generally familiar with the basic principles of environmental health (e.g., acute versus chronic exposures and cold shock).

July 31 of each year (US EPA, 2011, Table 8-5, pg. 209). This threshold is expressed as an hourly maximum, and EPA states that it should be measured at S-0, which is at or near where the Station's discharge canal empties into the river.

16. The daily statistical summary that the Station submitted to EPA for June 29, 2018 indicates that the maximum temperature at S-0 was 30.93° C, and the average was 27.30° C. Although the daily statistics show that the 29.5° C temperature threshold was exceeded at S-0, they do not indicate the duration of the exceedance. The 15-minute continuous data demonstrates that the hourly maximum temperature was exceeded for a total of 6.5 hours. A reviewer might draw two very different conclusions from the daily statistical summary than from the continuous data. From looking at the daily statistical summary, it is possible that no exceedance of the threshold occurred, i.e., if the temperature was above 29.5° C for less than one hour. Or it is possible that exceedances were limited to one or two hours during the day. From looking at the 15-minute data, it is clear that the 29.5° C threshold for American Shad Larva was exceeded for a continuous 6.5 hours on that date.

17. The foregoing is only an example. EPA has also developed maximum protective temperature thresholds as hourly maximums for other species, life stages, and time periods. The daily statistical summaries mask the existence and duration of exceedances of those thresholds in the same way.

Rate of Change of Water Quality Conditions

18. A second way that daily statistical summaries hinder evaluation of the Station's aquatic impacts is by hiding the rate of change in water quality conditions.

19. Adverse conditions in the river can harm organisms. Rapid changes from one set of environmental conditions to another set of environmental conditions may harm organisms even if

neither the initial set environmental conditions nor the subsequent environmental conditions are harmful. One example of this phenomena in fish is cold shock, where rapid decreases in water temperature lead to physiological responses, behavioral responses, and even death (Donaldson, et al., 2008). Daily statistical summaries prevent a reviewer from identifying harm to fish in the form of cold shock.

20. For example, on December 14, 2018 the maximum temperature recorded at S-0 was 22.0° C and the minimum temperature was 9.0° C. It is impossible to tell from the daily statistical summaries the rate of change, i.e., whether the river gradually cooled off or its temperature dropped dramatically in the span of an hour or two. But this is apparent in the 15-minute data, which shows that the rate of temperature change at S-0 on that day ranged from 1.1° C/hr to 2.8 C/hr between 2:00 PM and 4:15 PM.

21. In comparison, the maximum rate of temperature change on December 16, 2018, a day when Merrimack Station was not generating electricity, was 0.7° C/hr. The 15-minute data shows that the rate of temperature change at S-0 was approximately four times greater on December 14, 2018 when compared to December 16, 2018. It would require a fisheries biologist to say whether the increased rate of temperature change is sufficient to cause cold shock. Nevertheless, the previous example shows that water quality conditions during times when Merrimack Station stops generating electricity change rapidly (on the order of hours). The daily statistical summaries at best provide approximate daily averaged estimates of these dynamic conditions and potentially hide dynamic conditions.

22. For these reasons I agree with the following statements by Ken Hickey and Peter Shanahan, PhD of HydroAnalysis Inc. in their December 11, 2017 report entitled *Review of Available Water Temperature Data and Thermal Plume Characterizations related to the Merrimack*

Power Station in Bow, NH: "Daily statistical summaries mask river temperature fluctuations over time making it impossible to see temperature fluctuations that would be apparent in the continuous temperature measurements. For example, large, short-term (e.g., over periods of minutes or hours) temperature variations that can harm aquatic organisms are not detectable in daily summary statistics."

Relationship of Water Quality Conditions Between Monitoring Stations

23. Another way that the daily statistical summaries make certain water quality evaluations more difficult or impossible is by obscuring an understanding of water quality conditions between upstream and downstream monitoring stations.

