THE NEW NORMAL – OPERATING AND MAINTAINING THE MALLARD CREEK WATER RECLAMATION FACILITY AFTER A PCB CONTAMINATION

Maggie Macomber[1,] Darrell DeWitt[2,] Jonathan Lapsley, PE[3,] Roger Smith, PG[4]

[1, 2]Charlotte Water, Charlotte, North Carolina
[3]CDM Smith, Charlotte, North Carolina
[4]S&ME, Inc., Charlotte, North Carolina
[1]Email: mmacomber@charlottenc.gov
[2]Email: ddewitt@charlottenc.gov
[3]Email: lapsleyjs@cdmsmith.com
[4]Email: rsmith@smeinc.com

ABSTRACT

Charlotte Water (CLTWater) has been managing a significant contamination event at the Mallard Creek Water Reclamation Facility (MCWRF) since February 6, 2014. An oily substance with very high levels of Polychlorinated Biphenyl (PCB) was illicitly discharged to the facility's collection system through a grease trap. Due to the high concentration of PCBs, CLTWater must respond to the event following the requirements outlined in the Toxic Substances Control Act (TSCA). CLTWater has spent the last three years dealing with the different phases of response including the initial emergency, the recovery or immediate aftermath during which contaminated materials were disposed of and a plan for decontamination was developed, and most recently the on-going facility decontamination project.

This manuscript discusses the impacts of the contamination on operating, maintaining, and engineering the collection system and MCWRF and the strategies that CLTWater is implementing to minimize or eliminate the impacts. CLTWater's PCB contamination demonstrates the potential for any utility to experience an illicit discharge and how significant the impacts can be. The information presented in the manuscript will help other utilities to be better prepared and, therefore, become more resilient.

KEYWORDS

Health And Safety Issues, Operations And Maintenance, Toxic Substances, Resiliency, PCB

INTRODUCTION AND BACKGROUND

In 2013, several collection systems and resource recovery facilities in South Carolina located along the Interstate 85 corridor were contaminated by illicit discharges containing PCBs. On February 6, 2014, a plant operator at the MCWRF noticed an unusual and very strong chemical smell. Upon further investigation, the plant staff detected an oily substance in several unit processes including the headworks, the diurnal flow control structure called the day tank, and the primary clarifiers. The sheen on the day tank is shown in Figure 1. Samples of the substance

were taken and quickly analyzed revealing that CLTWater had become the latest victim of an illicit PCB discharge.

Figure 1: PCB Contamination in Day Tank

The concentration of PCB entering the facility made it such that CLTWater had to follow TSCA requirements for handling and decontaminating equipment and disposing of materials from the collection system and facility. CLTWater has worked closely with several regulating bodies including the U.S. Environmental Protection Agency (U.S. EPA) since the first day of the contamination.

The PCB contamination event has had several different phases that CLTWater has had to manage. During the first weeks of the PCB contamination event, CLTWater successfully mitigated the immediate health risks to the public, response crews, and CLTWater staff and weathered significant disruption to the normal operation of the facility and the overall utility. The next several months were spent recovering by doing the following:

- Learning how to apply TSCA requirements to a resource recovery facility,
- Altering standard operating procedures to reduce exposure and contaminant spreading,
- Decontaminating rental equipment used during the emergency response,
- Amending the existing residuals management contract for CLTWater's biosolids land application program allowing the service provider who administers the program to load, haul and dispose of highly contaminated solids,
- Developing an approach for facility decontamination.

The next phase involved selecting a service provider to execute the decontamination scope. This work is expected to be complete by September, 2017. After the project, CLTWater will enter into a long term contamination management phase to handle the facilities that remain contaminated.

This manuscript will present the following topics:

- Background information about the MCWRF, PCBs, and the contamination event,
- Summary of impacts on normal business at the facility and other CLTWater divisions,
- Efforts to minimize or eliminate the impacts of contamination for safer and more efficient operation, maintenance, and rehabilitation of the facility.

DESCRIPTION OF THE MALLARD CREEK WATER RECLAMATION FACILITY

The MCWRF is located in the northern part of Charlotte, NC, and is one of CLTWater's seven wastewater treatment facilities including five large plants and two package plants. The facility was originally constructed in 1979 and discharges treated effluent to Mallard Creek which flows to Rocky River and is part of the Yadkin-Pee Dee River Basin.

