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December 11, 2020

Mary-Frances Klimek
Racine Wastewater Utility
800 Center St. #227
Racine, WI 53403

Subject: UV Replacement Project – Phase I – Conceptual and Preliminary Design/Equipment Preselection Scope and Fee

Dear Ms. Klimek:

Thank you for the opportunity to work with you on this important UV disinfection system replacement project. Attached please find our proposed scope and fee for the Phase I – Conceptual and Preliminary Design/Equipment Preselection portion of the project. As discussed, the scope/fee for the remaining phases of the work, Phase II – Final Design and Bidding Services, and Phase III – Construction and Post-Construction Services, will be refined as we near the end of Phase I and the detailed design needs are more clear.

Our proposed fee to complete this Phase I – Conceptual and Preliminary Design/Equipment Preselection is $225,000 as summarized in the table below.

Task	Total Carollo Cost
1 – Project Coordination	$52,000
2 – Basis of Design	$55,000
3 – Preliminary Engineering and UV Equipment Preselection	$118,000
Total	**$225,000**
Optional Tasks:	
1 – OEI Energy Efficiency Grant Support	$8,600
2 – Particle Size Distribution Analysis	$9,500
3 – Additional Collimated Beam Sample	$3,200

Please call me at 608-250-0763 or e-mail me at lbusch@carollo.com with any questions on this information. Looking forward to working with you and your staff!

Sincerely,

CAROLLO ENGINEERS, INC.

Lindsey I. Busch

Lindsey Busch
Associate Vice President/Project Manager

Enclosures: Attachment A – Scope of Services for the Racine WWTP UV Disinfection Replacement Project

cc:
Keith Haas, City of Racine
Mike Gitter, City of Racine
Bruce Bartel, City of Racine
Dan Mason, City of Racine
Bill Sotirakos, Carollo

ATTACHMENT A

SCOPE OF SERVICES

for the

Racine Wastewater Utility

WWTP UV Disinfection Replacement Project

Project Understanding

The Racine Wastewater Utility (Utility) plans to replace the existing Trojan UV4000 ultraviolet (UV) disinfection system at its Wastewater Treatment Plant (WWTP) due to aging infrastructure. A new low-pressure, high-output (LPHO) UV disinfection system is being proposed in its place. The new UV system will be installed in either the existing structures or new structures adjacent to the existing UV structures since the new UV systems being considered have a larger footprint. Further design work is required to determine which option is more cost effective.

The key factors for consideration in implementing a proposed new UV system typically include:

- Operation and maintenance efficiency (O&M). - The UV equipment selection and implementation must place heavy emphasis on operator and maintenance staff impacts.
- Disinfection effectiveness - The UV system must meet or exceed the disinfection effectiveness required to meet discharge requirements and to produce a high quality effluent that protects the environment.
- Energy efficiency - The UV equipment selection and system design must stress energy efficiency to minimize operations costs and be promote sustainability.
- Hydraulics – The existing Trojan UV4000 system operates as a pseudo-pressurized reactor which allows for the reactor to operate in a submerged state. The new LPHO UV systems cannot operate in this fashion (need an open channel with constant water level), so the hydraulic profile from the final settling tanks to the UV disinfection effluent channel will be impacted.
- Constructability – The existing UV system is comprised of two parallel trains allowing for one train to be taken offline during the dry season for it to be retrofitted. Once the new UV equipment is installed in one train and fully tested and approved, the same modifications can be performed on the second train. This approach minimizes impacts to current operations and treatment.

Our team's approach, as described below, is focused on addressing each of these considerations for the Utility's UV disinfection replacement project.

Project Approach

The scope of work is divided into the following phases, tasks, and subtasks, summarized below.

PHASE I – CONCEPTUAL AND PRELIMINARY DESIGN/EQUIPMENT PRESELECTION

Task 1 - Project Coordination

Carollo will work closely with the Utility and the selected UV manufacturer after preselection. Close project coordination will be required throughout the design process to deliver a project that meets the Utility's expectations for quality, schedule, and public perception.

