2. Introduction to the Deer Creek Critical Aquifer Recharge Area Literature and Desktop Review PFAS Source Identification Study *Fifth Reading and Beyond* – Planning and Development Services (60 minutes)

City Council Agenda Item 10.2

September 8, 2026 - Regular Meeting

TITLE:	Introduction to the Deer Creek Critical Aquifer Recharge Area Literature and Desktop Review PFAS Source Identification Study (Fifth Reading and Beyond)
DEPARTMENT:	Planning and Development Services
PRESENTER:	Jeff Taraday; Brad Shipley; EA Engineering, Science, and Technology (consultant)
NEEDED FROM COUNCIL:	Informational
RECOMMENDATION:	Review the attached study, receive the presentation, ask questions, and provide feedback and direction for staff if time allows. The topic will come back on September 22 for further work and additional Council touches will be scheduled as needed.

BUDGET:

Total Dollar Amount:	0	☐ Approved in Budget
Fund(s):	0	☐ Budget Reallocation Required
		☒ No Budget Impact

PROBLEM/ISSUE STATEMENT:

Concern about the potential contamination of Olympic View Water and Sewer District's Deer Creek aquifer by per-and polyfluoroalkyl substances (PFAS) led the City to prohibit the use of shallow subsurface stormwater discharge techniques within the Deer Creek Critical Aquifer Recharge Area (CARA) as part of the 2025 Critical Areas Ordinance periodic update.

Because there are no other feasible means of managing stormwater within the Deer Creek CARA, prohibiting shallow subsurface discharge effectively meant no development or redevelopment could occur in the area, except for interior work and very minor work outside of buildings.

To avoid frustration and confusion during the permitting process which would have resulted from the inability to effectively manage new stormwater runoff, Council adopted Ordinance 4430, which was a moratorium suspending acceptance of permit applications that would trigger stormwater management requirements within the Deer Creek CARA. The six-month pause, effective February 18, 2026, was intended to provide time to:

- Complete the Deer Creek PFAS study;
- Evaluate whether other feasible stormwater management alternatives exist for this area;
- Consider potential amendments to CARA and/or stormwater regulations informed by completed scientific analysis; and

- Avoid the futile processing of applications.

The Deer Creek PFAS study was not able to be completed during the time of the initial six-month permit moratorium so Council extended that on August 18, 2026 for another six months (Ordinance 4445). The completed study was received on August 27, 2026, and is included as Attachment 1.

CONTEXT, ANALYSIS, & ALTERNATIVES:
The study compiles current best available science using a desktop literature review and then identifies three tiers of potential actions, which are broken out into 12 separate recommendations.

RECOMMENDATION:
Review the attached study, receive the presentation, ask questions, and provide feedback and direction for staff if time allows. The topic will come back on September 22 for further work and additional Council touches will be scheduled as needed.

BUDGET IMPACTS:
No immediate budget reallocation is required. However, the moratorium has resulted in some temporary loss of revenue associated with development activity within the Deer Creek CARA, including permit fees, plan review fees, impact fees, and other development-related charges that would otherwise have been collected during the moratorium period.

ITEM HISTORY:
On January 6, 2026, the Edmonds City Council adopted the periodic update to the City's critical area ordinance (CAO), which contained a prohibition on the use of shallow subsurface stormwater management techniques within the Deer Creek CARA.

On February 10, 2026, City Council adopted Ordinance 4430, which established a six-month moratorium on the acceptance of permit applications that would trigger stormwater management requirements within the Deer Creek CARA. After the required public hearing on March 3, 2026, Council adopted findings of fact to retain the ordinance in Resolution 1587 on March 10, 2026.

After a public hearing on August 18, 2026, Council adopted Ordinance 4445, which extended the permit moratorium through February 26, 2027. The extension allowed additional time to receive the PFAS study and analyze possible revisions to codes and processes to protect the Deer Creek aquifer using current best available science.

ADDITIONAL INFORMATION:
None

ATTACHMENTS:

Attachment 1 - Deer Creek Critical Aquifer Recharge Area Literature and Desktop Review PFAS Source Identification Study, August 2026

Deer Creek Critical Aquifer Recharge Area Literature and Desktop Review PFAS Source Identification

Prepared for

City of Edmonds
121 Fifth Avenue North
Edmonds, Washington 98020

Prepared by

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Version: FINAL
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List of Abbreviations

AFFF	Aqueous Film-Forming Foam
CARA	Critical Aquifer Recharge Area
EA	EA Engineering, Science, and Technology, Inc., PBC
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ITRC	Interstate Technology & Regulatory Council
OECD	Organisation for Economic Co-operation and Development
PFAS	Per- and polyfluoroalkyl substance
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctane sulfonate
NADP	National Atmospheric Deposition Program
NIEHS	National Institute of Environmental Health Sciences
NPDES	National Pollutant Discharge Elimination System
ng/L	Nanograms per liter
QA	Quality assurance
QC	Quality control
TAPE	Technology Assessment Protocol – Ecology
UIC	Underground injection control

1. Summary

EA Engineering, Science, and Technology, Inc., PBC (EA) conducted this desktop study to evaluate published literature, regulatory guidance, and publicly available local information relevant to potential per- and polyfluoroalkyl substance (PFAS) sources and transport pathways in the Deer Creek Critical Aquifer Recharge Area (CARA). The review focused on PFAS occurrence in urban and residential stormwater, atmospheric deposition and precipitation, built-environment materials, consumer and commercial products, and stormwater infiltration pathways that may be relevant to aquifer recharge settings.

The literature indicates PFAS can occur in urban stormwater and may be transported through developed watersheds via runoff from roads, roofs, paved areas, landscaped surfaces, school properties, recreational areas, and stormwater conveyance systems. In aquifer recharge settings, stormwater infiltration may represent a plausible pathway for PFAS movement toward groundwater; however, the significance of this pathway is highly site-specific and depends on stormwater concentrations, pretreatment, infiltration design, vadose-zone conditions, aquifer properties, dilution, travel time, and compound-specific PFAS behavior. Therefore, PFAS presence in stormwater should be treated as a pathway of concern but not as direct evidence of aquifer impact without supporting groundwater or vadose-zone data.

Atmospheric deposition is also a relevant potential input pathway. Published studies and agency materials indicate PFAS can be transported through the atmosphere and deposited through rainfall and dry deposition, including in areas without an obvious single point source. As a result, PFAS detected in developed recharge areas may reflect a combination of regional/background atmospheric inputs, stormwater runoff mobilization, and localized material or land-use sources rather than one dominant source category.

The review also found that PFAS use is broadly documented in built-environment and consumer-product categories relevant to residential and mixed-use urban settings. Potential source categories include roofing materials, exterior coatings, sealants, waterproofing products, treated textiles, carpets, consumer products, artificial turf, playground surfaces, and other outdoor polymeric or weather-exposed materials. The strength of evidence varies by material class. The evidence is strongest for documented PFAS use in coatings, textiles, carpets, consumer goods, exterior building products, and certain artificial turf components. Direct field-scale runoff data for specific residential materials, ordinary pavement products, and some landscaping materials remain more limited. Accordingly, these materials should be considered plausible diffuse PFAS source categories during source-screening efforts, while recognizing their relative contribution in Deer Creek cannot be quantified from the current desktop record alone.

Publicly available Deer Creek-specific technical information appears limited. The available record primarily consists of city permitting and planning materials, Washington State Department of Ecology (Ecology) guidance, public issue-history materials, litigation-related documents, and Washington analog studies rather than detailed, Deer Creek-specific PFAS fate-and-transport investigations. City materials confirm Deer Creek is a mapped CARA and projects within the Deer Creek and 228th Street CARA require city coordination before stormwater design, confirming the area is already treated as aquifer-sensitive in local permitting. Planning materials also indicate projected growth within Edmonds is concentrated in the Edmonds Marsh, Deer Creek, and Shell Creek watersheds, making development patterns and stormwater management directly relevant to the Deer Creek pathway evaluation.

Madrona K-8 School has become a focal point in the local PFAS concern context. Publicly available issue-history and litigation materials report PFAS detections in stormwater and bioretention planter soils at or near the school site and identify concerns regarding stormwater discharge through underground injection control wells above the Deer Creek aquifer. Reported stormwater concentrations in the litigation materials include values up to 32.2 nanograms per liter (ng/L) perfluorooctanoic acid (PFOA) and 18.9 ng/L perfluorooctane sulfonate (PFOS); however, those materials do not present the reported detections as direct aquifer groundwater results. These materials are important for understanding the local concern and potential pathway questions, but they should be treated as public-issue history and litigation context rather than final technical determinations of source attribution, groundwater impact, or aquifer contamination.

When compared with published urban stormwater literature, the reported Madrona stormwater PFAS concentrations appear broadly consistent with values reported in other urban runoff studies, although the reported PFOA concentration is near the upper end of some comparable datasets. This supports the conclusion that the reported stormwater detections warrant attention in a recharge-sensitive setting but do not, by themselves, prove a unique source mechanism or aquifer impact.

Stormwater-management alternatives within the Deer Creek CARA should also be evaluated in the context of the ultimate disposition of stormwater. Most of the CARA lies within closed drainage basins, where stormwater that is not managed through engineered infiltration may pond and ultimately infiltrate naturally unless it is collected and conveyed elsewhere. Other portions of the CARA may discharge toward Deer Creek, creating a distinct surface-water pathway. Consequently, prohibiting an engineered infiltration facility does not necessarily eliminate subsurface recharge or PFAS transport; it may instead change where infiltration occurs or redirect PFAS-bearing stormwater to another receptor. The relative protectiveness of engineered infiltration, natural infiltration, and non-infiltration alternatives therefore depends on site-specific hydrology, infiltration configuration, source-water quality, available controls, and receptor relationships.

Overall, the current record supports a multiple-lines-of-evidence conceptual model for the Deer Creek CARA. Plausible PFAS inputs include atmospheric deposition, diffuse urban stormwater, weather-exposed built-environment materials, landscaping and recreational materials, and household or commercial product-related sources. Stormwater may then transport PFAS through engineered infiltration, natural infiltration, stormwater conveyance, or surface-water discharge pathways depending on local drainage and site conditions.

The available information is sufficient to support targeted source-control measures and a tiered, risk-differentiated approach to stormwater and infiltration management, but it is not sufficient to identify a single dominant PFAS source, quantify the relative contribution of individual sources or pathways, or determine whether reported stormwater detections have resulted in aquifer impacts. Accordingly, source control should be emphasized where controllable PFAS inputs can be reduced before runoff is generated, while infiltration and other stormwater-management decisions should consider system configuration, hydrogeologic conditions, source-water quality, pretreatment where they are relied upon as a protective measure, monitoring, and the ultimate receiving pathway.

Key data gaps include the limited availability of Deer Creek-specific PFAS sampling data, incomplete source-area characterization, uncertainty regarding stormwater routing and drainage boundaries, limited information regarding engineered and natural infiltration pathways, incomplete characterization of surface-water and groundwater connectivity, limited hydrogeologic and vadose-zone information, and the need for complete PFAS-specific quality assurance (QA)/quality control (QC) documentation. These limitations currently prevent quantitative comparison of PFAS loading associated with engineered infiltration, natural infiltration, and surface-water discharge pathways.

Future work should prioritize well-documented stormwater and source-area sampling, drainage and infiltration-infrastructure mapping, characterization of closed-basin and direct-discharge areas, review of existing groundwater and surface-water information, and targeted evaluation of higher-priority source materials. Where warranted by project scale or pathway risk, additional hydrogeologic, groundwater, vadose-zone, pretreatment-performance, or receiving-water monitoring could be used to evaluate hydraulic and chemical connections and refine the City’s tiered source-control and stormwater-management framework.

2. Literature and Guidance Review

2.1. Purpose and Scope

This review summarizes published information relevant to PFAS occurrence in urban and residential stormwater, atmospheric deposition and precipitation, and mitigation approaches applicable to developed recharge settings. The emphasis is on diffuse-source urban environments rather than point-source industrial discharges because the literature most relevant to the Deer Creek CARA concerns mixed land-use runoff, precipitation inputs, and the potential for multiple concurrent PFAS pathways. Current agency materials indicate this remains an evolving management area. U.S. Environmental Protection Agency (EPA) is using existing National Pollutant Discharge Elimination System (NPDES) authorities to reduce PFAS discharges and improve monitoring, while broader PFAS effluent and criteria frameworks continue to develop (EPA 2022). Washington State has published PFAS investigation and remediation guidance; however, current stormwater-management frameworks do not establish PFAS-specific treatment-performance criteria or a comprehensive municipal PFAS framework for residential runoff and infiltration settings.

2.2. PFAS in Urban and Residential Stormwater

Published literature indicates urban stormwater can act as a transport pathway for PFAS in developed areas. In a review focused specifically on sustainable water recycling through aquifers, Page et al. 2019 noted urban stormwater runoff and other urban waters may contain PFAS at levels relevant to managed aquifer recharge and infiltration schemes and further observed the implications for groundwater depend on source concentrations, aquifer properties, and treatment configuration rather than on source presence alone. This framing is important because it places PFAS in stormwater within a broader recharge-risk context and avoids oversimplified assumptions that either all infiltration is benign or all infiltration is inherently unacceptable (Page et al. 2019).

Studies of infiltrated stormwater also show groundwater effects are site-dependent. Edwards et al. 2022 evaluated stormwater infiltration through dry wells at suburban residential and suburban commercial locations and found the likelihood of contaminants reaching groundwater was strongly influenced by pretreatment and subsurface conditions. Their work concluded that infiltration through dry wells with pretreatment may pose relatively low groundwater-quality risk under some settings, while also emphasizing dry wells can bypass portions of the vadose zone; therefore, require careful evaluation. Although that study addressed a broad range of stormwater chemicals rather than PFAS alone, it is directly relevant to the question of how infiltrated urban runoff can affect shallow groundwater and aquifer recharge systems (Edwards et al. 2022).