The MCWRF has a permitted capacity of 12 million gallons per day (mgd) and is a conventional activated sludge plant with tertiary filters, UV disinfection, and centrifuge dewatering. The National Pollutant Discharge Elimination System (NPDES) permit requirements include CBOD limits of 4.2 (summer)/8.3 (winter) mg/l and NH3 limits of 1.0 (summer)/2.0 (winter) mg/l. The MCWRF also has a non-discharge permit allowing a portion of the treated effluent to be further disinfected with sodium hypochlorite and pumped to a nearby golf course and public park for irrigation.

In addition to earning and maintaining ISO 14001 certification since 2007, MCWRF has received a National Association of Clean Water Agencies (NACWA) Peak Performance award annually since 2004 for excellence in permit compliance.

Figure 2: Mallard Creek Water Reclamation Facility

MCWRF contributes to CLTWater's successful biosolids land application program. CLTWater uses approximately 4,000 acres of permitted land each year to beneficially reuse Class B biosolids. Weather conditions and product quality are two factors that can make it necessary to land fill the biosolids instead of land applying. Like MCWRF, the CLTWater biosolids program is ISO 14001 certified and has a long history of excellent regulatory compliance.

REGULATORY THRESHOLD AND EFFECTS OF PCBS ON HUMAN HEALTH AND THE ENVIRONMENT

PCB Effects

Several governmental organizations share a plethora of information, research, and data concerning the impacts of PCBs on human health and the environment on their web pages. The following information is summarized from the U.S. EPA's webpage dedicated to PCBs (2017).

According to the U.S. EPA, PCBs are man-made organic chemicals that were domestically manufactured from 1929 until manufacturing was banned in 1979. PCBs were used in many applications because of their high boiling point, electrical insulating properties, and chemical stability. PCBS were typically manufactured in plasticizers used in rubber products and in electrical, heat transfer, and hydraulic equipment prior to 1979.

PCBs are referred to as a chlorinated hydrocarbon and their degree of toxicity is related to the amount of chlorine that they contain. There are many trade names for PCBs with the most common known as Aroclor. The different Aroclors are distinguished by a number that indicates the degree of chlorination.

The U.S. EPA asserts that PCBs are a probable human carcinogen and can cause a variety of adverse health effects on the immune system, reproductive system, nervous system, and endocrine system. PCBs do not readily break down and are found in the environment throughout the world. As a result, they can accumulate in leaves and parts of plants and food crops and can bioaccumulate in small organisms and fish resulting in PCB exposure to humans who eat them.

Regulatory Threshold

If the source concentration of a substance has a PCB concentration of 50 ppm or greater, the substance and facilities, storage containers, streams, etc. that have come into contact with the PCBs are regulated by TSCA for the handling and disposing of the materials and decontaminating of structures, equipment, and waterways.

THE CONTAMINATION EVENT

Finding the Source

An important part of the city-wide emergency response on February 6, 2014, was finding the source of the contamination because the contaminant had been flowing into the facility for hours

with no signs of letting up. Crews investigated the collection system on foot and in trucks and finally found a grease trap at a local grocery store where the substance was discharged to the collection system. The contaminated grease trap is shown in Figure 3. The contamination traveled through approximately 14 kilometers (8.7 miles) of pipeline and 181 manholes to the MCWRF. While PCBs are odorless, another chemical in the oil substance called trichlorobenzene has a strong diesel-like odor which helped the crews track the contamination through the system.

Figure 3: Contaminated Grease Trap

Samples taken from the grease trap revealed that the PCB concentration had significantly exceeded 50 ppm. The limits of contamination included the collection system from the grease trap connection to MCWRF and most unit processes within MCWRF. The grocery store was responsible for dealing with the contamination of their grease trap. Analytical results from the grease trap sampling are shown in Table 1.

Table 1: Analytical Results from Illicit Discharge Point Sampling

Parameter	Results	Parameter	Results
PCB-1254	4,210 mg/L (ppm)	Molybdenum	336 ug/L
PCB-1260	2,940 mg/L (ppm)	Nickel	136 ug/L
Total PCB	**7,150 mg/L (ppm)**	Zinc	10,200 ug/L
Chromium	232 ug/L	Lead	615 ug/L
Copper	1,500 ug/L		

A Team Response

The resources required to respond to this event have been staggering. Figure 4 lists the major groups who contributed to the emergency response in the hours and days after the contamination was detected. Many of the vendors who assisted were already under contract with the City of Charlotte enabling CLTWater to get the necessary resources mobilized quickly. Several

members of the initial team are still helping with the recovery and decontamination phases of the event.

