Horsham Water & Sewer Authority Experience with PFAS Contamination – Making "Unwell Waters" Well Again

New Jersey Water Environment Association Annual Conference

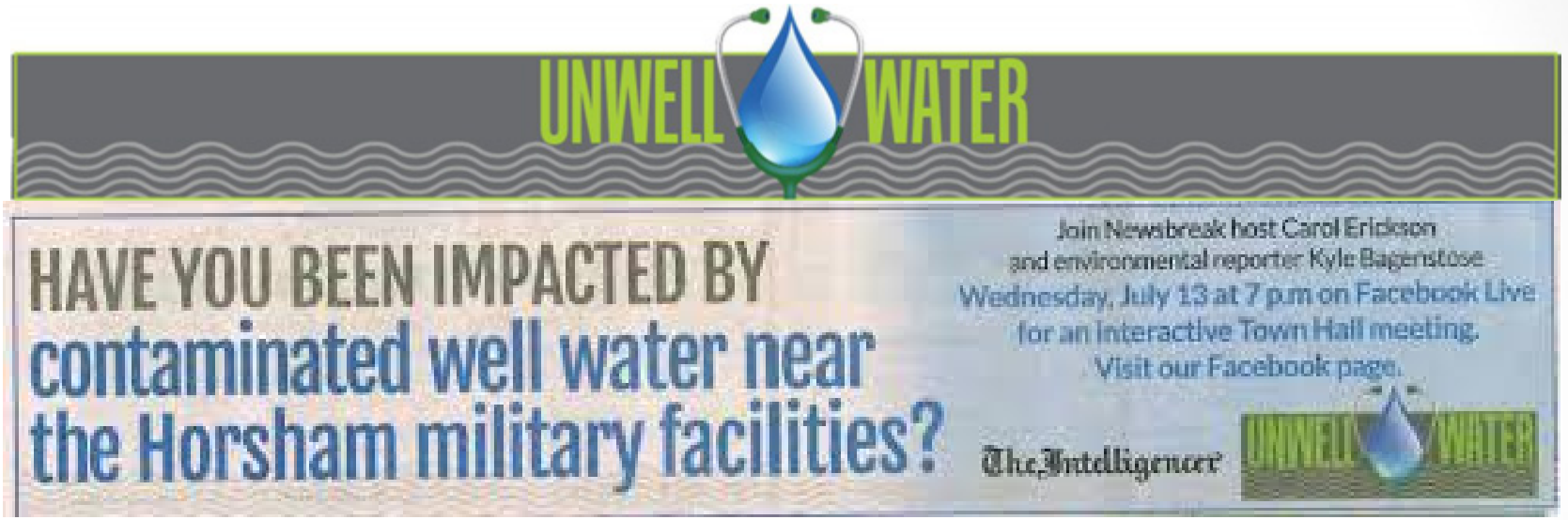
Atlantic City

May 7, 2019

Horsham Township

- Founded in 1717
- ~ 18 miles north of center city Philadelphia
- 17.32 Square Miles (11,090 acres)
- 26,147 residents
- 32,000 + jobs
  - Over 600 companies in five high-end office parks featuring many Fortune 500 companies including health, financial and technology companies
- In 2011, Horsham Township was named one of the top 100 places to live in America by CNN Money Magazine, and climbed into the top 50 in 2013
- Although the township was disappointed when the local naval base (there since 1942) was closed on September 15, 2011, it was looking forward to the potential redevelopment opportunities presented by the 862 acres of surplus property in the heart of the township (8% of our community)

But in 2014 the 1st shoe drops . . .



- Starting in 2014, Horsham became spot-lighted by the media as a community with “PFC” problems

So what happened?

- Prior to 2014, Horsham's public water supply utilized 14 active groundwater wells (~90%) and 2 interconnections with neighboring suppliers (~10%)

- 2014: EPA's UCMR3 sampling revealed the presence of PFAS in 5 of the 14 then-active public supply wells
  - PFOS concentrations in 2 wells (#26 & #40) exceeded the then-current provisional health advisory level of 200 ppt for PFOS
    - Well #26: PFOS = 700 ppt/PFOA = 290 ppt
    - Well #40: PFOS = 1,000 ppt/PFOA = 63 ppt
  - In "consultation" with EPA & PADEP these wells were immediately shut down and public notice was issued

- 2015: Analyses at lower detection levels (~2.5 ppt) revealed PFAS concentrations in all HWSA wells and one of the interconnects

What are PFCs/PFAS?

- Group of fluorinated organic, manufactured compounds that have been widely used to make everyday products more impervious to stains, grease and water.
- Perfluoralkyl substances are fully fluorinated (perfluoro-) alkane (carbon-chain) molecules.
- Polyfluoroalkyl substances are not fully fluorinated.
- More than 3,500 manmade fluorinated organic compounds that have been produced since the mid-20th century
- Extremely long-lived in the environment due to their resistance to environmental degradation and invulnerability to metabolism.
- Class B fluorine-containing firefighting foams include aqueous film forming foam (AFFF) that are a complex mixture of both known and unidentified PFAS of differing molecular structures present in varying proportions.

Common PFAS Analytes

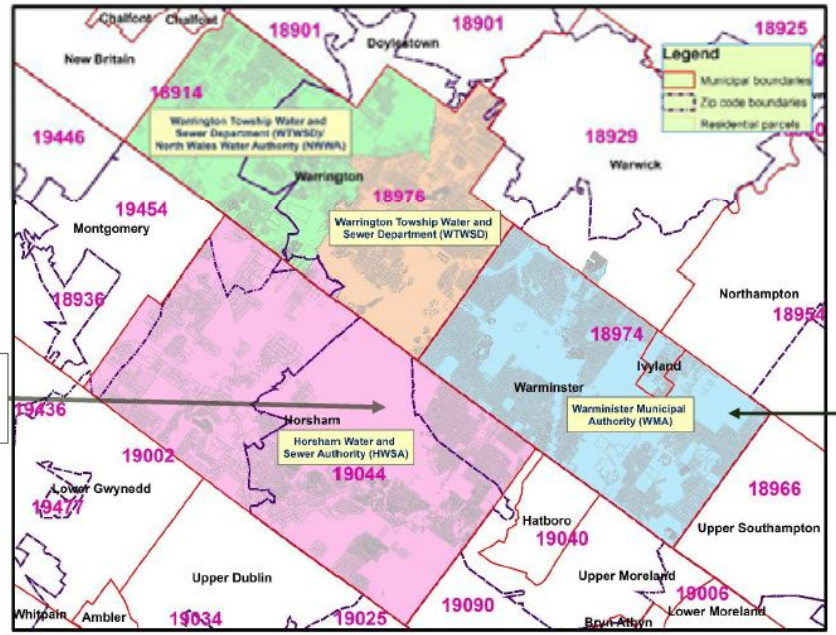
PFAS	Name	Mol.Wt.	Type	Length
PFHxA	Perfluorohexanoic acid	314	carboxylate	short
PFHpA	Perfluoroheptanoic acid	345	carboxylate	short
PFOA	Perfluorooctanoic acid	414	carboxylate	long
PFNA	Pefluorononanoic acid	464	carboxylate	long
PFBS	Perfluorobutanesulfonic acid	300	sulfonate	short
PFHxS	Perfluorohexanesulfonic acid	400	sulfonate	long
PFOS	Perfluorooctanesulfonic acid	500	sulfonate	long

Where does the PFAS come from in Horsham?

- The source of the PFAS contamination has been linked to historical activities, particularly to use of AFFF fire-fighting foam, at the former Willow Grove Naval Air Station Joint Reserve Base (NASJRB) and existing Horsham Air Guard Station (HAGS). The former Naval Air Warfare Center in Warminster is ~ 4 miles east

