State College Borough Water Authority

Treatment Plant Design for Emerging Contaminants

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GD&F
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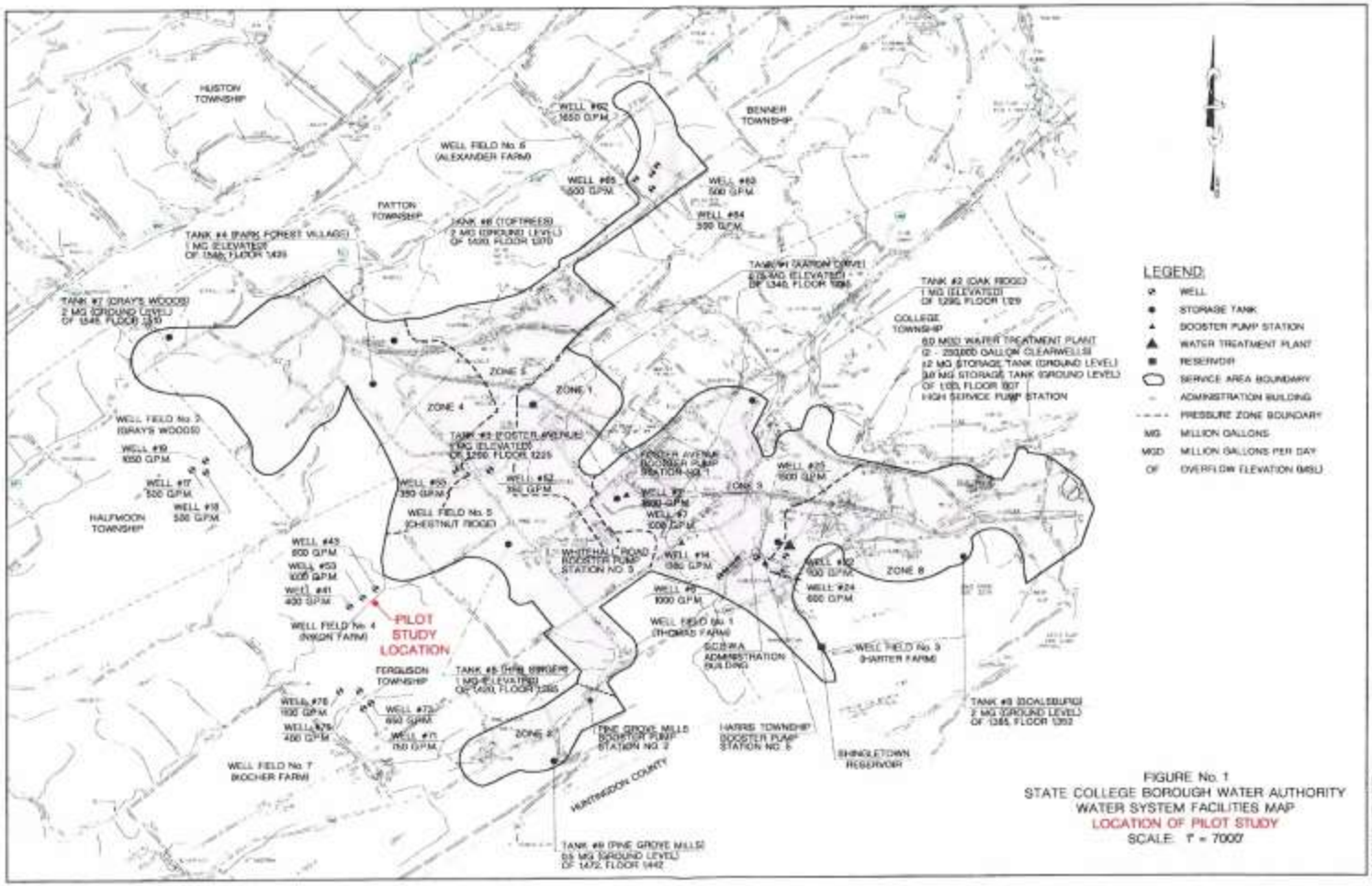
ENGINEERS