24. The relative difference in temperature between an upstream monitoring station and a downstream monitoring station is particularly important in evaluating the impacts of a discharge. The relative difference between upstream and downstream is commonly referred to as the "Delta-T." A Delta-T value tells you how much thermal conditions differ from what would be naturally occurring at the same location, if the discharge did not exist. It is my professional experience that Delta-T values are a common part of NPDES permits. They are often used to determine a thermal mixing zone or a heat dissipation area. They are also used to support a determination of whether there is a zone of passage for fish in a receiving water body.

25. Accurate Delta-T values cannot be calculated from the daily summary statistics. This is apparent from the following example. On August 30, 2018, the daily statistical summaries reported in the 2019 annual report state that the average Delta-T between N-10 and station S-4 was 2.0° C, but the 15-minute data shows that the maximum Delta-T for that day was 4.5° C. A Delta-T of greater than 4.0° C was present for approximately 5 hours on that date.

26. In addition, Section I.A.11.b of the permit imposes requirements based on the

"Delta-T," which it defines as the relative difference in temperatures between monitoring station N-10 and station S-4. One example of these requirements is the operation of the Power Spray Module system when the temperature at N-10 exceeds 68° F (20° C) and Delta-T is greater than 1° F (0.6° C). The daily statistical summaries prevent verification of this permit requirement.

27. The daily summary statistics summaries hide the maximum Delta-T. This means that it is not possible to assess Delta-T relative to safe levels for fish populations or verify the correct operation of the Power Spray Module system.

Cause of Water Quality Standard Violations

28. A fourth issue is determining the cause of water quality standard violations.

29. The Merrimack River is classified as a Class B waterbody under the New Hampshire water quality standards. The state water quality standards for Class B waters include an instantaneous minimum standard for dissolved oxygen of 5.0 mg/L at all times (N.H. Code R. Env-Wq § 1703.07(b)).

30. Section I.A.1.b of Merrimack Station's permit states that "The discharges shall not jeopardize any Class B use of the Merrimack River and shall not violate applicable water quality standards."

31. Daily statistical summaries may provide information to identify violations, but they may also allow for exceedances to be hidden. As an example, a low dissolved oxygen event at N-05 is not caused by operations at Merrimack Station because it occurs upstream of the Merrimack Station discharge. A low dissolved oxygen event that occurs at S-0 may be caused by the Merrimack Station discharge, and represents a violation of water quality standards.

32. If the daily minimum dissolved oxygen levels are below 5.0 mg/L at both N-5 and S-0 on any given day, the cause of the low oxygen event at S-0 may be unclear from the daily

statistical summaries. But the 15-minute data will show the dissolved oxygen concentration of the river water upstream near the Station's intake during and just before the low oxygen event at the discharge point, providing corroborating information that the discharge caused the event.

33. In sum, daily statistical summaries prevent a reviewer from fully understanding water quality conditions in the Merrimack River. The daily statistical summaries do not provide the information necessary to assess the duration of adverse water quality conditions, the rate of change of water quality conditions, the relative difference between upstream and downstream water quality conditions, and the causal relationship between downstream water quality and the effluent from the discharge. Daily statistical summaries provide only a partial picture of the conditions that the water quality monitoring is meant to observe.

34. The references I mention above are:

Donaldson, M.R., Cooke, S.J., Patterson, D.A., and Macdonald, J.S., 2008. Review Paper, Cold Shock and Fish. Journal of Fish Biology. 73, 1491-1530.

Ji, Z.G., 2008. Hydrodynamics and Water Quality, Modeling Rivers, Lakes, and Estuaries. John Wiley & Sons, Inc. 2008.

US EPA, 2011. Clean Water Act NPDES Permit Determinations for the Thermal Discharge and Cooling Water Intake Structures at Merrimack Station in Bow, New Hampshire. NPDES Permit no. NH 001465. EPA – New England. (AR-618)

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

Executed on May 14, 2020

Matthew Hodge

MATT HODGE, PE

Water Resources Engineer

EDUCATION

MIT (2008), M.Eng.
Civil and Environmental Engineering

MIT (2007), M.S.
TPP Engineering Systems Division

U. of South Carolina (2004), B.S.
Civil and Environmental Engineering

REGISTRATIONS/MEMBERSHIPS

- Professional Engineer, MA
- American Society of Civil Engineers, Chair of the Environmental Water Resources Institute (EWRI) for the Boston Society of Civil Engineers Section (BSCES), 2015-2016