The PFAS-specific recharge literature points in the same direction. Page et al. 2019 described PFAS as a relevant concern for urban aquifer infiltration and water recycling because stormwater and treated waters may introduce persistent fluorinated compounds to groundwater systems. A more recent systematic review of contaminants of emerging concern in managed aquifer recharge similarly identified PFAS as part of the contaminant suite that may enter groundwater where source waters are insufficiently controlled or treated. Taken together, these studies support a neutral but important conclusion: PFAS in stormwater is a plausible concern in recharge areas, but the significance of that concern depends on source strength, pretreatment, infiltration design, and subsurface transport conditions (Mumberg et al. 2024a; Page et al. 2019).

2.3. Atmospheric Deposition and Rainwater as PFAS Sources

Atmospheric deposition is also a documented PFAS input pathway. EPA materials recognize PFAS may affect environmental media through atmospheric releases and deposition, and the National Atmospheric Deposition Program (NADP) now includes a PFAS precipitation subnetwork to support evaluation of atmospheric transport and wet deposition. This reflects a broader scientific consensus that PFAS can be transported through the atmosphere and deposited by rainfall, even in areas lacking an obvious local discharge source (NADP, 2024; U.S.EPA, 2020).

Recent global-scale analyses suggest PFAS in precipitation may be widespread, with some authors proposing atmospheric PFAS contamination has reached levels of global concern, even in remote regions (Cousins et al., 2022). Peer-reviewed precipitation studies provide direct evidence of this pathway. Kim and Kannan reported PFAS in urban air, rain, snow, surface runoff, and lakes, demonstrating early on that atmospheric deposition and runoff can act as linked pathways within urban watersheds (Kim and Kannan, 2007). Shimizu et al. 2021 later documented both legacy PFAS and replacement PFAS in wet and dry deposition in North Carolina, providing direct evidence newer fluorinated compounds, including replacement chemistries, can also be transported atmospherically and deposited to the land surface (Shimizu et al., 2021). In Wisconsin, Pfotenhauer et al. 2022 analyzed 89 precipitation samples across 8 monitoring sites and found summed PFAS concentrations in rainwater ranging from 0.7 to 6.1 ng/L, with regional differences in compound profiles that suggested local or regional source influences superimposed on a broader background signal (Pfotenhauer et al., 2022). Great Lakes precipitation studies likewise reported measurable PFAS concentrations and deposition at multiple sites, reinforcing precipitation can provide both a regional background input and a spatially variable source indicator (Gewurtz et al., 2019; Xia et al., 2024).

Viewed together, the stormwater and atmospheric deposition literature suggests PFAS detections in developed recharge areas may reflect more than one input pathway. Stormwater runoff can mobilize PFAS from urban surfaces and land uses, while precipitation can independently deliver PFAS from atmospheric transport and deposition. The relative contribution of each pathway likely varies by land use, material sources, precipitation patterns, and hydrogeologic setting. Therefore, PFAS occurrence in recharge settings should be evaluated using a multiple-lines-of-evidence approach that considers diffuse background deposition, runoff mobilization, and site-specific transport conditions rather than assuming a single dominant source category from the outset (Edwards et al., 2022; Page et al., 2019; Pfotenhauer et al., 2022).

From a management perspective, available guidance currently emphasizes source reduction, monitoring, and targeted controls. EPA's 2022 PFAS NPDES memorandum states the agency is leveraging permitting authorities to reduce PFAS discharges at the source and obtain more comprehensive information on PFAS sources and quantities while broader effluent limitation and criteria frameworks continue to be developed (Fox, 2022). Ecology's PFAS guidance similarly reflects a broader investigation-and-management approach rather than a narrowly defined stormwater-specific municipal PFAS rule set for residential recharge areas. In practical terms, the current guidance landscape supports careful monitoring, source characterization, and evaluation of treatment or pretreatment options where warranted, while acknowledging the regulatory structure remains under active development ((Washington State Department of Ecology, 2023).

2.4. Built-Environment and Product-Related PFAS Sources

Published literature indicates PFAS use extends well beyond industrial facilities and firefighting applications and includes a broad range of materials relevant to the built environment. Glüge et al. 2020 compiled a large global inventory of PFAS uses and identified more than 200 use categories and subcategories, including uses in building and construction, textiles, coatings, paper, and numerous consumer-product applications (Glüge et al., 2020). That review, together with later summaries focused on occupational and industrial use, indicates that PFAS have historically been incorporated into products to provide water repellency, stain resistance, grease resistance, weather resistance, lubrication, and related functional properties that are directly relevant to urban and residential land uses (Gaines, 2023).

Within the building sector, PFAS use has been reported in roofing materials, paints and coatings, flooring, sealants, caulks, adhesives, carpets, and other building products. A recent survey chapter focused specifically on building products described PFAS applications across roofing, coatings, flooring, sealants, and related materials, while broader use inventories similarly identify construction materials and coating applications as important PFAS use categories (Bruton and Ray, 2023; Glüge et al., 2020). These findings are relevant to stormwater studies because many of these materials are installed on or near weather-exposed surfaces; therefore, they may interact directly with rainfall, runoff generation, or both.

Although the stormwater literature has more commonly documented runoff contributions from metals and conventional urban pollutants than from PFAS-specific building products, studies of roof runoff show roofing materials can materially influence runoff quality. That broader runoff literature supports the premise that stormwater contacting roofs, facades, and other construction materials should not be assumed to be chemically uniform or source-free (De Buyck et al., 2021). In the PFAS context, the importance of roofing, coatings, waterproofing products, and sealants lies less in a single definitive runoff study for each material type than in the converging evidence such materials can contain fluorinated chemistries and are exposed to weathering and runoff over long service lives (Bruton and Ray, 2023; Udvary et al., 2025).

Consumer products represent another relevant source category. EPA states PFAS are found in a wide array of consumer and industrial products, and Ecology identifies common PFAS-containing product categories, including carpets, waterproof products, and other stain-, oil-, or grease-resistant materials (EPA., 2025; Washington State Department of Ecology, 2023). The Interstate Technology & Regulatory Council (ITRC) PFAS guidance further notes that degradation of PFAS-treated consumer products, such as textiles, carpets, and paper, can release PFAS to surrounding environments (ITRC, 2026). While some of that evidence comes from indoor exposure studies, the same product classes are relevant to outdoor urban settings where weathering, abrasion, littering, washing, or disposal may create pathways to stormwater.

Carpets and coated textiles are among the best documented PFAS-containing product classes. Wu et al. found strong associations between PFAS concentrations in paired carpet and dust samples, indicating carpets can act as both a source and a sink for PFAS (Wu et al., 2020b). Additional work on indoor air similarly concluded carpets can be significant sources of neutral and volatile PFAS in indoor environments (Morales-McDevitt et al., 2021a). These studies do not directly quantify stormwater loading, but they do show treated polymeric and textile surfaces can retain and release PFAS over time, which is relevant when considering analogous outdoor materials or disposal-related pathways.

Weathering studies provide especially useful evidence for outdoor-source discussions. Van Der Veen et al. reported weathering affects both PFAS profiles and measured concentrations in durable water-repellent outdoor clothing (van Der Veen et al., 2020a). Schellenberger et al. later demonstrated PFAS release from functional textiles under outdoor aging conditions involving sunlight, precipitation, wind, and heat (Schellenberger et al., 2022). Together, these studies show treated materials can change chemically during use and can release measurable PFAS or PFAS precursors during environmental exposure. This mechanism is directly relevant to outdoor built environments where coated fabrics, weatherproof materials, or PFAS-treated surfaces may be exposed to repeated rainfall.

Landscaping and recreational materials may also warrant consideration. Artificial turf systems, playground materials, and related outdoor polymeric surfaces have received increasing attention as possible PFAS-containing materials. A 2022 study of artificial turf fields in Stockholm reported widespread occurrence of non-extractable fluorine in field components, suggesting fluorinated substances were common in backing, blades, and filling materials (Lauria et al., 2022b). Review literature has also noted turf backing can contain PFAS, although release behavior remains less well characterized than occurrence (Goulding, 2025; Zuccaro et al., 2022). These studies do not establish that all recreational surfaces are important PFAS runoff sources, but they do support including turf- and polymer-based outdoor materials within a broader source-screening framework for developed areas.

Overall, the available literature supports a neutral but important conclusion: building materials, infrastructure, landscaping materials, and consumer products constitute a credible class of potential PFAS sources in developed areas. The significance of any one material class will vary by land use, product composition, age, weathering history, maintenance practices, and hydrologic connectivity. However, the breadth of documented PFAS use across construction materials, treated products, textiles, and outdoor polymeric surfaces indicates these source categories should be considered in source identification efforts alongside atmospheric deposition and stormwater transport processes rather than excluded at the outset.

2.4.1. Roofing, Sealants, Coatings, and Waterproofing Products

The literature strongly supports treating roofing-related materials, sealants, coatings, and waterproofing products as plausible PFAS sources. The Consumer Product Safety Commission’s PFAS white paper identifies PFAS-containing paints, varnishes, and sealants as relevant product categories and notes that PFAS can be released throughout product life cycles, including use, washing, weathering, and end-of-life disposal. The same report also notes these materials can contribute to landfill leachate and runoff once discarded, reinforcing that building products can remain environmentally relevant after installation and use (Commission, 2023).

Recent product-testing work strengthens this conclusion. A 2025 study on Canadian building products analyzed 145 samples of paints, sealers, and textiles, mostly intended for exterior use, and directly investigated both nonpolymeric PFAS and side-chain fluorinated polymers in those materials. The study was designed specifically to assess whether exterior building products may act as environmental PFAS sources, making it highly relevant to source-screening in developed runoff settings (Liu et al., 2025). Broader coatings literature is also relevant. Organisation for Economic Co-operation and Development (OECD) has documented PFAS use and alternatives in coatings, paints, and varnishes, showing fluorinated chemistries have been used in protective coatings because of their surface-active and repellent properties. Taken together, the building-products and coatings literature supports inclusion of roofing, coatings, sealants, and waterproofing-related materials as plausible diffuse PFAS sources, even though direct field runoff measurements from every individual product type remain limited (OECD, 2022).

2.4.2. Pavement, Asphalt, and Construction Materials

A 2023 review on PFAS-contaminated asphalt and concrete concluded PFAS interactions with these materials are important enough to raise significant management and characterization questions and identified 24 knowledge gaps and management challenges related to concrete and asphalt (Douglas et al., 2023). However, much of the direct PFAS literature for pavement and concrete concerns contaminated sites, especially locations impacted by Aqueous Film-Forming Foam (AFFF) or known PFAS releases, rather than ordinary residential streets or routine urban paving products (Mayer et al., 2024). Vo et al. 2023 tested commercially available sealants for mitigating PFAS release from AFFF-impacted concrete and found that sealant effectiveness differed by product type and PFAS behavior. This type of work demonstrates that PFAS leaching from paved materials is a recognized issue in the scientific and remediation literature, although most directly studied cases involve previously contaminated infrastructure rather than ordinary neighborhood pavement (Vo et al., 2023).

Accordingly, pavement treatments, asphalt modifiers, and related construction materials can reasonably be considered in PFAS source screening, but the strength of evidence is not the same as for broader building-product or consumer-product use categories. A balanced interpretation is that paved materials may act as PFAS reservoirs or release surfaces under some conditions, but the magnitude of their contribution in typical residential runoff settings remains uncertain.

2.4.3. Playground Surfaces, Turf, and Landscaping Materials

Artificial turf and similar recreational surfaces have received increasing attention as possible PFAS-containing materials. Lauria et al. 2022a reported widespread occurrence of non-extractable fluorine in artificial turf field components from Stockholm, Sweden, including backing, blades, and filling materials. The authors concluded that fluorinated substances were common in the sampled turf systems, although targeted extractable PFAS concentrations were generally low. This distinction is important because it supports the presence of fluorinated materials while also indicating release behavior is not yet fully characterized (Lauria et al., 2022a). The artificial-turf literature is, therefore, useful for source identification, but it does not establish that all playground or turf materials are major PFAS runoff sources. Rather, it supports inclusion of these materials within a broader screening framework for developed areas. For landscaping materials more generally, direct PFAS field studies are relatively sparse. However, broader PFAS use inventories and building-product surveys support considering outdoor polymeric materials, treated fabrics, and related weather-exposed specialty materials as plausible source categories where such products are present (Glüge et al., 2020).

Compost and other organic soil amendments represent a distinct landscaping-material category because they are commonly applied directly to the land surface or incorporated into shallow soils, where they may interact with precipitation, runoff, and infiltrating water. Recent studies have documented PFAS in commercially available compost and related soil-amendment products. Compost may represent one of several landscaping-related PFAS source categories that warrants consideration where substantial quantities are used. (Saffari Aman et al., 2026) analyzed five commercial composts and reported a mean concentration of 9.07 ± 12.22 µg/kg dry weight for the sum of 13 measured PFAS. An earlier study of commercially available composts, garden soils, and potting mixes reported total concentrations for 38 targeted PFAS ranging from 1.26 to 11.84 µg/kg dry weight across the tested products and also identified evidence of PFAS precursors (Sivaram et al., 2022). These studies demonstrate that PFAS occurrence in compost and organic amendments can vary substantially among products and feedstocks and should not be assumed to be uniform.

Because these materials may be applied in relatively large quantities and have direct contact with recharge soils, compost and similar organic amendments are appropriate for inclusion in PFAS source screening within the Deer Creek CARA. The available literature does not establish that all compost represents a significant PFAS source, nor does it provide a direct basis for predicting PFAS concentrations in stormwater or groundwater from a measured compost concentration. However, the documented occurrence of PFAS in commercial compost products provides a technical basis for considering product documentation or analytical verification where these materials are proposed for use in recharge-sensitive areas.