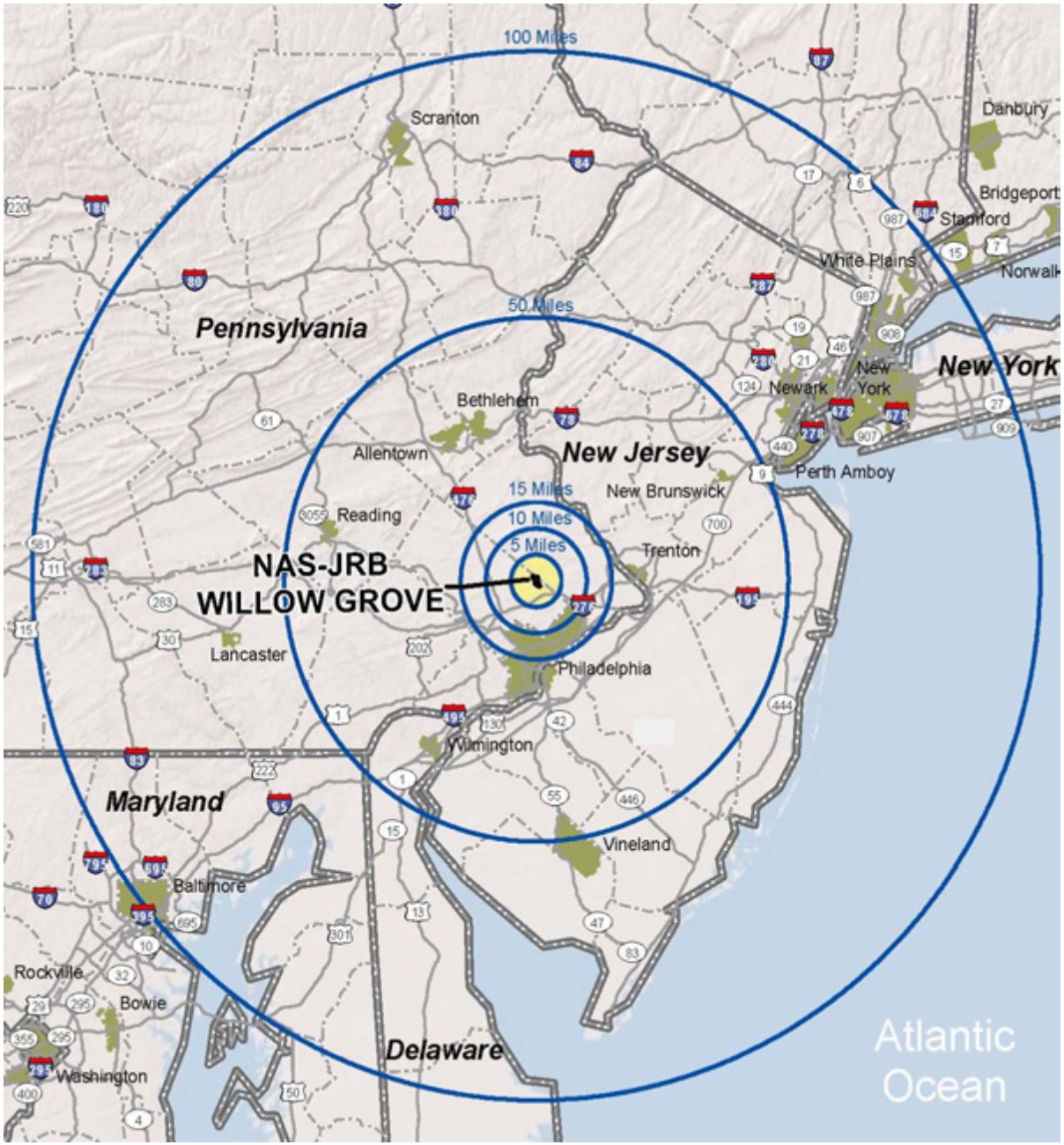
PFAS Exposure in Southeastern PA

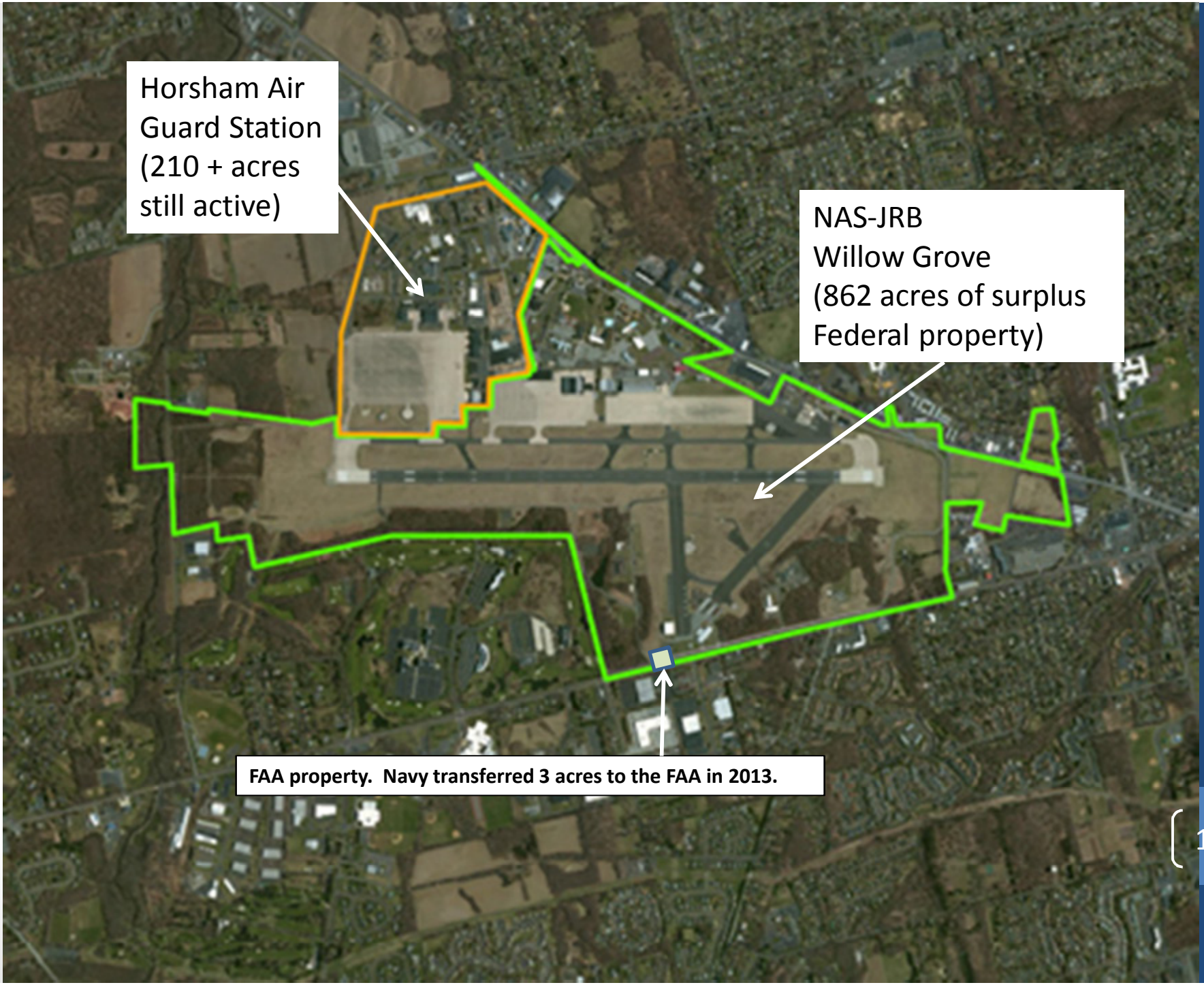
- Affected area = population of 84,184 (2010 census)
- 32,595 households in water service area



Horsham Air Guard Station

Naval Air Warfare Center

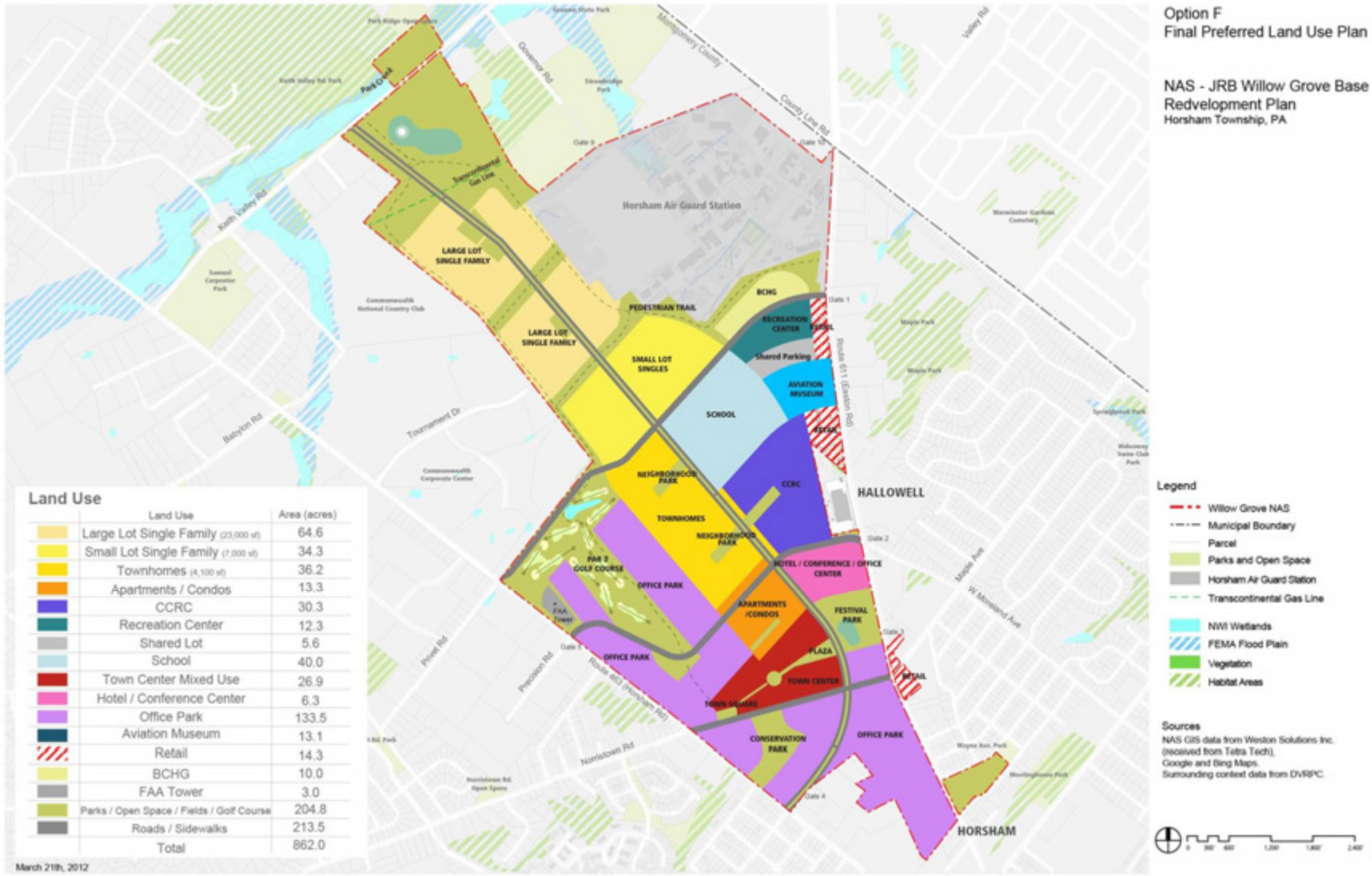

100 Miles
50 Miles
15 Miles
10 Miles
5 Miles
NAS-JRB
WILLOW GROVE
Pennsylvania
New Jersey
New York
Maryland
Delaware
Atlantic
Ocean
Scranton
Bethlehem
Allentown
Reading
Lancaster
Philadelphia
Trenton
New Brunswick
Perth Amboy
Newark
New
York
White Plains
Stamford
Bridgeport
Danbury
Norwalk
Wilmington
Vineland
Baltimore
Rockville
Bowie
Washington


Horsham Air Guard Station (210 + acres still active)
NAS-JRB Willow Grove (862 acres of surplus Federal property)
FAA property. Navy transferred 3 acres to the FAA in 2013.

The Redevelopment Plan

- Township was slated to receive 860 acres of the former Willow Grove base from the Navy.
- Plans for housing, a school, a festival ground, a hotel, office park, and a town center
  - Would create ~ 7,000 new jobs
  - Would net as much as $4.7 million in new municipal taxes
  - Would represent a 22% increase over township's current annual revenue of $22 million
- Since the discovery of PFAS in the soils and groundwater, the redevelopment plan has been halted and property is fast becoming a 862 acre abandoned, decaying property.

APPROVED REDEVELOPMENT PLAN



Navy & HWSA enter into an Environmental Services Cooperative Agreement (ESCA)

- Executed in July 2015
- Navy to provide funding for HWSA to provide PFAS remediation at any HWSA wells containing PFOS/PFOA at or above the existing or any future drinking water standard (Health Advisories are considered a standard under the ESCA)
- ESCA also covers costs for the extension of water mains to areas served by private wells that have been found the drinking water standard and public water supply does not currently exist
- Design of GAC treatment for HWSA's Wells #26 and #40 begin

Then in 2016, the 2nd Shoe drops …

- 2016: EPA issued a new combined PFOA/PFOS Lifetime HAL at 70 ppt
  - 3 more HWSA wells (#10, #17 & #21) were immediately shut down, and again immediate public notice was given
  - Public concern and outcry was much more pronounced in 2016 than 2014

- Since then, the township has hosted numerous community education events, congressional roundtables, workgroups, a national EPA PFAS Listening Session, a national health study pilot and recently the PA PFAS Action Team

- The end result is that Horsham Township has become an epi-center to the growing PFAS issue

Township adopts its own PFAS drinking water standard

- By this time, the Horsham Council and the residents had lost faith in following an EPA standard
  - Council directed HWSA to develop plans to reduce the PFAS levels in the drinking water
  - In six-weeks, alternatives were presented to Council and in 2016 Short and Long Term PFAS Plans were adopted to enact the "Horsham Standard" :
    - *In light of concerns as to the evolving nature of the science regarding PFAS and the historic, chronic exposure in this community, Horsham Township has chosen to set a local water quality standard with a goal of "non-detect"*

Short-Term PFAS Action Plan

- The Short-Term Plan goal is to minimize levels of PFAS in the public supply through optimization of sources with the lowest PFAS concentrations while performing the phased installation of treatment systems
  - 5 wells with Navy-funded PFAS treatment systems restored to service
    - permanent GAC treatment (26 and 40)
    - temporary GAC treatment (17 and 21)
    - temporary Anion Exchange Resin (10)
  - 8 wells suspended from service
  - Temporary increase in purchased water from neighboring supplier while wells are out of service for treatment system installation
- The system-wide average in the HWSA public water system is currently ~ 4 ppt for PFOA/PFOS combined
- Annual cost of Short-Term Plan is currently ~ $1.0 Million and is being funded by Horsham ratepayers in the form of a recurring surcharge (originally ~ $24/quarter for typical residential customer, now ~$14/quarter)

Temporary treatment sites

GAC trailer at Well 17

Anion exchange resin vessels at Well 10

Long-Term PFAS Action Plan

- $10M Long-Term Plan infrastructure is grant funded through PennVest
  - Construct permanent treatment systems on 5 wells < 70 ppt
    - Well 22 was placed in service on 2/28/2019 and we are awaiting an operations permit from PA DEP for Well 20.
    - Wells 2, 4 and 19 are expected back in service by June 30, 2019
  - Construct permanent treatment system on existing interconnection with neighboring supplier
  - Install an additional interconnection with a separate neighboring supplier (Completed)
- Convert temporary treatment systems at 3 Navy-funded wells (10, 17 and 21) and to permanent systems