Task 1.1 – Project Management, Coordination, and Reporting (6 months)
Invoices will be submitted monthly in accordance with the Utility's payment protocols. Each invoice will be submitted with a progress report detailing the work executed during the invoice period and work remaining.

Task 1.2 –Kickoff Meeting and Site Walkthrough
Carollo will conduct a project kick-off meeting and site walk through at the beginning of the project.

Task 1.3 – Bi-weekly Progress Calls (12 total)
Carollo will conduct bi-weekly progress calls with Racine staff to provide project coordination and updates.

Task 1.4 – QA/QC
Quality assurance and quality control will be on-going throughout the conceptual and preliminary design process and will be discussed at the regularly scheduled meetings. In addition, internal technical reviews will be performed at each of the design milestones. The internal review will be performed by senior technical experts, remote from the project design, which will provide a senior, objective review of the project. Comments from the internal review will be shared with the team, and responses will be developed collaboratively.

Task 1.5 – Regulatory and Funding Coordination
Carollo will coordinate with the Utility staff during execution of the Clean Water Fund Program (CWFP) process administered by the Wisconsin Department of Natural Resources (WDNR) and provide documents as needed. Carollo will conduct one meeting with WDNR on the Utility's CWFP.

Carollo will provide support for a Focus on Energy grant application. Support for other grant programs are listed separately as an optional service.

Task 1.6 – Project Coordination Workshops
Carollo will attend up to four (4) workshops with Utility staff and other consultants to coordinate this project with other ongoing projects and Utility initiatives, including meetings with the City Sustainability Director.

Deliverables and Meetings

- Meetings
    - Kickoff Meeting (Virtual) and Site Walkthrough
    - Bi-weekly Progress Calls (12 total)
    - Regulatory Meeting with WDNR (1 total, virtual)
    - Project Coordination Workshops (4 total, including 2 virtual)
- Deliverables
    - Meeting/Workshop Agendas and Minutes (electronic copies)
    - Regulatory and Funding Documents

Optional Tasks

- Wisconsin OEI Energy Efficiency Grant Support

Task 2 – Basis of Design
The basis of design task is critical to project success, as it provides the foundation for the entire project. Our team members have completed similar efforts for UV designs on more than 40 projects in the past five years, all of which led to successful installations that met our client's needs. The outcome of this phase will be a Basis of Design Technical Memorandum that will be used for the Task 3 Preliminary Engineering Report.

Task 2.1 - Definition of Operating Conditions
We will develop a comprehensive understanding of the range of operating conditions. This allows us to design the optimal UV system to meet current (fecal coliform) and future (*E. coli*) permit limits with a good safety measure during normal operation, and can stretch to meet permit requirements under extreme conditions. The main operating conditions that impact UV design include the required dose, water quality (as measured by UV transmittance (UVT) and Total Suspended Solids (TSS)), and flow.

- Dose. The dose levels to meet the current fecal coliform and future *E. coli* permit limits will be determined through multiple collimated beam analyses of the undisinfected secondary effluent. Two sets of collimated beam analyses will be performed by a third-party laboratory: one at average plant conditions and one during a high flow condition. A third summer (high algae) condition will also be collected if feasible.

- Flow. The WWTP peak flow is 108 mgd based on the current Plant permit. Plant data will be analyzed to determine the current plant average and minimum flow rates as well as determining the frequency of the high flow events. We understand that the high flow events are tied to the weather but we need to understand how frequently the flow exceeds the capacity of a single train (~ 54 mgd).

- UVT. The design UVT should allow for efficient operation for the majority of the time, but also be conservative enough to meet the majority of low UVT occurrences. UVT is the most critical design parameter for a UV system. A 5 percent difference in the UVT can result is a 20 percent change in the number of lamps for a UV system. This not only affects the UV system's equipment and construction cost but also will continue to affect the annual operation and maintenance cost of the UV system. Plant data will be analyzed to confirm that the lower 10th percentile value of all of the UVT data collected.

- TSS. Solids in the effluent can shield bacteria from germicidal UV light. Bacteria exist in wastewater effluent as free-living cells or as associated with particles via aggregation or floc. Aggregates or flocs vary in size, shape, porosity, density and composition. Carollo has performed numerous particle size distribution (PSD) analyses to help understand how the solids effect UV system operation. The dose response curves developed from the collimated beam analyses above will determine if PSD analysis is required (optional task if necessary).

