CITY WATER TREATMENT SYSTEM DESIGN PLANS AND SPECIFICATIONS

ATTICA, INDIANA

NOVEMBER 6, 2009
REF. NO. 019190 (39)

Prepared by:
Conestoga-Rovers & Associates

6520 Corporate Drive
Indianapolis, IN 46278

Office: (317) 291-7007
Fax: (317) 328-2666

web: http:\\www.CRAworld.com

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 BACKGROUND

The City of Attica (City), population approximately 3,400, is located in Fountain County in west-central Indiana, approximately 80 miles west-northwest of Indianapolis and 20 miles southwest of Lafayette, Indiana (Figure 1.1). The City operates a wellfield with two municipal supply wells (Nos. 1 and 2) located in the northwestern portion of town adjacent to the Wabash River (Figure 1.2). These two wells, each capable of producing at a rate of approximately 1,000 gallons per minute (gpm), pump groundwater directly into the City's distribution network and into two 500,000-gallon reservoirs located southeast of the wellfield. The City has a third well (Well No. 3) that is located approximately 800 feet southwest of Wells No. 1 and 2, but this well has been out-of-service for a number of years due to vandalism of the electrical components.

Historically, low-level concentrations of the compound trichloroethene (TCE) have been detected in Wells No. 1 and 2, generally at concentrations below the Indiana Department of Environmental Management's (IDEM's) Residential Default Closure Level (RDCL) and the federal Maximum Contaminant Level (MCL) of 5 micrograms per liter (µg/L). However, occasional detections of TCE at concentrations slightly above the RDCL and MCL have occurred at Well No. 1, but not in consecutive sampling rounds.

1.2 PURPOSE

At the request of the U.S. EPA, Conestoga-Rovers & Associates (CRA) previously has submitted the City Water Treatment System Design Work Plan ("Work Plan"). The purpose of the Work Plan was to describe the steps involved in the design of a system to treat water obtained from the two municipal wells located adjacent to the Wabash River for low levels of TCE. The purpose and objective of the City Water Treatment System is to treat the water extracted from City Wells No. 1 and No. 2 for TCE to levels below the MCL and IDEM's RDCL until U.S. EPA determines that such treatment is no longer necessary.

The next step in the process was to develop an Interim Measures (IM) Design Program to implement the treatment technology selected in the Work Plan.

The IM Design Program included the following:

- Design Plans and Specifications

- Operations and Maintenance Plan
- Project Schedule
- Final Design Documents.

This IM Design Program Report is being submitted to the Agency to document the results of the implementation of the Design Program formatted in accordance with the 1999 U.S. Environmental Protection Agency (U.S. EPA) Region V Resource Conservation and Recovery Act (RCRA) 3008(h) Consent Order No. IND 005 477 021 issued to Radio Materials Corporation.

2.0 DESIGN STRATEGY

2.1 CITY WELL CONSTRUCTION AND OPERATION

The City of Attica's (the City's) water is supplied by two production wells located adjacent to the Wabash River west of Water Street and north of State Highway 41. The two production wells (No. 1 and No. 2) are screened to depths of 110 feet to 125 feet below ground surface in alluvial sand and gravel deposits.[1] Both wells are fitted with 30-feet of slotted screen. The two operating wells are located in relatively close proximity, within approximately 50 feet of each other. The two wells are fitted with 100 horsepower turbine pumps rated at approximately 1,000 gallons per minute (gpm). The City generally operates the wells on an alternating basis, where only one of the pumps operates at any given time. However, both wells can run simultaneously during periods of peak demand. The City adds chlorine and fluoride to the water at a small building located on the wellfield.

Water is pumped from the two extraction wells to two 500,000-gallon capacity reservoirs located approximately two-thirds of a mile southeast of the well field. One of these reservoirs is a tower that serves the "upper" portion of the City (higher elevations away from the River) and the second is an in-ground reservoir serving the lower elevations of the City. Water pumped to the reservoirs charges the water supply lines en route to the reservoirs.

CRA obtained daily production records from the City for the period from February 2006 through August 2008. Those records were submitted to the U.S. EPA in the Work Plan. In general, daily water production was below 800,000 gallons per day (gpd), or approximately 556 gpm. However, depending on weather conditions, demand can increase to 900,000 to 1,000,000 gpd (625 to 694 gpm). The peak use observed was during a 2-day period in June 2007, when the water production rate approached 2,000,000 gpd (1,389 gpm).

