Third-Party Technology Verification of the Hydropath Technology at the Tulsa Southside Wastewater Treatment Plant, Tulsa, Oklahoma.

PREPARED FOR: Tal Journo/*Hydro*FLOW USA LLC (*Hydro*FLOW USA)

PREPARED BY: Samuel Jeyanayagam, PhD, PE, WEF Fellow/CH2M HILL, Inc. (CH2M)

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Scope and Purpose

The primary objective of this independent, third-party technology verification is to validate the effectiveness of the *Hydro*FLOW I Range product with respect to controlling struvite scaling at selected test sites. The verification is based on a review of visual observations and discussion with plant staff. It focuses on identifying changes to struvite scaling before and after installing *Hydro*FLOW units. During the testing period, no effort was made to investigate the mechanism that allows *Hydro*FLOW units to prevent scale accumulation. *Hydro*FLOW USA intends to examine the mechanism in the near future.

This technical memorandum specifically discusses the verification testing completed at the Tulsa Southside Wastewater Treatment Plant (WWTP) in Tulsa, Oklahoma, and the observed outcome.

Technology Description

The *Hydro*FLOW I Range is powered by the patented Hydropath technology. When properly installed on a pipe (see Figure 1), it induces a 150 kilohertz, oscillating sine wave, alternating current (AC) signal. The electric induction is performed by a special transducer connected to a ring of ferrites. The pipe and the flowing fluid act as a conduit, which allows the signal to propagate. The induced AC signal is believed to cause the mineral ions that make up struvite (magnesium, ammonium, and phosphate) to form loosely held together clusters. When certain conditions are created (e.g., pressure change, temperature change, and turbulence) the clusters precipitate out of solution and form stable crystals of struvite that remain in suspension. The crystals are not able to adhere to surfaces as hard scale and are carried away with the flow. Because hard scale no longer accumulates, the shear forces created by the flowing liquid erode and soften existing scale deposits over time. It is important to note that constant liquid flow is required to remove hard scale deposits from a system.

Figure 1. Typical *Hydro*FLOW Unit Installation

Southside Wastewater Treatment Description

The Southside WWTP (see Figure 2), is one of four wastewater treatment plants that serve the City of Tulsa's service population. It is managed, operated, and maintained by the City's Water and Sewer Department. The WWTP, designed for 42 mgd, currently treats an average flow of 20 mgd.

Figure 2. The Southside Wastewater Treatment Plant

The liquid treatment train includes offsite flow equalization, influent pumping, headworks, primary settling, intermediate pumping, activated sludge process with bioselectors, final clarification, chlorination and dechlorination. The solids treatment process includes gravity thickening, and anaerobic digestion. The digested sludge is conveyed approximately two miles for dewatering using belt filter presses (BFP) before application to drying beds.

The WWTP has been battling struvite scale buildup on each of five belt filter presses. Scale removal is required frequently and is labor intensive. It entails the use of high pressure (3,500 psi) water to loosen and remove small pieces of scale at a time.

Test Details

The Tulsa WWTP and *Hydro*FLOW USA signed a memorandum of understanding to participate in a 90-day product evaluation testing to determine the effectiveness of the Hydropath technology in mitigating scale formation. A site-specific test protocol was also developed outlining details of the tests and providing a consistent framework and guidance for testing so that the results could be used for the third-party technology verification by CH2M. Seminal information from the protocol is presented in the following sections.

Test Period

The 90-day test period began on 17 February 2017 and ended on 31 May 2017. During this period, the *Hydro*FLOW unit was continuously in operation.

*Hydro*FLOW Unit Installation

The *Hydro*FLOW unit was installed on the six-inch diameter pump discharge pipe (ductile iron) feeding one of the Andritz BFPs, approximately 50 feet upstream of the BFP (Figure 3). The average flow rate and pressure in the pipe are 120 gpm and 12 psi, respectively.

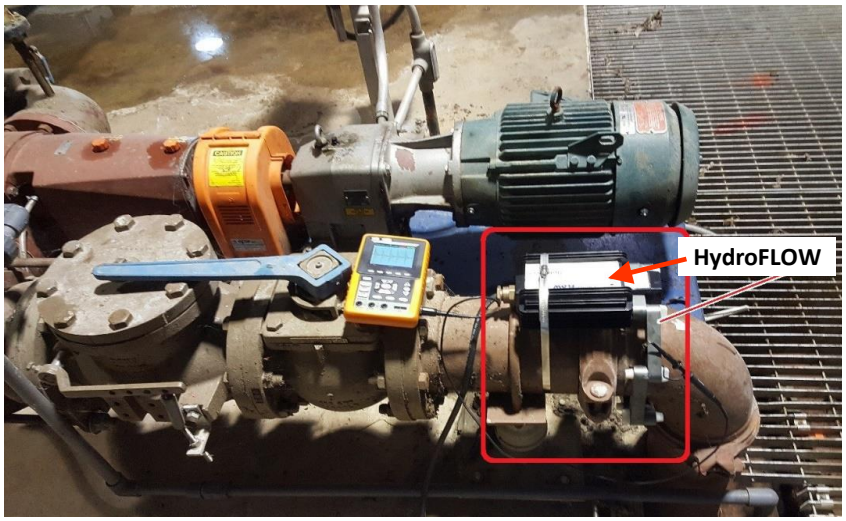

Figure 3. *Hydro*FLOW Unit Installed on the 6-inch BFP Sludge Feed Pipe

Location of Visual Observations

The WWTP staff identified one of the BFPs for testing *Hydro*FLOW, and made visual observations and took pictures of the scaled area to assess the effectiveness of *Hydro*FLOW in abating struvite scaling.

