

## **Blue Plains Engineering Studies for Fiscal Year 2014**

### **Solar Feasibility Study:**

Purpose: To evaluate the feasibility of install a solar photovoltaic (PV) energy project at Blue Plains to develop an understanding of site related issues in addition to creating preliminary solar array layouts. The feasibility study evaluated solar energy production estimates, analyzed site electricity consumption, reviewed the current regulatory environment in DC and conducted conversations with developers to understand the economics behind this project. The results of these efforts are contained within this technical study.

Status: Study is complete.

### **Hydrogen Sulfide Corrosion:**

Purpose: To address continuing maintenance issues with electronic equipment caused by hydrogen sulfide gas corrosion at the Blue Plains Advanced Wastewater Treatment Plant (AWTP). This report contains a literature review, which indicates the root cause of electronic equipment failures of concern are likely the result of the worldwide adoption of International Organization for Standardization (ISO) Restriction of Hazardous Substances (RoHS) regulations intended to reduce heavy metal exposure and contamination of waste streams. These regulations initiated the elimination of lead and other heavy metals in the manufacture of electronic circuit boards, with the unfortunate result that much electronic equipment is now susceptible to corrosion from airborne contaminants at much lower contaminate concentrations than had previously been acceptable.

To address the corrosion issues that can be expected at Blue Plains AWTP, this study provides an evaluation of current H<sub>2</sub>S related electronic corrosion issues facing DC Water; presents mitigation strategies for the existing equipment; suggests specification guidelines for future electronic equipment installations within the District; and suggests projects for the purpose of developing a Capital Improvement Program (CIP), with costs suggested on an order of magnitude basis for the purpose of initial screening and not for funding..

Status: Study was completed and a white paper submitted in August 2014.

**Flood Inundation Mapping:**

Purpose: To document the modeling efforts used to establish a relationship between the water surface elevations measured at the U.S. Geological Survey (USGS) stream gage at Wisconsin Avenue (USGS 01647600) and downstream water surface elevations along the Potomac River at the Blue Plains Advanced Wastewater Treatment Plant (AWTP) (Blue Plains). The report conclusion includes the following:

- Background on the existing level of flood protection and need for correlation to the Wisconsin Avenue gage.
- Procedure for terrain development, hydraulic modeling, mapping, and assumptions.
- Blue Plain's inundation maps and Flood Emergency Actions based on Wisconsin Avenue gage predictions.
- Discussion of storm surge and riverine Flood Emergency Actions.

Status: Study was completed and Report submitted in March 2014.

**Sewage Ejector Condition Assessment**

Purpose: To conduct an inventory and condition assessment of all bathrooms, locker rooms, showers, laundry rooms, drinking fountain stations, and kitchenettes (Support Facilities) and verify sewage ejector location and equipment inventory at Blue Plains. The work was done by conducting surveys of buildings identified by DC Water for support facilities condition assessments and recommending improvements to the existing physical conditions and code compliance of the Support Facilities at Blue Plains.

Status: Study was completed and Report submitted in December 2013.

**Grit Chamber Study:**

Purpose: Deteriorated concrete beneath the cover of Grit Chamber 9 at the Blue Plains Advanced Wastewater Treatment Plant (AWTP) resulted in a comprehensive study with an assessment of the concrete grit chamber tank and channel structures in both Grit Chamber Buildings (GCB-1 and GCB-2).

Status: Study was completed and Report submitted in August 2014.

**HVAC Equipment Survey:**

Purpose: To conduct a survey of all ventilation equipment at the Blue Plains Advanced Wastewater Treatment Plant (AWTP). This is done by reviewing contract and as-built drawings for ventilation equipment and field-verifying that they exist. For project management purposes, the Blue Plains AWTP has been divided into eight treatment areas and three miscellaneous areas. The National Fire Protection Association (NFPA)-classified "Influence Areas" in the buildings or galleries of these areas are identified from the reviewed contract and record drawings and the air exchange rate is approximated from the equipment rating and "Influence Area" volume. Volumes are either based on dimensions from contract drawings or field measurements

Status: Study is ongoing and a draft report was submitted in January 2015.

**Lime Slurry System:**

**Purpose:** To evaluate options for a temporary and long term approach to alkalinity addition at Blue Plains and to implement the approved method.

The approved method of alkalinity adjustment was a lime slurry (30% calcium hydroxide)) application system to supplement the alkalinity requirements of the wastewater treatment process. With the a new Filtrate Treatment Facility due to start operations at Blue Plains in 2017, the total alkalinity demand of the plant is expected to increase. Before this project, the method of alkalinity addition and pH adjustment used was the introduction of caustic soda (50% sodium hydroxide). Based upon an analysis of the costs of caustic soda, and project cost, the project is projected to result in significant annual chemical cost savings.

