September 4, 2018

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City of Flint Water Distribution System Optimization Plan

Subject: Blended GLWA and GCDC Water Quality Assessment and Impacts to Corrosion Control Treatment Study

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PURPOSE

Arcadis U.S., Inc. and Cornwell Engineering are conducting a corrosion control study (CCS) as a part of ongoing distribution system optimization efforts for the City of Flint (City). The City currently receives treated water from the Great Lakes Water Authority (GLWA) through control station II (CS II). The City boosts chlorine to approximately 2 mg/L and orthophosphate to at least 3.1 mg/L at CS II prior to distribution. In addition, the City has the ability to raise the pH of water received from GLWA if necessary to meet current optimal corrosion control treatment (OCCT) conditions. The CCS includes harvested lead service line pipe loops and is evaluating various orthophosphate doses to determine if additional corrosion control treatment enhancements can or should be made.

Long-term Flint water system operations include a backup supply from the Genesee County Drainage Commission (GCDC). To keep water in the pipeline from GCDC to the City fresh, GCDC water will be continuously blended with GLWA water at a 5:95 ratio at CS II.

The United States Environmental Protection Agency (USEPA) has indicated that they would like future phases of the CCS to include testing of the blended supply unless it can be demonstrated that it is not necessary. Such test conditions would be fraught with logistical challenges – the most significant of which is the fact that the GCDC pipeline to the City is not yet complete. As such it would require trucking of water to the Flint Water Treatment Plant (WTP) several times per week. There, water would be stored and pumped into the line feeding the loops at a 5:95

GCDC:GLWA ratio. Approximately 400 gallons of GCDC water are needed per day. It is assumed approximately 1200 – 1500 gallons would be stored at the Flint WTP, thus water in the tank could be two to three days old before it is fed to the loops. Additional storage may also be needed to cover longer periods of inclement winter weather.

The purpose of this memorandum is to evaluate the water quality impacts of blending GCDC and GLWA water and determine the likelihood that the blended water supply is likely to produce different CCS test results compared to testing with the GLWA supply alone.

APPROACH

Water quality data from the City of Flint and GCDC monthly operating reports (MORs) were used to compare treated water quality and estimate blended water quality. Michigan Department of Environmental Quality (MDEQ) provided GCDC MORs from December 2017 to April 2018. City MORs for the same period were pulled from the MDEQ Flint Water site. For the purposes of this analysis, GLWA water quality is Flint "raw" water quality and was measured at CSII prior to chemical adjustment. GCDC water quality was reported as "domestic water analysis" and is equivalent to distributed water quality and would be similar to that received by the City at CS II.

Daily values of key corrosion parameters and other parameters of interest (pH, alkalinity, hardness and chloride) were plotted and are presented as Figures 1 through 4. Note that data are limited to what is contained in the MORs and other parameters that might be of interest, such as aluminum or sulfate, were not available. The impact of the limited data availability is discussed in the following section.

Following the evaluation of MOR data, water was collected from GLWA and GCDC. The waters were collected on five consecutive days and analyzed separately as well as in a 95 % GLWA to 5% GCDC blend to simulate the anticipated full-scale operating condition.

RESULTS AND DISCUSSION

MOR Data Analysis

Figures 1 through 4 present the results of the water quality comparison. For parameters whose concentration in the blended supply is proportional to its concentration in each of the respective sources, the estimated blended water quality is also presented.