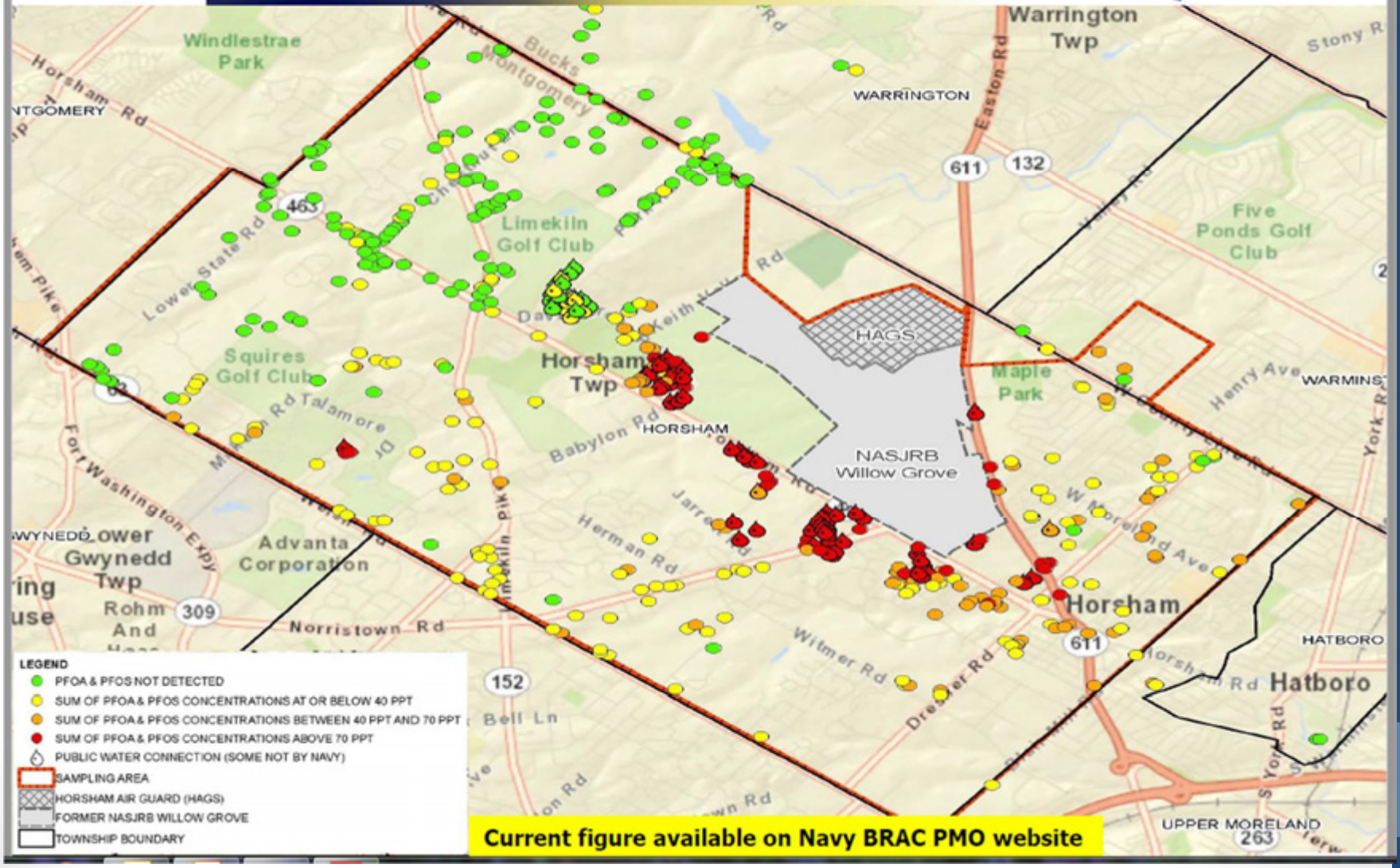
Long-Term PFAS Action Plan

- 4 wells with a combined production capacity of ~250,000 gpd will be placed in reserve status (#1, #3, #7, #9)
- Increased purchased water commitment
- Total of 11 permanent PFAS treatment systems (either GAC or IX)
- Capital and O&M costs for treatment of the 5 wells > 70 ppt PFOA/PFOS funded by the Navy
- Other long-term plan O&M costs to be borne by HWSA ratepayers

Private wells

- The PFAS contamination is not limited to the public water supply wells:
- Navy has funded private well sampling – Currently 511 wells have been sampled
- 97 private drinking water wells have been tested above the 70 ppt LHAL
  - 1.8 miles of new HWSA water mains in areas where public water was not previously available have been constructed - Navy funded
  - 88 have been connected to the public water system – Navy funded
  - 5 are in the process of being connected at this time
  - 2 have rejected the Navy's offer to pay for connection to the public water system
  - 2 have not responded
- 60 wells detected in the 40–70 ppt range are sampled quarterly

Private Drinking Water Well Sampling



Current figure available on Navy BRAC PMO website

PFAS is not just a drinking water issue

- HWSA Park Creek Wastewater Treatment Plant:
  - HWSA was compelled by PADEP to issue the HAG a discharge permit for flows entering the HWSA collection system
    - Discharge permit required PFAS monitoring only
  - Effluent monitoring results averaging ~ 25 ppt for PFOA/PFOS since installation of temporary treatment on HAGs supply wells
  - HWSA's NPDES permit renewal effective January 2019 formalized requirements for influent and effluent monitoring for PFOA/PFOS (although there is no approved method for PFAS measurement in wastewater)
- Storm water runoff from the base continues to enter local creeks which feed a larger stream (Neshaminy Creek) that is the source water for a surface water drinking water plant ~11 miles downstream
  - Navy/HAG have plugged outfalls, CCTV'd storm pipes and installed temporary treatment on a stormwater basin treating some of the flow but the system needs to be upgraded

So what does this all mean to our health?

- PFAS Exposure Assessment Technical Toolkit (PEATT) Pilot Project in 2018
  - The PA Department of Health conducted 235 (out of 600 contacted) randomly selected community members as part of a pilot project in May to September 2018 to evaluate the PEATT developed by the CDC and the ATSDR
  - The project was funded by the Association of State and Territorial Health Officials (ASTHO)
  - Serum samples were analyzed for 11 PFAS compounds

PEATT Project Summary

- Household level response rate: 46% (276 out of 600 participants)
- Household participation rate: 19.6% (118 out of 600 households)
- Participation rate: 40% (235 out of 584 eligible participants)
- 235 participants (from 118 different households)
- Only 26 children (ages 3-17) prevented any meaningful analysis of the data for this age group

Results Overall—4 main compounds

- Average serum PFAS levels (level of PFAS in the blood) were higher compared to NHANES's averages
  - 94% had higher levels of PFHxS
  - 81% had higher levels of PFOS
  - 75% had higher levels of PFOA
  - 59% had higher levels of PFNA
- Results are consistent with other studies on PFAS exposure through drinking water

	Community Results				NHANES Results (2013-2014)	
PFAS Compound	**Average**	95% Confidence Interval	Median	Range	**Average**	95% Confidence Interval
PFOA	**3.13**	2.81-3.50	3.06	0.55-24.8	**1.94**	1.76-2.14
PFOS	**10.24**	8.86-11.83	9.86	1.02-105.00	**4.99**	4.50-5.52
PFHxS	**6.64**	5.51-7.99	6.61	0.54-116.00	**1.35**	1.20-1.52
PFNA	**0.74**	0.67-0.80	0.76	0.50-2.56	**0.68**	0.61-0.74

- Results shown in ug/L. Range excludes <LOD

pennsylvania
DEPARTMENT OF HEALTH

PEATT Project Results

- **Of the 11 PFAS compounds tested, only PFOA, PFOS, PFHxS and PFNA were consistently detected in serum samples of the participants**
- The other 7 PFAS compounds were detected in less than 15 participants
- In general, PFAS levels increased with residence time and water service area's proximity to military base (The average PFAS Blood level for the 29 participants drinking HWSA's water was higher than the other 3 water sources)
  - For PFAS, the average PFAS blood levels for participants drinking HWSA's water was 3.69, 12.38, 8.81, and 0.79 µg/l for PFOA, PFOS, PFHxS, and PFNA respectively

CDC Multi-site Study

- The SEPA PEATT pilot (another pilot was performed in NY) and the recently awarded exposure testing at 8 other sites nationally do not include health outcomes
- A larger multi-site national health study is to be conducted by sampling 8,000 (6,000 adults and 200 children) in 6 PFAS-impacted communities throughout the country
  - Study has a funding level of $32,500,000 over 5 years
  - Proposals are due May 30, 2019
  - PA DOH is in the lead for the SEPA communities
  - Will not include cancer as a health outcome to the “limited” sample size
  - Previous health study funded by DuPont in the Ohio River Valley that did include cancer had 32,000 participants

PFAS Raw Water Sampling Data Review

- Typically only see detectable results for 7 PFAS analytes: PFOS, PFOA, PFHxS, PFNA, PFBS, PFHxA, and PFHpA
- All 14 wells have detectable results for PFOS/PFOA
- PFOS is greater than PFOA in 7 wells; ~ the same in 2; and less then PFOA in 5
- PFOS/PFOA ratios range from 50 to 60% of the detected PFAS
- Next highest PFAS compound is usually PFHxS, then PFBS or PFHxA, then PFHpA, the PFNA
- The 4 long chain PFAS compounds (PFOS, PFOA, PFHxS, and PFNA) are typically 70 – 90% of the detected PFAS
- PFNA is usually ND or right at the detection level. Highest levels are in the 2 wells with the highest PFOS/PFOA levels, but still in the single digits ppt

