State College Borough Water Authority

Treatment Plant Design for Emerging Contaminants

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SCBWA Water System Overview

- Currently serve a connected population of 73,000
- Customer base of 15,000 connections
- Average daily production – 4.75 MGD (5.82 Peak)
- Sources: 1 surface water intake (0.5 MGD max.) and seven (7) large capacity well fields
- True groundwater well treatment with chlorine/fluoridation
- 1 - 6 MGD (Woodside Drive) Treatment Plant for surface water source and 2 GUDI well fields (Harter and Thomas)
- WTF Process: Solids contact/upflow clarification and multi-media filtration
- 275 miles of main, 13 storage tanks and 6 booster stations
Nixon and Kocher Well Fields

- Seven (7) wells with total combined safe yield of 4.1 MGD
- Not currently considered GUDI sources by PADEP
- Turbidity spikes and water level increase after rain events
- Located in Karst limestone (sink holes present)
- Authority began a system-wide baseline water quality monitoring program in 2014 testing for 96 endocrine disrupter chemicals (EDCs) Pharmaceuticals and Personal Care Products (PPCPs) EDC/PPCP in each source
- Results yielded trace amounts of various EDCs and PPCPs such as: Atrazine, Simazine, DACT, DIA, DEA, Lidocaine, Testosterone, Albuterol, etc.
Nixon Well Field (Building No. 43)
Advantages of New WTF for Nixon-Kocher

- Membrane filtration would remove particulate and bacteria
- Granular Activated Carbon (GAC) would remove organic contaminants (EDCs and PPCPs)
- UV disinfection - secondary barrier and for future Advanced Oxidation Processes (AOP)
- Woodside Drive WTF (60% of system production) would have redundancy
- Better aid in meeting future regulations (UCMRs, Chapter 109, etc.)
Pilot Study Overview

• Began 5-month pilot study on May 8, 2015, and ended October 8, 2015
• Featured a Pall Corporation 0.1 micron membrane filtration system
• Featured an Evoqua 4 column GAC system
• Raw water entered membrane system where turbidity was removed and then entered 2 sets of GAC vessels in lead/lag arrangement to remove organic contaminants
• 2 different types of GAC media were tested – coconut shell based and bituminous coal based
Pall Membrane Filtration Pilot Test Equipment
Evoqua GAC Pilot Test Equipment
Pilot Study Membrane System Description

- A single Pall PVDF module with 538 SF
- Outside to inside flow regime
- 400 micron pre-strainer
- Flux Rate +/- 50 GFD (18 GPM)
- Daily Integrity Tests
- Automatic backwashing every 50 minutes
- No Enhanced Flux Maintenances (EFMs)
- 1 Clean-in-Place (CIP) with caustic/hypo and citric acid heated to 95 degrees F.
Pilot Study GAC System Description

• Membrane effluent feed source
• Total of four (4) adsorber vessels (2 sets in series)
• 6.6 gpm/sq. ft. loading rate
• Flow rate per column of 0.33 gpm
• 3.5 minute contact time per column
• 2 columns enhanced coconut shell-based carbon
• 2 columns bituminous coal-based carbon
• No backwashing, initial rinsing of fines only
• Low pressure filtering (2-4 PSI)
Pilot Study Results

• Average reduction in raw water turbidity was from 0.13 NTU to 0.011 NTU through membrane system

• Low solids loading rate resulted in high recovery (98%+) and infrequent chemical cleanings at 50 GFD

• The organic contaminants were all reduced to non-detectable levels through the GAC system (raw water contaminants 5-190 nanograms/liter or ppt)
What We Learned...

- Due to the presence of fine sand particles, it was decided to use 100 micron pre-strainers in the full-scale design.
- Due to such low TSS (less than 5 mg/L) of the MF backwash waste, all waste could be recycled.
- Due to well hardness, CIP cleaning water had to be softened.
- The wells had high levels of dissolved oxygen, thus nitrate removal through GAC was not possible biologically.
What We Learned Continued...

- Contaminant break-through of the GAC was not observed during pilot timeframe at the max. design flow rate, thus long life of media expected (2-3 yr. projection)

- Lead/lag GAC design allows switch-over of saturated vessel and/or gives ability to double the contact time

- GAC does not remove hexavalent chromium (CR-6), this must be done with resin material
Proposed Nixon-Kocher WTF Site Plan
Proposed Nixon-Kocher WTF Floor Plan
Full-Scale Plant Design Features

• New 5.0 MGD Water Treatment Facility
• Nixon and Kocher Well pump upgrades (new pumps and VFDs)
• Membrane filtration system with feed pumps, pre-strainers, module racks, backwash pumps, compressed air system and CIP system (with neutralization)
• UV disinfection system
• 6 GAC vessels with lead/lag configuration
• Chemical feed systems (gas chlorine, sodium fluoride, etc.)
• New generator, SCADA and telemetry system
Full-Scale Plant Design Features Cont.

- Equipment redundancy (pumps, strainers, modules racks, UV, GAC, chemical feed pumps, 2-sided clearwell, PLC)

- Future chemical injection points for Advanced Oxidation Processes (AOP) such as hydrogen peroxide ahead of UV to form oxidizing hydroxyl radicals to remove organic contaminants [1,4 dioxane and (NDMA – byproduct of chlorination)]
Project Cost, Funding and Schedule

Total Estimated Project Cost: $25,000,000
Projected Funding Source: Pennvest

Schedule
Begin Design – Spring 2018
Complete Design – December 2018
Obtain All Permits – May 2019
Bid Project – June 2019
Begin Construction – Fall 2019
Project Completion – Fall 2021
Questions/Comments?