



**AUTHORIZATION TO DISCHARGE UNDER THE NEW HAMPSHIRE STATE SURFACE
WATER DISCHARGE PERMIT**

In compliance with the provisions of the State of New Hampshire Revised Statutes, Title L Water Management and Protection, Chapter 485-A Water Pollution and Waste Disposal,

Nippo Lake Association, Inc., P.O. Box 313, Barrington, NH 03825

is authorized to apply, as a demonstration:

Aluminum

to receiving water named

Nippo Lake in Barrington, New Hampshire

in accordance with effluent limitations, monitoring requirements and other conditions set forth herein.

This permit shall become effective on the date of signature.

This permit extends until the treatment and monitoring requirements specified herein have been satisfied or if the treatment is determined to be harmful to the aquatic life or human health.

Effective Date: _____

Expiration Date: _____

Signed this (day) of (month), (year).

Thomas O'Donovan, P.E.
Director, Water Division
New Hampshire Department of Environmental Services

PART I. PROJECT OVERVIEW

1. Project Description

The project, as permitted below, allows for the application of aluminum to Nippo Lake in Barrington, NH to control the frequency and severity of cyanobacteria blooms. The project serves as demonstration of the use of aluminum for lake restoration purposes in New Hampshire. Aluminum will be introduced by the addition of aluminum sulfate [$Al_2(SO_4)_3$] and sodium aluminate [$NaAlO_2$] from a vessel outfitted with holding tanks, pumps, hoses, and meters for delivery of the chemicals. Chemicals will be added, as permitted below, at a ratio of the volume of aluminum sulfate to sodium aluminate equal to the prescribed dose of aluminum per area. A majority of the aluminum added will precipitate as floc on the lake bottom in the approximate area of application. The aluminum floc will bind with internal phosphorus in the benthic sediments and significantly reduce the amount of phosphorus that is available to fuel cyanobacteria blooms and result in a net benefit for lake condition.

2. Purpose, justification, and benefit

The purpose of the project is to restore the recreational use and ecological health of Nippo Lake. In eight of the ten years from 2010 – 2019 Nippo Lake has experienced cyanobacteria blooms that have interfered with recreation and had ecological impacts for a significant portion of the summer season and stretching into fall. An evaluation of lake conditions and development of a lake loading model identified that 34% of the annual phosphorus load is contributed by lake bottom sediments. Data collected from Nippo Lake documented that at depths below 8 meters there is little to no dissolved oxygen. The condition, known as anoxia, results in the release phosphorus from the sediments into the water which is then available for uptake by cyanobacteria. Data from a typical year in 2016 indicated that concentrations of phosphorus at depths of 13 - 15 meters were between 140 to 180 ug/L while concentrations near the surface were around 10 ug/L.

The goal of the demonstration treatment is to reduce the phosphorus load to Nippo Lake as released from benthic sediments by 80-90% over current conditions in order to meet a target annual phosphorus concentration of 7.2 ug/L. By reducing the phosphorus load, the risk of cyanobacteria blooms in Nippo Lake will be minimized to the extent possible for a period expected to extend 10 – 20 years provided additional nutrient sources are controlled. Aluminum application as a demonstration in Nippo Lake was chosen as the best alternative as compared to other internal nutrient management options such as aeration, oxygenation, or dredging for achieving the desired outcome of the project as it best targets the source of nutrients, is proven as a successful additive to control the release of phosphorus from the sediments, and is most cost effective as compared with other options. The demonstration project will improve the overall condition of Nippo Lake by reducing the frequency and extent of cyanobacteria blooms and, in turn, the length of time when the waterbody is a potential risk

to human, pet, and livestock health and increasing the length of time it suitable for recreation. Secondly, by reducing the dominance of cyanobacteria, a more balanced and adaptive plankton community is expected to proliferate. Lastly, a reduction in nutrient availability is expected to increase water clarity and dissolved oxygen concentrations during the summer months.