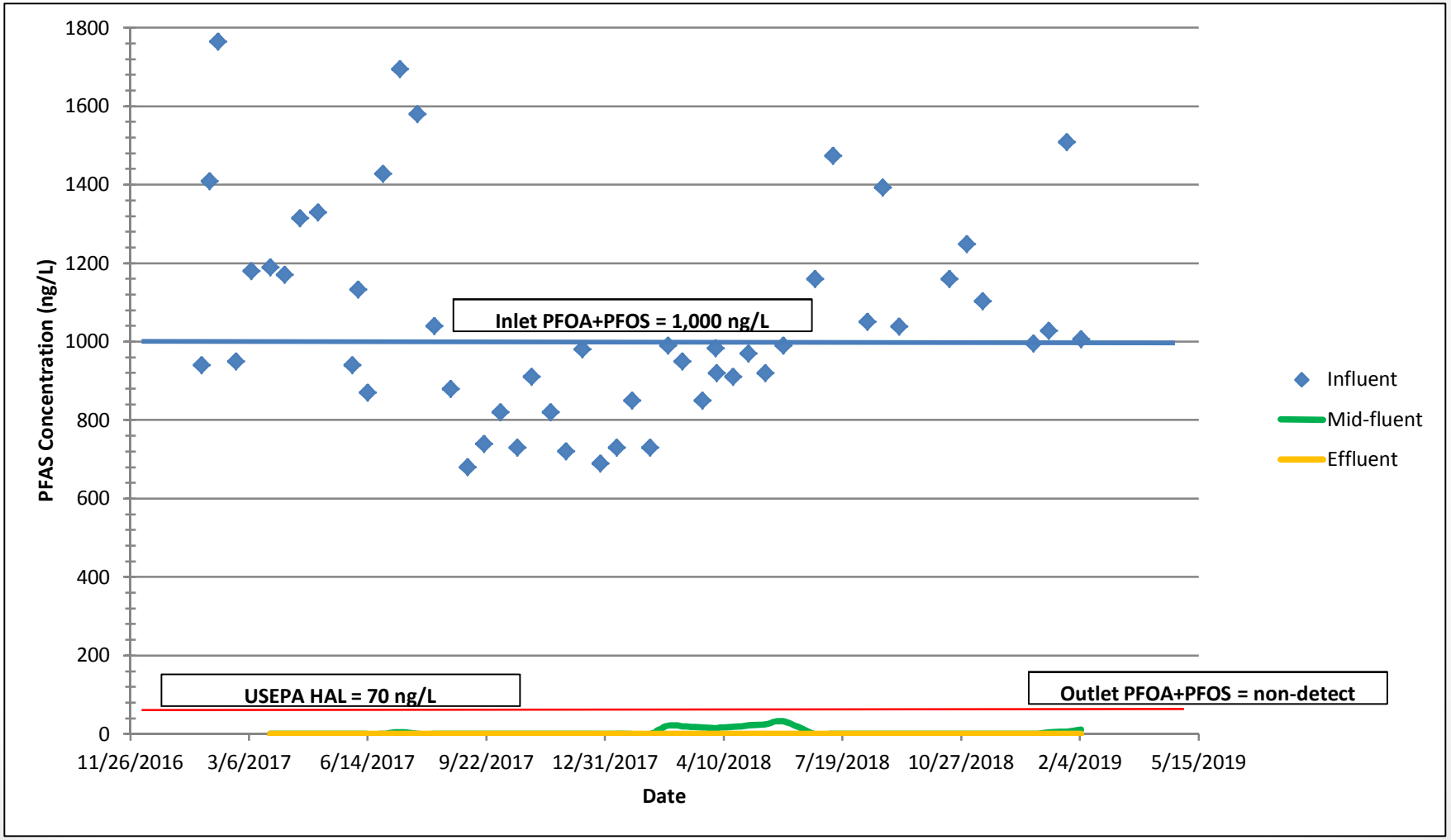
GAC Case Study
HSWA - Well 26

- 2018 Total Volume Treated = 92 million gallons

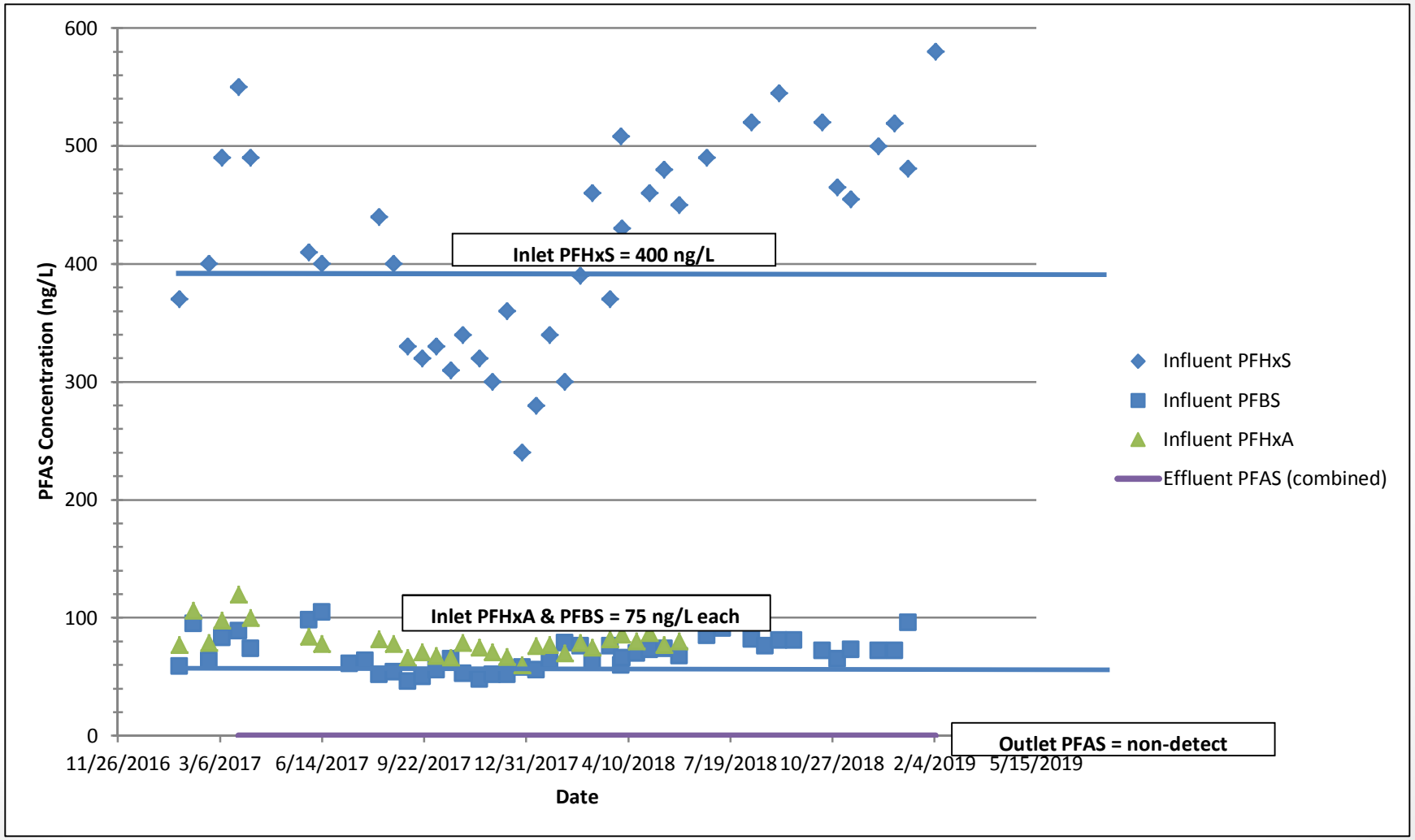
- Intermittent operation
  - 8-12 hours per day
  - Flow Rate = 200-250 gpm
  - PFOA+PFOS = 1,000 ng/L

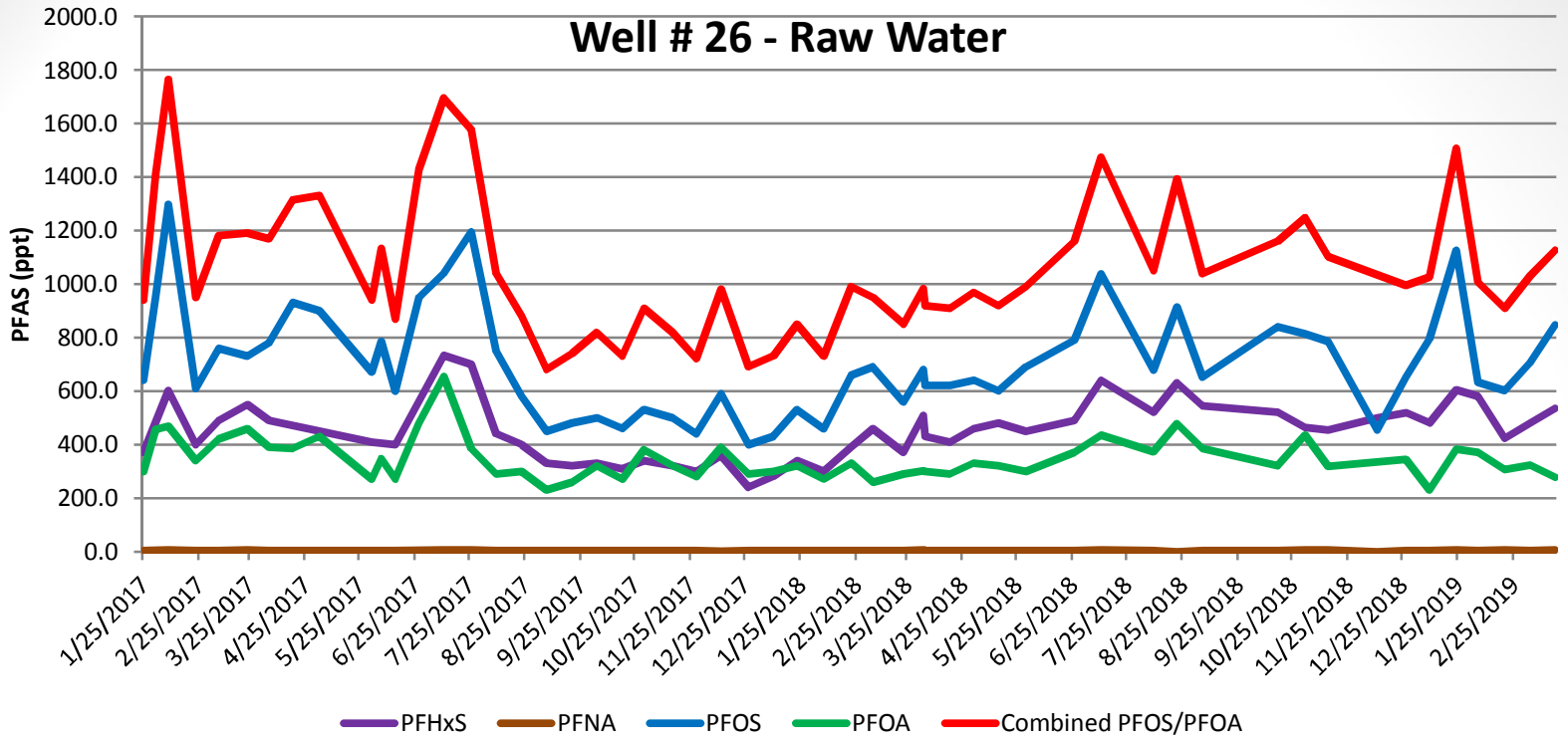
- Model 10 Adsorption System
  - 2 x 10' diameter vessels
  - 20,000 lb GAC per vessel
  - 12x40 mesh, reagglomerated bituminous
  - Lead-Lag Operation

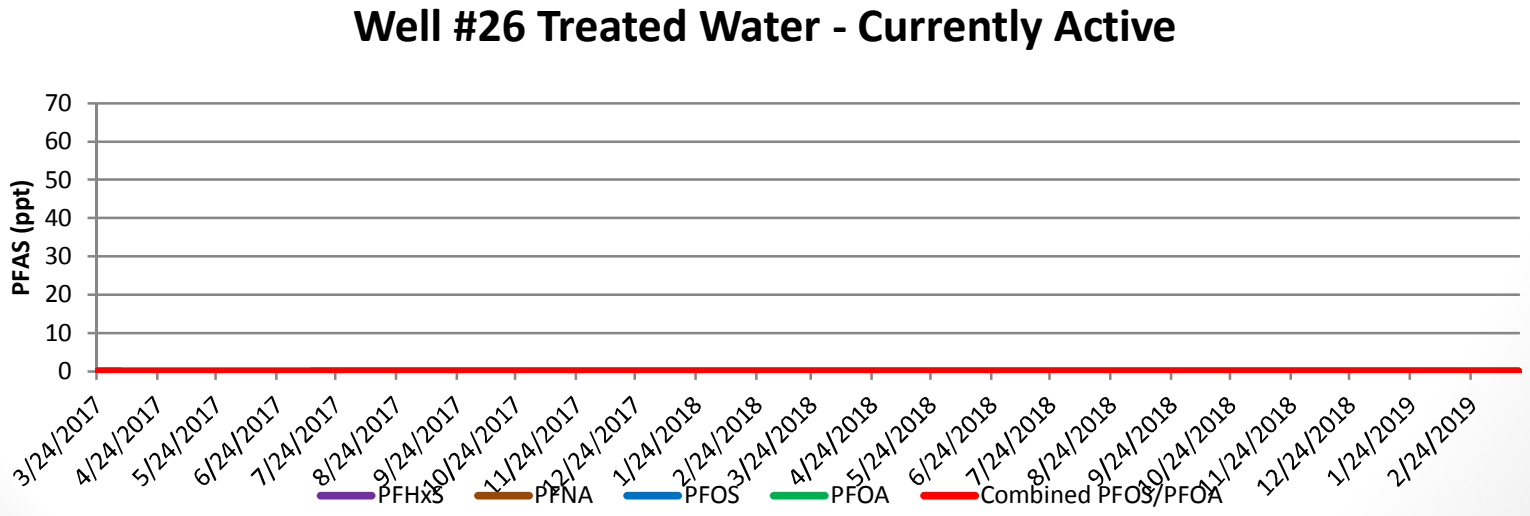
Perfluorooctanoic acid (PFOA) & Perfluorooctanesulfonic acid (PFOS)

