

Memorandum

Date: March 16, 2020
To: The Chemours Company FC, LLC
From: Geosyntec Consultants of NC, PC
Subject: Mass Loading Model Update – November 2019 Sampling Event

INTRODUCTION

Geosyntec Consultants of NC, PC (Geosyntec) has prepared this memorandum for The Chemours Company FC, LLC (Chemours) for the Fayetteville Works facility, North Carolina (the Site). The mass loading model was developed (Geosyntec, 2019a) to evaluate contributions of Table 3+ PFAS from various pathways to the Cape Fear River. This memorandum describes the results of the sampling event that took place on November 12, 2019 to estimate mass loading of Table 3+ per and polyfluoroalkyl substances (PFAS) to the Cape Fear River. As requested by North Carolina Department of Environmental Quality (NCDEQ) and Cape Fear River Watch (CFRW), the November event was completed during a rain event. By pathway the mass loads were consistent with previous events with the exception of Outfall 002, which had higher Table 3+ PFAS loading due to sampling coincidence with a rain event of 0.33 inches over a 4 hour time period from about 12:20 pm to 4:25 pm. Other site activities investigating total Table 3+ PFAS contributions from stormwater indicated that total Table 3+ PFAS loads to Outfall 002 are influenced by stormwater (Geosyntec, 2019b).

RESULTS

During the November 2019 event, two types of Outfall 002 samples were collected: a twenty-four-hour composite sample which collected water before, during and after the rain event and a grab sample collected midway through the rain event (Figure 1). Prior dry events used a combination of 84-hour composite and grab sample data to estimate loadings from Outfall 002 to the Cape Fear River. For this November 2019 rain event, the 24-hour composite sampler collected an aliquot of Outfall 002 water once every 30 minutes for a total of 48 aliquots over the 24 hours. Since stormwater concentrations can be variable over short durations of time, the 24-hour composite sample was considered to be more representative of loadings to the river during this event than the grab sample. Accordingly, the composite sample was used to estimate the mass loads of total Table 3+ PFAS to the river for the November 2019 event.

The data used to calculate pathway-specific loadings are described in Table 1, the mass loading results from this event are presented in Tables 2 and 3, and the analytical data used in the calculations are provided in Table 4. The estimated loading percentage per pathway are provided in Table 2 and the estimated load per pathway and in the Cape Fear River are provided in Table 3. The loads from all pathways (e.g., seeps, onsite groundwater) are generally consistent with the range of previously reported values. The load from Outfall 002 was higher than prior loads at 8% due to increased concentrations at Outfall 002 from stormwater (rainfall occurred during four of the 24 hours over which the composite sample was collected).

The total estimated mass loading to the Cape Fear River on a per pathway basis were higher than the measured load in the Cape Fear River based on a sample collected at Bladen Bluffs Intake (Table 3). This discrepancy is likely due to the Bladen Bluffs sample collection preceding the arrival of stormwater flows from the Site. Bladen Bluffs is approximately 5 miles downstream from the W.O. Huske Dam (the southern edge of the Site). The Bladen Bluffs sample was taken during the rainfall period as were most samples onsite. However, based on numerical modeling of the Cape Fear River, water traveling from the W.O. Huske Dam to the Bladen Bluffs sampling point is estimated to take 10 hours to arrive. Therefore, stormwater flows from the Site, including from Outfall 002, had not reached the Bladen Bluffs sampling point when the sample was collected (see Figure 1).