2.4.4. Household and Commercial Product Pathways

Household and commercial products represent one of the strongest literature-backed PFAS source categories. The National Institute of Environmental Health Sciences (NIEHS) states PFAS have been used in many everyday products, including clothes, carpets, stain-resistant materials, cookware, and packaging. ITRC similarly documents PFAS use in textiles, upholstery, carpets, leather, and apparel, including fluoropolymer and side-chain fluorinated polymer coatings used to impart oil, water, and stain repellency. These sources are especially important because they connect PFAS occurrence to ordinary residential and mixed urban land uses rather than only to specialized industrial settings (ITRC, 2023; NIEHS, 2025). The environmental-release literature supports the relevance of these products. Wu et al. 2020a found strong associations between PFAS concentrations in paired carpets and dust samples from childcare centers, concluding carpets can act as both sources and sinks of PFAS. Morales-McDevitt et al. likewise found that concentrations of volatile PFAS in indoor air, carpet, and dust were closely related, indicating carpets and dust are major indoor PFAS sources. Although these are indoor studies, they are valuable because they demonstrate treated surfaces and consumer materials can retain and release PFAS over time (Morales-McDevitt et al., 2021b; Wu et al., 2020a).

Studies of treated outdoor textiles make the outdoor relevance even clearer. Van der Veen et al. found that weathering affected both PFAS profiles and measured concentrations in durable water-repellent clothing, while Schellenberger et al. 2022 showed outdoor aging under sunlight, precipitation, wind, and heat led to PFAS emissions from functional textiles. These studies provide a direct mechanism by which PFAS-treated consumer or commercial materials exposed to environmental conditions may contribute to environmental loading (Schellenberger et al., 2022; van der Veen et al., 2020b).

Recent reviews of literature also reinforces the breadth of the consumer-product issue. Yang et al. 2025 reviewed PFAS occurrence in consumer products and summarized evidence across textiles, leather, paper, food-contact materials, and related consumer goods, concluding consumer products remain an important PFAS reservoir and exposure source. Consumer Product Safety Commission white paper similarly emphasizes PFAS, and precursors can be released during production, use, washing, disposal, and recycling, and PFAS-containing materials can re-enter the environment through waste handling pathways (Commission, 2023; Yang et al., 2025). From a runoff perspective, literature does not support a single dominant product class; rather, household and commercial products provide multiple plausible pathways for PFAS release to the urban environment, including weathering, washing, abrasion, disposal, dust generation, and runoff contact. As a result, these pathways are appropriately treated as diffuse source categories that may contribute to PFAS occurrence in developed watersheds.

2.5. Screening-Level Source Prioritization and Regulatory-Relevance Framework

The current desktop review does not support definitive quantitative ranking of individual PFAS sources within the Deer Creek Critical Aquifer Recharge Area (CARA) because representative source-area, stormwater, vadose-zone, and groundwater data are limited. However, the available literature supports a screening-level prioritization of source categories based on multiple factors, including documented PFAS occurrence or use, potential material quantity or exposed surface area, likelihood of rainfall or runoff contact, potential release or leaching, hydrologic connection to stormwater or recharge soils, and relevance to residential or mixed-use development within the CARA.

Where reasonably comparable concentration information was identified in the literature, **Table 1** includes that information to provide additional context regarding potential source strength. Concentration data should be interpreted cautiously because available studies use different material matrices, analyte lists, analytical methods, reporting limits, and study designs. Concentrations measured directly in solid products or materials, such as compost or building materials, are not directly comparable to PFAS concentrations measured in stormwater, and product concentrations alone do not establish the mass ultimately released to runoff or groundwater. For several built-environment source categories, the literature establishes PFAS occurrence or use but does not provide sufficiently comparable field-runoff data to assign a representative concentration range.

Accordingly, the screening priority in Table 1 should not be interpreted as a quantitative PFAS mass-loading ranking for the Deer Creek CARA or as evidence that every product within a listed category contains PFAS. Rather, the framework identifies source categories that warrant differing levels of attention based on the combined strength of evidence, potential exposure and hydrologic relevance, and ability to control the source through development review or other management measures. Site-specific product documentation, source-area sampling, and runoff data would be needed to refine the framework and quantitatively compare the relative contribution of individual PFAS sources within the CARA.

Table 1. Screening-level PFAS source prioritization and regulatory relevance for the Deer Creek CARA.

Note: Table 1 is a conceptual, screening-level prioritization and should not be interpreted as a quantitative source-strength ranking. The categories reflect the relative strength of published evidence for PFAS use or release potential, likely exposure to rainfall and runoff, and hydrologic relevance to the Deer Creek CARA. The desktop review did not identify sufficient Deer Creek-specific data or directly comparable material-specific runoff studies to assign quantitative source-strength values or rank individual materials by PFAS mass contribution. Future source-area sampling, product documentation, or site-specific runoff data could be used to refine this screening framework.

Screening Priority	Source Category	Basis for Inclusion	Available Concentration Information	Regulatory / Source-Control Relevance
Higher	Exterior coatings, sealants, waterproofing products, and treated building materials	Strong literature basis for PFAS use in coatings and treated building products; likely outdoor exposure and direct rainfall/runoff contact.	PFAS have been measured in exterior building products, but the reviewed literature does not provide a directly comparable field-runoff concentration range suitable for assigning a Deer Creek-specific source strength.	Strong candidates for material documentation, certification, product substitution, or restrictions for major weather-exposed components.
Moderate/material-dependent	Artificial turf, playground surfacing, and outdoor polymeric recreational materials	Evidence of fluorinated substances in some artificial turf and recreational-surface components, with direct relevance to schools, parks, and redevelopment settings. PFAS occurrence and potential release appear to be product-specific, and direct runoff data remain limited.	Targeted PFAS and non-extractable fluorine have been reported in turf components, but directly comparable PFAS runoff concentration data remain limited.	Consider manufacturer documentation, PFAS-related specifications, or alternative materials where runoff is hydrologically connected to infiltration or sensitive receiving waters.

Screening Priority	Source Category	Basis for Inclusion	Available Concentration Information	Regulatory / Source-Control Relevance
Moderate	Roofing materials, façade treatments, membranes, and weather-resistant products	Plausible outdoor PFAS source category with large, exposed surface area and direct rainfall/runoff contact; product-specific evidence varies by formulation.	The reviewed literature supports PFAS occurrence in some building products, but a representative PFAS runoff concentration range for roofing materials was not identified.	High relevance for documentation because roofing has extensive direct rainfall contact. Manufacturer specification information could be incorporated into certification requirements.
Moderate	Pavement sealants, asphalt/concrete treatments, construction chemicals, and specialty surface treatments	PFAS interactions with pavement materials and some specialty products are documented, although much of the literature concerns contaminated infrastructure rather than ordinary residential paving.	Insufficient directly comparable runoff data are available to assign a representative concentration range for routine residential paving or construction materials.	Focus controls on specialty treatments or products with documented/intentionally added PFAS rather than treating all pavement or concrete as equivalent PFAS sources.
Moderate / material-dependent	Compost and other bulk organic soil amendments	PFAS have been reported in commercial composts and other waste-derived soil amendments. These materials may be applied in substantial quantities directly to soils where they can interact with rainfall and infiltrating water.	A recent study of five commercial composts reported a mean Σ13 PFAS concentration of 9.07 ± 12.22 µg/kg dry weight. Concentrations vary by feedstock and product, and material concentrations are not directly comparable to stormwater concentrations in ng/L (Aman et al., 2026).	Reasonable candidate for source screening or verification before use within the CARA. A rebuttable-presumption approach could be considered, provided the City defines acceptable analytical or documentation criteria.
Moderate	Household and commercial diffuse sources	Strong evidence of PFAS use in consumer and commercial products, but	No single representative concentration range is appropriate because this category includes numerous products and release mechanisms.	Better addressed through education, waste management, procurement, housekeeping, and targeted source identification

Screening Priority	Source Category	Basis for Inclusion	Available Concentration Information	Regulatory / Source-Control Relevance
		source-to-stormwater pathways are diffuse and less directly controlled through development review.		rather than material restrictions alone.
Background / contextual	Atmospheric deposition and rainwater	Documented regional/background PFAS input pathway that can contribute PFAS even where no discrete local source is present.	Pfotenhauer et al. (2022) reported summed PFAS concentrations of approximately 0.7–6.1 ng/L in precipitation samples collected across Wisconsin; concentrations vary geographically and by analyte list and method.	Use as background/context for interpreting stormwater results rather than as a locally controllable source category.
Site-specific / data-dependent	UIC wells, dry wells, infiltration galleries, and infiltration BMPs	These features are not PFAS sources but may transmit PFAS-bearing stormwater toward the subsurface.	Not applicable as a source concentration. Relevant concentrations are those in the stormwater entering the system and, where treatment is used, the water following pretreatment.	Manage as pathway features through risk-differentiated review, source-water characterization, hydrogeologic evaluation, pretreatment where appropriate, O&M, and monitoring.

2.6. Deer Creek CARA: Available Information and Site Context

2.6.1. Land Use, Development Patterns, and Stormwater Exposure Pathways

Publicly available Deer Creek-specific technical information appears limited. Materials identified during this desktop review consist primarily of city permitting and planning pages confirming the Deer Creek CARA designation, Ecology guidance, and broader stormwater and groundwater-protection references. A substantial body of Deer Creek-specific peer-reviewed or agency case-study literature on PFAS transport through stormwater infiltration to the aquifer was not identified. Accordingly, the available local record is useful for framing land use, development pressure, infrastructure type, and plausible exposure pathways, but it is not sufficient by itself to resolve PFAS source attribution.

Available city materials indicate Deer Creek is a mapped CARA and projects within the Deer Creek and 228th Street CARA require coordination with city staff before stormwater systems are designed. This confirms Deer Creek is already treated as an aquifer-sensitive planning area in local permitting. City stormwater planning materials also indicate projected growth within city limits is concentrated in the Edmonds Marsh, Deer Creek, and Shell Creek watersheds, which makes development pressure in the Deer Creek watershed directly relevant to stormwater management and groundwater-recharge questions (City of Edmonds, 2026a; b).

The key publicly available documents and information sources identified during this desktop review and their relevance to land use, development patterns, and potential stormwater exposure pathways in the Deer Creek CARA are summarized in **Table 2**. As shown in Table 2, the available Deer Creek-specific record is limited and consists primarily of permitting materials, state guidance, public issue-history documents, and broader Washington analog sources rather than detailed, site-specific technical studies.

Stormwater-management conditions within the Deer Creek CARA are not uniform. Most of the CARA lies within closed drainage basins where no direct surface-water outlet is available and stormwater that is not managed through engineered infiltration must pond and ultimately infiltrate naturally unless it is collected and conveyed outside the basin. Other portions of the CARA drain toward Deer Creek and primarily discharge to the creek without infiltrating, including areas upstream of and near the wellhead. These drainage settings create different potential PFAS transport pathways and should be considered separately when evaluating stormwater-management alternatives.

In closed-basin areas, the relevant technical comparison may be between managed engineered infiltration and less-controlled natural infiltration rather than between infiltration and complete elimination of subsurface recharge. In areas draining to Deer Creek, a non-infiltration approach may instead transfer PFAS-bearing stormwater to a surface-water pathway. The relative significance of these pathways depends on stormwater flow and PFAS concentrations, infiltration characteristics, hydrogeologic connectivity, travel time, dilution, and receptor relationships. The current desktop review does not include the hydraulic or mass-flux information necessary to quantitatively rank these pathways.

