Kimley»Horn

David D. Peters
Public Works Director
121 SW Flagler Avenue
Stuart, Florida 34994

Dear Mr. Peters,

Upon review of the last ten (10) months of operational data of the Per- and Poly-fluorinated substances (PFAS) Ion Exchange treatment system, we believe that the Dowex PSR2 Plus ion exchange resin has, and continues to be, the top performing resin out of the 4 tested. Each of the vessels contains the following media:

Vessel 1: Calgon – PFAS Resin with GAC Topping

PFAS treating resin: Calres 2304 – 459 ft^3

TOC Topping: Filtrasorb 400 – 106 ft^3 (Bituminous coal granular activated carbon (GAC))

Vessel 2: Evoqua – PFAS Resin Only

PFAS treating resin: Dowex PSR2 Plus – 564 ft^3

TOC Topping: None

Vessel 3: Purolite – PFAS Resin with TOC Resin Topping

PFAS treating resin: PFA694E – 425 ft^3

TOC Topping: A502P – 148 ft^3 (A macroporous resin)

Vessel 4: Resintech – PFAS Resin with GAC Topping

PFAS treating resin: SIR-110-HP – 452 ft^3

TOC Topping: AGC-30-AW – 113 ft^3 (Coconut shell GAC)

The City of Stuart (City) wellfield contains elevated levels of total organic carbon (TOC), a contaminant that affects and reduces the treatment capacity of each resin bed to remove PFAS. When TOC occupies a large portion of available surface area on each resin particle, that greatly reduces the amount of PFAS adsorption, it is known as blinding. To combat blinding and elongate the life of the resin, Calgon, Purolite, and Resintech utilized a pretreatment topping believed to help reduce TOC impact on the resin's ability to remove PFAS contaminants.

There are two terms that were used in evaluating the system performance, **resin BV's** and **total BV's**. It is important to distinguish between the two for the following reasons:

1) Calgon, Purolite, and Resintech implemented pretreatment resins/GAC that were used with the intent of making PFAS-adsorbing resin last longer. This was done by adding a topper of GAC or Resin above the PFAS resin bed. This represents "total BV's".

2) While both resin and GAC will remove PFAS from the water supply, another term "resin BV" can be used to evaluate the amount of water treated by the PFAS-adsorbing resin. While the argument can be made that the pretreatment will adsorb some of the PFAS, that is not its intended use. This was clearly demonstrated with Vessel 3 that used a topping resin for TOC reduction only. The others had a GAC topping which reduced both TOC and PFAS.

The thought process behind this was that no matter how much quantity of resin is loaded, if one resin is achieving a better ratio of water treated/amount of resin present, it distinguishes it as performing better. This is an important distinction, as both values represent two separate approaches to evaluating performance. The "total BV's" value compares each vessel as a system of pretreatment and PFAS-adsorbing media (used to evaluate if a topper would help elongate the life of the resin), where the "resin BV's" represent the amount of water treated by the PFAS-adsorbing resin. The intent was to evaluate all the resin manufacturers fairly and on an equal playing field, in the event the pretreatment wasn't effective.

As of 4/15/2020, Vessel 2's effluent stream PFOS+PFOA level is still undetected at **59,695** resin/total BV's. In comparison:

Vessel 1 broke through the effluent stream with 10 ppt on January 16th, 2020 at 45,602 resin BV's and 37,007 total BV's.

Vessel 3 broke through the effluent stream with 2 ppt on November 13th, 2020 at 38,150 resin BV's and 28,296 total BV's.

Vessel 4 broke through the effluent stream with 9 ppt on January 16th, 2020 at 48,180 resin BV's and 38,544 total BV's.

When comparing both the "resin" and "total" treated BV's, the PSR2 Plus resin clearly performed the best. The PSR2 Plus can withstand the high TOC environment without the need for pretreatment, while also reducing PFAS levels to non-detect to past 60,000 BV's – longer than any of the other resins.

Table 1 attached and below depicts the results for each vessel, with yellow highlighted sections representing breakthrough >10 parts per trillion (ppt) was detected, while orange represents that breakthrough ≥ 10 ppt was detected.

