PFAS WATER TREATMENT LESSONS LEARNED

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SITE-SPECIFIC PARAMETERS INFLUENCING GAC AND AIX O&M COSTS FOR PFAS

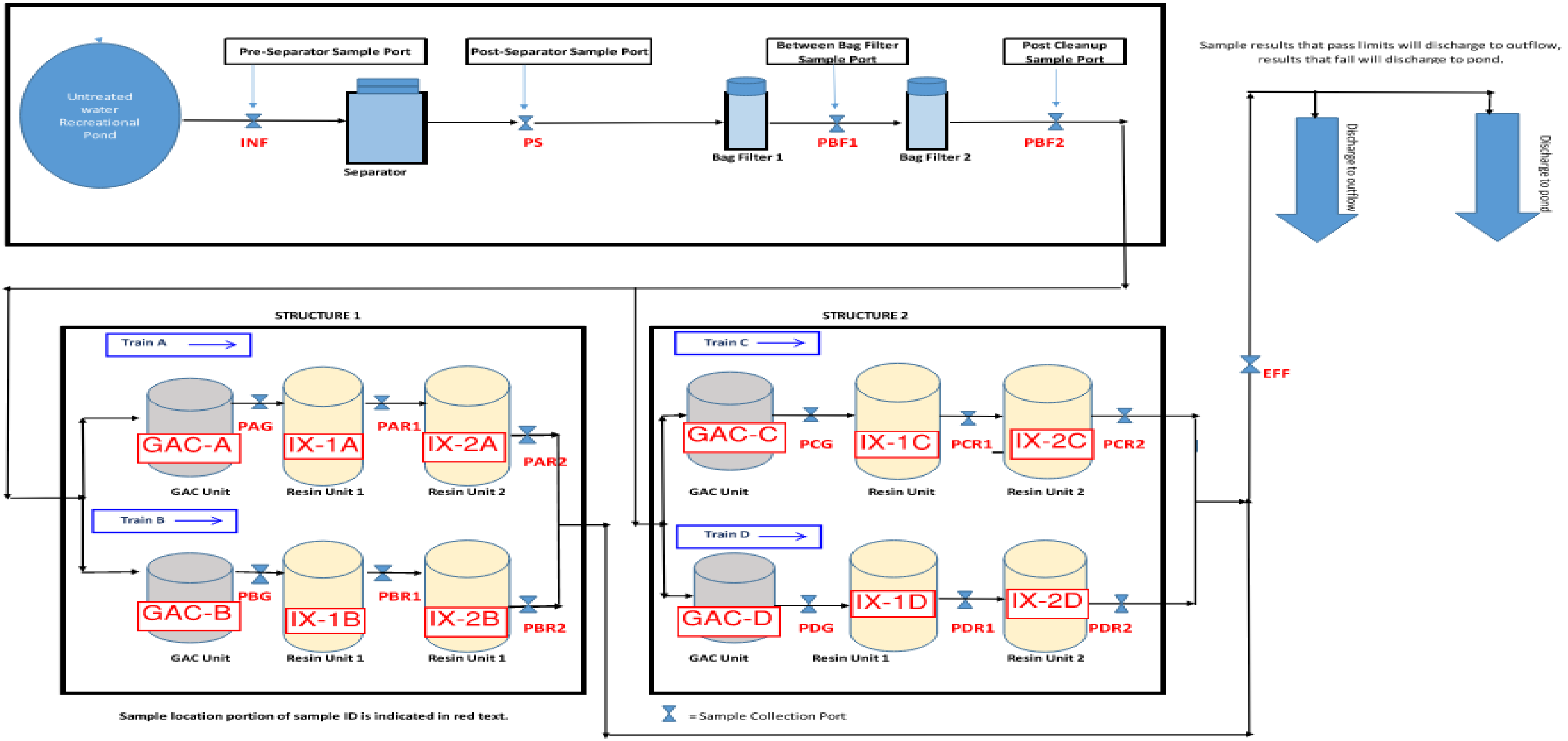
- Media cost (AIX media higher cost vs GAC)
- Contaminant mix and competitive species
- Any pretreatment needs (AIX performance impacted by metals and biological fouling, TSS, and TOC – can be damaged by oxidants)
- Influent concentrations (For PFAS, AIX becomes more cost effective at higher ppb concentrations vs GAC because of its higher adsorption capacity, which reduces change-out frequencies)
- Flow rate
- Discharge criteria
- Media change-out criteria (dictates change-out frequency)
- Media disposal (GAC offers lower cost commercial thermal reactivation option; cost estimates also need to include transportation to nearest disposal site)

CASE STUDY #1

<u>Goal:</u> Rapid construction of stormwater treatment system to limit PFAS contamination from entering waterway.

