

# INVESTIGATE-DESIGN-BUILD APPROACH LEVERAGES VALUE OF CSO STRUCTURAL FACILITY IMPROVEMENTS FOR GLWA

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**M**aintaining concrete structures in a wastewater environment is challenging. Acidic or corrosive substances in the wastewater, combined with abrasion erosion and freeze-thaw conditions, can deteriorate and crack concrete over time. Access to structures is often difficult and unknown conditions are likely. As the largest water utility in Michigan, the Great Lakes Water Authority (GLWA) provides wastewater collection and treatment services to nearly 30% of Michigan's population and drinking water distribution and treatment to almost 40% of the state. With an operation of this size, GLWA conducts regular inspections, condition assessments, and repairs of concrete structures to maximize service life while addressing cost, accessibility, and personnel safety issues.

Nine combined sewer overflow (CSO) treatment facilities, located throughout Dearborn and Detroit, are some of the most difficult concrete structures for GLWA to maintain. These CSO retention treatment basins (RTB)

and screening and disinfection facilities include large underground tanks used to capture and treat excess stormwater and wastewater during wet weather events to protect waterways in southeastern Michigan. The basins are primarily below-grade structures with storage capacities ranging from less than half a million to 22 million gallons. They must be kept in service 24/7 and contain complex features like sloped floors, elevated benches, and confined/narrow spaces. The oldest RTB dates to 1994 and the youngest to 2011.

In 2021, GLWA began a long-term maintenance program with the design-build team of PULLMAN/Wade Trim to improve structural elements at its nine CSO treatment facilities. Understanding that the repair of these structures required a higher level of investigation, solution building, and budget adherence, investigation activities were integrated into the design-build delivery method to achieve better value for GLWA. Working within a fixed budget, the project team prioritized, designed, and constructed repairs



Leveraging a collaborative workflow, experienced structural engineers, and reality capture technology experts, the project team saved GLWA preparation time and cost that otherwise would have been necessary to assess the basins' concrete conditions. Photo courtesy of Wade Trim

based on structural and life safety risks, and GLWA's operational requirements.

Structural assessments were completed to identify potential deterioration and repairs were designed for a minimum useful service life of 20 years. Potential worker safety hazards were identified, and a three-year capital planning budget and schedule were developed for prioritized repairs. The repair projects are primarily concrete rehabilitation in permit-required confined spaces within the facility boundaries. Construction of improvements began in the fall of 2021 and will continue through 2024.

### Collaborative Investigation Better Informs Design of Repairs

Benefits of the design-build delivery method are rooted in collaboration. The owner, engineer, and contractor work together from the start to address problems early, streamline communication, and improve budget accuracy. Everyone is fully accountable to the owner for results. The PULLMAN/Wade Trim team's approach magnified these benefits by collaborating during the facility inspection and condition assessment activities.

Accessing the interior of these facilities required each basin to be isolated, cleaned, and dewatered. The preparation process is labor intensive, hazardous for personnel, and costly. System operations and impacts from wet weather events must also be managed. Facility downtime comes with significant risks and costs.

An investigate - design - build approach leveraged the team's early collaboration benefits to better inform design and repair work and associated costs. In a traditional bid-build project, the engineer would perform the condition assessment work independent of the contractor. Working alongside PULLMAN, Wade Trim engineers were able to perform thorough facility inspections with help from the contractor's resources like lighting, cleaning, safety support, and extra hands to move things around. In turn, PULLMAN got a first-hand look at existing conditions and the extent of repairs needed.



**Reality capture during inspection improved safety and increased data retrieval efficiency in areas with complex geometry and confined space constraints. The information helped facilitate planning and desktop evaluation of existing conditions.** Photo courtesy of Wade Trim

### Mobile Capture Technology Shortens Investigation Timeline

The speed of investigation also got a boost with mobile capture technology. Normal condition assessment typically entails weeks of reporting using paper drawings, cameras, and teams of inspectors. Using a combination of hardware and software data capture, Wade Trim obtained survey-grade digital data for each facility in a few workdays. The drones and mobile capture equipment provided accurate 3D and photographic records of facility conditions including uneven surfaces and difficult to reach corners. The approach dramatically reduced the time needed to complete the structural inspections as well as safety risks for workers.

Mobile capture technology delivered more robust as-built data, eliminating the need for follow-up visits. Full-scale point cloud data and high-definition 360-degree panoramic photographs captured were placed into a "digital twin" environment,

allowing all project stakeholders to collaborate in an immersive, navigable virtual project environment. Concrete defects, such as cracks and spalls, were virtually assessed and quantified without having to re-enter the confined space. The data also created a modern record of GLWA's structures for future use.

The intelligent digital dataset was

tied to construction documents and carried through the as-built process to maintain record quality. All data were associated with digital field markups on the condition assessment tool. As PULLMAN worked through scope items, each repair was documented with details that created a history of work in real time. The digital representation of required rehabilitation work allowed

construction staff to easily identify the location, type, and anticipated repair detail in the field. This also fostered a common understanding of repairs for all stakeholders and created detailed record documentation of the work upon project completion.