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QUALIFICATIONS

Matt Hodge is a Professional Engineer (PE) with experience in many aspects of environmental modeling. Matt specializes in numerical modeling of surface water resources and groundwater. Matt has more than 10 years of experience providing modeling of wetlands, estuaries, lakes, rivers, streams, and coastal zones. Matt has expertise in hydrodynamic modeling, hydrology and hydraulics, sediment transport, contaminant fate and transport, water quality, and mixing zone models. Matt works with a range of numerical models such as ADCIRC, BASINS, CGWAVE, CMS-FLOW, CORMIX, EFDC, GNOME, HEC-HMS, HEC-RAS, HEC-5, HEC-5Q, HSPF, HydroCAD, ICPR, MODFLOW, PHABSIM, PTM, QUAL2K, RIVER2D, RMA2, RMA4, STWAVE, SWMM, and WASP.

PROJECT EXPERIENCE

Water Quality

NPDES Permit Model Review: HydroAnalysis, Inc.* **Kershaw County, SC**
A local municipality requested a technical review of a nearby town's most recent draft wastewater treatment plant (WWTP) National Pollutant Discharge Elimination System (NPDES) permit in order to provide appropriate comments during public comment period. Reviewed QUAL2E model and supporting documentation. Provided memo to client explaining potential basis for comment and challenge of draft permit.

TMDL Model Review: DK Water Resource Consulting* **Davidson, NC**
Provided technical review of EFDC model for Total Maximum Daily Load (TMDL) study of High Rock Lake. Review was specifically focused on the incorporation of dam spillways into EFDC water quality model.

Waste Load Allocation Study: HydroAnalysis, Inc.* **Sumter County, SC**
In support of study to evaluate assimilative capacity of receiving water, modeled 12 miles of river in QUAL2K. Used model to evaluate dissolved oxygen (DO), biochemical oxygen demand (BOD), and ammonia under low flow conditions. Provided modeling expertise through project scoping, field program, regulatory review and final allocation decision.

Waste Load Allocation Study: Multiple Municipalities* **Catawba County, NC**
In support of study to evaluate assimilative capacity of receiving water, modeled multiple streams within watershed. Evaluated DO, BOD, and ammonia under a range of flow and operating conditions. Evaluated optimal performance options for multiple wastewater treatment plants within watershed incorporating historical evaluations and biological studies to provide recommendations on appropriate permit limits.

Water Quality Modeling Study: Geosyntec Consultants* **Fox River, IL**
As a part of the modeling team provided guidance and expert review of watershed modeling using HSPF. Contributed to QUAL2K6 model calibration for nutrients, phytoplankton, bottom algae and dissolved oxygen. Leveraged technical expertise and collaborative approach to achieve project goals.

* denotes Hodge.WaterResources, LLC project

Expert Review Long Term Control Plan: HydroAnalysis, Inc.* **New York, NY**

Reviewed draft long-term control plan (LTCP) for urban estuary in New York City. Evaluated LTCP data review for appropriateness of findings. Conducted a preliminary assessment of the selected alternative ability to meet performance gaps identified in the LTCP. Compared selected alternative to approved alternatives for other relevant LTCPs in New York City. Evaluated modeling that formed the basis of the LTCP findings. Provided feedback to client on how LTCP would impact contaminants of concern in estuary.

Discharge Model and Salinity Analysis: Environmental Consulting & Technology, Inc.* **Virginia**

In support of Virginia Pollutant Discharge Elimination System (VPDES) permit application, evaluated mixing zone of proposed cooling water discharge of 2 million gallons per day (mgd) to a tidally-influenced river using CORMIX. Investigated the influence of CORMIX model assumptions on resulting predictions and provided support to client during review of applicable regulations.

Studied the influence of the proposed 10 mgd cooling water intake on the upstream extent of brackish water. Developed algorithm to identify and extract isohaline contours from results of the Chesapeake Bay Operational Forecast System (CBOFS) model and authored technical memorandum summarizing assumptions, analysis, and findings that demonstrated the minimal impact likely to occur from the withdrawal.