- A 500 gallons per minute (gpm) treatment system specified.
- Mobile treatment system installed.
- Use of pond volume via increasing the pool elevation or drawdown of the pond to provide storage volume and maximize stormwater capture.
- Studies of different pretreatment methods and media treatment configurations between July 2020 and May 2022 - optimization ongoing.

INITIAL TREATMENT SYSTEM



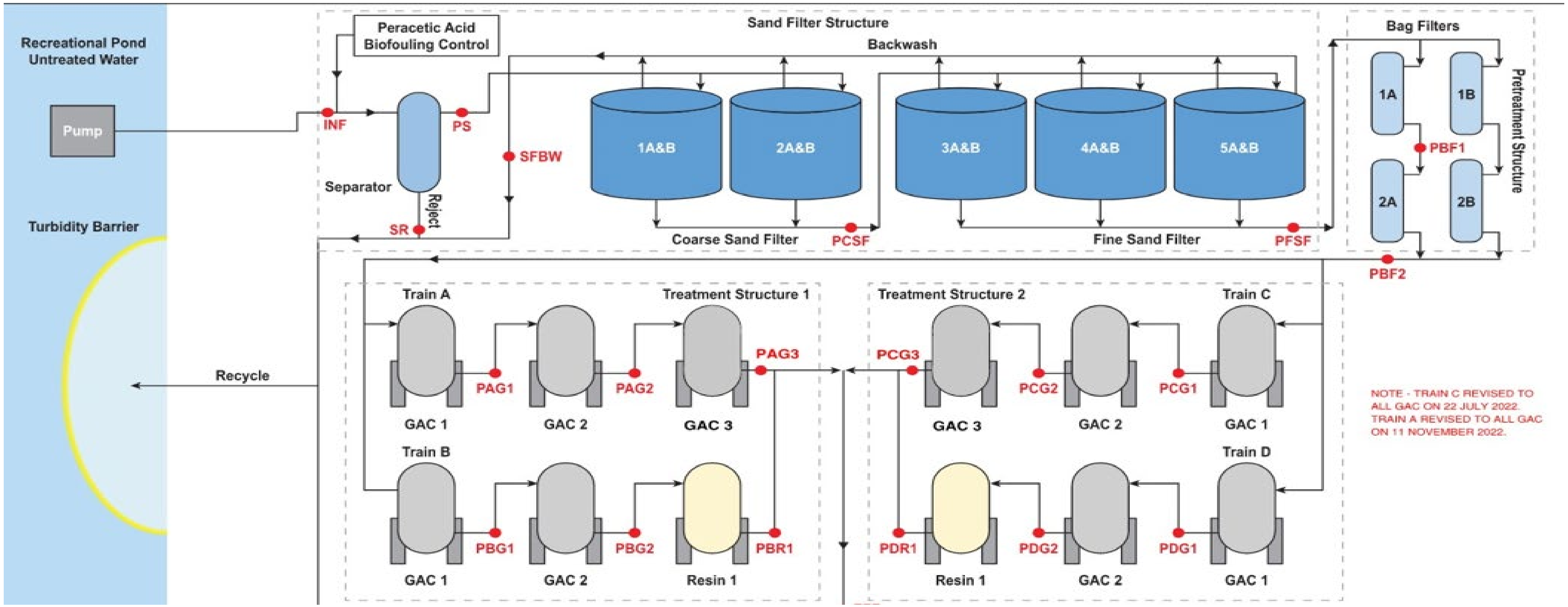
ISSUES OBSERVED AFTER STARTUP

- Pretreatment system was undersized for level of turbidity/ suspended solids. Improvement of the solids pretreatment needed to address chronic fouling of the anionic exchange (AIX) media.
- Fouling caused excessive pressure drops and premature media breakthrough for AIX units.
- Biological slime fouled both the granular activated carbon (GAC) and AIX media requiring preventative measures.
- Manufacturer suggested that future operations needed to prevent oxidation deterioration of the AIX media from treatment chemicals.

STUDY RECOMMENDATIONS

- Shut down treatment system during significant rain events (approximately 0.5 to 1.0 inches or more) to reduce turbidity.
- Install dual stage (coarse and fine) sand filter pretreatment system and 5-micron filter bags to address media fouling.
- Continuously dose a biocide (below regulatory discharge criteria).
- Backwashing the GAC columns causes channeling within the media beds. After a backwash, the vessels should be drained, and the media bed releveled to prevent channeling and premature PFAS breakthrough.
- Backwashing AIX not recommended by vendors - causes excessive media loss and premature breakthrough.
- GAC backflushing minimized fouling and breakthrough.

