METCALF AND EDDY
ACADEMIC DESIGN COMPETITION 2007-2008

PROBLEM 2

Design Topic

Selection of water treatment processes upgrade to meet Arsenic limit. Assess possible modifications to existing treatment process and/or additional treatment, compare the alternatives and provide recommendations.

Background

A water treatment plant currently treating water from two sources is challenged with two issues: stringent Arsenic removal requirement, and changes in the blend of water sources. Treated water must also meet the national drinking water standards on other constituents. The three main water quality issues for the treatment plant are arsenic, organic carbon, and bromate.

For arsenic, current national primary drinking water regulations set 0.010 mg/L (10 µg/L) as a maximum contaminant level (MCL), and 0 mg/L as a maximum contaminant level goal (MCLG). Each State can set more/less stringent MCLs. Some water supply agencies are foreseeing further reduction of MCL in the near future and setting the treatment goals to lower than the national/state MCL.

The engineers at the treatment plant determined that enhanced coagulation (EC) or a high-rate clarification process might be the best solution to achieve the plant's treatment goals.

Design Question

Develop a design recommendation for an enhanced coagulation or a high-rate clarification process to reliably and cost-effectively achieve the treatment goals. The treatment plant must meet the national primary drinking water standards and arsenic level of less than 5 µg/L while maintaining ozonation and disinfection byproduct levels below 40 percent of the MCLs.

Specify water quality parameters to be monitored and tested. Propose a conceptual level design to produce water meeting the above requirements, and justify the selected design based on performance and cost. Existing water treatment plant data and design conditions are provided below.

Existing WTP Process Data

Existing water treatment process includes pre-ozonation, chemical coagulation, flocculation, and rapid filtration with dual-media filters (sand and anthracite), as shown in the figure below. Note that the figure is showing only half of the plant, i.e., there are two treatment trains in a mirror image. Ferric chloride and a polymer are used as coagulants. Product water is chlorinated before distributed to the water distribution system. Current plant has 16 feet headloss between the fine screen and the product water outlet. The hydraulic loading rate for the existing filtration process is 9.0 gpm/ft^2.

Source water is by average 35 percent from Source A, 65 percent from Source B, but it can be shifted to 100 percent Source A or B depending on the availability of water from each source. Chemical dosing and resulting water quality from the existing treatment process are shown in the table below.

Table: Source water quality data

Parameter	Source A	Source B
Average/Max flow contribution, %	25/100	75/100
Average/Max flow rate, mgd	250/600 (combined)	
Arsenic (µg/L)	25 (10-day peak = 70)	2
pH	8.0	8.0
Alkalinity (mg/L as $CaCO_3$)	108	76
Turbidity (NTU)	1.5	9
Total organic carbon (mg/L)	3.0	4.3
Bromide (mg/L)	0.05	0.27
Total phosphorus (mg/L)	0.06	0.10

Table: Existing treatment process data

Parameter	Unit	Value
CHEMICAL DOSING		
Pre-ozonation O_3 dose	mg/L	1.15
Ferric Chloride	mg/L	1.2
Cationic polymer (25% active solids)	mg/L	1.0
Chlorine (effluent)	mg/L	2.4
PRODUCT WATER QUALITY (annual average)		
Alkalinity	mg/L as $CaCO_3$	88
Arsenic (total)	µg/L	3.8
Bromate	µg/L	5.5
Chlorine residual	mg/L	2.0
Total haloacetic acids	µg/L	40
Total trihalomethanes	µg/L	60
pH	pH unit	7.6
Total organic carbon	mg/L	2.1
Turbidity	NTU	0.07

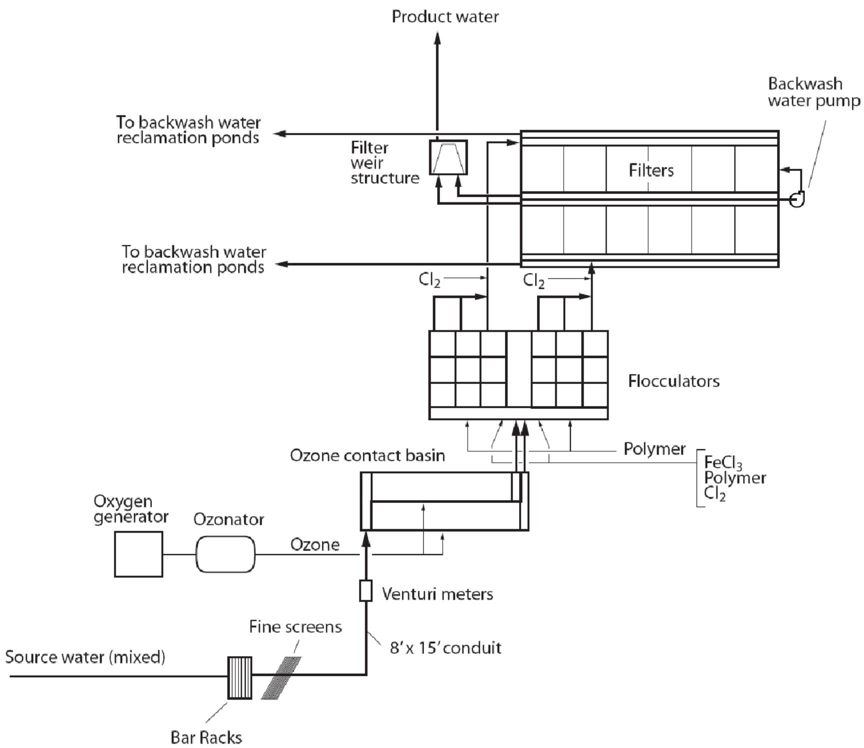

Figure: Existing water treatment process

Design Conditions

- Assume the design produces a peak flow to the WTP with the following characteristics
  - Peak (design) flow = 600 mgd; Average treatment flow = 250 mgd
  - Source: by average 50% Source A, 50% Source B, but the contribution from either source could be 100% depending on the availability
- Use the existing plant data to estimate the performance of the treatment alternatives
- Develop possible treatment alternatives and assess each option in terms of cost and non-cost issues
- Make recommendations for the plant upgrade and justify the selected technologies

For more information, please contact Roy Tsuchihashi (Ryujiro.Tsuchihashi@m-e.aecom.com). Information can also be obtained at www.m-e.com.

Metcalf & Eddy | AECOM provides planning, design, construction and operations services for water, wastewater and hazardous waste management facilities and programs. Metcalf & Eddy | AECOM is part of a diversified professional technical services organization with over 30,000 employees worldwide. AECOM is a global leader in the transportation, environmental and facilities markets with projects in more than 60 countries. Named to Forbes magazine's list of the Top 500 Private Companies, AECOM Technology Corp. is a $2.6 billion corporation.

Further information on the firm is available through its website at www.m-e.com