- Redundancy. The UV system will be designed to provide 100 percent redundancy at average flow conditions plus a diurnal peak. The UV system may also include one redundant UV bank per channel to provide operation and maintenance staff increased flexibility in operating the system.

Task 2.2 - Sizing of UV Equipment

The design effort starts by answering two fundamental but critical questions that will drive every subsequent decision:

- How Much UV? To kick-start this project, you need a team who can efficiently confirm the key variables critical in sizing UV process equipment. As previously discussed, these include basic water quality parameters such as flow, UVT, TSS and associated effluent quality variability.

- How Many Lamps? Once the UV dose levels are determined for the different target organisms, we will define the number of UV lamps required to deliver this dose. The standard approach used by others is to request vendor sizing using basic criteria and minimum specified performance (i.e., fecal coliform counts). In this "black box" approach, the number of lamps is determined by the supplier that desires to sell their equipment, not by your design team. The drawbacks of this approach become evident when UV systems are sized independently by the manufacturers, and the power usage between the systems is found to be wildly different. These systems should all use about the same amount of energy (+/– 15 percent) and variations outside of that may indicate inaccuracy.

To help our clients rapidly move through UV system analysis, Carollo has compiled an extensive treatment performance knowledge base into a proprietary modeling tool that includes the exact formulas for sizing all major systems. These formulas are derived from the third party testing and certification (validation) work done for each reactor, with more than 90 percent of this work done by members of this Carollo team. This gives us the knowledge to establish minimum lamp requirements for your reactors, eliminating significant variability (and risk) in the supplier's

approach to sizing. More importantly, this gives you the confidence that your UV reactors will be sized based on meeting permit with a reasonable safety margin, and is ready for an apples-to-apples life-cycle cost analysis.

Task 2.3 - Initial Evaluation of Equipment
Selecting the proper UV system for the Utility will be critical to the success of this project. This key choice requires an understanding of the technology and the characteristics in each of the prospective manufacturers' system. As part of this project, our team will present the pros and cons of each of these UV systems to the Utility, and will collaborate to select a "short-list" of UV equipment that will be considered for best-value selection (see Task 3.7).

Task 2.4 – UV System Site Visits (2 total)
Carollo will setup and accompany Racine staff on two (2) site visits to view installed and operating UV systems within a 100 mile radius of Racine, WI.

Task 2.5 – Conceptual Design Technical Memorandum Development
Carollo will summarize the evaluations into a Conceptual Design Technical Memorandum (TM). A draft TM will be provided to the Utility for review followed by a virtual Conceptual Design workshop 2 weeks after the draft TM deliverable. It is assumed a virtual workshop will take place. A final TM will be delivered following the Workshop that will incorporate Utility comments.

Deliverables and Meetings

- Meetings
    - UV System Site Visits (2 total)
    - Draft Conceptual Design TM Review Workshop (Virtual)
- Deliverables
    - Meeting/Workshop Agendas and Minutes (electronic copies)
    - Draft Conceptual Design Technical Memorandum (electronic deliverable)
    - Final Conceptual Design Technical Memorandum (electronic deliverable)

Optional Tasks

- Particle Size Distribution Analysis
- Additional Collimated Beam Analysis

Task 3 - Preliminary Engineering and UV Equipment Preselection
The Preliminary Engineering and Equipment Preselection task will detail the design to approximately the 30 percent level for inclusion in the Preliminary Engineering Report, which will serve as the basis of design for Phase II – Final Design and Bidding Services. This task will also develop design documents to the extent necessary to perform preselection of the UV equipment.

Task 3.1 - Hydraulic Analysis
Carollo typically uses Computational Fluid Dynamic (CFD) modeling to achieve an equal flow split with the right hydraulic approach to the reactors which is absolutely essential for UV performance; however, since the WWTP's design includes two disinfection trains, flow split is not a concern. Each UV train will be controlled independently based on the flow from the final settling tanks.

