The Chemours Company
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November 4, 2019

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Kemp Burdette
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Re: Cape Fear River PFAS Loading Reduction Plan - Supplemental Information Report

Dear Ms. Holman and Mr. Burdette,

On August 26, 2019, Chemours submitted the Cape Fear River PFAS Loading Reduction Plan, pursuant to paragraph 12 of the Consent Order entered by the Superior Court for Bladen County on February 25, 2019. The enclosed Supplemental Information Report, prepared by Geosyntec Consultants of NC, P.C. (Geosyntec) and Parsons of NC (Parsons), provides supplemental information to support the evaluation of remedial options to reduce loadings of PFAS originating from the Chemours Fayetteville Works Site (the Site) to surface waters surrounding the Site including the Cape Fear River, Willis Creek, Georgia Branch Creek and Old Outfall 002. As with the August 26 submission, Chemours is simultaneously transmitting this submission to downstream public water utilities.

Sincerely,

Brian D. Long
Plant Manager
Chemours – Fayetteville Works

Enclosure

Cape Fear River PFAS Loading Reduction Plan - Supplemental Information Report

Cc:

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Geoff Gisler, SELC

Downstream Public Water Utilities

Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

CAPE FEAR RIVER PFAS LOADING REDUCTION PLAN – SUPPLEMENTAL INFORMATION REPORT

Chemours Fayetteville Works

Prepared for

The Chemours Company FC, LLC
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Geosyntec Project Number TR0795

November 2019

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LIST OF ABBREVIATIONS

%	percent
µg/s	micrograms per second
µm	micrometers
BMP	best management practice
CAP	Corrective Action Plan
CFRW	Cape Fear River Watch
EAA	Engineering Alternatives Analysis
EQ	influent equalization
ft	feet
ft bgs	feet below ground surface
GAC	granular activated carbon
gabions	large wire baskets
gpm	gallons per minute
HDPE	high-density polyethylene
HFPO-DA	Hexafluoropropylene oxide dimer acid
IPC	inclined plate clarifier
MMF	multimedia filtration
NCCW	non-contact cooling water
NCDEQ	North Carolina Department of Environmental Quality
NPDES	National Pollutant Discharge Elimination System
NPV	net present value
ng/L	nanogram per liter
OOF2	Old Outfall 002
PFAS	per- and polyfluoroalkyl substances
PFMOAA	perfluoro-1-methoxyacetic acid
PMPA	Perfluoromethoxypropyl carboxylic acid
ROM	rough order of magnitude
SWPPP	Stormwater Pollution Prevention Plan
TRD	Trench cutting and Remixing Deep
TSS	total suspended solids
USACE	United States Army Corps of Engineers
WWTP	wastewater treatment plant

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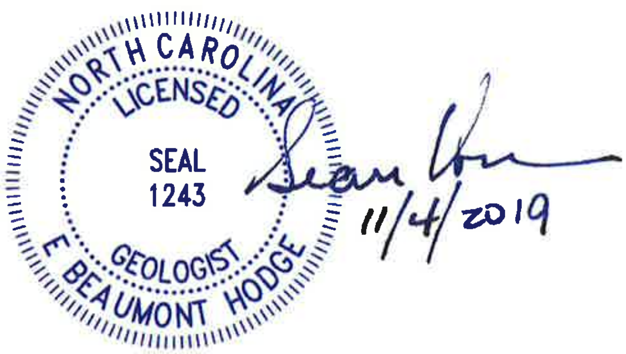
CAPE FEAR RIVER PFAS LOADING REDUCTION PLAN – SUPPLEMENTAL INFORMATION REPORT
CHEMOURS FAYETTEVILLE WORKS

Seals, as applicable:



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CAPE FEAR RIVER PFAS LOADING REDUCTION PLAN – SUPPLEMENTAL INFORMATION REPORT
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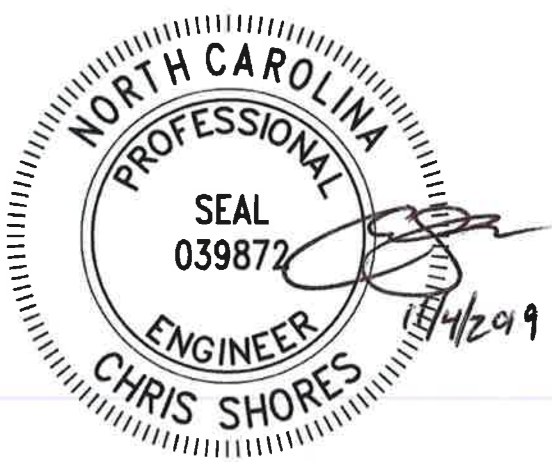

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CAPE FEAR RIVER PFAS LOADING REDUCTION PLAN – SUPPLEMENTAL INFORMATION REPORT
CHEMOURS FAYETTEVILLE WORKS

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11-4-19

1 INTRODUCTION

The Cape Fear River PFAS Loading Reduction Plan (Geosyntec, 2019a) was submitted to the North Carolina Department of Environmental Quality (NCDEQ) and Cape Fear River Watch (CFRW) on August 26, 2019 pursuant to Paragraph 12 of the Consent Order among Chemours, NCDEQ, and (CFRW). This report ("Supplemental Report") was prepared by Geosyntec Consultants of NC, P.C. (Geosyntec) and Parsons of NC (Parsons) for The Chemours Company FC, LLC (Chemours) and provides supplemental information to support the evaluation of remedial options to reduce per- and polyfluoroalkyl substances (PFAS) originating from the Chemours Fayetteville Works Site (the Site) to surface waters surrounding the Site including the Cape Fear River, Willis Creek, Georgia Branch Creek and Old Outfall 002. Further, this Supplemental Report was prepared in response to comments on the Reduction Plan by NCDEQ and the CFRW, provided to Chemours in letters dated September 26, 2019 and October 23, 2019.

This Supplemental Report provides information regarding proposed remedies presented in the Reductions Plan submitted on August 26, 2019 (Seeps, Outfall 002, Old Outfall 002, Georgia Branch Creek, Willis Creek and Offsite Groundwater). In addition, this Supplemental Report also provides information on:

- potential interim alternatives to reduce PFAS mass loadings from onsite seeps and onsite groundwater to the Cape Fear River on an accelerated timeframe;
- provisional remedial alternatives under consideration and subject to more extensive evaluation to reduce onsite groundwater PFAS mass loading to the Cape Fear River[1]; and
- remedial alternatives that were considered but not proposed.

The Reduction Plan (Geosyntec 2019a) did not previously identify onsite groundwater PFAS treatment options, other than those for Old Outfall 002 and the Seeps; assessment activities were still ongoing. This evaluation will be the principal focus of the Corrective Action Plan (CAP) to be submitted in December 2019. A working conceptual site model

[1] The onsite groundwater remedy approaches presented here are provisional. Chemours's consultants have been preparing a numerical groundwater model to evaluate Site groundwater flows and will use this model to evaluate the technological feasibility of potential groundwater control options. The results of the model and the implications for the finalization of actions for expedited reductions of PFAS loadings to surface water will be provided in conjunction with the Corrective Action Plan due December 31, 2019.

has been recently developed and data gaps are being considered and assessed. The current site conceptual model was outlined in the On and Offsite Assessment Report on September 30, 2019 (Geosyntec, 2019b) and updated on October 31, 2019.This document provides a proposed schedule for further development, implementation and optimization of such reduction measures.

1.1 Actions Implemented

Actions already implemented by Chemours have reduced yearly HFPO-DA mass loadings from the facility to the environment by at minimum 5,150 pounds per year (lbs/yr) compared to pre-June 2017 emissions and discharges (Geosyntec 2019a). Air emission reductions to date, on an annualized basis for 2019, have resulted in an estimated yearly reduction of 2,150 pounds of HFPO-DA, a greater than 93% reduction. Cessation of Chemours process water discharge to Outfall 002 resulted in at minimum an estimated yearly reduction of 3,000 lbs/yr of HFPO-DA. These actions have reduced HFPO-DA mass loadings, through Outfall 002, by over 99% from June 2017 levels (Geosyntec 2019a). This has resulted in reductions of HFPO-DA to the Cape Fear River. Present estimates of HFPO-DA mass loading to the Cape Fear River from all pathways are between 64 and 129 pounds per year (lbs/yr). This represents upwards of a 95% reduction in mass loading to the Cape Fear River from all pathways (Geosyntec 2019a).

Chemours has also implemented multiple actions to further reduce loading of PFAS to the Cape Fear River as outlined in the Reduction Plan (Geosyntec, 2019a).

These reductions will be further enhanced by implementation of the Thermal Oxidizer by the end of 2019, which will control over 99.99% of PFAS emissions routed to it, and the actions proposed in this plan will further reduce HFPO-DA and other PFAS loadings to the environment.

Outfall 002 loading rates in 2019, integrating both dry and wet weather periods, are presently 8% lower than in calendar year 2018. This reduction is potentially a result of various completed actions at the Site, including reduced air emissions. Loading at Outfall 002 is expected to continue a downward trajectory year over year.

Actions outlined in this supplemental report are generally intended to address PFAS that is present in soil and groundwater from historical operations.

1.2 Overview of Remedial Selection Process

The process of selecting remedial alternatives is based on numerous factors, including the Site setting, the nature of the compounds of concern and potential receptors and technological and economic feasibility. At the Site, Table 3+ PFAS are present in many areas. These are relatively recent compounds being considered for environmental remediation and as such there are few treatment technologies with full-scale demonstrations of effectiveness. PFAS remediation is a rapidly evolving field and new technologies may become available and suitable for the PFAS at the Site that would expand the set of alternatives available for consideration. Therefore, the set of remedial alternatives considered for this Site are subject to enhancement over time.

1.3 Document Organization

The remainder of this Supplemental Report contains an overview of the evaluation process for potential remedies (Section 2); a description of the remedial alternatives (Section 3); the assessment of alternatives against the criteria, including alternatives not selected (Section 4); selection of interim remedial alternatives for seeps (Section 5); selection of interim remedial alternatives for onsite Black Creek Aquifer groundwater (Section 6); a summary (Section 7); and report references are provided in Section 8.

2 REMEDIAL ALTERNATIVE IDENTIFICATION AND SELECTION PROCESS

The following process may be used to identify remedial approaches to advance, and is described herein for the evaluation to reduce PFAS originating from the Site:

1) Define Remedial Objectives
2) Identify Remedial Alternatives
3) Compare Remedial Alternatives

2.1 Remedial Objectives

Consistent with Paragraph 12 of the Consent Order, the following three Remedial Objectives are appropriate for interim actions and actions considered as part of the Reductions Plan (Geosyntec 2019a):

i. Reduce PFAS Mass Loading to the Cape Fear River
ii. Reduce PFAS Mass Loading to Willis Creek, Georgia Branch Creek and Old Outfall 002; and
iii. Identify alternatives to provide maximum loading reductions in two years, and if greater reductions can be achieved consider up to a five-year implementation period.

Further, proposed interim measures may ultimately integrate into the overall remedies. The objectives of the remedies will include, in addition to the above criteria, protecting human health and the environment and compliance with groundwater standards or alternate groundwater standards using criteria from 15A NCAC 02L.

2.2 Identify Remedial Alternatives

Remedial alternatives were identified which could satisfy the remedial objectives for each PFAS Mass Loading Pathway identified in the Cape Fear River PFAS Mass Loading Model submitted to DEQ and CFRW (Geosyntec, 2019c). The remedial alternatives identified by this process are described in Section 3.

2.3 Compare Remedial Alternatives

Remedies can be assessed and scored for the following criteria:

i. Environmental Protection (i.e. reduction of PFAS Mass Loading);
ii. Adverse Environmental Effects;
iii. Technical Feasibility;
iv. Timing (i.e., 2 years or 5 years); and

v. Economic Feasibility (i.e., reduction achieved per relative cost expended).

These criteria recognize the adverse impacts may result during remediation and that selected alternatives must be both technologically and economically feasible. The following sub-sections describe each assessment criteria and how it was scored on a scale of 1 to 5 where 1 was the most favorable score and 5 the least favorable score.

2.4 Assessment Criteria 1 – Environmental Protection

Remedial alternatives were assessed to establish the expected degree of loading reduction they would provide to the Cape Fear River, Willis Creek, Georgia Branch Creek, and Outfall 002. For each waterbody based on professional engineering and scientific judgement and analyses of the alternatives presented in this Supplemental Report, the alternatives were assigned scores as follows:

Total Table 3+ PFAS Mass Loading Reductions to Surface Water Body	Scoring
>20%	1
>10 - 20%	2
>5 - 10%	3
>2 - 5%	4
0 - 2%	5

2.5 Assessment Criteria 2 – Adverse Environmental Effects

Remedial alternatives were assessed to establish the potential degree of adverse environmental effects they might cause (e.g. habitat destruction). Based on professional engineering and scientific judgement and analyses of the alternatives presented in this Supplemental Report were assigned scores as follows:

Adverse Environmental Effect	Scoring
No anticipated local effect	1
Some destruction of local habitat	2
Some alteration to local waterbody	3
Habitat destruction or alteration over a large extent	4
Extensive destruction of habitat type or waterbody	5

2.6 Assessment Criteria 3 – Technical Feasibility

Remedial alternatives were assessed to establish their potential technical feasibility. Based on professional engineering and scientific judgement and analyses of the alternatives presented in this Supplemental Report were assigned scores as follows:

Technical Feasibility Criteria	Scoring
Simple to Implement	1
Some Challenges, Success Fairly Certain	2
Complex or Large, Some Uncertainty about Degree of Success	3
Complex, Large, Access Issues, Success Potentially Possible	4
Complex, Large, Access Issues, Success Unlikely	5

2.7 Assessment Criteria 4 – Timeframe

Remedial alternatives were assessed to establish the timeframes in which they could be implemented. Based on professional engineering and scientific judgement and analyses of the alternatives presented in this Supplemental Report were assigned scores as follows:

Time To Implement	Scoring
Up to 1 year	1
From 1 to 2 years	2
>2 - 3 years	3
>3 - 5 years	4
> 5 years	5

2.8 Assessment Criteria 5 – Economic Feasibility

Remedial alternatives were assessed to establish their economic feasibility, where feasibility was established using the metric of cost in millions of dollars per reduction of one percent of Total Table 3+ PFAS Loading to the Cape Fear River. Based on the reductions to the Cape Fear River for each alternative and the estimated costs of each were assigned scores as follows:

Cost (Millions of Dollars) to achieve a 1% Reduction in Cape Fear River Total Table 3+ PFAS Loading	Scoring
$0 - $1M	1
>$1M - $2.5M	2
>$2.5M - $5M	3
>$5M - $10M	4
>$10M	5

2.9 Selection Process

Chemours is committed to taking actions to achieve expedited loading reduction for groundwater seeps and onsite groundwater, and the feasibility of each is evaluated in this Supplemental Report. The remedial alternatives for these pathways are still undergoing a final remedy selection process, as the technical evaluation of these options is in progress as described in Sections 5 and 6.

For remedies considered as part of the Reduction Plan (Geosyntec 2019a), selection is advanced herein as follows:

- Step 1: Initial screening
- Step 2: Selection of several viable remedial alternatives per pathway

In Step 1, alternatives with scores of 5, the least favorable score, for criteria 2, 3 and 5 (adverse impacts, technical feasibility and economic feasibility) were removed from the selection process.

Criteria	Action
1 – Achieves Reductions	All remedies regardless of scores are advanced
2 – Adverse Impacts	Remedies with a score of 5 are removed from selection process
3 – Technical Feasibility	Remedies with a score of 5 are removed from selection process
4 – Implementation Timing	All remedies regardless of scores are advanced
5 – Economic Feasibility	Remedies with a score of 5 are removed from selection process

If a proposed remedial alternative would cause severe adverse environmental impacts, it was not advanced as the purpose of remediation is to protect human health and improve environmental quality. If a remedy was infeasible, in other words if it was scored as 5, it was not advanced as it would not be implementable. If two proposed alternatives effectively achieved the same goals, the lower cost remedy was advanced. If a remedy was economically infeasible, i.e. it did not provide benefit that was commensurate with the cost to implement the remedy, it was not advanced for consideration. In Step 2, remedies were selected for further evaluation after balancing perspectives from all criteria presented here, comparison against remedial objectives and using professional engineering and scientific judgement.

Ultimately, those remedial options selected to advance will require further evaluation in the context of how the remedy integrates into the longer-term remedial approach. The additional evaluation includes groundwater flow modeling and the empirical studies currently underway.

3 DESCRIPTION OF REMEDIAL ALTERNATIVES

In the Reduction Plan, nine PFAS transport pathways to the Cape Fear River were identified, and were generally organized from upstream to downstream, as shown below in Table 1, which also includes the estimated mass loading of PFAS per pathway based on two sampling events. Additional quarterly sampling events are being conducted, and the mass loading model will be updated to adjust the model for variability over time. Figure 1 is a schematic conceptual site model of the pathways. For each of the pathways, a number of treatment options have been identified for evaluation and associated approaches in Table 2.

Table 1: Estimate of PFAS Mass Loading from the facility on a per-pathway basis.

Pathway	Total Table 3+ Estimated Loading Percentage per Pathway per Event	
	May 2019 Event	June 2019 Event
[1] Upstream River Water and Groundwater*	4%	15%
[2] Willis Creek	10%	4%
[3] Aerial Deposition on the River	< 2%	< 2%
[4] Outfall 002	4%	7%
[5] Onsite Groundwater	22%	17%
[6] Seeps	32%	24%
[7] Old Outfall 002	23%	29%
[8] Offsite Adjacent and Downstream Groundwater*	< 2%	< 2%
[9] Georgia Branch Creek	4%	3%

* Pathways 1 and 8 (upstream river and groundwater; adjacent and downstream groundwater) are assessed together in this Supplemental Report as “offsite groundwater”

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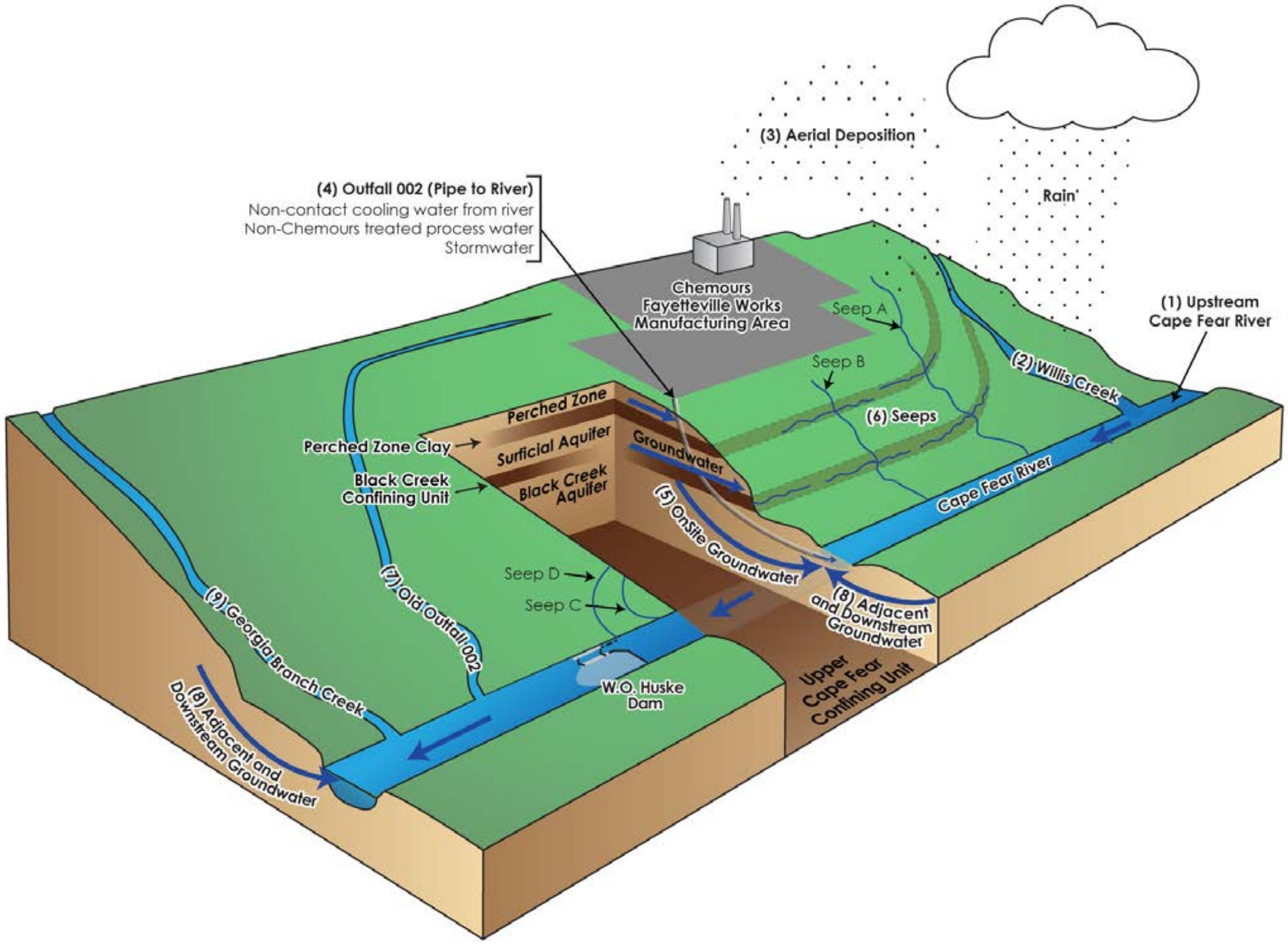

Figure 1: Schematic Conceptual Site Model of the Site including geological layers, and PFAS transport pathways

Table 2: Remedial Alternatives Considered in Supplemental Action Plan

Pathway	Potential Treatment Approach	Sub-Section
Direct Aerial Deposition	Air Emission Control Technologies	3.1.1
Old Outfall 002	Capture and Treat Old Outfall 002	3.2.1
Seeps	Flow Through Cells CFR Seeps - *Interim*	3.3.1
	Ex Situ Capture and Treatment CFR Seeps - *Interim*	3.3.2
	Plume Stop CFR Seeps A and B - *Interim*	3.3.3
	Flow Through Cells CFR Seeps	3.3.4
	Flow Through Cells Willis Creek Seeps	3.3.4
	Ex Situ Capture and Treatment CFR Seeps	3.3.5
	PlumeStop Willis Creek Seeps	3.3.6
Onsite Groundwater	Extract from Black Creek Monitoring Wells - Interim	3.4.1
	Install New Black Creek Extraction Wells - Interim	3.4.2
	Groundwater Extraction	3.4.3
	Groundwater Extraction with Barrier Wall	3.4.4
Outfall 002	Conveyance Network Sediment Removal	3.5.1
	Stormwater Pollution Prevention Plan	3.5.2
	Targeted Stormwater Control	3.5.3
	Terracotta Pipe Decommissioning	3.5.4
	Groundwater Intrusion Mitigation	3.5.5
	Treat all stormwater at Outfall 002	3.5.6
	Treat all flows at Outfall 002	3.5.7
Willis and Georgia Branch Creeks	Treat all Flows at Willis Creek & Georgia Branch Creek Mouths	3.6.1
	PlumeStop™ along Willis Creek & Georgia Branch Creek Lengths	3.6.2
Offsite Groundwater	Groundwater Extraction with Barrier Wall	3.7.1
	Air Emission Control Technologies	3.1.1

For each proposed alternative, the following sections provide a detailed description, estimated reduction in PFAS that may be achievable, implementation schedule, and estimated cost.

Construction and annual operating costs for each alternative have been estimated with a range of -30 % to +50 %, and the 20-year net present value (NPV) is estimated at a 3.5% discount rate. Cost estimates are not intended for budgetary or future planning purposes;

they have been prepared from the currently available information to facilitate an inter-alternative comparison. The final costs of any selected alternative will depend on final approved design, actual labor and material costs, and competitive variable factors.

A distinction has been made between cost estimates that are considered rough order of magnitude (ROM) versus costs that are considered conceptual. For remedies that are already in development or are intended to be implemented, including those previously described in the Reduction Plan, ROM costs have been prepared as the scope of these remedies can be defined somewhat reliably. For remedies that have been conceptualized herein without sufficient design inputs like the numerical groundwater model , the cost estimates are considered conceptual. Detailed backup sheets for each of these alternatives are provided in Appendix A.

For long-term onsite groundwater remedies, the numerical model is explicitly necessary to develop and evaluate modeling scenarios (such as groundwater extraction behind a barrier wall), which will generate the design inputs that are needed to develop reliable cost estimates. As the model was not available at the time of this Supplemental Report, possible modeling scenarios are provided, but costs were not developed, as they would improperly inform the inter-alternative comparison. Accordingly, the onsite groundwater remedies conceptualized herein are to be brought forward (i.e., retained), on both a long term and expedited basis, in the following two months for detailed evaluation and ultimately for selection in, or in conjunction with, the CAP.

Similarly, for targeted stormwater treatment, which has been previously proposed, costs are not able to be reliably estimated at this time since the scope of treatment required and the technologies to be implemented have not been assessed, since stormwater investigations are ongoing. The action plan to be proposed as part of or in conjunction with the CAP will outline the stormwater areas for potential treatment and control technologies to pilot test and optimize.

3.1 Pathway: Direct Aerial Deposition

Direct aerial deposition of PFAS emissions from the facility has the potential to result in mass loading to surface water bodies; however, the mass loading model estimated that aerial deposition contributed less than 2% of the mass loading observed in the Cape Fear River. Aerial deposition was identified as a pathway of concern primarily due to offsite drinking water wells. The remedial approach identified to mitigate impacts to offsite drinking water wells is a series of air emission control technologies.

3.1.1 Control Technology Improvements to Reduce Aerial Emissions

Pursuant to Paragraph 7 of the Consent Order, Chemours completed a number of operational improvements to control air emissions. In November 2018 Chemours installed a packed bed scrubber to control emissions from the Division Waste Gas Scrubber and in December 2018 Chemours completed the tie-in of the Carbon Absorber unit for the Second Phase Scrubber at the Vinyl Ether North Plant. By December 31, 2019 Chemours is installing a Thermal Oxidizer to control air emissions of PFAS from process streams from the Monomers IXM Area (Figure 2). As required by the Consent Order, the thermal oxidizer will control air stream PFAS routed to it at an efficiency of 99.99% leading to a facility wide reduction of PFAS emissions to air of 99% or greater. The reduction of PFAS emissions to air will over time result in lower concentrations of PFAS in offsite soils and groundwater and lead to reductions of loading to Willis Creek, Georgia Branch Creek and the offsite Cape Fear River. The total construction cost for the thermal oxidizer is expected to be approximately $100 million or greater (a cost detail sheet is not provided in Appendix A as this remedy is under construction). The image below shows the current progress of this control technology.

Figure 2: October 2019 Image of Thermal Oxidizer Structure During Construction.

3.2 Pathway: Old Outfall 002

The Old Outfall 002 is a natural feature that discharges to the Cape Fear River. Perched zone and surficial aquifer groundwater also discharge to this feature. Since Site groundwater has elevated PFAS concentrations, Old Outfall 002 also has elevated PFAS levels. The results of the Mass Loading Model indicate Old Outfall 002 is one of the primary contributors of PFAS mass loading originating from the facility to the Cape Fear River, estimated to contribute about 25% of observed mass loading.

The remedial approach that was identified, and which is currently in detailed design, planning and permitting, is Capture and Treatment of Old Outfall 002 flows.

3.2.1 Capture and Treat at Old Outfall 002

Remedy Description

As described in Proposed Action 1 of the Reduction Plan, Chemours will continue to comply with the existing Consent Order requirements by implementing an ex situ capture and treatment remedy for Old Outfall 002. Chemours provided details on the approach for treatment in the Old Outfall 002 Engineering Report (Parsons, 2019b) and Old Outfall 002 Engineering Alternatives Report (Parsons, 2019a). A process flow diagram of the treatment process is shown in Figure 3. Based on the most recent flow measurements, the dry weather baseflow at Old Outfall 002 is between 500 and 750 gallons per minute (gpm); therefore, the facility is being designed to treat up to 750 gpm.

The treatment system is required to be constructed and operational by September 30, 2020, assuming permits are issued in a timely manner. In order to continue and accelerate progress on implementing this remedy, Chemours is clearing the land where the Old Outfall treatment system will be located by the end of 2019 and is arranging for power to be available at this location by early 2020. Chemours is currently soliciting bids from water treatment vendors to provide the treatment system.