OPTIMIZED TREATMENT SYSTEM



CASE STUDY #2

EE/CA Remedy (now in design phase)

- Groundwater Recovery
  - Interceptor trench downgradient of source
  - Average flow rate: 20 to 40 gpm
- Surface Water Capture
  - Intercept base flow and first-flush peak flow
  - Base flow: 25 to 50 gpm
  - First-flush peak flow: 300 to 500 gpm
- Water Treatment System
  - Combined flow rate: 45 to 500 gpm
  - PFAS influent concentration:150 to 700 nanograms per liter (ng/L)

Past Pilot Study

- Evaluated two different types of pretreatment media for removal of metals (iron and manganese)
- Estimated the capacity of each pretreatment and primary treatment media to determine:
  - Media life
  - Identification of most cost-effective media for the full-scale system
- Evaluated potential fouling of media due to biological growth, metals, and total suspended solids
- Characterized the backwash streams for PFOA and PFOS

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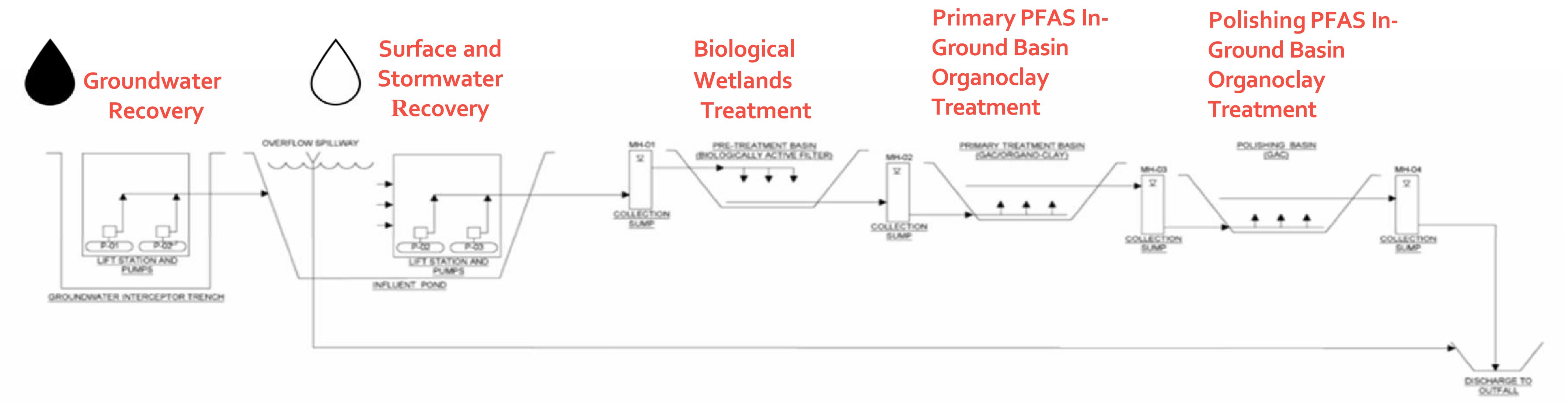
PROPOSED TREATMENT SYSTEM DESIGN SCHEMATIC



- Constructed wetlands with controlled **biologically active filtration** (e.g., reed beds) are traditionally used in wastewater/storm water treatment scenarios for their ability to remove organic solids and nutrients to **reduce biofouling.**
- PFAS is removed by two below grade basins in series by GAC or organoclay using an upflow design to fluidize the media.

