Stormwater Best Management Practice

Treatment Chemicals for Particulate Removal from Construction Stormwater

Minimum Measure: Construction Site Stormwater Runoff Control
Subcategory: Sediment Control

Description

Turbidity is a measure of suspended material in water that affects water's clarity. It is an optical property of water that indicates the presence of any material that reduces light transmission, such as colloids, clays, silts, and a variety of organic or inorganic particles. Turbidity in waterbodies may increase due to natural causes, such as river turbulence or algal blooms, but it may result from human disturbances, such as construction and development, urban stormwater, or combined sewer overflows. In stormwater discharges from construction sites, high turbidity often indicates sediment export that can damage downstream ecosystems. Although water quality standards vary by state, jurisdiction and receiving water classification, a commonly implemented criterion limits turbidity to no more than 5 Nephelometric Turbidity Units (NTUs) above the background turbidity of the receiving water (McLaughlin & Zimmerman, 2009).

At some construction sites, traditional stormwater control measures may not be able to adequately control sediment export. This can be due to a number of factors, including the high proportion of fine particles in on-site soils or challenging site conditions, such as steep slopes or highly erodible soils. In such cases, the use of treatment chemicals may be a consideration. Treatment chemicals stabilize sediment through coagulation or flocculation, processes that aggregate sediment particles into larger masses (often referred to as "floc") that are easier to remove through settling or filtration. The application of treatment chemicals to soil or to erosion control matting, a practice referred to as chemical stabilization, can also reduce erosion and sediment export.

A number of treatment chemicals are available for reducing stormwater-based sediment export from construction sites, including polyacrylamide (PAM—a generic term for a broad class of compounds), chitosan, gypsum, alum (aluminum sulfate), and DADMAC (diallyldimethylammonium chloride). Stormwater treatment chemicals are predominately water-soluble and, depending on their structure, may carry an electric

A truck equipped to spray chemical stabilizers throughout a construction site can be more effective at suppressing dust than water alone.

charge—cationic polymers carry a positive charge, and anionic polymers carry a negative charge. Some polymers are nonionic (no charge), and others are amphoteric (the charge depends on the pH of the water).

Although treatment chemicals can be effective at reducing sediment export, studies have shown significant toxicity in aquatic organisms from the application and misapplication of certain polymers. Cationic polymers are particularly toxic to aquatic organisms. As a result, some federal and state permitting authorities have restricted polymer use in stormwater management. Some require any construction site operator proposing to use cationic chemicals for sediment control to obtain prior approval to ensure proper use. Permits may also require that users of any other types of treatment chemicals comply with restrictions regarding their selection, application and storage to minimize the risk of a chemical release into the aquatic environment. Other state permitting programs have established restrictions (or prohibitions in some cases) on the types of chemicals that construction staff can use, the conditions under which they can apply them, the minimum training required for construction staff, and/or whether residual toxicity testing before and during application is a requirement. Therefore, before

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using any chemicals to treat construction site stormwater discharges, construction staff should contact their local stormwater permitting authorities to ensure that their use complies with federal, state and local requirements.

Siting and Design Considerations

Construction staff can apply treatment chemicals in several ways to reduce sediment levels in their stormwater discharges, such as on dry land or directly to stormwater discharge using passive or active systems, as described below. In all cases, consider using conventional erosion and sediment controls before and after the chemical treatment controls, both to improve overall effectiveness and to reduce the chance of downstream impact from the use of chemicals (U.S. EPA, 2019).

Passive Treatment Systems

Passive treatment refers to systems that apply treatment chemicals to existing soils, water impoundments, dispersion areas or conveyance features. Passive treatment systems are common, owing to their simplicity and generally lower cost. The following are several examples of passive treatment chemical applications.

Chemical soil stabilization

In a soil application, treatment chemicals help maintain soil structure by binding soil particles together. This makes soil more resistant to the erosive forces of wind or water and helps maintain infiltration rates early in a rain event (McLaughlin, 2015; Sojka et al., 2007). Treatment chemical application can be directly onto soil through the mixing in of dry granular powder or in liquid spray form. Liquid application is more effective for chemicals that require uniform application at low concentrations, such as PAM. Using liquid treatment chemicals in a hydroseeding mix can bind the seed, fertilizer and other additives to the soil until new vegetation establishment occurs. Applying a powdered treatment chemical over erosion control matting, straw or mulch can enhance its effectiveness.

Dust control

Construction sites can use treatment chemicals to control dust from haul roads, tailings piles, waste dumps and open areas. Similar to soil applications, application of the treatment chemical often involves dissolving it in water and then spraying it directly onto the road or other ground surface. Common chemical methods of dust control include water absorbing, organic non-petroleum, organic petroleum, synthetic polymer emulsion, concentrated liquid stabilizer and clay additive (Jones, 2017). Using treatment chemicals to bind the dust particles can also reduce the amount of water necessary to spray dusty construction areas.

Dispersion fields

Construction sites can use treatment chemicals within a dispersion field to help reduce sediment in their stormwater discharges. Dispersion fields reduce the velocity, erosive force and turbidity of rapidly flowing water and allow it to spread out over a relatively level area. These fields often use checks or wattles that are perpendicular to the flow to further reduce stormwater velocity. The addition of treatment chemicals to erosion control matting covering the dispersion field can facilitate a reduction in construction site stormwater discharges by binding together suspended particles that settle and adhere to the matting.