Table 2. Summary of publicly available documents and their relevance to land use, development patterns and potential stormwater exposure pathways in the Deer Creek CARA

Data Source	What It Tells Us	Relevance to PFAS Source/Pathway Screening	Key Uncertainty/ Limitation
Deer Creek CARA drainage and stormwater-management information	Most of the CARA lies within closed drainage basins where stormwater may ultimately infiltrate unless it is collected and conveyed outside the basin. Other portions of the CARA drain toward Deer Creek, including areas upstream of and near the wellhead.	Establishes two distinct stormwater-management settings that should be considered in the PFAS pathway analysis: closed-basin areas where engineered and natural infiltration may represent alternative subsurface pathways, and areas where stormwater may be conveyed to a surface-water receptor.	Planning-level drainage context. This desktop review did not independently perform basin hydraulic modeling, quantify stormwater volumes, evaluate conveyance capacity, or calculate comparative PFAS mass loading to groundwater and surface-water receptors.
City of Edmonds Permit Assistance/ Permit Information Pages	Confirms Deer Creek is a mapped CARA and projects in the Deer Creek or 228th Street CARA require city coordination before stormwater design. (edmondswa.gov)	Establishes that Deer Creek is already treated as an aquifer-sensitive planning area where stormwater design is a special issue	Administrative pages; do not provide hydrogeologic detail, contaminant data, or source characterization
Edmonds Stormwater Management Action Planning Materials	States projected growth within city limits is concentrated in the Edmonds Marsh, Deer Creek, and Shell Creek watersheds. (ArcGIS StoryMaps)	Supports review of land use and development pressure as part of the Deer Creek pathway analysis	Planning-level information; not a PFAS investigation
Ecology Cara Guidance	Explains the purpose of CARAs and emphasizes protection of both groundwater quality and recharge function. (apps.ecology.wa.gov)	Provides the technical basis for why infiltration, land use, and contaminant pathways matter in this setting	Statewide guidance; not Deer Creek-specific and not PFAS-specific
Ecology PFAS Guidance	States PFAS contamination in Washington surface waters occurs mainly through stormwater and wastewater pathways. (apps.ecology.wa.gov)	Strong state-level support for including stormwater as a recognized PFAS pathway in Washington	Not Deer Creek-specific and not focused on CARA infiltration design
Olympic View PFAS Public Materials	Describes PFAS detections in stormwater and soils at the school site and frames concern around groundwater risk to the Deer Creek aquifer. (Olyview)	Identifies a local concern area and a claimed stormwater-to-groundwater pathway that should be acknowledged in the desktop review	Party-position source; should be treated as issue history rather than independent technical proof

Data Source	What It Tells Us	Relevance to PFAS Source/Pathway Screening	Key Uncertainty/ Limitation
Local news coverage of moratorium and study	Reports that the city paused development while conducting a PFAS study in Deer Creek and states city staff view infiltration as a key stormwater management issue in the basin. (HeraldNet.com)	Useful background for the policy and development context driving the study	News reporting; not a technical study
2024 Stormwater Management Manual for Western Washington	Provides the regional technical framework for stormwater quantity and quality control. (apps.ecology.wa.gov)	Useful for identifying likely facility types and stormwater design context in Edmonds	Not PFAS-specific and not Deer Creek-specific
Ecology Artificial Turf Runoff Study	Designed to assess whether Washington artificial turf installations release PFAS and other chemicals into stormwater runoff. (apps.ecology.wa.gov)	Relevant analog for screening school, playground, and recreational surfaces as possible PFAS runoff contributors	Statewide analog; not Deer Creek-specific
Ecology Greater Lake Washington PFAS Survey	Assesses PFAS sources and pathways in a developed Washington watershed. (apps.ecology.wa.gov)	Useful Washington urban-watershed analog for pathway framing	Different watershed and not a CARA-specific case study
Older regional groundwater references for Snohomish County	Provide broad groundwater and hydrogeologic context for western Snohomish County. (apps.ecology.wa.gov)	Potential supporting regional context for aquifer sensitivity and groundwater vulnerability	Old and too regional for Deer Creek-specific conclusions

Notes:
CARA = Critical Aquifer Recharge Area
Ecology = Washington State Department of Ecology
PFAS = per- and polyfluoroalkyl substance

At the state level, Ecology’s CARA guidance provides a broader technical context for why land use and stormwater pathways matter in this setting. The guidance emphasizes protection of both groundwater quality and recharge quantity and supports evaluation of hydrogeologic sensitivity, contaminant fate and transport, and land-use controls in recharge areas. Ecology’s PFAS guidance for Washington also states PFAS contamination of surface water in Washington occurs mainly through stormwater and wastewater pathways, which supports inclusion of stormwater infrastructure and runoff-generating land uses in the Deer Creek source/pathway review (Washington State Department of Ecology, 2021; 2023).

Based on the available information, potential PFAS inputs and transport pathways in the Deer Creek CARA include runoff from developed and weather-exposed surfaces, stormwater conveyance, engineered and natural infiltration, and, where a surface-water outlet is present, discharge toward Deer Creek or another receiving water. **Figure 1** provides a screening-level conceptual representation of these potential sources, transport pathways, and receptors and is intended to support pathway evaluation rather than depict confirmed Deer Creek-specific source mechanisms.

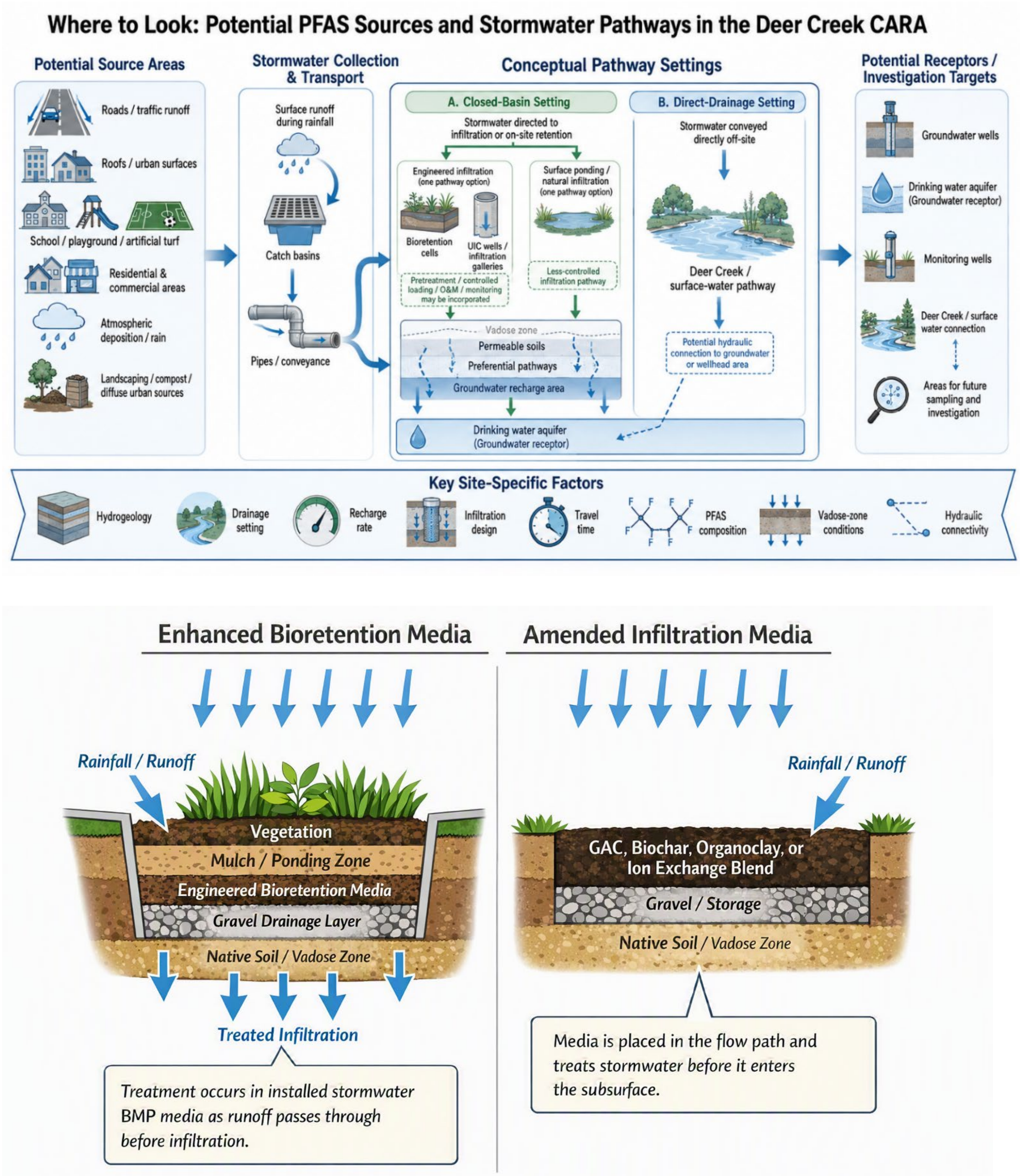

Figure 1. Conceptual model of potential PFAS sources and stormwater transport pathways in the Deer Creek CARA, including engineered and natural infiltration in closed-basin areas and surface-water discharge pathways in direct-drainage areas.

2.6.2. Madrona K-8 and Other Publicly Available PFAS Concern Information

Within this broader conceptual framework, the Madrona K-8 site represents the most prominent publicly documented local example of how PFAS-related source and pathway concerns have been framed in the Deer Creek CARA. Publicly available issue-history materials indicate PFAS detections at or near the Madrona K-8 School site have become a significant part of the Deer Creek CARA concern context. Public statements by Olympic View Water & Sewer District describe PFAS detections in stormwater and soils at the school site and identify concern regarding infiltration through underground injection systems above the Deer Creek aquifer. Recent local news coverage likewise indicates the city's current study was commissioned in the context of a development moratorium and ongoing concern over PFAS and stormwater infiltration in the Deer Creek CARA (Olympic View Water & Sewer District, 2026; Peterson, 2026; Wippel, 2026). These materials are not independent technical findings and should be treated as issue-history sources rather than conclusive evidence, however, they identify the types of pathway questions already being raised locally.

Publicly available litigation materials related to the Madrona K-8 School further indicate the site has become a focal point for local PFAS-related concern (Godwin, 2025). In a 2025 Safe Drinking Water Act complaint, filed by Olympic View Water & Sewer District against Edmonds School District Number 15, the plaintiff alleged stormwater discharged through 16 underground injection control (UIC) wells at Madrona K-8 may endanger the Deer Creek drinking water aquifer. The complaint states PFAS were detected in stormwater samples collected in 2022, 2023, and 2024 and in bioretention planter soils sampled in 2025; however, the filing does not present these reported concentrations as direct aquifer groundwater results.

Reported stormwater values in the filing include concentrations up to 32.2 ng/L PFOA and 18.9 ng/L PFOS. The filing also reports PFAS detections in bioretention planter soils and compares those reported values to federal Maximum Contaminant Levels and Washington State Action Levels; however, because the litigation materials present soil results in the same parts per trillion format used for water, the original laboratory reporting units for soil are not clear from the filing itself. The complaint further states Ecology issued a letter of concern in August 2024, indicating PFAS concentrations entering the UIC wells may violate the non-endangerment standard. Because these statements are drawn from litigation materials and public issue-history sources, they are best treated in this review as relevant site context and evidence of documented local concern. They should not be interpreted as final adjudicated findings regarding source attribution, aquifer groundwater concentrations, or aquifer impact.

2.6.3. Washington-Specific Analog Studies and Guidance

Washington-specific analog information is available even though Deer Creek-specific case studies are sparse. Ecology's 2024 Stormwater Management Manual for Western Washington provides the regional technical framework for stormwater quantity and quality management in western Washington. Ecology's statewide PFAS assessment planning documents also explicitly include stormwater outfalls, runoff from developed surfaces, and stormwater facilities in PFAS pathway investigations, supporting the broader relevance of stormwater infrastructure and developed-surface runoff in Washington PFAS assessments (Washington State Department of Ecology, 2024a; 2025b).

In addition, Ecology is conducting a Washington study on toxic chemicals in runoff from artificial turf installations that specifically includes PFAS, which is relevant to screening school and recreational surfaces as possible contributors in developed areas (Washington State Department of Ecology, 2024a). Ecology's Greater Lake Washington watershed PFAS survey is also useful as a Washington urban watershed analog because it evaluates sources and pathways of PFAS in a developed watershed, although it is not a CARA-specific study (Salamone, 2025; Washington State Department of Ecology, 2024a; b; 2025b; Wong, 2022). These Washington-specific sources provide useful regional context for evaluating potential PFAS source categories and stormwater-related transport pathways in Deer Creek. However, they should be treated as analogs and guidance rather than direct evidence of conditions at the Deer Creek CARA.

2.6.4. Interpretation of Local PFAS Information in Context of Published Literature

Published literature supports PFAS-bearing stormwater can represent a plausible pathway to groundwater in infiltration and recharge settings; however, the literature reviewed does not provide a reliable basis to infer a specific aquifer concentration from the stormwater concentrations reported at the Madrona K-8 site. Quantitative translation from stormwater concentration to groundwater concentration is strongly site-specific and depends on hydrogeology, vadose-zone attenuation, infiltration design, PFAS composition, and travel time (Edwards et al., 2022; Mumberg et al., 2024b).

Published stormwater literature also indicates the PFAS concentrations reported in the Madrona litigation materials are generally within the range of urban stormwater concentrations reported elsewhere, although the reported PFOA concentration appears to be at the upper end of several comparable studies. The litigation materials report stormwater concentrations up to 32.2 ng/L PFOA and 18.9 ng/L PFOS at the Madrona K-8 site. By comparison, Xiao et al. (2012) reported urban stormwater runoff concentrations up to 30.6 ng/L PFOA and 42.5 ng/L PFOS, while Houtz and Sedlak

(2012) reported urban runoff ranges of 2.1 to 16 ng/L for PFOA and 2.6 to 26 ng/L for PFOS. These comparisons suggest the Madrona stormwater values are not anomalous relative to published urban stormwater literature, although the reported PFOA concentration is somewhat elevated relative to some urban runoff datasets and above the residential-area values summarized by Xiao et al (Houtz and Sedlak, 2012; Washington State Department of Ecology, 2025a; Xiao et al., 2012). At the same time, broader urban studies have reported substantially higher total PFAS concentrations in stormwater, particularly where short-chain PFAS dominate.

The publicly raised concern regarding PFAS in stormwater within the Deer Creek CARA is reasonable considering the reported PFAS detections in stormwater and soil at the Madrona K-8 site, the presence of UIC systems, and the recharge-sensitive setting. However, the currently available information does not by itself establish direct aquifer contamination, identify a unique PFAS source mechanism, or quantify the relative contribution of engineered infiltration, natural infiltration, surface-water discharge, or other plausible PFAS transport pathways.

Accordingly, the reported stormwater detections should be interpreted as evidence that PFAS-bearing runoff warrants management within the CARA, rather than as evidence that a single stormwater-management pathway is inherently more or less protective. The relative significance of each pathway depends on stormwater PFAS concentrations and mass loading, infiltration configuration, hydrogeologic conditions, travel time, source controls, pretreatment where applicable, and the hydraulic relationship between stormwater, Deer Creek, groundwater, and drinking-water receptors.