PART II. CHEMICAL ADDITIVES AND RECEIVING WATER LIMITS

1. Chemical additives - During the period beginning on the effective date and lasting through the expiration date, the permittee is authorized to apply aluminum sulfate (alum) and sodium aluminate (aluminate) to Nippo Lake in order control the growth of algae in the lake by inactivating iron-bound phosphorus in surficial bottom sediments. The active ingredient in both of these additives is aluminum. The application shall be limited as specified below in Table 1.

Table 1. Limits of chemical addition to Nippo Lake, Barrington, NH.

Chemical Additive	Limit of Application ¹		
	Approximate Ratio of Application ²	Maximum Daily Dose ³ (grams of aluminum / m ²)	Permit Dose Maximum ⁴ (grams of aluminum / m ²)
Aluminum Sulfate, Al ₂ (SO ₄) ₃ ; ~4.4% aluminum by volume	1.8 parts aluminum sulfate : 1 part sodium aluminate by volume	27	54
Sodium Aluminate, NaAlO ₂ ; ~10.2% aluminum by volume			
pH ⁵	None such that the receiving water limits are exceeded.		

2. Receiving water limits - The receiving water is defined as Nippo Lake, Barrington, New Hampshire. Chemical additives, as defined above, shall be added to the receiving water in 3 distinct phases; pilot, application 1 and application 2. Each phase will be broken into daily events that occur in one of five zones. The limits of receiving water quality criteria are specified in Table 2. Attainment of receiving water limitations shall be evaluated as the average of the of the measurements from all zones during the respective application phase. In the case of pH, supplemental measures outside of the zones, as described in the monitoring plan, shall also be included evaluating the attainments receiving water limitations.

Table 2. Limit of receiving water criteria in Nippo Lake Barrington, NH.

Receiving Water Characteristics	Receiving Water Limitation ⁶		
	Daily Event Maximum ⁷	Weekly Average ⁸	End of Permit Term ⁹
Acid Soluble Aluminum ¹⁰ , ug/L	750	87	Pre-alum application ambient concentration ¹¹
Turbidity ¹²	10 NTUs above conditions prior to treatment		
pH ¹³	6.5 - 8.0 S.U.		

Footnotes:

1. Adherence to the limit of application shall be estimated and reported by the permittee to NHDES based on the known mass of aluminum in the chemical compounds, the percentage of aluminum in the solutions applied, and measured as the volumes of solutions applied.
2. The ratio of alum to aluminate may be adjusted during any application in order to control pH within a target range of 6.0 – 8.0 units within a treatment zone to minimize risks to aquatic life. Adjustments to the ratio of alum to aluminate must be accounted for in the limits of the maximum daily dose and the permit dose maximum.
3. The maximum daily dose applies to the zone planned for treatment during each respective phase.
4. The permit dose maximum applies areas equal to or greater than 15 feet in depth (approximately 56 acres in total) and represents the cumulative total of daily treatments applied within the zones.
5. Given that the chemical addition permitted herein is temporary in nature and does not represent a continuous discharge of effluent pollutants from a fixed location, the concept of “end of pipe” limits as required in Env-Wq 301.17, is not directly applicable to this permit. The application of the aluminum product sinks through the water column adsorbing phosphorus as it falls and binding with phosphorus in the sediment. The critical point of measure is not an end of pipe but rather the final receiving water outside the application zone during the treatment. Therefore, the end of pipe pH criteria, as defined in Env-Wq 301.17, does not apply, except that the receiving water limits must be met.
6. The receiving water limits are defined as the average of the concentrations or measurements from Nippo Lake.
7. Attainment of the daily event maxima limitation is defined as the average of all samples collected at the end of the treatment day as specified in PART VI. MONITORING.
8. Attainment of the weekly average limitation is defined as the average of all samples collected at the end the day for each phase of treatment ending 7-days after the beginning of each phase of treatment as specified in PART VI. MONITORING. If a treatment phase extends beyond 7-days, the permittee shall contact NHDES and discuss how to address weekly average limitations.