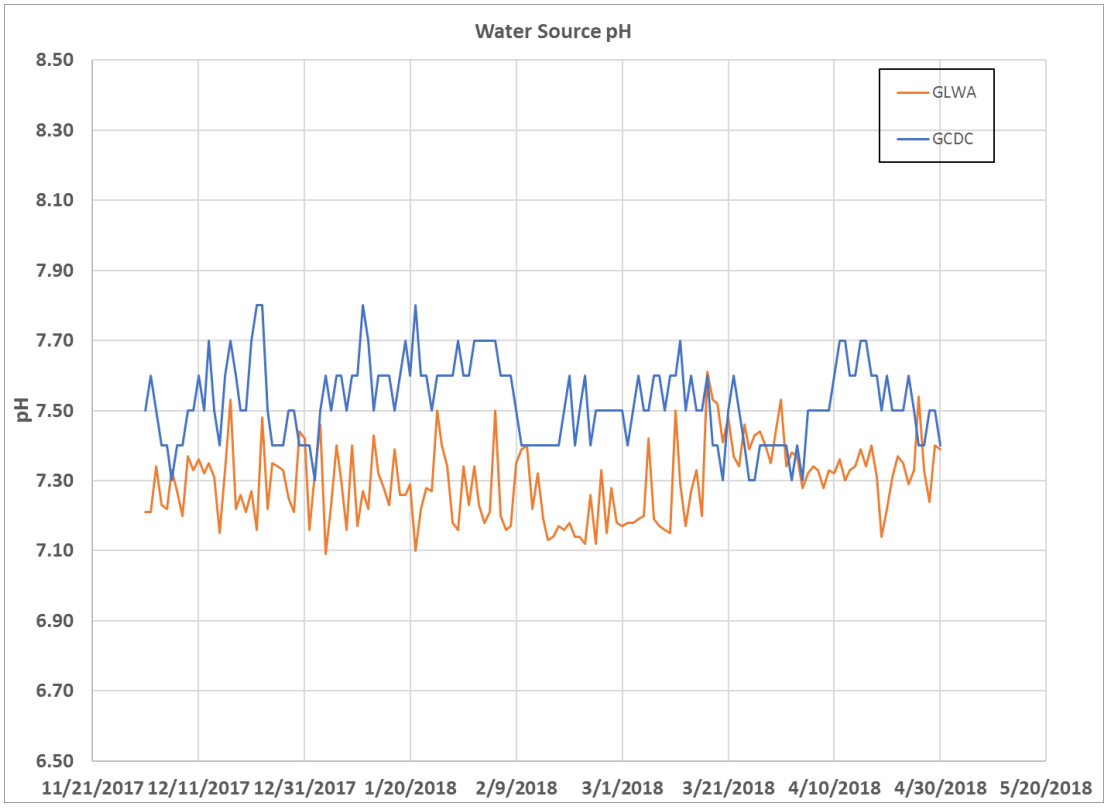

Figure 1 Comparison of GLWA and GCDC Treated Water pH-MOR Data

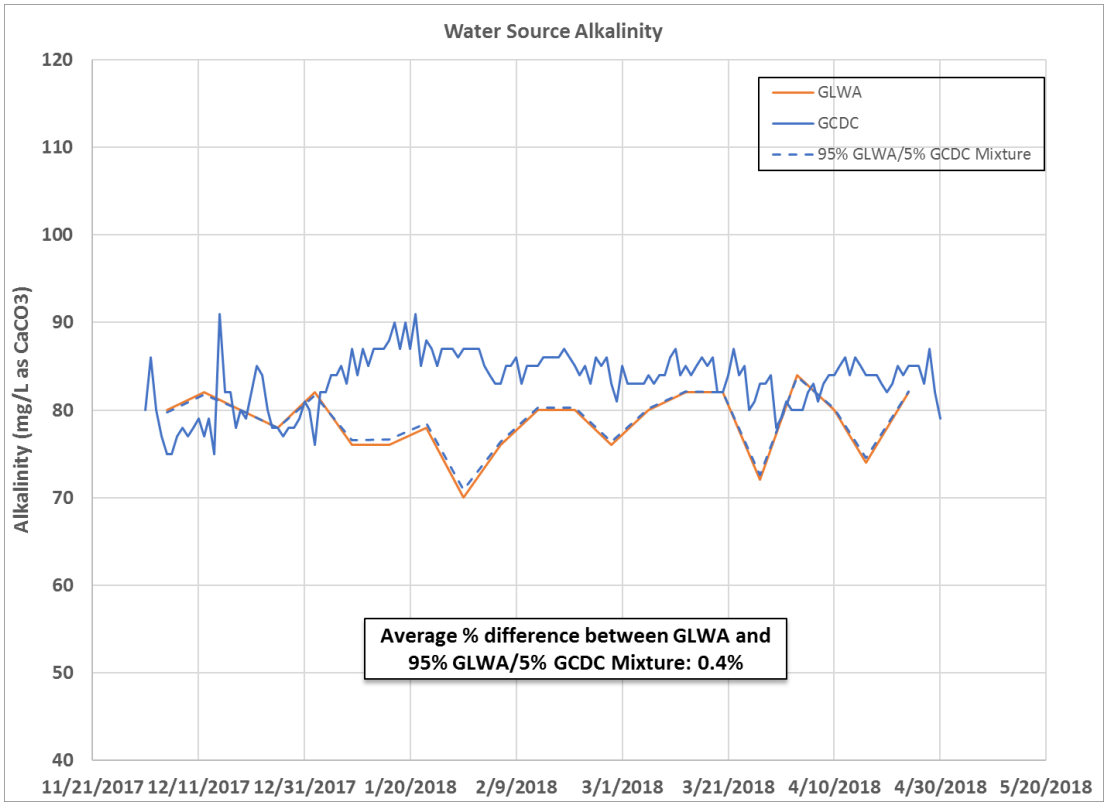

Figure 2 Comparison of GLWA and GCDC Treated Alkalinity-MOR-Data

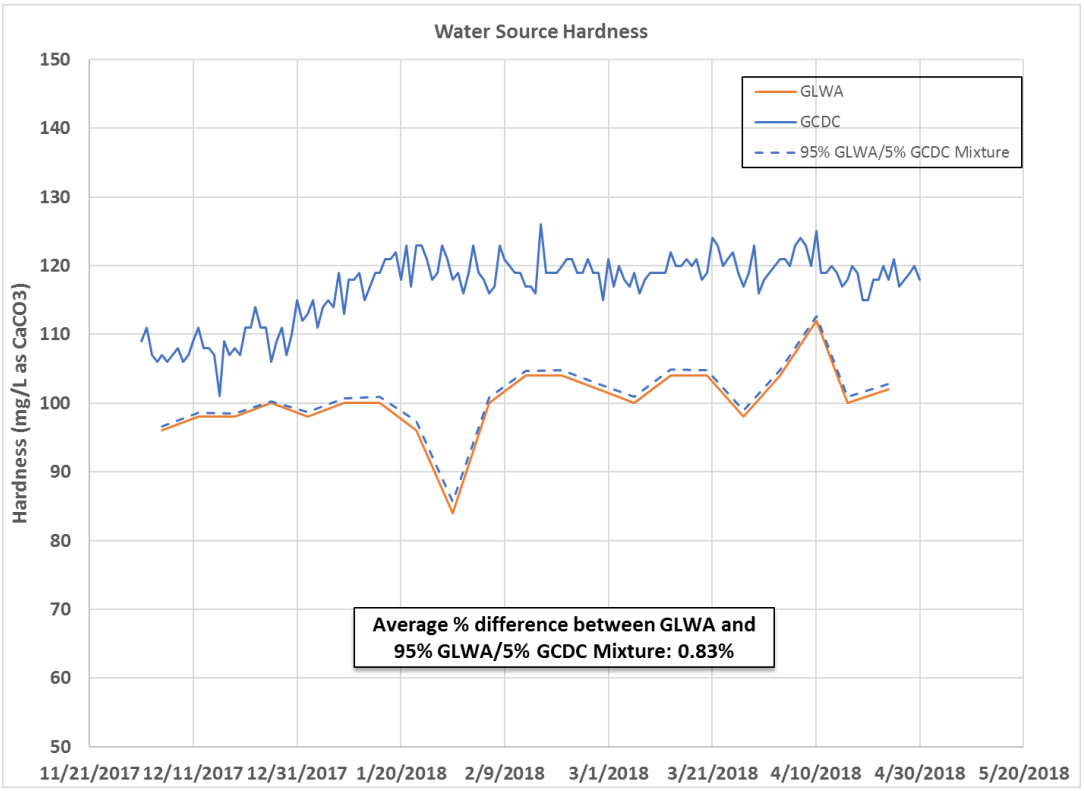

Figure 3 Comparison of GLWA and GCDC Treated Hardness-MOR Data

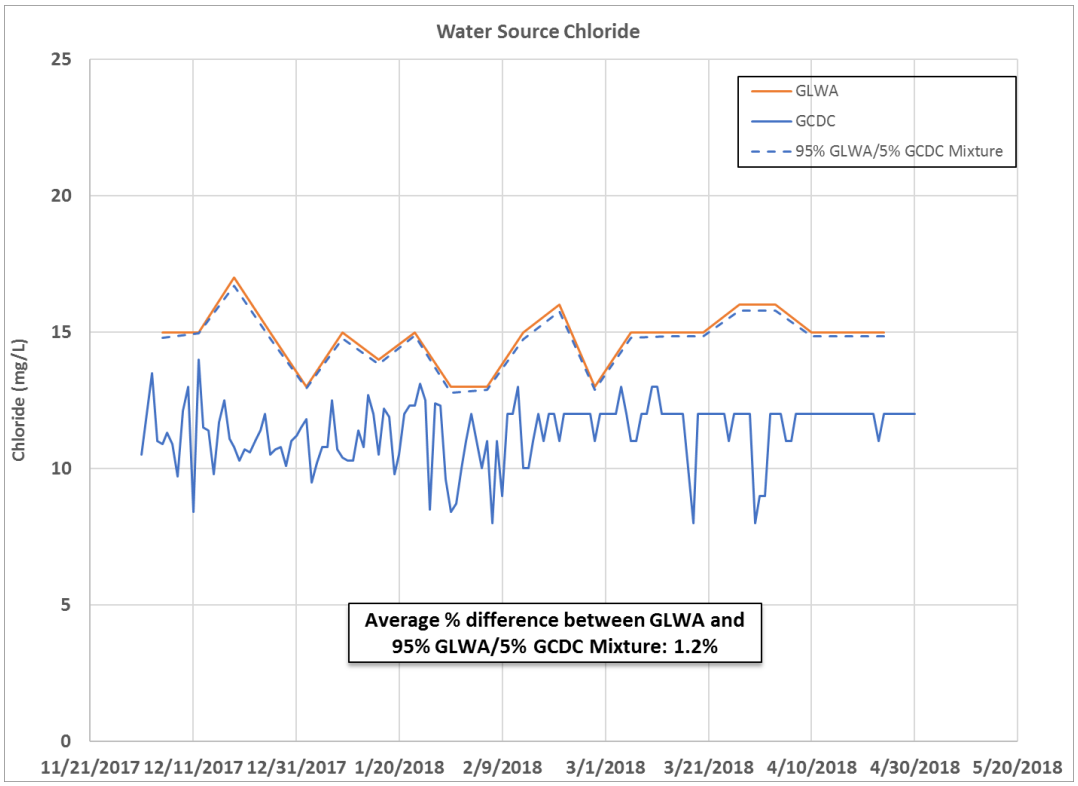

Figure 4 Comparison of GLWA and GCDC Treated Chloride-MOR Data

As can be seen in Figures 1 through 4, water quality from the GLWA and GCDC sources are similar. However, the most significant observation is that the blended water quality is nearly identical to the current Flint supply (GLWA) which is being used for the corrosion control study. It should also be noted that pH will be adjusted prior to distribution in the Flint system, so any variance in pH will not be an issue.