CLTWater notified regulators from the U.S. EPA, North Carolina Department of Environmental Quality (NCDEQ), and Mecklenburg County Land Use & Environmental Services Agency (LUESA) within hours of detecting the substance flowing into the facility. Representatives from each entity were present at MCWRF to assist with emergency response, and CLTWater continues to work with the U.S. EPA on decontamination planning.

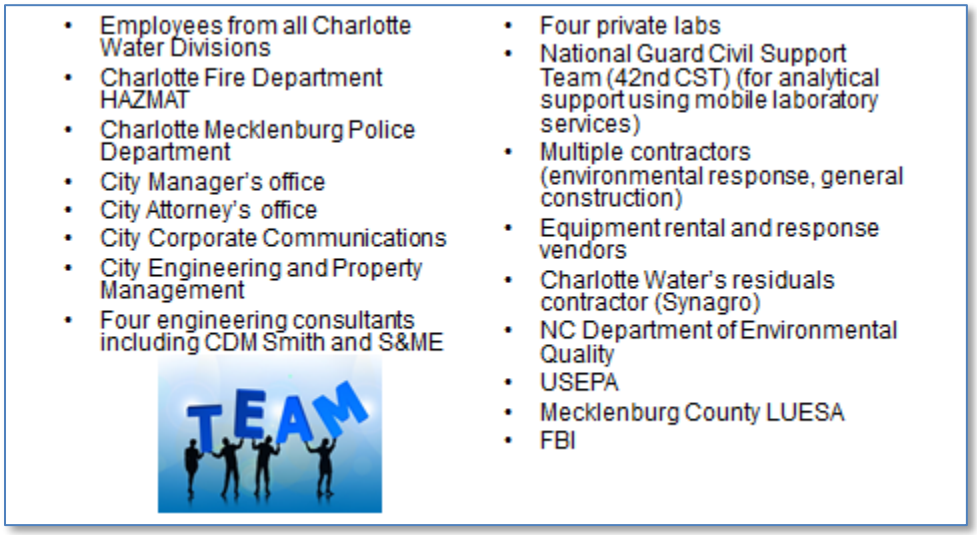

Figure 4: Contamination Response Team

Sampling Plan and Initial Data

An extensive sampling plan was developed in order to track and trend movement of the contamination through the liquid and solids treatment trains and understand its impact on the wastewater treatment process. Since 2014, approximately 2,400 process and exploratory samples have been taken and analyzed for PCBs. Table 2 shows the maximum PCB concentrations detected at liquid and solid sampling points throughout the facility. The data indicate the maximum concentrations detected at the liquid sample locations were well below those found in the solid sample locations.

The sampling also showed that the presence of PCBs did not affect the activated sludge process or inhibit the UV disinfection process. MCWRF has maintained compliance with its NDPES permit throughout the PCB contamination.

Table 2: Maximum Detected PCB Concentration for Different Liquids and Solids

Liquid Samples		
Sample Type	**Maximum Detected PCB Concentration (mg/l or ppm)**	**Sample Date**
Raw Influent	13.50	2/8/14
Primary Clarifier Effluent	3.07	2/18/14
Final Clarifier Influent	6.33	2/12/14
Facility Effluent	0.0058	2/7/14
Stream (upstream of outfall)	0.0007	2/8/14
Stream (downstream of outfall)	0.0077	2/7/14
Solid Samples		
Sample Type	**Maximum Detected PCB Concentration (mg/kg or ppm)**	**Sample Date**
Grit/Screenings	1,090	2/10/14
Primary Sludge	10,690	2/8/14
Return Activated Sludge	35.9	2/9/14
Dewatered Digested Sludge	2,870	2/21/14

The normal wastewater treatment process at MCWRF was effective at removing PCBs from the liquid stream by way of the solids handling process. Most of the PCB contamination was removed during the screening process, grit removal, and primary clarification. As a result, the concentration of PCBs in the effluent discharged to Mallard Creek was minimized. During the emergency response, the EPA set a goal for CLTWater to maintain the PCB concentration in the effluent below 3 ug/L (ppb). CLTWater met this goal by the second day of the event on February 7, 2014, and the effluent has tested non-detect for PCBs since March 1, 2014.