ADJUSTMENTS TO FUTURE EVENTS AND REPORTING

In future events two adjustments will be made to improve the representativeness of samples collected. First, composite samplers will be used to collect 24-hour integrated samples from Willis Creek, all four seeps, Outfall 002, Old Outfall 002 and from the downstream river location at Tar Heel Ferry Road bridge. The Tar Heel Ferry Road bridge location is approximately 2.1 miles downstream from the Bladen Bluffs sampling location, i.e. 7 miles downriver from the Site. This sampling location is suitably far enough downstream of the Site for the water to be well mixed (see transect sampling reported in the Assessment of the Chemical and Spatial Distribution of PFAS in the *Cape Fear River* report [Geosyntec, 2018]). The composite samplers will collect sample aliquots once per hour. Collecting composite samples from these locations will allow for a more accurate assessment of loads reaching the river compared to grab samples; composite samples smooth out potential variability in data when sampling heterogenous and dynamic natural systems.

The second adjustment will be to use the results of a numerical model of the Cape Fear River to estimate the arrival times of water passing the Site at the downstream Tar Heel Ferry Road bridge location. As such, the composite sample at the Tar Heel Ferry Road bridge location will be collected during a representative interval, to the extent feasible, to account for the arrival times.

For example, sample collection at Tar Heel Ferry Road bridge may begin 10 hours later to sequence collection with when water that left the Site is reaching the downriver sampling location.

Additionally, as described in a response to NCDEQ comments on Paragraph 12 (Geosyntec, 2020), composite samples will be collected continuously, to the extent practicable, at the Tar Heel Ferry Road bridge. These composite samples will provide a more continuous record of river total Table 3+ PFAS concentrations and loadings to the Cape Fear River. Using an autosampler will also allow for an evaluation of seasonal or shorter temporal trends (e.g., wet weather).

The adjustments described above will result in modifications to the presentation of the mass loading results. Specifically, the total mass load in the Cape Fear River will be assessed using only the downstream Cape Fear River composite samples. The estimated pathway-specific loads will continue to be presented to provide an assessment of the relative loads to the measured total Table 3+ PFAS load to the Cape Fear River. Finally, additional descriptions of groundwater concentrations adjacent to the Cape Fear River will be provided.

REFERENCES

Geosyntec, 2018. Assessment of the Chemical and Spatial Distribution of PFAS in the Cape Fear River. Chemours Fayetteville Works. September 17, 2018.

Geosyntec, 2019a. Cape Fear River PFAS Mass Loading Model Assessment and Paragraph 11.1 Characterization of PFAS at Intakes. Chemours Fayetteville Works. August 26, 2019.

Geosyntec, 2019b. Assessment of HFPO-DA and PFMOAA in Outfall 002 Discharge and Evaluation of Potential Control Options. Chemours Fayetteville Works. August 26, 2019.

Geosyntec, 2020. Response to North Carolina Department of Environmental Quality Comments - Dated December 19, 2019. Chemours Fayetteville Works. January 31, 2020.

TABLE 1
PFAS MASS LOADING MODEL POTENTIAL PATHWAYS
Chemours Fayetteville Works, North Carolina

Transport Pathway Number	Potential PFAS Transport Pathway	Analytical Data Source for Mass Loading Model¹	Flow Data Source for Mass Loading Model¹
1	Upstream River and Groundwater	Measured from Cape Fear River samples CFR-MILE-76 collected on November 12, 2019 directly upstream of Site.	Measured flow rates from USGS gauging station at W.O. Huske Dam ² .
2	Willis Creek	Measured from Willis Creek samples collected on November 12, 2019.	Measured flow rate through point velocity flow gauging on November 12, 2019.
3	Aerial Deposition on River	Estimated from air deposition modeling as described in the Mass Loading Model Report and the ERM Air Deposition Modeling Report.	
4	Outfall 002	Measured from a 24-hour composite sample from Outfall 002 collected in November 2019.	Measured daily Outfall 002 flow rates.
5	Onsite Groundwater	Measured from LTW well samples collected in December 2019.	Estimated from calculated hydraulic gradients based on November 2019 water levels and hydraulic conductivities of LTW wells from slug tests performed in 2019.
6	Seeps	Measured from Seeps A, B, C, and D samples collected on November 12, 2019.	Measured flow rates through flumes in Seeps A, B and C and salt dilution gauging at Seep D on November 12, 2019.
7	Old Outfall 002	Measured from an Old Outfall 002 sample collected on November 12, 2019.	Measured flow rates through flume on November 12, 2019.
8	Adjacent and Downstream Groundwater	Estimated from residential well data as described in the Mass Loading Model Report.	
9	Georgia Branch Creek	Measured from Georgia Branch Creek sample collected on November 12, 2019.	Measured flow rate through point velocity flow gauging on November 12, 2019.

