ALUM TREATMENT
TOOLBOX

PRACTICAL GUIDELINES FOR RESTORING EUTROPHIC LAKES USING ALUM TREATMENT

Interreg
Baltic Sea Region

Co-funded by
the European Union

SUSTAINABLE WATERS
TRUST ALUM

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Interreg Baltic Sea Region 2021-2027 Programme's funded project «Building trust in target groups for ALUM treatment – an effective, yet misunderstood method for water quality improvement» TRUST ALUM.

ALUM TREATMENT
RECCOMENDATIONS

SUMMARY

This section provides concise, evidence-based recommendations to assist national authorities in making informed decisions about funding and regulating the use of the ALUM method—an effective but underutilized water treatment solution for reducing phosphorus pollution in lakes. In this document you will find information what are necessary steps to implement ALUM treatment in your country, it will showcase the cost-efficiency of ALUM treatment based on TRUST ALUM project results, outline funding opportunities, highlight the need for legal documents updates to accommodate ALUM treatment within national legal framework, emphasizing practical steps for integrating ALUM treatment in national lake management strategies.

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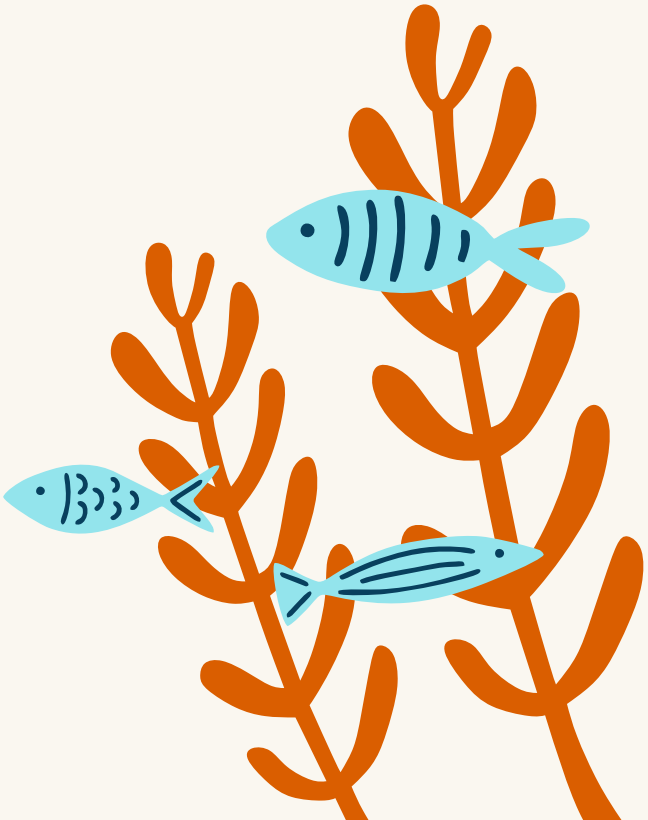


Eutrophication remains a pressing **environmental challenge** across the **Baltic Sea Region**, often driven by **historical phosphorus accumulation** in lake sediments. This nutrient enrichment leads to excessive algal blooms, deteriorating water quality, harming aquatic ecosystems, and posing risks to human health. While various **mitigation strategies** exist, the application of **aluminium-based compounds**, notably polyaluminum chloride (PAC), has emerged as a proven method to **bind and immobilize phosphorus in sediments**.

Despite its **successful implementation** in countries like Sweden, Finland and the USA, the ALUM treatment remains relatively unknown in the Baltic States. **Barriers** such as limited awareness, misconceptions about costs, and concerns over chemical safety have restricted its broader adoption. The **TRUST ALUM project** seeks to address these challenges by fostering **trust** and providing clear, evidence-based **recommendations** to national authorities.

HERE ARE THE MAJOR STEPS HOW TO BEGIN IMPLEMENTING ALUM TREATMENT IN YOUR COUNTRY IF THIS HAS NEVER BEEN DONE BEFORE OR HAS BEEN DONE WITH LITTLE SUCCESS:

1. **Recognise ALUM treatment as an efficient solution:** Acknowledge the benefits of ALUM treatment in reducing internal phosphorus loading, leading to improved water quality and ecosystem health.

2. **Evaluate whether changes in national regulations are necessary to legalise ALUM treatment:** Often current legal documents do not support ALUM treatment simply because of the reason it has never been relevant and differs from other traditionally applied treatment methods, e.g. dredging, aeration, etc. Consider including ALUM treatment as one of the methods for phosphorus mitigation in River Basin (District) Management Plans.