Removing the PCBs from the Facility by Managing the Solids

During the first year of the contamination event, most of the PCBs removed from MCWRF were attached to the different solids that were removed through normal wastewater treatment as documented above.

CLTWater stored contaminated solids having PCB concentrations greater than 50 mg/kg (ppm) on-site while procuring services for the proper handling, hauling, and disposal of the material. In total, CLTWater disposed of approximately 3,500 wet tons of PCB contaminated solids to a Resource Conservation and Recovery Act (RCRA) Subtitle C landfill for toxic and hazardous materials in Emelle, Alabama.

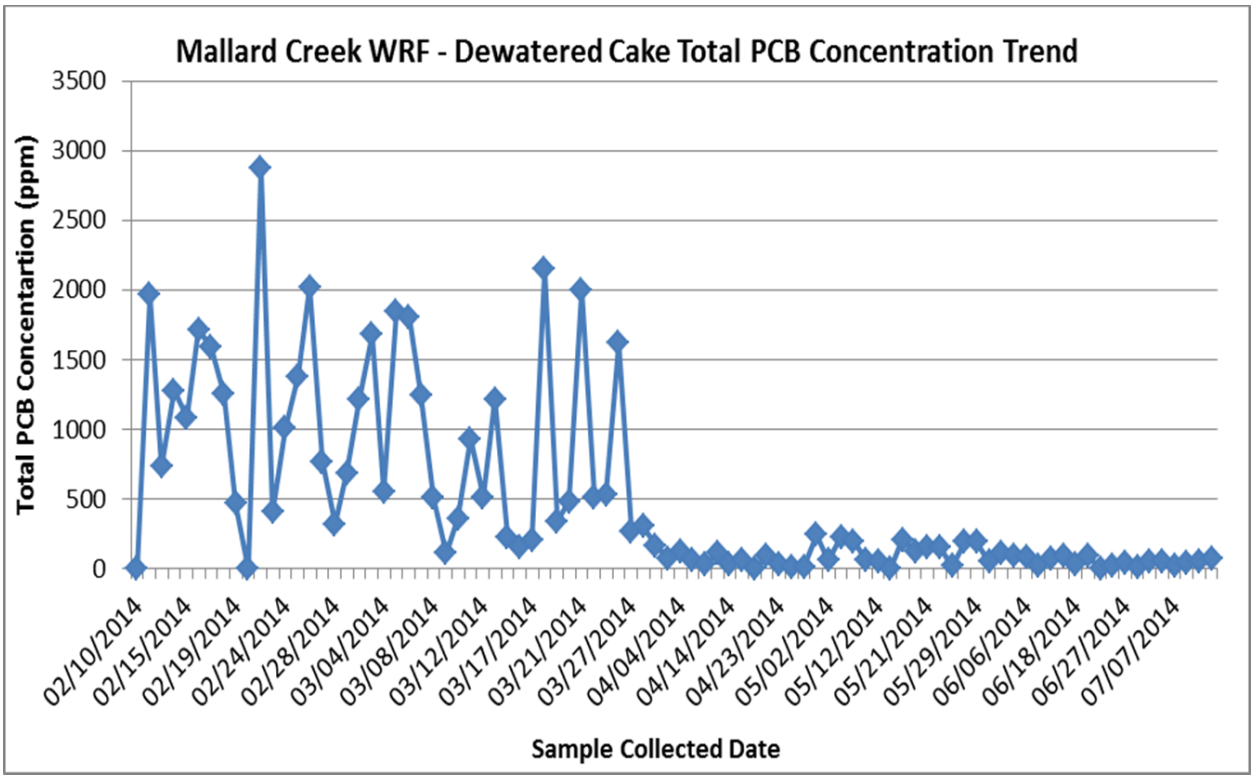

Figure 5: PCB Concentrations in the Dewatered Solids - 2014

The U.S. EPA gave CLTWater permission to dispose of wastewater treatment solids with PCB concentrations less than 50 mg/kg (ppm) at the local RCRA Subtitle D landfill. The PCB concentration in the screenings and grit was consistently under 50 mg/kg (ppm) within approximately 4 months and was disposed of locally.