Treatment ditches

Treatment chemicals can enhance sediment removal in stormwater treatment ditches. For example, tethering soluble polymer along the upstream portion of a ditch that receives sediment-laden stormwater enables settleable floc formation. Applying erosion control matting to the lower portion of the ditch can reduce the water's velocity and allow the sediment to settle and adhere to the matting. Check dams can serve a similar purpose by reducing stormwater velocity and promoting settling.

Stormwater pipes

Anchoring soluble polymer blocks in split or closed stormwater pipes allows sediment particles to bind in flowing water, which in turn allows settling to occur in downslope practices before discharge of the water.

Active Treatment Systems

Active treatment systems provide a greater level of effectiveness and control but generally require more equipment and greater expense. These types of systems are applicable when traditional control measures or passive treatment systems cannot meet water quality standards. Active treatment systems typically require on-site chemical storage, chemical mixing, a reaction and clarification tank or basin, and media filtration. They often contain automated instrumentation to monitor water quality, flow rate and dosage control of treatment chemicals for both influent and effluent flows.

Chemical Selection

One of the most important factors when considering chemical treatment for erosion control or turbidity management is chemical selection. Even within major chemical groups, there is considerable variation to take into account and evaluate based on site-specific conditions. Factors that affect chemical effectiveness, and therefore chemical selection, include sediment type and composition (e.g., relative fractions of clay, silts, sand and organic matter). If treating stormwater directly, construction staff should consider additional water quality parameters such as hardness, pH and dissolved organic carbon. If chemicals are land-applied, factors like vehicle traffic and rainfall (or lack thereof) are important considerations.

When using liquid-based chemical treatment for turbidity management, preliminary jar tests are a good way to test a range of chemicals using actual site soil and water. Jar tests allow for the screening of multiple chemicals as well as the determination of the optimal dose. Chemical manufacturers generally provide specific testing protocols and will often do the testing themselves if sites provide them with site water and soil. Soil testing is also possible for land-based applications.

Once a design engineer selects a specific chemical, they should determine the proper dosage to both optimize effectiveness and limit the potential for export of unreacted chemical. Again, manufacturers are a good source of preliminary information. However, depending on the chemical and specific site conditions, field-based testing may be necessary to measure effectiveness and chemical residuals in stormwater. In all cases, design engineers should consult local permitting authorities, who can often provide guidance on chemical-handling requirements, appropriate application methods and downstream water quality requirements.

Effectiveness

The effectiveness of chemical treatment depends on site-specific conditions as well as overall water quality goals of the project. Any one polymer is not effective for all soils and increasing the treatment chemical application rate will not necessarily result in better performance; in fact, over-application often causes more harm than good.

The goals of most system designs are to reduce sediment export, often measured in terms of turbidity, to a level that local regulations consider acceptable. The definition of this level is typically within 5 NTU of background turbidity, but it can be more stringent for environmentally sensitive waters. As such, some projects may require greater than 90 percent reduction in turbidity, while others may require less than 50 percent. For active and passive systems, concentration reductions from around 300 NTU to 5 NTU are common, while a properly designed active treatment system is effective for treatment of waters up to 1000 NTU (Druschel, 2014).

Cost

Chemical treatment costs vary widely depending on the chemical type and application method. In a review of construction projects using liquid-based active treatment systems, Druschel (2014) cited work from McLaughlin and Zimmerman (2009) that found reported treatment costs for continuous treatment (in-line) systems were between $0.01 and $0.03 per gallon and costs for batch reactor (off-line) systems were as high as $0.08 per gallon. Where water requires less treatment, passive treatment systems may allow for cost savings. Land application may also be less expensive. McLaughlin (2015) notes that at a cost of $6 per pound and a standard application rate of 20 pounds per acre, material application costs for PAM are around $120 per acre.

Additional Resources

- U.S. Department of Agriculture. (2016). *Conservation practice standard for anionic polyacrylamide (PAM) application* (450-CPS-1).

Additional Information

Additional information on related practices and the Phase II MS4 program can be found at EPA's National Menu of Best Management Practices (BMPs) for Stormwater website

References

Druschel, S. J. (2014). *Flocculation treatment BMPs for construction water discharges* (Final Report 2014-25). Research Services & Library, Minnesota Department of Transportation.

Jones, D. (2017). Guidelines for the selection, specification and application of chemical dust control and stabilization treatments of unpaved roads. University of California Pavement Research Center.

McLaughlin, R. (2015). *Using polyacrylamide (PAM) to reduce erosion on construction sites*. NC State Extension.

McLaughlin, R. A., & Zimmerman, A. (2009). *Best management practices for chemical treatment systems for construction stormwater and dewatering* (Report No. FHWA-WFL/TD-09-001)*.* Technology Deployment Program, Western Federal Lands Highway Division, Federal Highway Administration, U.S. Department of Transportation.

Sojka, R. E., Bjorneberg, D. L., Entry, J. A., Lentz, R. D., & Orts, W. J. (2007). Polyacrylamide in agriculture and environmental land management. *Advances in Agronomy, 92*, 75–162.

U.S. Environmental Protection Agency (U.S. EPA). (2019). *EPA's 2017 Construction General Permit (CGP) and other related documents*. National Pollutant Discharge Elimination System (NPDES).