9. The end of permit term limitation shall be the average of samples collected during the last month of sampling in the year in which the treatment occurs as specified in PART VI. MONITORING.
10. Acid soluble aluminum concentration shall be determined using EPA method 200.7 with a laboratory quantitation limit of at least 15 ug/L.
11. Pre-alum application ambient concentration is defined as the pre-alum application ambient sampled concentration, plus 20% of the remaining assimilative capacity for aluminum within the lake.
12. Turbidity shall be estimated using Standard Method 2130 B by way of a suitable field or laboratory meter that measures to the nearest 0.1 NTU.
13. pH shall be estimated using Standard Method 4500-H+B by way of a suitable field or laboratory meter that measures to the nearest 0.01 standard units.

Part III. ADHERENCE TO WATER QUALITY STANDARDS

1. The addition of the aluminum sulfate and sodium aluminate as provided herein shall not cause a violation of the water quality criteria of the receiving water defined in Table 2.
2. The discharge shall be free from substances in kind or quantity that settle to form harmful benthic deposits; float as foam, debris, scum or other visible substances; produce odor, color, taste or turbidity that is not naturally occurring and would render the surface water unsuitable for its designated uses; result in the dominance of nuisance species; or interfere with recreational activities except as occurs for the explicit purpose of this permit.
3. The discharge shall not result in toxic substances or chemical constituents in concentrations or combinations in the receiving water that injure or are inimical to plants, animals, humans or aquatic life; or persist in the environment or accumulate in aquatic organisms to levels that result in harmful concentrations in edible portions of fish, shellfish, other aquatic life, or wildlife that might consume aquatic life.
4. The permittee shall not at any time, either alone or in conjunction with any other person(s), cause directly or indirectly the discharge of any chemicals into receiving waters except chemicals that have been applied in accordance with the permit limits in such a manner as to not lower the applicable class water quality, interfere with the existing uses or designated uses assigned to waters by the legislature, or violate any of the conditions listed in the permit.
5. The permittee shall conduct monitoring in accordance with the conditions specified in the permit (PART VI), using analyses performed in accordance to those prescribed or referred to herein. If the Permittee monitors any pollutant more frequently than required by the permit using similar procedures as conditioned in this permit, the results of such monitoring shall be included in the calculation and reporting of the data so long as the additional samples do not bias the results for the purpose of meeting the permit limitations.
6. The chemical additive and receiving water limitations contained in the permit and the classification of waters requirements as provided by RSA 485-A:8 shall be met and maintained at all times. Whenever it is demonstrated that the limitations are not adequate to maintain said classification requirements, the permittee shall be required to cease chemical additions until such time as the classification requirements are met.
7. The department maintains the authority to suspend or revoke this permit at any time following the criteria and procedures set forth in Env-Wq 301.10.

PART IV. UNAUTHORIZED DISCHARGES

1. This permit authorizes the application of aluminum sulfate and sodium aluminate in quantities defined in Table 1 to specific areas of Nippo Lake as a demonstration. Controlled application or release of these chemicals from any other sources or locations into Nippo Lake or its tributaries are not authorized by this permit.
2. The Permittee shall report any noncompliance which may endanger health or the environment including but not limited to receiving water permit limit violations, chemical spills, change of volume or type of pollutant and adverse incident as defined in the permit. Information shall be provided verbally within 24-hours from the time the Permittee becomes aware of the circumstances. A written report shall also be provided within 5-days of the time the Permittee becomes aware of the circumstances. The written report shall contain a description of the noncompliance and its cause; the period of noncompliance, including exact dates and times, and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance.