Baseline Condition

Before energizing the *Hydro*FLOW unit, baseline information was gathered at the BFP. The "before" observations represent the baseline condition and provide a basis for making a qualitative determination of the effectiveness of the *Hydro*FLOW unit. Specifically, the extent of scale accumulation was observed and photographed. As shown in Figure 4, heavy struvite encrustation was evident on the drum surface. Other parts of the BFP also showed scaling.

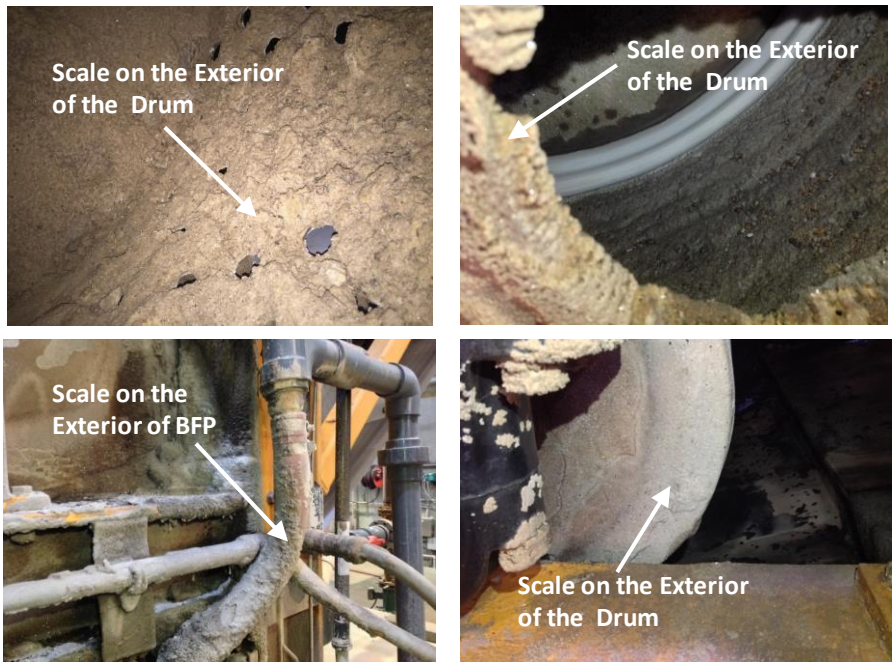

Figure 4: Baseline Condition Before Energizing *Hydro*FLOW

Before initiating the test, a portion of the drum surface was cleaned of the thick scale completely, exposing bare metal (Figure 5). The purpose of cleaning a portion of the drum is to observe the extent of new scale formation during the test period with *Hydro*FLOW activated.

Figure 5: A Portion of the Drum Cleaned of Heavy Scale to Expose Bare Metal Surface

Test Results

The outcome of the 90-day test with *Hydro*FLOW continuously energized is best presented by reviewing Figure 6, which shows the condition of the previously cleaned section of the drum. The WWTP operators reported the following findings:

- The cleaned surface did not show any new scale formation.
- Some areas of the drum that had heavy encrustation of struvite at the beginning of the test, had noticeably thinned.
- Some areas could be scraped to bare metal with a paint scraper, which was not possible before.
- The use of a power washer easily removed the scale in three to four-inch diameter pieces. This operation was much less labor-intensive than during routine maintenance without *Hydro*FLOW.

Figure 6: Condition of BFP Drum Surface at the End of 90-day Test Period

Conclusion

The dewatering BFPs at the Southside WWTP experience struvite scaling, which calls for labor-intensive periodic cleaning. One *Hydro*FLOW I Range was installed on the sludge feed line to one of the BFPs to evaluate its effectiveness in controlling scaling. The assessment was made based on visual observations and photographs of scaled BFP drum surfaces.

Based on the review of the collected information and discussions with WWTP staff, the use of the *Hydro*FLOW I Range unit on BFP sludge feed pipe was found to be effective in softening the existing scale and preventing the formation of new scale. Softening of the existing scale allowed it to be removed relatively easily. It is conceivable that the continued use of *Hydro*FLOW beyond 90 days may allow further softening of the scale thereby enabling the shearing action of the flowing liquid to erode and remove the soft scale.

This Third-Party Technology Verification Report validates that the use of a *Hydro*FLOW I Range unit at the Southside WWTP prevented scale formation in a BFP used for dewatering anaerobically digested sludge. The *Hydro*FLOW unit also caused changes in the physical characteristics of the existing scale, making it easier to be removed.

It should be noted that based on the positive results of the 3-month trial, the Southside WWTP has designated funding to purchase a large custom *Hydro*FLOW unit that will treat the common header feeding all 5 BFPs. Installation is planned for the second quarter of 2018, following the completion of ongoing construction.

Disclaimer

This Third-Party Technology Verification Report is not a global validation of *Hydro*FLOW units and/or Hydropath technology and provides no assurance that it will be successful in mitigating scaling at other water resource recovery facilities. CH2M recommends that other facilities interested in using *Hydro*FLOW units to mitigate scale formation, conduct onsite testing to validate its effectiveness under plant-specific conditions. Such tests are valuable in demonstrating technical and financial feasibility of implementing *Hydro*FLOW. CH2M understands that *Hydro*FLOW USA has a limited number of rental units that it uses for trials. The availability of the rental equipment should be discussed directly with *Hydro*FLOW USA.

Acknowledgment

This technology verification was made possible through the assistance of the Tulsa Southside WWTP staff, who were involved in data collection and overall coordination. HydroTech Solutions, Inc. (the regional *Hydro*FLOW USA representative) provided and installed the test units. This study was funded by *Hydro*FLOW USA and Hydropath Technology, Ltd.