3. **Develop clear regulatory frameworks:** Establish guidelines and standards for the application of ALUM treatment, ensuring environmental safety and consistency across the country.

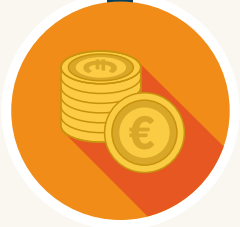
4. **Allocate dedicated funding:** Provide financial support for pilot projects and full-scale implementations of ALUM treatment or at least for parts of the treatment, i.e. monitoring or aluminium dose modelling, considering long-term cost-effectiveness and environmental benefits. Often ALUM treatment costs are not feasible for smaller municipalities. Such projects could be supported by small national grants intended for ecosystem services, fisheries resources improvement, lake cleaning and similar activities.

5. **Promote knowledge sharing:** Invest in the dissemination of information to equip regional and local authorities with the necessary knowledge for implementing ALUM treatments.

6. **Encourage stakeholder engagement:** Foster collaboration among scientists, policymakers, and community members to build trust and ensure the successful adoption of ALUM treatments.

COST EXAMPLES FROM THE INTERREG BSR TRUST ALUM PROJECT, BASED ON THE ALUM TREATMENT PILOT DONE IN A LATVIAN LAKE IN OCTOBER 2024*

ca. €670 net	Initial Lake Survey	If no previous data on the lake is available, an initial lake survey is needed to evaluate if the ALUM method may be suitable for the lake.
min. €600 net	Depth Map Creation	If no depth map and shapefile are available, a depth survey and measurements need to be performed.
min. €15K net	Pre-Treatment Monitoring	A full year of monthly monitoring is required to collect all necessary data for model creation and later evaluation of the treatment effectiveness.
€6-8K net	Lake Model Creation	In many cases a dynamic lake model will be needed to evaluate phosphorus balans in the lake system and perform later treatment design.
min. €1K net	Treatment Design	The ALUM treatment requires precise calculation of the appropriate aluminum dosage and dosing scheme based on the data aquired in previous steps.
case-specific **	Lake Treatment	Costs of lake treatment are determined individually and the costs are predominantly dependant on lake size and degree of phosphorus load.
min. €1.5K net/year	Post-Treatment Monitoring	At least a full year of seasonal monitoring is required to assess the effects of the treatment. However, more prolonged monitoring is highly advised.



* Prices are indicative for 2025 and may change. Be aware of the fact that the treatment of Lake Velnezers was more expensive than usual, since an additional boat was built and all technique and chemicals were transported over the Baltic Sea. If the treating company is located nearby, the logistics are easier and costs are lower. Lake location, size and phosphorus load will change prices.

** For example, in Sweden in 2024 a 5 ha lake was treated for €90 000, while in 2023/24 a 432 ha lake was treated for €1 360 000.

ALUM TREATMENT

TECHNICAL DOCUMENTATION AND MONITORING REQUIREMENTS

SUMMARY

This document provides step-by-step technical guidance for regional authorities responsible for implementing the ALUM treatment method in lake restoration projects. It translates the complex scientific and procedural knowledge gathered during the TRUST ALUM project into practical instructions and monitoring protocols. In this document you will find information about permit acquisition, treatment planning, and monitoring application procedure and documents needed as example from treatment case in Latvia, monitoring framework for pre-, during- and post-treatment, including a list of obligatory, optional and supplementary analyses and sampling frequency.

Contact person from national/regional authorities with Interreg BSR TRUST ALUM project experience:

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Contact person for lake monitoring:

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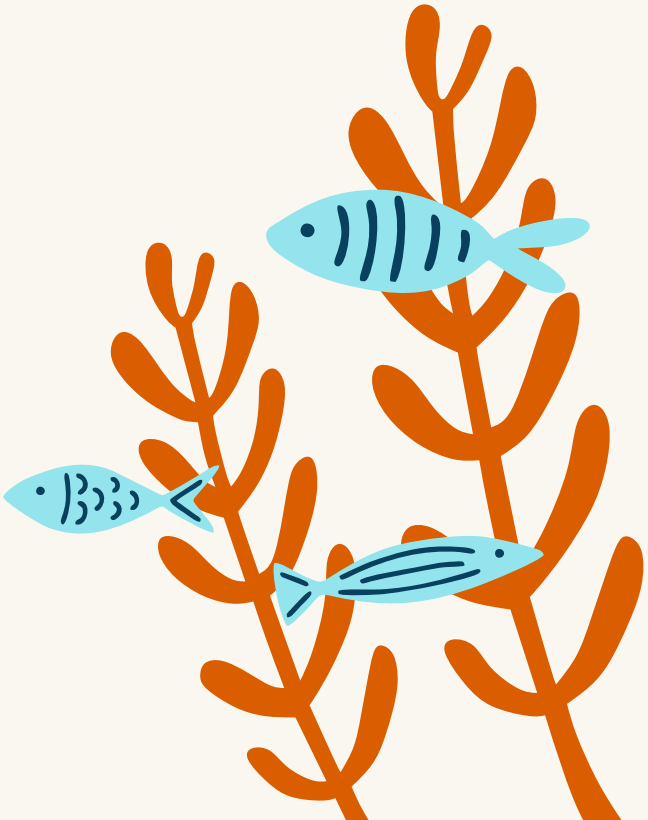

PROCEDURE FOR IMPLEMENTING ALUM TREATMENT IN LAKES DEVELOPED BASED ON THE INTERREG BSR TRUST ALUM PROJECT*

I have a eutrophic lake and would like to consider the ALUM method to restore it.

Get in touch with LHEI to assess available data and discuss about an initial survey.

LHEI performs an initial 1-time survey

YES

NO

The lake might be appropriate for ALUM treatment

The lake is not appropriate for ALUM treatment

If necessary, carry out consultations with your country's environmental regulatory authorities** or other relevant institutions***

LHEI preforms a detailed 1-year survey

Application submission for permit aquisition to relevant Institution in your country**

* The procedure was developed when the pilot treatment was performed in Latvia in 2024. Procedures in other countries may differ.

** State Envrionmental Service in Latvia.

*** E.g. Nature Conservation Agency for nature protected territories, National Cultural Heritage Administration if cultural monuments or their protection zones are affected, etc.

SIMPLIFIED SCHEME FOR ALUM TREATMENT ACQUISITION IN LATVIA*

Application submission for permit aquisition to the State Environmental Service

Main attached documents include:
- Monitoring data on the lake's physical and chemical parameters for at least one year prior to the planned activity.
- Certified experts' opinions on the treatment's impact and its restrictions concerning fish, other species, and biotopes
- Public involvement action plan and feedback form the local community.
- Pollution data for oil products, heavy metals and other anthropogenic pollution in any, basedon available information on the historical and current situation of the lake.
- Information if the tratment site has any protection status (e.g. nature reserve, etc.).

Other documents may be required.

State Environmental Service evaluates the application

State Environmental Service prepares the Initial Environmental Impact Assessment**

State Environmental Service applies the procedure for remediation of contaminated sites

Permit issued

Refusal to perform ALUM treatment

The permit outlines technical regulations, **treatment requirements**, as well as the corresponding **monitoring scheme**.

* The application must be submitted not less then 1 month before the planned treatment. It should be noted that the State Environmental Service, after evaluating the application, may request additional information and documentation, in accordance with the requirements of regulatory enactments, which may require additional time to receive the permit.

** The procedure must be specified in accordance with the requirements of applicable laws and regulations at the time of submission of the application, e.g. permit aqusition process. Permit aqusition process may vary in case of specific infrastucture needs.

LAKE MONITORING FRAMEWORK FOR LAKES TREATED WITH THE ALUM METHOD

Pre-Treatment Monitoring
*once per month**

Obligatory analyses:

Water analysis:
- Relative Water Level
- Transparency
- Colour
- Temperature
- pH
- Alkalinity
- Dissolved Oxygen
- Conductivity
- Ammonium
- Nitrates
- Nitrites
- Total Nitrogen
- Orthophosphate
- Total Phosphorus
- Filtered Total Phosphorus
- Silicate
- Dissolved Organic Carbon
- Chlorophyll *a*
- Total Suspended Solids
- Chloride ions
- Sulfate
- Sodium
- Calcium
- Magnesium
- Total Aluminium
- Filtered Total Aluminium

Sediment analysis:
- Dry Weight
- Total Organic Carbon
- Density
- Total Phosphorus
- Sequential P Fractionation

Supplementary analyses:

- Phytoplankton analysis
- Zooplankton analysis
- Zoobenthos analysis
- Macrophyte analysis
- Fish analysis

