January 13, 2012

Thomas M. Hitch
McGinty, Hitch, Housefield, Person,
Yeadon & Anderson, P.C.
601 Abbot Road
P.O. Box 2502
East Lansing, MI 48226

RE: Sampling and Analysis Plan
City of Charlotte Well Field
Charlotte, Michigan
AMEC Project No. 18846.6

Dear Mr. Hitch:

AMEC Environment & Infrastructure, Inc., (AMEC) has prepared this Sampling and Analysis Plan (Plan) and Fee Estimate for the City of Charlotte well field (subject site). This Plan was prepared in accordance with your request in furtherance of an additional assessment regarding whether surface water near the subject site may be infiltrating to production wells in sufficient volume in order to consider the City's water supply wells as "groundwater under the direct influence of surface water," also known by the acronym GWUDISW.

Geologic Setting and Regulatory Background

The subject site is situated in glacial outwash deposits near the Battle Creek River. Within the well field, three production wells (identified as PW-3, PW-5, and PW-6) provided potable water to the City of Charlotte. It should be noted that a well identified as PW-1A was determined to have been improperly installed and was properly abandoned in 2011.

All of the production wells at the subject site are screened in a sand and gravel aquifer that has been determined through aquifer testing to be unconfined or weakly confined by overlying sandy and gravelly clays. The Michigan Department of Environmental Quality (MDEQ) expressed concerns that recharge to the sand and gravel aquifer under pumping conditions may occur from

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the Battle Creek River in sufficient quantities such that the City of Charlotte's wells may be considered GWUDISW.

In response to the MDEQ's concerns, AMEC, on behalf of the City of Charlotte, reviewed existing hydrogeologic, geochemical, physical, and biological data from wells PW-1A, PW-3, and PW-5 for the purpose of evaluating the MDEQ's GWUDISW inquiry. Data evaluated spanned a period from 1993 through January 2010. Bacteriological testing completed during a 12-week study in 2007 by Malcolm Pirnie did not detect the presence of bacteria in any samples. AMEC's evaluation of all of this previously collected data was compiled into a report titled Production Well Water Quality Report, dated October 27, 2010, which provided the following conclusions:

> *The cumulative results of the historical and recent testing of groundwater samples from production wells PW-3 and PW-5 and a surface water sample from the Battle Creek River support the conclusion that groundwater in the City of Charlotte well field is not under the direct influence of a surface water source (the Battle Creek River). In addition, historical and recent laboratory testing results confirm that PW-1A preferentially captured water from the upper portion of the aquifer and the chemistry of groundwater at PW-5 appears to be influenced by the geochemistry of the underlying bedrock.*

On March 24, 2011, the MDEQ issued a letter to the City of Charlotte which concluded that:

> *Based upon our review of the information provided by BCI's report, the bacteriological history of the production wells, and the aquifer's hydrogeologic formation, DEQ staff conclude that the source of the city's production wells is under the direct influence of surface water.*

The City of Charlotte responded to the MDEQ letter on April 18, 2011, and disagreed with the MDEQ's determination. In addition, the City also offered the following information in support of its disagreement with the MDEQ:

> *The City has been providing municipal water to its residents since at least 1886 during which time there have not been any illness outbreaks associated with our water supply. In addition, over the last 20 years, the City has embarked upon various best management practices actions, including wellhead protection activities that further ensure that our water supply is safe and not, in our opinion, GWUDI.*

Due to the problems noted with well PW-1A, the City of Charlotte contracted with AMEC to complete geologic studies, install a replacement well (well PW-6), and assist with the design, permitting, and installation of a pump and ancillary piping for PW-6. A permit to complete the construction of PW-6 as a production well was issued to the City of Charlotte by the MDEQ on

March 29, 2011. Following completion of the permit required bacteriological testing, well PW-6 was placed into production. Well PW-1A was subsequently properly abandoned.

To further the evaluations regarding GWUDISW, AMEC completed additional sampling and testing of groundwater from production well PW-6.

Both definitions of GWUDISW were considered and examined as part of the PW-6 investigation and AMEC concluded that well PW-6 does not fit the criteria for a GWUDISW well. The water quality as measured by microscopic particulate analysis (MPA), including direct measurement of *Giardia* and *Cryptosporidium*, show the water quality to be low risk with a collective risk score of zero for contamination of pathogenic protozoa. The lack of correlation of the physical parameters described in the USEPA Surface Water Drinking Rule between PW-6 and the Battle Creek River demonstrates clearly that well PW-6 is not GWUDISW.