PART V. SPECIAL CONDITIONS

1. A mixing zone as defined in Env-Wq 1707.02 is designated as the surface area of Nippo Lake treated on any given day as specified in this permit. Mixing zone water quality criteria must be met at all times within the specified treatment zone on the day(s) of treatment.
2. The permittee shall request termination of the permit when the monitoring specified herein has been completed. NHDES shall respond to the termination request in writing.
3. The permittee is responsible for ensuring that the entity applying the chemicals allowed by this permit controls the amount applied as necessary to meet applicable state water quality criteria standards as defined in PART III of this permit with compliance required upon initiation of the application and ending upon permit termination.
4. If the permittee or the entity applying the chemicals allowed by this permit becomes aware (e.g., through self-monitoring or by notification from the state or third party), or the State determines that the chemicals cause or contribute to an excursion of any applicable water quality standard, the permittee is responsible for ensuring that the entity applying the chemicals takes appropriate corrective action(s) up to and including ceasing the discharge.
5. An Operations and Management Plan must be submitted to NHDES by the permittee at least 30-days prior to the addition of chemicals included in this permit. The Operations and Management Plan shall be approved by NHDES prior to application of the chemicals to Nippo Lake. The NHDES approved Operations and Management Plan, along with all supporting maps and documents, must be retained at the address provided in the application for this permit. The Operations and Management Plan and all supporting documents must be readily available, upon request, and copies of any of these documents provided, upon request, to the State, federal, or local agencies governing chemical applications within their respective jurisdictions. The Operations and Management Plan shall contain no less than:
 - a) A clear statement that this is a demonstration project.
 - b) Details on the access and staging areas including a basic site map.
 - c) The method of chemical delivery, transfer, and on-site storage as well as the length of time chemicals will be stored at the site and plans for securing chemicals during storage.
 - d) Safety measures for minimizing chemical spillage or leakage and chemical spillage containment measures.
 - e) The names and contact information for the persons responsible for chemical management as well as emergency contact information.

- f) Details for cleaning up at the access and chemical transfer points following application.
6. Notice shall be given to all abutters via mail or email, and shall be posted in the local newspaper, at least 14-days prior to the addition of the chemicals as outlined herein. Notice of chemical application shall be posted every 200 feet along shoreline at least 3-days prior to the chemical application and maintained in place for at least 30 days following the last date of application.
7. The Permittee shall provide NHDES a description of the vessel to be used for the application of chemicals including the pumps, hoses, holding tanks, meters, and onboard spillage containment measures along with the vessel's size, engine type and horsepower prior to any application of chemicals to Nippo Lake. The vessel shall track the volumes of each chemical added and the course of application on each given day.
8. Chemical applications shall occur in three phases as follows:
 - a) Pilot phase – 10 acres of Nippo Lake in an area >15 feet deep at a rate of 27g of aluminum / m².
 - b) Phase 1 – 46 acres of Nippo Lake contiguous to the Pilot phase in an area >15 feet deep at a rate of 27g of aluminum / m².
 - c) Phase 2 – 56 acres of Nippo Lake contiguous to the Phase 1 but not including the Pilot phase in an area >15 feet deep at a rate of 27g of aluminum / m².
9. The timing and duration of the three phase shall be as follows:
 - a) Pilot phase – a one to two-day application duration.
 - b) Phase 1 – at least two weeks and not more one month following the Pilot phase with a four to five day application duration. No more than 12-acres shall be treated on any one day.
 - c) Phase 2 – at least two days following Phase 1 and upon evaluation of pH conditions in Nippo Lake as described below with a four to five day application duration. No more than 15-acres shall be treated on any one day.
10. A change to the timing and duration of the demonstration project authorized by this permit maybe requested by permittee provided good cause is submitted in writing and approved by NHDES. Changes in the timing and duration of the demonstration project must not extend the project initiation beyond May 2022.
11. The Permittee shall provide NHDES with map depicting a minimum of 5 application zones at least 14 days prior to commencing any chemical applications. The application zones shall be labeled: PILOT; ZONE 1; ZONE 2; ZONE 3; ZONE 4. No chemical shall be added by the

Permittee prior to receiving approval, in writing or email, of the application zones by NHDES. The application zones shall correspond to phases as follows:

- a) PILOT ZONE (~10 acres) – Pilot phase only.
- b) ZONE 1 (~11.5 acres) – Phase 1 and 2.
- c) ZONE 2 (~11.5 acres) – Phase 1 and 2.
- d) ZONE 3 (~11.5 acres) – Phase 1 and 2.
- e) ZONE 4 (~11.5 acres) – Phase 1 and 2.