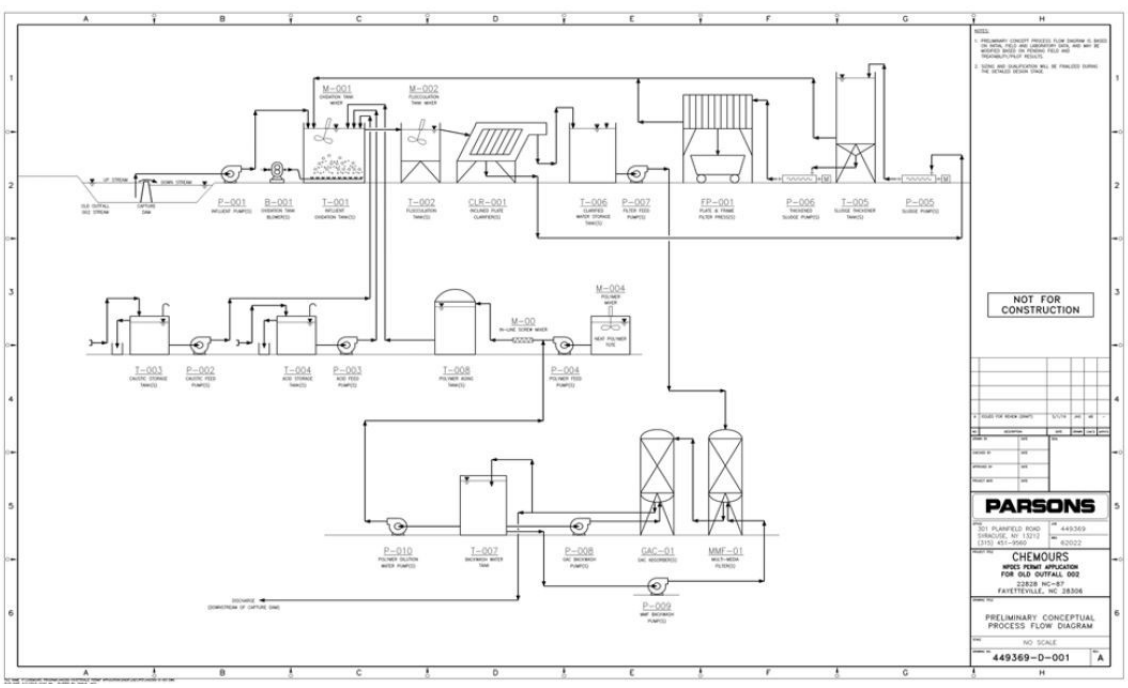

Figure 3. Old Outfall 002 Treatment System Process Flow Diagram

Schedule

Task	Duration (months)	2019				2020			
Geotechnical Investigation	2								
Electrical Enabling Package	3								
Electical Upgrades (EMC)	6								
Prepare RFP for WTP	1								
Bidding and Award (WTP Only)	2								
Lift Station/Dam Design	2								
NPDES Permitting (1)	9								
Lift Station/Dam Construction	3								
WTP Design/Procurement	6								
Startup	1								

1 - Task timing is dependent upon agency approval timing

ROM Cost

The Old Outfall 002 Engineering Alternatives Analysis (EAA) presented cost estimate ranges for the technically feasible wastewater alternatives (Parsons, 2019a); however, the design of the system continues to progress and these costs have been refined based on new flow measurements and data from the pilot treatment study (Parsons, 2019c). Chemours is currently evaluating the need for iron removal at the facility which would reduce the construction and operational requirements of the facility. Therefore, the cost estimate was prepared without iron removal or a treatment building. Construction cost was estimated to be $7 to 15 million, annual O&M costs are estimated to be $1 to 2 million, and the 20-year NPV is $21 to 45 million. The detailed estimate is presented in Appendix A.

3.3 Pathway: Groundwater Seeps

Four groundwater seeps discharging from the bluff slope directly to the Cape Fear River were identified and described in the Seeps and Creeks Investigation report (Geosyntec, 2019d). Additionally, five smaller seeps also draining into Willis Creek were identified. The Mass Loading Model estimated that the onsite seeps discharging to the Cape Fear River contributed between 24% to 32% of PFAS mass load; by contrast, the seeps draining into Willis Creek are estimated to represent less than 0.4% of the mass loading of the Cape Fear River Seeps (17 / 5200 *100% = 0.33%), as calculated from the values presented in Table 3. On this basis, the identified Willis Creek seeps represent a de minimis source of PFAS to both Willis Creek at 2% of the load to Willis Creek (17 / 880 * 100% = 1.9%) and by extension the Cape Fear River (maximum estimate of 0.2%; 10% maximum mass loading of Willis Creek to Cape Fear River * 2% Willis Creek Seep Loading = 0.2%).

Table 3: PFAS Loading from Seeps and in Willis Creek

Seeps	Flow Rate May 2019 (gpm)	T3+ PFAS May 2019 Concentration (ng/L)	Mass Loading (ug/s)
Seep A	120	300,000	2,270
Seep B	100	310,000	1,960
Seep C	30	350,000	660
Seep D	30	170,000	320
Total Cape Fear River Seeps			**5,200**
WC-1-TR2	4.4	7,100	2.0
WC-3-TR2	4.8	21,000	6.3
WC-3-TR3	3.3	4,200	0.9
WC-3-TR5	1.2	2,388	0.2
WC-4-TR1	34	3,500	7.6
Total Willis Creek Seeps			**17**
Willis Creek	2,900	4,800	**880**

Notes – Total Table 3+ PFAS concentrations come from the May 2019 sampling event reported in the Seeps and Creeks Investigation (Geosyntec, 2019d).

gpm – gallons per minute

ng/L – nanograms per liter

µg/s – micrograms per second

T3+ PFAS – Results of Table 3+ PFAS analytes summed

Three remedial alternatives were identified for reducing the PFAS Mass Loading from seeps:

- Alternative A: Passive Treatment via Flow-Through Cells;
- Alternative B: Ex Situ Capture and Treatment using French Drains or equivalent;
- Alternative C: In Situ Treatment using PlumeStop™

Each of these options is considered viable for use as both an interim and long-term measure to reduce mass loading from Cape Fear River Seeps (i.e. Seeps A through D). These options are also considered suitable as means to reduce mass loading from Willis Creek Seeps. These options are described in the following sub-sections and the potential location of these treatment technologies is shown in Figure 4.

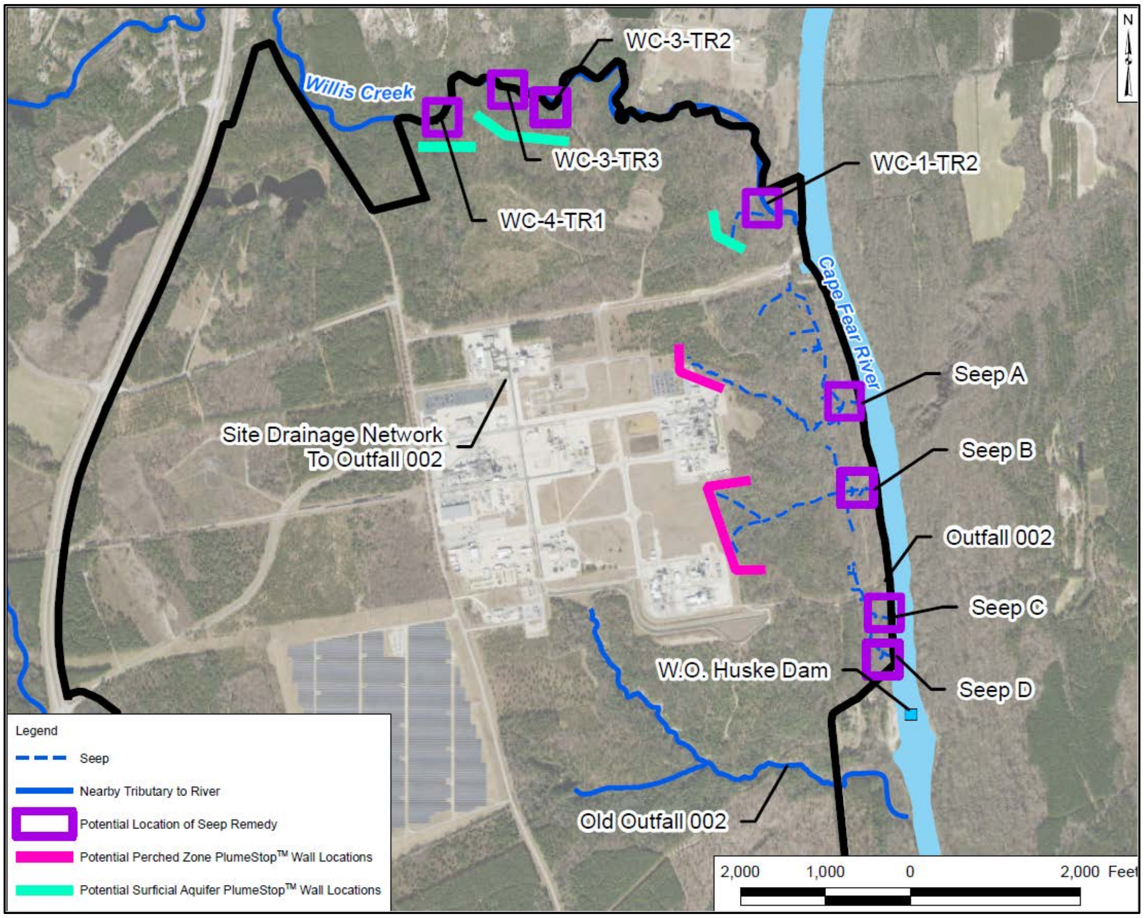

Figure 4: Location of Potential Seep Remedies

3.3.1 Interim Remedial Alternative for Seeps: Flow-Through Cells

Interim application at Seeps A through D would involve the installation of V-shaped sheet pile walls at each seep location to guide seep water discharge through a controlled structure for on-location treatment. Large wire baskets (gabions), filled with granular activated carbon (GAC) would be installed in the discharge structures such that the water discharging from each seep location would flow through the GAC filled gabions. The PFAS compounds in the seep water would be sorbed by the GAC in the gabions and the treated water, containing much lower concentrations of PFAS compounds, would flow out the downhill side of the gabions.

Installation of the seep flow-through structures would commence after the river access road and all clearing and grubbing is complete. It is assumed that a total of 16 15-foot lengths of standard steel 22-inch wide sheet pile will be installed at each seep location. The sheet pile will be driven vertically into the ground to a depth of approximately 11 feet below ground surface (ft bgs) to form a V-shaped sheet pile wall centered on and oriented perpendicular to the seep discharge channel. The center 2 sheet piles will be driven an additional approximate 3 feet (ft) to form a window in the middle of the sheet pile wall such that seep water can flow through the wall. A steel plate approximately 44-inches wide and 72-inches long will be placed flat side down in the sheet pile window and welded in place (to the sheet pile) to provide a flat stable surface for the GAC filled gabions.

Each gabion will be lined with geotextile fabric and filled with new, unused GAC. The geotextile fabric liner will then be fastened closed and the top of the gabions will be closed and fastened with steel wire such that the gabions can be moved. Three gabions will be installed first in the seep A structure as depicted in Figure 5 below using an excavator and load straps or equivalent. After installation, the gabions will be secured with sandbags to ensure they stay in place.

If flow-through structures are advanced as an interim measure, the first structure will likely be constructed at Seep A, and operated for approximately 4-months during which performance and operational data will be collected to assess system performance. Lessons learned and performance upgrades developed during this time frame at Seep A will be incorporated as design modifications for potential application at Seeps B, C, and D to be installed approximately six months following the Seep A structure installation.

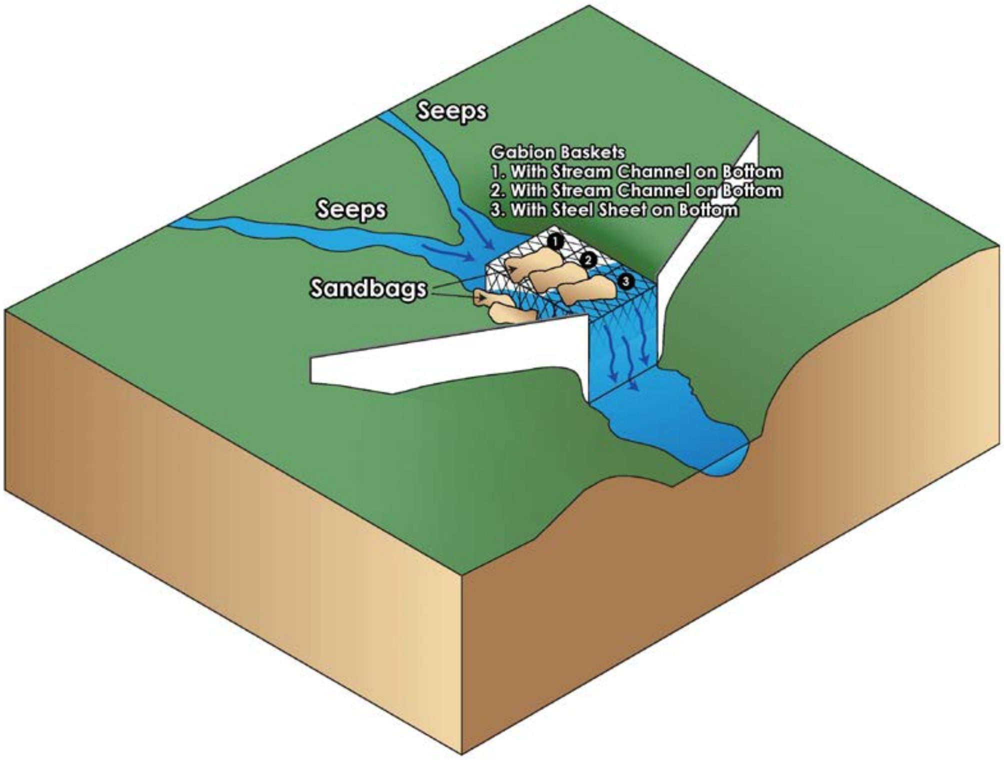

Figure 5: Conceptual Diagram of Seep Flow Through Passive Treatment

Schedule

Task	Duration (months)	Year 1				Year 2			
Bench Scale Testing and Lab Analysis	1								
Pilot Study Work Plan	1								
NCDEQ Review (1)	2								
Preliminary Design	1								
Geotechnical Drilling and Analysis	2								
404/401 Permitting (1)	5								
Detailed Design	3								
Endangered Species Study / Permitting (1)	3								
Clearing and Grubing	1								
Access Road Construction	1								
Flow Through Cell Construction at Seep A	2								
Seep A Pilot Study	4								
Flow Through Cell Construction at Seeps B, C, & D	2								

1 - Task timing is dependent upon agency approval timing

ROM Cost for Seeps A-D

The +50/-30% estimated construction cost for the interim application of flow-through cells for Seeps A through D is $0.9 to 2 million. The annual O&M cost is estimated to be $385,000 to $825,000. For simplicity, as interim measures are defined as implementable within two years, a NPV calculation was not performed. Some or all of the infrastructure installed during the interim action could be used if this option were converted to a permanent remedy. The NPV calculation for potential conversion to permanent installation is presented in Section 3.3.4.

3.3.2 Interim Remedial Action for Seeps: Ex Situ Capture French Drains

This interim remedial measure involves the installation of French drains or equivalent sumps at each seep location (Seeps A, B, C and D) to capture seep water discharge for subsequent conveyance to the planned treatment plant to be located at Old Outfall 002 (OOF2). The French drains would consist of permeable trenches excavated across each seep with perforated piping to collect the water, and sump pumps to pump the captured seep water to the river access road pipeline for subsequent conveyance to the planned OOF2 treatment system for treatment and subsequent disposal.

After supporting infrastructure is in place, including roads, power, and conveyance lines, the seep capture structures will be installed one at a time starting with Seep A and ending with Seep D. At each seep location, a small catch basin will be excavated upstream from the planned French drain location. A portable pump with sufficient capacity for total seep flow will be placed in the basin with the pump discharge hose established to pipe water from the basin around the planned French drain location for subsequent discharge downstream from the construction area. Temporarily diverting seep discharge flow around the construction area will allow for safe and efficient French drain installation.

French drain construction is anticipated to consist of geotextile fabric lining, permeable backfill (2-inch diameter rocks), and a horizontal perforated pipe at the bottom and a vertical "sump" pipe at one end. The trench will be approximately 20-ft long and 6 ft deep with the bottom of the trench sloping to one end. After the piping is installed and the trench is backfilled, it will be armored at the ground surface with an additional layer of geotextile and concrete paver blocks to prevent erosion during storm events. A conceptual diagram is shown below in Figure 6.

After the French drain installation a submersible pump will be installed in the vertical sump, wired to provide power, connected to the previously installed piping and function tested to ensure proper operation. The temporary seep water diversion pump and discharge hose will be removed, and the seep collection system will be put in operation.

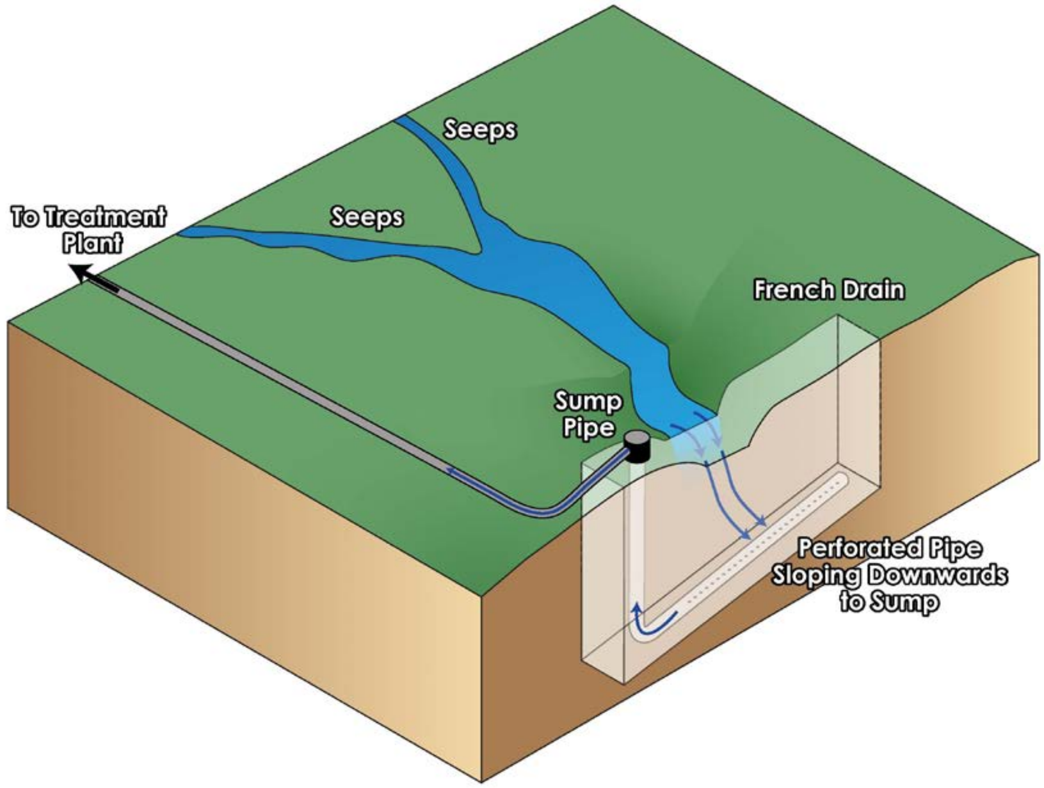

Figure 6: Conceptual Diagram of Seep French Drain Ex Situ Capture

Schedule

Task	Duration (months)	Year 1				Year 2				Year 3			
Bench Scale Testing and Lab Analysis	2												
Preliminary Design	2												
Endangered Species & Wetland Study	3												
Geotechnical Drilling and Analysis	2												
404/401 Permitting[1]	5												
Detailed Design	4												
Bidding and Award	3												
New Electrical Service	5												
Clearing and Grubing (assumes ES restriction)	2												
Collection System Construction	4												
Treatment System Construction & startup testing	4												
System Startup	1												

1 - Task timing is dependent upon agency approval timing

ROM Cost for French Drains

The +50/-30% estimated construction cost for the interim application of French drains to capture Seeps A through D is $9.5 to 20 million. The annual O&M cost is estimated to be $410,000 to $890,000. For simplicity, as interim measures are defined as implementable within two years, a NPV calculation was not performed. The NPV calculation for potential conversion to permanent installation is presented in Section 3.3.5. Much of the infrastructure installed during the interim action could be used if this option were converted to a permanent remedy.

3.3.3 Interim Remedial Action for Seeps: PlumeStop™

PlumeStop™ is an innovative groundwater remediation technology designed to sequester groundwater contaminants via sorption. It is composed of very fine particles (1 to 2 micrometers [µm]) of activated carbon suspended in water. The material is held in suspension using proprietary organic polymers that allow easy injection and dispersion into the subsurface. As the polymer breaks down, the carbon coats the solid material in the aquifer matrix creating a passive, subsurface carbon adsorption filter. PlumeStop™ has been successfully applied to remediate various contaminants including site specific PFAS.

As an interim measure, PlumeStop™ barriers would be installed in the perched zone immediately upgradient of Seeps A and B (Figure 7). Based on the currently available geologic data, the Seep A barrier would be 900 ft long with a treatment zone from 8 to 18 ft bgs and the Seep B barrier would be 1,800 ft long with a treatment zone from 12 to 15 ft below grade. Prior to placing each barrier, a detailed investigation would be performed to refine the design parameters for each wall and install monitoring wells for performance monitoring. Two design life options were considered (5 years and 10 years). The barrier would be designed to retard the flow of site specific PFAS for a minimum of 5 or 10 years depending on the size of the barrier and amount of plume stop injected. At the end of the design life additional product could be injected to extend the life of the barrier. However, for this analysis it was assumed that a permanent remedy would be in place and no additional material would be injected.

A limitation of the PlumeStop™ approach is that the PFAS mass is not removed from the subsurface but is effectively transferred to a solid phase. This mechanism is effective until the solid is saturated and then requires additional applications or the solid media can become a source on its own. Long term studies have not been completed so it is not known if the upgradient groundwater no longer has PFAS if the PFAS sorbed to the material would then begin to release PFAS due to equilibrium forces.

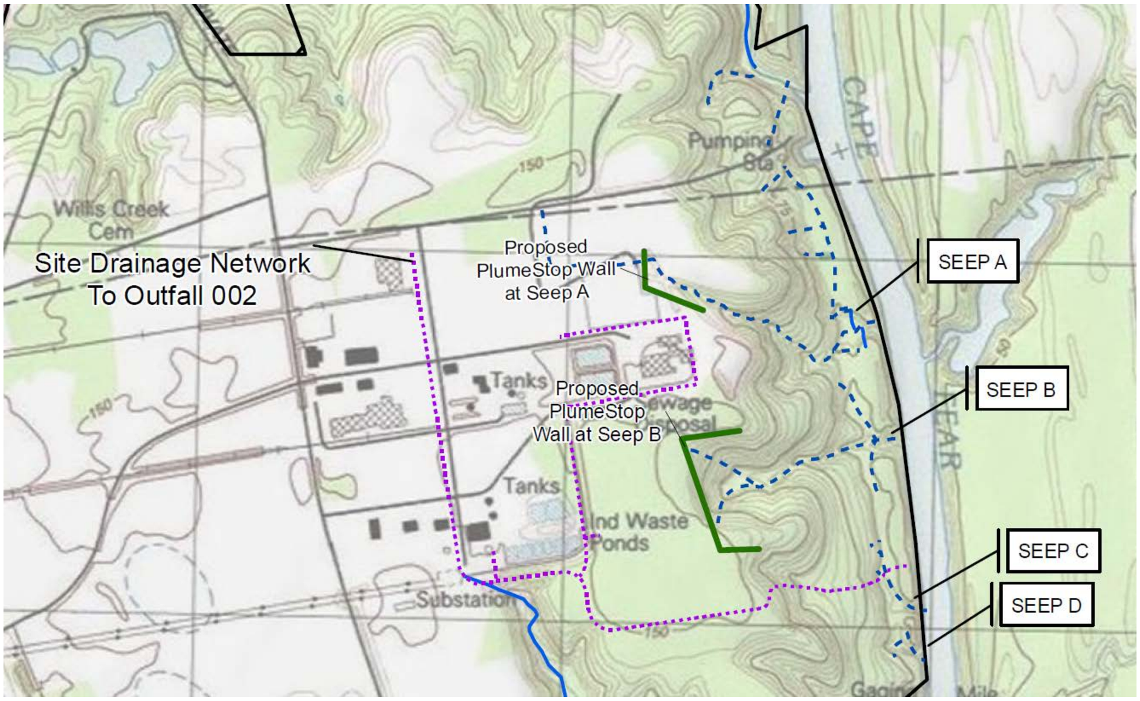

Figure 7: Location of potential interim PlumeStop™ applications for groundwater seeps originating from Perched Zone groundwater flow.

Schedule

Task	Duration (months)	Year 1	Year 2	Year 3	Year 4	Year 5
Pilot Study Work Plan	1					
NCDEQ Review[1]	1					
Pre-design data collection and well Installation	2					
Lab Analysis	2					
Injection and Mix Design	2					
Injection Permit Application/Review/Issuance[2]	1					
PlumeStop Injection	1					
Performance Monitoring	60					

1 - Task timing is dependent upon agency approval timing

2 - Task timing is dependent upon permitting process and assumes multiple permits

Conceptual Cost for PlumeStop™

The +50/-30% estimated construction cost for the interim application of PlumeStop™ at Seeps A and B is $9 to 19 million. The annual O&M cost is estimated to be $91,000 to $195,000.

3.3.4 Permanent Remedial Alternative for Seeps: Flow-Through Cells

Assuming testing and analysis of the IM performance confirms this is a viable long-term remedy, then a permanent design of flow-through cells would be completed (similar to Section 3.3.1). Improvements based on lessons learned from early implementation and ongoing maintenance and replacement of GAC would be incorporated.

ROM Cost for Seeps A-D

The +50/-30% estimated NPV of 20 years of flow-through cells at Seeps A through D is $7 to 15 million. This includes the construction costs already discussed in Section 3.3.1.

ROM Cost for Willis Creek Seeps

The +50/-30% estimated construction cost for the permanent application of flow-through cells for Willis Creek Seeps is $35,000 to 75,000. The annual O&M cost is estimated to be $63,000 to 135,000. The 20-year NPV is estimated to be from $1.4 to 3.0 million.

3.3.5 Permanent Remedial Alternative for Seeps: Ex Situ Capture French Drains

Assuming testing and analysis of the IM performance, if applied, shows it to be a viable long-term remedy, the permanent application of French drains would be similar to those described in Section 3.3.2, with improvements made to the structures based on lessons learned from early implementation, and ongoing maintenance.

The +50/-30% estimated NPV of 20 years of French drains at Seeps A through D is $15 to 33 million. This includes the construction costs already discussed in Section 3.3.2.

3.3.6 Permanent Remedial Alternative for Seeps: PlumeStop™

In this alternative, as a permanent measure, three PlumeStop™ barriers would be installed upgradient of the four Willis Creek seeps. Based on the available geologic data, the barriers would be 700, 1,200, and 700 feet long for seeps WC-1-TR-2, WC-3-TR-2, WC-3-TR-3-, and WC-4-TR-1, respectively. The barrier would be designed to retard the flow of site specific PFAS for a minimum of 20 years. At the end of the design life additional product could be injected to extend the life of the barrier.

Schedule

Task	Duration (months)	Year 1	Year 2	Year 3	Year 4	Year 5
Work Plan Preparation	1					
NCDEQ Review[1]	1					
Pre-design Data Collection	4					
Injection and Mix Design	2					
Injection Permitting[2]	3					
PlumeStop Inections	1					
Performance Monitoring	60					

1 - Task timing is dependent upon agency approval timing

2 - Task timing is dependent upon permitting process

The +50/-30% estimated construction cost for the permanent application of PlumeStop™ at the Willis Creek seeps is $34 to 73 million. The annual O&M cost is estimated to be $91,000 to 195,000. The 20-year NPV is estimated to be $36 to 77 million. The cost at this location is controlled by the higher gradient and hydraulic conductivity in the surficial zone as well as the desired longer life of the barrier.

3.4 Pathway: Onsite Black Creek Aquifer Groundwater

In addition to the seven projects outlined in the Reduction Plan, Chemours also proposes to act on an expedited basis to address surface water loadings from onsite groundwater, other than the seeps. The potential interim and permanent remedies described in the following sections are highly conceptual due to the lack of sufficient design inputs that would be derived from scenarios programmed in the numerical groundwater model, which is currently in final stages of development. This model will be utilized to further evaluate these concepts and present the findings in or in conjunction with the CAP.

3.4.1 Interim Alternatives Groundwater Extraction from Existing Monitoring Wells

This interim remedial alternative consists of installing submersible electric pumps in seven existing black creek monitoring wells and pumping the water to the OOF2 treatment plant for treatment and discharge. Submersible electric pumps would be installed in seven site wells: BCA-01, BCA-02, PW-9D, PW-10DR, PW-11, PW-14, and PW-15R (Figure 8). Piping would be installed to convey the water to the proposed OOF2 treatment plant, potentially above-grade as a time-saving measure. Based on available information, it is anticipated that a sustained flow rate of 2 gpm from each well could be achieved. Therefore, the total flow would be 14 gpm. It is assumed that there will be sufficient excess capacity at the OOF2 treatment plant and that the discharge could be covered under the current National Pollutant Discharge Elimination System (NPDES) permit application for that plant without additional modification.