Oil Spill Trajectory Study: Industrial Client **Confidential Location**

Developed two-dimensional model of tidal estuary in order to predict current field in vicinity of oil spill. Applied National Oceanic and Atmospheric Administration (NOAA) GNOME model to predict spill trajectory and compared predicted oil transport to field observations collected immediately after spill to evaluate model performance. Made preliminary assessments of water column and sediment concentrations based on transport of spilled oil in support of natural resource damage assessment.

Thermal Discharge Study: Epsilon Associates* **Schuylkill River, PA**

Provided senior review of mixing zone study for a thermal discharge to the Schuylkill River. The project included CORMIX modeling consistent with the Delaware River Basin Commission (DRBC) water quality standards and approaches. Study determined existing mixing zone and made recommendations on alternative outfall designs to reduce the mixing zone. Subsequent phase of project included three-dimensional hydrodynamic and thermal model of the lower eight miles of the Schuylkill River. Completed modeling, using EFDC, and provided technical support as a part of the permitting process.

Thermal Discharge Study: Oil Refining Company **Lake Erie, OH**

Serving as lead modeler, developed three-dimensional hydrodynamic model in order to delineate extent of thermal plume in Lake Erie using the EFDC model. The EFDC model was coupled to the NOAA Great Lakes Coastal Forecasting System (GLCFS). Evaluated extent of thermal impact of cooling water discharge. Assessed lateral extent and vertical temperature profile in order to determine likelihood of available fish passage around thermal plume. Provided technical expertise from project development, through field program, modeling, and NPDES permit application.

Thermal Discharge Study: Oil Refining Company **Lake Michigan, IN**

Serving as lead modeler for 316(a) study, developed coupled three-dimensional hydrodynamic and water quality model in order to delineate extent of thermal plume in Lake Michigan using EFDC. Evaluated normal operation and maximum permitted operational effluent in response to range of ambient conditions in order to delineate thermal plume extents. Worked with biological survey team to plan field study that identified and characterized representative fish populations.

Water Quality Assessment– Flushing Model: Private Developer **Englehard, NC**

Developed two-dimensional hydrodynamic model, using RMA2/RMA4, to predict flushing times for a proposed boating marina in tidal estuary. Used available salinity data to make assessment of fresh water flows. Analyzed alternative designs in order to improve flushing, maintain water quality and enable proposed marina to be permitted. Provided preliminary design of mechanical system to maintain DO in boat basin.

Hydrodynamic Data Collection QAPP: Industrial Client **Passaic River, NJ**

Developed Quality Assurance Project Plan (QAPP) for data collection to support development of tidally influenced sediment erosion model using acoustic Doppler current profiler (ADCP). Oversaw data collection and conducted quality assurance checks of final dataset.

Hydrology and Hydraulics

Hydrologic and Hydraulic Study: OptiRTC, Inc.* **Prince George's County, MD**

Developed HydroCAD models for a number of stormwater ponds to evaluate peak flood elevations, storage volumes, and discharge flows. Obtained model inputs from as-built plans, publicly available topography and land use data, as well as the Maryland Stormwater Design Manual.

Hydraulic Analysis of Bridge Construction: Private Property Owner* **Delaware River, NY**

Assessed the risk of additional flooding due to temporary channel fill added to support ongoing bridge construction. Reviewed applicable Flood Insurance Study (FIS), local topography, and construction plan details to understand how flooding might increase during a range of high-flow events.

Expert Review of Site Hydrology and Hydraulics: Private Property Owner* **Scituate, MA**

On behalf of a private property owner, reviewed site hydrology to understand increased frequency of flooding as a result of development in abutting property. Reviewed developer property site plans and related hydrology and hydraulics modeling. Identified errors made by developer's engineers. Presented on behalf of private property owner at Town of Scituate Planning Board meeting. Successfully argued on behalf of private property owner that developer needed to change site grading to protect private property from future flooding.