The Concept of GWUDISW

The basic concept of GWUDISW is that certain groundwater sources that receive recharge from surface water bodies may be at risk for contamination by the pathogenic protozoa *Giardia* and *Cryptosporidium*. In such cases, sources deemed GWUDISW are required to provide filtration in order to remove these microorganisms as they are highly resistant to disinfection by chlorination and most other disinfectants used by water utilities.

In the Surface Water Treatment Rule (SWTR), the USEPA defines GWUDISW as:

1. "Any water beneath the surface of the ground with significant occurrence of insects, other macroorganisms, algae, or large diameter pathogens such as *Giardia lamblia*" or
2. "Any water beneath the surface of the ground with significant and relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity, or pH that closely correlate to climatological or surface water conditions". (40 CFR 141.2).

Only *Giardia* was mentioned in the 1989 SWTR because *Cryptosporidium* was not at that time recognized as a waterborne pathogen. Both pathogens now need to be considered.

GWUDISW - a Federal and State Perspective

As presented above, there are two definitions of GWUDISW, and in making GWUDISW determinations, states have used these in combination, used one or the other, or chosen to use neither. Since the state has the discretion to decide how it wants to make GWUDISW determinations, the range of criteria used by states is broad. Some states have taken a minimal

approach relying on distance to a surface source and sanitary survey results, requiring no specific water quality monitoring. Many states use MPA as part of the evaluation and some rely on it as the final determining factor. Others use the physical parameters (temperature, pH, conductivity, and turbidity) described in the second definition of GWUDISW, measuring one or more over a defined period of time and incorporating surface water data for comparison. Some states have used both definitions and used the microbiological and physical data for GWUDISW determinations. When MPA is used in the determination, samples may be a single one which is usually collected in the spring or fall, or a set of samples taken seasonally over the course of a year.

Because new information on the microbiology of groundwater has emerged since the SWTR was promulgated in 1989, the use of MPA based solely on the relative risk of surface water influence as described in the SWTR guidance manual (USEPA, 1992) is being augmented with additional data collection activities. MPA continues to be used as a measure of microbiological water quality, but the data are interpreted differently from the high, moderate, and low risk categories historically used.

Use of MPA Analysis for GWUDISW Determinations

MPA is a microscopic technique used to identify and quantify macro and some microorganisms found in water samples. There are two published USEPA methods for MPA. One is for examining groundwater to aid in making GWUDISW determinations and is called "Consensus Method for Determining Groundwater under the Direct Influence of Surface Water Using Microscopic Particulate Analysis (MPA)" (USEPA, 1992). The second method is "Microscopic Particulate Analysis (MPA) for Filtration Plant Optimization" (USEPA, 1996). The methods are very similar in sample collection, processing and microscopic analysis, and differ mainly in data recording and interpretation.

MPA is useful in comparing concentration of indicators in surface water to that in a hydraulically connected well to determine the reduction of indicators by those mechanisms noted above to determine removal through the natural process of water recharging the aquifer. Clancy (1992) first presented the concept of using MPA to compare surface and groundwater quality in the same way that MPA is used to measure reduction of MPA indicators in surface water treatment plant performance optimization evaluations.

Scope of Work

A year-long study of the City of Charlotte's three production wells and the Battle Creek River is proposed to further evaluate if the Battle Creek River could be a potential source of surface water

contamination with increased risk of pathogenic protozoa entering the City of Charlotte's production wells.

The monitoring program will be conducted for a one year period and include the following items:

1. Collect and analyze Battle Creek River water samples, as well as raw and finished water samples, at each location monthly for turbidity determination.
2. Collect one MPA sample monthly from the Battle Creek River and each production well to assess general water quality. *Giardia* and *Cryptosporidium* will also be measured in all samples using USEPA Method 1623. If a high infiltration event is noted (e.g., flooding), additional samples may also be taken.
3. Collect temperature, pH, and specific conductivity data from the Battle Creek River and at each production well weekly, provided that a given production well is being used at the time of sample collection.
4. Summarize all data and prepare report of findings.

Methodologies and Data Interpretation

Samples will be collected into laboratory supplied containers after purging. Field water quality indicator constituents such as temperature, specific conductance, and turbidity will be continuously monitored during MPA sampling of the production wells. The results will be recorded electronically and downloaded for review.