In summary, it is our opinion that the Dowex PSR2 Plus Ion Exchange resin clearly provides the best performance at removing PFAS down to non-detect levels and treatment goals of 10 ug/L to 20 ug/L setup in 2017 (see attached letter).

It is our recommendation to utilize the Dowex PSR2 Plus IX resin as the replacement resin for your PFAS treatment system, based on performance with the City's raw water supply.

Please call with any questions regarding these recommendations.

Sincerely,

Kimley-Horn and Associates, Inc.

Mark D. Miller, P.E.
Senior Vice President
FL PE #045320

Kimley»Horn

Table 1: COS IX Resin Comparison

CITY OF STUART - IX PFAS TREATMENT SYSTEM

VESSEL 1 - Calgon	Polymer Structure	Volume $(ft)^3$	Weight (lbs)
CALRES 2304	Gel - 100% N-Tri-Butyl Amine	459	-
Filtrasorb 400		106.6	3,200
Total Amount of media in top 25% (ft^3)		565.6 141.85	3,200

Date	INF PFOS+PFOA Level (ug/L)	EFF PFOS+PFOA Level (ug/L)	Gals Treated	Resin BV	Vessel BV
11/13/2019	0.036	U	115,800,000	33,726	27,370
12/9/2019	0.130	U	130,445,000	37,991	30,831
1/16/2020	0.117	0.010	156,576,000	45,602	37,007
2/13/2020	0.090	0.003	174,187,000	50,731	41,169
3/12/2020	0.106	0.002	191,814,000	55,864	45,336
4/15/2020	0.116	0.012	214,386,000	62,438	50,671

VESSEL 2 - Evoqua	Polymer Structure	Volume $(ft)^3$	Weight (lbs)
Resin PSR2 Plus	Styrene-divinylbenzene	564	-
			-
Total Amount of media in top 25% (ft^3)		564 140.25	0

INF PFOS+PFOA Level (ug/L)	EFF PFOS+PFOA Level (ug/L)	Gals Treated	Resin BV	Vessel BV
0.036	U	116,799,000	27,684	27,684
0.130	U	142,973,000	33,888	33,888
0.117	U	171,596,000	40,672	40,672
0.090	U	195,705,000	46,386	46,386
0.106	U	220,030,000	52,152	52,152
0.116	U	251,854,000	59,695	59,695

Note: U = Undetect

VESSEL 3 - Purolite	Polymer Structure	Volume $(ft)^3$	Weight (lbs)
PFA694E	Polystyrene crosslinked with divinylbenzene	425	17,850
A502P	Macroporous polystyrene crosslinked with divinylbenzene	148	-
Total Amount of media in top 25% (ft^3)		573 149.25	17,850

Date	INF PFOS+PFOA Level (ug/L)	EFF PFOS+PFOA Level (ug/L)	Gals Treated	Resin BV	Vessel BV
11/13/2019	0.036	0.002	121,288,000	38,150	28,296
12/9/2019	0.130	0.003	136,595,000	42,965	31,868
1/16/2020	0.117	0.011	166,556,000	52,389	38,857
2/13/2020	0.090	0.010	185,298,000	58,284	43,230
3/12/2020	0.106	0.010	205,115,000	64,517	47,853
4/15/2020	0.116	0.017	227,236,000	71,475	53,014

VESSEL 4 - Resintech	Polymer Structure	Volume $(ft)^3$	Weight (lbs)
SIR-110-HP	Styrene-divinylbenzene	452	18,532
AGC-30-AW	Coconut Shell	113	3,107
Total Amount of media in top 25% (ft^3)		565 141.25	21,639

INF PFOS+PFOA Level (ug/L)	EFF PFOS+PFOA Level (ug/L)	Gals Treated	Resin BV	Vessel BV
0.036	U	116,662,000	34,503	27,603
0.130	U	133,593,000	39,511	31,608
0.117	0.009	162,905,000	48,180	38,544
0.090	0.004	182,113,000	53,861	43,088
0.106	0.004	203,336,000	60,137	48,110
0.116	0.013	226,740,000	67,059	53,647