Expert Review of Site Hydrology and Hydraulics: Private Property Owner* **Hingham, MA**

On behalf of a private property owner, reviewed site hydrology to understand risks of flooding as a result of proposed road construction in a right of way that crossed the property. Evaluated constructions plans against federal flood protection requirements and town by-laws and ordinances. Provided advice to private property owner in advance of a Massachusetts Department of Environmental Protection (DEP) appeal meeting.

Energy Facility Stormwater Model: ESS Group, Inc.* **Massachusetts**

Working with a project team tasked with evaluating permitting requirements for an energy-from-waste facility, reviewed and updated the facility HydroCAD model to understand the capacity of existing retention basins to meet water usage needs of facility as well as the likelihood of off-site discharge from the facility in the event of a large precipitation event. Evaluated most recent hydrologic design storms for facility and provided preliminary design guidance on the need for additional retention ponds.

Energy Facility Base Flood Elevation Delineation: ESS Group, Inc.* **Rhode Island**

In support of facility expansion permitting, conducted hydrologic and hydraulic study of a set of streams that flood during large precipitation events. Developed a HEC-RAS model of the area surrounding the facility and used model to make a determination of the 100-year base flood elevation (BFE) for the streams. Incorporated site-specific survey with statewide datasets and culverted road crossings to establish flood plain around the facility.

Technical Support for PHABSIM Fish Habitat Model: DK Water Resource Consulting* **Chattahoochee River, GA**

Supported a team of multiple consulting firms in developing and updating a PHABSIM model of the Chattahoochee River. Provided on-call technical expertise including trouble shooting and helping to develop a conceptual understanding.

Dam Restoration and Removal Study: Town of Franklin **Franklin, MA**

Conducted hydraulic and hydrologic analysis of dam system to determine maximum ponding elevations during a range of storm events in order to inform decisions about potential dam removal stream restoration.

Preliminary Stormwater Storage Design: Town of Winchester **Winchester, MA**

Modeled existing stormwater system in order to make recommendations for improvements to the system that would lead to reduced flooding of Aberjona River during storm events. Completed conceptual design of upgrades and underground storage. Met with municipality staff to discuss modeling and preliminary designs.

Wetland Flood Study: U.S. Army Corps of Engineers **Somerville, NJ**

Updated existing HEC-RAS model of portion of Raritan River in order to assess likely peak flooding elevations and predicted inundation of revitalized wetland area. Mapped localized inundation based on model results and assessed potential improvement of wetland water budget based on changes to wetland restoration design.

Sediment Transport

Sediment Transport Study: ESS Group, Inc.* **Raritan Bay & NJ Coastline, NJ**

In order to assess impacts of proposed cable laying operation, developed hydrodynamic model using ADCIRC and sediment transport model using PTM to predict transport of sediment suspended during proposed cable laying operations. Evaluated available sediment coring data to determine representative grain size and variability of grain size. Provided demonstrations of suspended concentrations in three dimensions within the water column. Study provided determination of the duration and extent of impacts attributable to cable laying operations.

Sediment Transport Study: ESS Group, Inc.* **Hudson River, NY/NJ**

In order to assess impacts of proposed cable laying operation, developed hydrodynamic model using ADCIRC and sediment transport model using PTM to predict transport of sediment suspended during proposed cable laying operations. Evaluated available sediment coring data to determine representative grain size and variability of grain size. Provided demonstrations of suspended concentrations in three dimensions within the water column. Study provided determination of the duration and extent of impacts attributable to cable laying operations.

Sediment Transport Study: ESS Group, Inc.* **Delaware River, DE/NJ**

In order to assess impacts of proposed cable laying operation, developed hydrodynamic model using ADCIRC and sediment transport model using PTM to predict transport of sediment suspended during proposed cable laying operations. Evaluated available sediment coring data to determine representative grain size and variability of grain size. Aided client in planning additional sediment data collection to support more accurate modeling of sediment dispersion.