In addition to the parameters above, there are other water quality parameters (e.g., aluminum, sulfate) which are also of potential interest, but not reported in the MORs. However, based on the blend ratio and the results shown in Figures 2 through 4, the concentrations would vary minimally from the current Flint (i.e. GLWA) supply due to the low proportion of GCDC in the blend, and as such are expected to have minimal impact on the results of the corrosion control study.

GLWA/GCDC Sampling and Mixture Study

Procedure

In addition to using the historical MOR data to compare water quality parameters, samples were collected and analyzed for analytes of interest to determine the difference, if any between the GLWA, GCDC and the blend of GLWA and GCDC water. During the week of 8/20/18 a Cornwell Engineering Group engineer drove to the GCDC water treatment plant in Columbiaville, Monday-Friday, and collected approximately 1.5 L of treated GCDC water each day. The samples were taken back to the Flint water treatment plant to be analyzed. Three samples were prepared, one sample contained 500 mL of GLWA water, one sample contained 500 mL of GCDC water, and the last sample was a 95% GLWA/5% GCDC mixture, 25 mL GCDC water and 475 mL GLWA water. The samples were then tested by the Flint lab staff for the following parameters, alkalinity, hardness, pH, chloride, sulfate, turbidity, and checked for precipitate. Samples were then sent to Michigan Department of Environmental Quality Drinking Water Laboratory to be tested for aluminum. A total of five sets of samples were analyzed.

Results of Study

Figures 5 through 10 present the results of the mixture study. Each parameter includes 5 data points for each sample, one for each day of the week. Chloride and sulfate data were collected and the chloride:sulfate ratio (CSMR) was calculated and graphed (Figure 9). It should be noted that there were no precipitates found in any of the samples.