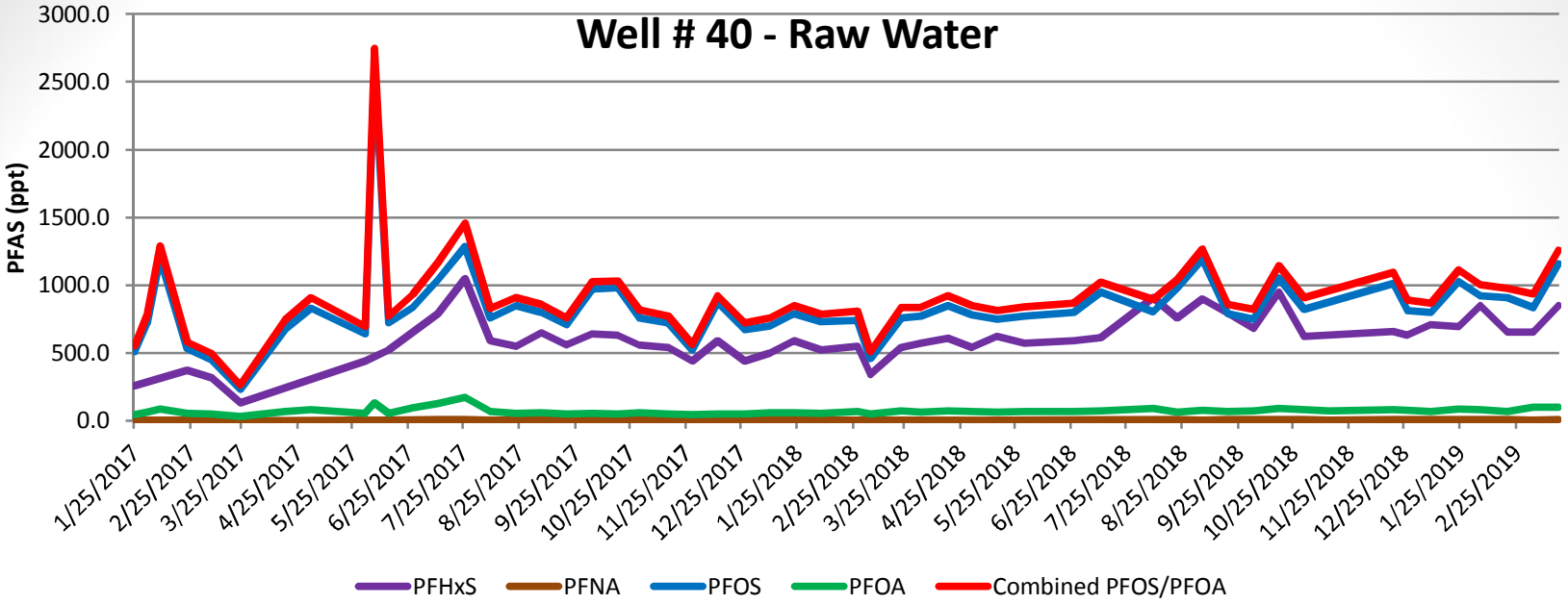


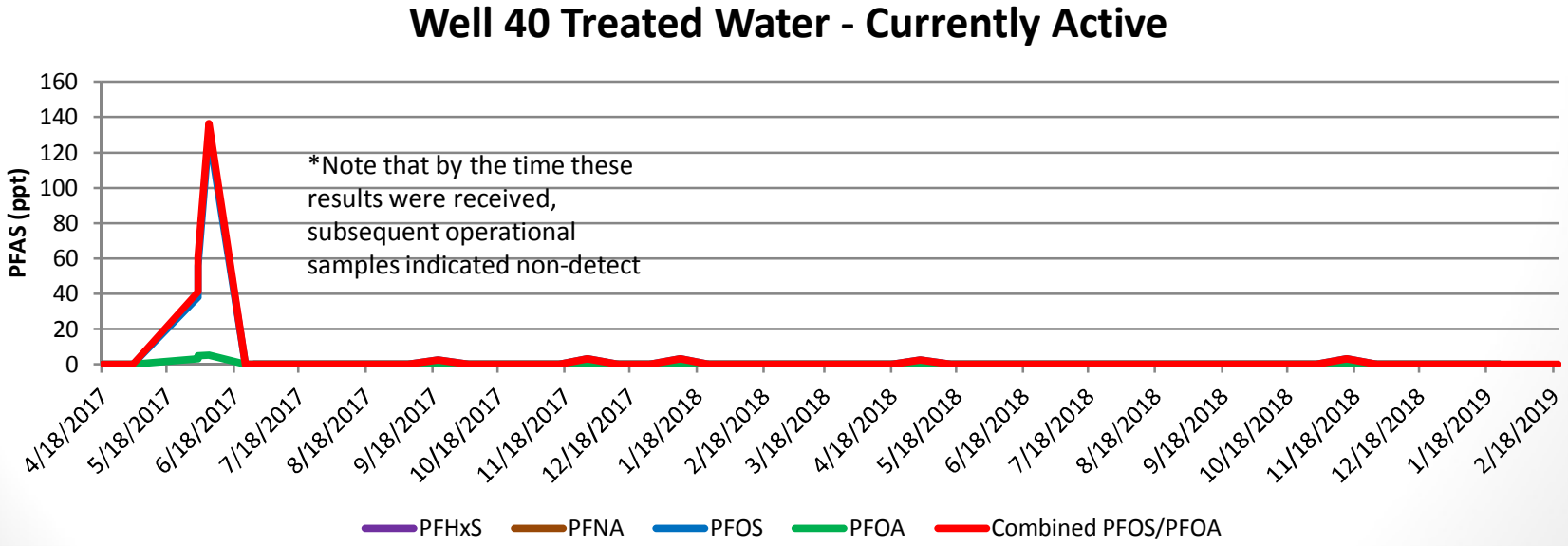
Perfluorohexanesulfonic acid (long chain sulfonate), Perfluorobutanesulfonic acid (short chain sulfonate) & Perfluorohexanoic acid (short chain carboxylate)

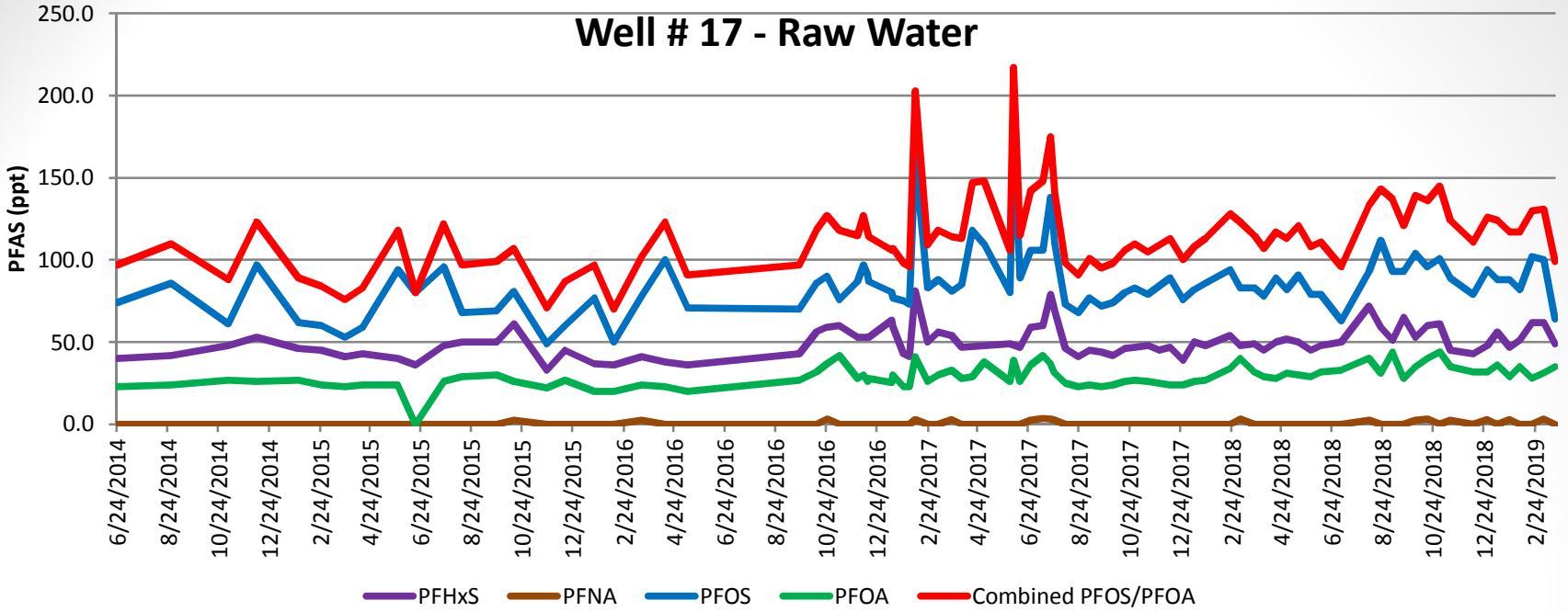


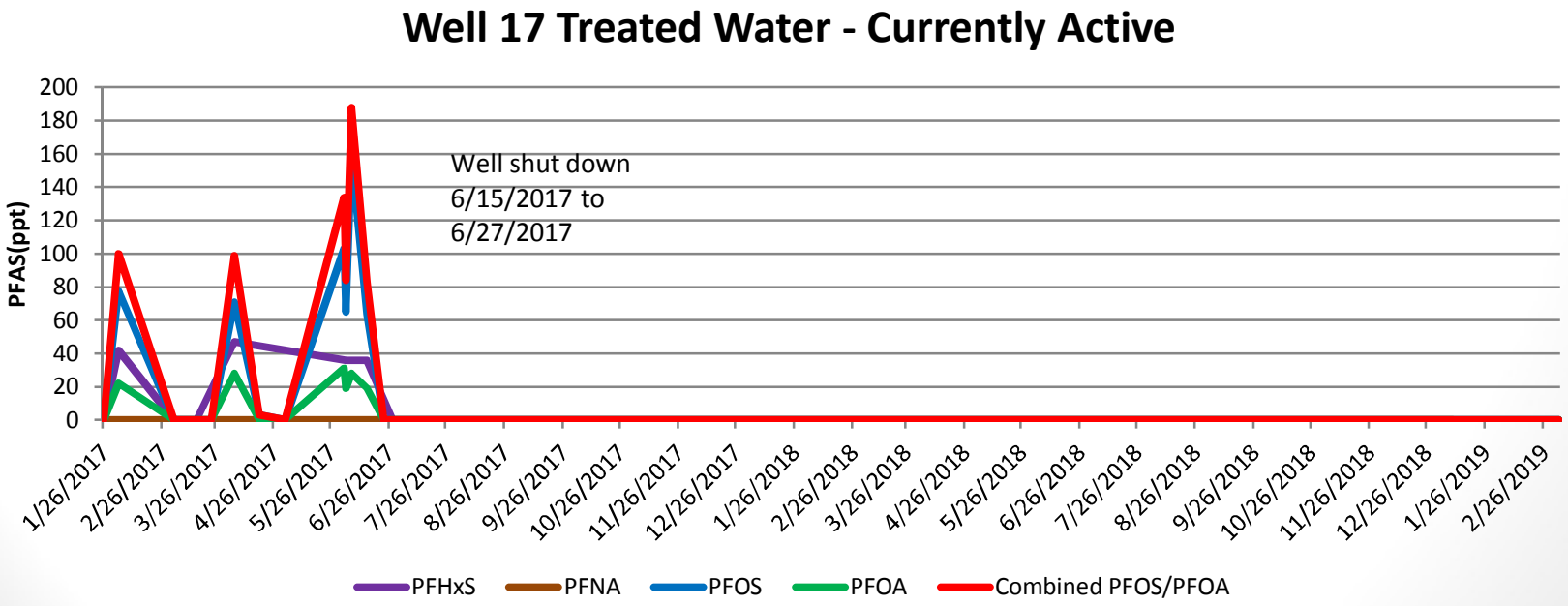

Well # 26 - Raw Water
PFAS (ppt)
2000.0
1800.0
1600.0
1400.0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
1/25/2017
2/25/2017
3/25/2017
4/25/2017
5/25/2017
6/25/2017
7/25/2017
8/25/2017
9/25/2017
10/25/2017
11/25/2017
12/25/2017
1/25/2018
2/25/2018
3/25/2018
4/25/2018
5/25/2018
6/25/2018
7/25/2018
8/25/2018
9/25/2018
10/25/2018
11/25/2018
12/25/2018
1/25/2019
2/25/2019
PFHxS
PFNA
PFOS
PFOA
Combined PFOS/PFOA