Sediment Transport Study: TRC Companies, Inc.* **Lake Champlain, NY/VT**

In order to assess impact of proposed cable laying operation, developed a hydrodynamic model (RMA2) and sediment transport model (PTM) to predict transport of sediment suspended during proposed cable laying operations. Evaluated available sediment coring data to determine representative grain size and variability of grain size. Used model to provide predictions of suspended sediment concentrations and deposition depths throughout model domain.

Sediment Transport Study: ESS Group, Inc.* **Raritan Bay and New York Bight, NY/NJ**

In order to assess impact of proposed cable laying operation, developed a hydrodynamic model (ADCIRC) and sediment transport model (PTM) to predict transport of sediment suspended during proposed cable laying operations. Evaluated available sediment coring data to determine representative grain size and variability of grain size. Used model to provide predictions of suspended sediment concentrations and deposition depths throughout model domain.

Sediment Transport Study: AECOM* **New York Bight, NY**

In support of permitting for a proposed natural gas pipeline conducted a study of sediment transport and deposition along coastal shelf. Developed a hydrodynamic model and sediment transport model to predict transport of sediment suspended during proposed excavation and backfilling activities. Evaluated available sediment coring data to determine representative grain size and variability of grain size. Used model to provide predictions of suspended sediment concentrations and deposition depths throughout model domain.

In Channel Construction Erosion Study: Private Developer **Kelso, WA**

Developed HEC-RAS model of Cowlitz River and confluence with Columbia River to evaluate shear stresses during peak flows in support of a proposed pier design. Evaluated potential for erosion and deposition patterns to change due to in-channel construction and potential for long-term geomorphic changes to river bed.

Groundwater

Review of Coal Combustion Residue (CCR) Groundwater Monitoring: HydroAnalysis, Inc.* **United States**

Conducted a preliminary review of the procedures and data for required groundwater monitoring at CCR facilities throughout the United States. As a part of a team of experts, reviewed more than 500 individual CCR units for adherence to required procedures and made preliminary assessment of groundwater quality monitoring data. Reviews submitted to United States Environmental Protection Agency for use in evaluating compliance with CCR Rule.

Expert Review of Hydrogeologic Study: Old New England Properties* **Arlington, MA**

Conducted expert review of a hydrogeologic study that was completed on behalf of the Town of Arlington. Provided developer an independent review of the study findings and assessed how those findings might impact the permitting and design of the planned development. Presented findings at Conservation Commission hearing and provided continued support to developer through the completion of permitting.

Flooding Assessment: Revere Little League* **Revere, MA**

Evaluated potential causes of chronic flooding at McMaken Field in Revere. Investigated regional geology, hydrogeology, and hydrology to understand why the field has seen chronic flooding in the last five years. Researched recent city construction including sewer lining to understand potential for construction to have impacted the field. Based on assessment of available information, provided likely cause of flooding and suggestions on how chronic flooding can be addressed.

Groundwater Contouring: MassDOT **Multiple Sites, MA**

In support of planned site closures, provided groundwater contouring based on available groundwater sampling data using SURFER. Evaluated seasonal changes in groundwater based on sampling surveys. Provided mapping of groundwater contours in context of larger regional aquifer.

3-D Groundwater Model: City of Calgary **Calgary, Alberta**

As a part of a performance evaluation for an existing pump and treat system, developed a three-dimensional groundwater model of site using MODFLOW. Incorporated hydrogeology, interaction with adjoining Bow River, regional groundwater patterns, active and inactive wells, as well as in-place slurry wall. Provided steady-state predictions of radius of influence from wells and flow paths (MODPATH) around impervious boundaries. Provided assessment of existing performance and made recommendations about modifications to pump-and-treat system in order to improve performance.

Dewatering Design: Private Developer **Southeastern, PA**

Provided predicted dewatering requirements based on groundwater characteristics including aquifer thickness and conductivity as a part of plans to excavate trench for installation of natural gas pipeline. Modeled radius of influence and maximum drawdown in WELFLO. Also provided preliminary guidance on pump sizing and installation layout in order to achieve needed drawdown for excavation.