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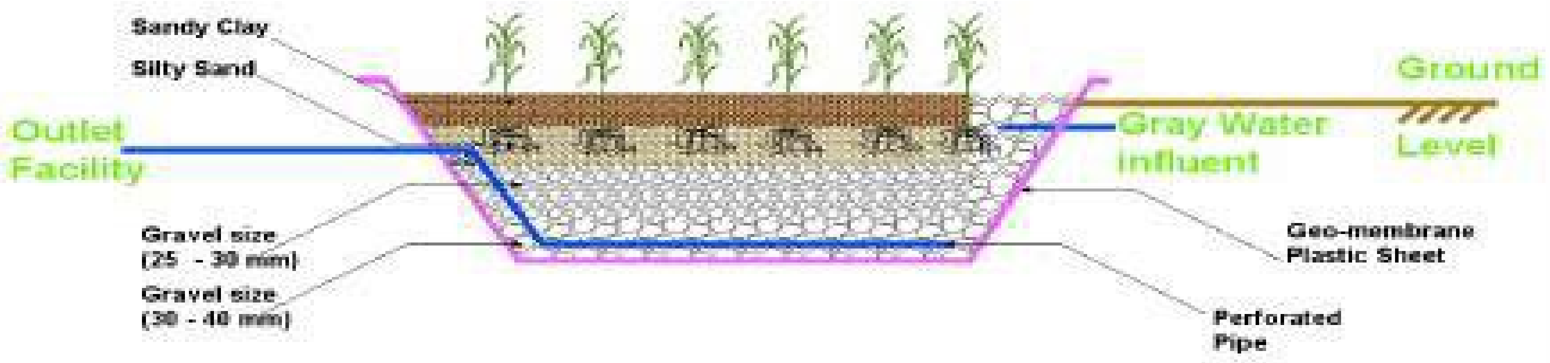
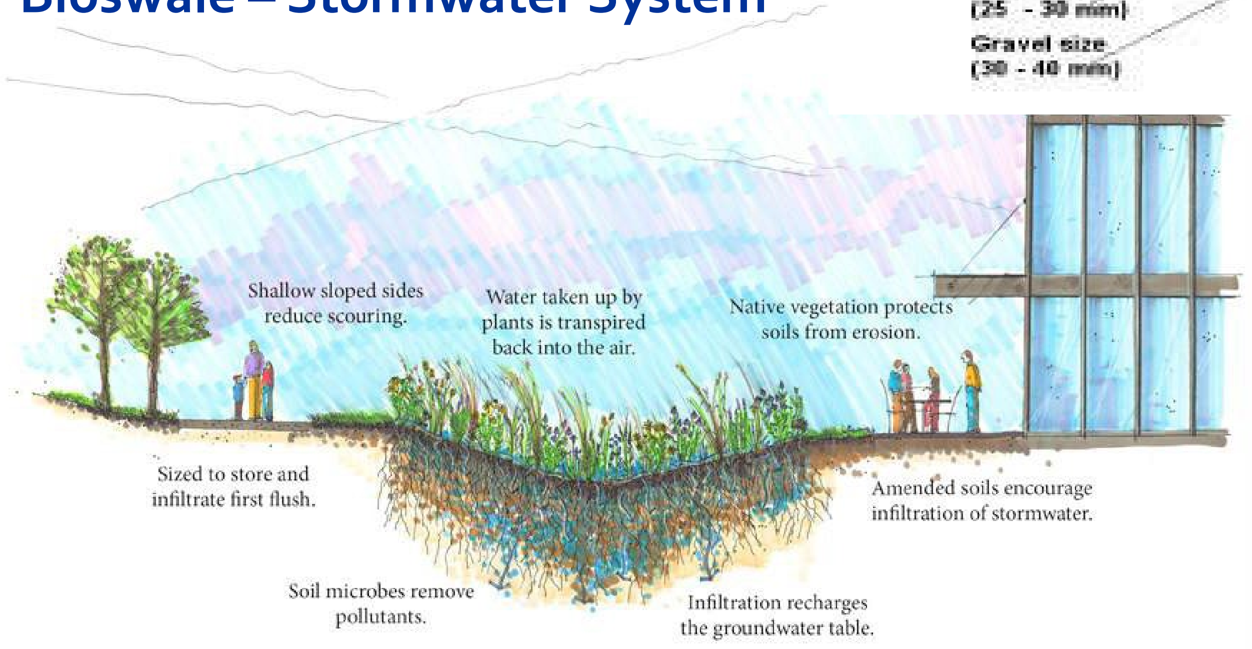
CONSTRUCTED WETLANDS

Reed Bed – Wastewater System



Bioswale – Stormwater System



- Biologically active treatment basin combines natural stormwater and wastewater treatment processes.
- Controlled biological growth provides organic solids and nutrient removal to reduce biofouling in downstream treatment cells.

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ARMY PFAS TREATMENT OPTIMIZATION STUDY

- In FY 2021, USACE performed optimization studies at four Army garrison sites, which included five drinking water systems. The focus of the optimization studies was to generate recommendations that could enhance reliability and durability, and/or reduce cost.
- The drinking water systems were considered representative of Army garrisons required to install PFAS treatment.
- Predominant contaminants were PFOS and PFHxS, except for one system where PFOA was the predominant contaminant.
- GAC had been installed for each of the systems.
- USACE performed a holistic evaluation of PFAS treatment for the systems summarized in an After-Action Report for the U.S. Army Installation Management Command (IMCOM) G-4 Facilities and Logistics.

ARMY AFTER ACTION REPORT LESSONS LEARNED

1. Develop contingency plan to address potential PFAS/emerging chemicals mitigation.
2. Perform treatability testing to identify and select PFAS treatment media.
3. Remove or bypass duplicative treatment processes.
4. Design PFAS treatment systems to accept different media types.
5. Ensure sufficient treatment system performance sampling can be completed under Army policy.
6. Ensure adequate GAC change-out procedures to avoid “false positives”.

Source: PFAS Drinking Water Treatment System Optimization After Action Review Report – Final, April 2022, Prepared for U.S. Army Installation Management Command (IMCOM) G-4 Facilities and Logistics

QUESTIONS