Notes:

1. Flow and concentration data are multiplied together to estimate the PFAS mass load in the Cape Fear River originating from each pathway.
2. Cape Fear River flow rates measured at USGS gauging station #02105500 located at William O Huske Lock & Dam accessed from <https://waterdata.usgs.gov> on 2019-07-12 23:42:42 EDT.

References:

- Geosyntec, 2019. Cape Rear River PFAS Mass Loading Model Assessment and Paragraph 11.1 Characterization of PFAS at Intakes. Chemours Fayetteville Works. 26 August 2019.
- ERM, 2018. Modeling Report: HFPO-DA Atmospheric Deposition and Screening Groundwater Effects. 27 April 2018.

**CAPE FEAR RIVER TOTAL TABLE 3+ PFAS
MASS LOADING MODEL PATHWAY APPORTIONMENT UPDATE
ESTIMATED LOADING PERCENTAGE PER PATHWAY
Chemours Fayetteville Works, North Carolina**

Pathway	Total Table 3+ PFAS Estimated Loading Percentage			
	per Pathway per Event			
	22-May-19 Event	07-Jun-19 Event	18-Sep-19 Event	12-Nov-2019 Event ¹
[1] Upstream River Water and Groundwater	4%	15%	8%	7%
[2] Willis Creek	10%	4%	3%	5%
[3] Aerial Deposition on Water Features	< 2%	< 2%	< 2%	< 2%
[4] Outfall 002	4%	7%	4%	8%
[5] Onsite Groundwater ²	22%	17%	14%	14%
[6] Seeps	32%	24%	41%	43%
[7] Old Outfall 002	23%	29%	27%	22%
[8] Offsite Adjacent and Downstream Groundwater	< 2%	< 2%	< 2%	< 2%
[9] Georgia Branch Creek	4%	3%	2%	1%

Notes:

1 - The mass loading sampling conducted on November 12, 2019 occurred during a rainfall of 0.33 inches as measured at the Site meteorological station.

2 - The onsite groundwater term is calculated for all events using the analytical solution presented in the mass loading model report (Geosyntec, 2019).

Acronyms:

cfs - cubic feet per second

mg/s - milligrams per second

ng/L - nanograms per liter

PFAS - per- and polyfluoroalkyl substances

**CAPE FEAR RIVER TOTAL TABLE 3+ PFAS
MASS LOADING MODEL PATHWAY APPORTIONMENT UPDATE
ESTIMATED LOADING PER PATHWAY
Chemours Fayetteville Works, North Carolina**

Pathway	Total Table 3+ PFAS			
	Estimated Mass Loading in mg/s per Pathway per Event			
	22-May-19 Event	07-Jun-19 Event	18-Sep-19 Event	12-Nov-2019 Event ¹
[1] Upstream River Water and Groundwater	0.43	1.87	0.94	0.73
[2] Willis Creek	1.06	0.49	0.31	0.53
[3] Aerial Deposition on Water Features	<0.01	<0.01	<0.01	<0.01
[4] Outfall 002	0.37	0.92	0.52	0.89
[5] Onsite Groundwater ²	2.01	1.87	1.70	1.47
[6] Seeps	3.36	3.11	5.00	4.68
[7] Old Outfall 002	2.42	3.75	3.32	2.32
[8] Offsite Adjacent and Downstream Groundwater	0.05	0.05	0.05	0.05
[9] Georgia Branch Creek	0.39	0.41	0.29	0.09
Calculated Total Table 3+ Loading (mg/s) at Bladen Bluffs³	10.1	12.5	12.1	10.8
Measured Total Table 3+ Loading (mg/s) at Bladen Bluffs^{3,4}	13.6	16.4	11.4	7.1
Cape Fear River Flow Rate at W.O. Huske Dam (cfs)	1,640	1,180	992	1,140
Measured Total Table 3+ at Bladen Bluffs (ng/L)	293	492	405	221
Measured Rainfall During Bladen Bluff Sampling Day (in)	0.00	0.00	0.00	0.33