Historical Superfund Site Analysis: HydroAnalysis, Inc.* **Confidential Location**

Conducted review of 30 years of hydrogeological investigations at former Superfund site in order to assess likely sources of groundwater contamination. Review included assessment of historical aerial photography, assessment of geologic stratigraphy, regional groundwater flow patterns, and mounding of groundwater on the site. Compiled findings and provided report of site history to client.

Coastal Modeling

Expert Review of Coastal Modeling Study: ESS Group, Inc.* **Wellfleet, MA**

In support of engineering design and permitted, reviewed coastal modeling study of Herring River restoration. Evaluated how the study addresses the Mill Creek tributary. Provided expert review of modeling to determine applicability of model results to design and permitting questions. Reviewed study documentation and provided insights into how the model handles precipitation, groundwater recharge, and proposed pumping. Provided findings of expert review to client for use in design and permitting of pump intake and pump design.

Estuary Hydrodynamic Modeling Study: US Fish and Wildlife Service **Reeds Beach Marsh, NJ**

In support of coastal resiliency efforts, developed a two-dimensional hydrodynamic model of the Reed's Beach estuary using the Coastal Modeling System (CMS) Flow model. Conducted comprehensive review of the calibration dataset. Effectively implemented wetting and drying model, and calibrated model to water levels and aerial observations. Used calibrated model to assess various design alternatives. Used calibrated model to assess various design alternatives for a breakwater structure. Used the Sea Level Affecting Marshes Model (SLAMM) model to evaluate how the selected design alterative would influence the long-term evolution of the marsh. Provided findings of modeling in comprehensive report and a series of presentation to the project team and the US Fish and Wildlife Service.

Estuary Hydrodynamic and Wave Modeling Study: US Fish and Wildlife Service **Supawna Meadows Marsh, NJ**

In support of coastal resiliency efforts, developed a two-dimensional hydrodynamic model of the Supawna Meadows estuary using the CMS Flow model and developed a wave model of the Delaware River Bay using CMS Wave. The wave model results and the flow model results were integrated to make predictions of cross-shore and long-shore currents during a range of storm events. Conducted comprehensive review of the calibration dataset. Effectively implemented wetting and drying model, and calibrated model to water levels and aerial observations. Used calibrated model to assess various design alternatives for a breakwater structure. Used the Sea Level Affecting Marshes Model (SLAMM) model to evaluate how the selected design alterative would influence the long-term evolution of the marsh. Provided findings of modeling in comprehensive report and a series of presentation to the project team and the US Fish and Wildlife Service.

Estuary Restoration Study: Massachusetts Division of Ecological Restoration **Dartmouth, MA**

In support of coastal resiliency efforts, developed a two-dimensional hydrodynamic model of the Reed's Beach estuary using the Coastal Modeling System (CMS) Flow model. Conducted comprehensive review of the calibration dataset. Effectively implemented wetting and drying model, and calibrated model to water levels and aerial observations. Used calibrated model to assess various design alternatives. Used calibrated model to assess various design alternatives for a breakwater structure. Used the Sea Level Affecting Marshes Model (SLAMM) model to evaluate how the selected design alterative would influence the long-term evolution of the marsh. Provided findings of modeling in comprehensive report and a series of presentation to the project team and the US Fish and Wildlife Service.

Coastal Hydrodynamic and Outfall Relocation Study: HydroAnalysis Inc.* **Confidential Location**

In support of an outfall relocation study, developed three-dimensional hydrodynamic harbor model using EFDC. Built set of tools in Python for post-processing model output to make results easily understandable. Conducted analysis to establish tidal datums for project area. Provided technical review of preliminary diffuser design, CORMIX modeling, and draft mixing zone application.

Littoral Zone Study: AECOM* **Lake Tahoe, CA**

As a part of a multi-year assessment of shoreline development, designed and executed modeling and analysis of wind-wave generation (STWAVE), wave transformation (CGWAVE), and long-shore current velocities (RMA2) in Lake Tahoe. Used the results from hydrodynamic modeling to evaluate changes in littoral drift processes caused by expansion of U.S. Coast Guard pier. Evaluated potential for erosion and deposition below water line as well as potential for erosion of shoreline. The types of shoreline development that were evaluated included installation of pilings, installation of floating dock, and dredging of lake bed. Provided comprehensive report on study findings in support of permitting.