Status: Study was completed in December 2014.

**Plantwide Emergency Alert System:**

**Purpose:** To summarize the District of Columbia's Water and Sewer Authority (DC Water's) existing Plant-wide Emergency Alert System (PEAS), evaluate code requirements, identify systems used at similar facilities, in addition to providing DC Water with recommendations that will assist them in the decision making process with regards to either updating or implementing a new PEAS.

Status: Study was completed and a report submitted in January 2014.

**Quick Lime System Audit:**

**Purpose:** To outline the performance review of the pneumatic system located at the DC Water plant in Washington. Specific focus was given to the pneumatic convey system and associated equipment.

Status: Study was completed and a report submitted in October 2013.

## **Blue Plains Research Studies for Fiscal Year 2014**

### **Quantitative Risk Model for Flooding of Plant Infrastructure:**

Purpose: To develop quantitative analytical tools for DC Water to assess the vulnerability of flooding at Blue Plains over a range of river stages and to develop data to assess breach points, sequence of inundation, and islanding of facilities in support of emergency response plans, and provide risk based evaluations for a range of flood wall configurations for the plant.

Status: Study is complete and Report due March 2015.

### **Greenhouse Gas Study in Headworks & Sewer:**

Purpose: To evaluate mitigation trials in both the US and Australia, through comprehensive field monitoring of GHG emissions from sewers.

Status: Study is ongoing and scheduled completion in 2016.

### **Aeration and Diffuser Fouling Study:**

Purpose: To study oxygen transfer rates of different diffusers, including membrane panel diffusers that might be used for future upgrades, and to investigate both the causes and possible mitigation methods, of microbial fouling.

Status: Study is ongoing and scheduled completion in 2016.

### **Full Plant Deammonification:**

Purpose: To study the application of full-plant deammonification for nitrogen removal. The successful implementation of this process could lead to a significant reduction in energy consumption and supplemental carbon addition. Two major technological concepts are applied – selective sludge wasting to retain Anammox granules and intermittent aeration to repress nitrite oxidizers..

Status: Study is ongoing and scheduled completion in 2016.

### **Deammonification Modeling:**

Purpose: To develop the modeling capability DC Water's mainstream deammonification process evaluation and optimization. Model prediction will be compared with laboratory results as a means to verify parameters.

Status: Study is ongoing and scheduled completion at the end of 2015.

### **Thermal Hydrolysis Pilot:**

Purpose: To determine the impact of THP temperature on viscosity, anaerobic digestion performance, and the production and treatment of recalcitrant dissolved organic nitrogen. A pilot-scale Cambi THP pilot was operated under different conditions to feed a number anaerobic digesters.

Status: Study completed at the end of 2014

**Anaerobic Treatment:**

Purpose: To investigate the impact of the thermal hydrolysis temperature on digestion including gas production, solids destruction, COD reduction and dewatering characteristics. The study will continue in order to investigate the impact of co-digestion of food waste and other high strength wastes.

Status: Study is ongoing and scheduled completion at the end of 2015.

**WERF Study Floc-Densification:**

Purpose: To test the soluble and particulate substrate removal efficiency in different full-scale and pilot plants to understand how substrate surface loading and diffusion resistance affects both granule and floc formation and performance. The possible synergy of maintaining a mixed floc and granule system to allow for high removal rates and good effluent quality will be explored.

Status: Study is in the beginning stages.

**High Rate Activated Sludge (HRAS) Process:**

Purpose: To investigate operational parameters for improve carbon capture and redirection of carbon to digestion and to investigate new methods by which to quantify the forms of carbon (particulate, colloidal and soluble) that is captured.

Status: Study will continue till the end of 2015.

## **UMCP –ARS DC Water cooperation projects (Mark Ramirez, DC Water Co-PI)**

### **Sponsored Projects for FY 2014**

A Feasibility Study to Assess the Energy Benefits of Sediment Microbial Fuel Cells in Wastewater Treatment (funded by DC Water and in cooperation with the Navy Research Laboratory) \$ 36,720.

Fate of POPs under different processing conditions: Bioreactor. DC Water \$ 47,878.

Fate and Bioavailability of POPs in Biosolids. DC Water \$85,450.

Utilizing on-line sensors and laboratory-scale simulations to examine critical factors influencing the formation of odorous VOC in biosolids (funded by DC Water and in cooperation and funding with in-kind instrumentation from ARS work will be extended to assess odors from large animal operations). DC Water \$ 26,986

Characterization to Demonstrate Regulatory Compliance of Class A Biosolids Product to be Generated and Distributed by Blue Plains. DC Water \$68,899.