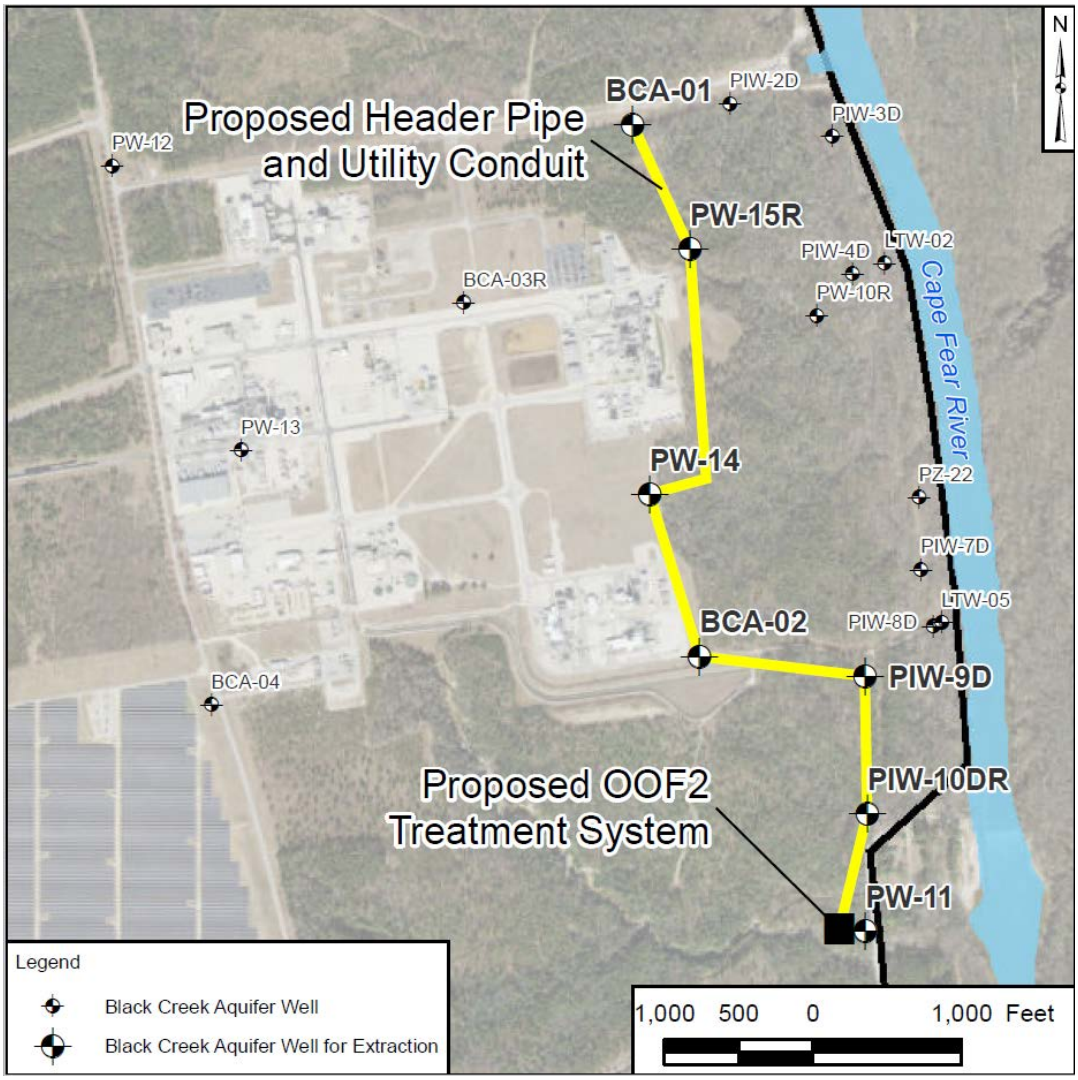

Figure 8: Potential Black Creek Monitoring Wells for Interim Action of Extraction and Treatment

Schedule

The OOF2 treatment system is required to be constructed and operational by September 30, 2020, assuming permits are issued in a timely manner. The installation of pumps in existing wells could be incorporated into the overall OOF2 treatment system construction in this timeframe as well.

The schedule table below represents the interim scenario for groundwater extraction from existing monitoring wells.

Task	Duration (months)	Year 1			
Detailed Design	2				
Contracting	1				
Site Work Installation	6				

ROM Cost for Groundwater Extraction from Existing Monitoring Wells

Costs were estimated and considered to be accurate within the +50/-30 % range. The construction costs range from $560,000 to 1.2 million, annual O&M costs are $48,000 to 102,000. For simplicity, as interim measures are defined as implementable within two years, a NPV calculation was not performed.

3.4.2 Interim Alternative Groundwater Extraction from Additional Extraction Wells

This interim alternative measure would enhance the interim remedy discussed in the previous section with the installation of seven additional wells (6” diameter extraction wells as opposed to the existing 2” monitoring wells). The wells would be installed along the same alignment as shown in Figure 8, in coverage gaps between the existing wells, with some efficiency in sharing a path to the OOF2 treatment plant. The depth of well installation would be on average 140 ft bgs to extract from the Black Creek aquifer in this area of the Site.

It is assumed that the additional wells would extract 10 gpm each (70 gpm total), and that there will be sufficient excess capacity at the OOF2 treatment plant and that the discharge could be covered under the current NPDES permit application for that plant without modification. Additional groundwater modeling is required to refine this approach.

Schedule

The OOF2 treatment system is required to be constructed and operational by September 30, 2020, assuming permits are issued in a timely manner. The installation of new wells and incorporating this additional flow could be achieved approximately within a similar timeframe.

The schedule table below represents the interim scenario for groundwater extraction from additional extraction wells.

Task	Duration (months)	Year 1				Year 2			
Pre-Design Investigation	3								
Detailed Design	6								
Potential mod. of NPDES Permit for OOF2 (1)	6								
Contracting	1								
Drilling	1								
Site Work Installation	6								

1 - Dependent upon agency approval.

ROM Cost for Groundwater Extraction from Additional Extraction Wells

Costs were estimated and considered to be accurate within the +50/-30 % range. The construction costs range from $0.7 to 1.5 million, annual O&M costs are $105,000 to 225,000. For simplicity, as interim measures are defined as implementable within two years, a NPV calculation was not performed.

3.4.3 Permanent Remedies for Onsite Groundwater: Extraction with Vertical Extraction Wells

This alternative would mitigate the flux of onsite groundwater into the Cape Fear River via hydraulic containment of groundwater. Groundwater could be extracted from a series of vertical wells or horizontal wells. For the purpose of this analysis, vertical wells were assumed; however, the final design would utilize the most efficient option. Following extraction, the water would be pumped to a new standalone treatment system, and then discharged to the river. This remedial alternative would not include a barrier between the extraction wells and the river (e.g., a steel sheet pile wall), thus the wells would be installed along an alignment sufficiently set back from the river to avoid drawing in river water to the Site. This alignment would need to be developed with the numerical model in a full design.

A conceptual layout is provided in Figure 9 which shows the 8,500 LF alignment of extraction wells. Based on drawdown requirements using analytical methods and assuming vertical extraction wells as a simplifying assumption, it was estimated that the wells would be installed at a spacing of 50 ft, and each would extract on average 30 gpm. This would require 170 extraction wells and a total flow rate of 5,100 gpm (7.3 MGD). It was assumed that extraction wells would be installed to an average depth of 100 ft bgs to reach the Black Creek aquifer.

It was assumed that the well pumps would feed into a common high-density polyethylene (HDPE) force main for distribution to a new treatment system constructed onsite. Pipe sizing would range from 2 to 24 inches in diameter, depending on the estimated head loss, which is a factor of flow rate and distance from the system. It is anticipated that with the availability of submersible well pumps to provide sufficient hydraulic head, no lift stations would be required.

The design basis for treatment of the extracted groundwater includes feed-forward pumps, a chemical precipitation system, multimedia filtration (MMF) skids, GAC skids, backwash supply and waste tanks, and a solids processing treatment train for chemical precipitation of solids. Major process equipment is assumed to be installed within pre-engineered buildings. It is assumed that the influent median Perfluoromethoxypropyl carboxylic acid (PMPA) and perfluoro-1-methoxyacetic acid (PFMOAA) concentrations would be 8,200 and 150,000 nanogram per liter (ng/L), respectively. It is assumed that PFMOAA is the driving influent COC for GAC utilization, and that 99% removal is required.

Discharge would require regulatory approval via NPDES permits, and construction of outfalls in the vicinity of the river would likely require regulatory approval from the United States Army Corps of Engineers (USACE).

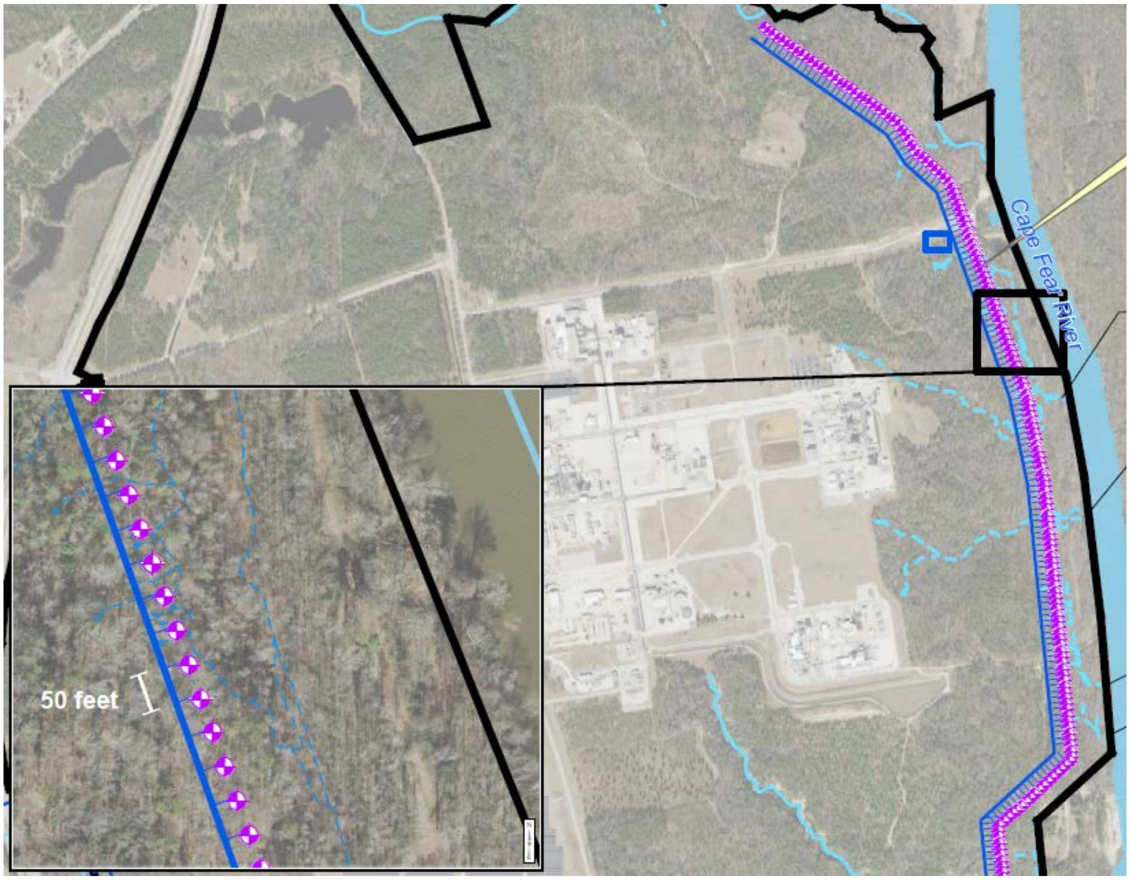

Figure 9: Conceptual Layout of Onsite Groundwater Extraction Remedy

Schedule

Task	Duration (months)	Year 1				Year 2				Year 3				Year 4				Year 5			
Numerical Modeling	1																				
Pre-Design Investigations	6																				
Detailed Design and Permitting (1)	12																				
Permits/ Agency Approvals (2)	12																				
Contracting	3																				
Drilling and Aquifer Pump Testing	6																				
Trenching and Piping Installation	24																				
System Installation	24																				
Testing and Commissioning	12																				

1- Permits include but may not be limited to 404/401 and NPDES

2 - Task timing is dependent upon agency approval timing

Cost

As discussed in the introduction to Section 3, the numerical model is necessary to generate the design inputs that are needed to develop reliable cost estimates for long-term groundwater remedies. The scenario described in this section is one of several that will be evaluated with the numerical model in the following months.

3.4.4 Permanent Groundwater Remedy: Barrier Wall and Groundwater Capture

This alternative would mitigate the flux of onsite groundwater into the Cape Fear River via the installation of steel sheet piles coupled with hydraulic containment of groundwater to keep groundwater from overtopping the sheet pile. The sheet pile would primarily serve to cut off the interface between groundwater and river water, preventing the undesired extraction of river water. A conceptual layout is provided in Figure 10, which shows the 8,500 linear ft of sheet piling. The installation depth was estimated to be 50 ft bgs in order to key into the Upper Cape Fear confining unit.

Groundwater could be extracted from a series of vertical wells or horizontal wells. For the purpose of this analysis, vertical wells were assumed; however, the final design would utilize the most efficient option. Following extraction, the water would be pumped to a treatment system, and then discharged to the river.

It is assumed that extraction well spacing behind the steel wall would be 200 ft, and that each well on average would yield 30 gpm. Drawdown requirements are less significant than the remedy discussed in the previous section, as the pumping is primarily required to prevent mounding behind the steel wall. This would result in approximately 1,275 gpm (1.8 MGD) of extracted groundwater.

Conceptual design of the hydraulic piping (head loss, etc.) and the treatment system (MMF and GAC skids, etc.) is similar in nature to that described in Section 3.4.3. It is assumed that the influent median PMPA and PFMOAA concentrations would be 8,200 and 150,000 ng/L, respectively. It is assumed that PFMOAA is the driving influent COC for GAC utilization, and that 99% removal is required.

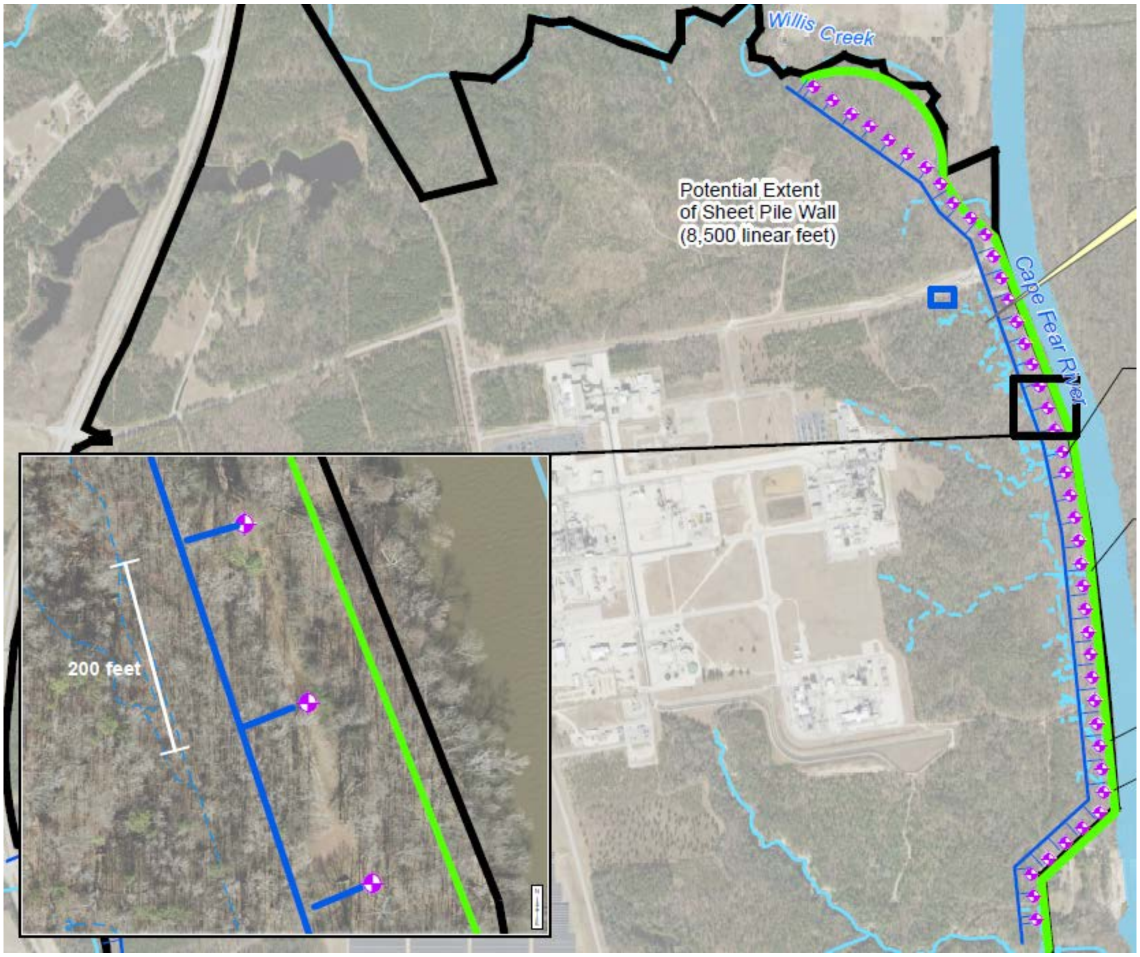

Figure 10: Conceptual Layout of Onsite Groundwater Extraction Remedy Behind Barrier Wall

Schedule

Task	Duration (months)	Year 1	Year 2	Year 3	Year 4	Year 5
Numerical Modeling of Permanent Onsite GW Remedy	1					
Pre-Design Investigations	6					
Detailed Design and Permitting (1)	12					
Permits/ Agency Approvals (2)	12					
Contracting	3					
Drilling and Aquifer Pump Testing	6					
Sheet Pile Installation	20					
Trenching and Piping Installation	24					
System Installation	24					
Testing and Commissioning	12					

1- Permits include but may not be limited to 404/401 and NPDES

2 - Task timing is dependent upon agency approval timing

Cost

As discussion in the introduction to Section 3, the numerical model is necessary to generate the design inputs that are needed to develop reliable cost estimates for long-term groundwater remedies. The scenario described in this section is one of several that will be evaluated with the numerical model in the next two months.

3.5 Pathway: Outfall 002

In addition to process water diversion and air abatement actions already in place, several other potential control approaches were evaluated to achieve even further reductions of PFAS reaching the Cape Fear River via Outfall 002. These options were outlined the Outfall 002 Assessment Report (Geosyntec 2019e) and the following options are further evaluated in this Supplemental Report:

- Remove targeted sediments, which could contain PFAS from historical aerial deposition, along the open section of the Cooling Water Channel and in the Open Channel to Outfall 002 (Section 3.5.1);
- Develop and implement an Industrial Stormwater Pollution Prevention Plan (SWPPP) to reduce the potential for stormwater contamination from industrial activities and other sources such as impacted soils or active construction (Section 3.5.2).
- Implement targeted stormwater source control and/or treatment, including covering/sealing of certain areas, replacement of materials, sweeping or washing/rinsing, or targeted collection and treatment (Section 3.5.3)
- Decommissioning of the terracotta pipe to the WWTP to prevent transport of PFAS that are potentially still present in the pipe or adhered to remnant sediments (Section 3.5.4).
- Assess the potential for groundwater intrusion of perched zone groundwater containing HFPO-DA infiltrating into the Open Channel to Outfall 002 (Section 3.5.5).
- Treat stormwater end of pipe, up to a given design flowrate, by constructing a separate collection system for either stormwater or NCCW to segregate these flows and provide treatment of the stormwater (Section 3.5.6).
- Diversion and treatment of all flows (i.e., stormwater and dry weather flows) end of pipe (at Outfall 002) using carbon filtration, up to a given design flowrate (Section 3.5.7).

These approaches provide differing levels of potential reductions, time to implement, and cost effectiveness for benefit achieved. The following sections provide more details on each proposed option.

3.5.1 Conveyance Network Sediment Removal

Chemours completed sediment removal in a section of the conveyance network in October 2019 (Figure 11). Sediment removal may become a maintenance activity and as such this alternative is outlined in this Supplemental Report.

This alternative would remove sediment that has accumulated in the Non-contact Cooling Water Channel of the IXM Monomers area, and the Open Channel to Outfall 002 (see proposed action 3 in the Reduction Plan [Geosyntec, 2019a] and section 4.2 of the Outfall 002 Assessment [Geosyntec, 2019e]). It is estimated that approximately 150 tons of sediment are within the 2,800 ft of the IXM Monomers Area, and 320 tons of sediment are within the Open Channel to Outfall 002. The sediment would be removed with a combination of vacuum trucks and long-reach excavators and deposited onsite until waste profiling is complete. For the purposes of this evaluation, it is assumed that the material would be sent to Waste Management's facility in Emelle, Alabama for disposal. Disposal rates were obtained from Chemours facility staff based on recent work.

Figure 11: Sediment removal from Open Channel on October 15, 2019

3.5.2 Stormwater Pollution Prevention Plan

As described in the Reduction Plan (Geosyntec, 2019a) and the Outfall 002 Assessment (Geosyntec, 2019e), PFAS from historical aerial deposition may be present in onsite soils and could potentially be transported to Outfall 002 through the Site Conveyance Network.

Chemours will fund a third party to prepare an industrial Stormwater Pollution Prevention Plan (SWPPP) and train Facility personnel on implementation of the SWPPP.

The SWPPP will include information such as roles and responsibilities of staff involved with stormwater management, location of industrial materials stored and transported at the site (indicating materials potentially exposed to precipitation), industrial activities in each area of the site, pollutants of concern related to exposed industrial activities, existing and planned best management practices (BMPs), and site drainage maps. The SWPPP will provide facility-specific guidance on stormwater BMPs, such as good housekeeping practices, exposure minimization, and erosion controls intended to reduce the potential for stormwater contamination from industrial activities and known sources (i.e., impacted soils, active construction, soil stockpiling).

Based on the single stormwater sampling event, conducted in June 2019, PFAS concentrations were not elevated near construction areas or soil stockpiles and data did not indicate any relationship between PFAS and total suspended solids (TSS). Therefore, this action is not expected to yield significant reduction of stormwater loads to the river, and no reduction quantification was possible at this time.

However, it may be possible that reducing soil erosion in wet weather will reduce sediment accumulation along the Site Conveyance Network (and PFAS were detected in sediment within the Cooling Water Channel), which could then reduce sediment contribution to overlying water during dry weather. Potential erosion control measures include silt fencing, hydroseeding, soil binders, fiber rolls, sandbags, or straw bales. An example of fiber rolls is shown in Figure 12.

Figure 12. Example Erosion Control Measure (fiber rolls)

Schedule

A SWPPP will be developed by April 30, 2020. Upon completion of the SWPPP, Chemours will provide an implementation schedule for action items identified in the SWPPP . The target timeline for SWPPP implementation will be six months to one year from completion of SWPPP development. In order to accelerate preparation and implementation of the SWPPP Chemours plant staff and the contractor preparing the SWPPP are having an in-person kick off meeting on November 12, 2019.

Conceptual Cost for Development and Implementation of SWPPP

Development of the SWPPP and training for Facility personnel will cost approximately $30,000. Training for new Facility personnel will be conducted on an as-needed basis. The costs to implement the SWPPP are uncertain until the SWPPP is developed, but implementation costs are estimated to be less than $0.5 million.

3.5.3 Targeted Stormwater Control

3.5.3.1 Stormwater Action Plan

As described in proposed action 5 of the Reduction Plan (Geosyntec, 2019a) and section 4.6 of the Outfall 002 Assessment (Geosyntec, 2019e), results from the stormwater sampling event in June 2019 indicated areas of elevated PFAS concentrations in stormwater. This suggests that some combination of targeted source control and stormwater collection and treatment could achieve mass loading reductions. Since only one data set exists at present, additional data and assessment activities are necessary to develop a better understanding of stormwater levels and spatial patterns throughout the Site in order to select and design suitable approaches.

Chemours will fund third party contractors to conduct two additional stormwater grab sampling programs to evaluate stormwater concentrations. Chemours will also fund a third-party contractor to develop a hydrologic stormwater model (calibrated using onsite flow measurements) and a targeted stormwater action plan and best management practices, based on the data from the stormwater grab sampling events and the outcome of modeling analyses. The stormwater action plan will outline initial actions to be performed, and future performance evaluation reporting of the actions will include any potentially recommended supplementary actions.

The challenge associated with development of the stormwater action plan is the need for additional data and the uncertainty in the level of additional data that may be necessary. Chemours continues to collect data to assess PFAS compounds in stormwater, including the additional stormwater grab sampling and hydrologic model development. However, further data collection related to PFAS in stormwater may be needed during development of the stormwater action plan.

Schedule

The approximate timeline for development of a stormwater action plan is one year. The schedule for implementation of actions identified in the stormwater action plan will be provided after the plan is developed. To accelerate schedule of developing the action plan Chemours has already collected a second round of stormwater data and is planning one more round of sample collection. Additional Chemours plant staff and the contractor preparing the action plan are holding a kick off meeting on November 12, 2019.

Cost

Development of a stormwater action plan, including conducting two additional stormwater sampling events and developing and calibrating a hydrologic model, will cost between $100,000 and 200,000. Costs associated with implementation of the plan are unknown until the plan is developed.

3.5.3.2 Example Targeted Stormwater Treatment

Based on results from the June 2019 stormwater sampling event, areas of high PFAS concentrations in stormwater were observed spatially within the Site. The Chemours Monomers IXM area, in the northeast portion of the Site, was one of the areas observed to have elevated stormwater concentrations. Because these observations were based on a single stormwater sampling event, further sampling is currently planned to provide additional evidence for these observations.

However, for planning purposes, targeted treatment of stormwater in this area was further investigated at a conceptual level. There are multiple options that could potentially be considered for treatment of stormwater in targeted areas. Development of the stormwater action plan (described above) will provide additional information on potential effectiveness of treating onsite stormwater through different measures.

Currently, before additional options have been investigated during development of the stormwater action plan, two potential treatment options include flow-through cells and ex-situ treatment. Flow through cells would be similar to Alternative A for treatment of groundwater seeps (described in Section 3.3), where stormwater would be directed through a controlled structure filled with GAC for on-location treatment.

Ex-situ treatment of stormwater in the Chemours Monomers IXM area could consist of carbon filtration, new stormwater collection systems (e.g., drain inlets or catch basins and piping), pump stations, local storage and pretreatment, and piping to discharge treated flows back into the Site Conveyance Network. The general concept for this targeted stormwater treatment is shown in Figure 13.

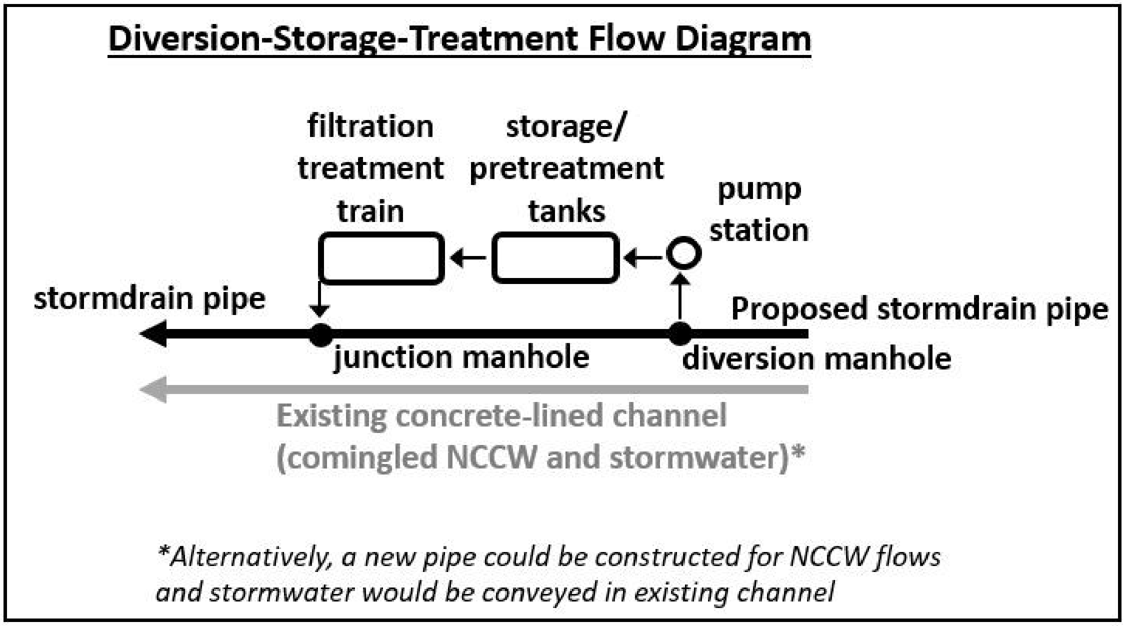

Figure 13. Targeted Stormwater Treatment Design Concept

A hydrologic model was used to model flowrates from the drainage area using historical hourly rainfall data from 2006 to 2018. This concept assumes that 13.9 acres in the Chemours Monomers IXM area drains to the BMP, the average imperviousness of the drainage area is 59%, and the underlying soils within the drainage areas consist of hydrologic soil group A (but soil was assumed to be compacted). Various storage volumes, representing a storage tank that would capture stormwater and slowly release the captured volume to the treatment system (with an assumed 24-hour drawdown time), were also modeled and the long-term percent capture of stormwater from the drainage area was determined for each storage volume. The range of storage volume sizes were then plotted against the long-term percent capture of runoff volume to determine a cost-effective design, where increasing the BMP size would add significant cost but very little increase in runoff volume captured. The average annual percent capture of runoff volume, from the 13.9-acre drainage area, for the selected BMP size was 81%. This expected capture of stormwater from the specified drainage area would result in an estimated reduction of HFPO-DA loading to the river of 1%, compared to loading to the river in 2018.