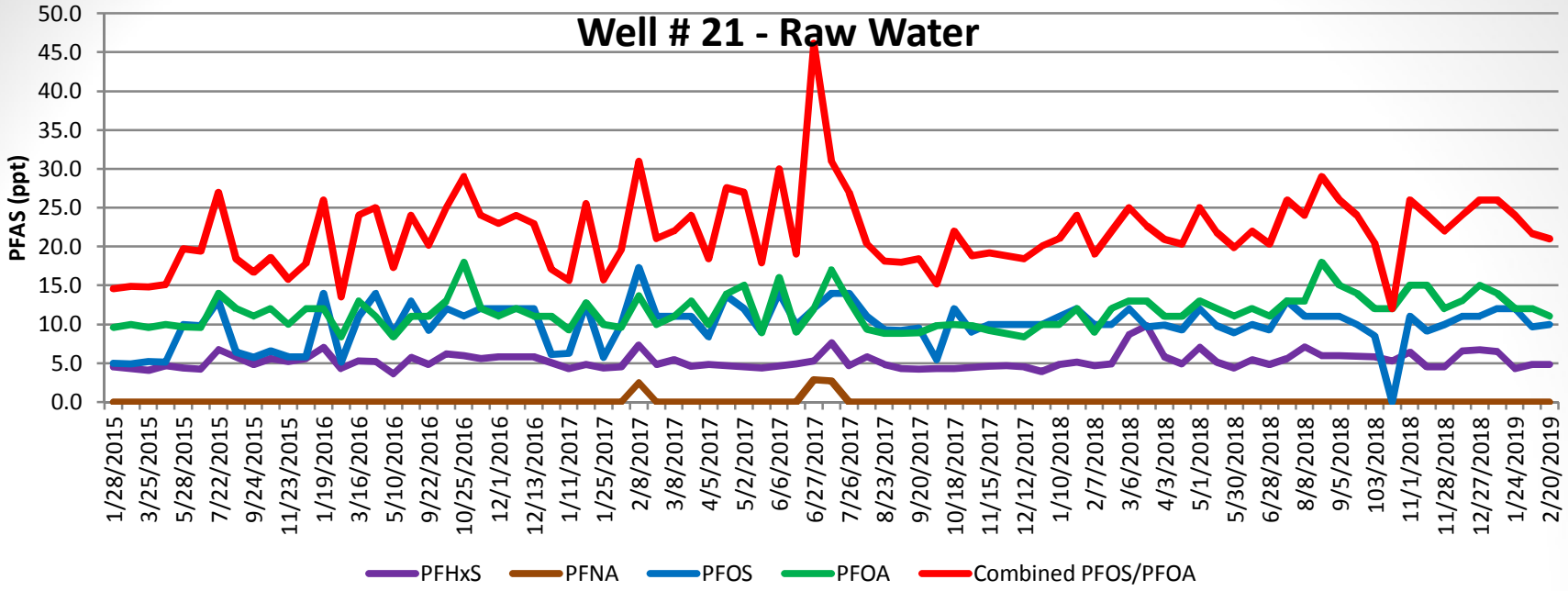

Well #26 Treated Water - Currently Active
PFAS (ppt)
70
60
50
40
30
20
10
0
3/24/2017
4/24/2017
5/24/2017
6/24/2017
7/24/2017
8/24/2017
9/24/2017
10/24/2017
11/24/2017
12/24/2017
1/24/2018
2/24/2018
3/24/2018
4/24/2018
5/24/2018
6/24/2018
7/24/2018
8/24/2018
9/24/2018
10/24/2018
11/24/2018
12/24/2018
1/24/2019
2/24/2019
PFHxS
PFNA
PFOS
PFOA
Combined PFOS/PFOA

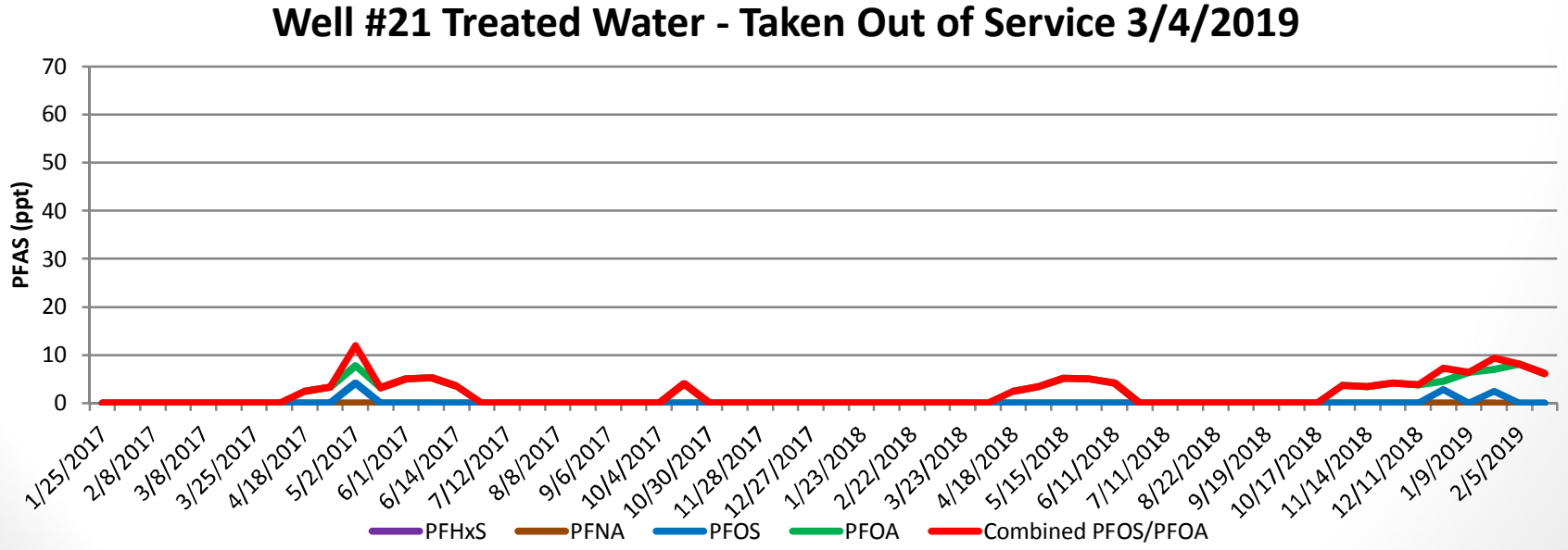

Well # 40 - Raw Water
PFAS (ppt)
3000.0
2500.0
2000.0
1500.0
1000.0
500.0
0.0
1/25/2017
2/25/2017
3/25/2017
4/25/2017
5/25/2017
6/25/2017
7/25/2017
8/25/2017
9/25/2017
10/25/2017
11/25/2017
12/25/2017
1/25/2018
2/25/2018
3/25/2018
4/25/2018
5/25/2018
6/25/2018
7/25/2018
8/25/2018
9/25/2018
10/25/2018
11/25/2018
12/25/2018
1/25/2019
2/25/2019
PFHxS
PFNA
PFOS
PFOA
Combined PFOS/PFOA


Well 40 Treated Water - Currently Active
PFAS (ppt)
160
140
120
100
80
60
40
20
0
*Note that by the time these results were received, subsequent operational samples indicated non-detect
4/18/2017
5/18/2017
6/18/2017
7/18/2017
8/18/2017
9/18/2017
10/18/2017
11/18/2017
12/18/2017
1/18/2018
2/18/2018
3/18/2018
4/18/2018
5/18/2018
6/18/2018
7/18/2018
8/18/2018
9/18/2018
10/18/2018
11/18/2018
12/18/2018
1/18/2019
2/18/2019
PFHxS
PFNA
PFOS
PFOA
Combined PFOS/PFOA


Well # 17 - Raw Water
PFAS (ppt)
250.0
200.0
150.0
100.0
50.0
0.0
6/24/2014
8/24/2014
10/24/2014
12/24/2014
2/24/2015
4/24/2015
6/24/2015
8/24/2015
10/24/2015
12/24/2015
2/24/2016
4/24/2016
6/24/2016
8/24/2016
10/24/2016
12/24/2016
2/24/2017
4/24/2017
6/24/2017
8/24/2017
10/24/2017
12/24/2017
2/24/2018
4/24/2018
6/24/2018
8/24/2018
10/24/2018
12/24/2018
2/24/2019
PFHxS
PFNA
PFOS
PFOA
Combined PFOS/PFOA


Well 17 Treated Water - Currently Active
PFAS(ppt)
200
180
160
140
120
100
80
60
40
20
0
Well shut down
6/15/2017 to
6/27/2017
1/26/2017
2/26/2017
3/26/2017
4/26/2017
5/26/2017
6/26/2017
7/26/2017
8/26/2017
9/26/2017
10/26/2017
11/26/2017
12/26/2017
1/26/2018
2/26/2018
3/26/2018
4/26/2018
5/26/2018
6/26/2018
7/26/2018
8/26/2018
9/26/2018
10/26/2018
11/26/2018
12/26/2018
1/26/2019
2/26/2019
PFHxS
PFNA
PFOS
PFOA
Combined PFOS/PFOA


Well # 21 - Raw Water
PFAS (ppt)
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
1/28/2015
3/25/2015
5/28/2015
7/22/2015
9/24/2015
11/23/2015
1/19/2016
3/16/2016
5/10/2016
9/22/2016
10/25/2016
12/1/2016
12/13/2016
1/11/2017
1/25/2017
2/8/2017
3/8/2017
4/5/2017
5/2/2017
6/6/2017
6/27/2017
7/26/2017
8/23/2017
9/20/2017
10/18/2017
11/15/2017
12/12/2017
1/10/2018
2/7/2018
3/6/2018
4/3/2018
5/1/2018
5/30/2018
6/28/2018
8/8/2018
9/5/2018
103/2018
11/1/2018
11/28/2018
12/27/2018
1/24/2019
2/20/2019
PFHxS
PFNA
PFOS
PFOA
Combined PFOS/PFOA


Well #21 Treated Water - Taken Out of Service 3/4/2019
PFAS (ppt)
70
60
50
40
30
20
10
0
1/25/2017
2/8/2017
3/8/2017
3/25/2017
4/18/2017
5/2/2017
6/1/2017
6/14/2017
7/12/2017
8/8/2017
9/6/2017
10/4/2017
10/30/2017
11/28/2017
12/27/2017
1/23/2018
2/22/2018
3/23/2018
4/18/2018
5/15/2018
6/11/2018
7/11/2018
8/22/2018
9/19/2018
10/17/2018
11/14/2018
12/11/2018
1/9/2019
2/5/2019
PFHxS
PFNA
PFOS
PFOA
Combined PFOS/PFOA

The ABCs of GAC

The ABCs of GAC

- Arsenic

The ABCs of GAC

- Arsenic
- Boil Water Advisory

The ABCs of GAC

- Arsenic
- Boil Water Advisory
- Corrosion

There is arsenic in coal-based GAC! Who knew?!?!