2.2 WATER QUALITY

Based on the historical analytical data obtained during monitoring activities performed by the City, TCE concentrations in the water pumped from Wells No. 1 and 2 generally range between 1 and 4 µg/L, with the concentrations observed at Well No. 1 being slightly higher than those at Well No. 2. On occasion, TCE concentrations reported at

[1] The City has a third production well that has been out of service for the last 7 or 8 years when, according to City personnel, the electrical controls and power feed were damaged by vandals.

Well No. 1 slightly exceed the IDEM's RDCL and the MCL of 5 µg/L. This occurred most recently in November 2007, when the TCE concentration measured at Well No. 1 was 6.74 µg/L and again in May 2008, when the TCE concentration at Well No. 1 was 5.3 µg/L. The TCE concentration measured at Well No. 2 during November 2007 and May 2008 were 3.03 µg/L and 3.3 µg/L, respectively. A summary of the TCE analytical data for the period of March 2002 to September 2009 is provided in Table 2.1.

2.3 DESIGN CRITERIA

The selected technology for City water treatment, air stripping, involves the mass transfer of volatile compounds from water to air. This process typically is conducted in a packed tower or an aeration tank. The packed tower air stripper includes a spray nozzle at the top of the tower to distribute water over the packing in the column, a fan to force air in the opposite direction to the water flow, and a sump at the bottom of the tower to collect treated water. Auxiliary equipment that can be added to the air stripper includes automated control systems with sump level switches, and safety features such as differential pressure monitors, and high sump level switches. Air stripping is a proven and effective technology for removing VOCs from groundwater. Additionally, air stripping technology is a process that requires minimal ongoing O&M activity particularly in circumstances, such as in Attica, when the water hardness is not excessive and excessive scaling of the packing material is not expected.

To provide the City with the most operational flexibility, the system design basis includes the capability to handle a peak flow rate of 2,000 gpm (2.88 million gpd). This would accommodate the maximum capacity of 2,000 gpm assuming that each of the two supply wells were operating at their individual maximum capacities. This eliminates any need to cycle the wells in order to meet the MCL/RDCL for TCE and allows full production capacity from the wellfield in the event of an emergency (i.e., additional short-term water capacity in the event of a fire, etc.). Additionally, the system was designed to allow bypass of the air stripping tower in the event of an emergency, malfunction, or need to perform maintenance on the tower.

The objective of the system is to treat the City water so that TCE concentrations are below the MCL/RDCL of 5 µg/L. To attain the target TCE effluent concentration, the system was designed to be 95 percent efficient in removing TCE at a concentration of 10 µg/L. At this operational efficiency, the TCE concentrations in the raw water supplied to the treatment system would have to exceed historical levels by a significant amount (approximately a factor of 20) before the MCL/RDCL for TCE would be potentially exceeded. At the current levels of TCE observed in the samples from Wells 1 and 2, it is anticipated that TCE concentrations will likely be below 0.5 µg/L following treatment.

Another design criterion for the system was to require a minimal amount of operational input from City personnel over and above that which is required to operate the current system. Additionally, for ease of constructability, the treatment system was designed to operate at the current location of the City wellfield on land owned by the City.

During February 2008, CRA collected water samples from Wells No. 1 and 2 and analyzed the samples for volatile organic compounds (VOCs) and a number of water quality indicators. The results are summarized in Table 2.2. Excessive scaling of the air stripper is not anticipated based on testing of the City water supply. Therefore, pretreatment of the water for the proper operation of the air stripper is not required.

2.4 PERMIT REQUIREMENTS

2.4.1 POTENTIAL EMISSIONS EVALUATION

CRA completed a potential emissions evaluation to determine if an air stripper to be installed to treat City water would be subject to Indiana air permitting in accordance with Article 2 (Permit Review Rules) of Title 326 (Air Pollution Control Board) of the Indiana Administrative Code (326 IAC 2).

Indiana air permitting is based upon potential emissions, also known as the potential to emit (PTE), of regulated air pollutants including carbon monoxide (CO), lead (Pb), nitrogen oxides (NO_X), particulate matter (PM), particulate matter with diameter less than 10 microns (PM_{10}), sulfur dioxide (SO_2), VOCs, and hazardous air pollutants (HAPs). Pursuant to 326 IAC 1-2-55, potential emissions are defined as follows:

> *"Emissions of any one (1) pollutant which would be emitted from a facility if that facility were operated without the use of pollution control equipment unless such control equipment is (aside from air pollution control requirements) necessary for the facility to produce its normal product or is integral to the normal operation of the facility. Potential emissions shall be based on maximum annual rated capacity unless hours of operation are limited by enforceable permit conditions. Potential emissions from a facility shall take into account the hours of operation per year and shall be calculated according to federal emission guidelines in AP 42-most recent edition-Compilation of Air Pollution Factors, or calculated based on stack test data or other equivalent data acceptable to the commissioner."*