Storm Surge Analysis: Rhode Island DOT **Kingston, RI**

Modeled tidal estuary's response to storm surge using RMA2. Developed complete model domain and conduct analysis of storm surge and breach of protective dunes in order to characterize scour at in-land bridge embankments during various storm surge events.

Hydrodynamic Modeling: U.S. Army Corps of Engineers **New Orleans, LA**

Assisted in development and analysis of model to determine maximum velocities during normal operation conditions for proposed gate structures in the Inner Harbor Navigation Channel. Conducted tidal constituent analysis for evaluation of model boundary conditions performance relative to alternative models.

Web Development

Green Infrastructure Asset Management System: EcoLucid* **Lancaster, PA**

Conducted a series of interviews with Stormwater Bureau and GIS staff at the City of Lancaster to identify requirements for a green infrastructure asset management system to support mandated annual reporting to US EPA. Developed scoring rubric for evaluating technology alternatives and developed three proofs of concept to present to city. Worked extensively with ArcGIS Online, ArcGIS Survey 123, ArcGIS Collector, and ArcGIS Workforce.

User Interface and Client-Side Model Implementation Development: University of Massachusetts*

As a part of the Ecosheds web development team (ecosheds.org), developed a user interface for a statistical model of stream temperatures throughout the northeastern region of the United States. Work includes development with JavaScript, HTML, Node.js, D3, Angular, and Bootstrap.

The Water Resources Report*

Conceptualized and developed the Water Resources Report (WRR) at www.WatResReport.com. The WRR tracks activity on Twitter by state regulatory agencies. Development of the WRR involved the use of JavaScript, HTML, Node.js, D3, Angular, and Postgres. Functionality of the WRR is based on executing and managing a series of Application Program Interface (API) calls and appropriate database storage of results. Current plans are to expand tracked organizations to include non-governmental organizations and potentially science/engineering firms that are active on different water bodies. There are also plans to increase filtering of tweets to provide time sensitive and content sensitive results.

PUBLICATIONS AND PRESENTATIONS

The Water Resources Report: Mapping Social Media for Water Resources, North American Lakes Management Society (NALMS) 35th Annual International Conference on Soils, Sediments, Water, and Energy. Hodge, M.; Smith, K., October 2018.

Oil Spills in Surface Water; New Approach Using NOAA pyGNOME, Association for Environmental Health and Sciences Foundation (AEHS) 39th International Symposium. Hodge, M.; Smith, K., November 2019.

Thermal Mixing Zone Studies, BP Internal Workshop for Facility Environmental Managers. Hodge, M.; Gerath, M., May 2013.

Design of Critical Cases for the Application of Calibrated Thermal Models: A Key Part of the Modeling Process, Gerath, M.; Heinen, E.; Hodge, M., Annual Meeting of the American Fisheries Society: Innovations in Thermal Research and Ecological Effect from Thermal Discharges. August, 2012.

Quantifying Potential Profit from Material Recycling: A Case Study in Brick Manufacturing, Hodge, M.; Ochsendorf, J.; Fernandez, J., Journal of Cleaner Production, Volume 18, Issue 12, p. 1190-1199. August, 2010.

The Use of Chemically Enhanced Primary Treatment (CEPT) in Honduran Imhoff Tanks, Mikelonis, A.M.; Hodge, M.M; Adams, E.E., Herrera, A., Proceedings of the Water Environment Federation, WEFTEC 2009: Session 61 through Session 70, p. 3879-3891. January, 2009.

Honduran Imhoff Tanks: Potentials and Pitfalls, Mikelonis, A.M.; Hodge, M.M; Adams, E.E., Herrera, A., Dynamic Modeling of Urban Water Systems, Monograph 18, p. 363-377. February, 2009.

PREVIOUS EMPLOYMENT

AECOM	2010 – 2012	Chelmsford, MA
ENSR/AECOM	2008 – 2010	Westford, MA
WK Dickson & Co., Inc.	2003 – 2004	Columbia, SC