Coagulant Enhanced Treatment (CET): New Efficient and Cost-Effective Stormwater BMP

DoD installations work hard towards achieving 2025 Total Maximum Daily Load (TMDL) targets and Municipal Separate Storm Sewer System (MS4) requirements consistent with EO 13508 for Chesapeake Bay protection and restoration. Innovative Best Management Practices (BMPs) that are more cost-effective and efficient in nutrient removal help installations meet these goals. Coagulant Enhanced Treatment (CET) is a recently approved BMP enhancement retrofit that can be implemented by treating large watersheds with a substantially small footprint when associated with existing or new wet ponds. This practice can potentially accelerate and simplify an installation's National Pollutant Discharge Elimination System (NPDES)/TMDL/MS4 compliance.

How does CET work?

The treatment process entails adding a common coagulant/flocculent to stormwater/surface water which forms precipitates to trap total phosphorus (TP), total nitrogen (TN), total suspended solids (TSS), and other pollutants. The choice of coagulant depends on the characteristics of raw water such as its pH. The most common coagulants are aluminum sulfate, polyaluminum chloride, and aluminum chlorohydrate. All of them typically contain aluminum because of their high pollutant removal efficiencies and precipitate stability.

CET can be added to an existing wet pond or can be constructed as a new BMP.

During treatment, water is diverted from a storm sewer or channel into an off-line treatment system or is treated in-line with a wet settling pond. Rapid mixing of water with the coagulant enables the formation of floc that traps pollutants and precipitates to settle in a wet pond. The volume of the pond is designed to allow enough detention time for the precipitate to settle to the bottom of the pond at the peak design water flow rate. The aluminum hydroxide precipitate traps particulate matter which might contain nitrogen and phosphorous. The second precipitate, aluminum phosphate, removes dissolved phosphorous. After treatment, water is returned to the storm sewer or channel downstream. Overall, these systems are designed to treat stormwater runoff from common rain events (1-1.5 inches) and obtain desired pollutant load reductions. Importantly, CET is a non-proprietary treatment process and is not patented as a BMP. While coagulants have been used in stormwater treatment previously, CET represents a novel approach for receiving pollution reduction credit towards Chesapeake Bay TMDL, local TMDLs for TP and Bacteria as well as for MS4 Permit compliance in Bay States (VA and PA will evaluate project MS4 credit eligibility on a case-by-case basis). CET is approved for nutrient credit in EPA regions 4 and 10 outside of the Chesapeake Bay with several successfully installed facilities.

Benefits of CET and advantages over other stormwater BMPs:

- CET facilitates higher removal rates of pollutants where typical removal efficiency ranges from 75% to 85% for TP, 40% to 45% for TN, and 79% to 90% for TSS.
- CET has a limited footprint and can treat large/whole watershed regions with a minimum area of 200 acres.
- When compared to traditional stormwater treatment practices such as bioretention, stormwater detention, stream restoration, and enhanced wetland treatment, CET has the lowest lifecycle cost per pound of TP, TN, and amount of pathogens removed. Typical life cycle costs (construction + 20 years of annual operation and maintenance (O&M)) range from $200 to $600 per pound TP removed and from $100 to $400 per pound TN removed.
- CET enhances surface water quality for habitat, aesthetics, and recreational use.
- CET can accelerate achievement of NPDES/TMDL/MS4 requirements.

How can CET benefit DoD installations in the Bay watershed?

Given the extensive land area of DoD facilities within the Chesapeake Bay watershed—comprising 64 major installations and over 120 sites, with approximately 346,000 acres[1] being currently treated by wet ponds, there exists significant potential for implementing CET systems. These systems offer an effective approach to stormwater treatment. The following points on the next page provide key considerations for CET systems on DoD facilities:

- **Single CET Facility:** A single CET facility installed on a military installation has the potential capacity to achieve all of the installation's TMDL reduction goals. This makes it a cost-effective treatment option, eliminating the need to maintain multiple smaller facilities and freeing up those lands and resources for other mission priorities.
- **Retrofitting Existing Wet Ponds:** When an existing wet pond can be retrofitted with CET, the design and construction costs are significantly reduced. With 190 existing wet ponds (source: FY2023 BMP Datacall) at DoD installations within the watershed with a combined drainage area more than 15,000 acres, there is a potential to optimize the cost of BMP implementation to achieve water quality goals using CET.
- **Intergovernmental Support Agreements (IGSAs):** Exploring IGSAs with localities that adopt CET can facilitate collaboration and support in the O&M of CET facilities, resulting in cost savings. Moreover, IGSAs can boost the achievement of DoD Chesapeake Bay Program's (CBP) partnering goals because, by collaborating with local communities, installations can access expertise and resources critical for CET operations. The DoD CBP Summer 2023 fact sheet on IGSAs provides detailed information on how they can be developed/utilized specific to each Service.

