

How a Single Coat, Non-Hazardous Epoxy Saves Charlotte Water Money in the Long Run

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ABSTRACT

The McAlpine Creek Wastewater Management Facility (MCWWMF) is the largest wastewater treatment facility operated by Charlotte Water (CLTWater). In 2018, CLTWater began a Reliability and Process Improvements project. The project involved the rehabilitation of 16 secondary concrete clarifiers that ranged from 95 to 150 feet in diameter, with the oldest clarifiers being nearly 60 years old.

CLTWater considered an epoxy coating. However, they historically ran into issues with failures of delamination. Thus, they opted to move forward with a pilot study with four different epoxy manufacturers where they analyzed cost, schedule, performance, quality, service life, and safety. Concluding the test, CLTWater determined the single coat epoxy to provide the best value for their project.

The product selected was not the lowest cost option. Yet, the epoxy's single coat application and non-hazardous attributes provided CLTWater seven months of time savings resulting in the greatest cost savings as compared to the other products tested. The coating system achieved the high build needed in one coat to rehabilitate the concrete aggregate and allowed the clarifiers to return to service within four to six hours.

The product was also free of volatile organic compounds, solvents, styrene, and isocyanates, making the product safe for applicators, workers, and the surrounding work site. This allowed multiple trades to work concurrently while the coating was applied.

Key words: epoxy, epoxy coatings, wastewater, clarifiers, single coat epoxies, epoxy solutions, rehabilitation, non-hazardous, pilot test, time savings, concrete, concrete rehabilitation

INTRODUCTION

CLTWater is one of the largest water entities in the Southeast region, managing a total of ten water and wastewater treatment plants serving a population of approximately one million. The MCWWMF is the largest wastewater treatment plant of five wastewater facilities owned and operated by CLTWater, rated at a 64 MGD treatment capacity and accounting for over half of CLTWater's wastewater treatment system.

The MCWWMF Reliability and Process Improvements Project

The MCWWMF Reliability and Process Improvements Progressive Design-Build was a \$138 million project issued in March 2018 to address aging infrastructure concerns as the original plant was built in the 1960s. The improvements scope of work included the rehabilitation and replacement of critical primary and secondary wastewater treatment structures over five years. The owner awarded the design-builder this scope, including the rehabilitation of 16 secondary clarifiers, 28 aeration basins, and replacement of the plant's three blower buildings, all while maintaining plant operations. In addition, the project included the installation and operation of a Return Activated Sludge (RAS) Fermentation Pilot Study, with data evaluation and implementation of a full-scale RAS fermentation system.

The rehabilitation scope of work included 16 secondary clarifiers ranging from 95 to 150 feet in diameter and 28 aeration tanks nearing the end of their service life, with the oldest structures having been in service for 60 years. To repair the degrading concrete and protect against future corrosion, the rehabilitation included strategically cleaning, coating, and inspecting these structures before returning them to service.¹ The owner worked with the design-build team to determine a comprehensive, cost-effective solution to extend the service life of the secondary clarifiers and aeration tank structures for long-term asset protection via epoxy coatings. However, the owner was apprehensive of selecting a coating product due to historical coating failures throughout their system.

Pilot Study Performance and Results

In collaboration with the design-build team, it was determined that conducting a pilot study would provide the owner with the most comprehensive solution—an opportunity to observe epoxy coatings in the field under live conditions, providing validation to prevent the coating failures experienced in the past. The owner, the design-build team, including the general contractor and engineer, and the four epoxy manufacturers invited to participate in the pilot study were involved in this testing stage. Additionally, the owner hired a third-party engineering firm as a consultant to provide corrosion and coatings expertise in the study. This firm oversaw the pilot study on site, assisting the owner in facilitating the study and determining the testing criteria. Following the test coating application, adhesion (pull) tests were conducted to measure substrate adhesion and holiday (spark) tests were completed to detect discontinuities.

Three of the four epoxy manufacturers invited to engage in the study participated in the event. Each manufacturer applied a test patch of epoxy in a designated area in the clarifier launder troughs. The test applications were time-recorded by the general contractor to validate the test results in accordance with their respective project schedules and cost estimates.

While the superior epoxy coating was not the lowest price, Coating #1 provided considerable cost savings by accelerating the construction schedule. Coating #1 had the shortest application time of the three, requiring no wait time for an underlayment to cure, unlike the other epoxies applied. Additionally, its non-hazardous attributes guaranteed safe application in and around the testing area. This allowed other trades to perform work concurrently on site without disruption. The pilot study results, coupled with the

cost and schedule analysis, translated into a value-based selection that saved time and money in the overarching Reliability and Process Improvements project.

EXPERIMENTAL PROCEDURE

For the rehabilitation scope of work, it was determined that an epoxy coating system was ideal to repair and protect the clarifier and aeration tank structures. However, the owner had experienced coating failures on past rehabilitation projects. More specifically, the prior coating material exhibited delamination due to factors such as surface preparation, reactivity to moisture, and application. To prevent delamination or other coating failures from reoccurring, the owner organized the pilot study to test prospective coating materials before final material selection.

Pilot Test Criteria and Procedures

The participating manufacturers were required to follow specific testing procedures to meet the baseline testing criteria. The baseline testing criteria was based on the following ASTM* standards—ASTM D4541 - Standard Test Method for Pull-Off Strength Using Portable Adhesion Testers, NACE SP0188_Testing of New Protective Coatings on Conductive Substrates, and ASTM G210 - Standard Practice for Operating the Severe Wastewater Analysis Testing Apparatus (SWAT). The epoxy coatings were also tested against several variables to provide the information critical to the value-based selection including cost, schedule, performance, quality, service life, and safety.

For the test, each manufacturer was provided a designated space in the clarifier launder troughs to apply the product. The manufacturers performed their respective surface preparation on the concrete substrate and applied a test patch of epoxy via the application method of choice. This test was overseen by the third-party engineering firm while stopwatch data was recorded and collected in a timetable by the general contractor for analysis. Following the application of the test patch, adhesion tests were performed to analyze each epoxy's adhesion and holiday testing was conducted with a high-voltage spark tester to identify any pinhole defects for repair. As a result, the three epoxy materials met the minimum requirements for adhesion.

Epoxy Manufacturers' Products and Application

Four epoxy manufacturers were invited to engage in the pilot test, each with a plural component 100% solids, spray-applied epoxy. Three of the four manufacturers participated in the study per the pilot test specification. Coating #1 was a VOC free, high build system, recommended for use as a single product system. Coating #2 was a solvent free, multiple coat system. Coating #3 was a low VOC, high build system, recommended for use with a primer.

Each epoxy was applied by spray application or through a combination of spray application, roll-on method, or trowel method. 200 mils (0.2 in) of Coating #1 was applied in a single coat via spray method following surface preparation. Epoxy Manufacturer #2 applied three different combinations of coatings and underlayment. 90 mils (0.09 in) of Coating #2 was applied in two coats with epoxy over screed and resin. Epoxy Manufacturer #3 applied 100 (0.1 in) mils of Coating #3 in two coats with a roll-on primer followed by epoxy. Tables 1-3 reference each manufacturer's corresponding stopwatch data recorded during the pilot test.

Table 1

* American Society for Testing and Materials (ASTM), 100 Barr Harbor Dr., P.O. Box C700, West Conshohocken, PA 19428

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