- Despite significant literature detailing the presence of arsenic in virgin coal-based GAC, that can be removed through flushing, PADEP appeared caught off guard when an IOC compliance sample at a neighboring utility that had just put a well back in service with GAC was analyzed at ~30 ppb for arsenic
- PADEP then emailed a new GAC SOP in June 2018:
  - Any system new or doing a vessel/filter change out of any bituminous coal-based GAC media shall:
    - Determine background arsenic level
    - Backwash the media and then filter-to-waste to remove any GAC fines
    - Sample the water during the filter-to-waste
    - Vessel/filter shall not be placed into service until the results show a before and after treatment increase of 0.001 mg/l or less of arsenic
- This SOP is resulting in days of flushing to get to this arbitrary 1 ppb goal with one well lost from production or over a week

Boil Water Advisory – May 30, 2018

HORSHAM
WATER AND SEWER AUTHORITY

215-672-8011
617 Horsham Road, Horsham PA 19044

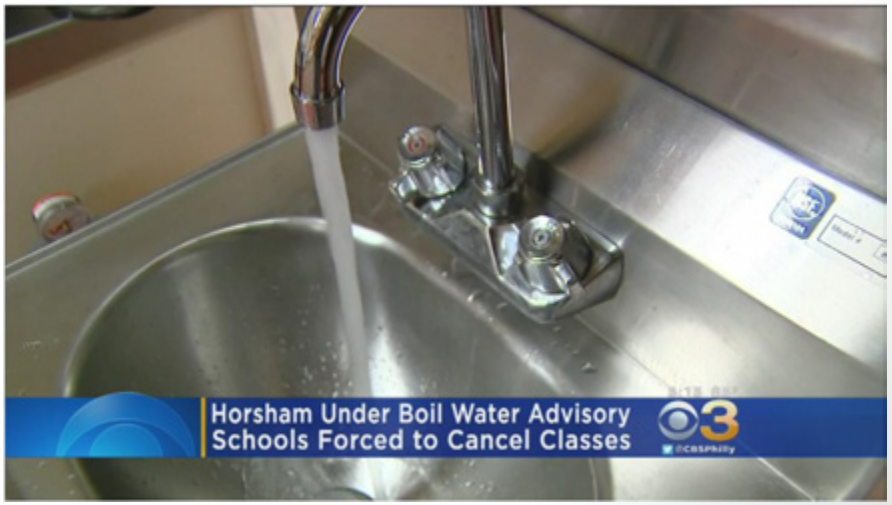
BOIL WATER ADVISORY

Updated May 31, 2018 - 4:26pm

BOIL WATER ADVISORY

This is an important notice from the Horsham Water & Sewer Authority sent May 31st, 2018 to customers of the Horsham water system within the area bounded by Limekiln Pike, County Line, Blair Mill and Welsh Roads.

- Loss of chlorine application to GW source for > 4 hours is a 4-log virus Treatment Technique violation requiring a Tier 1 (BWA) in PA
- BWA's are never pleasant but in Horsham, it's another opportunity for the press to talk about the "contaminated" water supply



Lead & Copper Rule Revisited – Its 1991 all over again!

- Despite literature demonstrating that GAC will not impact the corrosivity of a water, PADEP has determined that the installation of GAC warrants a sufficient change in treatment to reset HWSA back to “initial monitoring” under the Lead and Copper Rule
  - For HWSA that means we need to find 60 Tier 1 homes and begin six-month monitoring beginning June 1st.
  - Sending out over 5,500 letters to homes older than ~1990 looking for opportunities to find qualifying homes and improve our materials inventory.
  - Currently conducting ~2 home inspections a day and will be doing so throughout the summer – huge time burden on an already beleaguered staff
  - Talking to customers that have been dealing with PFAS and remember the BWA about lead potentially in their water is not a pleasant experience

Customer Regenerated GAC

- Following the initial acceptance of 2 vessels with virgin bituminous GAC, and starting with the first change out of carbon in the lead vessel, the carbon removed from HWSA wells is sent back for regeneration
- Thus, going forward 3 loads of carbon per well system are owned by HWSA and regenerated by Calgon.
- Regeneration destroys PFAS
- Regeneration does result is some loss of carbon up that has to be replenished with virgin GAC

Single-Pass Anion Exchange Pilot Study

- On April 11, 2017, HWSA placed Well 10 in service with a permitted pilot for anion exchange to remove PFAS.
- The well was equipped with 2 GAC vessels and 1 anion exchange vessel in series and went to the distribution system
- Per permit, once breakthrough occurred with the GAC, the well would be sent to waste rather than the system
- On January 16, 2018, the well was removed from service, the GAC filters were by-passed and began pumping to waste 24/7 using only the anion exchange vessel
- In September 2018, the pilot was ended.
- On October 10, 2018, the well with 2 vessels of new IX media in series was placed in service to the distribution system. The first use of anion exchange for PFAS removal in PA

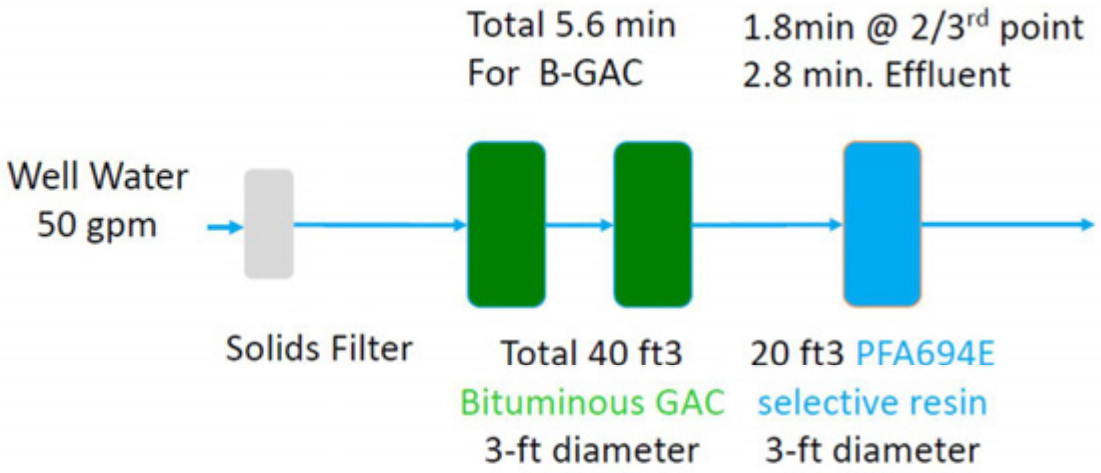
Anion Exchange Case Study

Temporary PFAS System for Well 10

Inlet Water:

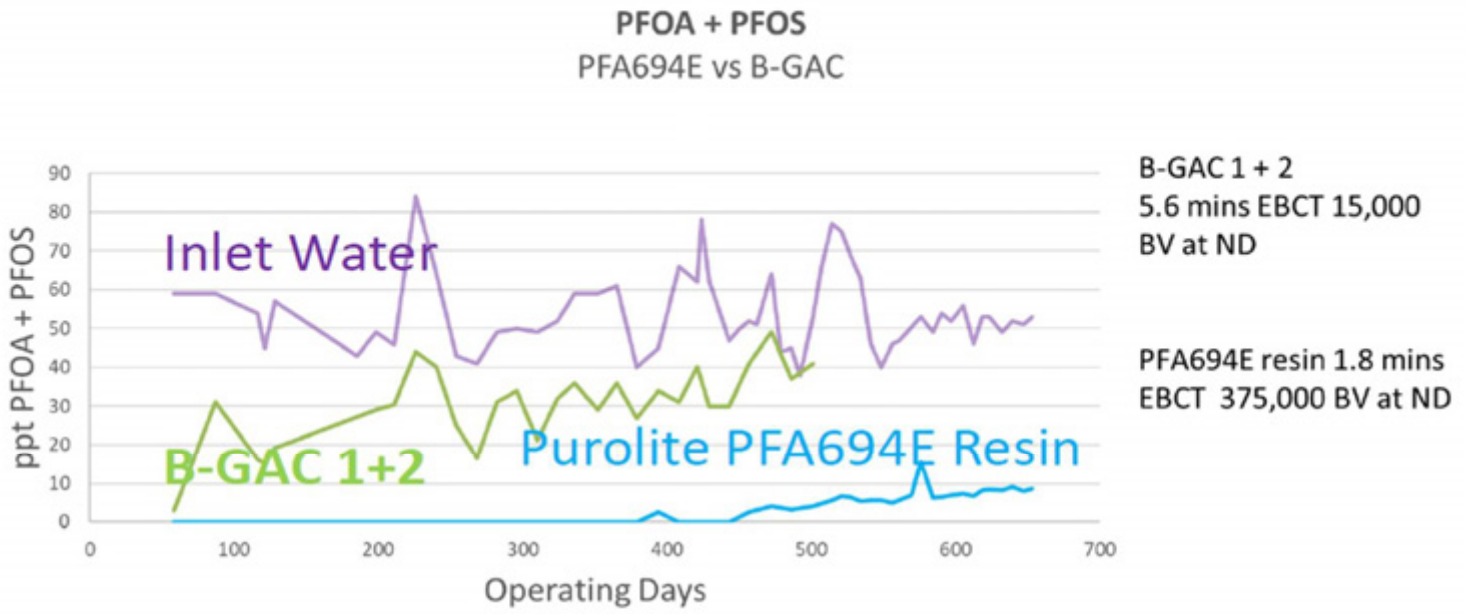
PFOS	55 ppt
PFOA	27 ppt
PFBS	8.4 ppt
PFHxA	9.6 ppt
PFHpA	4.7 ppt
PFHxS	36 ppt

Total PFAS 140 ppt



Perfluorooctanoic acid & Perfluorooctane sulfonic acid

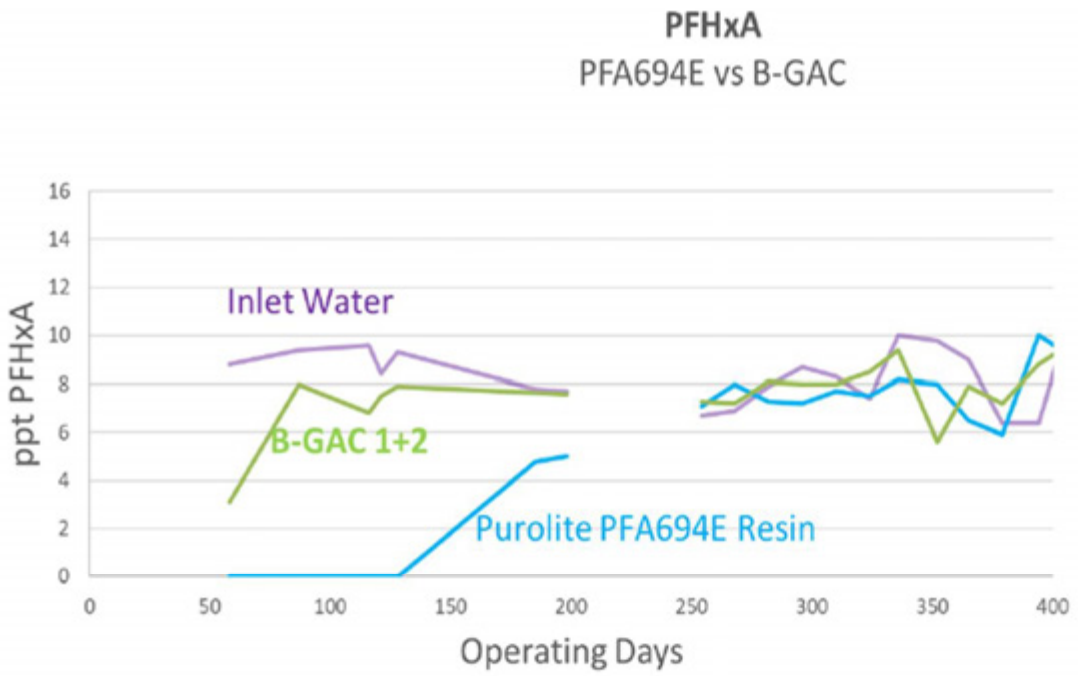
PFOA + PFOS



GAC stopped after 515 days; Resin to 653 days
375,000 BV = 2.8 million gallons /cubic foot of resin