12. The Permittee is responsible for applying for and securing any additional permits that may be required to carry out this project. The issuance of this permit does not relieve the Permittee from obtaining any other permits or approvals required by law.

PART VI. MONITORING

The permittee is responsible for monitoring Nippo Lake prior to, during, and after chemical application as described below:

1. Baseline Monitoring – A single event completed two to three weeks prior to the Pilot Phase at two locations approximately 10-meters deep and one location approximately 14-meters deep. Field measures of temperature and dissolved oxygen concentration and percent saturation shall be collected at 1 meter intervals from the surface to the bottom. At each site samples shall be collected at 1/3, 1/2, and 2/3 total depth or, if stratified, the midpoint of the epilimnion, metalimnion, and hypolimnion and analyzed for specific conductance, turbidity, pH, alkalinity, hardness, dissolved organic carbon, acid soluble aluminum, total aluminum, total phosphorus, chlorophyll a, and turbidity. A Secchi disc transparency estimate shall be collected at each sample location. The results must be made available to NHDES for review at least 7-days prior to any application of chemicals.
2. Pre-application Monitoring – Three additional sample events, each no more than two days prior to the initiation of the Pilot Phase, Phase 1 and Phase 2, shall be completed prior to applying chemicals. For each event a single sample location approximately 14-meters deep shall be sampled at 1 meter intervals from the surface to the bottom for temperature and dissolved oxygen concentration and percent saturation. For the Pilot Phase sample event only, samples shall be collected and analyzed for turbidity and pH as described in Baseline Monitoring. For Phase I and II, samples shall be collected and analyzed for specific conductance, turbidity, pH, alkalinity, hardness, dissolved organic carbon, acid soluble aluminum, total aluminum, total phosphorus, chlorophyll a, and turbidity at depths as described in Baseline Monitoring. For all phases, a Secchi disc transparency estimate shall be collected and zooplankton and phytoplankton samples shall be collected to a depth of 1/2 the total depth.

3. Application Monitoring – On each day chemicals are applied sampling shall occur at the deepest point in each of zones 1 through 4 at time intervals approximately 1-hour prior to starting the application, approximately midway through the daily application, and approximately 1-hour after the application is completed. Monitoring locations shall be same for each sampling event and document each location's latitude and longitude. Monitoring at each time interval shall consist of field measures of pH and turbidity at 1/3, 1/2, and 2/3 of the total depth or the midpoints of the epilimnion, metalimnion, and hypolimnion if Nippo Lake is stratified. Additionally, the pH shall be measured at 10 documented supplemental locations not within the application zones in areas with depths between 2 and 5 meters. Supplemental pH measures shall be collected at a depth of approximately 0.5 meters. Grab samples collected approximately 1-hour after the application is completed at 1/3, 1/2, and 2/3 of total depth or the midpoints of the epilimnion, metalimnion, and hypolimnion if Nippo Lake is stratified shall be analyzed for alkalinity, hardness, dissolved organic carbon, acid soluble aluminum, total aluminum, total phosphorus, and turbidity. End-of-day phytoplankton and zooplankton samples shall be collected from the same location and in the same fashion as described in the pre-application monitoring section after each day chemicals are applied. At all times during treatment, pH must be continuously monitored and recorded within the active application zone. Continuous observations must be made within and nearby the active application zone for distressed aquatic organisms and chemical application shall immediately cease if observed.