While CFD modeling is not necessary for flow split analysis for this application, it will be used to fit the new UV system within the plant's existing hydraulic profile. We have used this tool on numerous projects where the available head is limited and therefore more accuracy in the hydraulic calculations is necessary. We will work closely with the Utility to determine available options for level control and flow measurement.

The figure below details the velocity profile of a 33 mgd facility with two channels and level control weirs similar one of the options being considered for the Utility.

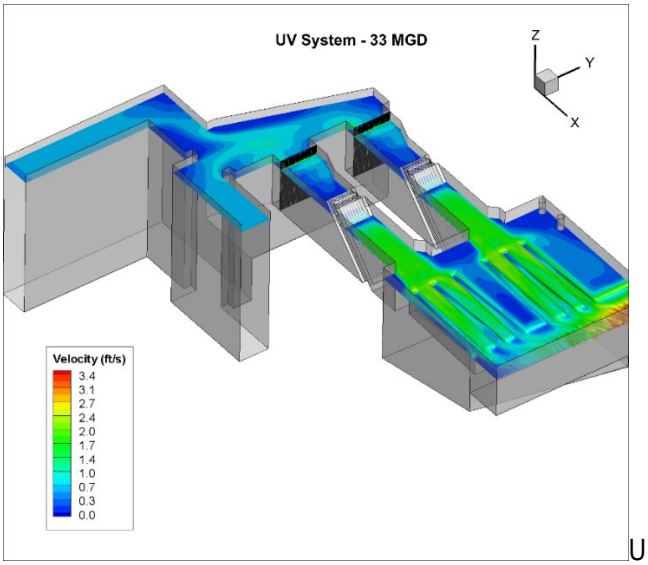

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Figure 1 - Velocity profile of a 33 mgd facility with limited available head

Task 3.2 - Operations and Maintenance Analysis
The UV system implemented at the WWTP needs to be easy to operate and maintain. Our analyses during preliminary design will meet this goal by addressing four main elements:

- UV Equipment. Lamp cleaning systems, lamp/ballast replacement, and control system flexibility with SCADA control must weigh heavily in selecting the UV equipment. We will use our industry knowledge to make sure that O&M needs are considered when selecting equipment and during final design.

- Equipment Protection. We will develop a variety of alternatives depending on whether the existing UV structures can be used with the new UV equipment. The recommended solution will ensure easy access and removal of UV equipment, provide proper ventilation and cooling of electrical equipment, and address ancillary sampling and safety concerns.

- System Controls. Carollo has developed dose monitoring and control approaches using calibrated UV sensors to minimize energy use and optimize O&M time. Our approach is to take advantage of the proven sensor technologies and use them for active and efficient control. The control formula minimizes energy use by a complex control equation that tracks flow, UVT, ballast/lamp power, and UV sensor intensity. The control system design will also ensure full SCADA monitoring and control.

- Channel Maintenance. Our design team will include process control provisions and valving to take channels off line periodically to clean all wetted surfaces. Proactive channel maintenance results in long-term UV system compliance.

A dedicated O&M workshop will be held with Racine staff to discuss the O&M aspects of the UV system and incorporate operations input into system design decisions.

Task 3.3 – Discipline Evaluations
Preliminary design evaluations will be performed for structural, electrical, I&C disciplines. This includes one site visit for the structural and EI&C disciplines to review the existing conditions at the site and recommend necessary modifications to incorporate a new UV system.

Task 3.4 - Preliminary Design Drawings and Specifications
We will prepare preliminary drawings and equipment specifications as a basis for further design development and the procurement of UV equipment. The specifications will incorporate the technical requirements and parameters established in the previous project tasks. The drawings and specifications will be submitted and reviewed with the Utility prior to finalizing as a procurement package.

Design CAMP®
Our team will conduct a one-day virtual Design CAMP®. During CAMP®, we will establish consensus on the preferred UV equipment selection, layout, and procurement method. The outcome of CAMP® will be full engagement of Utility staff with the design elements, and a basic 30% submittal developed. This basic 30% submittal will consist of Process and Instrumentation Controls Diagram (P&ID), process flow diagram (PFD) drawings, site layout, and a 3D model in SketchUp.