Notes:

1 - The mass loading sampling conducted on November 12, 2019 occurred during a 0.33 inch rainfall event as measured at the Site meteorological station.

2 - The onsite groundwater term is calculated for all events using the analytical solution presented in the mass loading model report (Geosyntec, 2019).

3 - Calculated loadings from the pathways are compared to the measured loadings in the Cape Fear River at Bladen Bluffs, approximately 5 miles downstream from the W.O. Huske Dam. Measured loadings at Bladen Bluffs are estimated by multiplying measured river concentrations at Bladen Bluffs by the flow rate of the river at the W.O. Huske Dam.

4 - The November 12, 2019 Bladen Bluffs sample was collected before stormwater flows from the Site reached Bladen Bluffs, thus potentially contributing to the difference between the calculated and measured Total Table 3+ PFAS loadings.

Acronyms:

cfs - cubic feet per second

in - inches

mg/s - milligrams per second

ng/L - nanograms per liter

PFAS - per- and polyfluoroalkyl substances

TABLE 4
NOVEMBER 2019 MASS LOADING EVENT ANALYTICAL RESULTS
Chemours Fayetteville Works, North Carolina

Potential PFAS Transport Pathway	1	2	4	4	5	5	5
Location ID	CFR-MILE-76	WC-1	OUTFALL 002	OUTFALL 002	LTW-01	LTW-02	LTW-03
Field Sample ID	CFR-RM-76-111219	WC-1-111219	OUTFALL 002-111219	SE91112	P16BLQ419-LTW-01-120619	P16BLQ419-LTW-02-120519	P16BLQ419-LTW-03-120619
Sample Date	11/12/2019	11/12/2019	11/12/2019	11/12/2019	12/6/2019	12/5/2019	12/6/2019
QA/QC							
Sample Type	Grab	Grab	Grab	Composite	Grab	Grab	Grab
SDG	320-56253-1	320-56275-1	320-56275-1	NA	320-56874-1	320-56876-1	320-56874-1
Lab Sample ID	320-56253-4	320-56275-2	320-56275-3	Onsite Lab	320-56874-6	320-56876-8	320-56874-1
<i>Table 3+ Lab SOP (ng/L)</i>							
HFPO-DA	4.8	440	1,600	357	24,000	7,200	11,000
PFMOAA	<5 UJ	710	160 J	277	50,000	23,000	150,000
PFO2HxA	<2	450	260	396	32,000	9,700	31,000
PFO3OA	<2	80 J	130 J	320	7,000	2,000	4,700
PFO4DA	<2	19 J	88 J	171	1,200	160	150
PFO5DA	<2	2.8	71	103	150	<34	<34
PMPA	11	570	110	118	21,000	3,700	8,900
PEPA	<20	150	56	<500	7,300	1,200	2,200
PFESA-BP1	<2	<2	630 J	188	<27	<27	<27
PFESA-BP2	<2	13	120	105	180	<30	<30
Byproduct 4	3.1 J	34 J	230 J	<100	860	220	510
Byproduct 5	<2	180 J	520 J	136	700	460	1,900
Byproduct 6	<2	<2	5.3	<100	<15	<15	<15
NVHOS	3.8	14	36	<100	460	210	880
EVE Acid	<2	<2	640	<100	<24	<24	<24
Hydro-EVE Acid	<2	7.3	54	<100	140	34	40
R-EVE	<2	19 J	76 J	<100	700	220	400 J
PES	<2	<2	<2	<100	<46	<46	<46
PFECA B	<2	<2	<2	<100	<60	<60	<60
PFECA-G	<2	<2	<2	<100	<41	<41	<41