The design basis for ex-situ targeted treatment of stormwater in the Chemours Monomers IXM area includes a stormwater lift station, influent equalization (EQ) tank, feed-forward pumps, MMF skids, GAC adsorption skids, chemical precipitation system to remove solids collected via the GAC and MMF backwash cycles (including flash and flocculant mixing tanks, inclined plate clarifier [IPC], chemical storage and metering tanks, backwash tank), and solids processing train for chemical precipitation solids (including solids transfer pumps, solids thickening tank, thickened solids pump, and plate-and-frame filter press). Details of the treatment process are shown in Figure 14.

The storage tank needed for this treatment scenario is expected to be approximately 220,000 gallons and the treatment flowrate is 150 gallons per minute. Approximately 8 million gallons of stormwater is expected to be treated annually (based on the modeling performed using rainfall data from 2006 through 2018).

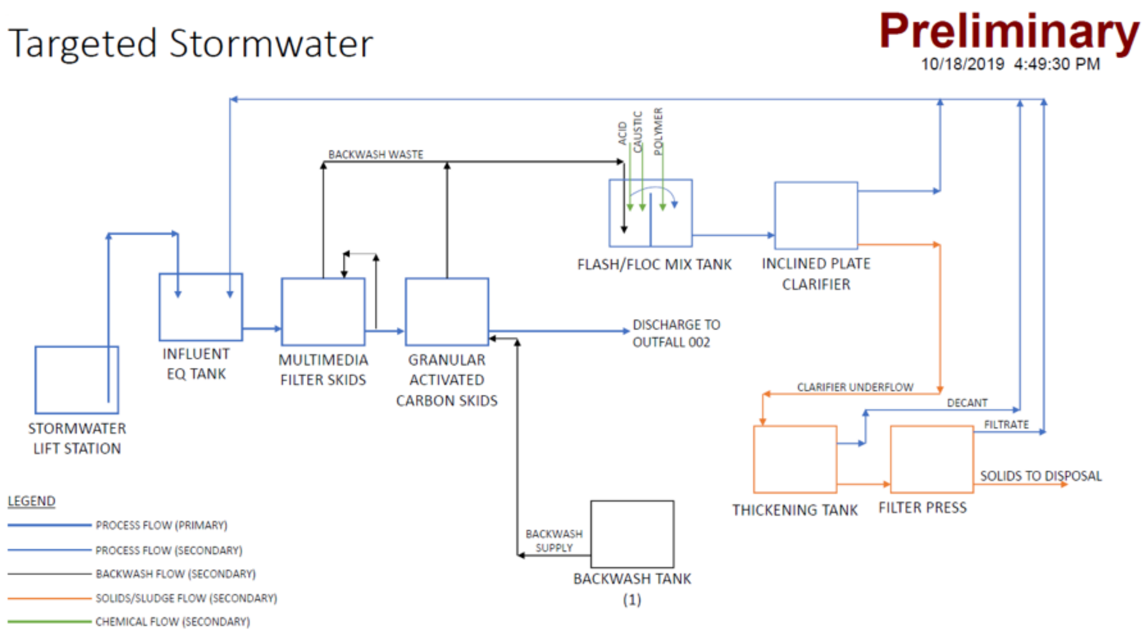

Figure 14. Targeted Stormwater Treatment

Schedule

The schedule for treatment of targeted stormwater using flow-through cells would be similar to the schedule outlined for the permanent remedial alternative for groundwater seeps via flow-through cells (shown in Section 3.3).

The schedule for implementation of a potential ex-situ treatment BMP in a high priority stormwater area will exceed two years. Implementation of targeted stormwater treatment BMPs may require up to four years. Following completion of additional sampling and development of the stormwater action plan, the interim tasks and approximate durations for this potential control approach include the tasks shown below.

Task	Duration (months)	Year 1	Year 2	Year 3	Year 4
Stormwater Action Plan	12				
Planning and Feasibility	6				
Preliminary Design (1)	6				
Permitting Plan	2				
Final Design	12				
Permits/Approvals (2)	12				
Contracting	3				
Construction	18				
Startup Testing	2				

1- Includes hydrologic/hydraulic calculations, topographic survey, geotechnical investigations

2 - Task timing is dependent upon agency approval timing

<u>ROM Cost</u>

As discussion in the introduction to Section 3, the scope of stormwater treatment and technology assessment are required to develop a reliable cost estimate for this remedy, which is being advanced.

3.5.4 Terracotta Pipe Decommissioning

The Terracotta pipe was designed to convey wastewaters from the various manufacturing areas on the Site to the wastewater treatment plant (WWTP). The pipe originated in the Chemours Monomers IXM Area and included inputs from Monomers IXM, Kuraray SentryGlas®, Kuraray Trosifol®, the Kuraray Laboratory, and wastewater from demineralized water production. Figure 15 shows the terracotta piping network. In 2017, Chemours diverted all Monomers IXM process wastewater flows from the WWTP and began sending them offsite for disposal. In 2019, the east-west section of the terracotta pipe (hatched piping line in Figure 15) that originates in Monomers IXM was grouted to mitigate the potential for PFAS originating from the terracotta pipe to be released to the Cape Fear River (Geosyntec, 2019f). The Kuraray areas and the Site demineralized water production operations actively transmit water to the WWTP via the terracotta pipe.

None of the current inputs to the terracotta pipe use or produce PFAS, and there have been no known contributions of process water from the Monomers IXM Area to the WWTP by the terracotta pipe since November 2017. However, to further mitigate the potential for PFAS to reach the Cape Fear River via the WWTP, the remaining ungrouted sections of the terracotta pipe will be fully decommissioned and grouted no later than

December 2021. Once this is completed the current flow through the terracotta pipe to the WWTP will be transmitted through new aboveground piping.

Schedule

This work will be completed by Kuraray and Chemours by fall 2021. Presently Kuraray is reviewing potential designs to advance the project to the detailed design phase.

ROM Cost

The cost for grouting the east-west portion of the terracotta pipe in 2018 was approximately $100,000. The remaining portions of the terracotta pipe that are still in use are expected to also cost approximately $100,000. Kuraray will be responsible for procurement and installation of the new aboveground piping and, as such, Chemours does not have costing information for this component.

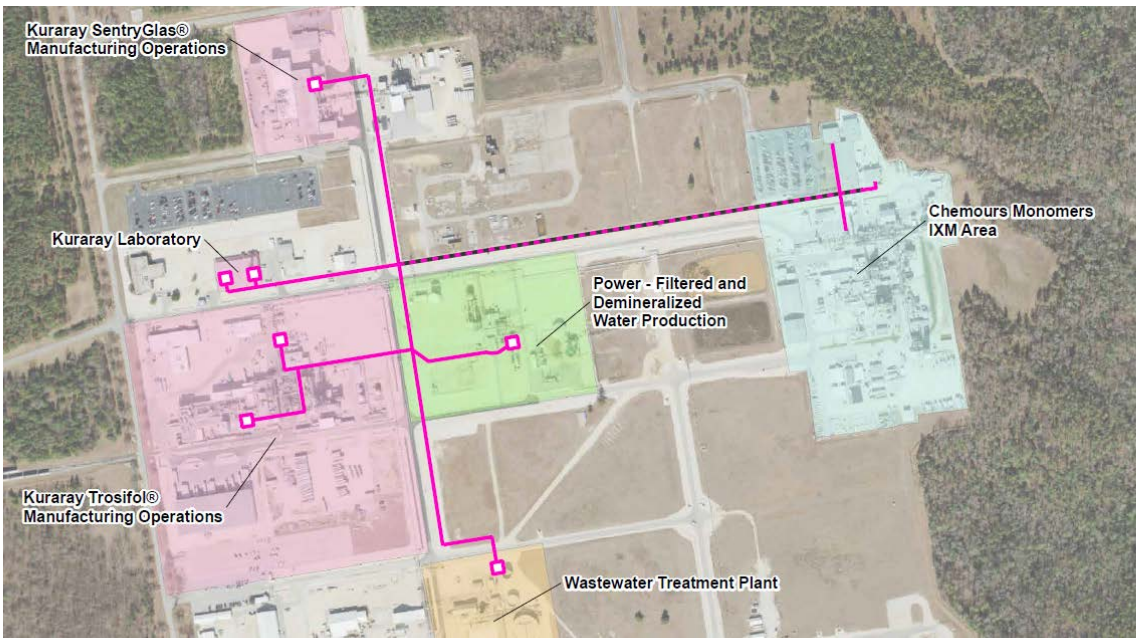

Figure 15: Terracotta Piping Layout

Notes: Hatched lines were decommissioned in 2018 all remaining will be replaced with above ground piping in 2021.

3.5.5 Mitigation of Groundwater Intrusion into Outfall 002

As described in proposed action 7 of the Reduction Plan (Geosyntec, 2019a) and section 4.3 of the Outfall 002 Assessment (Geosyntec, 2019e), it is possible that perched zone groundwater is entering the Open Channel to Outfall 002 near the DuPont area, and contributing to PFAS loading. This scenario is still under evaluation, but for the purposes of this response, it is assumed that groundwater is entering the open channel, and that active mitigation would be performed.

To mitigate this intrusion, it is assumed that the infiltration of DuPont non-contact cooling water (NCCW) into the perimeter unlined ditches is a significant contributor to the perched zone groundwater head, and that routing this NCCW directly to Outfall 002 will reduce the perched zone levels to the point that groundwater intrusion is eliminated. For cost purposes, it was assumed that up to eight discharges from the DuPont area would be connected to new process piping and conveyed in a common trench about 500 linear ft to the Open Channel.

Schedule

The timeframe required to implement the piping redirection would be one year, after which point additional data collection, analysis and evaluation would be required to assess the potential impact on groundwater intrusion. If insufficient, additional measures could be required, such as groundwater extraction under the DuPont area. Accordingly, it is conservatively estimated that the full implementation of this alternative would take approximately three to five years. To accelerate assessment and implementation of this action Chemours surveyed the bottom of the open channel to Outfall 002 during the October 2019 plant shutdown when there was limited water present in the Outfall (see Figure 16).

Task	**Duration (months)**	Year 1	Year 2	Year 3	Year 4	Year 5
Detailed Design	3					
Contracting	1					
Implementation	6					
Effectiveness Evaluation	12					
Contingent Action	12-36					

Conceptual Cost

Costs were estimated and considered to be accurate within the +50/-30 % range. The construction costs range from $490,000 to 1,050,000. No annual costs would be required.

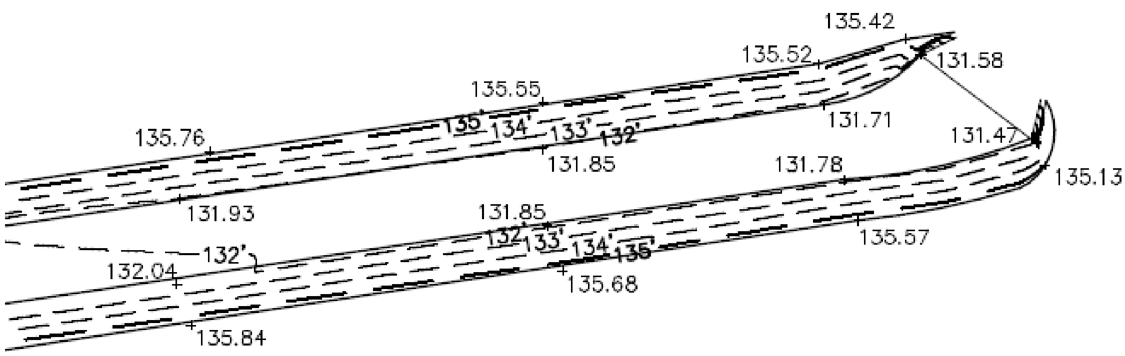

Figure 16: Surveyed elevations of the bottom of the Open Channel to Outfall 002

3.5.6 Treatment of all Stormwater at Outfall 002

As described in section 4.7 of the Outfall 002 Assessment (Geosyntec, 2019e), a potential control approach for addressing PFAS from Outfall 002 involves treating stormwater flows "end of pipe" (i.e., at Outfall 002), up to a given design flowrate. This approach involves constructing a separate collection system for either stormwater or NCCW to achieve segregation of these flows, since dry weather flows and stormwater are currently conveyed to Outfall 002 via a combined network. Collection system separation and treatment of stormwater from the entire Site would require significant cost and time to plan, design, permit and construct, and significant cost to operate and maintain given the expected required pace of carbon replacement or regeneration.

Similar to the potential control approach of targeted stormwater control through capture of stormwater flows in high priority stormwater areas and treatment using carbon filtration, the potential control approach to treat all stormwater flows was modeled using a hydrologic model of the Site. The area within the Site that drains to Outfall 002 was modeled using the long-term simulation of historical rainfall from 2006 through 2018. This concept assumes that 230 acres drain to Outfall 002 (modeled as 50 catchments), the average imperviousness of the entire drainage area is 35%, and the majority of underlying soils within the drainage areas consist of hydrologic soil group A (but soil was assumed to be compacted).

A range of storage volume sizes was also modeled, and the cost-effective storage size was determined based on the plot of storage volume (i.e., BMP size) versus percent capture of runoff volume. Increasing the BMP size greater than the selected storage volume would add significant cost but would only result in minimal increases in the amount of runoff volume captured and treated. The average annual % capture of runoff volume, from the entire Site draining to Outfall 002, for the selected BMP size was 85%. This expected capture of Site stormwater would result in an estimated reduction of HFPO-DA loading to the river of 2% (compared to loading to the river in 2018).

The design basis for treatment of all Site stormwater includes rerouting NCCW to a new piping system (such that stormwater is still conveyed in the Site Conveyance Network), a stormwater lift station, influent EQ tank, feed-forward pumps, MMF skids, GAC adsorption skids, chemical precipitation system to remove solids collected via the GAC and MMF backwash cycles (including flash and flocculant mixing tanks, IPC, and chemical storage tanks and metering pumps), and solids processing train for chemical precipitation solids (including solids transfer pumps, solids thickening tank, thickened solids pump, and plate-and-frame filter press). Details of the conceptual treatment system are shown in Figure 17.

The required storage volume and treatment flowrate for this scenario would be very large. The storage tank for this scenario is expected to be approximately 5.5 million gallons and the treatment flowrate is approximately 3,800 gallons per minute. Approximately 120 million gallons of stormwater is expected to be treated annually (based on the modeling performed using rainfall data from 2006 through 2018).

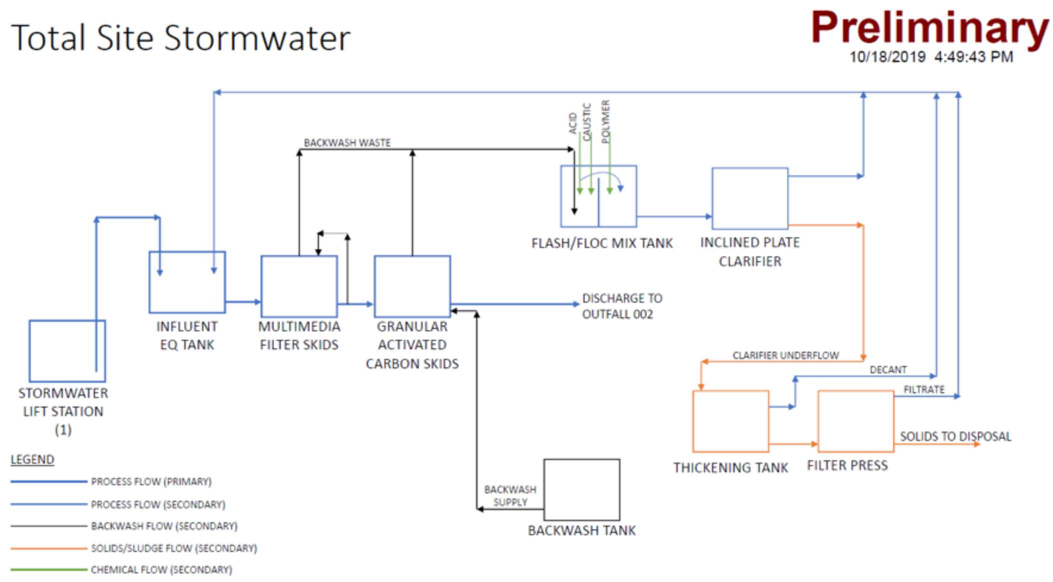

Figure 17. All Site Stormwater Treatment

Schedule

Implementation of this potential control approach would be expected to take up to five years.

Task	Duration (months)	Year 1				Year 2				Year 3				Year 4				Year 5			
Planning and Feasibility	6																				
Preliminary Design	6																				
Permitting Plan	2																				
Final Design	12																				
Permits/Approvals (1)	12																				
Contracting	3																				
Construction (2)	18																				
Startup Testing	2																				

1- Dependent upon agency approval timing.

2 - Includes construction of treatment system and new site conveyance network.

ROM Cost

Costs were estimated and considered to be accurate within the +50/-30 % range. The cost estimate for treatment of all stormwater end of pipe (up to a certain flowrate) includes construction costs that range from $50 to 108 million, annual O&M costs for 20 years from $1.3 to 2.7 million, and an NPV ranging from $68 to 146 million.

3.5.7 Treatment of all Flows at Outfall 002

As described in section 4.9 of the Outfall 002 Assessment (Geosyntec, 2019e), a potential control approach for addressing PFAS from Outfall 002 involves treating all flows (i.e., stormwater and dry weather flows) end of pipe (at Outfall 002), up to a given design flowrate. This option would not require separation of the current collection system; therefore, the existing Site Conveyance Network could remain. This would require a new diversion structure above Outfall 002, a new pump station, a new storage tank, and a new treatment system similar to that described in the Treatment of all Stormwater control approach (discussed in Section 3.5.6). Treated flows would be discharged back into the Open Channel above Outfall 002.

This control approach was conceptually designed to achieve an 80% reduction in HFPO-DA loading at Outfall 002, as compared to 2018. This involves determining a treatment flowrate that achieves 100% dry weather flow capture and significant stormwater flow capture (73% of stormwater flow, in the 2018 calendar year). The required treatment flowrate for this scenario is approximately 21.1 million gallons per day (14,600 gallons per minute) and the total annual treated volume of water is approximately 7,700 million gallons per year (based on the modeling performed using rainfall data from 2006 through 2018). This potential control approach would result in an estimated reduction of HFPO-DA loading to the river of 3% (compared to loading to the river in 2018).

The design basis for treatment of all Outfall 002 flows includes influent wetwell for stormwater and process wastewater collection, feed-forward pumps, MMF skids, GAC adsorption skids, chemical precipitation system to remove solids collected via the GAC and MMF backwash cycles (including flash and flocculant mixing tanks, IPC, chemical storage tanks and metering pumps), and solids processing train for chemical precipitation solids (including solids transfer pumps, solids thickening tank, thickened solids pump, and plate-and-frame filter press). Details of the conceptual treatment system are shown in Figure 18.

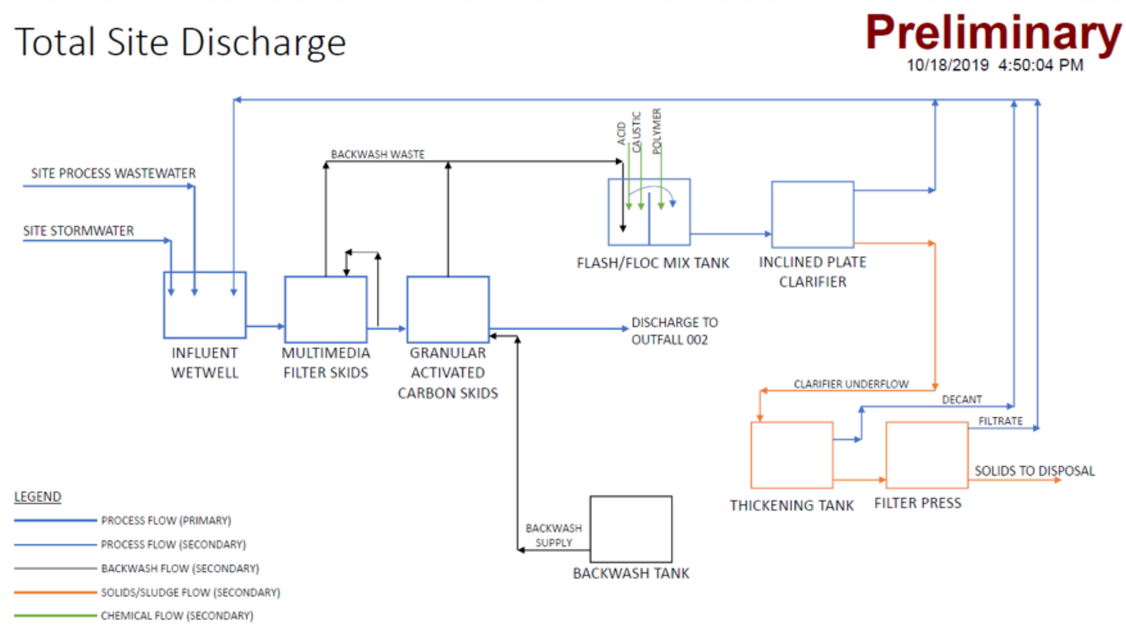

Figure 18. All Outfall 002 Treatment

Schedule

Implementation of this potential control approach would be expected to take up to between three to five years.

Task	Duration (months)	Year 1				Year 2				Year 3				Year 4				Year 5			
Planning and Feasibility	6	■	■																		
Preliminary Design	6			■	■																
Permitting Plan	2					■															
Final Design	12						■	■	■	■											
Permits/Approvals (1)	12										■	■	■	■							
Contracting	3													■							
Construction (2)	18														■	■	■	■	■	■	
Startup Testing	2																				■

1- Dependent upon agency approval timing.
2 - Includes construction of treatment system and new site conveyance network.

ROM Cost

Costs were estimated and considered to be accurate within the +50/-30 % range. The cost estimate for treatment of all flows at Outfall 002 (up to a specified flowrate) includes construction costs ranging from $59 to 127 million, annual O&M costs for 20 years of $4.1 to 8.7 million, and a NPV ranging from $118 to 252 million.

3.6 Pathway: All Loadings From Willis Creek and Georgia Branch Creek

The flow and estimated PFAS loading to Willis Creek and Georgia Branch Creek have been previously estimated (Geosyntec 2019c). These creeks are tributaries to the Cape Fear River. Two remedial alternatives were considered as outlined below.

3.6.1 Capture and Treatment at Mouths of Creeks

This option would require the installation of dams at the mouths of both Willis and Georgia Branch Creeks (estimated to be 2,917 and 2,440 gpm, respectively), and pumping and treatment systems similar to that described in previous sections for Outfall 002. Figure 19 shows where hypothetical capture locations for the creeks would be located. It is assumed that PMPA is the driving influent PFAS for GAC utilization, that 99% removal is required, and that the average influent concentration for Willis Creek and Georgia Branch Creek would be 540 ng/L and 900 ng/L, respectively. Due to the distance between the two creeks, they would be entirely separate systems. Treated flows would be discharged back into the respective creeks or directly into the Cape Fear River.

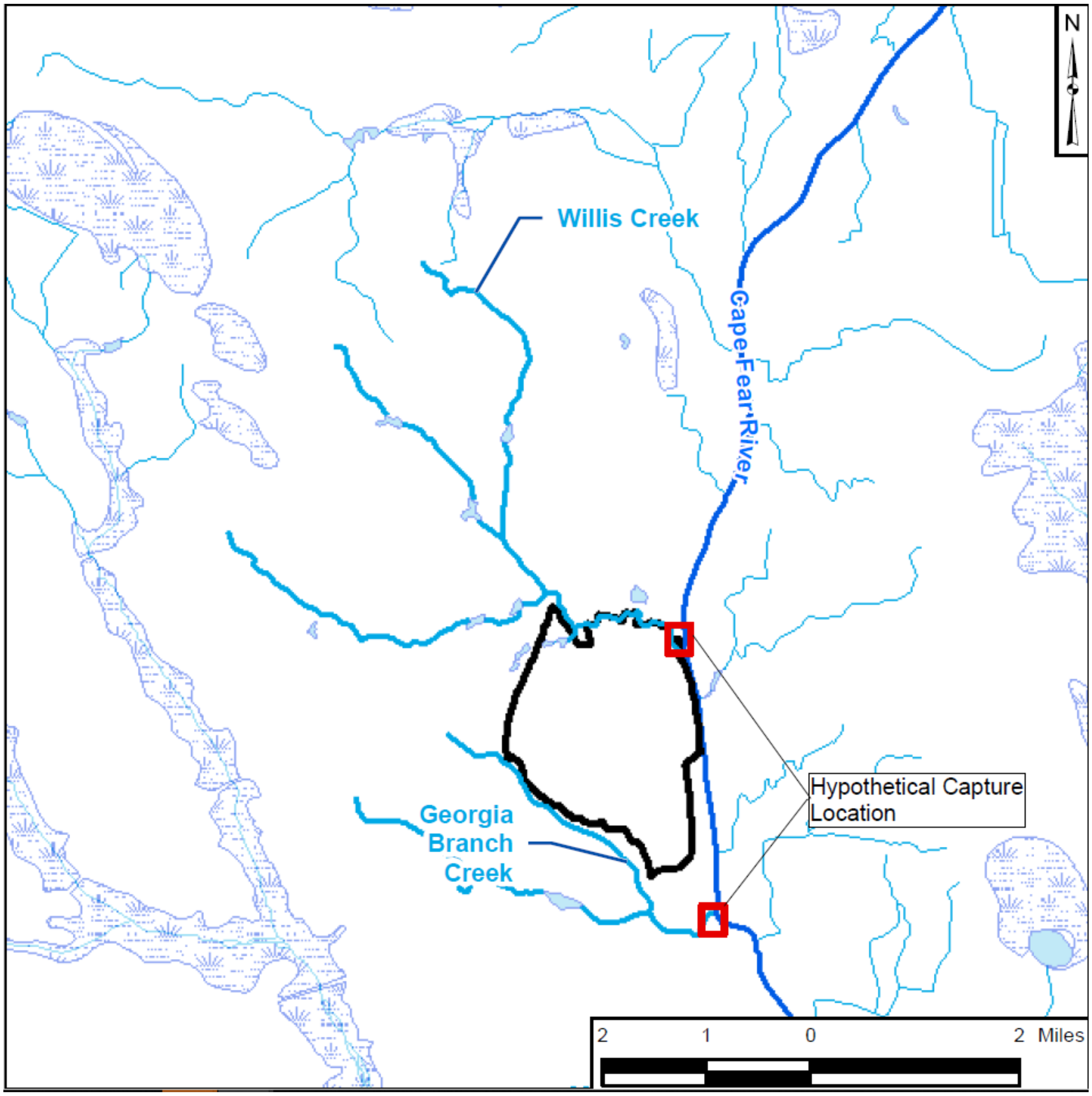

Figure 19: Willis Creek and Georgia Branch Creek Drainage Areas and Hypothetical Capture Locations

<u>Schedule</u>

Task	Duration (months)	Year 1	Year 2	Year 3	Year 4	Year 5
Planning and Feasibility	6					
Preliminary Design	6					
Permitting Plan	2					
Final Design	12					
Permits/Approvals (1)	12					
Contracting	3					
Construction (2)	18					
Startup Testing	2					

1- Dependent upon agency approval timing.

2 - Includes construction of treatment system and new site conveyance network.

<u>Conceptual Cost</u>

Costs were estimated and considered to be accurate within the +50/-30 % range. A NPV calculation was performed using a discount factor of 3.5 %. The construction costs range from $53 to 114 million, annual O&M costs are $4.6 to 9.8 million, with a 20-year NPV for the alternative ranging from $120 to 260 million.

3.6.2 Application of PlumeStop™ to Length of Willis Creek and Georgia Branch Creek

A PlumeStop™ barrier would be installed along both sides of Willis Creek and its tributaries. This would result in approximately 22 miles of barrier (11 miles each side). A second barrier would be installed along Georgia Branch and its tributaries resulting in approximately 14.25 miles of barrier (7.12 miles each side). The barrier would be designed to retard the flow of site specific PFAS for a minimum of 20 years. At the end of the design life additional product could be injected to extend the life of the barrier if required.