As shown in Figure 5, the PCB concentrations in the dewatered digested sludge fluctuated above 50 mg/kg (ppm) until the July, 2014 (Lapsley, 2015). Once it was consistently below the required threshold, CLTWater was confident that the risk of contaminating trucks was low and management of the dewatered digested sludge changed. CLTWater began live loading trucks, sampled each trailer, held the trailers awaiting analytical results, and released the trucks to the offload at the landfill once the PCB concentration was confirmed. Since October 2014, every truck load of dewatered digested sludge has had a PCB concentration less than 50 mg/kg (ppm) and has been disposed of at the local RCRA Subtitle D landfill.

IMPACTS OF LONG TERM CONTAMINATION ON NORMAL BUSINESS

Health and Safety

Until the entire facility is decontaminated per the TSCA guidelines, regular health and safety training concerning PCB exposure will be required for many groups within CLTWater who operate, maintain, or construct projects for the MCWRF and the affected part of the collection system. This program is currently in the process of being developed.

The personal protective equipment (PPE) that staff is required to use for day-to-day activities to protect against common wastewater treatment and industrial hazards proves to be adequate in most areas contaminated with PCBs. However, additional PPE may be required to prevent the spread of PCBs or if work will increase the chance of inhaling PCBs.

Land Application Program

All dewatered digested sludge produced at MCWRF has been sampled and landfilled either locally or at the RCRA Subtitle C facility since February, 2014. CLTWater has worked closely with the contractor who administers the land application program on the loading, sampling, hauling, and disposal logistics required for each phase of the response. As a result, unit pricing adjustments were made and other significant costs were incurred. It is anticipated that biosolids from Mallard will begin to be land applied again beginning September, 2017.

Maintenance, Rehabilitation and Repair Projects

The PCB contamination will continue to impact maintenance, rehabilitation and repair projects of all sizes until the entire facility has been decontaminated per the TSCA guidelines.

During the last three years, projects that were not emergencies were simply delayed until buildings and equipment were successfully decontaminated. Examples include the delay of a centrifuge replacement project necessary to ensure reliability of MCWRF's dewatering operation, a scheduled maintenance activity in the contaminated portion of the collection system that helps prevent sanitary sewer overflows, and a sewer tap for a new development.

Once the decontamination project is complete, CLTWater staff will have to analyze each work activity to determine if any parts of the project will affect contaminated infrastructure. If they do, these projects will have a more complicated scope of work because of factors such as employee exposure to the PCBs, decontamination requirements for tools and equipment, complex waste disposal requirements, more substantial insurance requirements, biddability of projects if not self-performed by CLTWater staff, potential sampling requirements that could extend project schedules, additional measures to prevent the spread of contamination, etc. All of these factors could possibly result in higher costs for CLTWater and projects taking longer to execute.

Cost

Since February 6, 2014, CLTWater has spent roughly $15 million U.S. dollars responding to the contamination event. This amount includes but is not limited to the emergency response vendors, additional costs for landfilling contaminated dewatered digested sludge, sample and analysis fees, equipment rental fees, decontamination of rental equipment, the decontamination project costs, fees for providing potable water to reuse customers, and consulting fees.

MINIMIZING THE IMPACTS OF CONTAMINATION ON CHARLOTTE WATER

CLTWater has identified several ways to minimize or eliminate impacts to the operations, maintenance, and engineering of the MCWRF and the collection system.

The Decontamination Project

Operating and maintaining a contaminated facility and collection system have proven to be disruptive and costly. It would be cost prohibitive, however, to decontaminate or replace every pipe, valve, concrete structure, and piece of equipment as part of one project. As a result, CLTWater decided to include specific areas of the facility in the scope of the project and manage the rest as contaminated to be addressed during future projects.

The scope of work for the initial decontamination project was selected based on the following criteria:

- Frequency with which staff has to enter a basin or make contact with a piece of equipment,
- Ability to control access to areas or equipment that is contaminated for preventing exposure or spreading,
- Disruption potential to reliable operations and maintenance if the area/equipment had to be decontaminated prior to work being performed,
- Risk of PCB release to the environment,
- Cost.

Equipment and some concrete in the following unit processes at MCWRF were included in the scope: influent pumping and intermediate pumping, diurnal flow and storm equalization, preliminary treatment, primary treatment, digestion, dewatering, and biosolids storage. Figure 6 shows the decontamination efforts in the storm equalization basin.