### **Presentations FY 2014**

Improving continuous monitoring of VOC emissions from alternative fertilizers. ACS 248<sup>th</sup> National Meeting and Exposition. San Francisco, CA.

Utilizing sensor array for continuous monitoring of VOC's emissions from alternative fertilizers. Poster presentation. 2014 EPA Air Sensors Work Shop. Research Triangle, NC.

Improving continuous monitoring of VOC emissions from alternative fertilizers. Platform presentation. Annual Meeting of the Chesapeake-Potomac Regional Chapter of the SETAC.

Utilizing electronic nose and GC-MS to examine critical factors influencing the formation of odorous VOC in biosolids to support an odor monitoring program. Poster presentation. University of Maryland / Beltsville ARS 3<sup>rd</sup> annual Trends in Agriculture Symposium. Climate Change: Food and Environmental Security. Beltsville, MD.

"The Configuration of Sediment Microbial Fuel Cells for Wastewater Treatment and Electricity Generation" AEESP annual conference

"Cathode optimization for Wastewater microbial fuel cells" UMD-CP Graduate Research Interaction Day (GRID). Won second Prize.

Temporal Trends and Influence of Storage Methods on Concentrations of Perfluoroalkyl Substances in Limed Municipal Wastewater Solids. SETAC Vancouver, CA.

Invited Seminars:

“Biosolids com a recurs: Limitacions i risks potencials” (*“Biosolids as a Resource: Limitations and potential risks”*) Invited seminar at: Catalan Institute for Water Research [www.icra.cat](http://www.icra.cat). January 2014.

“Cooperacio en temes d'investigacio: Industria-govern-universitat; exemples en temes de Ingeniería del Medi Ambient a la Universitat de Maryland” Invited Seminar at Universitat de Vic, Escola Politecnica Superior. June, 2014.

## **Publications and Conference Papers:**

De Clippeleir H., Battiste-Alleyne H., Mofei H., Al-Omari A., Jones K., Wett B., Giraldo E., Murthy S. A New Approach to Physically Separate Solid Retention Time based on Function: Mainstream Deammonification Case Study. IWA Specialist Conference - Global Challenges: Sustainable Wastewater Treatment and Resource Recovery, Kathmandu, Nepal, 26-30 October 2014. Oral presentation.

Stinson, B., De Clippeleir H., Murthy S., Bailey W., Al-Omari A. Intensification and Resource Recovery: A Convergence of Two Paradigms. IWA Specialist Conference - Global Challenges: Sustainable Wastewater Treatment and Resource Recovery, Kathmandu, Nepal, 26-30 October 2014. Oral presentation.

Han, M., De Clippeleir H., Regmi P., Al-Omari A., Wett B., Vlaeminck S.E., Bott C., Murthy S. Carbon-nitrogen-energy Nexus Governs Technology Decision for Resource-efficient Sewage Treatment. IWA Specialist Conference - Global Challenges: Sustainable Wastewater Treatment and Resource Recovery, Kathmandu, Nepal, 26-30 October 2014.

De Clippeleir H., Han M., Al-Omari A., Bott C., Wett B. and Murthy S. From nitrite shunt to mainstream deammonification strategy: pilot-scale demonstration. WEFTEC 2014, New Orleans, 28-30 September 2014. Oral presentation.

Han M., De Clippeleir H., Al-Omari A., Wett B., Vlaeminck S.E. and Murthy S. Balancing denitrification and anammox activities during mainstream deammonification: influence of COD input and aeration regime. WEFTEC 2014, New Orleans, 28-30 September 2014.

De Clippeleir H., Takacs I., Wett B., Chandran K. and Murthy S. Estimation of dynamic apparent nitrification kinetics as the key for reliable greenhouse gas emission prediction. 4th IWA/WEF Wastewater treatment modelling seminar (wwtmod 2014), Spa, Belgium, March 30rd - April 2nd 2014. Oral presentation.

Regmi, P., Miller, M.W., Holgate, B., Bunce, R., Park, H., Chandran, K., Wett, B., Murthy, S., and Bott, C.B. (2014) Control of aeration, aerobic SRT and COD input for mainstream nitrification/denitrification. *Water Research* 57, p162-171.

Al-Omari, A; Wett, B; Nopens, I; De Clippeleir, H; Han, H; Regmi, P; Bott, C, Murthy, S. 2014. Model-based evaluation of mechanisms and benefits of mainstream shortcut nitrogen removal processes. WWTmod Conference 2014, Spa, Belgium. Accepted for publication in *Water Science and Technology*.

Shaw A., Takacs I., Pagilla K., Riffat R., De Clippeleir H., Wilson C. and Murthy S. The Case of the Ks: Diffusion versus Strategy. 4th IWA/WEF Wastewater treatment modelling seminar (wwtmod 2014), Spa, Belgium, March 30rd - April 2nd 2014.