Monitoring During Treatment
*once per hour***

Obligatory analyses:

Water analysis:
- pH
- Alkalinity

Optional analyses:

Water analysis:
- Relative Water Level
- Transparency
- Colour
- Temperature
- Dissolved Oxygen
- Conductivity

Post-Treatment Monitoring
*once per season****

Obligatory analyses:

Water analysis:
- Relative Water Level
- Transparency
- Colour
- Temperature
- pH
- Alkalinity
- Dissolved Oxygen
- Conductivity
- Total Nitrogen
- Orthophosphate
- Total Phosphorus
- Total Aluminium

Optional, but important analyses:

Water Analysis:
- Ammonium
- Nitrates
- Nitrites
- Filtered Total Phosphorus
- Dissolved Organic Carbon
- Chlorophyll *a*
- Filtered Total Aluminium

Sediment analysis:
- Dry Weight
- Total Organic Carbon
- Density
- Total Phosphorus
- Sequential P Fractionation

Supplementary analyses:

- Phytoplankton analysis
- Zooplankton analysis
- Zoobenthos analysis
- Macrophyte analysis
- Fish analysis

* Some parameters are measured more or less frequently than once per month.
** Parameters are measured after every hour of aluminum additon.
*** At least one year after treatment, but preferably longer.

ALUM TREATMENT
ROADMAP

SUMMARY

This section aims to guide local authorities in evaluating the feasibility, safety, and cost-effectiveness of ALUM treatment. It will allow local authorities to select lakes that would strongly benefit from ALUM treatment and will provide further instruction on how to plan treatment, calculate and save costs, implement and maintain the ALUM treatment process in their administrative territory.

Contact person from local authorities with Interreg BSR TRUST ALUM project experience:

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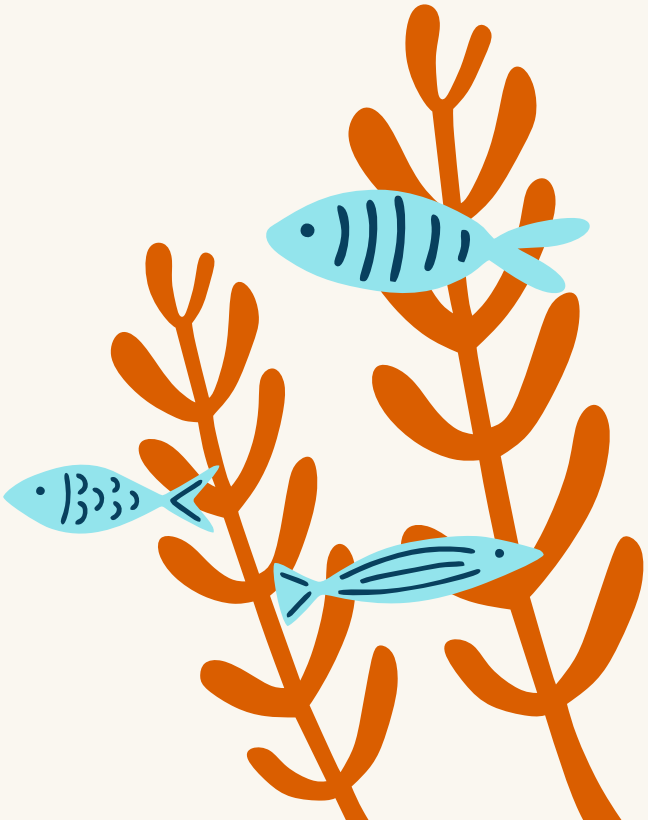


HOW DO I KNOW IF THE LAKE IS APPROPRIATE FOR ALUM TREATMENT?

Appropriate	Inappropriate	Possible issues or things to consider
Lakes with no considerable inflow or outflow. Lakes with historical phosphorus load which needs to be supressed. Lake depth map and shapefiles are available. Temperature during planned treatment will be at least 10°C (May-October in Latvia). Historical and/or current monitoring data is available.	Lake has high external phosphorus input which cannot be managed. Water pH measured throughout the year is below 6. The lake is very shallow (water depth must be at least 2 m for treatment). Areas inhabited by plants with strong root systems developed in the sediment (e.g. Phragmites australis, Nymphaeceae, etc.).	Underwater cable and/or pipe systems. Installed fountains. Archeological objects. Protected areas. Protected species. Nesting birds and spawning grounds for fish. Location in a swampy area. Location with a lot of trees and bushes. Hanging cables. Carring capacity of roads and bridges. Private acess roads and other road barriers. Trash or wrecks on the bottom of the lake. Vegetaion spread in the shallower areas of the lake. Permission issueance (dependant on specific site and country legislation). Regular monitoring before, during and after treatment. Informative initiatives for local people.