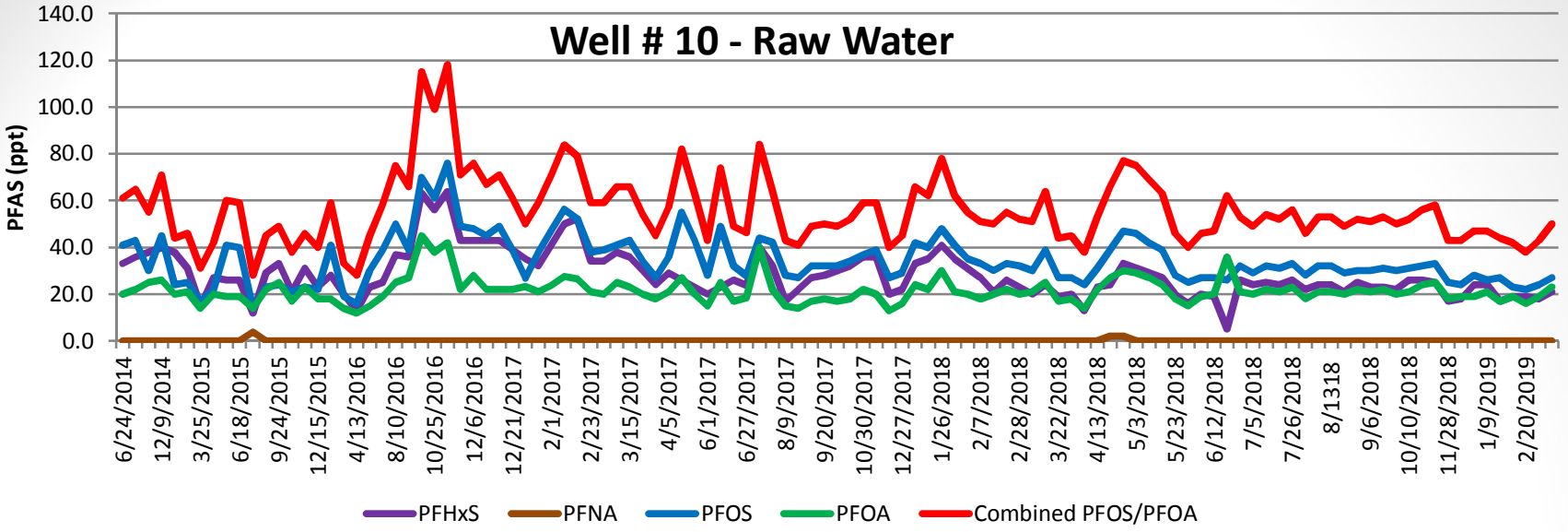
Perfluorohexanoic Acid (short-chain carboxylate)

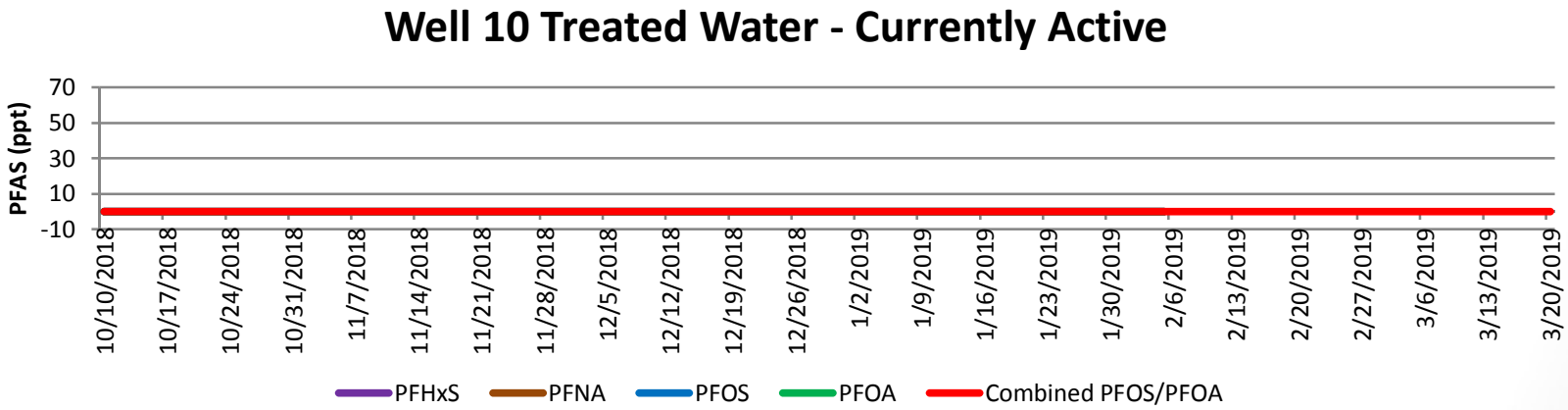
PFHxA



B-GAC 1+2
5.6 mins EBCT
< 15,000 BV

PFA694E resin 1.8 mins
EBCT 102,000 BV at ND


Well # 10 - Raw Water
PFAS (ppt)
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
6/24/2014
12/9/2014
3/25/2015
6/18/2015
9/24/2015
12/15/2015
4/13/2016
8/10/2016
10/25/2016
12/6/2016
12/21/2017
2/1/2017
2/23/2017
3/15/2017
4/5/2017
6/1/2017
6/27/2017
8/9/2017
9/20/2017
10/30/2017
12/27/2017
1/26/2018
2/7/2018
2/28/2018
3/22/2018
4/13/2018
5/3/2018
5/23/2018
6/12/2018
7/5/2018
7/26/2018
8/1318
9/6/2018
10/10/2018
11/28/2018
1/9/2019
2/20/2019
PFHxS
PFNA
PFOS
PFOA
Combined PFOS/PFOA


Well 10 Treated Water - Currently Active
PFAS (ppt)
70
50
30
10
-10
10/10/2018
10/17/2018
10/24/2018
10/31/2018
11/7/2018
11/14/2018
11/21/2018
11/28/2018
12/5/2018
12/12/2018
12/19/2018
12/26/2018
1/2/2019
1/9/2019
1/16/2019
1/23/2019
1/30/2019
2/6/2019
2/13/2019
2/20/2019
2/27/2019
3/6/2019
3/13/2019
3/20/2019
PFHxS
PFNA
PFOS
PFOA
Combined PFOS/PFOA

GAC vs. IX

Capacity to Break from ND
Avg. Inlet 140 ppt total PFAS (Horsham #10)

	Bituminous GAC 5.6 mins EBCT BV Capacity at ND	Purofine PFA694E PFAS-Selective Resin 1.8 mins EBCT BV Capacity at ND	Ratio IX/ GAC
PFHxA short chain	< 15,000	102,000	~7
PFHpA short chain	15,000	354,000	24
PFOA long chain	22,000	375,000	17
PFBS short chain	15,000	>522,000	35
PFHxS long chain	22,000	>522,000	24
PFOS long chain	22,000	>522,000	24

522,000 BV = 3.9 millions gallons/cubic foot of resin

GAC vs. IX Costs (100 gpm)

- Capital Costs:
  - Although IX resin is more expensive than GAC (~$400/ft3 vs. $65/ft3), because the EBCT in minutes per vessel is less (3 vs. 10.5), less media is needed.
  - GAC requires 80% more footprint than IX
  - Capital Costs are expected to be ~55% less for IX than GAC
- Operating Costs:
  - IX is achieving higher BVs before breakthrough occurs (350,000 vs. 35,000)
  - Annual operating costs are expected to be 75% less for IX than GAC ($8,000 vs. $78,000)
- Other considerations
  - IX does not have the arsenic SOP issue
  - IX does not require backwashing which produces a waste stream
  - IX is incinerated leaving
  - IX does potentially raise more legitimate “simultaneous compliance” concerns
  - IX resins are proprietary

Completing the PFAS Long Term Plan

- Once Wells 2, 4, 19 & 20 are returned to service over the next couple of months, the interconnect with neighboring supplier will be taken out of service for installation of GAC treatment.
- Wells 10, 17 and 21 which have been using temporary GAC treatment (Navy funded) will be taken out of service for permanent PFAS installation (Expect permits for IX systems to be submitted within weeks)
- Currently looking to set up IX column testing equipment to test various anion exchange resins versus the one pilot tested at Well 10

Challenges

- Not only are the capital costs expensive, but installing GAC treatment on wells, particularly those with small land footprints and/or in residential areas, is significantly altering to the landscape of the neighborhood

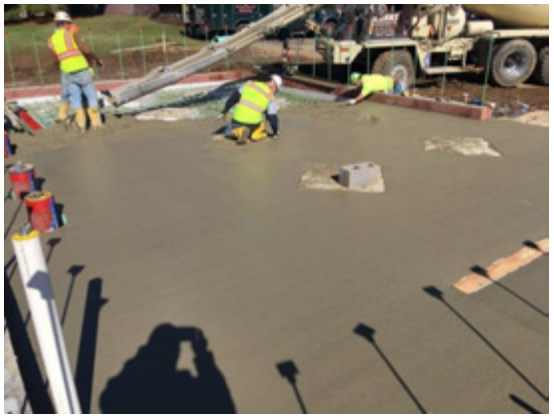
The changes are substantial
Well 2

Well #4

Well #19

Well #20

Well #22



HWSA Challenges

- O&M is labor intensive, expensive and obtrusive
  - Carbon change outs (and associated sampling now being required by PADEP) can result in wells being out of service (with the associated loss of production) for days to weeks at a time
  - Depending on location, carbon delivery is disruptive to residents
- GAC/IX treatment on wells is a substantial change in operational complexity and knowledge – these are transformative changes for small/medium groundwater systems
- Permitting of new treatment is proving to be difficult, which is frustrating considering both GAC and IX are not new technologies for drinking water and PFAS is not "regulated"

Willow Grove NASJRB/HAGs Base PFAS Clean Up

- The Navy is currently investigating the nature and extent of the PFAS contamination on the base.
- Any cleanup actions require comparing the levels of contamination at the base with established standards.
- However, there are no standards for PFAS compounds for soils, surface water, sediment or air. The drinking water standard is only a recommended health advisory from the US EPA.
- Moving forward with the redevelopment without established standards may result in future landowners and residents occupying property which may put them in an environment which is unsafe.

Note: On April 25th, EPA released "draft interim" PFAS cleanup guidance for addressing groundwater contaminated with PFOA & PFOS:

- Proposes a 40 ppt screening level for further investigation
- Proposes a 70 ppt "preliminary remediation goal" that can "inform final cleanup levels" of PFOA and PFOS when it is used or could be used for drinking water
- Guidance is still not enforceable and is advisory only
- 45 day comment period ending June 10, 2019

Navy PFAS Investigations/Actions

- Evaluating groundwater extraction and treatment systems using pilot test information
  - Plan to conduct extraction well pilot test at Hanger 680 starting April 2019
  - Pilot test start up and testing in summer of 2019
  - Six month duration after start up
  - NASJRB is supporting ~5.12 M in funded research investigating new assessment and remediation technologies by local and national universities and consulting firms
- Evaluating video inspections of 2 miles of stormwater pipes and requested funding to award repair contracts for 1,400 ft.
- Excavated 3,500 tons of soil with high levels of PFAS adjacent to fire station and Hanger 175.
  - Completed in January 2019
  - Planned to be disposed of at a RCRA Subtitle D lined landfill in NJ
  - Local public concern killed the plan and the soil now sits on the base under tarps
- Navy says it has spent $58 M: $35 on filters for wells or alternative water and $23 M on environmental testing, studies and interim measures to stop PFAS from leaving the base yet there is still no permanent remediation treatment in place

There is still much to do

- ***The impacts of the past exposure cannot be ignored*** **-** While we are proud of our Horsham Standard and our efforts to achieve it, health studies to give people answers to their legitimate concerns to their health from the past exposure, including cancer as a health outcome, must be performed

- ***The PFAS contamination and all associated pathways must be mitigated at the source in an expedited fashion through a coordinated and concurrent remediation of both the former NASJRB and existing HAGS -*** The raw water in the aquifer remains contaminated and likely will be for decades to come – pumping and treating the public supply wells cannot be the only long-term remediation method for the aquifer.

Final thoughts

- Based on our experience, HWSA and other PFAS impacted water suppliers, ***need collaboration, cooperation, and a sense of urgency from regulators*** in implementing new technologies and adjusting to new regulatory burdens on an accelerated schedule – This is still an emergency to us!

- ***We need help with risk communication strategies*** to address public concerns regarding sources of contamination, impacts of past exposures and explaining regulatory inconsistencies

- ***And lastly, the citizens of Horsham, Warminster & Warrington should not bear any of the costs for removing PFAS from their drinking water –*** these are manmade chemicals and the residents didn't put them there.

Thank you

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