2.7. PFAS Sampling Considerations and QA/QC Limitations

A key consideration in PFAS investigations is that sample collection and handling require especially stringent QA/QC procedures to minimize the risk of cross-contamination (Arcadis, 2022; ITRC, 2022). Multiple guidance documents note cross-contamination can occur from sampling equipment, ineffective decontamination, incidental contact with PFAS-containing materials, personal care products, food packaging, field clothing, and sample handling and shipment (Kidd et al., 2022; Pulster et al., 2024). For this reason, PFAS investigations typically rely on matrix-specific sampling precautions and multiple QC samples, such as trip blanks, equipment or rinse blanks, and field blanks, to help distinguish site-related detections from contamination introduced during collection, handling, transport, or analysis (Washington State Department of Ecology, 2023). Accordingly, PFAS detections reported in site investigations are most defensible when interpreted together with the associated QA/QC record, including the types of blanks collected, whether contamination was observed in blanks, and whether sampling materials and procedures were consistent with PFAS-specific guidance.

2.8. Key Data Gaps, Uncertainties, and Implications for Source Identification

The literature review and desktop assessment indicate that multiple plausible PFAS source categories and transport pathways may be relevant to the Deer Creek CARA, including atmospheric deposition, urban stormwater, building materials, recreational surfaces, and household or commercial product-related pathways. At present, however, the available information is not sufficient to identify a single dominant PFAS source or pathway for the Deer Creek setting. Rather, the existing record supports a multiple-lines-of-evidence interpretation in which several diffuse inputs may contribute to PFAS occurrence in developed recharge areas.

One of the most significant limitations is the scarcity of Deer Creek-specific technical information. Publicly available materials identified during this review consist primarily of planning and permitting documents, state guidance, litigation-related materials, and broader Washington analog studies, rather than detailed site-specific investigations of PFAS occurrence, fate, and transport in the Deer Creek CARA. As a result, current understanding of source areas, release mechanisms, and exposure pathways is based largely on plausibility, analogy, and conceptual pathway assessment rather than on a comprehensive local dataset. This limitation is particularly important because the published literature indicates PFAS occurrence and transport in recharge settings are strongly influenced by site-specific factors, including land use, stormwater routing, infrastructure design, hydrogeologic conditions, and vadose-zone characteristics.

A second major uncertainty concerns source attribution. Publicly available materials related to the Madrona K-8 site report PFAS detections in stormwater and bioretention soils; however, those materials do not present direct aquifer groundwater results and do not conclusively establish the original PFAS source. More broadly, the literature reviewed in this study indicates that PFAS concentrations in urban stormwater can reflect multiple overlapping inputs, including atmospheric deposition, weathered built-environment materials, treated products, and other diffuse urban sources. Accordingly, the currently available information does not support assigning the reported PFAS detections to a unique source category without additional site-specific evidence.

There is also substantial uncertainty in relating reported stormwater concentrations to potential aquifer impacts. Although published studies support the conclusion that PFAS-bearing stormwater can represent a plausible pathway to groundwater in infiltration and recharge settings, the literature reviewed does not provide a reliable basis for inferring specific groundwater concentrations from the stormwater concentrations reported in publicly available Deer Creek-related materials. Quantitative relationships between PFAS in stormwater and PFAS in groundwater depend on multiple site-specific variables, including vadose-zone attenuation, pretreatment, infiltration configuration, hydraulic connectivity, travel time, dilution, and compound-specific transport behavior. Consequently, the presence of PFAS in stormwater should be interpreted as evidence of a plausible pathway of concern, but not as direct evidence of aquifer impact (Adamson et al., 2026; Edwards et al., 2022; Mumberg et al., 2024a)

An additional source of uncertainty relates to data quality and interpretation of low-level PFAS detections. As discussed previously, PFAS sampling requires particularly stringent quality assurance and quality control measures because cross-contamination can occur from field materials, equipment, packaging, clothing, personal care products, and sample handling procedures. Interpretation of PFAS detections is therefore most robust when supported by complete QA/QC documentation, including blanks, rinsates, and matrix-specific sampling precautions. Where such information is incomplete, unavailable, or not clearly documented in public-facing materials, confidence in source-specific interpretation is correspondingly reduced.

An additional uncertainty concerns the ultimate disposition of stormwater within different portions of the Deer Creek CARA. Most of the CARA lies within closed drainage basins, where stormwater that is not managed through engineered infiltration may pond and ultimately infiltrate naturally unless it is collected and conveyed elsewhere. Other portions of the CARA may discharge toward Deer Creek, creating a distinct surface-water pathway. These hydrologic settings are important to PFAS management because eliminating an engineered infiltration facility does not necessarily eliminate subsurface recharge and, where stormwater is conveyed to a surface-water outlet, may instead redirect PFAS loading to another receptor.

The currently available information is not sufficient to quantitatively compare PFAS loading associated with engineered infiltration, natural infiltration, or direct surface-water discharge. Such a comparison would require additional information regarding drainage boundaries and routing, stormwater flow and volume, representative PFAS concentrations and profiles, infiltration characteristics, groundwater and surface-water connectivity, travel time, and receptor relationships. Consequently, the relative protectiveness of these pathways should be evaluated using site-specific hydrologic and PFAS information rather than assuming that avoidance of one stormwater pathway necessarily results in an overall reduction in PFAS risk.

Collectively, the available information and associated uncertainties have important implications for source identification and PFAS management in the Deer Creek CARA. First, the current record supports a screening-level conceptual model that includes multiple plausible PFAS source categories and transport pathways rather than assuming that a single source or pathway is responsible for observed detections. Second, the available information is sufficient to support targeted source-control and pathway-management measures, but it is not sufficient to establish direct aquifer contamination, quantify the relative contribution of individual PFAS sources, or quantitatively rank engineered infiltration, natural infiltration, and surface-water discharge pathways.

These limitations support use of a risk-differentiated management approach rather than a uniform assumption regarding PFAS sources or stormwater pathways. Section 3 evaluates the relative strengths and limitations of available mitigation and aquifer-protection alternatives within that framework.

3. Mitigation and Aquifer-Protection Alternatives

The available literature on PFAS-specific stormwater mitigation remains limited, and most stormwater BMPs were not developed specifically to remove dissolved PFAS. However, the current science supports a structured comparison of aquifer-protection alternatives based on whether a measure reduces PFAS inputs, reduces or redirects PFAS transport, treats stormwater before infiltration, or improves the City's ability to manage uncertainty through monitoring and adaptive decision-making. For the Deer Creek CARA, that comparison must also consider the hydrologic setting and the ultimate disposition of stormwater rather than evaluating an engineered infiltration facility in isolation.

Most of the Deer Creek CARA lies within closed drainage basins with no direct surface-water outlet. In these areas, stormwater that is not managed through engineered infiltration may pond and ultimately infiltrate naturally unless it is collected and pumped or conveyed outside the basin. Portions of the CARA outside the closed-basin areas drain toward Deer Creek upstream of and near the wellhead. These settings create different pathway considerations. In closed-basin areas, prohibiting an engineered infiltration facility may not eliminate subsurface recharge; instead, it may change where infiltration occurs and the degree to which pretreatment, hydraulic loading, operation and maintenance, and monitoring can be controlled. In areas with a feasible surface-water outlet, a non-infiltration approach may redirect PFAS-bearing stormwater to Deer Creek or another receiving water and therefore requires consideration of the receiving-water pathway as well.

Accordingly, the alternatives in **Table 3** are compared at two levels: (1) their ability to control or avoid intentional subsurface discharge at the project scale, and (2) their likely effect on the ultimate PFAS transport pathway at the basin and receptor scale. This distinction is important because preventing use of an engineered infiltration facility does not necessarily eliminate infiltration or PFAS transport from the watershed. The comparison is intended as a planning-level assessment based on currently available information; it does not constitute a basin-scale hydraulic analysis or a quantitative comparison of PFAS mass loading to groundwater versus surface-water receptors.

Table 3. Structured comparison of mitigation and aquifer-protection alternatives.

Alternative	Description	Relative PFAS Risk Reduction	Key Limitations	Applicability to Deer Creek CARA
Continue categorical or area-wide prohibition on engineered stormwater infiltration.	Prevents use of engineered infiltration facilities in designated areas. In closed-basin portions of the CARA, this does not necessarily prevent stormwater from entering the subsurface because unmanaged water may pond and infiltrate naturally unless it is collected and pumped or conveyed elsewhere.	Variable. High for avoiding intentional discharge through a regulated infiltration facility but potentially limited at the basin scale where stormwater still infiltrates naturally or is redirected to a different receptor.	Protective benefit depends on the feasible ultimate disposition of stormwater. A prohibition may remove the opportunity to require pretreatment, controlled hydraulic loading, enforceable operation and maintenance, and monitoring at an engineered infiltration facility. It may also require storage, pumping, conveyance, basin analyses, and downstream capacity.	Potentially defensible for discrete higher-risk sites where infiltration cannot be shown to be protective or where a feasible non-infiltration pathway exists. The available information does not establish a technical basis for treating categorical prohibition as uniformly the most protective strategy across the entire CARA.
Allow engineered infiltration under a tiered or conditional framework with enhanced pretreatment.	Allows shallow infiltration or selected UIC use where source controls, PFAS-relevant pretreatment, site-specific hydrogeologic review, enforceable operation and maintenance, and monitoring are incorporated. In closed-basin areas, engineered infiltration may provide a more controllable pathway than unmanaged ponding and natural infiltration because pretreatment, hydraulic loading, maintenance, and monitoring can be incorporated into the facility design and operation.	Moderate to high where source-water quality is controlled and treatment and hydrogeologic safeguards are demonstrated; uncertain where PFAS treatment performance or pathway conditions are not adequately characterized.	PFAS removal performance in stormwater remains an evolving area. Dissolved and shorter-chain PFAS can be difficult to remove, and performance may be affected by stormwater flow variability, sediment and organic matter loading, media breakthrough, maintenance, and replacement requirements. No pretreatment approach should be assumed to provide consistent PFAS removal without supporting performance data and operation and maintenance controls.	Potentially appropriate where infiltration is hydrologically necessary or preferred and site-specific review can support protective conditions. This approach may be particularly relevant in closed-basin areas and where shallow infiltration can be differentiated from deeper UIC configurations based on hydrogeologic setting and pathway risk.

Alternative	Description	Relative PFAS Risk Reduction	Key Limitations	Applicability to Deer Creek CARA
Use source-control material restrictions, certification, or documentation.	Reduces or documents the use of materials containing intentionally added PFAS, particularly major weather-exposed or high-surface-area materials with direct rainfall, runoff, or soil contact. Potential measures may include certification or manufacturer documentation for major building, roofing, paving, landscaping, turf, and other components with a plausible direct connection to stormwater or recharge soils.	Moderate to potentially high for controllable future sources, although the magnitude of reduction cannot be quantified from the current Deer Creek dataset.	Product-specific PFAS information may be incomplete or reported using different definitions and analytical approaches. Implementation would require clear definitions of covered materials, an appropriate product-content or analytical acceptance criterion, acceptable documentation, treatment of minor components, verification procedures, and consideration of product availability and administrative burden.	Strong near-term option because source control acts upstream of both infiltration and surface-water pathways and can be combined with either engineered infiltration or non-infiltration stormwater management. A focused certification and documentation program may provide a practical way to prioritize major weather-exposed materials without requiring testing of every individual component.
Use site-specific hydrogeologic and PFAS-risk review for higher-risk infiltration proposals.	Evaluates hydrostratigraphy, depth to groundwater, seasonal water-level conditions, infiltration rate, travel time, preferential pathways, UIC configuration, source-water quality, and proximity or hydraulic connection to drinking-water receptors.	Moderate to high where the review is supported by representative site-specific data and is tied to enforceable design, pretreatment, operation and maintenance, and monitoring requirements.	A hydrogeologic report does not by itself demonstrate that infiltration is protective. The technical value of the review depends on the quality and representativeness of the site data and whether PFAS source-water quality, infiltration design, preferential pathways, pretreatment performance, and receptor connectivity are adequately evaluated. The level of effort may also be disproportionate for small projects.	Most appropriate for larger redevelopment, deeper or higher-risk UIC configurations, substantial impervious areas, or projects near sensitive receptors. A site-specific review can also provide the technical basis for determining whether a proposed infiltration system should be allowed conditionally, modified, or restricted.

Alternative	Description	Relative PFAS Risk Reduction	Key Limitations	Applicability to Deer Creek CARA
Use lined, detained, conveyed, or treated non-infiltration systems.	Collects stormwater and manages it without intentional onsite subsurface discharge through storage, pumping, conveyance, treatment, reuse, or controlled surface-water discharge.	Variable. High for avoiding intentional onsite infiltration, but overall PFAS risk depends on the ultimate receiving pathway and whether PFAS-bearing stormwater is redirected to Deer Creek or another receptor.	May require substantial storage, pumping, conveyance infrastructure, downstream hydraulic capacity, land area, maintenance, and permitting. In closed-basin portions of the CARA, a feasible surface-water discharge point may not exist without additional infrastructure.	Most applicable where a technically and environmentally defensible receiving pathway is available. In closed-basin areas, feasibility may be limited unless new pumping or conveyance infrastructure is developed, and the receiving-water pathway should be evaluated rather than assuming that avoiding onsite infiltration necessarily reduces overall PFAS risk.
Use monitoring-based adaptive management.	Uses rainwater, stormwater, source-area, treatment-media, infiltration-system, vadose-zone, and groundwater data, as appropriate, to evaluate source strength, treatment performance, pathway behavior, and changing conditions over time.	Indirect but important for reducing uncertainty, verifying whether source controls and treatment measures are functioning as intended, and determining whether management requirements should be adjusted.	Monitoring does not reduce PFAS loading by itself and requires sustained sampling, data review, and clearly defined decision criteria. Because generally applicable PFAS action levels for municipal stormwater have not been established for the Deer Creek CARA, monitoring results should be interpreted using trends, treatment performance, applicable criteria for the relevant environmental medium, and multiple lines of evidence rather than a single universal stormwater threshold.	Important across the CARA because Deer Creek-specific PFAS source, stormwater, treatment-performance, and groundwater-pathway data remain limited. Monitoring can support a tiered management approach by providing information to maintain, modify, or strengthen source-control, pretreatment, infiltration, or other protective measures as additional data become available.