HOW CAN LOCAL AUTHORITIES BE INVOLVED AND POSSIBLY DECREASE COSTS?

Collect available information

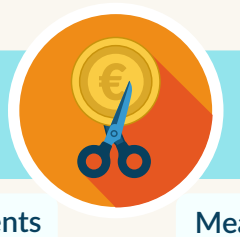
Collect archival monitoring data, bathymetric maps, lake infrastructure design plans and other information.

Secure experts' opinions

Secure experts' opinions about treatment impact and restrictions as to fish, other species and biotopes.

Provide practical help during sampling

Provide boat or help during measurements and sampling, etc.



Help with data collection

Measure water level changes every week, etc.

Prepare the site before treatment

Cut the bushes near the lake, organize the needed technical elements (e.g. fencing, tent, security, etc.) and obtain permits.

Clear up the treatment site after treatment

Restore the surface if it became damaged during treatment, remove the technical elements, etc.

WHAT TO DO AFTER TREATMENT?

Avoid additional phosphorus inflow

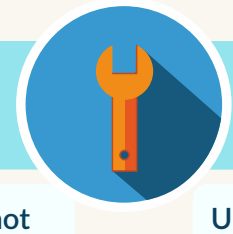
Make sure to lremove any potential sources of P. to the lake (e.g. waste water management, lake side infrastructure, etc.)

Continue monitoring the lake after treatment

Arrange post-treatment monitoring at least every other year to see any changes and assess treatment effectivness.

Measure pH levels

Regularly monitor pH to check if it is not considerably decreasing (below 6).



Provide maintenence to the lake

Upkeep good health of the lake by implementing suggested measures (e.g. aeration fountain, biomanipulation, etc.).

For ALUM treatment permit acquisition in Latvia, one of the key requirements is a public involvement action plan and documented feedback from the local community. It is important not to underestimate this step, as the use of aluminium for lake restoration still carries negative associations in the public's perception. Open communication, combined with clear, science-based evidence, is essential to build trust and support for the restoration project.

SOME SUGGESTED ACTIVITIES FOR MUNICIPALITIES:

Public Information Meetings: Organize open community meetings or workshops where experts explain the ALUM treatment process, expected benefits, safety measures, and timeline, allowing residents to ask questions and express concerns. Use the Interreg BSR TRUST ALUM webpage for useful information, including a frequently asked questions and answers section there.

Informative Materials: Develop and distribute flyers and posters clearly explaining the project in easy-to-understand language.

On-Site Informative Tent: Set up an information tent near the lake or in public spaces during the treatment period with visual displays (e.g., posters, videos, before/after examples, etc.) and experts available to answer questions (as done successfully in the TRUST ALUM project).

Demonstration Activities: Conduct simple demonstrations like the Jar Tests to visually show how the ALUM process works, helping people better understand the process and its environmental benefits.

Online Surveys or Feedback Forms: Create simple online or paper-based surveys to collect opinions, concerns, and suggestions from residents, ensuring that all voices are heard and documented.

Media Outreach: Publish articles, interviews, or announcements in local newspapers, radio to reach a wider audience.

Stakeholder Meetings: Involve local NGOs, fishing associations, citizen communities early in the process to build trust and partnership.

All feedback received should be summarized and included in the public involvement report submitted with the permit application!

TRUST ALUM

BUILDING TRUST IN TARGET GROUPS FOR ALUM TREATMENT - AN EFFECTIVE, YET MISUNDERSTOOD METHOD FOR WATER QUALITY IMPROVEMENT

MORE INFORMATION ABOUT THE PROJECT

interreg-baltic.eu/project/trust-alum

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PROJECT PARTNERS

LATVIJAS HIDROEKOLOĢIJAS INSTITŪTS

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VATTENRESURS

ECAT

LAKE RESTORATION

SLU
SWEDISH UNIVERSITY OF AGRICULTURAL SCIENCES

State Environmental Service
Republic of Latvia

Ministry of Climate and Energy
Republic of Latvia

SEI Stockholm Environment Institute

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