TCE is classified as a VOC and HAP and is the regulated air pollutant that would be emitted from the air stripper. Below is a list of conservative assumptions underlying the calculation of the potential emissions of the air stripper:

- the maximum TCE concentration of the water stream undergoing treatment is 10 parts per billion (ppb), which is equivalent to 10 µg/L;
- the maximum water flow rate through the air stripper is 2,000 gpm;
- the air stripper will operate 24 hours per day and 365 days per year; and
- the air stripper will transfer 100 percent of the TCE in the water stream undergoing treatment to an air stream emitted to the atmosphere.

Based on these assumptions, the potential emissions were estimated to be 88 pounds of TCE per year, which is 0.044 tons per year (tpy). Detailed calculations of the estimated potential emissions are provided in Table 3.1. Air permitting is not required for a new source that has potential emissions less than 10 tpy of VOCs and less than 10 tpy of a single HAP. The estimated potential emissions of TCE from the air stripper are well below these thresholds so the air stripper would not require an Indiana air permit in accordance with 326 IAC 2.

2.4.2 PERMIT TO CONSTRUCT

A permit for construction of the water treatment system has been issued by IDEM as required by 327 IAC 8-3-3. In accordance with 327 IAC 8-3-2, the permit is issued in the name of the entity that allows the construction, installation, or modification of any facility, equipment, or device for any public water supply. In this case, it is the City of Attica that applied for and was issued a permit to construct by IDEM (Permit No. WS-10302). A copy of the permit to construct a public water system was provided in the Work Plan.

2.4.3 CITY PERMITS

The City will be responsible for completing any applications necessary, obtaining any City permits required for construction of the treatment system building and components, and coordinating any necessary inspections during system construction.

2.5 WELLFIELD PROPERTY BOUNDARY SURVEY

During the initial design phase, the City was unable to provide an appropriate boundary survey of the land under its control that comprises the wellfield property. Therefore, Miller Surveying Inc. of Noblesville, Indiana was commissioned to perform a boundary and topographic survey of the wellfield property. The survey also included existing features present on the property. This survey was a basis for placement of structures on the property that house or are associated with the water treatment system. A copy of the survey provided by Miller Surveying is provided in Appendix A.

3.0 DESIGN COMPONENTS

The City water treatment system design includes the following components:

- the construction site layout and grading plan;
- the air stripper treatment system and associated components;
- the discharge transfer tank;
- the plumbing components, piping, and associated discharge transfer pumps to connect to the City water distribution network;
- the system controller, associated controls, and electrical components;
- a heated, ventilated, and lighted steel-framed building to house the air stripper; and
- a chloride and fluoride treatment relocated to the new treatment building downstream of the air stripper.

CRA submitted the design basis requirements to Delta Cooling Towers, Inc. Delta designed an air stripper to meet the required flow rates, contaminant removal requirements, and structural requirements. The Delta design calculations are presented in Appendix B.

The system requires transfer pumps to move the water from the air stripper receiving tank, through the City mains to the City reservoirs. CRA performed the necessary calculations to determine the required pump size. CRA calculations are presented in Appendix C.

In order to verify that the subsoils at the location selected for the installation of the treatment system had adequate bearing strength to support the system, CRA conducted a geotechnical investigation at the building site. The results of this investigation indicated that the chosen location was acceptable for the installation of the system. The scope of work for the investigation and the investigative results are presented in Appendix D.

The system includes the capability to divert the flow through a control valve directly into the City water supply during routine maintenance (i.e., cleaning of packed tower), in an emergency, or in the event of equipment malfunction.

The selected components for the system are commercial products currently accepted for use in groundwater treatment and environmental control. The use of this equipment and components enhances the ability to construct the system and provides for ease of maintenance. The system components will be assembled using standard construction practices and techniques.

4.0 SYSTEM DESIGN

CRA prepared a preliminary Process and Instrumentation Diagram (P&ID) for the City water treatment system and provided the diagram to the City for comment on May 23, 2008. Hannum, Wagle & Cline Engineering of Terre Haute, Indiana (HWC) provided comments to CRA, on behalf of the City, on July 1, 2008. These comments were incorporated into the design.