Schedule

Task	Duration (months)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Work Plan Preparation	3										
NCDEQ Review[1]	3										
Access / Right-of-Way	60										
Pre-design Data Collection	60										
Injection and Mix Design	54										
Injection Permitting[2]	57										
PlumeStop Inections	60										
Performance Monitoring	20 years										

1 - Task timing is dependent upon agency approval timing

2 - Task timing is dependent upon permitting process and assumes multiple permits

Conceptual Cost

Costs were estimated and considered to be accurate within the +50/-30 % range. A NPV calculation was performed using a discount factor of 3.5 %. The construction costs range from $1.7 to 3.7 billion, annual O&M costs are $360,000 to 780,000, with a 20-year NPV for the alternative ranging from $1.7 to 3.7 billion.

3.7 Pathway: Offsite Groundwater

3.7.1 Hydraulic Containment and Treatment

This alternative would mitigate the flux of offsite groundwater into the Cape Fear River via the installation of steel sheet piles coupled with hydraulic containment of groundwater. The steel sheeting would be installed on both sides of the river and would primarily serve to cut off the interface between groundwater and surface water, preventing the undesired extraction of river water. Groundwater would be extracted from vertical recovery wells, pumped to treatment systems, and then discharged to the river.

A conceptual layout is provided in Figure 20 which shows the 20 miles (10 miles on each side, 6 upstream and 4 downstream) of sheet piling. Note that the onsite portion of this alignment is excluded as this is covered by other alternatives. This alignment represents the extent of HFPO-DA concentrations in offsite residential wells with concentrations between 140 - 1,400 ng/L (On and Offsite Assessment, Geosyntec 2019b). At least 120 acres of riverine land, much of it wetlands, would be required to site the sheet piling, extraction wells, piping trenches, and access roads. The installation depth was estimated to be 50 ft bgs in order to key into the Upper Cape Fear confining unit.

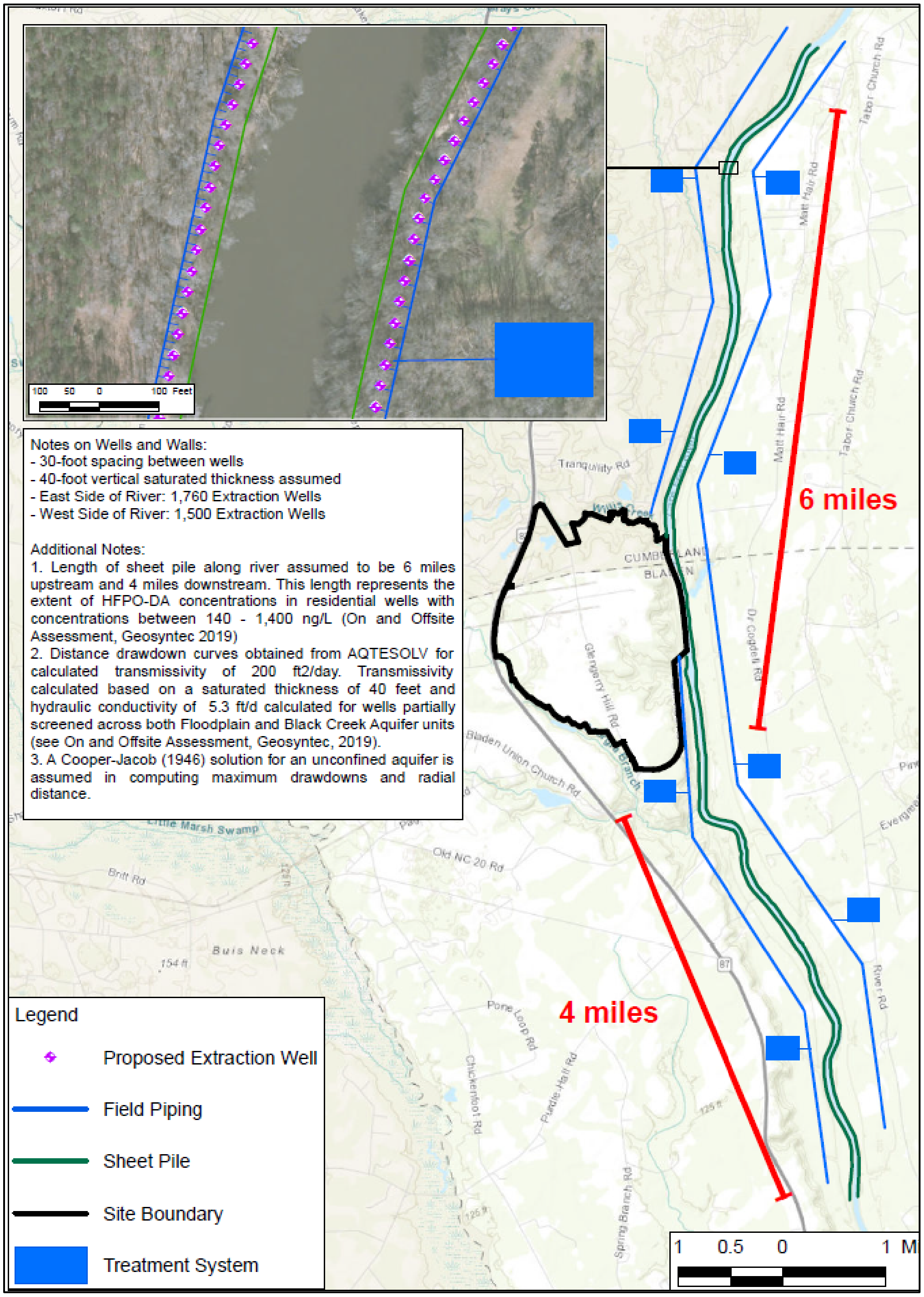

Figure 20: Conceptual Layout of a Hypothetical Offsite Groundwater Remedy

There would be significant challenges to implementing these continuous runs of sheet pile, including but not limited to obtaining access agreements, permitting extensive impacts to wetlands, and the availability of 5.3 million square feet (SF) of steel within the time constraints of the project. For the purposes of this evaluation, it was assumed that these challenges could be overcome.

Based on drawdown requirements to reduce head below the river stage using analytical methods, it was estimated that 3,520 extraction wells at a spacing of 30 ft, each pumping 15 gpm, would be required. This would result in approximately 38 MGD of extracted groundwater on each side of the river (76 MGD total). Due to the scale of the remedy both in terms of flow rate and distance along the river, it was assumed that eight separate treatment systems would need to be constructed to manage the water.

Conceptual design of the hydraulic piping (head loss, etc.) and the treatment system (MMF and GAC skids, etc.) is similar in nature to that described in Section 3.4.3. It is assumed that PMPA is the driving influent COC for GAC utilization, that 99% removal is required, and that the average influent concentration would be 172 ng/L. Discharge would require regulatory approval via NPDES permits, and construction of outfalls in the vicinity of the river would likely require regulatory approval from the USACE.

Schedule

The estimated timeframe to implement a remedy of this scale would be 7 to 10 years. This includes up to two years for design, one year for permitting after design is complete, and four to five years for drilling, site work, and treatment system installation.

Task	Duration (months)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Pre-design Investigation	6										
Detailed Design	24										
Permitting[1]	12										
Contracting	6										
Drilling	12										
Site Work Installation	48										
Treatment System Installatio	12										
Testing and Commissioning	24										

1 - Task timing is dependent upon agency approval timing

Conceptual Cost

Costs were estimated and considered to be accurate within the +50/-30 % range. An NPV calculation was performed using a discount factor of 3.5 %. The construction costs range from $0.7 to 1.5 billion, annual O&M costs are $41 to 89 million, with a 20-year NPV for the alternative ranging from $1.3 to 2.8 billion.

4 ASSESSMENT OF REMEDIES

This section presents an assessment and scoring of the alternatives described in Section 3 using the framework described in Section 2. This assessment is performed on a per pathway basis. For each pathway subsection, the alternatives identified are listed, and then for alternatives not advanced, an explanation is provided. Each subsection also includes a table summarizing the characteristics and attributes of the alternatives (estimated reductions, costs, timeframes) and scores them against the criteria outlined in Section 2.

4.1 Old Outfall 002

The remedial alternative considered for Old Outfall 002 is Alternative A: Capture and Treat Old Outfall 002. This action was as shown in Table 4 and advanced per Chemours's compliance with provisions in Consent Order Paragraph 12. The other alternative identified and tested for Old Outfall 002 was PlumeStop™. PlumeStop™ was not described here since Chemours has already proposed moving forward with the Capture and Treat alternative. The PlumeStop™ alternative, though able to initially reduce concentrations, may experience diminishing performance over time and may result in re-release of sorbed Table 3+ PFAS.

Table 4: Assessment of Old Outfall 002 Alternatives

Alternatives	Interim / Long Term	Estimated Reductions to Old Outfall 002	Estimated Reductions to the Cape Fear River	Estimated Time to Implement (years)	Millions of Dollars per Percentage River Reduction	Conceptual Estimated Construction and 20 Year O&M NPV Value For Remedy Comparison Purposes		
						-30%	Base Case	50%
Capture and Treat Old Outfall 002	Long Term	0%	26%	2	$1.7	$21,000,000	$30,000,000	$45,000,000

Alternatives	Reductions to the Cape Fear River Scoring	Adverse Environmental Effects Scoring	Technological Feasibility Scoring	Time Scoring	Cost per Loading Removal Scoring
Capture and Treat Old Outfall 002	1	3	2	2	2

Notes:

O&M - Operation and Maintenance

NPV - Net Presnt Value

w - with

wo - without

- Estimated reductions to the Cape Fear River were derived by averaging the estimated Old Outfall contributions for the May and June Mass Loading Model sampling events as described in the August 26, 2019 Reductions Plan (Geosyntec, 2019). Then the following reductions were assumed:
    - 99% reduction of Total Table 3+ PFAS by both Old Outfall alternatives.

4.2 Groundwater Seeps

Remedial alternatives considered for groundwater seeps that could potentially reduce PFAS loadings to the Cape Fear River within 2 and 5 year timeframes are listed below and the assessment presented in Table 5:

- Alternative A: Flow-Through Cells – Cape Fear River Seeps (Interim and Long Term)
- Alternative B: Ex Situ Capture French Drains – Cape Fear River Seeps (Interim and Long Term)
- Alternative C: PlumeStop™ – Cape Fear River Seeps A and B (Interim)
- Alternative D: Flow-Through Cells – Willis Creek Seeps (Long Term)
- Alternative E: PlumeStop™ – Willis Creek Seeps (Long Term)

Alternative A and B, flow-through cells and ex situ capture French drains, for Cape Fear River Seeps A, B, C and D were advanced for further consideration, with both Alternatives proposed as interim actions likely leading to long term implementation of one of the options (see Section 5.1). Both approaches have the potential to reduce by 95% the loading from the seeps to the Cape Fear River within a 2 to 3 year time period.

Alternative C, PlumeStop™ application on an interim basis to the perched zone seepage of seeps A and B was not advanced. Alternatives A & B performed on an interim basis can achieve greater reductions than Alternative C at a lower cost. Additionally, PlumeStop™ would only marginally reduce the mass and flow rate of the seeps going into the river and could extend the life of ex situ treatment at captured seeps downgradient. However, it is noted that PlumeStop™ has been demonstrated to be effective in reducing flux of PFAS, and is generally retained for future consideration at the Site.

Alternatives D and E, Flow-Through Cells and PlumeStop™ for Willis Creek Seeps, were not advanced. Both alternatives are estimated to result in a 2% reduction in loading to Willis Creek and a 0.1% reduction to the Cape Fear River. In contrast, the onsite groundwater remedy advanced further consideration in Section 4.3 is estimated to result in reductions to Willis Creek Loadings of 65% at lower costs per percentage reduction achieved.

Table 5: Assessment of Groundwater Seep Alternatives

Alternatives	Interim / Long Term	Estimated Reductions to Willis Creek	Estimated Reductions to the Cape Fear River	Estimated Time to Implement (years)	Millions of Dollars per Percentage River Reduction	Conceptual Estimated Construction and 20 Year O&M NPV Value For Remedy Comparison Purposes[1]		
						-30%	Base Case	50%
Flow Through Cells - CFR Seeps A, B, C & D[1]	Interim	--	--	2	--	$1,700,000	$2,400,000	$3,600,000
Flow Through Cells - CFR Seeps A, B, C & D	Long Term	--	27%	2	$0.45	$7,000,000	$10,000,000	$15,000,000
Flow Through Cells - WC Seeps	Long Term	2%	0.1%	2	$15	$1,400,000	$2,000,000	$3,000,000
Ex Situ Capture and Treatment - CFR Seeps A, B, C & D[1]	Interim	--	--	3	--	$11,000,000	$15,000,000	$23,000,000
Ex Situ Capture and Treatment - CFR Seeps A, B, C & D	Long Term	--	27%	3	$0.94	$15,000,000	$22,000,000	$33,000,000
Plume Stop - CFR Seeps A and B - Interim[1]	Interim	--	--	1	--	$9,100,000	$13,000,000	$20,000,000
PlumeStop - WC Seeps	Long Term	2%	0.1%	1	$391	$36,000,000	$51,000,000	$77,000,000

Alternatives	Reductions to the Cape Fear River Scoring	Adverse Environmental Effects Scoring	Technological Feasibility Scoring	Time Scoring	Cost per Loading Removal Scoring
Flow Through Cells - CFR Seeps A, B, C & D	NA[2]	2	3	2	NA[2]
Flow Through Cells - CFR Seeps A, B, C & D - Interim	1	2	2	2	1
Flow Through Cells - WC Seeps	5	2	2	2	5
Ex Situ Capture and Treatment - CFR Seeps A, B, C & D - Interim	NA[2]	2	2	3	NA[2]
Ex Situ Capture and Treatment - CFR Seeps A, B, C & D	1	2	2	3	1
Plume Stop - CFR Seeps A and B - Interim	NA[2]	1	4	1	NA[2]
PlumeStop - WC Seeps	5	1	3	1	5

Notes:

1 - Costing of interim flow through cells and french drains assumes construction costs and two years of annual O&M and five years for PlumeStop™ at Seeps A and B.

2 - Reductions to Cape Fear River from interim remedies not assessed since interim remedies have not yet been pilot tested at the Site.

O&M - Operation and Maintenance

NPV - Net Present Value

- Estimated reductions to Willis Creek Seeps were derived from the calculation of the loading coming from these seeps presented in Section 3.3. The reductions to the Cape Fear River were derived by averaging the estimated seep pathway contributions for the May and June Mass Loading Model sampling events as described in the August 26, 2019 Reductions Plan (Geosyntec, 2019). Total reductions were calculated using the following values:
    - Willis Creek represents 7% of loading to the river; Willis Creek seeps represent 2% of loadings to Willis Creek;
    - Seeps A, B, C and D represents 28% of loadings to the river;
    - Seep remedies assumed to be 95% effective at reducing loadings per pathway.

4.3 Onsite Black Creek Aquifer Groundwater

Remedial alternatives considered for Onsite Black Creek Aquifer Groundwater that could potentially reduce loadings to the Cape Fear River within a five year timeframe are listed below and the assessment presented in Table 6:

- Alternative A: Extract from Black Creek Monitoring Wells (Interim);
- Alternative B: Install New Black Creek Extraction Wells (Interim);
- Alternative C: Groundwater Extraction (Long Term); and
- Alternative D: Groundwater Extraction with Barrier Wall (Long Term).

For interim alternatives, Alternative A is proposed as an interim measure in Section 6 as it can be implemented relatively quickly. Alternative B was not selected as an interim measure at this time since it would take longer to implement, and its efficacy has not yet been evaluated using a numerical groundwater model.

Alternatives C and D, groundwater extraction and groundwater extraction with a barrier wall, were both advanced for further consideration, and the alternative finalization sequence for onsite groundwater is assessed in Section 6.

Table 6: Assessment of Onsite Black Creek Aquifer Groundwater Alternatives

Alternatives	Interim / Long Term	Estimated Reductions to Willis Creek	Estimated Reductions to the Cape Fear River	Estimated Time to Implement (years)	Millions of Dollars per Percentage River Reduction	Conceptual Estimated Construction and 20 Year O&M NPV Value For Remedy Comparison Purposes		
						-30%	Base Case	50%
Extract from Black Creek Monitoring Wells - Interim	Interim		--	1	--	$800,000	$1,200,000	$1,800,000
Install New Black Creek Extraction Wells - Interim	Interim		--	2	--	$1,300,000	$1,800,000	$2,700,000
Groundwater Extraction	Long Term	65%	23%	5	--	NA[1]	NA[1]	NA[1]
Groundwater Extraction with Barrier Wall	Long Term	65%	23%	5	--	NA[1]	NA[1]	NA[1]

Alternatives	Reductions to the Cape Fear River Scoring	Adverse Environmental Effects Scoring	Technological Feasibility Scoring	Time Scoring	Cost per Loading Removal Scoring
Extract from Black Creek Monitoring Wells - Interim	NA[2]	1	2	1	NA[2]
Install New Black Creek Extraction Wells - Interim	NA[2]	1	2	2	NA[2]
Groundwater Extraction	NA[1]	1	3	4	NA[1]
Groundwater Extraction with Barrier Wall	NA[1]	2	3	4	NA[1]

Notes:

1 - Costs for full-scale, long term onsite groundwater remedies will be prepared using the results of remedy evaluation in the numerical groundwater model.

2 - Reductions to Cape Fear River from interim remedies not assessed since interim remedies have not yet been evaluated with the numerical groundwater model. Interim remedy costs reflect an assumed five and four year annual O&M costs for the alternatives that use existing wells and installing additional wells respectively.

O&M - Operation and Maintenance

NPV - Net Present Value

- The reductions to the Cape Fear River were derived by averaging the estimated Onsite Groundwater direct discharge contributions for the May and June Mass Loading Model sampling events as described in the August 26, 2019 Reductions Plan (Geosyntec, 2019). Total reductions were calculated using the following values:
    - Willis Creek represents 7% of loading to the river, onsite groundwater represents 68% of loading to Willis Creek;
    - Onsite groundwater represents 20% of loading to the river;
    - Groundwater remedies are assumed able to reduce pathways loadings by 95%.

4.4 Outfall 002

Remedial alternatives considered for Outfall 002 that could potentially reduce loadings to the Cape Fear River within two and five years are listed below and the assessment presented in Table 7:

- Alternative A: Conveyance Network Sediment Removal;
- Alternative B: Stormwater Pollution Prevention Plan;
- Alternative C: Targeted Stormwater Control;
- Alternative D: Terracotta Pipe Decommissioning;
- Alternative E: Groundwater Intrusion Mitigation;
- Alternative F: Treat all stormwater at Outfall 002; and
- Alternative G: Treat all flows at Outfall 002.

The five actions represented in Alternatives A through E were advanced as proposed actions in the Reduction Plan (Geosyntec 2019a). Together these actions have the potential with iterative assessment and control to provide a high degree of Total Table 3+ PFAS reductions to Outfall 002.

Alternative F, treat all stormwater at Outfall 002, was not advanced. It would be an exceedingly disruptive remedy to implement at an active manufacturing plant as it would require extensive reorganization of the many facilities and the non-contact cooling water and process water supply networks. Similarly, Alternative G, treat all flows at Outfall 002, was not advanced. It would necessitate treatment of all non-contact cooling water flows in addition to all stormwater flows at the Site.

Rather, the five actions represented in Alternatives A through E were proposed since they have the potential to capture much of the reductions that F or G would accomplish by targeting sources of PFAS entering the Outfall. Alternatives F and G do not provide reductions commensurate with their cost and are economically infeasible.

Table 7: Assessment of Outfall 002 Alternatives

Alternatives	Interim / Long Term	Estimated Potential Reductions to Outfall 002	Estimated Reductions to the Cape Fear River	Estimated Time to Implement (years)	Millions of Dollars per Percentage River Reduction	Conceptual Estimated Construction and 20 Year O&M NPV Value For Remedy Comparison Purposes		
						-30%	Base Case	50%
Conveyance Network Sediment Removal	Long Term	NQ[1]	NQ[1]	1	--	$160,000	$230,000	$350,000
Stormwater Pollution Prevention Plan	Long Term	NQ[1]	NQ[1]	2	--	$400,000	$500,000	$800,000
Targeted Stormwater Control	Long Term	30%	1.7%	4	--	NA[2]	NA[2]	NA[2]
Terracotta Pipe Decommisioning	Long Term	2%	0.1%	2	--	NA[3]	NA[3]	NA[3]
Groundwater Intrusion Mitigation	Long Term	13%	0.7%	3	$1	$500,000	$700,000	$1,100,000
Treat all stormwater at Outfall 002	Long Term	40%	2.2%	5	$45	$68,000,000	$97,000,000	$150,000,000
Treat all flows at Outfall 002	Long Term	80%	4.4%	5	$39	$120,000,000	$170,000,000	$260,000,000

Alternatives	Reductions to the Cape Fear River Scoring	Adverse Environmental Effects Scoring	Technological Feasibility Scoring	Time Scoring	Cost per Loading Removal Scoring
Conveyance Network Sediment Removal	5	1	1	1	NA[1]
Stormwater Pollution Prevention Plan	5	1	1	2	NA[1]
Targeted Stormwater Control	5	1	2	4	NA[2]
Terracotta Pipe Decommisioning	5	1	2	2	NA[3]
Groundwater Intrusion Mitigation	5	1	2	3	1
Treat all stormwater at Outfall 002	4	1	4	4	5
Treat all flows at Outfall 002	4	1	2	4	5

Notes:

1 - Reduction estimates could not be determined at present for conveyance network sediment removal and a Stormwater Pollution Prevention Plan, but they will be less than the calculated total Outfall Loading to the Cape Fear River, 5.5%.

2 - Costing for targeted stormwater control is being developed based on assessment of stormwater loadings at the facility and testing and evaluation of potential control approaches.

3 - Cost of terracotta pipe decommisioning and replacement is not included in this assessment since it is being performed for operational reasons at the Site, but does have some benefit for Cape Fear River Reductions.

O&M - Operation and Maintenance

NPV - Net Present Value

- Estimated reductions to the Cape Fear River were derived by averaging the estimated Outfall 002 loadings to the river for the May and June Mass Loading Model sampling events as described in the August 26, 2019 Reductions Plan (Geosyntec, 2019).

4.5 Willis Creek and Georgia Branch Creek

Remedial alternatives considered for Willis Creek and Georgia Branch Creek that could potentially reduce loadings to the Cape Fear River within a five-year timeframe are listed below and the assessment presented in Table 8:

- Alternative A: Treatment of Onsite Black Creek Aquifer groundwater prior to discharging to Willis Creek;
- Alternative B: Treatment of all flows at the mouths of the creeks; and
- Alternative C: Application of PlumeStop™ along the length of each creek

For Alternative A, an onsite Black Creek Aquifer groundwater remedy is described in more detail in Section 4.3. This option was selected for further evaluation.

For Alternative B, treating all flows at the mouths of the creeks was not advanced. It would be disruptive to the local habitat, alter local wildlife patterns and challenging to construct (e.g., obtaining access to private lands) in the desired timeframe. These remedies were also not advanced since they do not provide reductions commensurate with their cost and were thus economically infeasible. Order of magnitude costs were $86,000,000 and $84,000,000 for Willis and Georgia Branch Creek, respectively, over a 20-year period, or expressed another way, $12,000,000 and $24,000,000 per loading percentage reduction to the Cape Fear River. As shown in Figure 21 and Figure 22 and described below in Section 0, these two remedies have vastly diminishing returns compared to proposed and provisional remedies.

For Alternative C, Applying PlumeStop™ to the length of the Creeks was also not advanced. While hypothetically this option could reduce PFAS loadings to each creek and by extension the Cape Fear River, the option would be challenging and have significant potential future issues. First, this option would disrupt local ecosystems along the length of each creek. Second, the sorptive capacity of PlumeStop™ diminishes over time and less strongly sorbing compounds would begin to desorb at greater rates than they had initially accumulated and reach the stream. Last, the costs and value for applying this option were not commensurate with its benefits. Screening level order of magnitude costs that were developed estimate that costs could be $1,500,000,000 for Willis Creek and $990,000,000 for Georgia Branch Creek or expressed another way, $240,000,000 and $310,000,000 per loading percentage reduction to the Cape Fear River.

Table 8: Assessment of Willis and Georgia Branch Creek Alternatives

Alternatives	Interim / Long Term	Estimated Reductions to Creek	Estimated Reductions to the Cape Fear River	Estimated Time to Implement (years)	Millions of Dollars per Percentage River Reduction	Conceptual Estimated Construction and 20 Year O&M NPV Value For Remedy Comparison Purposes		
						-30%	Base Case	50%
Treating all Flows at Willis Creek Mouth	Long Term	0%	7%	5	$12	$60,000,000	$86,000,000	$130,000,000
Treating all Flows at Georgia Branch Creek Mouth	Long Term	0%	3%	5	$24	$59,000,000	$84,000,000	$130,000,000
PlumeStop™ along full Willis Creek Length	Long Term	90%	6%	9	$240	$1,100,000,000	$1,500,000,000	$2,300,000,000
PlumeStop™ along full Georgia Branch Creek Length	Long Term	90%	3%	9	$310	$690,000,000	$990,000,000	$1,500,000,000
Onsite Groundwater Willis Creek Reductions	Long Term	65%	5%	5	--	--	--	--

Alternatives	Reductions to the Cape Fear River Scoring	Adverse Environmental Effects Scoring	Technological Feasibility Scoring	Time Scoring	Cost per Loading Removal Scoring
Treating all Flows at Willis Creek Mouth	3	3	3	4	5
Treating all Flows at Georgia Branch Creek Mouth	4	3	3	4	5
PlumeStop™ along full Willis Creek Length	3	3	5	5	5
PlumeStop™ along full Georgia Branch Creek Length	4	3	5	5	5
Onsite Groundwater Willis Creek Reductions	1	2	3	4	--

Notes:

O&M - Operation and Maintenance

NPV - Net Present Value

- Estimated reductions to the Cape Fear River from Willis Creek and Georgia Branch Creek Alternatives were derived from the average loadings for each creek using the May and June Mass Loading Model sampling events loadings as described in the August 26, 2019 Reductions Plan (Geosyntec, 2019). Total reductions were calculated using the following values:
    - Treatment of waters from the creeks are assumed to remove 99% of loadings;
    - PlumeStop applied to the creeks is assumed to reduce 90% of the loadings;
    - Willis Creek represents 7% of loading to the river, onsite groundwater represents 68% of loading to Willis Creek; and
    - Groundwater remedies are assumed able to reduce pathways loadings by 95%.

While no offsite alternative was advanced for either creek, both creeks will overtime have declining PFAS concentrations as a result of air control technology improvements to reduce aerial PFAS emissions from the Site. These actions will reduce aerial PFAS emissions by 99% leading to offsite aerial deposition reductions and consequently reductions over time in groundwater that discharges to these creeks.

4.6 Cost vs. Performance Assessment of Alternatives

The benefit of Cape Fear River PFAS loading reductions per alternative versus cost expended was assessed by dividing the base case estimated cost of each remedy by the estimated reductions to the Cape Fear River. These values are described in the subsections of this section and presented below in Table 9. To further assess the benefit of alternatives versus their costs, a cumulative cost and loading reduction scenario was evaluated by selecting alternatives for each pathway and then plotting the cumulative reductions to the Cape Fear River and the cumulative costs as remedies were added to the scenario. Proposed alternatives are those proposed in the August 26, 2019 Reduction Plan, while provisional alternatives are those where Chemours is advancing alternative selection. Also included in the evaluation are remedies not selected due to technological and economic infeasibility. These data are plotted in Figure 21 and Figure 22 and provided in Table 9.

The plot clearly shows that the presently proposed and provisional alternatives provide significantly more value for cost expended then alternatives not selected. Additionally, these proposed and provisional alternatives are projected to achieve considerable reductions in Total Table 3+ PFAS loadings to the Cape Fear River and surrounding creeks. Meanwhile remedies not selected for advancement have diminishing returns compared to proposed and provisional remedies.

Table 9: Cost Benefit Summary for Remedy Scenario Evaluation

Cost Benefit Evaluation Scenario Alternatives	Reduction to River per Remedy[1]	Conceptual / ROM Estimated Costs	Cost per percentage removed	Designation
A: Groundwater Extraction with Barrier Wall	23%	NA	NA	Proposed
B: Targeted Stormwater Control	1.3%	NA	NA	Proposed
C: Terracotta Pipe Decommisioning	0.1%	NA	NA	Proposed
D: Stormwater Pollution Prevention Plan	NQ	$500,000	NA	Proposed
E: Conveyance Network Sediment Removal	NQ	$230,000	NA	Provisional
F: Groundwater Intrusion Mitigation	1%	$700,000	$1,000,000	Proposed
G: Flow Through Cells - CFR Seeps	27%	$10,000,000	$400,000	Provisional
H: Capture and Treat Old Outfall 002	26%	$30,000,000	$1,200,000	Proposed
I: Treating all Flows at Georgia Branch Creek Mouth	3.5%	$84,000,000	$24,000,000	Not Selected
J: Treating all Flows at Willis Creek Mouth	6.9%	$86,000,000	$12,000,000	Not Selected
K: Treat all flows at Outfall 002	4.4%	$170,000,000	$39,000,000	Not Selected
L: Offsite Groundwater Extraction with Barrier Wall	11.5%	$1,900,000,000	$170,000,000	Not Selected

NA - Costing or estimated reductions not available.