MPA samples will be collected by directing approximately 500 gallons of water at a rate of approximately one gallon per minute through laboratory supplied filter media. Sampling will be performed during a time period wherein an individual production well is supplying water to the City of Charlotte distribution system. As such, AMEC will need to coordinate its sampling activities with the City of Charlotte. The filter samples from the Battle Creek River and production wells for MPA, *Giardia*, and *Cryptosporidium* will be shipped under chain-of-custody procedures to CEC within 24 hours of collection for analysis.

The sample of water from the Battle Creek River will be collected from the center of the river at the park trail bridge crossing using a clean sampling device and placed directly into laboratory supplied containers, placed on ice, and shipped to CEC using chain-of-custody procedures.

As outlined above, the production wells and the Battle Creek River will be monitored for MPA monthly (definition 1) and for physical characteristics including pH, temperature, specific conductance, and turbidity (definition 2) as described above.

MPA data will be used to assess the relative risk of surface water influence, as defined in the guidance manual tables, and to calculate the log removal of these same biological particulates that naturally occur in the aquifer. Temperature, conductivity, and pH measurements only demonstrate that a hydraulic connection may exist between surface and groundwater. Hydraulic connection means that water has the capability of flowing to the aquifer. However, these parameters do not demonstrate the actual risk for contamination by pathogenic protozoa.

Previous studies have shown that temperature is an important parameter in determining hydraulic connection and mixing of surface water and groundwater. The amplitude of the temperature curve provides a general indication of the amount of mixing. Groundwater amplitudes that overlie and are of the same magnitude as surface water indicates direct recharge from surface water. Groundwater temperature amplitudes that are relatively constant (e.g., straight line at or near the average annual air temperature) are indicative of groundwater that receives no local recharge from surface water. Typically, most groundwater that receives localized recharge has amplitudes somewhere in between those of surface water and non-connected groundwater.

Specific conductivity data, while being collected as part of this study plan, are more difficult to interpret. Conductivity is based upon the amount of total dissolved solids in water. Groundwater is typically higher in conductivity due to the water dissolving minerals from certain types of rock. The longer the water is in contact with rock, the higher the conductivity value. What can limit the use of conductivity for characterizing connection with surface water is that surface water may have a high conductivity due to base flow conditions upstream (groundwater discharging to surface water) or from areas of chemical contamination. It is important to understand the conditions for conductivity throughout the watershed in order to determine sources of total dissolved solids. In some cases the temperature and conductivity parameters can be conflicting in nature, which is why temperature is a better parameter to determine hydraulic connection. Based on the previous work at the subject site, both conductivity and temperature data were useful indicators of the difference between the production wells and the Battle Creek River.

Report of Findings

At the conclusion of the monitoring period, the data will be evaluated and a report prepared. Within the report will be a description of the historical data, as well as data collected as part of this study. It is also anticipated that calculations representing the magnitude of the different GWUDISW indicators (e.g., *Giardia*, *Cryptosporidium* diatoms, and turbidity) between the Battle Creek River and the production wells will be presented.

This study's approach is consistent with what has been reported in peer reviewed published literature since the SWTR was promulgated. The approach outlined above for additional data collection in making a GWUDISW determination on the City of Charlotte's production wells is

not unique. It is based upon the large body of scientific literature on the subject of groundwater quality and changes in the regulations.

Fee Estimate

Attached please find AMEC's Work Order and Fee Schedule covering the specific scope of work outlined herein. In order to initiate this work, please sign and return two copies of this Work Order to our office. Upon receipt of these documents from you, AMEC will return a fully executed copy to you for your records. This proposal will expire 60 days from the date hereof.

AMEC's estimated budget for the above Scope of Work is shown below:

Production Well and Surface Water Sampling and Analysis		
Project Management and Coordination	$720/month	$ 8,640.00
Sample Collection	$2,592/month	31,104.00
Database Management	$384/month	4,608.00
Laboratory Analysis (4 samples/month @ $630/sample)	$2,520/month	30,240.00
Reimbursable Field Equipment & Travel	$1,600/month	19,200.00
Sampling and Analysis Subtotal:	**$7,816/month**	**$ 93,792.00**
Data Analysis and Report Preparation		
Data Analysis		$ 3,000.00
Report Preparation and Submittal		5,500.00
Data Analysis and Report Preparation Subtotal:		**$ 8,500.00**
Total Fee Estimate:		**$102,292.00**
Contingency Sampling Surveys		
Sampling and Coordination		$ 1,776.00
Laboratory Analysis		1,280.00
Reimbursable Field Equipment and Travel		510.00
Contingent Sampling Subtotal – Per Event:		**$ 3,566.00**

AMEC will collect all of the MPA samples and understands that personnel from the City of Charlotte will collect the remaining data. Included within the project contingency item are costs to complete additional sampling surveys in the event that a significant event (e.g., flooding) occurs within the Battle Creek River. AMEC also understands that the City of Charlotte will contract directly with CEC.