Alternative	Description	Relative PFAS Risk Reduction	Key Limitations	Applicability to Deer Creek CARA
Use standard stormwater BMPs without additional PFAS-specific controls.	Continues conventional stormwater management without PFAS-specific source controls, treatment-performance requirements, monitoring, or site-specific PFAS pathway evaluation.	Low to uncertain for PFAS-specific risk reduction. Conventional BMPs may reduce solids and particle-associated contaminants, but their effectiveness for dissolved PFAS is not well established.	Standard stormwater BMPs were generally not developed or validated specifically for PFAS removal. Their performance may vary substantially depending on PFAS composition, suspended solids, organic matter, hydraulic loading, and facility type. Absence of PFAS-specific controls also provides limited ability to verify whether PFAS loading or transport is being reduced.	Standard BMPs may remain an important component of stormwater management but are not sufficient, by themselves, to demonstrate PFAS protectiveness in a recharge-sensitive setting. They are best used as part of a broader framework that may include source control, site-specific review, monitoring, and PFAS-relevant pretreatment where warranted.

Viewed against the City's two recent regulatory approaches, the current prohibition on infiltration BMPs for new development provides certainty that new projects will not intentionally discharge stormwater through engineered infiltration facilities. In closed-basin portions of the CARA, however, this approach may not eliminate subsurface recharge if stormwater ultimately ponds and infiltrates naturally, and a true non-infiltration alternative may require collection, pumping, or conveyance to another discharge location. By comparison, the City's prior risk-differentiated approach, which distinguished deeper Class V UICs from shallow Class V UICs and required enhanced pretreatment for allowed infiltration, provided greater opportunity to manage where and how infiltration occurred through design requirements, pretreatment, operation and maintenance, and other project controls. However, the available information does not establish that the prior approach would consistently provide adequate PFAS protection because PFAS removal performance of stormwater treatment systems remains uncertain and subsurface transport is strongly dependent on site-specific hydrogeologic conditions. Accordingly, neither approach can be assumed to be categorically more protective across the entire CARA. A tiered approach that combines source control, risk-differentiated infiltration review, site-specific hydrogeologic evaluation, pretreatment where practicable, monitoring, and targeted restrictions where pathway risk cannot be adequately resolved is more consistent with the available technical evidence.

Any area-wide restriction on infiltration should also be evaluated within the City's broader stormwater-management and regulatory framework. Where infiltration is limited or unavailable, alternative stormwater management may require additional storage, pumping, conveyance, downstream capacity, or discharge infrastructure, particularly in closed-basin areas without an existing surface-water outlet. Such changes may also require additional basin-scale drainage and engineering analyses. Accordingly, the practical feasibility of a broad infiltration restriction depends not only on PFAS pathway considerations but also on consistency with applicable stormwater requirements, available infrastructure, and the feasibility of the ultimate discharge pathway.

Figures 2 and **3** illustrate conceptual examples of engineered treatment approaches that could be considered where PFAS-relevant pretreatment is evaluated as part of a conditional stormwater-management strategy. These figures are intended to illustrate potential treatment components rather than recommended or established treatment trains for the Deer Creek CARA. PFAS treatment of stormwater remains an evolving application, and treatment selection and performance would need to be evaluated under representative stormwater flow and water-quality conditions. Ecology's current Technology Assessment Protocol – Ecology (TAPE) framework establishes performance criteria for conventional stormwater treatment objectives such as suspended solids, oil, metals, and phosphorus, but does not currently establish a PFAS-specific stormwater treatment performance criterion (Ecology, 2026).

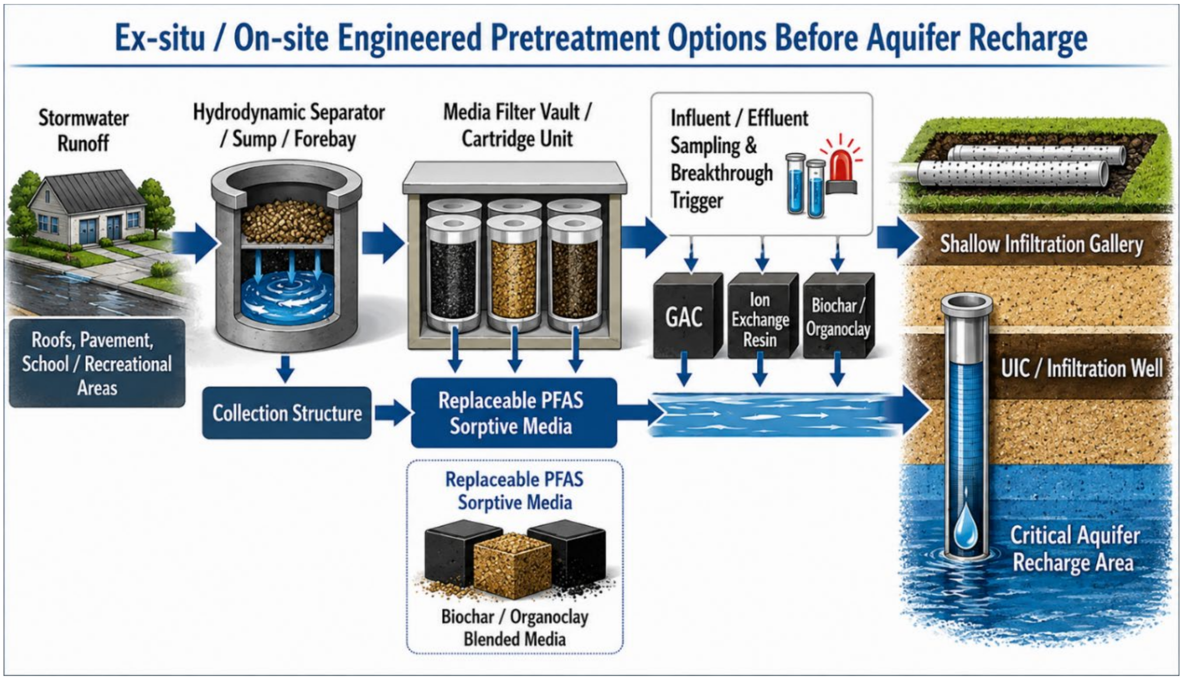

Figure 2. Conceptual ex-situ/on-site engineered pretreatment train for PFAS management before infiltration in a critical aquifer recharge area.

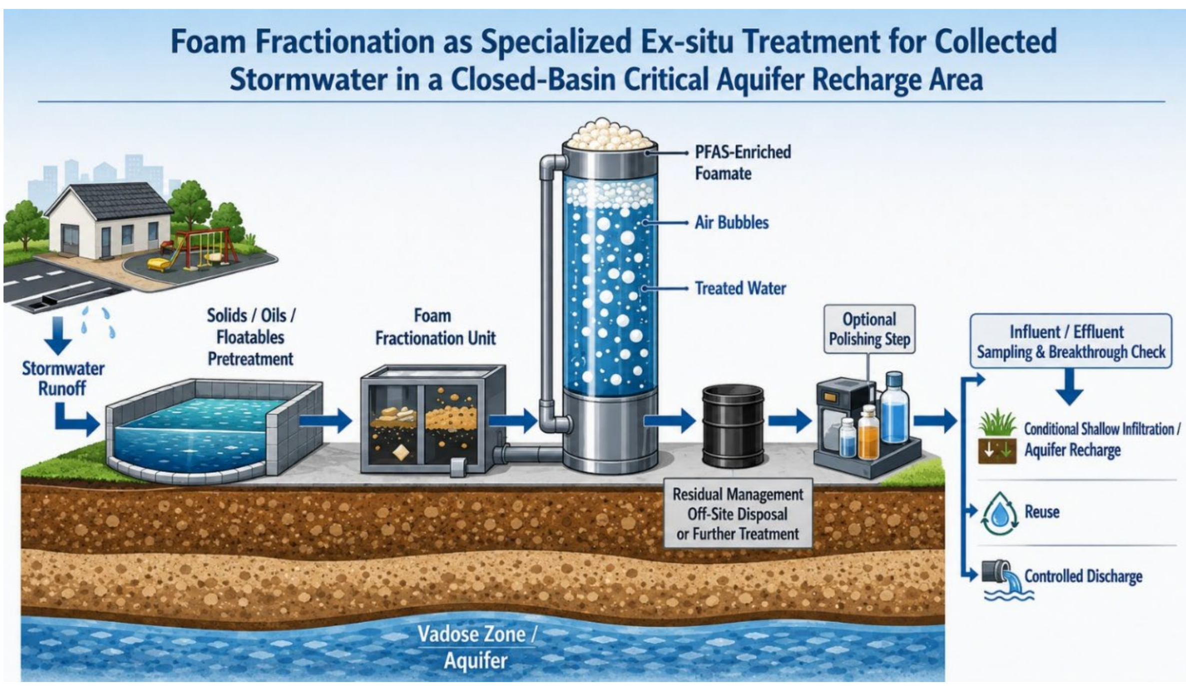

Figure 3. Conceptual ex-situ foam fractionation treatment train for collected PFAS-impacted stormwater before conditional recharge, reuse, or controlled discharge.

Based on this comparison, the most technically defensible approach is not reliance on a single CARA-wide measure. Rather, the City could combine source control, conditional engineered infiltration where supported by site-specific hydrogeologic information and appropriate safeguards, targeted restrictions for higher-risk infiltration configurations, PFAS-relevant pretreatment where practicable, and phased monitoring. A prohibition or restriction remains technically supportable where a proposed infiltration system could create a relatively direct pathway to groundwater, where PFAS source-water quality cannot be adequately controlled, where pretreatment and enforceable operation and maintenance cannot be demonstrated, or where site-specific information is insufficient to evaluate risk to a drinking-water receptor. Conversely, in closed-basin areas where stormwater would otherwise pond and infiltrate naturally, engineered infiltration with appropriate controls may provide greater ability to manage pretreatment, hydraulic loading, maintenance, and monitoring than uncontrolled infiltration. This tiered approach allows the City to apply more protective measures where pathway risk is greater while preserving flexibility to refine management decisions as additional Deer Creek-specific PFAS, drainage, and hydrogeologic information becomes available.

3.1. Conditional Framework for Class V UIC Wells and Infiltration Appropriateness

From a hydrogeologic and PFAS-risk perspective, a site-specific hydrogeologic report could provide useful scientific justification for evaluating whether a Class V UIC or other infiltration facility may be appropriate under specific site conditions. Class V UIC is a regulatory classification that can encompass infiltration systems with substantially different depths, configurations, and hydraulic relationships to groundwater. Accordingly, shallow infiltration systems and deeper UIC configurations should not be assumed to present equivalent PFAS transport risks. Shallow systems may preserve greater unsaturated-zone separation and residence time between the infiltration feature and groundwater, whereas deeper systems may bypass portions of the vadose zone and shorten the potential transport pathway to the aquifer. The significance of these differences is site-specific and depends on hydrostratigraphy, depth to groundwater, preferential pathways, infiltration rate, PFAS composition, and other transport conditions.

A site-specific report could therefore support a technically defensible decision regarding conditional infiltration, but it should provide representative site data sufficient to evaluate the potential PFAS migration pathway to the Deer Creek aquifer or drinking-water receptors and determine whether the proposed system can be managed with appropriate safeguards. The report should focus on the quality and representativeness of the hydrogeologic and PFAS data and on the ability to implement appropriate source controls, pretreatment, operation and maintenance, monitoring, and contingency measures.

A conditional framework is therefore recommended in which the level of review is matched to the potential PFAS pathway risk of the proposed infiltration system. Relevant factors include the depth and configuration of the infiltration feature, separation from groundwater, hydrostratigraphic conditions, potential preferential pathways, drainage-area PFAS source characteristics, representative source-water quality, pretreatment performance, hydraulic loading, operation and maintenance requirements, monitoring, and contingency measures. Shallow systems with substantial vadose-zone separation and lower-risk source areas may warrant a different level of review than deeper UIC configurations, systems that bypass portions of the unsaturated zone, or projects located near sensitive drinking-water receptors.

This framework would allow the City to distinguish among projects where available information supports conditional infiltration, projects where additional safeguards or technical evaluation are warranted, and projects where infiltration risk cannot be adequately resolved. The key technical elements for this site-specific evaluation are summarized in **Table 4**.

Table 4. Information to consider in a site-specific hydrogeologic and PFAS-risk evaluation for Class V UIC or infiltration proposals.

Evaluation Element	Information to Consider
Hydrostratigraphy	Soil borings, lithologic logs, depth to groundwater, confining or semi-confining layers, permeable zones, and potential preferential pathways.
Hydraulic setting	Recharge rate, infiltration rate, groundwater gradient, seasonal water-level variability, and groundwater mounding potential.
Travel time and unsaturated-zone residence	Estimated vertical and lateral travel time from the infiltration feature to groundwater and potential receptors, including the expected residence time within the unsaturated zone. The evaluation should consider whether the proposed infiltration configuration preserves meaningful vadose-zone separation or bypasses portions of the unsaturated profile, recognizing that longer residence time does not necessarily equate to effective PFAS removal and that attenuation is compound- and site-specific.
UIC configuration and subsurface pathway	Depth and configuration of the infiltration feature; presence and depth of horizontal perforated piping, open or screened intervals, or other subsurface discharge components; vertical separation from groundwater; thickness and characteristics of the unsaturated zone; and the potential for the system to bypass portions of the vadose zone or create preferential hydraulic pathways. The evaluation should distinguish shallow Class V UIC configurations from deeper injection structures based on their physical relationship to groundwater rather than regulatory classification alone.
Artesian or drilling risk	Assessment of artesian conditions, drilling-induced conduits, short-circuiting, and the potential for construction to create new hydraulic connections.
PFAS source water quality	Representative stormwater PFAS data for the proposed drainage area, not only literature values or assumptions.
PFAS-relevant pretreatment	Pretreatment configuration, media or treatment type, available evidence of PFAS removal under representative stormwater conditions, hydraulic loading and flow variability, sediment and organic matter loading, expected media life, breakthrough monitoring, maintenance requirements, and replacement schedule. Because PFAS treatment performance for stormwater remains an evolving area, proposed treatment should be evaluated using available performance data and should not be assumed to provide consistent removal of all PFAS under all operating conditions.