ROM - Rough Order of Magnitude

1 - Estimated reductions to the Cape Fear River were estimated by averaging the estimated pathway contributions from the May and June Mass Loading Model sampling events as described in the August 26, 2019 Reductions Plan (Geosyntec, 2019) and then applying expected remedial alternative efficacy to each pathway as described in the assesements of the alternatives for each pathway in Tables 5 - 8 and Table 10.

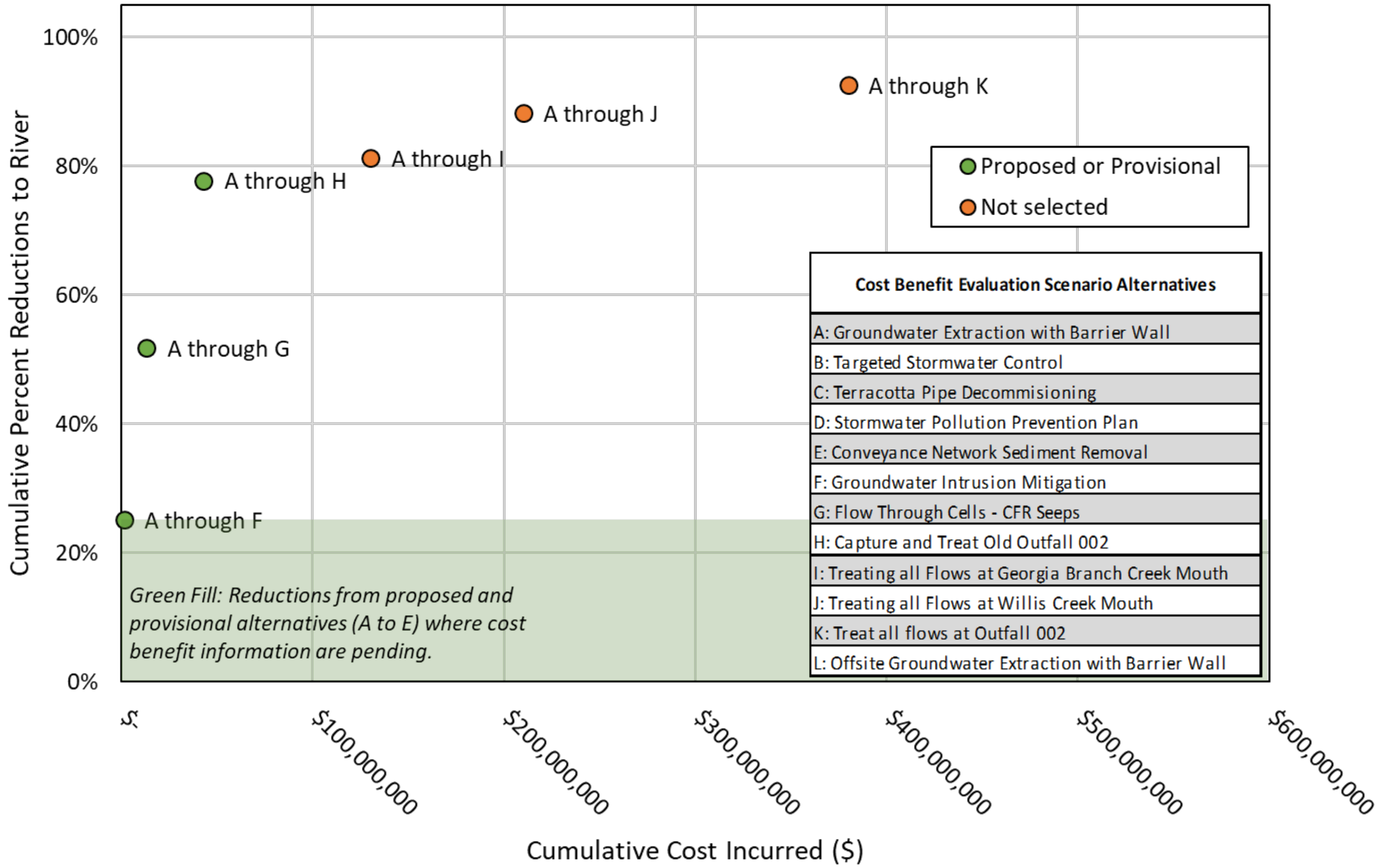

Figure 21: Cost-Benefit Analysis (Cumulative – Zoomed in x-axis extent) For Remedial Alternative with Conceptual Costs

Note: Data plotted are provided in Table 9

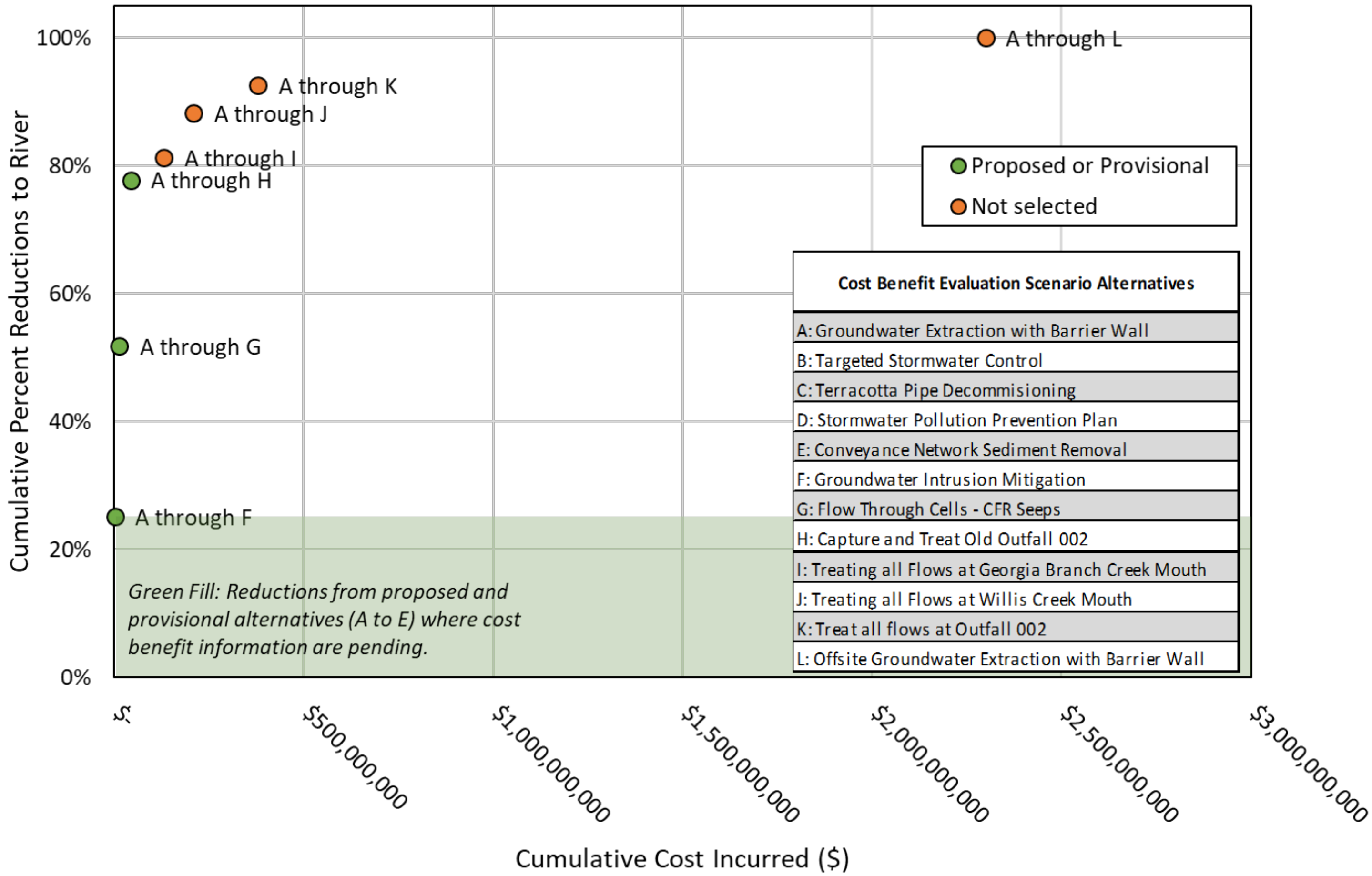

Figure 22: Cost-Benefit Analysis (Cumulative – Full x-axis extent) For Remedial Alternative with Conceptual Costs

Note: Data plotted are provided in Table 9

4.7 Offsite Groundwater

The remedial alternative considered for offsite groundwater was Alternative A: Offsite Groundwater Extraction with Barrier Wall. The assessment for this alternative is presented in Table 10. This alternative was not advanced. This alternative would be exceedingly complicated to implement as it would require access to numerous, contiguous private property parcels to build a wall that could stop groundwater flow. Additionally, the length of the wall and the size of the extraction systems would result in significant complexity to install and operate. The length of the wall built adjacent to the Cape Fear River would also be disruptive to local habitat and wildlife. Last, this remedy was not advanced since it does not provide reductions commensurate with its cost and was thus economically infeasible. The estimated order of magnitude costs was $1,900,000,000 (1.9 billion dollars) over a 20-year period, or expressed another way, $170,000,000 (170 million dollars) per loading percentage reduction to the Cape Fear River. As shown in Figure 22 and described in Section 0, this alternative has incredibly diminished returns compared to other proposed and provisional remedies for other pathways.

While no offsite groundwater alternative was advanced, over time offsite groundwater will have declining PFAS concentrations as a result of air control technology improvements to reduce aerial PFAS emissions from the Site. These actions will reduce aerial PFAS emissions by 99% leading to offsite aerial deposition reductions and consequently reductions over time in groundwater that discharges to the Cape Fear River.

Table 10: Assessment of Offsite Groundwater Alternative

Alternatives	Interim / Long Term	Estimated Potential Reductions to Other Water Bodies	Estimated Reductions to the Cape Fear River	Estimated Time to Implement (years)	Millions of Dollars per Percentage River Reduction	Conceptual Estimated Construction and 20 Year O&M NPV Value For Remedy Comparison Purposes		
						-30%	Base Case	50%
Offsite Groundwater Extraction with Barrier Wall	Long Term	--	11.5%	10	$190	$1,300,000,000	$1,900,000,000	$2,800,000,000

Alternatives	Reductions to the Cape Fear River Scoring	Adverse Environmental Effects Scoring	Technological Feasibility Scoring	Time Scoring	Cost per Loading Removal Scoring
Offsite Groundwater Extraction with Barrier Wall	2	4	5	5	5

Notes:

O&M - Operation and Maintenance

NPV - Net Present Value

- Estimated reductions to the Cape Fear River were derived by averaging the estimated offsite groundwater loadings to the river for the May and June Mass Loading Model sampling events as described in the August 26, 2019 Reductions Plan (Geosyntec, 2019).

5 PROPOSED SEEPS INTERIM ACTIONS AND ALTERNATIVE SELECTION SEQUENCE

This section describes the interim actions Chemours proposes to implement for groundwater Seeps A, B, C and D reaching the Cape Fear River at the Site. This section also describes how Chemours proposes to implement a long-term alternative.

5.1 Proposed Interim Actions

Chemours proposes to implement a combination of flow-through cells and ex situ capture using French drains. The flow-through cell interim actions would start at Seep A with implementation progressing successively through Seeps B and C where lessons learned from the construction and operation of the flow-through cells at the prior seeps would be used to design and operate the subsequent flow-through cells.

An ex-situ capture French drain would be installed at Seep D. This method, while more power intensive and disruptive to habitats does have a higher certainty for water treatment capabilities and would serve as a pilot location of this option.

- Seep A → Flow-Through cell – Phase 1
- Seep B → Flow-Through cell – Phase 2
- Seep C → Flow-Through cell – Phase 3
- Seep D → French Drain (to Old Outfall 002 treatment system)

5.2 Alternative Selection Sequence

Chemours proposes operating the interim seep actions for a period of two years during which the performance of each approach can be monitored and optimized. Then Chemours proposes selecting an approach as the long-term remedy. A combined schedule for implementation of the interim and long-term seep remedies is shown below in Table 11 (note that this sequence is generalized, and notable assumptions about permit and agency approvals are noted).

Table 11: Schedule for Proposed Interim Actions for Seeps

Task	Duration (months)	Year 1	Year 2	Year 3	Year 4	Year 5
Bench Scale Testing and Lab Analysis	2					
Design, Work Planning and Permitting (1)	2					
Agency Approvals (2)	2					
Clearing and Grubbing	1					
Access Road Construction	1					
Electrical Service	5					
Seep A Flow Through Cell Construction and Pilot	6					
Seep D French Drain Construction and Pilot	6					
Seeps B and C Flow Through Cells Construction	6					
Evaluation of Initial Performance at Seeps A - D	6					
Optimization/Replacement of Cells/Drains as Needed	12					
Ongoing Operations and Maintenance	18					

1- Permits include but may not be limited to 404/401 and NPDES

2 - Task timing is dependent upon agency approval timing

6 PROPOSED ONSITE GROUNDWATER INTERIM ACTIONS AND ALTERNATIVE SELECTION SEQUENCE

This section describes the interim action Chemours proposes to implement for onsite Black Creek Aquifer groundwater. Then this section describes how Chemours proposes to implement a long-term alternative.

6.1 Proposed Interim Actions

Chemours proposes extraction of groundwater from existing onsite wells as described in Section 3.4.1. This extraction would continue until a more permanent long-term remedy is operational unless otherwise improved, modified or demonstrated to be ineffective by subsequent analyses or evaluations.

6.2 Alternative Selection Sequence

Chemours's contractors are presently constructing a detailed numerical groundwater model to quantitatively evaluate Site groundwater flow. This groundwater model will be used to assess the efficacy and viability of groundwater alternatives under consideration and refine these proposed alternatives. Nevertheless, to address the requests from DEQ and CFRW a groundwater remedy similar in concept to that described in Section 3.4.4 (Barrier Wall and Groundwater Capture) will be utilized for this evaluation. A combined schedule for implementation of the interim and a long-term onsite groundwater alternative is shown below in Table 12 (note that this sequence is generalized, and notable assumptions about permit and agency approvals are noted).

Table 12: Implementation schedule for On-Site Groundwater

Task	Duration (months)	Year 1	Year 2	Year 3	Year 4	Year 5
Interim - Design and Work Planning for Pumping from Existing MWs	2					
Interim - Installation and Operation	6					
Contingent Action Based on Interim Performance Monitoring	12					
Numerical Modeling of Permanent Onsite GW Remedy	1					
Pre-Design Investigations	6					
Detailed Design and Permitting (1)	12					
Permits/ Agency Approvals (2)	12					
Contracting	3					
Drilling and Aquifer Pump Testing	6					
Sheet Pile Installation	20					
Trenching and Piping Installation	24					
System Installation	24					
Testing and Commissioning	12					

1- Permits include but may not be limited to 404/401 and NPDES

2 - Task timing is dependent upon agency approval timing

7 SUMMARY

This Supplemental Report describes the evaluation process for assessing potential remedies for the Site including: potential interim measures to reduce PFAS mass loadings from onsite seeps and onsite groundwater to the Cape Fear River on an accelerated timeframe; provisional remedial approaches under consideration and subject to more extensive evaluation to reduce onsite groundwater PFAS mass loading to the Cape Fear River; and remedial options that were considered but not advanced.

This remedial alternative evaluation used information developed in the mass loading model, which was based on two sampling events. Future sampling and updates may produce additional data. In addition, the Table 3+ PFAS compounds at the Site have only been recently considered for environmental remediation, and the availability of treatment technologies is limited at this time; this is a rapidly evolving field and new technologies may become available. Therefore, it is critical that the set of remedial alternatives considered for this Site be subject to enhancement over time based on continued improvement of the conceptual site model and emerging treatment technologies for Table 3+ PFAS.

Table 13 describes the estimated performance and tentative schedule for proposed interim remedies and initial conceptual designs for long-term remedial strategies as both are closely integrated.

The onsite groundwater remedy approaches presented here are provisional. Chemours's contactors have been preparing a numerical groundwater model to evaluate Site groundwater flows and will use this model to evaluate the technological feasibility of potential groundwater control options. The results of the model and the implications for the finalization of actions for expedited reductions of PFAS loadings to surface water will be provided in conjunction with the CAP that will be submitted by December 31, 2019.

The remedy screening and evaluation has been rigorous but also conducted under a compressed timeframe. Further, remedy selection may be adjusted to account for changing site conditions and adaptive management of a complex selection of remedies.

Table 13: Overall Estimated Reductions Plan Schedule and Reductions to Cape Fear River Total Table 3+ PFAS Loadings

Proposed and Provisional Remedial Alternatives	Loading Reduction	Duration (Years)	Year				
			1	2	3	4	5
Air Abatement Controls and Thermal Oxidizer[1]	<2%	1					
Conveyance Network Sediment Removal[2]	NQ[3]	1	✓				
Capture and Treat Old Outfall 002	26%	1					
Terracotta Pipe Replacement	0.1%	2					
Stormwater Pollution Prevention Plan	NQ[3]	2					
Groundwater Intrusion Mitigation	0.7%	2					
Interim Action - CFR Seeps	NQ[3]	2					
Interim Action - Onsite Groundwater	NQ[3]	1					
Targeted Stormwater Control	1.3%	4					
Ex Situ Capture and Treatment - CFR Seeps[4]	27%	4					
Onsite Groundwater Treatment[4]	23%	5					
Cumulative Estimated Total Table 3+ PFAS River Reductions to River[5]	78%	--	26%	27%	40%	53%	78%

Notes

- Schedule for multiple alternatives are dependent upon permitting requirements.
- Loading reductions are to the Cape Fear River
- Duration listed for implementation

1 - Scheduled implementation is December 31, 2019.
2 - Completed Octotber 2019.
3 - Anticipated reduction from action can not be quantified at present.
4 - Remedial alternatives and schedules are provisional at present as alternative selection is presently being performed.
5 - Cumulative estimated reductions assumes:
a) that reductions are achieved at the end of the implementation period;
b) that the time period for contingent actions is not needed; and
c) seeps capture reduction is 14% and 27% in Year 3 and 4 respectively.

Legend

Action Complete	✓
Planned Action Implementation Period	
Time Period for Contingent Actions	

8 REFERENCES

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

Geosyntec, 2019f. Summary of Grouting of East-West Section of Terracotta Pipe from Chemours Monomers IXM Area. August, 2019.

Parsons, 2019a. Chemours Fayetteville Engineering Alternatives Analysis (EAA) for NPDES Permit Application – Old Outfall 002 Discharge. July 2019.

Parsons, 2019b. Chemours Fayetteville Engineering Report on Wastewater Treatability. July 2019.

Parsons, 2019c. Chemours Fayetteville Engineering Report Old Outfall 002 GAC Pilot Study Results. September 2019.

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APPENDIX A

Remedy Costing Tables

APPENDIX A
Remedy Costing Tables

Preliminary cost estimates were developed to support the evaluation of remedial alternatives. Cost estimation can take a range of variations, and the relative accuracy of a cost reaches more clarity as final designs are prepared. For each proposed alternative, construction and annual operating costs (if applicable) are estimated. The cost is then normalized to a 20-year net present value using a 3.5% discount rate. Alternatives are estimated as -30 percent (%) to +50%.

As noted elsewhere, treatment technologies for PFAS compounds are an emerging field and as such there is more uncertainty than in more conventional treatment technologies. Many of the costs rely on the use of granular activated carbon, and this material is also subject to cost fluctuations, which may have significant impacts on total costs over time. There are new technologies emerging but these have not been tested on the Site associated PFAS and have not been included in this assessment.

Cost estimates are not intended for budgetary or future planning purposes.

The table below summarizes the Alternatives that have been proposed in the Supplemental Report

Page	Pathway	Potential Alternative	Interim (Y/N)	Report Section	Costing Evaluation
1	Old Outfall 002	Capture and Treat Old Outfall 002	N	3.2	Rough Order of Magnitude
2	Seeps	Flow Through Cells CFR Seeps	Y	3.3.1	Rough Order of Magnitude
3	Seeps	Ex Situ Capture French Drain and Treatment CFR Seeps	Y	3.3.2	Rough Order of Magnitude
4	Seeps	Plume Stop CFR Seeps A and B	Y	3.3.3	Conceptual
5	Seeps	Flow Through Cells CFR Seeps	N	3.3.4	Rough Order of Magnitude
6	Seeps	Flow Through Cells WC Seeps	N	3.3.4	Rough Order of Magnitude
7	Seeps	Ex Situ Capture and Treatment CFR Seeps	N	3.3.5	Rough Order of Magnitude
8	Seeps	PlumeStop WC Seeps	N	3.3.6	Conceptual
9	On-Site Groundwater	Extract from Black Creek Monitoring Wells	Y	3.4.1	Rough Order of Magnitude
10	On-Site Groundwater	Install New Black Creek Extraction Wells	Y	3.4.2	Rough Order of Magnitude
11	Outfall 002	Conveyance Network Sediment Removal	N	3.5.1	Rough Order of Magnitude
	Outfall 002	Targeted Stormwater Control	N	3.5.3	Rough Order of Magnitude
12	Outfall 002	Groundwater Intrusion Mitigation	N	3.5.5	Conceptual
13	Outfall 002	Treat all stormwater at Outfall 002	N	3.5.6	Rough Order of Magnitude
14	Outfall 002	Treat all flows at Outfall 002	N	3.5.7	Rough Order of Magnitude
15	Creeks	Treat all Flows at Willis Creek Mouth	N	3.6.1	Conceptual
16	Creeks	Treat all Flows at Georgia Branch Creek Mouth	N	3.6.1	Conceptual
17	Creeks	PlumeStop™ along Willis Creek Length	N	3.6.2	Conceptual
18	Creeks	PlumeStop™ along Georgia Branch Creek Length	N	3.6.2	Conceptual
19 & 20	Off-Site Groundwater	Groundwater Extraction with Barrier Wall	N	3.7.1	Conceptual

Rough Order of Magnitude Cost Estimate for Treatment at Old Outfall 002
Chemours Fayetteville Works, North Carolina

Basis of Cost Estimate (Scope and Assumptions):
Direct Discharge-750 gpm without Iron Removal, No Pre-Fab Building
Scaled costs used from 1000 gpm (Using six-tenths rule of cost estimation)

Item	Qty	Unit	Unit Cost	Total	Notes
Construction Costs					
Influent & Effluent Handling	Process Package		$ 108,000	$ 108,000	
Multi Media Filtration	Process Package		$ 331,000	$ 331,000	
Granular Activated Carbon	Process Package		$ 1,239,000	$ 1,239,000	
Solids Handling and Chemical Precipitation	Process Package		$ 1,074,000	$ 1,074,000	
Prefabricated Building & Containment Structure	Process Package		$ -	$ -	
Land Costs	Package		$ -	$ -	
Raw Construction Costs				$ 2,752,000	
Installation Cost (Construction, Site Preparation, Civil, Structural)	60%	of	Raw Construction Costs	$ 1,700,000	
Anciliary Cost (I&C, Piping-Mechanical & Electrical)	40%	of	Sum of Raw Construction Costs and Installation Cost	$ 1,800,000	
Total Construction Cost	Sum	of	Raw Construction Costs, Installation Cost and Anciliary Cost	$ 6,300,000	
Professional Services Costs					
Engineering and Project Management	12%	of	Total Construction Cost	$ 800,000	
Construction Management, Project Management, General Conditions	8%	of	Sum of Total Construction Cost, Engineering/PM & Contingency Costs	$ 800,000	
Professional Services Subtotal				$ 1,600,000	
Contingency	30%	of	Sum of Total Construction Cost and Engineering/PM cost	$ 2,200,000	
C_0, Construction Cost				**$ 10,100,000**	
+50%				$ 15,150,000	
-30%				$ 7,070,000	
Annual Operations & Maintenance Costs					
Electricity			$ 26,680	$ 26,680	
GAC Usage & Replacement			$ 552,000	$ 552,000	
Chemicals for treatment (Acid, Caustic, Ferric, Polymer)			$ 27,000	$ 27,000	
Solids Disposal			$ 25,000	$ 25,000	
Sampling & Analytical			$ 53,000	$ 53,000	
Operational Labor			$ 450,000	$ 450,000	
Equipment Maintenance			$ 237,000	$ 237,000	
Annual O&M Subtotal				$ 1,400,000	
C, Annual Cost				**$ 1,400,000**	
+50%				$ 2,100,000	
-30%				$ 980,000	
n, Years	**20**				
r, Discount Rate	**3.5%**				
Present Worth Formula	$PV = C_o + C\left[\frac{(1+r)^n - 1}{r(1+r)^n}\right]$				
Total: Present Worth Value of Construction & Annual O&M Costs over 20 Years				**$ 30,000,000**	
+50%				$ 45,000,000	
-30%				$ 21,000,000	

Costs are rough order of magnitude estimates, and assumed to represent the actual installed cost within a range of -30%/ +50% of the value indicated above. The estimates have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on final approved design, actual labor and material costs, and competitive variable factors. These estimates are not intended for budgetary or future planning purposes; they have been prepared to facilitate an inter-remedial alternative comparison.

Rough Order of Magnitude Cost Estimate for Interim Seep Flow Through Cells
Chemours Fayetteville Works, North Carolina

Basis of Cost Estimate (Scope and Assumptions):
IM: Seeps A, B, C, and D Flow Through Structures
See supporting document for treatment scenario, assumptions, and drawing

Item	Qty	Unit	Unit Cost	Total	Notes
Construction Costs					
Road Installation Along River	1	Lump	$ 500,000	$ 500,000	
Clearing, Grubbing, and Seep Access	4	Seep	$ 10,000	$ 40,000	
Sheet Pile Installation	1,800	ft^2	$ 40	$ 72,000	
Gabion Baskets and Frame (1 frame and 3 baskets per seep)	4	Seep	$ 6,200	$ 24,800	
First Install GAC Seep A	3,742	Pound	$ 1.75	$ 6,549	
First Install GAC Seep B	3,742	Pound	$ 1.75	$ 6,549	
First Install GAC Seep C	3,742	Pound	$ 1.75	$ 6,549	
First Install GAC Seep D	3,742	Pound	$ 1.75	$ 6,549	
Raw Construction Costs				$ 662,995	
Total Construction Cost	Sum	of	Raw Construction Costs, Installation Cost and Anciliary Cost	$ 700,000	
Professional Services Costs					
Engineering and Project Management	12%	of	Total Construction Cost	$ 100,000	
Construction Management, Project Management, General Conditions	18%	of	Sum of Total Construction Cost, Engineering/PM & Contingency Costs	$ 200,000	
Professional Services Subtotal				$ 300,000	
Contingency	30%	of	Sum of Total Construction Cost and Engineering/PM cost	$ 300,000	
C_0,Construction Cost				**$ 1,300,000**	
+50%				$ 1,950,000	
-30%				$ 910,000	
Annual Operations & Maintenance Costs					
GAC Usage & Replacement	97,297	pound	$ 1.75	$ 170,270	
GAC Changeout Equipment and Labor	12	event	$ 3,200.00	$ 38,400	
Brush clearing and Path Maintenance	12	monthly	$ 2,500	$ 30,000	
Solids Disposal	4	event	$ 640	$ 2,560	
Sampling & Analytical (monthly performance sampling)	12	month	$ 17,200	$ 206,400	
Operational Labor	4	event	$ 7,500	$ 30,000	
Equipment Maintenance	1	event	$ 5,000	$ 5,000	
Road Maintenance	1	event	$ 5,000	$ 5,000	
Storm Damage Repair and Gabion Replacement	1	event	$ 24,800	$ 24,800	
Annual Data Management and Performance Reporting	1	event	$ 35,000	$ 35,000	
Annual O&M Subtotal				$ 550,000	
C,Annual Cost				**$ 550,000**	
+50%				$ 825,000	
-30%				$ 385,000	

Costs are rough order of magnitude estimates, and assumed to represent the actual installed cost within a range of -30%/ +50% of the value indicated above. The estimates have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on final approved design, actual labor and material costs, and competitive variable factors. These estimates are not intended for budgetary or future planning purposes; they have been prepared to facilitate an inter-remedial alternative comparison.