Notes:

Bold - Analyte detected above associated reporting limit

J - Analyte detected. Reported value may not be accurate or precise

NA - not applicable

ng/L - nanograms per liter

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TABLE 4
NOVEMBER 2019 MASS LOADING EVENT ANALYTICAL RESULTS
Chemours Fayetteville Works, North Carolina

Potential PFAS Transport Pathway	5	5	6	6	6	6	6	7
Location ID	LTW-04	LTW-05	SEEP-A-1	SEEP-A-1	SEEP-B-1	SEEP-C-1	SEEP-D-1	OLDOF-1
Field Sample ID	P16BLQ419-LTW-04-120619	P16BLQ419-LTW-05-120519	SEEP-A-1-111219	SEEP-A-1-111219-D	SEEP-B-1-111219	SEEP-C-111219	SEEP-D-1-111219	OLDOF-1-111219
Sample Date	12/6/2019	12/5/2019	11/12/2019	11/12/2019	11/12/2019	11/12/2019	11/12/2019	11/12/2019
QA/QC				Field Duplicate				
Sample Type	Grab	Grab	Grab	Grab	Grab	Grab	Grab	Grab
SDG	320-56874-1	320-56876-1	320-56313-1	320-56313-1	320-56273-1	320-56273-1	320-56275-1	320-56313-1
Lab Sample ID	320-56874-4	320-56876-4	320-56313-1	320-56313-2	320-56273-4	320-56273-8	320-56275-1	320-56313-3
<i>Table 3+ Lab SOP (ng/L)</i>								
HFPO-DA	30,000	5	18,000 J	28,000 J	25,000	27,000	9,100	5,100
PFMOAA	87,000	190,000	84,000	95,000	200,000	220,000	120,000	81,000
PFO2HxA	30,000	52,000	37,000	41,000	49,000	62,000	28,000	17,000
PFO3OA	6,000	17,000	13,000	15,000	12,000	20,000	7,900 J	4,800
PFO4DA	800	2,600	6,300	7,800	1,800	5,600	2,100 J	1,700
PFO5DA	39	<67	2,800	3,600	140	<67	98 J	870
PMPA	22,000	4,700	20,000	20,000	35,000	13,000	7,500	5,000
PEPA	8,400	400	7,100	7,300	15,000	4,000	2,400	1,600
PFESA-BP1	<27	<53	3,700	4,500	1,100	<53	<27	400
PFESA-BP2	160	220	950	1,100	620	620	300	340
Byproduct 4	1,900	960	1,700 J	2,000 J	3,700 J	1,200 J	600 J	380 J
Byproduct 5	3,400	1,500	14,000 J	18,000 J	30,000 J	2,400 J	1,700 J	1,200 J
Byproduct 6	17	36	40 J	60 J	54	41	20	<15
NVHOS	1,600	1,300	890	980	2,600	1,700	890	730
EVE Acid	<24	<49	720 J	980 J	1,400	<49	<24	36
Hydro-EVE Acid	610	1,000	1,100	1,300	2,000	2,600	1,300	210
R-EVE	2,300	1,200	1,100 J	1,300 J	2,500 J	2,200 J	850	230 J
PES	<46	<92	<46	<46	<46	<92	<46	<46
PFECA B	<60	<120	<60	<60	<60	<120	<60	<60
PFECA-G	<41	<82	<41	<41	<41	<82	<41	<41

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Chemours Fayetteville Works, North Carolina