Evaluation Element	Information to Consider
Operation and maintenance enforceability	Inspection frequency, maintenance obligations, cartridge or media replacement procedures, sediment removal, and reporting commitments.
Monitoring	Influent/effluent stormwater monitoring, treatment-media monitoring, vadose-zone monitoring where feasible, and groundwater monitoring for larger or higher-risk projects.
Contingency and decision criteria	Pre-established decision criteria for additional evaluation, maintenance, media replacement, operational changes, temporary suspension of infiltration, retrofit, or other corrective action. Criteria may be based on increasing PFAS trends, treatment breakthrough or declining performance, changes in source-water quality, detections at relevant downgradient monitoring locations, or exceedance of applicable criteria for the environmental medium being evaluated. Because generally applicable PFAS action levels have not been established for municipal stormwater in the Deer Creek CARA, contingency decisions should rely on multiple lines of evidence rather than a single universal stormwater concentration threshold.

Therefore, site-specific hydrogeologic reports may provide a scientifically useful basis for evaluating Class V UIC or other infiltration proposals where they include adequate field data, characterize the physical relationship between the infiltration system and groundwater, evaluate travel time and preferential pathways, consider representative PFAS source-water quality, and address pretreatment, operation and maintenance, monitoring, and contingency measures as appropriate. Such reports should not rely on vadose-zone attenuation as a presumed protective mechanism; rather, any expected reduction in PFAS transport should be supported by site-specific hydrogeologic conditions and relevant technical evidence. For smaller residential projects, the cost and complexity of this level of review may limit practical usefulness unless the City develops a simplified, risk-tiered review process.

3.2. Multi-Media Monitoring Strategy

Because PFAS occurrence in the Deer Creek CARA may reflect overlapping atmospheric, stormwater, built-environment, and localized source inputs, no single monitoring medium is sufficient to resolve source attribution, pathway significance, or aquifer risk. A phased, multi-media monitoring strategy is therefore recommended. Near-term monitoring should include the planned rainwater sampling to establish atmospheric/background context, while representative stormwater and targeted source-area monitoring can be incorporated in future phases where additional source or pathway characterization is warranted.

Where engineered infiltration or Class V UIC systems are proposed or already present, monitoring may be expanded, as appropriate to project scale and risk, to characterize stormwater entering the infiltration system, evaluate pretreatment influent and effluent where treatment is used, assess treatment or bioretention media, and evaluate vadose-zone or groundwater conditions where warranted. Monitoring should be designed to support pre-established decision criteria and adaptive management rather than rely on a single universal PFAS concentration threshold. The recommended monitoring lines of evidence, their purpose, and their relative priority are summarized in **Table 5**.

Table 5. Recommended multi-media monitoring strategy for PFAS source and pathway evaluation.

Monitoring Line of Evidence	Purpose	Priority / Use
Rainwater sampling	Establish atmospheric/background PFAS input to the CARA and provide context for stormwater detections.	Near-term; already included in the project scope, pending suitable storm conditions.
Representative stormwater sampling	Evaluate PFAS concentrations and profiles in runoff before infiltration, discharge, or treatment.	High priority for understanding pathway risk and comparing with rainwater.
Source-area runoff sampling	Compare runoff from roofs, paved areas, school or recreational surfaces, landscaped areas, and redevelopment areas.	High priority if source-control or material restrictions are being considered.
Bioretention soil or media sampling	Evaluate PFAS accumulation and distribution within treatment or infiltration media and provide information on media condition and potential need for additional performance evaluation.	Moderate to high priority where bioretention receives runoff from developed surfaces.
Engineered infiltration or UIC influent and pretreatment-effluent monitoring	Characterize PFAS concentrations entering the infiltration system and evaluate whether pretreatment is reducing PFAS loading before infiltration. Where treatment is used, paired influent and effluent data can also be used to identify changes in performance, potential media breakthrough, and the need for maintenance or replacement.	High priority for larger, higher-risk, or conditionally approved infiltration systems where PFAS pretreatment is relied upon as a protective measure. Monitoring frequency and duration should be scaled to project risk, treatment configuration, stormwater variability, and the role of pretreatment in supporting continued infiltration.
Vadose-zone monitoring	Evaluate vertical migration through unsaturated materials where technically feasible.	Useful for larger or higher-risk projects but may be impractical for small residential sites.
Groundwater monitoring	Evaluate whether PFAS detected in stormwater or infiltrated water is hydraulically and chemically linked to groundwater conditions and assess whether concentrations or PFAS profiles change over time in locations relevant to potential drinking-water receptors.	Highest priority for larger or higher-risk infiltration systems, existing UIC systems of concern, or locations where hydrogeologic information indicates a plausible connection to sensitive groundwater receptors. Groundwater monitoring may not be warranted for every individual project and should be scaled to pathway risk, project size, existing monitoring infrastructure, and the value of the data for reducing uncertainty.

Monitoring should be interpreted using multiple lines of evidence rather than single-sample comparisons alone. Rainwater data can help distinguish atmospheric background input from localized runoff contributions; stormwater and source-area data can identify areas where runoff concentrations or PFAS profiles differ; pretreatment influent and effluent data can evaluate whether treatment is functioning as intended; and groundwater data can help determine whether infiltrated stormwater is hydraulically and chemically linked to groundwater conditions. Where stormwater is managed through a surface-water discharge rather than infiltration, monitoring may also be used to evaluate the receiving-water pathway and determine whether PFAS loading is being redirected rather than reduced. This multi-media strategy is consistent with the current uncertainty in the Deer Creek CARA and provides a practical basis for adaptive management and refinement of source-control, treatment, infiltration, and non-infiltration strategies over time.

4. Recommendations for PFAS Source Control, Stormwater Management, and Aquifer Protection

The recommendations below provide a practical, science-based framework for reducing potential PFAS inputs and managing PFAS transport pathways within the Deer Creek CARA. The recommendations are based on the literature review, available local information, and the limitations of the current Deer Creek-specific dataset. They are intended to support technical decision-making regarding source control, stormwater management, infiltration, monitoring, and development review rather than resolve legal or policy questions regarding specific code requirements.

Consistent with the comparative analysis in Section 3, the recommended approach emphasizes controls that reduce PFAS before runoff is generated, management of the ultimate stormwater pathway, risk-differentiated review of engineered infiltration, and monitoring to reduce uncertainty over time. Source-control measures are particularly important because they can reduce PFAS loading regardless of whether stormwater ultimately infiltrates to groundwater or is conveyed to a surface-water receptor. Because the current desktop record does not support definitive ranking of individual PFAS sources or quantitative comparison of pathway-specific PFAS loading within Deer Creek, the recommendations are organized using a tiered approach. Tier 1 recommendations identify measures that are supportable now based on available evidence and the recharge-sensitive setting. Tier 2 recommendations identify conditional measures that may be appropriate where site-specific information is available. Tier 3 recommendations identify monitoring and adaptive-management actions that can improve future decision-making. The overall recommendation framework is summarized in **Table 6**.

Table 6. Big-picture recommended approach for the Deer Creek CARA.

Recommendation Theme	Big-Picture Action	Reason for Including
Reduce PFAS inputs before runoff is generated.	Use a focused source-control framework for major weather-exposed and high-surface-area materials, supported by contractor certification, manufacturer documentation, or other verification tools. Priority materials may include roofing, exterior building materials, paving and surface treatments, landscaping materials, turf, and other components with direct rainfall or runoff contact.	Source control reduces potential PFAS loading before stormwater enters either the groundwater or surface-water pathway. It can therefore complement engineered infiltration, non-infiltration stormwater management, and monitoring without requiring the City to first determine the exact contribution of each individual material to PFAS concentrations in the CARA.

Recommendation Theme	Big-Picture Action	Reason for Including
Manage untreated infiltration based on pathway risk and site conditions.	Use a risk-differentiated approach that considers whether stormwater would otherwise infiltrate naturally, whether the proposed facility is shallow or deeper, the degree of vadose-zone separation, PFAS source-water quality, hydrogeologic conditions, and proximity or connection to drinking-water receptors. Restrict untreated infiltration where these factors indicate a higher or unresolved PFAS migration risk.	Engineered infiltration is a potential PFAS transport pathway, but prohibiting an infiltration facility does not necessarily eliminate subsurface recharge in closed-basin areas. The protective value of a restriction therefore depends on the site-specific pathway and the ultimate disposition of stormwater.
Use a tiered, risk-differentiated review framework.	Differentiate among shallow infiltration systems, deeper Class V UIC configurations, closed-basin versus direct-discharge settings, project scale, PFAS source-water characteristics, weather-exposed source materials, and proximity or hydraulic connection to sensitive receptors. Match the level of hydrogeologic review, source-control documentation, pretreatment, monitoring, and other safeguards to the potential pathway risk.	Infiltration systems with different depths, configurations, source areas, and hydrogeologic settings do not present equivalent PFAS transport risks. A tiered framework allows the City to apply more stringent requirements where pathway risk or uncertainty is greater while avoiding unnecessary requirements for lower-risk projects.
Evaluate PFAS-relevant pretreatment where infiltration is considered.	Where pretreatment is relied upon as part of a conditional infiltration approach, evaluate treatment options using available PFAS performance data under representative stormwater conditions. Consider treatment configuration, hydraulic loading, sediment and organic matter loading, media life, breakthrough, maintenance, replacement requirements, and the ability to verify performance through monitoring.	Conventional stormwater BMPs can provide important sediment and runoff-quality control but generally have not been validated specifically for removal of dissolved PFAS. PFAS treatment performance in stormwater remains an evolving area, particularly for shorter-chain compounds; therefore, pretreatment should be treated as a project-specific protective measure rather than assumed to provide uniform PFAS removal.
Use monitoring and adaptive management to reduce uncertainty over time.	Use rainwater, representative stormwater, source-area, pretreatment-performance, infiltration-system, and groundwater data, as appropriate to project scale and pathway risk, as multiple lines of evidence. Establish pre-defined decision criteria for when monitoring results should trigger additional evaluation, maintenance, treatment modification, or changes to infiltration or other stormwater-management requirements.	Monitoring can verify whether source-control and pretreatment measures are functioning as intended, help distinguish among potential PFAS pathways, and provide the technical basis for adjusting management requirements as local data and PFAS science evolve. Decision-making should rely on trends, treatment performance, applicable criteria for the relevant environmental medium, and multiple lines of evidence rather than a single universal stormwater PFAS threshold.

4.1. Tier 1: Measures Based on Existing Evidence

Recommendation 1: Prioritize PFAS source control as the first line of protection. The most direct near-term strategy for reducing future PFAS loading is to limit controllable PFAS inputs before they enter stormwater. This approach is applicable regardless of whether stormwater is ultimately managed through engineered infiltration, natural infiltration, or surface-water discharge. The literature supports PFAS use in a broad range of built-environment and outdoor product categories, including exterior coatings, sealants, waterproofing products, roofing and façade materials, specialty surface treatments, artificial turf components, and other weather-exposed materials. Although the relative contribution of individual material categories to PFAS loading in the Deer Creek CARA cannot be quantified from the current desktop record, the documented use of PFAS in these categories provides a technical basis for targeted source-control measures.

Source-control measures should focus on major weather-exposed or high-surface-area materials with direct rainfall, runoff, or soil contact. Potential implementation mechanisms include material certification, manufacturer documentation, procurement requirements, and targeted verification. Recommendations 2 and 5 provide additional considerations for prioritizing material categories and establishing a practical certification and verification framework. Implementation could begin with voluntary guidance or limited priority materials before broader application.

Recommendation 2: Prioritize weather-exposed materials with direct stormwater or soil pathways. Not all potential PFAS-containing materials present the same likelihood of contributing to stormwater or recharge-area loading. Source-control requirements should therefore focus first on materials that are installed outdoors, have relatively large, exposed surface areas or are applied in substantial quantities, are subject to rainfall, weathering, abrasion, or leaching, and are hydrologically connected to stormwater conveyance, infiltration features, or recharge soils. Examples include roofing and exterior waterproofing products, façade treatments, specialty pavement and surface treatments, artificial turf, playground surfacing, and selected landscaping materials.

Compost warrants separate consideration because it is typically applied directly to the land surface in relatively large quantities and may have direct contact with precipitation, runoff, and infiltrating water. Where available information indicates that compost or similar organic amendments may contain PFAS, the City could consider requiring documentation demonstrating that the material meets an established PFAS-related acceptance criterion before use within the CARA. A rebuttable-presumption approach, under which compost is treated as a potential PFAS source unless acceptable documentation or analytical information demonstrates otherwise, could provide a conservative screening mechanism while allowing use of materials for which PFAS concerns have been adequately addressed. The specific analytical basis, concentration criterion, sampling requirements, and acceptable documentation for such a program would need to be defined before implementation.

Indoor consumer products and minor exterior components may contribute to broader urban PFAS loading but are generally less suitable for development-review controls where their quantity, exposed surface area, or hydrologic connection is limited. Prioritizing materials based on the strength of available evidence, potential material quantity or exposed surface area, and pathway relevance can reduce administrative burden while focusing source-control efforts on materials with greater potential to influence stormwater or recharge.