Task 3.5 – Envision™ Pre-assessment
Carollo will perform a sustainability evaluation using the ISI Envision™ checklist rating system. This checklist and corresponding discussion will be integrated in to the Preliminary Engineering Report.

Task 3.6 – Preliminary Engineering Report Development
Carollo will summarize the evaluations into a Preliminary Engineering Report (PER). This will include an opinion of probable construction cost estimate at the preliminary design level. A draft PER will be provided to the Utility for review followed by a virtual Draft Preliminary Engineering Report Review workshop two weeks after the draft PER deliverable. A final PER will be delivered following the Workshop that will incorporate Utility comments.

Task 3.7 - UV Equipment Preselection
The procurement package prepared as part of Task 3.4 will be submitted, in accordance with the Utility's procurement policies, to the "short-list" of preferred UV equipment manufacturers. Proposals, including costs, will be received from the UV equipment manufacturers and reviewed for completeness. Carollo will prepare a best-value analysis of the proposals and meet (virtually) with the Utility to select the UV equipment to move forward into design development.

Deliverables and Meetings
- Meetings
  - O&M Workshop (Virtual)
  - Discipline Site Visits (1 total)
  - Design CAMP® (Virtual)
  - Draft Preliminary Engineering Report Review Workshop (Virtual)
  - UV Equipment Preselection Analysis (Virtual)
- Deliverables
  - Meeting/Workshop Agendas and Minutes (electronic copies)
  - Draft Preliminary Engineering Report (electronic deliverable)
  - Final Preliminary Engineering Report (electronic deliverable)
  - UV Equipment Preselection Package (electronic deliverable)
  - UV Equipment Preselection Best-Value Analysis (electronic deliverable)

PHASE II – FINAL DESIGN AND BIDDING SERVICES

Development of specific tasks and subtasks describing the scope of services for the Phase II work will be incorporated through subsequent amendment(s) to the Agreement. **The actual scope and corresponding budget for the Phase II work will be predicated upon the specific design details of the Phase I services described herein.** General scope items are discussed below. It is assumed that the Utility will pay fees to procure the UV equipment shop drawings for the selected manufacturer.

Task 4 - Design Development

Task 4.1 – Design Drawings and Technical Specifications

Plans and specifications will be developed to sufficient detail (approximately 90 percent ultimate level of completion) for the Utility to cost and construct the project. The design will progress as a collaborative effort between the Utility, Carollo, and the selected Contractor to develop a project that is constructible, minimizes impact to operations, maintains access, and carries a reasonable cost. Plans and specifications will be prepared and submitted to the team at the 60 percent and 90 percent design development levels.

Task 4.2 – Civil Design

Carollo will work with a local surveying and geotechnical engineering firm to perform these final design tasks.

PHASE III - CONSTRUCTION AND POST-CONSTRUCTION SERVICES

Development of specific tasks and subtasks describing the scope of services for the Phase III work will be incorporated through subsequent amendment(s) to the Agreement. **The actual scope and corresponding budget for the Phase III work will be predicated upon the specific design details of the Phase I and II services.** General scope items are discussed below.

Task 5 - Construction Management

Carollo provides engineering services during construction (ESDC) for nearly every design that we produce. In this arrangement, the design team will typically move right into the bid and construction phases, posed to support our clients' in-house (or hired third party) construction management team.

The benefit of using the design team during construction is two-fold:

- The arrangement enhances project continuity, ongoing client collaboration, and increases the overall efficiency of our efforts during construction.
- With design and construction experience, our engineers know how facilities are constructed and can avoid issues typically observed in "office engineer" designs.

Typical services provided with an ESDC arrangement include:

- Participation in progress report meetings.
- Review of contractor and supplier equipment and material submittals.
- Response to contractor and client requests for information.
- Preparation of design clarifications.
- Assistance with change order requests.
- Start-up and testing and training assistance.
- System validation and test witnessing.
- Specialty inspection (where desired).

These basic services can be expanded (or reduced) to include the level of participation specifically desired for each project.