As with the P&ID, the City was provided the preliminary design package and the 95 percent design drawings for the water treatment system for comment. The 95 percent design package contained all of the necessary information, drawings, plans, and specifications for construction of the City water treatment system. The 95 percent design package was submitted to the U.S. EPA and the City for review and comment on November 24, 2008. CRA received comments from the City's engineer dated January 22, 2009 and based on these comments on the 95 percent design package, CRA prepared the 100 percent design package (Final Design).

5.0 OPERATION AND MAINTENANCE MANUAL

CRA has developed a draft Operation and Maintenance (O&M) manual for the treatment system, which addresses the following:

- Equipment start-up and operator training
- Description of equipment
- Description of normal operation and maintenance
- Description and schedule of routine monitoring
- Potential O&M issues and common remedies

The draft O&M manual for the water treatment system will be provided to U.S. EPA as a separate document as requested by U.S. EPA. This document will be finalized following discussions and input from City personnel.

6.0 DESIGN SCHEDULE

The design of the treatment system is completed and construction of the water treatment system is already well underway and anticipated to be completed in December 2009. A construction schedule is provided in Figure 6.1.

7.0 FINAL DESIGN DOCUMENTS

The Final Design Documents including the plans and specifications are provided in Appendix D.

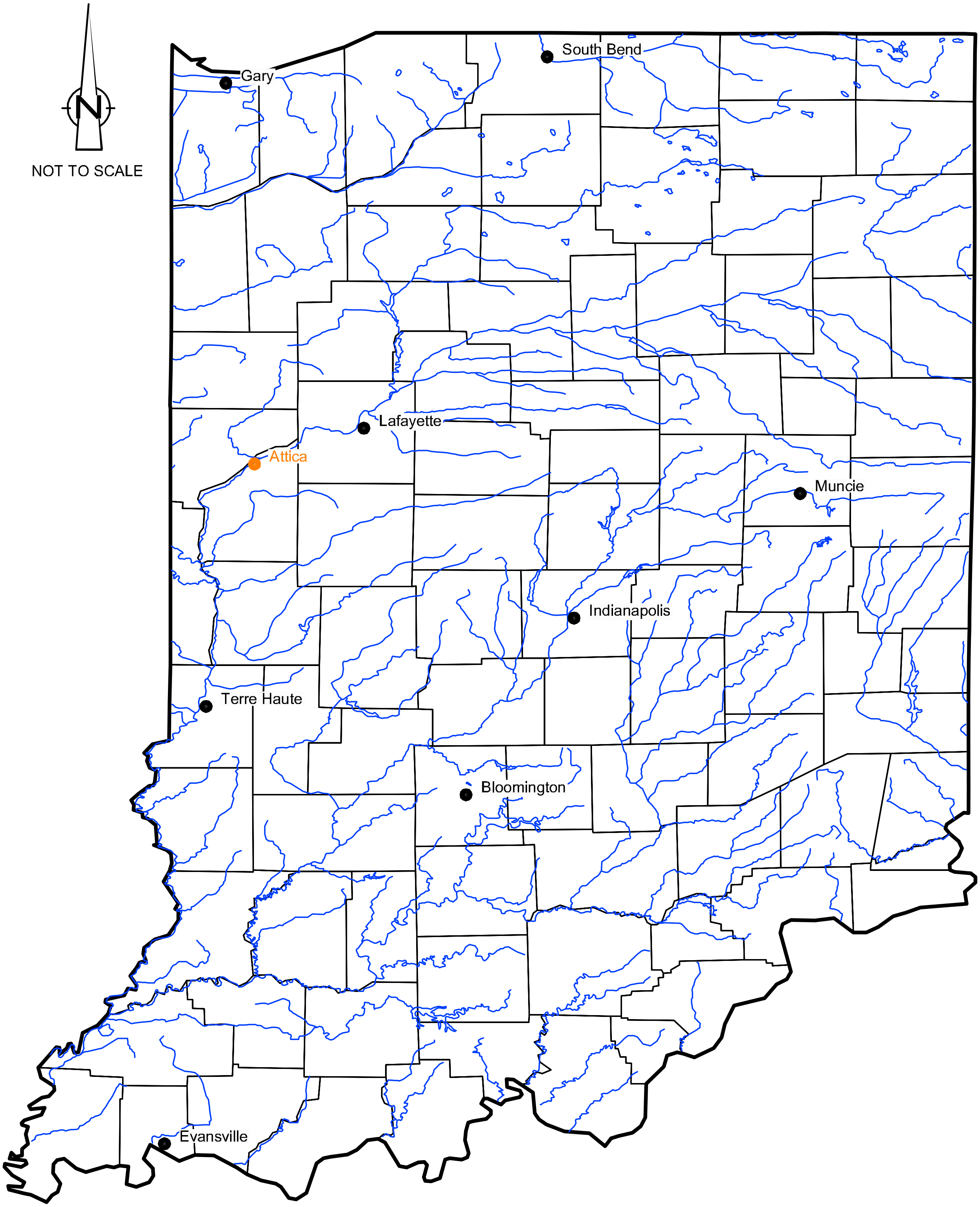


figure 1.1

CITY LOCATION MAP
Attica, Indiana

19190-03(039)GN-WA002 NOV 05/2009

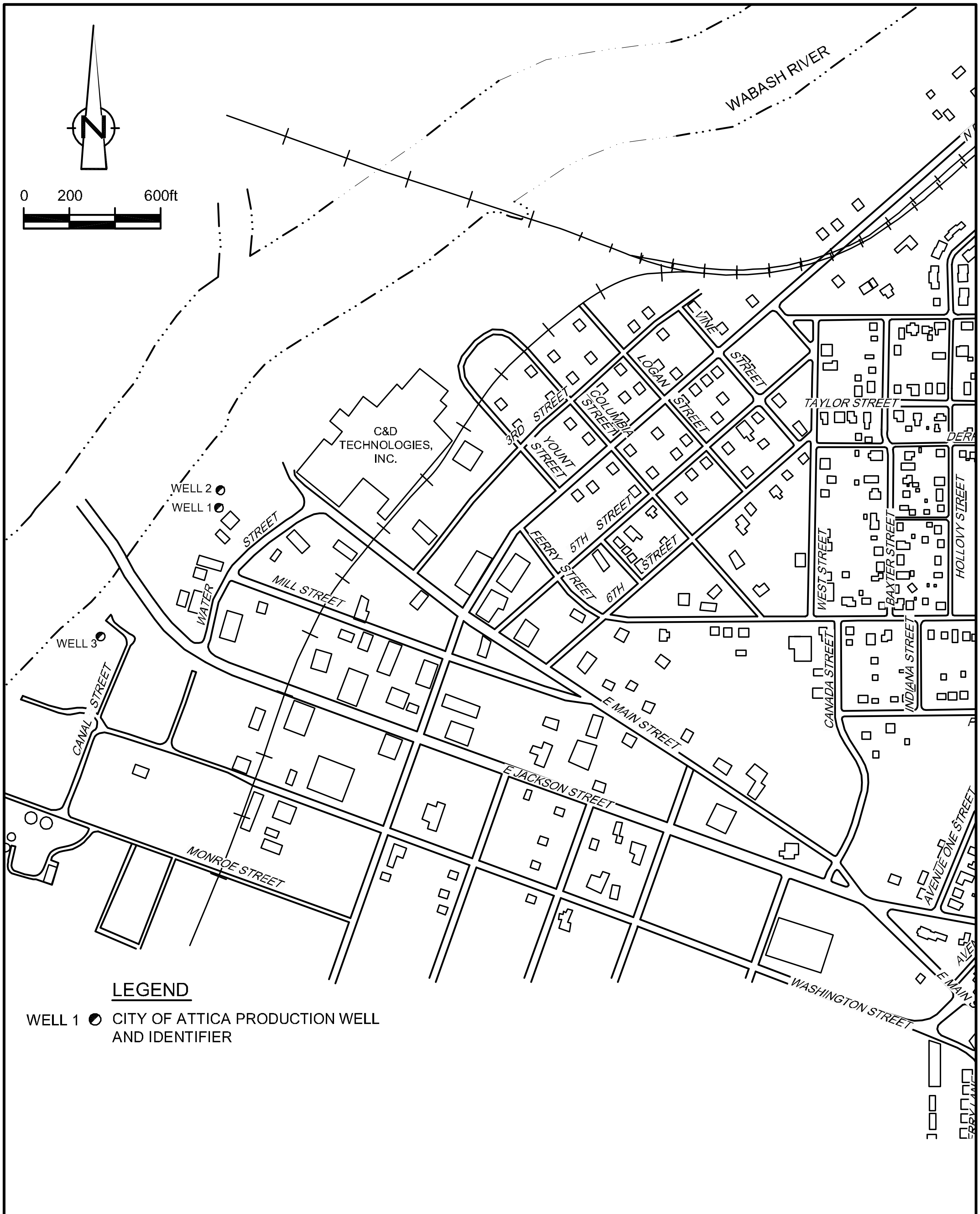


figure 1.2

CITY PRODUCTION WELL LOCATIONS

Attica, Indiana

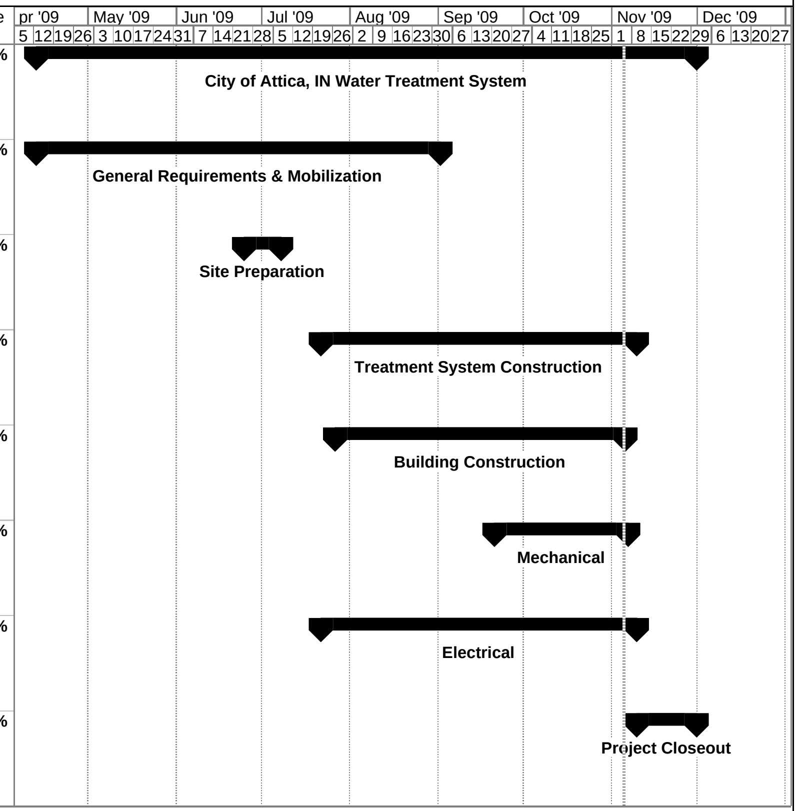
19190-03(039)GN-WA001 NOV 05/2009

CONESTOGA-ROVERS & ASSOCIATES

FIGURE 6.1

CONSTRUCTION SCHEDULE
CITY WATER TREATMENT SYSTEM
ATTICA, INDIANA

ID	WBS	Task Name	Duration	Start	Finish	% Complete
1	1	**City of Attica, IN Water Treatment System**	**166 days**	**Mon 4/13/09**	**Mon 11/30/09**	**89%**
2	**1.1**	**General Requirements & Mobilization**	**102 days**	**Mon 4/13/09**	**Tue 9/1/09**	**99%**
27	**1.2**	**Site Preparation**	**9 days**	**Thu 6/25/09**	**Tue 7/7/09**	**100%**
31	**1.3**	**Treatment System Construction**	**79 days**	**Wed 7/22/09**	**Mon 11/9/09**	**87%**