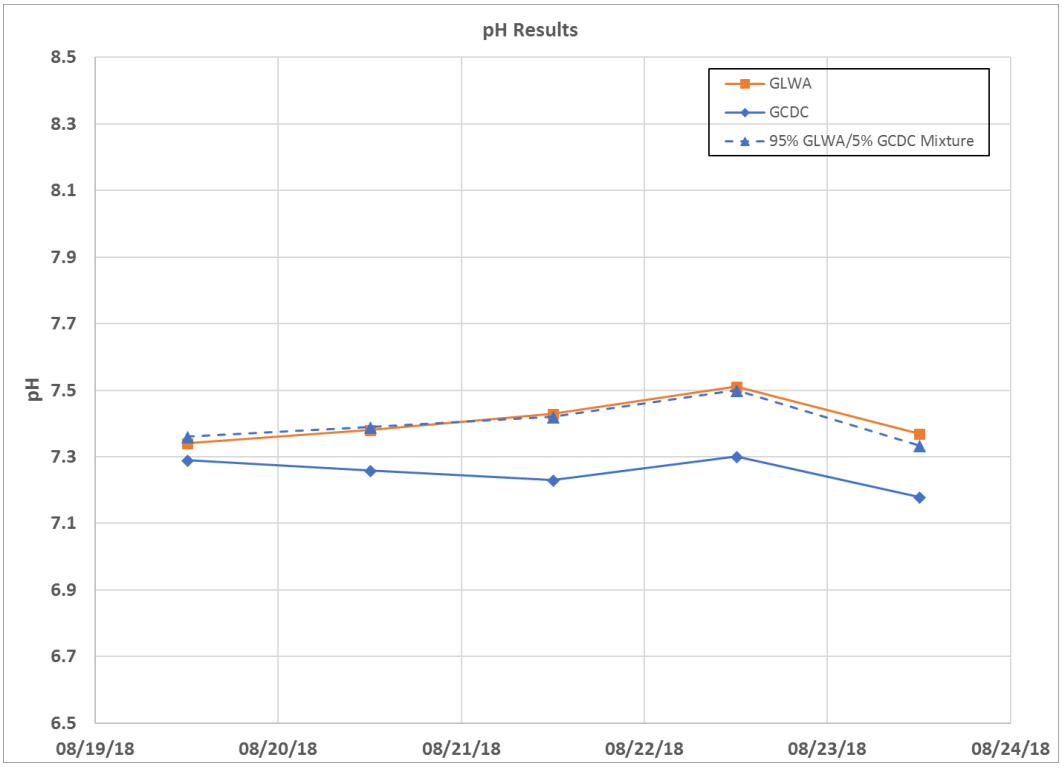

Figure 5 Comparison of GLWA/GCDC Mix to GLWA and GCDC pH Collected August 2018

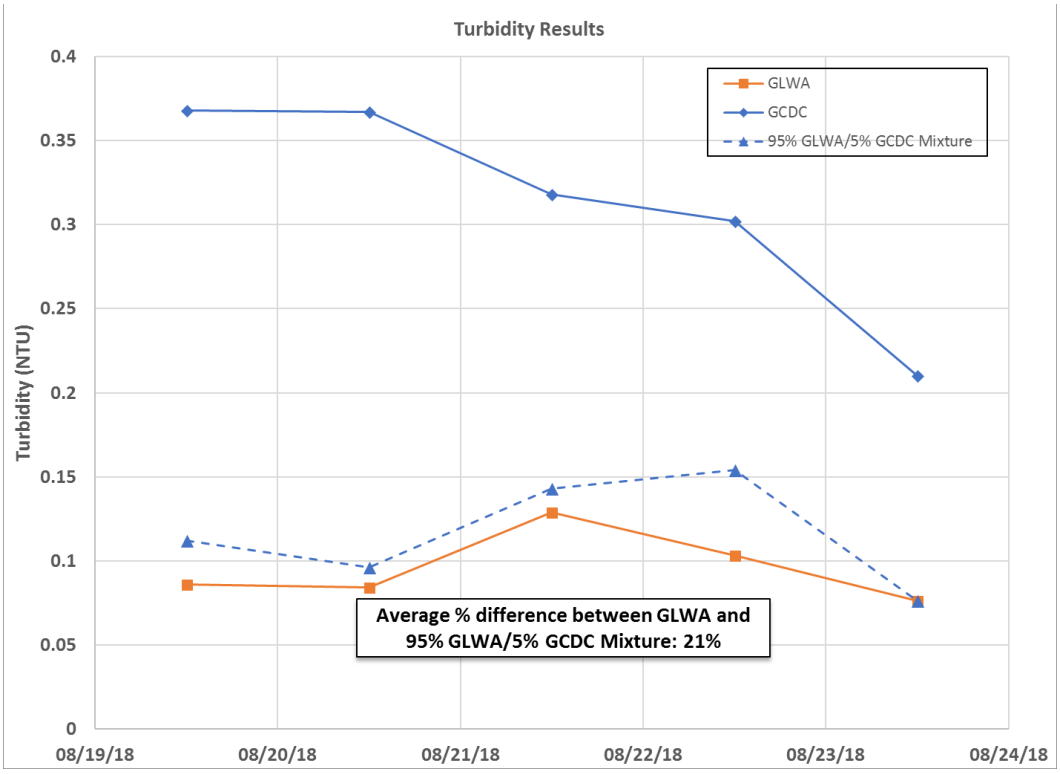