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

SCBWA Water System Map



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)

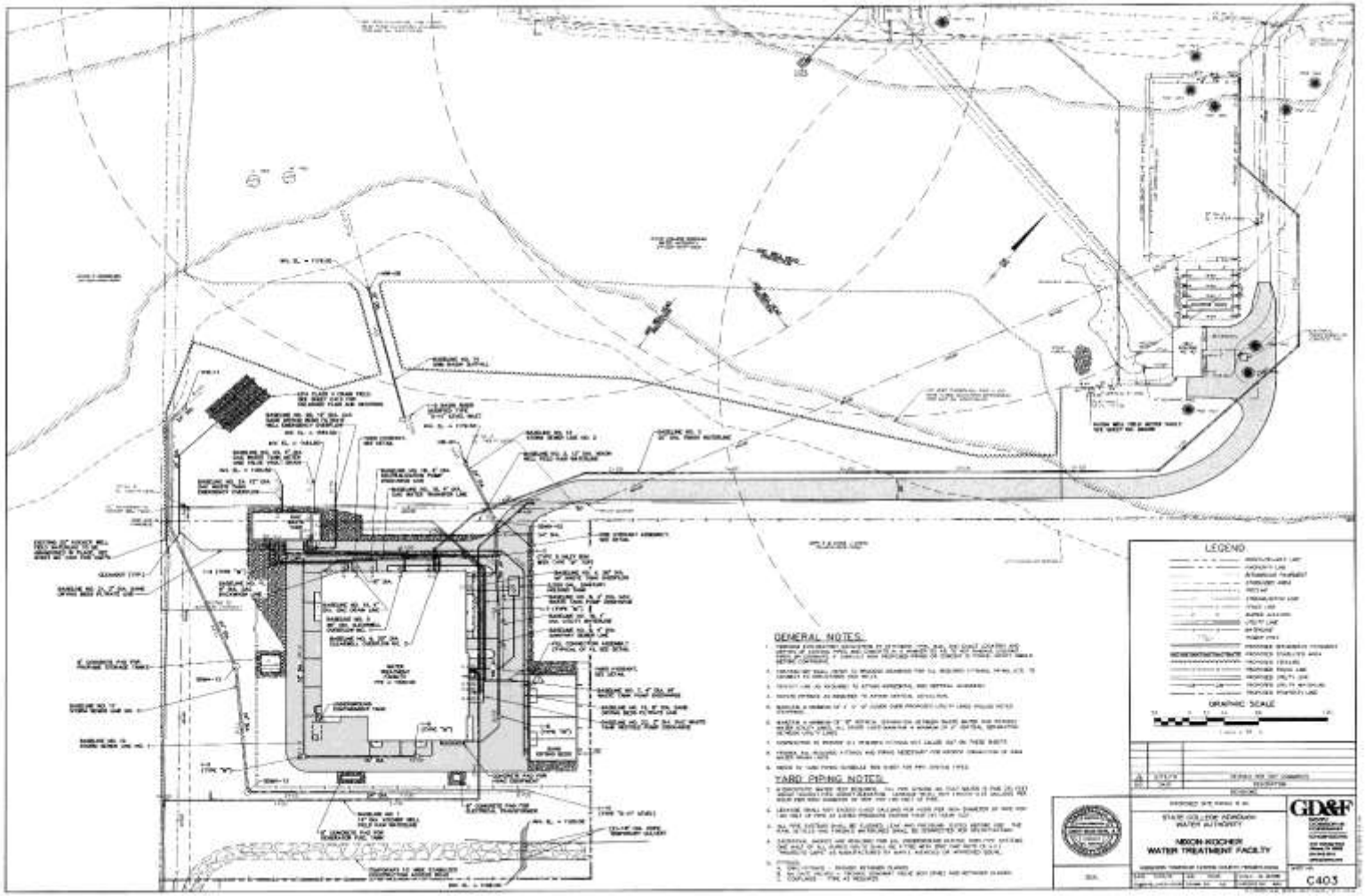
What We Learned…

- 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