Potential PFAS Transport Pathway	7	9	Bladen Bluffs	Kings Bluff Intake	NA	NA	NA
Location ID	OLDOF-1	GBC-1	CFR-BLADEN	CFR-KINGS	EB	EB	FBLK
Field Sample ID	OLDOF-1-111219-D	GBC-1-111219	CFR-BLADEN-111219	CFR-KINGS-111219	EQBLK-01-111219	EQBLK-02-111219	FBLK-01-111219
Sample Date	11/12/2019	11/12/2019	11/12/2019	11/12/2019	11/12/2019	11/12/2019	11/12/2019
QA/QC	Field Duplicate				Equipment Blank	Equipment Blank	Field Blank
Sample Type	Grab	Grab	Grab	Liquid	LIQUID	LIQUID	LIQUID
SDG	320-56313-1	320-56275-1	320-56253-1	320-56253-1	320-56275-1	320-56275-1	320-56253-1
Lab Sample ID	320-56313-4	320-56275-5	320-56253-5	320-56253-6	320-56275-6	320-56275-7	320-56253-7
<i>Table 3+ Lab SOP (ng/L)</i>							
HFPO-DA	6,100	530	68	19	<4	<4	<4
PFMOAA	86,000	67 J	74 J	46 J	<5	<5	<5
PFO2HxA	18,000	310	43	26	<2	<2	<2
PFO3OA	5,100	48 J	11 J	6.5 J	<2	<2	<2
PFO4DA	1,800	15 J	3.9 J	2.2 J	<2	<2	<2
PFO5DA	870	<2	<2	<2	<2	<2	<2
PMPA	5,300	760	25	24	<10	<10	<10
PEPA	1,700	240	<20	<20	<20	<20	<20
PFESA-BP1	400	<2	<2	<2	<2	<2	<2
PFESA-BP2	360	17	<2	<2	<2	<2	<2
Byproduct 4	350 J	29 J	5.1 J	7.9 J	<2	<2	<2
Byproduct 5	1,100 J	<2	15 J	12 J	<2	<2	<2
Byproduct 6	<15	<2	<2	<2	<2	<2	<2
NVHOS	740	3.5	3.7	6.1	<2	<2	<2
EVE Acid	43	<2	<2	<2	<2	<2	<2
Hydro-EVE Acid	210	<2	<2	<2	<2	<2	<2
R-EVE	95 J	11 J	2.7 J	3.2 J	<2	<2	<2
PES	<46	<2	<2	<2	<2	<2	<2
PFECA B	<60	<2	<2	<2	<2	<2	<2
PFECA-G	<41	<2	<2	<2	<2	<2	<2