32	**1.3.1**	**Building Construction**	**74 days**	**Mon 7/27/09**	**Thu 11/5/09**	**98%**
48	**1.3.2**	**Mechanical**	**35 days**	**Mon 9/21/09**	**Fri 11/6/09**	**88%**
56	**1.3.3**	**Electrical**	**79 days**	**Wed 7/22/09**	**Mon 11/9/09**	**72%**
64	**1.4**	**Project Closeout**	**15 days**	**Tue 11/10/09**	**Mon 11/30/09**	**0%**



Date: Thu 11/5/09

Task		Summary		Rolled Up Progress		Project Summary	
Progress		Rolled Up Task		Split		Group By Summary	
Milestone		Rolled Up Milestone		External Tasks		Deadline	

019190 (39)

TABLE 2.1

CITY OF ATTICA TCE ANALYTICAL RESULTS
MARCH 2002 THROUGH SEPTEMBER 2009
WELLS NO. 1 AND 2
ATTICA, INDIANA

	TCE Concentration (ug/L)	
Date	***Well #1***	***Well #2***
2/22/2001	3.1	1.8
3/19/2002	3.0	1.1
5/12/2003	3.3	1.2
8/2/2004	4.7	1.5
3/3/2005	5.5	1.1
3/29/2005	2.5	2.5
6/20/2005	5.5	1.6
9/7/2005	3.7	2.5
12/21/2005	4.8	1.8
1/23/2006	3.7	1.1
6/13/2006	2.4	<0.5
8/28/2006	3.8	2.0
11/15/2006	0.7	1.7
3/12/2007	2.8	0.9
5/14/2007	1.8	0.6
8/6/2007	3.86	2.42
11/26/2007	6.74	3.03
2/26/2008	3.71	1.17
5/19/2008	5.3	3.3
9/8/2008	4.38	<0.5
11/11/2008	4.2	2.33
2/16/2009	4	2.3
6/9/2009	2.8	1.9
9/30/2009	2.8	<0.5
Summary		
Minimum	*0.7*	*<0.5*
Maximum	*6.7*	*3.3*