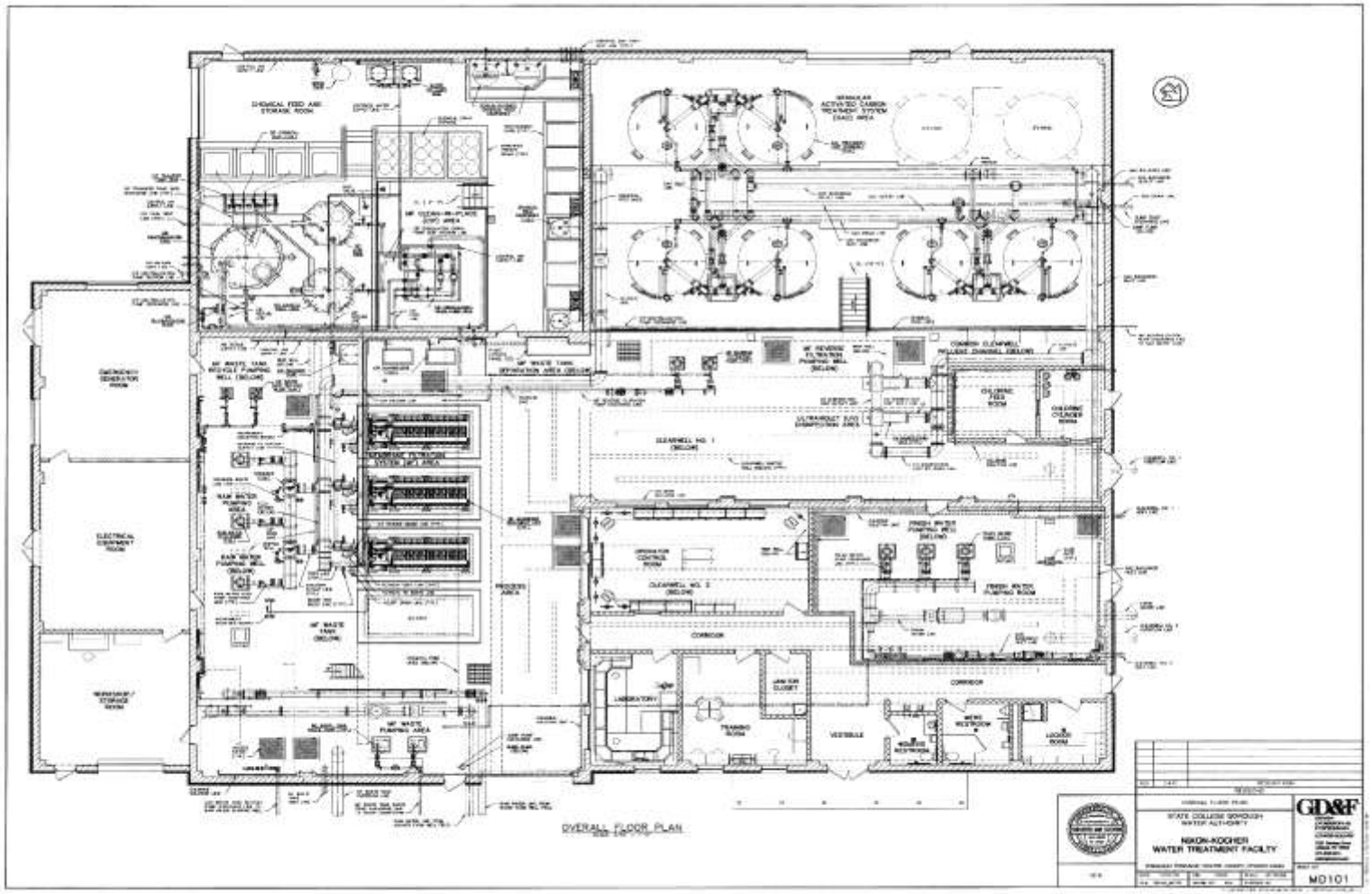
What We Learned Continued…

- 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

<u>Schedule</u>

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?