Rough Order of Magnitude Cost Estimate for Interim
Seeps Ex Situ Capture using French Drains
Chemours Fayetteville Works, North Carolina

Basis of Cost Estimate (Scope and Assumptions):
IM: Seeps A, B, C, and D Capture and Treat using French Drains
See supporting document for treatment scenario, assumptions, and drawing

Item	Qty	Unit	Unit Cost	Total	Notes
Construction Costs					
Road Installation Along River	1	lump	$ 500,000	$ 500,000	
Treatment Plant Expansion to Handle Additional 300 gpm Flow	1	lump	$ 6,800,000	$ 6,800,000	
Pipeline and Power Installation Along River	5,900	linear ft	$ 29	$ 171,100	
Lift Station at south end	1	lump	$ 25,000	$ 25,000	
Clearing, Grubbing, and Seep Access	4	Seep	$ 10,000	$ 40,000	
French Drain Installation	1,440	ft^2	$ 42	$ 60,480	
Sump Pump Installation	4	Seep	$ 2,980	$ 11,920	
Feeder Electrical and discharge Line Seep A	800	linear ft	$ 29	$ 23,200	
Feeder Electrical and discharge Line Seep B	720	linear ft	$ 29	$ 20,880	
Feeder Electrical and discharge Line Seep C	670	linear ft	$ 29	$ 19,430	
Feeder Electrical and discharge Line Seep D	910	linear ft	$ 29	$ 26,390	
Raw Construction Costs				$ 7,698,400	
Total Construction Cost	Sum	of	Raw Construction Costs, Installation Cost and Anciliary Cost	$ 7,700,000	
Professional Services Costs					
Engineering and Project Management	12%	of	Total Construction Cost	$ 1,000,000	
Construction Management, Project Management, General Conditions	18%	of	Sum of Total Construction Cost, Engineering/PM & Contingency Costs	$ 2,100,000	
Professional Services Subtotal				$ 3,100,000	
Contingency	30%	of	Sum of Total Construction Cost and Engineering/PM cost	$ 2,700,000	
C_0,Construction Cost				**$ 13,500,000**	
+50%				$ 20,250,000	
-30%				$ 9,450,000	
Annual Operations & Maintenance Costs					
Electrical Power	25,000	lump		$ 25,000	
GAC Usage & Replacement	90,000	pound	$ 1.75	$ 157,500	
Brush clearing and Path Maintenance	12	monthly	$ 2,500	$ 30,000	
Solids Disposal	12	event	$ 320	$ 3,840	
Sampling & Analytical (monthly performance sampling)	12	month	$ 17,200	$ 206,400	
Operational Labor	12	event	$ 7,500	$ 90,000	
Equipment Maintenance	1	event	$ 11,900	$ 11,900	
Road, Pipe, and Power Maintenance	1	event	$ 35,000	$ 35,000	
Storm Damage Repair and Pump Replacement	1	event	$ 21,920	$ 21,920	
Annual O&M Subtotal				$ 590,000	
Annual Cost				**$ 590,000**	
+50%				$ 885,000	
-30%				$ 413,000	

Costs are rough order of magnitude estimates, and assumed to represent the actual installed cost within a range of -30%/ +50% of the value indicated above. The estimates have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on final approved design, actual labor and material costs, and competitive variable factors. These estimates are not intended for budgetary or future planning purposes; they have been prepared to facilitate an inter-remedial alternative comparison.

Conceptual Cost Estimate for PlumeStop Application to Seeps
Chemours Fayetteville Works, North Carolina

Basis of Cost Estimate (Scope and Assumptions):

Interim Measure (IM) for Seeps A and B

Plume Stop in Perched Zone (See Attached Diagram)

-5 year design life for PRB ; no reapplication

- Seep A 900 LF; treatment zone is proximately 8 to 18 feet bgs.
- Seep B 1,900 LF; treatment zone is aproximately 12 to 16 feet bgs.

Item	Qty	Unit	Unit Cost	Total	Notes
Construction Costs					
Design Verification Testing	LS		$ 120,000	$ 120,000	
Install Perfomrance Monitoring Wells	LS		$ 50,000	$ 50,000	
Regenesis Costs	LS		$ 7,000,000	$ 7,000,000	
				$ -	
				$ -	
Total Construction Cost				$ 7,170,000	
Professional Services Costs					
Engineering and Project Management	12%	of	Total Construction Cost	$ 900,000	
Construction Management, Project Management, General Conditions	18%	of	Sum of Total Construction Cost, Engineering/PM & Contingency Costs	$ 2,000,000	
Professional Services Subtotal				$ 2,900,000	
Contingency	30%	of	Sum of Total Construction Cost and Engineering/PM cost	$ 2,500,000	
C_0,Construction Cost				**$ 12,600,000**	
+50%				$ 18,900,000	
-30%				$ 8,820,000	
Annual Operations & Maintenance Costs					
Annual GW Sampling	LS		$ 100,000	$ 100,000	
Annual Reporting	LS		$ 30,000	$ 30,000	
				$ -	
				$ -	
				$ -	
				$ -	
				$ -	
Annual O&M Subtotal				$ 130,000	
C,Annual Cost				**$ 130,000**	
+50%				$ 195,000	
-30%				$ 91,000	

Costs are conceptual estimates, and assumed to represent the actual installed cost within a range of -30%/ +50% of the value indicated above. The estimates have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on final approved design, actual labor and material costs, and competitive variable factors. These estimates are not intended for budgetary or future planning purposes; they have been prepared to facilitate an inter-remedial alternative comparison.

Rough Order of Magnitude Cost Estimate for Permanent Seeps Flow Through Cells
Chemours Fayetteville Works, North Carolina

Basis of Cost Estimate (Scope and Assumptions):

Seeps A, B, C, and D Flow Through Structures

See supporting document for treatment scenario, assumptions, and drawing

Item	Qty	Unit	Unit Cost	Total	Notes
Construction Costs					
Road Installation Along River	1	Lump	$ 500,000	$ 500,000	
Clearing, Grubbing, and Seep Access	4	Seep	$ 10,000	$ 40,000	
Sheet Pile Installation	1,800	ft^2	$ 40	$ 72,000	
Gabion Baskets and Frame (1 frame and 3 baskets per seep)	4	Seep	$ 6,200	$ 24,800	
First Install GAC Seep A	3,742	Pound	$ 1.75	$ 6,549	
First Install GAC Seep B	3,742	Pound	$ 1.75	$ 6,549	
First Install GAC Seep C	3,742	Pound	$ 1.75	$ 6,549	
First Install GAC Seep D	3,742	Pound	$ 1.75	$ 6,549	
Raw Construction Costs				$ 662,995	
Total Construction Cost	Sum	of	Raw Construction Costs, Installation Cost and Anciliary Cost	$ 700,000	
Professional Services Costs					
Engineering and Project Management	12%	of	Total Construction Cost	$ 100,000	
Construction Management, Project Management, General Conditions	18%	of	Sum of Total Construction Cost, Engineering/PM & Contingency Costs	$ 200,000	
Professional Services Subtotal				$ 300,000	
Contingency	30%	of	Sum of Total Construction Cost and Engineering/PM cost	$ 300,000	
C_0,Construction Cost				**$ 1,300,000**	
+50%				$ 1,950,000	
-30%				$ 910,000	
Annual Operations & Maintenance Costs					
GAC Usage & Replacement	97,297	pound	$ 1.75	$ 170,270	
GAC Changeout Equipment and Labor	12	event	$ 3,200.00	$ 38,400	
Brush clearing and Path Maintenance	12	monthly	$ 2,500	$ 30,000	
Solids Disposal	4	event	$ 640	$ 2,560	
Sampling & Analytical (monthly performance sampling)	12	month	$ 17,200	$ 206,400	
Operational Labor	4	event	$ 7,500	$ 30,000	
Equipment Maintenance	1	event	$ 5,000	$ 5,000	
Road Maintenance	1	event	$ 5,000	$ 5,000	
Storm Damage Repair and Gabion Replacement	1	event	$ 24,800	$ 24,800	
Annual Data Management and Performance Reporting	1	event	$ 35,000	$ 35,000	
Annual O&M Subtotal				$ 550,000	
C,Annual Cost				**$ 550,000**	
+50%				$ 825,000	
-30%				$ 385,000	
n,Years	**20**				
r,Discount Rate	**3.5%**				
Present Worth Formula	$PV = C_0 + C\left[\frac{(1+r)^n - 1}{r(1+r)^n}\right]$				
Total: Present Worth Value of Construction & Annual O&M Costs over 20 Years				**$ 10,000,000**	
+50%				$ 15,000,000	
-30%				$ 7,000,000	

Costs are rough order of magnitude estimates, and assumed to represent the actual installed cost within a range of -30%/ +50% of the value indicated above. The estimates have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on final approved design, actual labor and material costs, and competitive variable factors. These estimates are not intended for budgetary or future planning purposes; they have been prepared to facilitate an inter-remedial alternative comparison.

Rough Order of Magnitude Cost Estimate for Willis Creek Seep Flow Through Cells
Chemours Fayetteville Works, North Carolina

Basis of Cost Estimate (Scope and Assumptions):
Willis Creek Seeps Flow Through Interim Measure
See supporting document for treatment scenario, assumptions, and location map

Item	Qty	Unit	Unit Cost	Total	Notes
Construction Costs					
Clearing, Grubbing, and Seep Access	3	Seep	$ 4,200	$ 12,600	
Hand Excavation of Seep Channels 5' long, 8" wide, 4" deep	3	Seep	$ 500	$ 1,500	
Geotube construction	3	geotube	$ 350	$ 1,050	
First Install GAC Seep A	94	Pound	$ 1.75	$ 165	
First Install GAC Seep B	94	Pound	$ 1.75	$ 165	
First Install GAC Seep C	94	Pound	$ 1.75	$ 165	
Raw Construction Costs				$ 15,644	
Total Construction Cost	Sum	of	Raw Construction Costs, Installation Cost and Anciliary Cost	$ 20,000	
Professional Services Costs					
Engineering and Project Management	12%	of	Total Construction Cost	$ 10,000	
Construction Management, Project Management, General Conditions	18%	of	Sum of Total Construction Cost, Engineering/PM & Contingency Costs	$ 10,000	
Professional Services Subtotal				$ 20,000	
Contingency	30%	of	Sum of Total Construction Cost and Engineering/PM cost	$ 10,000	
C_0,Construction Cost				**$ 50,000**	
+50%				$ 75,000	
-30%				$ 35,000	
Annual Operations & Maintenance Costs					
GAC Usage & Replacement	1,128	pound	$ 1.75	$ 1,974	
GAC Changeout Equipment and Labor	4	event	$ 3,200.00	$ 12,800	
Brush clearing and Path Maintenance	12	monthly	$ 1,500	$ 18,000	
Sampling & Analytical (quarterly performance sampling)	4	month	$ 13,600	$ 54,400	
Equipment Maintenance	1	event	$ 2,550	$ 2,550	
Annual O&M Subtotal				$ 90,000	
C,Annual Cost				**$ 90,000**	
+50%				$ 135,000	
-30%				$ 63,000	
n,Years	**20**				
r,Discount Rate	**3.5%**				
Present Worth Formula	$PV = C_0 + C\left[\frac{(1+r)^n - 1}{r(1+r)^n}\right]$				
Total: Present Worth Value of Construction & Annual O&M Costs over 20 Years				**$ 2,000,000**	
+50%				$ 3,000,000	
-30%				$ 1,400,000	

Costs are rough order of magnitude estimates, and assumed to represent the actual installed cost within a range of -30%/ +50% of the value indicated above. The estimates have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on final approved design, actual labor and material costs, and competitive variable factors. These estimates are not intended for budgetary or future planning purposes; they have been prepared to facilitate an inter-remedial alternative comparison.

Rough Order of Magnitude Cost Estimate for Seeps Permanent
Ex Situ Capture using French Drains
Chemours Fayetteville Works, North Carolina

Basis of Cost Estimate (Scope and Assumptions):
Seeps A, B, C, and D Capture and Treat using French Drains
See supporting document for treatment scenario, assumptions, and drawing

Item	Qty	Unit	Unit Cost	Total	Notes
Construction Costs					
Road Installation Along River	1	lump	$ 500,000	$ 500,000	
Treatment Plant Expansion to Handle Additional 300 gpm Flow	1	lump	$ 6,800,000	$ 6,800,000	
Pipeline and Power Installation Along River	5,900	linear ft	$ 29	$ 171,100	
Lift Station at south end	1	lump	$ 25,000	$ 25,000	
Clearing, Grubbing, and Seep Access	4	Seep	$ 10,000	$ 40,000	
French Drain Installation	1,440	ft^2	$ 42	$ 60,480	
Sump Pump Installation	4	Seep	$ 2,980	$ 11,920	
Feeder Electrical and discharge Line Seep A	800	linear ft	$ 29	$ 23,200	
Feeder Electrical and discharge Line Seep B	720	linear ft	$ 29	$ 20,880	
Feeder Electrical and discharge Line Seep C	670	linear ft	$ 29	$ 19,430	
Feeder Electrical and discharge Line Seep D	910	linear ft	$ 29	$ 26,390	
Raw Construction Costs				$ 7,698,400	
Total Construction Cost	Sum	of	Raw Construction Costs, Installation Cost and Anciliary Cost	$ 7,700,000	
Professional Services Costs					
Engineering and Project Management	12%	of	Total Construction Cost	$ 1,000,000	
Construction Management, Project Management, General Conditions	18%	of	Sum of Total Construction Cost, Engineering/PM & Contingency Costs	$ 2,100,000	
Professional Services Subtotal				$ 3,100,000	
Contingency	30%	of	Sum of Total Construction Cost and Engineering/PM cost	$ 2,700,000	
C_0,Construction Cost				**$ 13,500,000**	
+50%				$ 20,250,000	
-30%				$ 9,450,000	
Annual Operations & Maintenance Costs					
Electrical Power	25,000	lump		$ 25,000	
GAC Usage & Replacement	90,000	pound	$ 1.75	$ 157,500	
Brush clearing and Path Maintenance	12	monthly	$ 2,500	$ 30,000	
Solids Disposal	12	event	$ 320	$ 3,840	
Sampling & Analytical (monthly performance sampling)	12	month	$ 17,200	$ 206,400	
Operational Labor	12	event	$ 7,500	$ 90,000	
Equipment Maintenance	1	event	$ 11,900	$ 11,900	
Road, Pipe, and Power Maintenance	1	event	$ 35,000	$ 35,000	
Storm Damage Repair and Pump Replacement	1	event	$ 21,920	$ 21,920	
Annual O&M Subtotal				$ 590,000	
Annual Cost				**$ 590,000**	
+50%				$ 885,000	
-30%				$ 413,000	
n,Years	**20**				
r,Discount Rate	**3.5%**				
Present Worth Formula	$PV = C_o + C\left[\frac{(1+r)^n - 1}{r(1+r)^n}\right]$				
Total: Present Worth Value of Construction & Annual O&M Costs over 20 Years				**$ 22,000,000**	
+50%				$ 33,000,000	
-30%				$ 15,400,000	

Costs are rough order of magnitude estimates, and assumed to represent the actual installed cost within a range of -30%/ +50% of the value indicated above. The estimates have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on final approved design, actual labor and material costs, and competitive variable factors. These estimates are not intended for budgetary or future planning purposes; they have been prepared to facilitate an inter-remedial alternative comparison.

Conceptual Cost Estimate for PlumeStop Application to Willis Creek Seeps
Chemours Fayetteville Works, North Carolina

Basis of Cost Estimate (Scope and Assumptions):

Interim Measure (IM) for Willis Creek

Plume Stop in Surficial Zone (See Attached Diagram)

-20 year design life for PRB ; no reapplication

- WC-1 Seep 700LF, treatment zone is proximately 5 to 30 feet bgs.
- WC-2 & 3 Seeps 1,200 LF; treatment zone is aproximately 5 to 10 feet bgs.
- WC-4 Seep 700 LF; treatment zone is aproximately 5 to 10 feet bgs.

Item	Qty	Unit	Unit Cost	Total	Notes
Construction Costs					
Design Verification Testing	LS		$ 200,000	$ 200,000	
Install Perfomrance Monitoring Wells	LS		$ 100,000	$ 100,000	
Regenesis Costs	LS		$ 28,000,000	$ 28,000,000	Quote from Regenesis
				$ -	
				$ -	
Total Construction Cost				$ 28,300,000	
Professional Services Costs					
Engineering and Project Management	12%	of	Total Construction Cost	$ 3,400,000	
Construction Management, Project Management, General Conditions	18%	of	Sum of Total Construction Cost, Engineering/PM & Contingency Costs	$ 7,500,000	
Professional Services Subtotal				$ 10,900,000	
Contingency	30%	of	Sum of Total Construction Cost and Engineering/PM cost	$ 9,600,000	
C_0,Construction Cost				**$ 48,800,000**	
+50%				$ 73,200,000	
-30%				$ 34,160,000	
Annual Operations & Maintenance Costs					
Annual GW Sampling	LS		$ 100,000	$ 100,000	
Annual Reporting	LS		$ 30,000	$ 30,000	
				$ -	
				$ -	
				$ -	
				$ -	
				$ -	
Annual O&M Subtotal				$ 130,000	
C,Annual Cost				**$ 130,000**	
+50%				$ 195,000	
-30%				$ 91,000	
n,Years	**20**				
r,Discount Rate	**3.5%**				
Present Worth Formula	$PV = C_o + C\left[\frac{(1+r)^n - 1}{r(1+r)^n}\right]$				
Total: Present Worth Value of Construction & Annual O&M Costs over 20 Years				**$ 51,000,000**	
+50%				$ 76,500,000	
-30%				$ 35,700,000	

Costs are conceptual estimates, and assumed to represent the actual installed cost within a range of -30%/ +50% of the value indicated above. The estimates have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on final approved design, actual labor and material costs, and competitive variable factors. These estimates are not intended for budgetary or future planning purposes; they have been prepared to facilitate an inter-remedial alternative comparison.

Rough Order of Magnitude Cost Estimate for Interim Groundwater Extraction from Existing Black Creek Monitoring Wells Chemours Fayetteville Works, North Carolina

Basis of Cost Estimate (Scope and Assumptions):

Extract GW from seven existing black creek monitoring wells for treatment
- BCA-01, PW-15R, PW-14, BCA-02, PIW-09D, PW-10DR, PW-11
- Assumes OOF2 Treatment Plant has excess capacity
- No NPDES permitting required (covered by OOF2)
- Assumes 2 gpm per well (14 gpm total)

Item	Qty	Unit	Unit Cost	Total	Notes
Construction Costs					
Clearing and Grubbing	1	Acre	$ 10,000	$ 10,000	
Subsurface Trenching/Piping - 0.5-inch (Installed)	850	Feet	$ 22	$ 18,700	
Subsurface Trenching/Piping - 1-inch (Installed)	3950	Feet	$ 24	$ 94,800	
Subsurface Trenching/Piping - 2-inch (Installed)	1900	Feet	$ 29	$ 55,100	
Subsurface Trenching Conduit (Installed)	6700	Feet	$ 6	$ 40,200	
Sumbersible Pumps & Controls (Installed)	7	EA	$ 10,000	$ 70,000	
Valve Boxes/Vaults	7	EA	$ 3,000	$ 3,000	
Total Construction Cost				$ 291,800	
Professional Services Costs					
Engineering and Project Management	12%	of	Total Construction Cost	$ 100,000	
Construction Management, Project Management, General Conditions	18%	of	Sum of Total Construction Cost, Engineering/PM & Contingency Costs	$ 200,000	
Professional Services Subtotal				$ 300,000	
Contingency	30%	of	Sum of Total Construction Cost and Engineering/PM cost	$ 200,000	
C_0,Construction Cost				**$ 800,000**	
+50%				$ 1,200,000	
-30%				$ 560,000	
Annual Operations & Maintenance Costs					
Electricity	LS		$ 5,000	$ 5,000	
Operational Labor	LS		$ 58,240	$ 58,240	
Equipment Maintenance	LS		$ 5,000	$ 5,000	
				$ -	
				$ -	
				$ -	
				$ -	
Annual O&M Subtotal				$ 68,240	
C,Annual Cost				**$ 70,000**	
+50%				$ 102,000	
-30%				$ 48,000	

Costs are rough order of magnitude estimates, and assumed to represent the actual installed cost within a range of -30%/ +50% of the value indicated above. The estimates have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on final approved design, actual labor and material costs, and competitive variable factors. These estimates are not intended for budgetary or future planning purposes; they have been prepared to facilitate an inter-remedial alternative comparison.

Rough Order of Magnitude Cost Estimate for Interim Groundwater Extraction from Additional Black Creek Extraction Wells Chemours Fayetteville Works, North Carolina

Basis of Cost Estimate (Scope and Assumptions):

Installation of additional wells to enhance pumping from onsite Black Creek aquifer wells.
The baseline interim remedy includes 7 existing monitoring wells, 2 gpm each, for a total of 14 gpm to the OOF2 Treatment Plant.
This remedy would enhance this baseline interim remedy by installing 7 additional wells to an average depth of 140 ft bgs each.
It is assumed that the new 6" diameter wells would produce 10 gpm each, and that the OOF2 Treatment Plant will have the excess capacity.
Some cost efficiencies would result from a common trench alignment (clearing/grubbing, etc.).
Wells for each treatment section will convey groundwater under pressure in a common force main up to the system.
Piping will be HDPE and trenches will be approximately 3 feet deep, and reuse of excacated soils as backfill will be permitted.
HDPE pipe sizes range from 2 to 4 inch diameter SDR 11.
Includes a 20-year net present value cost with a 3.5% discount factor applied.

Item	Qty	Unit	Unit Cost	Total	Notes
Construction Costs					
Drilling Costs					
Driller mobilization	1	LS	$ 5,000	$ 5,000	Engineer's Estimate
Extraction Wells drilling and well installation (no appurtenances)	980	LF	$ 225	$ 220,500	Engineer's Estimate
IDW	980	LF	$ 10	$ 9,800	Engineer's Estimate
Drilling Subtotal				$ 235,300	
Site Work Costs					
Subsurface Trenching/Piping - 2-inch (Installed)	1,500	LF	$ 29.00	$ 43,500	Engineer's Estimate
Subsurface Trenching/Piping - 3-inch (Installed)	3,500	LF	$ 36.00	$ 126,000	Engineer's Estimate
Subsurface Trenching/Piping - 4-inch (Installed)	2,000	LF	$ 45.00	$ 90,000	Engineer's Estimate
Subsurface Trenching Conduit (installed)	7,000	LF	$ 6.00	$ 42,000	
Sumbersible Pumps & Controls (Installed)	7	EA	$ 10,000.00	$ 70,000	Engineer's Estimate
Valve Boxes/Vaults	7	EA	$ 15,000.00	$ 105,000	Engineer's Estimate
Site Work Subtotal				$ 476,500	
Total Construction Costs				$ 711,800	
Professional Services Costs					
Modeling, Design, Work Planning	12%	of	$ 711,800	$ 85,416	adapted from EPA Guidance
Construction Oversight	8%	of	$ 711,800	$ 56,944	adapted from EPA Guidance
Project Management	6%	of	$ 711,800	$ 42,708	adapted from EPA Guidance
Professional Services Subtotal				$ 185,068	
Contingency	30%	of	$ 896,868	$ 269,060.40	
Construction Cost				**$ 1,000,000**	
+50%				$ 1,500,000	
-30%				$ 700,000	
Annual Operations & Maintenance Costs					
Electricity	1	LS	$ 25,000	$ 25,000	
Operational Labor	1	LS	$ 100,000	$ 100,000	
Equipment Maintenance	1	LS	$ 25,000	$ 25,000	
Annual O&M Subtotal				$ 150,000	
Annual Cost				**$ 150,000**	
+50%				$ 225,000	
-30%				$ 105,000	

Costs are rough order of magnitude estimates, and assumed to represent the actual installed cost within a range of -30%/ +50% of the value indicated above. The estimates have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on final approved design, actual labor and material costs, and competitive variable factors. These estimates are not intended for budgetary or future planning purposes; they have been prepared to facilitate an inter-remedial alternative comparison.

Rough Order of Magnitude Cost Estimate for Conveyance Network Sediment Removal
Chemours Fayetteville Works, North Carolina

Basis of Cost Estimate (Scope and Assumptions):

Sediment removal from the IXM Monomers cooling water channel and the open channel to Outfall 002 (design input values below).
As a simplifying assumption, it is assumed that the sediment will be removed with vacuum trucks.
Long-reach excavators may also be used where practical.
The vacuum trucks will have 2,500 gallon capacity and will mobilize from 1-hr away.
The vacuum trucks will remove sediment at a rate of 2,500 gal/day (one truck per day). Excavator will support each day.
The vacuum trucks/excavators will deposit the media into containment areas onsite, and waste profiling will be conducted on the collected material.
It is assumed that ultimately the media will be loaded for transport to the WM facility in Emelle, Alabama for disposal as hazardous waste
Disposal costs are sourced from Eddie Vega at the Fayetteville Works facility.
This estimate assumes the sediment removal effort will not need to be repeated, hence no annual costs.

Design Inputs

Cooling Water Channel

Item	Value	Units	Notes
Length	2,825	ft	Scaled from site maps
Width	5	ft	Scaled from site maps
Average Sediment Depth	0.167	ft	Assumed
Sediment Volume	2,354	ft3	Calculated
Sediment Volume	17,610	gal	Converted
Sediment Density	0.064	ton/ft3	Assumed
Mass of Sediment	151	tons	Calculated

Open Channel

Item	Value	Units	Notes
Length	3,000	ft	Scaled from site maps
Width	10	ft	Scaled from site maps
Average Sediment Depth	0.167	ft	Assumed
Sediment Volume	5,000	ft3	Calculated
Sediment Volume	37,403	gal	Converted
Sediment Density	0.064	ton/ft3	Assumed
Mass of Sediment	320	tons	Calculated

Item	Qty	Unit	Unit Cost	Total	Notes
Construction Costs					
Vac truck operation, incl. mob/demob and onsite	11	day	$ 1,500	$ 16,504	average of CCI and HERR
Excavator operation, incl. mob/demob and onsite	11	day	$ 1,500	$ 16,504	Engineer's estimate
Characterization and profiling	1	LS	$ 5,000	$ 5,000	Engineer's estimate
Transportation to Emelle as haz waste	471	ton	$ 175	$ 82,352	current rates per Chemours
Haz disposal	471	ton	$ 71	$ 33,411	current rates per Chemours
Construction Costs				$ 153,771	
Professional Services Costs					
Design, Work Planning, and Permitting	1	LS	$ 10,000	$ 10,000	Engineer's estimate
Construction Oversight	1	LS	$ 5,000	$ 5,000	Engineer's estimate
Project Management	1	LS	$ 5,000	$ 5,000	Engineer's estimate
Professional Services Subtotal				$ 20,000	
Contingency	30%	of	$ 173,771	$ 52,131	
Construction Cost				**$ 230,000**	
+50%				$ 345,000	
-30%				$ 161,000	
Annual Operations & Maintenance Costs					
None				$ -	
Annual O&M Subtotal				$ -	
Annual Cost				**$ -**	
+50%				$ -	
-30%				$ -	
Years	**20**				
Discount Rate	**3.5%**				
Net Present Value (NPV) of Annual Costs over 20 Years				**$ -**	
+50%				$ -	
-30%				$ -	
Total Cost - Construction and Annual O&M					
Total: Conceptual + NPV of Annual Costs over 20 Years				**$ 230,000**	
+50%				$ 345,000	
-30%				$ 161,000	

Costs are rough order of magnitude estimates, and assumed to represent the actual installed cost within a range of -30%/ +50% of the value indicated above. The estimates have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on final approved design, actual labor and material costs, and competitive variable factors.
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Conceptual Cost Estimate for Mitigation of Groundwater Intrusion into Outfall 002
Chemours Fayetteville Works, North Carolina

Basis of Cost Estimate (Scope and Assumptions):

DuPont's non-contact cooling water (NCCW) and steam condensate currently discharge to unlined channels and are suspected to primarily infiltrate into the ground.
This alternative involves the collection of this NCCW and condensate and transmission directly to the Open Channel to Outfall 002.
Objective of the diversion of water is to mitigate high groundwater head in the DuPont area which is a possible cause of groundwater intrusion in the Open Channel.
It is assumed that 8 point discharges from the DuPont area will need to be connected to new piping, and trenched underground to the Open Channel about 500 LF.
It is assumed that the conveyance pipes on average will be 6-inch diameter and constructed of HDPE.
Professional services include NPDES modification.

Item	Qty	Unit	Unit Cost	Total	Notes
Construction Costs					
Subcontractor Installation Costs-Piping 6"	4,000	LF	$ 75.00	$ 300,000	
HDPE SDR 11 - 6"	4,000	LF	$ 8.43	$ 33,705	
HDPE fusing and fittings	1	LS	$ 10,000.00	$ 10,000	
Discharge connection to Open Channel	1	LS	$ 50,000.00	$ 50,000	
Site restoration	1	LS	$ 10,000.00	$ 10,000	
Construction Costs				$ 403,705	
Professional Services Costs					
Design, Work Planning, and Permitting (including NPDES)	15%	of	$ 403,705	$ 60,556	EPA FS Guidance
Construction Oversight	10%	of	$ 403,705	$ 40,371	EPA FS Guidance
Project Management	8%	of	$ 403,705	$ 32,296	EPA FS Guidance
Professional Services Subtotal				$ 133,223	
Contingency	30%	of	$ 536,928	$ 161,078	
Construction Cost				**$ 700,000**	
+50%				$ 1,050,000	
-30%				$ 490,000	
Annual Operations & Maintenance Costs					
None				$ -	
Annual O&M Subtotal				$ -	
Annual Cost				**$ -**	
+50%				$ -	
-30%				$ -	
Years	**20**				
Discount Rate	**3.5%**				
Net Present Value (NPV) of Annual Costs over 20 Years				**$ -**	
+50%				$ -	
-30%				$ -	
Total Cost - Construction and Annual O&M					
Total: Capital + NPV of Annual Costs over 20 Years				**$ 700,000**	
+50%				$ 1,050,000	
-30%				$ 490,000	

Costs are conceptual estimates, and assumed to represent the actual installed cost within a range of -30%/ +50% of the value indicated above. The estimates have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on final approved design, actual labor and material costs, and competitive variable factors.
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Rough Order of Magnitude Cost Estimate for Treatment of All Stormwater at Outfall 002
Chemours Fayetteville Works, North Carolina

Basis of Cost Estimate (Scope and Assumptions):

Standard Factored Costs were assumed as follows:

- Installation Cost (Including Civil/Structural) = 75% of Equipment Cost;
- Ancillary Cost (I&C, Piping-Mechanical & Electrical) = 30% of Sum of Equipment & Installed Construction Costs;
- Engineering Cost = 12% of the sum of Equipment, Installation & Ancillary Costs;
- Contingency Cost = 30% of the sum of Equipment, Installation, Engineering & Ancillary Costs; and
- CM Cost & General Conditions = 18% of the sum of Equipment, Installation, Engineering, Ancillary Cost & Contingency Costs.