Post-application Monitoring – After all chemical applications are completed, weekly monitoring shall be completed during the first four weeks immediately following the completion of chemical applications, then monthly monitoring shall be conducted for the next three months, and three additional sampling events shall be conducted as directed by NHDES within one year of the completion of the chemical application. All post-application monitoring events shall be completed at a single location that is approximately 14-meters deep and include measures of dissolved oxygen and temperature at 1-meter intervals. Grab samples collected at 1/3, 1/2, and 2/3 of total depth or the midpoints of the epilimnion, metalimnion, and hypolimnion if Nippo Lake is stratified and shall be analyzed for pH, turbidity, alkalinity, hardness, dissolved organic carbon, acid soluble aluminum, total aluminum, total phosphorus, chlorophyll a, and turbidity. A Secchi disc transparency estimate shall be collected. Zooplankton and phytoplankton samples shall be collected to a depth of 1/2 the total depth. A visual survey for dead or distressed aquatic organisms shall be completed during each sampling event completed within the first four months following application.

PART VII. REPORTING AND RECORDKEEPING REQUIREMENTS

1. The permittee shall submit records of the chemicals applied and the following information:

- a) The name, chemical formula, and percent aluminum by volume, and the supplier of the chemicals applied to Nippo Lake.
 - b) A daily account of the volume of each chemical applied, combined mass of aluminum per area (dose), location (zone), estimated area, and vessel track of chemical application as well as copies of the field records supporting the daily account.
 - c) A map showing the application zones, ranges of dates during which chemicals were applied within each respective zone.
 - d) A record of the approximate average ratio by volume of sodium aluminate to aluminum sulfate applied on each application day including periods during the application when the ratio was intentionally modified from the requirements specified in this permit.
 - e) An electronic record of pH readings taken within the application zone on each respective day chemicals are applied to that application zone during the application.
 - f) Notes of any equipment failures or deviations from the Operations and Management Plan as required herein.
2. The permittee shall submit monitoring results as full laboratory results (including Chain of Custody) and all records of data collected in the field electronically, as applicable, no later than 14-days following each monitoring period, except as may be necessary for baseline monitoring, whereby all monitoring results must be made available to NHDES for review at least 7-days prior to initiating any chemical application to Nippo Lake. Additionally, temperature, dissolved oxygen, specific conductance, turbidity, pH, and Secchi disc transparency estimate data from pre-application monitoring shall be made available to NHDES for review at least 24-hours prior to initiating chemical application.
 3. The Permittee shall retain records of all monitoring information, including all calibration and maintenance records, copies of all reports required by this permit, and records of all data required by this permit, for a period of at least 3-years from the date of the last monitoring event.
 4. A report that summarizes the all components of this project shall be submitted to NHDES for review no more than 18 months after the date of final chemical treatment. NHDES shall be afforded an opportunity to comment and request revision to the report. A final report shall be submitted to NHDES no more than 21 months after the date of final chemical treatment.

Submittal of requests and reports to NHDES

- a. The following requests, reports, and information required as a condition of this permit shall be submitted to New Hampshire Department of Environmental Services, Water Division (NHDES-WD):

- 1) Notification of chemical application at least three (3) days prior to the commencement of the application;
 - 2) Notification of any substantial change (realized or anticipated) in the volume or character of pollutants being introduced into the receiving water;
 - 3) Notification of chemical spills;
 - 4) Notification of spillage or leakage of permitted chemicals and containment or lack of containment as defined in the operations and management plan and changes to safety measures to prevent future incidents;
- b. These reports, information, and requests shall be submitted to NHDES-WD electronically at david.neils@des.nh.gov.

Verbal Reports and Verbal Notifications

- a. Any verbal reports or verbal notifications, if required as a condition of this permit, shall be made to NHDES. This includes verbal reports and notifications which require reporting within 24 hours.
- b. Verbal reports and verbal notifications shall be made to:
NHDES Contact: **(603) 271-8865**

PART VIII. APPEAL, MODIFICATION, AND TRANSFER OF PERMIT

1. Appeal - Any person aggrieved by the decision may file an appeal with the N.H. Water Council (“Council”) that meets the requirements specified in RSA 21-O:14 and the Water Council’s procedural rules Env-WC 100 *et seq.*. The appeal must be filed directly with the Council within 30-days of the date of permit issuance.
2. Permit Modification – Modifications to this permit by the permittee shall follow the process and procedures set forth in Env-Wq 301.13
3. Permit transfer - The permit shall not be transferable.