AMEC is pleased to have the opportunity to provide the City of Charlotte with this proposal for additional evaluation of groundwater quality in the well field. We are available at your convenience to discuss any questions you may have.

Sincerely,

Mark B. Sweatman, CPG
Michigan Regional Manager

Reviewed and Affirmed by:

Garret E. Bondy, PE
Michigan Area Manager

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References

Clancy, J.L. 1992. Interpretation of Microscopic Particulate Analysis Data – A Water Quality Approach Proc. AWWA Water Quality Technology Conference, pp 1831-1847. Toronto, Ontario.

USEPA. 1992. Consensus Method for Determining Ground Waters under the Direct Influence of Surface Water using Microscopic Particulate Analysis, EPA 910/9-92-029, Port Orchard, WA.

USEPA. 1996. Microscopic Particulate Analysis for Filtration Plant Optimization, EPA 910-R-96-001, USEPA Office of Environmental Assessment, Seattle WA.

WORK ORDER NO.: 6

Issued Pursuant to Master Services Agreement Effective March 31, 2010, By and Between

AMEC Environment & Infrastructure, Inc. (AMEC) and City of Charlotte (CLIENT)

CLIENT Office:	City of Charlotte 111 E. Lawrence Avenue Charlotte, MI 48813	AMEC Project No: 18846.6 Work Order Type: (Check One) Time and Materials (rates attached) X
CLIENT Contact:	Amy Schoonover	Fixed Price _____
AMEC Office:	10503 Citation Drive, Ste. 600 Brighton, MI 48116	CLIENT Reference No:_____
AMEC Contact:	Mark B. Sweatman, CPG	Date: January 13, 2012

1. SCOPE OF WORK: Sampling and Analysis Plans - See attached proposal letter, dated January 13, 2012, which is incorporated herein by reference.

2. LOCATION/CLIENT FACILITY INVOLVED: City of Charlotte, Michigan, well field

3. PERIOD OF PERFORMANCE: One year

4. AUTHORIZED FUNDING: $102,292.00

5. SPECIAL PROVISIONS: AMEC's current Fee Schedule is attached. This proposed Work Order will expire 60 days from the date hereof.

CLIENT:		AMEC:	
By:	_____	By:	_____
Name:	_____	Name:	_____
Title:	_____	Title:	_____
Date:	_____	Date:	_____
Address:	_____	Address:	10503 Citation Drive, Ste. 600 Brighton, MI 48116
	_____		

MICHIGAN
FEE SCHEDULE

FEE SCHEDULE FOR PROFESSIONAL SERVICES

Engineers, Geologists, Scientists, and Technical Specialists*	**Hourly Rate**
Principal	$180
Associate	$147
Project Manager/Senior Professional II/Project Manager	$137
Senior Professional/Project Manager	$130
Project Professional II/Project Manager	$118
Project Professional/Project Manager	$96
Staff Professional III	$82
Staff Professional II	$69
Staff Professional I	$57
Technical Assistant	$45
Technical Support	
Senior Designer	$90
Senior CADD/GIS Technician	$82
CADD/GIS Technician	$72
Programmer	$110
GPR Specialist	$70
Researcher/Coordinator	$75
Administrative/Clerical	$58
Construction Inspection/Administration	
Resident Inspector	$90
Construction Inspector	$80
Senior Lab/Field Technician II	$68
Senior Lab/Field Technician I	$61
Lab/Field Technician II	$51
Lab/Field Technician I	$44
Expenses	
Support	
Based on Professional Labor	12%
Computer CAD/GIS Modeling	$13.00
Vehicles	$1.15 per mile
Subcontractors and Reimbursable Expenses	15%

*** Legal Services - Mediation, Deposition, Court Appearances – hourly rates plus 25%**