Considerations and assumptions:

- The influent flow from the equalization tank is assumed to be consistent.
- Major process equipment is assumed to be installed within a pre-engineered building.
- The chemical precipitation and solids processing systems are sized to only remove accumulated solids contained in the backwash.
- PFMOAA influent concentration of 4,672 ng/l has been assumed, per data provided by Geosyntec.
- It is assumed that 95% removal of PFMOAA is required and PFMOAA is the driving influent COC for GAC utilization

Item	Qty	Unit	Unit Cost	Total	Notes
Construction Costs					
Influent & Effluent Handling	Process Package		$ 6,700,000	$ 6,700,000	Parsons
Multi Media Filtration	Process Package		$ 950,000	$ 950,000	Parsons
Granular Activated Carbon	Process Package		$ 2,400,000	$ 2,400,000	Parsons
Solids Handling and Chemical Precipitation	Process Package		$ 600,000	$ 600,000	Parsons
Prefabricated Building & Containment Structure	Process Package		$ 5,500,000	$ 5,500,000	Parsons
Separation of Stormwater and Non Contact Cooling Water	NA		$ 2,000,000	$ 2,000,000	Chemours
Raw Construction Costs				$ 18,200,000	
Installation Cost (Construction, Site Preparation, Civil, Structural)	75%	of	Raw Construction Costs	$ 13,700,000	Parsons
Anciliary Cost (I&C, Piping-Mechanical & Electrical)	30%	of	Sum of Raw Construction Costs and Installation Cost	$ 9,570,000	Parsons
Total Construction Cost	Sum	of	Raw Construction Costs, Installation Cost and Anciliary Cost	$ 41,500,000	
Professional Services Costs					
Engineering and Project Management	12%	of	Total Construction Cost	$ 5,000,000	Parsons
Construction Management, Project Management, General Conditions	18%	of	Sum of Total Construction Cost, Engineering/PM & Contingency Costs	$ 10,900,000	Parsons
Professional Services Subtotal				$ 15,900,000	
Contingency	30%	of	Sum of Total Capital & Construction Cost and Engineering/PM cost	$ 14,000,000	
C_0, Construction Cost				**$ 71,400,000**	
+50%				$ 107,100,000	
-30%				$ 49,980,000	
Annual Operations & Maintenance Costs					
Electricity			$ 60,000	$ 60,000	Parsons
GAC Usage & Replacement			$ 110,000	$ 110,000	Parsons
Chemicals for treatment (Acid, Caustic, Ferric, Polymer)			$ 90,000	$ 90,000	Parsons
Solids Disposal			$ 120,000	$ 120,000	Parsons
Sampling & Analytical			$ 75,000	$ 75,000	Parsons
Operational Labor			$ 900,000	$ 900,000	Parsons
Equipment Maintenance			$ 380,000	$ 380,000	Parsons
Annual O&M Subtotal				$ 1,800,000	
C, Annual Cost				**$ 1,800,000**	
+50%				$ 2,700,000	
-30%				$ 1,260,000	
n, Years	**20**				
r, Discount Rate	**3.5%**				
Present Worth Formula	$PV = C_o + C\left[\frac{(1+r)^n - 1}{r(1+r)^n}\right]$				
Total: Present Worth Value of Construction & Annual O&M Costs over 20 Years				**$ 97,000,000**	
+50%				$ 145,500,000	
-30%				$ 67,900,000	

Costs are rough order of magnitude estimates, and assumed to represent the actual installed cost within a range of -30%/ +50% of the value indicated above. The estimates have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on final approved design, actual labor and material costs, and competitive variable factors. These estimates are not intended for budgetary or future planning purposes; they have been prepared to facilitate an inter-remedial alternative comparison.

Rough Order of Magnitude Cost Estimate for Treatment of All Flows at Outfall 002
Chemours Fayetteville Works, North Carolina

Basis of Cost Estimate (Scope and Assumptions):

Standard Factored Costs were assumed as follows:
- Installation Cost (Including Civil/Structural) = 75% of Equipment Cost;
- Ancillary Cost (I&C, Piping-Mechanical & Electrical) = 30% of Sum of Equipment & Installed Construction Costs;
- Engineering Cost = 12% of the sum of Equipment, Installation & Ancillary Costs;
- Contingency Cost = 30% of the sum of Equipment, Installation, Engineering & Ancillary Costs; and
- CM Cost & General Conditions = 18% of the sum of Equipment, Installation, Engineering, Ancillary Cost & Contingency Costs.

Considerations and assumptions:
- The influent flow is assumed to be consistent. The treatment design flowrate is based on reasonable assumptions regarding the site permeability and Geosyntec's rainfall modelling data.
- PFMOAA influent concentration of 232 ng/l has been assumed, per data provided by Geosyntec.
- Major process equipment is assumed to be installed within a pre-engineered building.
- Stormwater and dry weather flow are assumed to be commingled (i.e., separation of stormwater and dry weather flow is not included).
- The influent wetwell is sized to serve as a collection well and not as a holding tank.
- The chemical precipitation system is sized only to treat backwash waste to remove accumulated solids.
- It is assumed that 95% removal of PFMOAA is required and PFMOAA is the driving influent COC for GAC utilization

Item	Qty	Unit	Unit Cost	Total	Notes
Construction Costs					
Influent & Effluent Handling Package	Process Package		$ 1,100,000	$ 1,100,000	Parsons
Multi Media Filtration Package	Process Package		$ 3,600,000	$ 3,600,000	Parsons
Granular Activated Carbon Package	Process Package		$ 8,700,000	$ 8,700,000	Parsons
Solids Handling and Chemical Precipitation Package	Process Package		$ 600,000	$ 600,000	Parsons
Prefabricated Building & Containment Structure Package	Process Package		$ 7,600,000	$ 7,600,000	Parsons
Raw Construction Costs				$ 21,600,000	
Installation Cost (Construction, Site Preparation, Civil, Structural)	75%	of	aw Construction Cos	$ 16,200,000	Parsons
Anciliary Cost (I&C, Piping-Mechanical & Electrical)	30%	of	Sum of Raw Construction Costs and Installation Cost	$ 11,340,000	Parsons
Total Capital & Construction Cost	Sum	of	Raw Construction Costs, Installation Cost and Anciliary Cost	$ 49,200,000	
Professional Services Costs					
Engineering and Project Management	12%	of	Total Construction Cost	$ 6,000,000	Parsons
Construction Management, Project Management, General Conditions	18%	of	Sum of Total Construction Cost, Engineering/PM & Contingency Costs	$ 13,000,000	Parsons
Professional Services Subtotal				$ 19,000,000	
Contingency	30%	of	Sum of Total Construction Cost and Engineering/PM cost	$ 16,600,000	
C_0, Construction Cost				**$ 84,800,000**	
+50%				$ 127,200,000	
-30%				$ 59,360,000	
Annual Operations & Maintenance Costs					
Electricity			$ 77,466	$ 77,466	Parsons
GAC Usage & Replacement			$ 2,975,000	$ 2,975,000	Parsons
Chemicals for treatment (Acid, Caustic, Ferric, Polymer)			$ 324,855	$ 324,855	Parsons
Solids Disposal			$ 428,828	$ 428,828	Parsons
Sampling & Analytical			$ 75,000	$ 75,000	Parsons
Operational Labor			$ 1,464,320	$ 1,464,320	Parsons
Equipment Maintenance			$ 439,293	$ 439,293	Parsons
Annual O&M Subtotal				$ 5,800,000	
C,Annual Cost				**$ 5,800,000**	
+50%				$ 8,700,000	
-30%				$ 4,060,000	
n,Years	**20**				
r,Discount Rate	**3.5%**				
Present Worth Formula	$PV = C_o + C\left[\frac{(1+r)^n - 1}{r(1+r)^n}\right]$				
Total: Present Worth Value of Construction & Annual O&M Costs over 20 Years				**$ 168,000,000**	
+50%				$ 252,000,000	
-30%				$ 117,600,000	

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Conceptual Cost Estimate for Capture and Treatment at Willis Creek Mouth
Chemours Fayetteville Works, North Carolina

Basis of Cost Estimate (Scope and Assumptions):
Willis Creek
See supporting document for treatment scenario, assumptions and block flow diagram

Item	Qty	Unit	Unit Cost	Total	Notes
Construction Costs					
Influent & Effluent Handling (Includes oxidation package for this option)	Process Package		$ 660,000	$ 660,000	
Multi Media Filtration	Process Package		$ 950,000	$ 950,000	
Granular Activated Carbon	Process Package		$ 1,400,000	$ 1,400,000	
Solids Handling and Chemical Precipitation	Process Package		$ 1,500,000	$ 1,500,000	
Prefabricated Building & Containment Structure	Process Package		$ 5,100,000	$ 5,100,000	
Dam Structure	Package		$ 68,800	$ 68,800	
Raw Construction Costs				$ 9,678,800	
Installation Cost (Construction, Site Preparation, Civil, Structural)	75%	of	Raw Construction Costs	$ 7,300,000	
Anciliary Cost (I&C, Piping-Mechanical & Electrical)	30%	of	Sum of Raw Construction Costs and Installation Cost	$ 5,100,000	
Total Construction Cost	Sum	of	Raw Construction Costs, Installation Cost and Anciliary Cost	$ 22,100,000	
Professional Services Costs					
Engineering and Project Management	12%	of	Total Construction Cost	$ 2,700,000	
Construction Management, Project Management, General Conditions	18%	of	Sum of Total Construction Cost, Engineering/PM & Contingency Costs	$ 5,900,000	
Professional Services Subtotal				$ 8,600,000	
Contingency	30%	of	Sum of Total Construction Cost and Engineering/PM cost	$ 7,500,000	
C_0, Construction Cost				**$ 38,200,000**	
+50%				$ 57,300,000	
-30%				$ 26,740,000	
Annual Operations & Maintenance Costs					
Electricity			$ 60,000	$ 60,000	
GAC Usage & Replacement			$ 1,700,000	$ 1,700,000	
Chemicals for treatment (Acid, Caustic, Ferric, Polymer)			$ 70,000	$ 70,000	
Solids Disposal			$ 60,000	$ 60,000	
Sampling & Analytical			$ 75,000	$ 75,000	
Operational Labor			$ 800,000	$ 800,000	
Equipment Maintenance			$ 500,000	$ 500,000	
Annual O&M Subtotal				$ 3,300,000	
C, Annual Cost				**$ 3,300,000**	
+50%				$ 4,950,000	
-30%				$ 2,310,000	
n, Years	**20**				
r, Discount Rate	**3.5%**				
Present Worth Formula	$PV = C_o + C\left[\frac{(1+r)^n - 1}{r(1+r)^n}\right]$				
Total: Present Worth Value of Construction & Annual O&M Costs over 20 Years				**$ 86,000,000**	
+50%				$ 129,000,000	
-30%				$ 60,200,000	

Costs are conceptual estimates, and assumed to represent the actual installed cost within a range of -30%/ +50% of the value indicated above. The estimates have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on final approved design, actual labor and material costs, and competitive variable factors.
These estimates are not intended for budgetary or future planning purposes; they have been prepared to facilitate an inter-remedial alternative comparison.

Conceptual Cost Estimate for Capture and Treatment at Georgia Branch Creek Mouth
Chemours Fayetteville Works, North Carolina

Basis of Cost Estimate (Scope and Assumptions):
Georgia Branch
See supporting document for treatment scenario, assumptions and block flow diagram

Item	Qty	Unit	Unit Cost	Total	Notes
Construction Costs					
Influent & Effluent Handling	Process Package		$ 750,000	$ 750,000	
Multi Media Filtration	Process Package		$ 950,000	$ 950,000	
Granular Activated Carbon	Process Package		$ 1,400,000	$ 1,400,000	
Solids Handling and Chemical Precipitation	Process Package		$ 1,300,000	$ 1,300,000	
Prefabricated Building & Containment Structure	Process Package		$ 5,100,000	$ 5,100,000	
Dam Structure	Package		$ 68,800	$ 68,800	
Raw Construction Costs				$ 9,600,000	
Installation Cost (Construction, Site Preparation, Civil, Structural)	75%	of	aw Construction Cos	$ 7,200,000	
Anciliary Cost (I&C, Piping-Mechanical & Electrical)	30%	of	Sum of Raw Construction Costs and Installation Cost	$ 5,100,000	
Total Construction Cost	Sum	of	Raw Construction Costs, Installation Cost and Ancillary Cost	$ 21,900,000	
Professional Services Costs					
Engineering and Project Management	12%	of	Total Construction Cost	$ 2,700,000	
Construction Management, Project Management, General Conditions	18%	of	Sum of Total Construction Cost, Engineering/PM & Contingency Costs	$ 5,800,000	
Professional Services Subtotal				$ 8,500,000	
Contingency	30%	of	Sum of Total Construction Cost and Engineering/PM cost	$ 7,400,000	
C_0, Construction Cost				**$ 37,800,000**	
+50%				$ 56,700,000	
-30%				$ 26,460,000	
Annual Operations & Maintenance Costs					
Electricity			$ 50,000	$ 50,000	
GAC Usage & Replacement			$ 1,700,000	$ 1,700,000	
Chemicals for treatment (Acid, Caustic, Ferric, Polymer)			$ 60,000	$ 60,000	
Solids Disposal			$ 60,000	$ 60,000	
Sampling & Analytical			$ 75,000	$ 75,000	
Operational Labor			$ 750,000	$ 750,000	
Equipment Maintenance			$ 450,000	$ 450,000	
Annual O&M Subtotal				$ 3,200,000	
C,Annual Cost				**$ 3,200,000**	
+50%				$ 4,800,000	
-30%				$ 2,240,000	
n,Years	**20**				
r,Discount Rate	**3.5%**				
Present Worth Formula	$PW = C_0 + C\left[\frac{(1+r)^n - 1}{r(1+r)^n}\right]$				
Total: Present Worth Value of Construction & Annual O&M Costs over 20 Years				**$ 84,000,000**	
+50%				$ 126,000,000	
-30%				$ 58,800,000	

Costs are conceptual estimates, and assumed to represent the actual installed cost within a range of -30%/ +50% of the value indicated above. The estimates have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on final approved design, actual labor and material costs, and competitive variable factors. These estimates are not intended for budgetary or future planning purposes; they have been prepared to facilitate an inter-remedial alternative comparison.

Conceptual Cost Estimate for PlumeStop Application to Length of Willis Creek
Chemours Fayetteville Works, North Carolina

Basis of Cost Estimate (Scope and Assumptions):
Plume Stop allong Creek
-20 year design life for PRB ; no reapplication
- 22 mile barrier.

Item	Qty	Unit	Unit Cost	Total	Notes
Construction Costs					
Design Verification Testing	LS		$ 500,000	$ 500,000	Engineer's Estimate
Install Perfomrance Monitoring Wells	LS		$ 200,000	$ 200,000	Engineer's Estimate
Regenesis Costs	22	miiles	$ 40,000,000	$ 880,000,000	Scaled cost est.
				$ -	
				$ -	
Total Construction Cost				$ 880,700,000	
Professional Services Costs					
Engineering and Project Management	12%	of	Total Construction Cost	$ 105,700,000	
Construction Management, Project Management, General Conditions	18%	of	Sum of Total Construction Cost, Engineering/PM & Contingency Costs	$ 230,900,000	
Professional Services Subtotal				$ 336,600,000	
Contingency	30%	of	Sum of Total Construction Cost and Engineering/PM cost	$ 296,000,000	
C_0,Construction Cost				**$ 1,513,300,000**	
+50%				$ 2,269,950,000	
-30%				$ 1,059,310,000	
Annual Operations & Maintenance Costs					
Annual GW Sampling	LS		$ 200,000	$ 200,000	
Annual Reporting	LS		$ 60,000	$ 60,000	
				$ -	
				$ -	
				$ -	
				$ -	
				$ -	
Annual O&M Subtotal				$ 260,000	
C,Annual Cost				**$ 260,000**	
+50%				$ 390,000	
-30%				$ 182,000	
n,Years	**20**				
r,Discount Rate	**3.5%**				
Present Worth Formula	$PV = C_0 + C\left[\frac{(1+r)^n - 1}{r(1+r)^n}\right]$				
Total: Present Worth Value of Construction & Annual O&M Costs over 20 Years				**$ 1,517,000,000**	
+50%				$ 2,275,500,000	
-30%				$ 1,061,900,000	

Costs are conceptual estimates, and assumed to represent the actual installed cost within a range of -30%/ +50% of the value indicated above. The estimates have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on final approved design, actual labor and material costs, and competitive variable factors.
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Conceptual Cost Estimate for PlumeStop Application to Length of Georgia Branch Creek
Chemours Fayetteville Works, North Carolina

Basis of Cost Estimate (Scope and Assumptions):

Plume Stop allong Creek

-20 year design life for PRB ; no reapplication

- 14.25 mile barrier.

Item	Qty	Unit	Unit Cost	Total	Notes
Construction Costs					
Design Verification Testing	LS		$ 500,000	$ 500,000	Engineer's Estimate
Install Perfomrance Monitoring Wells	LS		$ 200,000	$ 200,000	Engineer's Estimate
Regenesis Costs	14	miiles	$ 40,000,000	$ 570,000,000	Scaled cost est.
				$ -	
				$ -	
Total Construction Cost				$ 570,700,000	
Professional Services Costs					
Engineering and Project Management	12%	of	Total Construction Cost	$ 68,500,000	
Construction Management, Project Management, General Conditions	18%	of	Sum of Total Construction Cost, Engineering/PM & Contingency Costs	$ 149,600,000	
Professional Services Subtotal				$ 218,100,000	
Contingency	30%	of	Sum of Total Construction Cost and Engineering/PM cost	$ 191,800,000	
C_0,Construction Cost				**$ 980,600,000**	
+50%				$ 1,470,900,000	
-30%				$ 686,420,000	
Annual Operations & Maintenance Costs					
Annual GW Sampling	LS		$ 200,000	$ 200,000	
Annual Reporting	LS		$ 60,000	$ 60,000	
				$ -	
				$ -	
				$ -	
				$ -	
				$ -	
Annual O&M Subtotal				$ 260,000	
C,Annual Cost				**$ 260,000**	
+50%				$ 390,000	
-30%				$ 182,000	
n,Years	**20**				
r,Discount Rate	**3.5%**				
Present Worth Formula	$PV = C_o + C\left[\frac{(1+r)^n - 1}{r(1+r)^n}\right]$				
Total: Present Worth Value of Construction & Annual O&M Costs over 20 Years				**$ 985,000,000**	
+50%				$ 1,477,500,000	
-30%				$ 689,500,000	

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Conceptual Cost Estimate for Offsite Groundwater Hydraulic Containment and Treatment
Chemours Fayetteville Works, North Carolina

Basis of Cost Estimate (Scope and Assumptions):

Steel sheet piling to cut off groundwater-surface water interface, with hydraulic containment behind the wall and ex-situ treatment.
Total impacted riverine length is 20 miles (10 miles on each side of the Cape Fear river, includes upgradient and downgradient reaches).
Average depth of sheet pile to key into the Upper Cape Fear Confining Unit is 50 feet.
This estimate did not evaluate the likelihood of sourcing such a significant quantity of steel in the time constraints of the project requirements
This estimate also assumes that access agreements and permits (notably, extensive wetlands impacts under USACE) will be obtained.
AQTESOLV parameters for Black Creek aquifer include transmissivity of 200 ft2/day, saturated thickness of 40 feet, K of 5.3 ft/day, and storativity of 0.1.
On average, each extraction well will pump 15 gpm and wells will be spaced 30 feet apart.
A total of 3,520 wells and 52,800 gpm (76 MGD) would be required for hydraulic containment.
The average PMPA concentration of the extracted groundwater is estimated to be 172 ng/L.
Extensive monitoring well network will be required to evaluate the pumping well drawdown.
Due to the scale of the containment remedy, eight (8) separate groundwater treatment plants will be built along the sections of wall
Wells for each treatment section will convey groundwater under pressure in a common force main up to the system.
Piping will be HDPE and trenches will be approximately 3 feet deep, and reuse of excacated soils as backfill will be permitted.
HDPE pipe sizes range from 2 to 24 inch diameter SDR 11.
Each treatment system will be sized at roughly 10 MGD and will treat the groundwater via adsorption.
Treated groundwater will be discharged to the Cape Fear river.
Includes a 20-year net present value cost with a 3.5% discount factor applied.
Parameters that were estimated using RACER v 11.2.16.0 are identified below, and are fully marked-up costs.

Item	Qty	Unit	Unit Cost	Total	Notes
Construction Costs					
Sheet Piling					
Contractor mob and demob	1	LS	$ 250,000	$ 250,000	Sevenson
Site clearing and prep (veg clearing, grading, pits, E&S)	121	ACRE	$ 25,000	$ 3,030,303	Sevenson
Utility location (for steel barrier and well locations)	1	LS	$ 150,000	$ 150,000	Engineer's Estimate
Permanent steel sheet piling, 38 psf, furnish and install	5,280,000	SF	$ 37	$ 195,360,000	RACER, Sevenson
Site restoration and revegetation	121	ACRE	$ 100,000	$ 12,121,212	Engineer's Estimate
Sheet Piling Subtotal				$ 210,911,515	
Drilling Costs					
Driller mobilization	1	LS	$ 50,000	$ 50,000	Engineer's Estimate
Extraction Wells drilling and well installation (no appurtenances)	176,000	LF	$ 225	$ 39,600,000	Engineer's Estimate
Aquifer pump testing on 25% of extraction wells	880	EA	$ 15,000	$ 13,200,000	Engineer's Estimate
Monitoring Wells drilling and installation	58,667	LF	$ 75	$ 4,400,000	Engineer's Estimate
IDW	234,667	LF	$ 10	$ 2,346,667	Engineer's Estimate
Drilling Subtotal				$ 59,596,667	
Site Work Costs					
HDPE SDR 11 - 2"	1,440	LF	$ 1.35	$ 1,941	Engineer's Estimate
HDPE SDR 11 - 4"	2,880	LF	$ 3.90	$ 11,228	Engineer's Estimate
HDPE SDR 11 - 6"	3,840	LF	$ 8.43	$ 32,357	Engineer's Estimate
HDPE SDR 11 - 8"	8,640	LF	$ 14.28	$ 123,376	Engineer's Estimate
HDPE SDR 11 - 10"	12,960	LF	$ 22.18	$ 287,425	Engineer's Estimate
HDPE SDR 11 - 12"	17,280	LF	$ 31.20	$ 539,129	Engineer's Estimate
HDPE SDR 11 - 14"	12,960	LF	$ 37.61	$ 487,488	Engineer's Estimate
HDPE SDR 11 - 16"	18,240	LF	$ 49.07	$ 895,119	Engineer's Estimate
HDPE SDR 11 - 18"	20,640	LF	$ 62.17	$ 1,283,281	Engineer's Estimate
HDPE SDR 11 - 24"	6,720	LF	$ 110.52	$ 742,686	Engineer's Estimate
HDPE fusing and fittings	1	LS	$ 72,000.00	$ 72,000	Engineer's Estimate
3'x3'x3' Well Vault + H20-Rated Lid (4.5x4.5x4.5)	3,520	ea	$ 12,993.00	$ 45,735,360	Engineer's Estimate
Flow Meters, Level and Pressure Transmitters	3,520	ea	$ 1,603.00	$ 5,642,560	Engineer's Estimate
Grundfos 3" 15SQ05-110-240V Submersible Pump, fittings, appurtenances	3,520	ea	$ 2,190.58	$ 7,710,854	Engineer's Estimate
Power poles, hardware, guy wires, excavation, wiring, transformers	192	ea	$ 30,639.71	$ 5,882,825	Engineer's Estimate
Local control panels	352	ea	$ 5,000.00	$ 1,760,000	Engineer's Estimate
Utility Connection to System	8	ea	$ 494,000.00	$ 3,952,000	Engineer's Estimate
Subcontractor Installation Costs-Piping 2"-6"	8,160	LF	$ 75.00	$ 612,000	Engineer's Estimate
Subcontractor Installation Costs-Piping 8"-14"	51,840	LF	$ 100.00	$ 5,184,000	Engineer's Estimate
Subcontractor Installation Costs-Piping 16"-24"	45,600	LF	$ 125.00	$ 5,700,000	Engineer's Estimate
Subcontractor Installation Costs-Well Vault	3,520	ea	$ 5,000.00	$ 17,600,000	Engineer's Estimate
Subcontractor Installation Costs-Electrical	1	LS	$ 1,844,000.00	$ 1,844,000	Engineer's Estimate
Subcontractor mobilization	5%	of	$ 106,099,629	$ 5,304,981	Engineer's Estimate
Site Work Subtotal				$ 111,404,610	

Conceptual Cost Estimate for Offsite Groundwater Hydraulic Containment and Treatment
Chemours Fayetteville Works, North Carolina

10 MGD Treatment Plant Cost (typical of eight)						
Influent & Effluent Handling, includes lift stations, EQ tanks, feed forward pumps, discharge pumps	Process Package		$ 1,176,733	$	1,176,733	Parsons
Multi Media Filtration, includes skids and backwash pumps	Process Package		$ 1,693,783	$	1,693,783	Parsons
Granular Activated Carbon, includes skid, water suppy tank, backwash waste tank, backwash pumps	Process Package		$ 2,496,101	$	2,496,101	Parsons
Solids Handling and Chemical Precipitation, includes feed pumps, clarifiers, sludge pumps, filter press, chemicals	Process Package		$ 2,674,394	$	2,674,394	Parsons
Prefabricated Building & Containment Structure	Process Package		$ 9,092,938	$	9,092,938	Parsons
Installation Cost (Construction, Site Preparation, Civil, Structural)	75%	of	$ 17,133,948	$	12,850,461	Parsons
Anciliary Cost (I&C, Piping-Mechanical & Electrical)	30%	of	$ 29,984,409	$	8,995,323	Parsons
10 MGD Treatment Plant Subtotal				$	38,979,731	
Eight 10 MGD Treatment Plants				$	311,837,850	
Total Construction Costs				$	693,750,642	
Modeling, Design, Work Planning, Site Access, and Permitting	5%	of	$ 693,750,642	$	34,687,532	adapted from EPA Guidance
Construction Oversight	5%	of	$ 693,750,642	$	34,687,532	adapted from EPA Guidance
Project Management	4%	of	$ 693,750,642	$	27,750,026	adapted from EPA Guidance
Professional Services Subtotal				$	97,125,090	
Contingency	30%	of	$ 790,875,732	$	237,262,720	
Construction Cost				**$**	**1,028,000,000**	
+50%				$	1,542,000,000	
-30%				$	719,600,000	
Annual Operations & Maintenance Costs						
Electricity - Field Equipment	1	LS	$ 4,302,000	$	4,302,000	Engineer's Estimate
Electricity - Treatment Systems	1	LS	$ 855,806	$	855,806	Parsons
GAC Usage & Replacement	1	LS	$ 32,377,252	$	32,377,252	Parsons
Chemicals for treatment (Acid, Caustic, Ferric, Polymer)	1	LS	$ 998,440	$	998,440	Parsons
Solids Disposal	1	LS	$ 855,806	$	855,806	Parsons
Sampling & Analytical	1	LS	$ 1,069,757	$	1,069,757	Parsons
Operational Labor	1	LS	$ 11,410,746	$	11,410,746	Parsons
Equipment Maintenance	1	LS	$ 7,131,716	$	7,131,716	Parsons
Annual O&M Subtotal				$	59,001,523	
Annual Cost				**$**	**59,000,000**	
+50%				$	88,502,285	
-30%				$	41,301,066	
Years	**20**					
Discount Rate	**3.5%**					
Net Present Value (NPV) of Annual Costs over 20 Years				**$**	**839,000,000**	
+50%				$	1,258,500,000	
-30%				$	587,300,000	
Total Cost - Construction and Annual O&M						
Total: Construction + NPV of Annual Costs over 20 Years				**$**	**1,867,000,000**	
+50%				$	2,800,500,000	
-30%				$	1,306,900,000	

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