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NA - not applicable

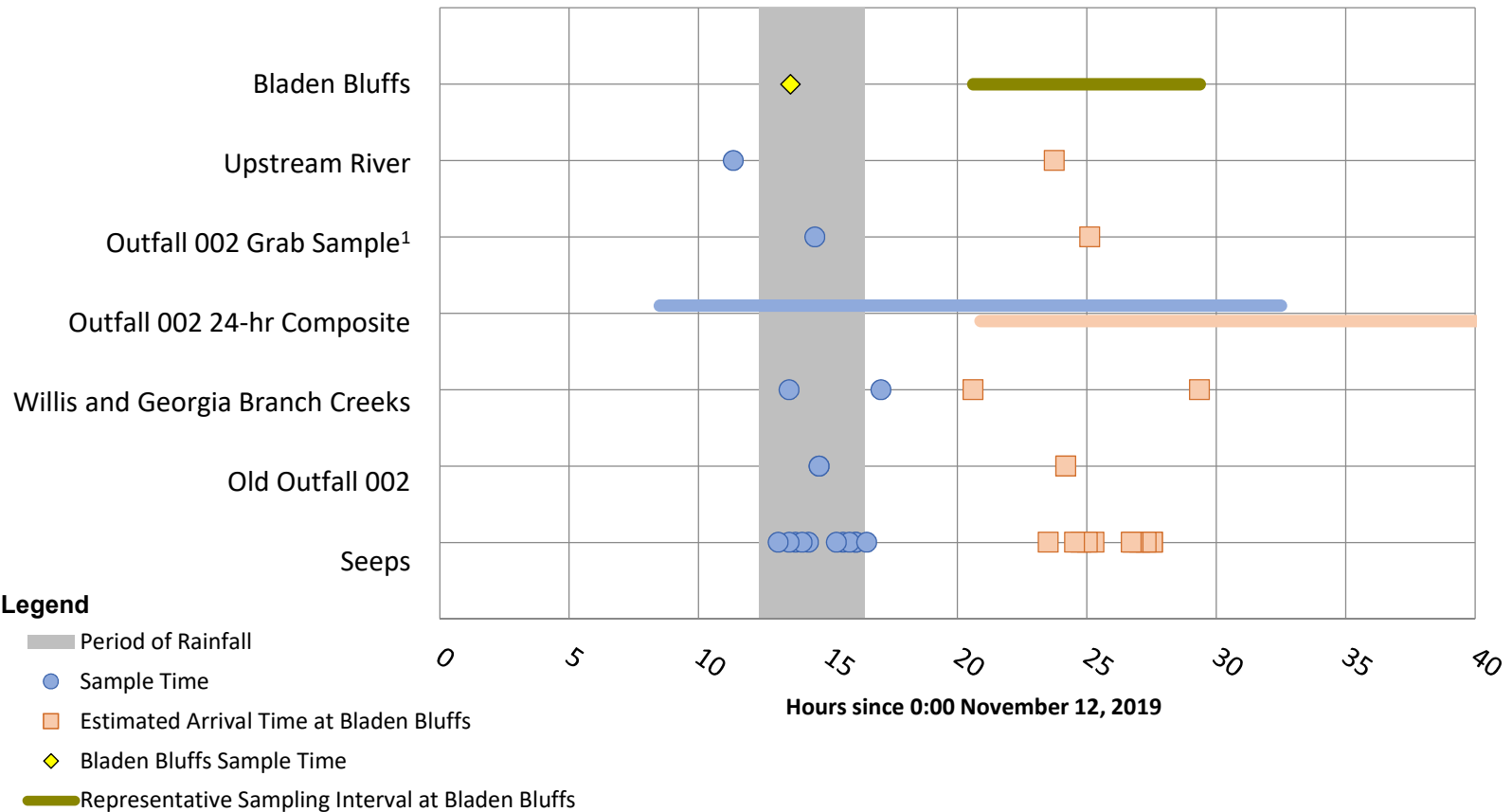
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Legend

- Period of Rainfall
- Sample Time
- Estimated Arrival Time at Bladen Bluffs
- Bladen Bluffs Sample Time
- Representative Sampling Interval at Bladen Bluffs

Notes

¹ - not used in mass loading model calculations.

This plot shows when Cape Fear River water was passing by the Site on November 12, 2019 and when it was estimated to reach the downstream sampling point at Bladen Bluffs (approximately 5 miles downstream from the Site). Samples collected at Bladen Bluffs are used to compare against the estimated mass loading from the model because PFAS loading is expected to be well mixed in the river by this point. During the November 12, 2019 sampling event, water passing W.O. Huske Dam was estimated to take 10 hours to reach Bladen Bluffs based on historical modeled travel time results generated from a numerical model of the Cape Fear River (corresponding with the river gage height reported as 1.42 feet at the W.O. Huske Dam per the United States Geological Survey). Travel times were calculated based on pathway-specific distances from the Bladen Bluffs sampling location. This plot demonstrates that samples collected at Bladen Bluffs should be collected later in time to correspond to arrival times of samples collected from the various mass loading pathways at the Site.

<p>November Mass Loading Sampling Times Chemours Fayetteville Works, North Carolina</p>	
Raleigh	March 2020
<p>Figure 1</p>	