Figure 6 Comparison of GLWA/GCDC Mix to GLWA and GCDC Turbidity Collected August 2018

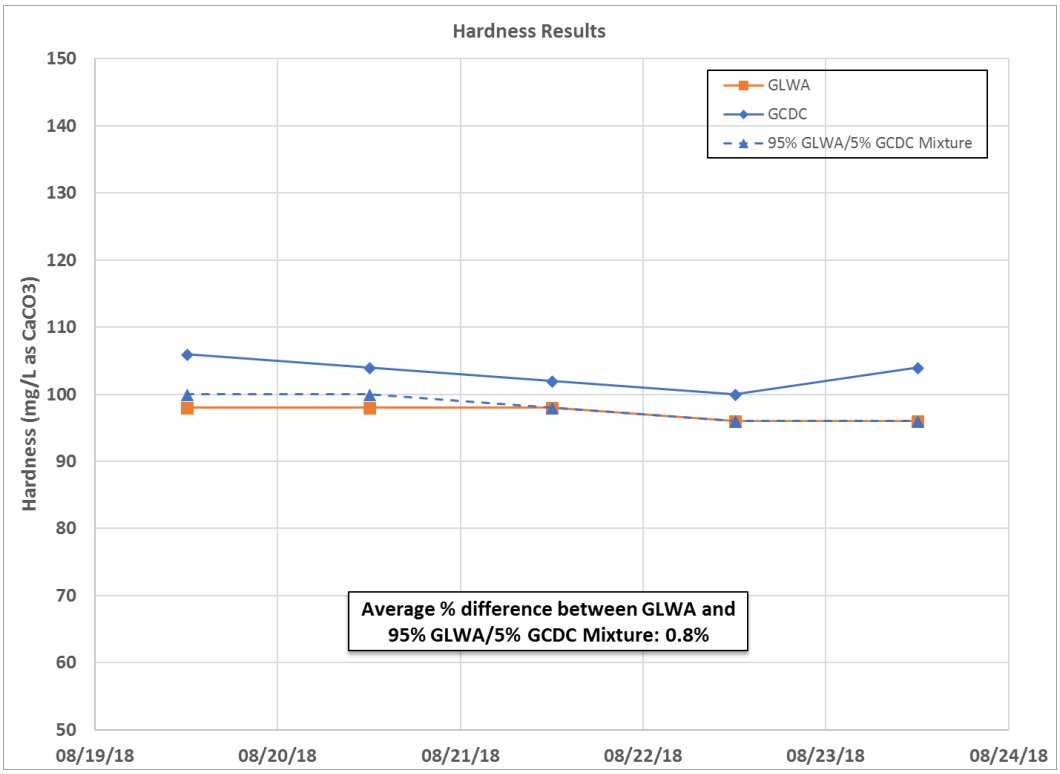

Figure 7 Comparison of GLWA/GCDC Mix to GLWA and GCDC Hardness Collected August 2018