Source: Indiana Department of Environmental Management - Drinking Water Branch

TABLE 2.2

SUMMARY OF CITY WATER ANALYTICAL RESULTS
FEBRUARY 2008
ATTICA, INDIANA

Sample Location:		*Attica Well 1*	*Attica Well 2*
Sample ID:		*CW-021408-MG-001*	*CW-021408-MG-002*
Sample Date:		*2/14/2008*	*2/14/2008*
Parameters	*Units*		
Volatile Organic Compounds			
1,1,1,2-Tetrachloroethane	ug/L	ND (0.50)	ND (0.50)
1,1,1-Trichloroethane	ug/L	ND (0.50)	ND (0.50)
1,1,2,2-Tetrachloroethane	ug/L	ND (0.50)	ND (0.50)
1,1,2-Trichloroethane	ug/L	ND (0.50)	ND (0.50)
1,1-Dichloroethane	ug/L	ND (0.50)	ND (0.50)
1,1-Dichloroethene	ug/L	ND (0.50)	ND (0.50)
1,1-Dichloropropene	ug/L	ND (0.50)	ND (0.50)
1,2,3-Trichlorobenzene	ug/L	ND (2.0)	ND (2.0)
1,2,3-Trichloropropane	ug/L	ND (0.50)	ND (0.50)
1,2,4-Trichlorobenzene	ug/L	ND (2.0)	ND (2.0)
1,2,4-Trimethylbenzene	ug/L	ND (2.0)	ND (2.0)
1,2-Dibromo-3-chloropropane (DBCP)	ug/L	ND (2.0)	ND (2.0)
1,2-Dibromoethane (Ethylene Dibromide)	ug/L	ND (2.0)	ND (2.0)
1,2-Dichlorobenzene	ug/L	ND (0.50)	ND (0.50)
1,2-Dichloroethane	ug/L	ND (0.50)	ND (0.50)
1,2-Dichloropropane	ug/L	ND (0.50)	ND (0.50)
1,3,5-Trimethylbenzene	ug/L	ND (2.0)	ND (2.0)
1,3-Dichlorobenzene	ug/L	ND (0.50)	ND (0.50)
1,3-Dichloropropane	ug/L	ND (0.50)	ND (0.50)
1,4-Dichlorobenzene	ug/L	ND (0.50)	ND (0.50)
2,2-Dichloropropane	ug/L	ND (0.50)	ND (0.50)
2-Butanone (Methyl Ethyl Ketone)	ug/L	ND (20)	ND (20)
2-Chlorotoluene	ug/L	ND (2.0)	ND (2.0)
2-Hexanone	ug/L	ND (20)	ND (20)
2-Phenylbutane (sec-Butylbenzene)	ug/L	ND (2.0)	ND (2.0)
4-Chlorotoluene	ug/L	ND (2.0)	ND (2.0)
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	ug/L	ND (20)	ND (20)
Acetone	ug/L	ND (20)	ND (20)
Benzene	ug/L	ND (0.50)	ND (0.50)
Bromobenzene	ug/L	ND (2.0)	ND (2.0)
Bromodichloromethane	ug/L	0.13 J	ND (0.50)
Bromoform	ug/L	ND (0.50)	ND (0.50)
Bromomethane (Methyl Bromide)	ug/L	ND (0.50)	ND (0.50)
Carbon disulfide	ug/L	ND (0.50)	ND (0.50)
Carbon tetrachloride	ug/L	ND (0.50)	ND (0.50)
Chlorobenzene	ug/L	ND (0.50)	ND (0.50)
Chlorobromomethane	ug/L	ND (0.50)	ND (0.50)
Chloroethane	ug/L	ND (0.50)	ND (0.50)
Chloroform (Trichloromethane)	ug/L	ND (0.50)	ND (0.50)
Chloromethane (Methyl Chloride)	ug/L	ND (0.50)	ND (0.50)
cis-1,2-Dichloroethene	ug/L	0.14 J	ND (0.50)
cis-1,3-Dichloropropene	ug/L	ND (0.50)	ND (0.50)
Cymene (p-Isopropyltoluene)	ug/L	ND (2.0)	ND (2.0)
Dibromochloromethane	ug/L	0.16 J	ND (0.50)