CLTWater awarded the decontamination project contract based on qualifications, experience, and cost. The Service Provider's team had to include expertise in sludge dewatering, PCB decontamination, coordination of hauling and disposal of toxic wastes, TSCA, and industrial construction. The project duration is approximately 485 days and will cost approximately $10 million U.S. dollars. Final completion of the project is expected by the end of September, 2017.

CLTWater hired S&ME to serve as CLTWater's independent environmental testing firm to manage all aspects of exploratory and required confirmatory sampling, analysis, and data review and interpretation.

Figure 6: Decontamination of MCWRF Equalization Basin

Records Management

CLTWater has declared the PCB contamination event a significant event, and as a result, considers all records related to the event as historic. City of Charlotte policy requires that CLTWater manage the historic records per the North Carolina Department of Cultural Resources, September 10, 2012 Municipal Records Retention and Disposition Schedule meaning that the records will be maintained permanently.

The CLTWater Records Administrator is responsible for coordinating the collection, scanning, cataloguing, and proper storage of records from all City of Charlotte departments involved in the event. Relevant records include but are not limited to analytical reports, waste disposal manifests and weight tickets, electronic and written correspondence, invoices, photographs, personnel records, presentations, procurement documents, and public announcements.

CLTWater has elected to use an enterprise content management system to fulfill records retention requirements because of the following benefits:

- Makes available a complete set of records in one location ensuring accessibility to City of Charlotte employees.
- Provides a more efficient system for retrieving documentation for financial audits, fulfilling public information requests, and discovery in the event that the City of Charlotte is involved in litigation.
- Allows CLTWater management to set up the system for permanent retention so records cannot be misplaced.

Data Management

A significant amount of analytical data has been generated during the response effort and will continue to be generated as future decontamination projects are performed. S&ME and CDM Smith were tasked with developing data storage and management tools for easy use and reference that could eventually be transitioned to CLTWater's record enterprise content management system. Some data may also be incorporated into the City of Charlotte's asset management system to help staff easily identify the contamination status of a piece of equipment or facility and print analytical reports to provide to machine shops and other vendors.

- *Exploratory, Process Control, and Biosolids Sample Data*. CDM Smith set up and manages an on-line project document storage site for CLTWater's response team. All analytical results and reports are housed on the site making it easy to create graphs for reports and monitor PCB concentration trends over time.

- *Decontamination Confirmatory Sample Data*. S&ME has also created an on-line project documentation storage site dedicated to managing official decontamination confirmatory sample data. This innovative system allows for efficient retrieval of very detailed documentation about sample locations including photographs and facility drawings, sampling dates, sample identification, PCB concentration levels, and decontamination pass/fail status. Refer to Figures 7 and 8 for screenshots of the information available on this site.