**Constructability Input Optimizes Value**

PULLMAN's early involvement in the facility investigation enabled the team to identify and proactively address constructability issues, which resulted in optimized design solutions and minimized conflicts in the field. For example, since CSO facility use is lowest in winter, it was the best time to perform rehabilitation. However, material specifications often don't allow for placement in extreme cold temperatures. Working within GLWA's operational requirements, PULLMAN helped modify some material specifications by connecting with suppliers to identify materials better suited for the cold. Multiple repair mortar and injection products and vendors were evaluated and approved to adapt to changing weather and supply chain conditions and meet schedule requirements.

Work advanced in real time as the project scope was further defined and design solutions progressed based on contractor and GLWA input. High priority items were expedited and changes in scope were addressed quickly to minimize change orders. When selected materials were unavailable due to supply chain issues, Wade Trim coordinated directly with PULLMAN to specify a different product and minimize impacts to the schedule.

**Flexible Delivery Enables Team to Adapt and Reduce Risk**

The PULLMAN/Wade Trim team worked with GLWA to develop an approach that provided defensible results for prioritizing improvements. Using Bluebeam software, a data collection condition assessment template was created. With built-in customized fields, inspectors identified the specific characteristics of each defect including geo-location, type, quantity, and condition to generate a probability of failure score. The data



The project team's investigate-design-build mindset allowed the team to preplan a targeted allocation of resources and materials to make repairs quickly, especially in areas exposed to live sewer tunnels with active dry weather flow. Photo courtesy of PULLMAN

was available for use across multiple teams as inspections continued. The consequences of failure and probability of failure scores were used in the risk-based repair prioritization.

Since CSO facilities can't be taken out of service, access had to be planned during dry weather, and the inspection plan had to be flexible. In addition to planning for float in the schedule, the team prepared contingency plans for inspections at alternate locations. Other ongoing construction projects at some of the facilities were also considered. Consistent coordination with GLWA helped identify dates and locations available for inspection.

The use of unit prices for each defect repair requirement enabled the PULLMAN/Wade Trim team to maximize the budget and minimize risks associated with the structural defects. Wade Trim worked with PULLMAN to develop unit price line items that included attributes such as type of defects, type of repair, size/length of repair, and location of

the repair. The unit price line items corresponded with the custom fields utilized during inspection. This enabled Wade Trim to apply structural repair unit prices to the defects and maximize the risk reduction per dollar. Of the nearly 2,600 repairs identified, Wade Trim determined that all high-risk and medium-high risk defects could be addressed with the budget, as well as several medium-level risk defects. All repairs extended the remaining useful life of the structures by an estimated 20 years or more.

**Improved Cost Certainty and Savings**

Integrating investigation into the design-build process strengthened the project team's ability to understand applicable costs early to support decision-making and risk management. Typically, the top causes of cost uncertainty from an owner's perspective are unforeseen site or construction issues, and design errors or omissions. Working together during investigation, the PULLMAN/Wade Trim

team better understood the magnitude of repairs and managed scope to match the budget.

Because the facilities had been isolated for investigation, repair work began immediately without having to repeat the preparation process. This eliminated significant cost and time for cleaning and sludge hauling. Time gained was used to shift resources further up in the project timeline.

**Highest Value Delivered at Lowest Cost**

GLWA's fixed budget was based on an assumed scope of work but was intended to be flexible. At the time of contract procurement, the types of defects, related repairs, and locations were generally identified along with some bid items. The PULLMAN/Wade Trim team helped GLWA work through a more detailed condition assessment and recommended how to budget and prioritize repairs to maximize value. GLWA's priorities, such as sidewalk repairs for operator safety, also had to



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Involving the design and contractor teams early in the process facilitated a shared understanding of all repairs needed, including overhead rehabilitation, in the underground basins. Photo courtesy of PULLMAN

be understood. Treating the budget as a pool of funds with scope flexibility, instead of limiting use to specific scope items, yielded more value. Based on the program’s success, GLWA elected to use a provisional contract allowance to continue the work.

Value can also be found in the quality of repairs. The majority of concrete repair work consisted of crack injections (structural and non-structural), spall and delamination repairs, and joint sealants. As design engineer, Wade Trim had representation in the field alongside PULLMAN to observe repair methods and confirm quality, and worked closely with the contractor to adapt



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repairs to field conditions. Several unique repairs, including the carbon fiber strengthening of precast concrete girders and emergency shoring and repair of a concrete corbel in one facility that received wet flow on a nightly basis, benefited from having a nimble design-build team.

“On this project, we accomplished all the required repairs and more at each facility within approved budget and ahead of contract time especially considering the challenges posed by wet weather conditions,” noted GLWA Life Cycle Project Manager Kashmira Patel, PE, PMP. “It required close collaboration between GLWA’s Operations Team and the Design-Build team to ensure smooth progress throughout the project. The structural condition assessments were completed efficiently, and priority repairs were completed ahead of schedule, so this was considered a successful project from my perspective.”

Value was also realized through GLWA’s design-build procurement process, which evaluated proposals based on qualifications and technical approach as opposed to lowest bid with traditional design-bid-build. The selection process considered past similar experience, workplan and approach, qualifications of design-build team members, technical and cost proposals, and post-bid interviews with key GLWA decision-makers.

The investigate - design - build delivery method is beneficial for any repair project where there is a need to identify the degree and root cause of problems before developing the proper repair design. Typically, access is difficult and unknown conditions are likely. The method is scalable because it delivers benefits to all project stakeholders. The contractor and engineer collaborate from investigation to construction of repairs, leveraging their respective experiences, talent, and resources where they have the greatest impact on resulting value to the owner. ♦

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