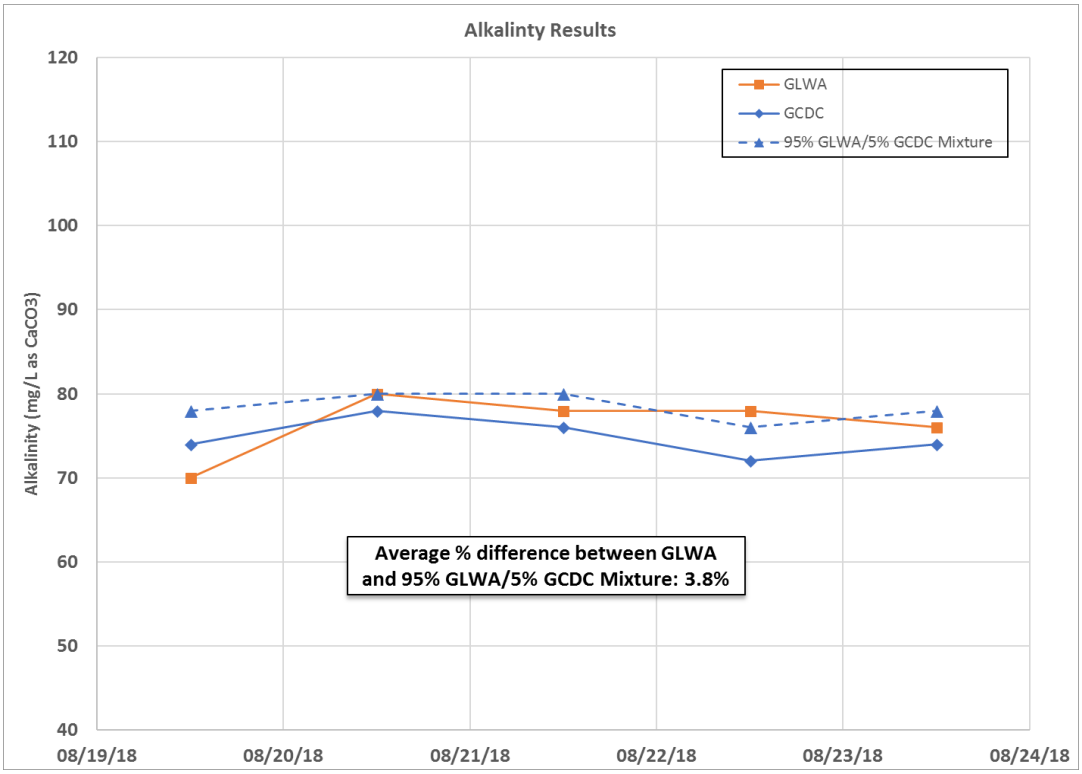

Figure 8 Comparison of GLWA/GCDC Mix to GLWA and GCDC Alkalinity Collected August 2018