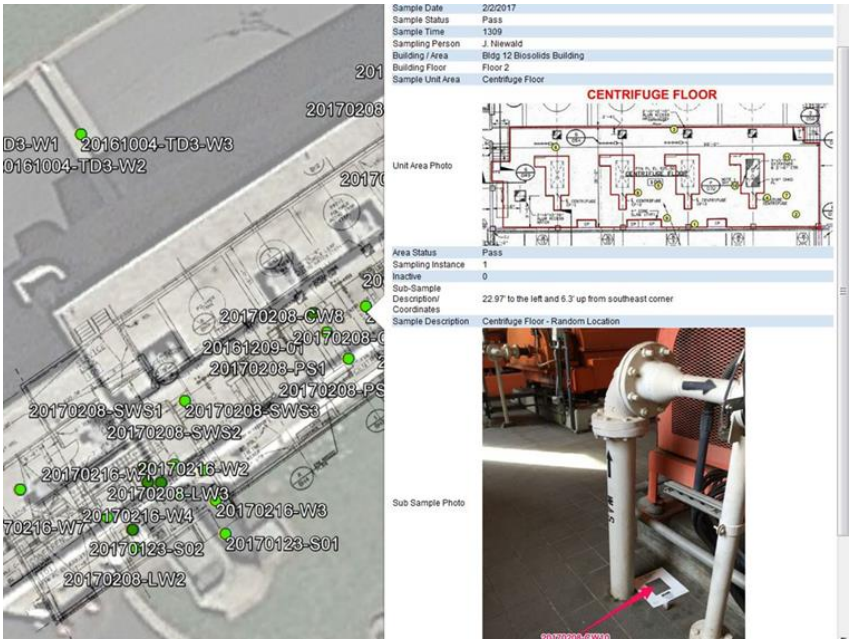

Figure 7: Screenshot of Decontamination Confirmatory Sample Data

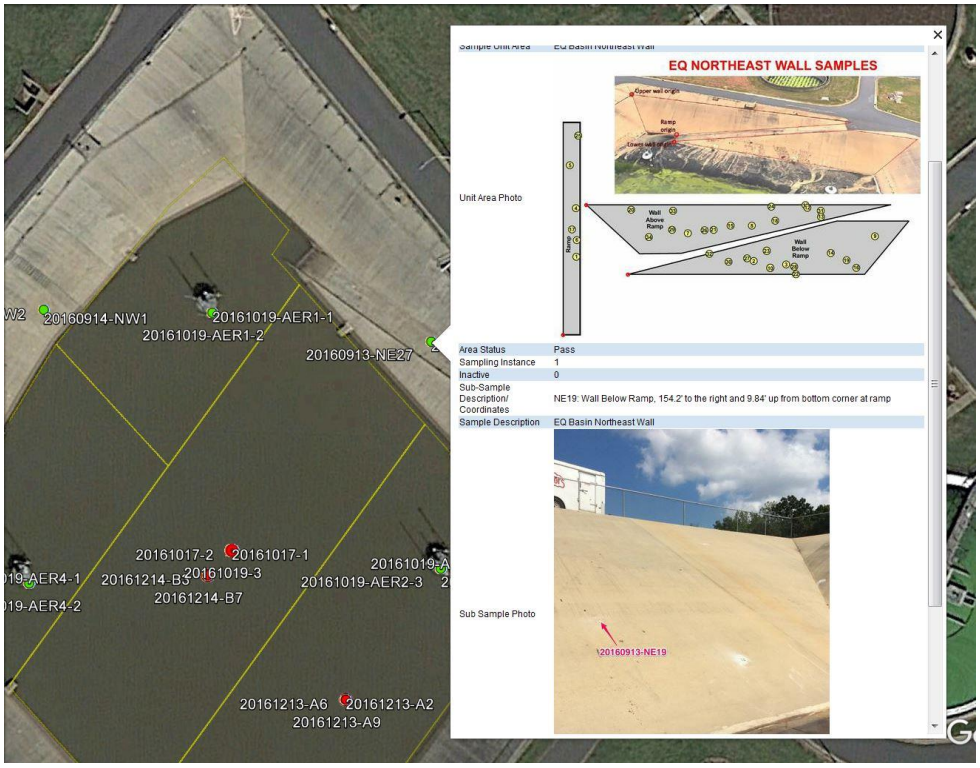

Figure 8: Screenshot of Decontamination Confirmatory Sample Data

Proactive Procurement

CLTWater is in the process of developing a Request for Proposals to hire a long-term on-call service provider for PCB decontamination, hauling, and disposal services. This service provider will help CLTWater work in portions of the MCWRF and the collection system that will remain contaminated after the decontamination project at the facility. The service provider is expected to be under contract by November, 2017. Having an on-call service provider will mitigate impacts to employee health and safety, project delays, and overall costs as described above.

SUMMARY

CLTWater was faced with a daunting challenge beginning February 6, 2014. Dedicated CLTWater and other City of Charlotte employees rose to the occasion and proved the depth of the City's resilience. There have been no interruptions of sewer service to customers, plant staff maintained exceptional compliance with the facility's NPDES permits, employee health and safety remained a priority, and contamination of Mallard Creek was prevented.

While CLTWater continues to experience the operational, financial, and regulatory impacts resulting from the PCB contamination, the decontamination project and other programs that are being developed will help the staff survive the new normal at MCWRF and in the collection system. Safety, fiscal responsibility, regulatory compliance, and reducing the impact on the

engineering, operations, and maintenance staff will remain the focus of the long term management of the PCB contamination.

REFERENCES

Lapsley, J; DeWitt, D. 2015. *Polychlorinated Biphenyls (PCBs) in Collection Systems and WWTPs – The Charlotte Water Mitigation Experience.*

U.S. Environmental Protection Agency. "Learn about Polychlorinated Biphenyls (PCBs)" www.epa.gov. https://www.epa.gov/pcbs/learn-about-polychlorinated-biphenyls-pcbs#laws (accessed June 30, 2017)