Matthew J. Higgins, Steven Beightol, Ushma Mandahar, Hung-Wei Lu, Trung Le, Joshua Mah, Steven Xiao, Bipin Pathak, John Novak, Ahmed Al-Omari, Sudhir N. Murthy. Effect of Thermal Hydrolysis Temperature on Anaerobic Digestion, Dewatering, and Filtrate Characteristics. (2014) Residual and Biosolids conference: Sustainability Made Simple: Facilitating Resource Recovery, Austin Convention Center Austin, Texas.

Weizhong Xiao, Hung-Wei Lu, Joshua Mah, Bipin Pathak, Ahmed Al-Omari, Sudhir Murthy, Matthew Higgins. Influence of Time and Temperature on Thermal Hydrolysis Performance. (2014) Residual and Biosolids conference: Sustainability Made Simple: Facilitating Resource Recovery, Austin Convention Center Austin, Texas.

Ryu Suzuki, Tanush Wadhawan, Sudhir Murthy, Bernhard Wett, Imre Takács, Matthew Higgins. Modeling Thermally Pretreated Mesophilic Anaerobic Digestion. (2014) Residual and Biosolids conference: Sustainability Made Simple: Facilitating Resource Recovery, Austin Convention Center Austin, Texas.

Matthew J. Higgins, Steven Beightol, Sudhir N. Murthy, Paal Jahre Nielsen. Insights into Rapid Volume Expansion in Anaerobic Digesters Associated with Gas Hold-Up. (2014) Residual and Biosolids conference: Sustainability Made Simple: Facilitating Resource Recovery, Austin Convention Center Austin, Texas.

Rahman A., Wadhawan T., Khan E., Riffat R., Takács I., De Clippeleir H., Wett B., Jimenez J.A., Al-Omari A., Pathak B., Murthy S. Characterizing and Quantifying Flocculated and Adsorbed Chemical Oxygen Demand Fractions in High-Rate Processes. IWA Specialist Conference - Global Challenges: Sustainable Wastewater Treatment and Resource Recovery, Kathmandu, Nepal, 26-30 October 2014.

Mancell-Egala A., De Clippeleir H., Kinnear D., Novak J., Takacs I., Murthy S. Metrics for Settling of Flocculent and Granular Solids. WEFTEC 2014, New Orleans, 28-30 September 2014.

Miller, M.W., Regmi, P., Wett, B., Murthy, S., and Bott, C.B. (2014) On-line sensors for the control and optimization of an adsorption-style HRAS pilot study. Proceedings of the IWA World Water Congress & Exhibition, Lisbon, Portugal, September 21-26, 2014.

Miller, M.W., Regmi, P., Jimenez, J., Murthy, S., Wett, B., and Bott, C.B. (2014) Optimizing adsorption-style high rate activated sludge for BNR and energy recovery. Proceedings of the IWA Specialist Conference Global Challenges: Sustainable Wastewater Treatment and Resource Recovery, October 26-30, 2014.

Lozano N, Andrade N.A, Deng D, Torrents A, Rice CP, McConnell LL, Ramirez M, Millner PD. "Fate of microconstituents in biosolids composted in an aerated silage bag" *Journal of Environmental Science and Health, Part A*. 2014;49(6):720-30. doi: 10.1080/10934529.2014.865461.

Andrade N.A, Lozano N, McConnell LL, Torrents A, Rice CP, Ramirez M, “Long-term trends of PBDEs, triclosan, and triclocarban in biosolids from a wastewater treatment plant in the Mid-Atlantic region of the US” *Journal of Hazardous Materials, Volume 282, 2015, 68-74.*

***Submitted:***

Armstrong, D.; Lozano, N.; Rice, C.; Ramirez, M; Torrents, A. “Temporal Trends of Perfluoroalkyl Substances in Limed Biosolids from a Large Municipal Wastewater Treatment Plant” Submitted to *Journal of Environmental Management*; November 2014.

***In Preparation:***

Andrade, N. A., McConnell, L., Torrents, A., Ramirez, M. “Polybrominated diphenyl ethers: soil residence time in fields after biosolids application.”

LOZANO, N., RICE, C.P., RAMIREZ, A., TORRENTS, A. (2014). Fate of Triclocarban in agricultural soils of commercial farms, after biosolids applications. To be submitted.

LOZANO, N., RICE, C.P., TORRENTS, A. (2014). Fate of Triclocarban in a single application soil after biosolids application. To be submitted.

Maia Tatinclaux, Kyla Gregoire, Justin Biffinger, Mark Ramirez, Alba Torrents Leonard Tender, “Electricity generation using sediment microbial fuel cells with a manganese dioxide cathode catalyst”