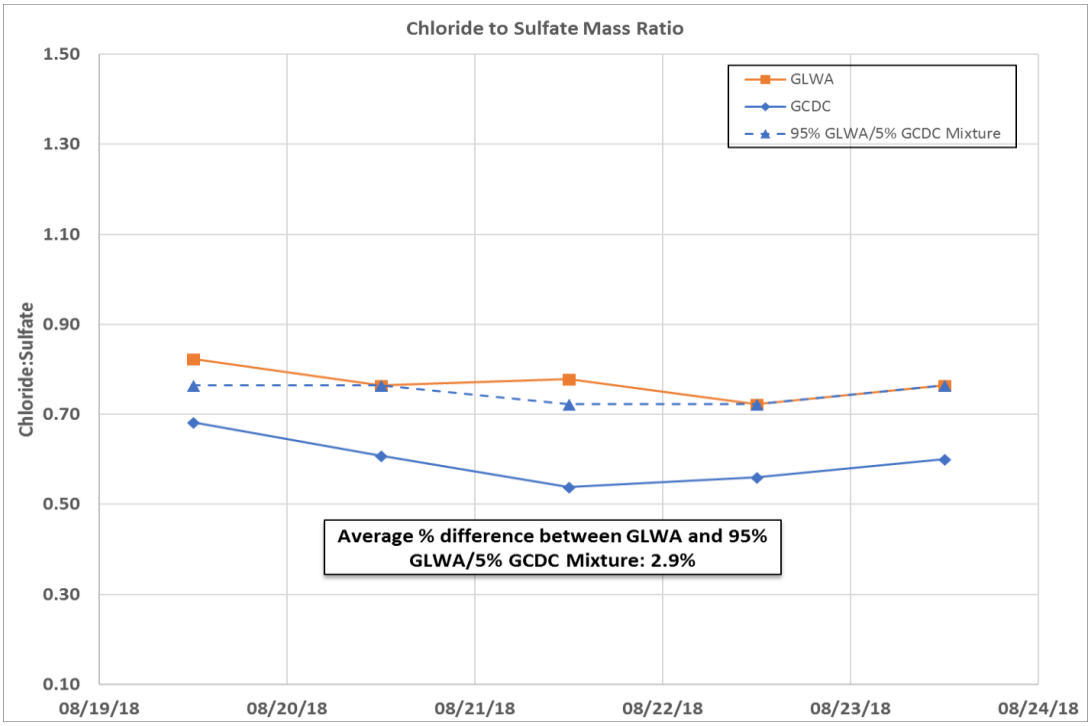

Figure 9 Comparison of GLWA/GCDC Mix to GLWA and GCDC CSMR Collected August 2018

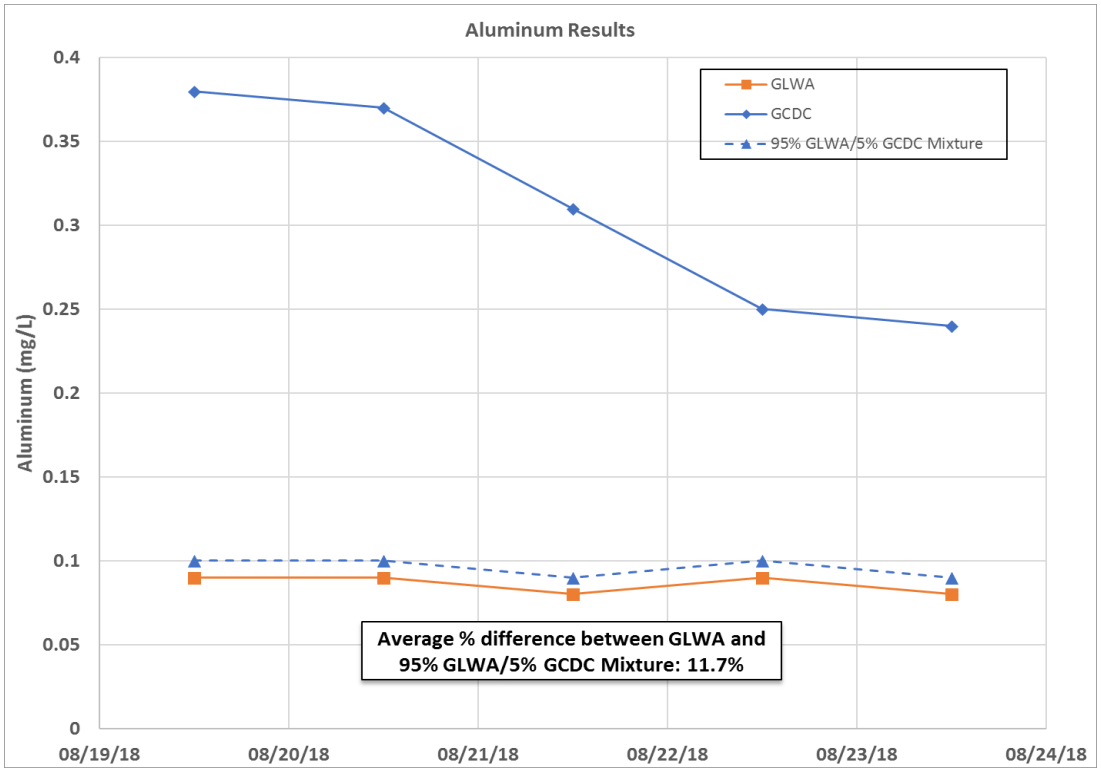

Figure 10 Comparison of GLWA/GCDC Mix to GLWA and GCDC Aluminum Collected August 2018

As can be seen in Figures 5 through 10 above, the 95% GLWA/5% GCDC mixed water and GLWA water are similar to each other, and generally within analytical variance. For the parameters included in both the historical MOR analysis and the mixture study the percent differences are outlined in the table below. Based on the data mixing the two water sources at a 95:5 ratio has little effect on the overall water quality parameters.

Table 1
% Difference of Historical MOR Analysis Compared to the % Difference of Mixture Study

WQP	MOR %Dif	Mixture Study %Dif
Alkalinity	0.4%	3.8%
Hardness	0.8%	0.8%
Chloride/CSMR	1.2%	2.9%

RECOMMENDATIONS

Based on the results of the water quality evaluation and the logistical challenges associated with using GCDC water during the CCS, it is recommended that the pipe loop study proceed using the current GLWA supply. The GCDC:GLWA blend is nearly identical in quality to the current supply due to the low proportion of GCDC water in the blend.