TABLE 2.2

SUMMARY OF CITY WATER ANALYTICAL RESULTS
FEBRUARY 2008
ATTICA, INDIANA

Sample Location:		*Attica Well 1*	*Attica Well 2*
Sample ID:		*CW-021408-MG-001*	*CW-021408-MG-002*
Sample Date:		*2/14/2008*	*2/14/2008*
Dibromomethane	ug/L	ND (0.50)	ND (0.50)
Dichlorodifluoromethane (CFC-12)	ug/L	ND (0.50)	ND (0.50)
Ethylbenzene	ug/L	ND (0.50)	ND (0.50)
Hexachlorobutadiene	ug/L	ND (2.0)	ND (2.0)
Isopropylbenzene	ug/L	ND (2.0)	ND (2.0)
m&p-Xylene	ug/L	ND (0.50)	ND (0.50)
Methylene chloride	ug/L	ND (2.0)	ND (2.0)
Naphthalene	ug/L	ND (2.0)	ND (2.0)
n-Butylbenzene	ug/L	ND (2.0)	ND (2.0)
n-Propylbenzene	ug/L	ND (2.0)	ND (2.0)
o-Xylene	ug/L	ND (0.50)	ND (0.50)
Styrene	ug/L	ND (0.50)	ND (0.50)
tert-Butylbenzene	ug/L	ND (2.0)	ND (2.0)
Tetrachloroethene	ug/L	ND (0.50)	0.14 J
Toluene	ug/L	ND (0.50)	ND (0.50)
trans-1,2-Dichloroethene	ug/L	ND (0.50)	ND (0.50)
trans-1,3-Dichloropropene	ug/L	ND (0.50)	ND (0.50)
Trichloroethene	ug/L	3.1	1.3
Trichlorofluoromethane (CFC-11)	ug/L	ND (0.50)	ND (0.50)
Vinyl chloride	ug/L	ND (0.50)	ND (0.50)
Metals			
Calcium	ug/L	100000	99700
Iron	ug/L	9 J	44.2
Manganese	ug/L	ND (5)	30.4
General Chemistry			
Alkalinity, Total (as CaCO3)	mg/L	286	290
Bicarbonate (as CaCO3)	mg/L	286	290
Chloride	mg/L	30.6	21.2
Fluoride	mg/L	1.2	0.153 J
Hardness, Carbonate	mg/L	388	376
Sulfate	mg/L	74.1	67.3
Total Dissolved Solids (TDS)	mg/L	449	400
Total Suspended Solids (TSS), Dissolved	mg/L	ND (5)	ND (5)

TABLE 3.1

SUMMARY OF ESTIMATED POTENTIAL EMISSIONS FROM AIR STRIPPER
ATTICA, INDIANA

Max. TCE Concentration of Water Stream in Air Stripper [ug/l] =	10
Max. TCE Concentration of Water Stream in Air Stripper [lb/gal] (1) =	8.3E-08
Max. Water Flow Rate through Air Stripper [gal/min] =	2,000
Max. Amount of TCE in Water through Air Stripper [lb/min] (2) =	1.7E-04
Max. Amount of TCE in Water through Air Stripper [lb/yr] (3) =	88
Estimated Potential Emissions of TCE from Air Stripper [lb/yr] (4) =	88
Estimated Potential Emissions of TCE from Air Stripper [tpy] =	4.4E-02

Notes:

(1) Max. TCE Concentration [lb/gal] = Max. TCE Concentration [ug/l] / 1,000,000 ug/g / 453.6 lb/g x 3.78 l/gal

(2) Max. Amount of TCE through Air Stripper [lb/min] = Max. Water Flow Rate through Air Stripper [gal/min] x Max. TCE Concentration of Water Stream in Air Stripper [lb/gal]

(3) Max. Amount of TCE through Air Stripper [lb/yr] = Max. Amount of TCE through Air Stripper [lb/min] x 60 min/hr x 24 hr/day x 365 day/yr

(4) Assumed that the air stripper will transfer 100% of the TCE in the water stream undergoing treatment to an air stream emitted to the atmosphere.

Acronyms/Units of Measure:

gal/min - gallons per minute
lb/gal - pounds per gallon
lb/min - pounds per minute
lb/yr - pounds per year
TCE - Trichloroethylene
tpy - tons per year
ug/l - micrograms per liter