What can Installations do next?

- Identify retrofit load reduction opportunities for larger watersheds with developed land and substantial nutrient load reduction potential with or without an existing wet pond and regional water quality pond retrofits from previous studies. Approximately 346,000 acres are currently treated by wet ponds on DoD installations in the Chesapeake Bay watershed. On average, the surface area of wet ponds constitutes about 3 percent of their contributing drainage area (as reported by Schueler in 1987). Consequently, there is potential for retrofitting up to 10,000 surface acres of wet ponds within the watershed. For instance, consider a 1,500-acre urban watershed with average annual stormwater loads of 1,500 lbs. of TP and 11,000 lbs. of TN. Figure 1 below shows the savings obtained per impervious acre treated by CET over traditional stormwater retrofit projects.

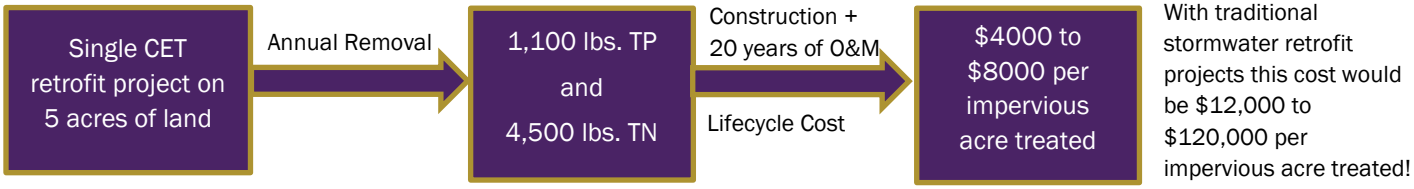

Figure 1: Cost savings from CET retrofits over traditional stormwater retrofit projects

Per this estimation, overall savings achieved for the example 1500-acre watershed would be $9 million to $84 million. There would be significant cost benefits if CET were used to address just a portion of the estimated 138,000 pounds of TP load reduction required by DoD installations in Maryland, Pennsylvania, Virginia, and Washington D.C. towards the Bay TMDL.

- Determine remaining TP and TN load reductions needed per MS4 permit or installation specific TMDL target or jurisdiction.[2]
- Conduct desktop analysis of select opportunities to evaluate viability and estimate additional CET load reductions, costs, and cost effectiveness.
- Determine the ability to trade or sell any excess reductions or bank them to meet future pollution reduction needs. Delaware, DC, Pennsylvania, Maryland, and Virginia have established nutrient trading programs within the jurisdiction.[3]
- The National Defense Authorization Act (NDAA) now allows installations to engage in nutrient trading. If the Services obtain approval from their respective Secretaries to trade credits, installations may be able to work together through a shared large system to trade nutrient credits both in the same service or between services to meet DoD's TMDL goals in the watershed.

CET systems can provide an efficient and cost-effective means of meeting current and future installation pollution reduction goals and requirements while improving water quality and habitat. CET enhancements may also help free up mission-critical land resources to adapt to future missions. As the Partnership looks beyond 2025 TMDL target deadlines and the additional pollution reductions necessary to make up for loss of existing BMP efficiency with projected climate changes, new CET systems and retrofits may provide a useful tool for DoD installation compliance.

References and More Information

[1]"CET for Use in Chesapeake Bay Watershed". Brown and Caldwell. https://d18lev1ok5leia.cloudfront.net/chesapeakebay/documents/VAB-Coagulant-Enhanced-Treatment-Report_FINAL-w-appendices.pdf

[2]"2022 DoD Chesapeake Bay TMDL Progress Evaluation and 2025 DoD Implementation Plan". Elizabeth Karivelil, Brown and Caldwell. DoD CBP October 2023 CBAT Presentation. Distributed via email.

[3]"Trading and offsets in the Chesapeake Bay Watershed". Environmental Protection Agency. https://www.epa.gov/chesapeake-bay-tmdl/trading-and-offsets-chesapeake-bay-watershed

"CET for Use in Chesapeake Bay Watershed". Jeff Herr, Brown and Caldwell. DoD CBP January 2024 CBAT Presentation. Distributed via email.