Recommendation 3: Treat stormwater infiltration as a pathway-management issue, not as a PFAS source by itself. UIC wells, infiltration galleries, dry wells, and other infiltration BMPs do not create PFAS; rather, they may provide a pathway by which PFAS-bearing stormwater is introduced to the subsurface. The significance of that pathway depends on source-water quality, infiltration depth and configuration, vadose-zone conditions, preferential pathways, travel time, and hydraulic connection to groundwater receptors.

Management decisions should therefore distinguish between controls that reduce PFAS loading and controls that manage where PFAS-bearing stormwater ultimately travels. In closed-basin portions of the CARA, prohibiting an engineered infiltration facility may not eliminate infiltration if stormwater subsequently ponds and infiltrates naturally. In areas where stormwater can be conveyed to a surface-water outlet, avoiding onsite infiltration may instead redirect PFAS loading to Deer Creek or another receiving water. Accordingly, source control reduces PFAS loading regardless of the ultimate stormwater pathway, while infiltration, conveyance, pretreatment, and monitoring requirements are pathway-management tools that should be selected based on site-specific hydrologic and receptor conditions.

Recommendation 4: Apply restrictions on untreated infiltration where pathway risk is elevated or cannot be adequately resolved. Untreated stormwater infiltration may warrant restriction where site conditions indicate a comparatively direct or insufficiently characterized pathway to groundwater. Relevant factors include infiltration depth and configuration, limited separation from groundwater, potential preferential pathways, higher-risk PFAS source areas, proximity or hydraulic connection to drinking-water receptors, and insufficient information regarding source-water quality, travel time, or subsurface transport conditions.

Restrictions should be applied based on these pathway-specific factors rather than as a uniform assumption that prohibiting engineered infiltration will eliminate PFAS transport.

In closed-basin portions of the CARA, stormwater may ultimately infiltrate through ponding or other natural pathways if engineered infiltration is not available, unless an alternative collection and conveyance system is provided. Under those conditions, an engineered infiltration system that incorporates source controls, pretreatment where appropriate, controlled hydraulic loading, enforceable operation and maintenance, and monitoring may provide greater management control than uncontrolled infiltration. Conversely, where a proposed infiltration configuration could bypass substantial portions of the vadose zone, create a preferential pathway, or otherwise result in unresolved risk to a drinking-water receptor, restriction or prohibition remains a technically supportable protective measure.

Recommendation 5: Establish a clear certification, documentation, and verification framework for source-control requirements. If the City implements material-based PFAS source controls, the compliance framework should clearly define the materials subject to review, the applicable PFAS criterion, acceptable documentation, treatment of minor components, and circumstances requiring additional verification. Focusing requirements on major weather-exposed or high-surface-area components with direct rainfall, runoff, or soil contact would provide a more targeted and practicable approach than attempting to regulate or verify every individual product used in construction or landscaping.

For manufacturing building, paving, and landscaping products, a practical first level of review could rely on contractor certification supported by manufacturer specification sheets, manufacturer declarations, safety or technical product information, or recognized third-party documentation. Roofing and other major weather-exposed materials are particularly suitable for this approach because of their large surface area and direct rainfall contact; manufacturer specification information should accompany the certification where available. Minor components could be addressed through a simplified or exempted process where their quantity, exposed surface area, or hydrologic connection indicates a comparatively low potential contribution to PFAS loading.

The compliance framework should distinguish between a product-content criterion and an analytical concentration threshold. For manufactured products, a criterion based on whether PFAS are intentionally added may be more readily implemented through manufacturer documentation than a numerical concentration threshold applied across substantially different material types. A single concentration threshold should not be assumed to have equivalent technical meaning for roofing, coatings, paving products, turf, landscaping materials, and other matrices. If the City elects to establish numerical acceptance criteria, the requirements should clearly define the PFAS analytes or measurement approach, applicable material matrix, sampling and sample-preparation procedures, analytical method, reporting limits, and interpretation of non-detect results.

Bulk materials such as compost or other organic soil amendments may warrant a different verification approach because PFAS content can reflect feedstocks and manufacturing inputs that may not be adequately characterized through a manufacturer declaration alone. For these materials, analytical verification may provide a more appropriate basis for demonstrating compliance. The current desktop review does not provide a sufficient technical basis for establishing a single health- or risk-based numerical PFAS concentration threshold applicable to all materials within the CARA; development of any numerical criteria should therefore consider material type, analytical capability, regulatory context, and the specific source-control objective.

Verification should be scaled to potential source significance and uncertainty. Routine laboratory testing of every manufactured product is unlikely to be necessary or practical where adequate documentation is available. Periodic third-party review, targeted verification of higher-priority materials, or additional documentation where certifications are incomplete could provide quality assurance while limiting administrative burden. The framework should also be designed to accommodate changes in product availability, manufacturer disclosure practices, analytical capabilities, and PFAS regulation over time.

The regulatory and product-information landscape for PFAS continues to evolve, including state initiatives that restrict or require reporting of intentionally added PFAS in selected product categories (Washington State Department of Ecology, 2025a). These developments may improve product transparency and reduce PFAS use over time but do not currently provide comprehensive requirements for the full range of roofing, paving, landscaping, and construction materials relevant to the Deer Creek CARA. Accordingly, any local source-control framework should be periodically reviewed and adjusted as state or federal requirements and market practices evolve. Product disclosures and PFAS-free claims should be interpreted based on the definitions and reporting requirements applicable at the time of review.

4.2. Tier 2: Conditional Measures Where Site-Specific Information Is Available

Recommendation 6: Use site-specific hydrogeologic and PFAS-risk information to support conditional infiltration decisions. A site-specific hydrogeologic evaluation can provide a technical basis for determining whether an engineered infiltration system or Class V UIC configuration may be appropriate under particular site conditions. The evaluation should be risk-based and should consider the physical configuration of the proposed infiltration system, the ultimate stormwater pathway, and the relationship between the infiltration feature and groundwater.

At a minimum, the evaluation should address hydrostratigraphy, depth to groundwater, seasonal groundwater variability, infiltration rate, vertical and lateral travel time, preferential pathways, groundwater flow direction, hydraulic connection to drinking-water receptors, and the potential for the proposed system to bypass portions of the unsaturated zone.

Where PFAS is a concern, the evaluation should include representative stormwater PFAS data for the contributing drainage area, information regarding higher-priority PFAS source materials, and an assessment of any source-control or pretreatment measures relied upon to reduce PFAS loading. Operation and maintenance requirements, monitoring, and contingency measures should also be considered where they are necessary to support continued infiltration.

A site-specific report should not be considered protective solely because it has been prepared. Rather, it should provide sufficient information to determine whether the proposed infiltration pathway can be managed with reasonable safeguards or whether additional controls, design modifications, monitoring, or restrictions are warranted.

Recommendation 7: Distinguish shallow infiltration and shallow Class V UIC configurations from deeper UIC systems based on physical pathway characteristics. Class V UIC is a regulatory classification that may encompass infiltration systems with substantially different depths, configurations, and relationships to groundwater. Accordingly, systems should not be assigned the same PFAS pathway risk solely because they fall within the same regulatory category.

Shallow bioretention, infiltration trenches, or shallow Class V UIC configurations may preserve greater separation from groundwater and longer residence within the unsaturated zone than deeper UIC systems. Deeper configurations may bypass portions of the soil profile or substantially shorten the vertical pathway between stormwater discharge and groundwater. These differences can affect travel time and the opportunity for interaction with soil and vadose-zone materials; however, greater vadose-zone thickness or residence time should not be assumed to provide reliable PFAS removal because PFAS mobility and retention are compound- and site-specific.

The level of technical review should therefore be based on system depth and construction, separation from groundwater, hydrostratigraphy, potential preferential pathways, source-water PFAS characteristics, and proximity or hydraulic connection to drinking-water receptors. Deeper UIC configurations or systems that bypass substantial portions of the unsaturated zone generally warrant greater technical scrutiny than shallow systems that maintain substantial vadose-zone separation, while recognizing that site-specific conditions ultimately determine pathway risk.

Recommendation 8: Evaluate PFAS-relevant pretreatment where it is relied upon to support conditional infiltration. Where pretreatment is used as part of the technical basis for allowing engineered infiltration, its expected performance should be evaluated under representative stormwater conditions rather than assumed from drinking-water or other treatment applications. Conventional stormwater BMPs can provide important sediment, particulate, and runoff-quality control, but they generally have not been demonstrated to provide consistent removal of dissolved PFAS, particularly shorter-chain PFAS.

PFAS-specific stormwater treatment remains an evolving area, and treatment performance can be affected by stormwater flow variability, suspended solids, dissolved organic matter, competing constituents, contact time, and hydraulic loading. Advanced treatment approaches such as sorptive media, granular activated carbon, ion exchange, specialized filter media, or other PFAS-relevant technologies may reduce PFAS under appropriate conditions, but their feasibility and effectiveness should be supported by applicable performance data rather than assumed to be transferable directly from drinking-water treatment.

Where pretreatment is proposed, the evaluation should address treatment configuration, available PFAS removal data, design flow and hydraulic loading, sediment and organic matter management, media life, breakthrough, replacement frequency, operation and maintenance, and a method for verifying performance over time. Pretreatment should therefore be treated as one component of a broader protective framework that includes source control, appropriate infiltration design, hydrogeologic review, and monitoring where warranted, rather than as a stand-alone assurance of PFAS protection.

Recommendation 9: Use a tiered, risk-based decision framework for development review. The City could use a structured decision process that matches source-control, hydrogeologic review, pretreatment, monitoring, and other requirements to the potential PFAS source and pathway risk of a proposed project. Relevant screening factors may include the location of the project within a closed-basin or direct-discharge area, the type and depth of any proposed infiltration system, separation from groundwater, project size and impervious area, proximity or hydraulic connection to drinking-water receptors, the presence of higher-priority PFAS source materials, and whether source-control documentation or certification is available.

Lower-risk projects may require primarily source-control documentation and standard stormwater requirements where no significant PFAS source materials or higher-risk infiltration pathways are present. Projects involving major weather-exposed materials could require contractor certification and supporting manufacturer documentation consistent with the source-control framework described above. Projects involving shallow engineered infiltration may warrant additional review of source-water quality, pretreatment, operation and maintenance, and site-specific hydrogeologic conditions where appropriate. Higher-risk projects involving deeper UIC configurations, limited vadose-zone separation, substantial impervious areas, higher-priority PFAS source areas, or sensitive receptors may warrant a more detailed hydrogeologic and PFAS-risk evaluation, pretreatment-performance assessment, and monitoring.

The decision framework should also account for the ultimate disposition of stormwater. In closed-basin areas, the comparison may be between managed engineered infiltration and natural ponding and infiltration rather than between infiltration and complete pathway elimination. In areas with a feasible surface-water outlet, the evaluation should consider whether non-infiltration management would redirect PFAS-bearing stormwater to Deer Creek or another sensitive receiving water. This approach would allow the City to apply requirements proportionate to source and pathway risk while avoiding a uniform regulatory response to projects with substantially different hydrologic and PFAS characteristics.

4.3. Tier 3: Monitoring and Adaptive Management Recommendations

Recommendation 10: Implement a phased, risk-based multi-media monitoring strategy using multiple lines of evidence. A single sampling medium is unlikely to resolve PFAS source attribution, pathway significance, or aquifer risk in the Deer Creek CARA. PFAS occurrence may reflect overlapping inputs from atmospheric deposition, stormwater runoff, built-environment materials, landscaping materials, and localized source areas. Monitoring should therefore be phased and scaled to the management question, project size, and potential source and pathway risk.

Rainwater sampling can establish atmospheric or regional background context. Representative stormwater sampling can characterize PFAS concentrations and profiles before infiltration or surface-water discharge. Source-area runoff sampling can help distinguish contributions from roofs, paved surfaces, landscaping areas, school or recreational surfaces, and other land uses, particularly where source-control measures are being evaluated. Where pretreatment is relied upon as part of a conditional infiltration approach, paired influent and pretreatment-effluent monitoring can be used to evaluate treatment performance and identify potential breakthrough. Treatment or bioretention-media sampling may provide additional information regarding PFAS accumulation and system performance.

Groundwater monitoring should be considered where project scale, UIC configuration, hydrogeologic conditions, or proximity to sensitive receptors indicate that the information would materially improve evaluation of the groundwater pathway. It should not be assumed necessary for every individual project. Where stormwater is conveyed to a surface-water outlet rather than infiltrated, monitoring may also be appropriate to evaluate the receiving-water pathway and determine whether PFAS loading is being reduced or redirected. Monitoring results should be interpreted collectively and used to refine source-control, treatment, infiltration, and other stormwater-management requirements over time.

Recommendation 11: Use monitoring to support adaptive management rather than one-time decision-making. PFAS science, analytical methods, treatment performance information, regulations, and product-use practices continue to evolve. The City should therefore treat PFAS management in the Deer Creek CARA as an adaptive process in which requirements can be refined as additional local information becomes available.

Monitoring results should be periodically reviewed to determine whether source-control requirements, pretreatment measures, infiltration conditions, monitoring programs, or other stormwater-management controls remain appropriate as new information becomes available. This adaptive approach is particularly useful where uncertainty remains regarding source contribution, treatment effectiveness, or the relative importance of groundwater and surface-water pathways. Recommendation 12 describes the decision criteria that can be used to determine when additional evaluation or corrective action is warranted.

Recommendation 12: Establish clear decision criteria for additional evaluation or corrective action. Where monitoring is used to support source control, pretreatment, engineered infiltration, or other stormwater-management decisions, the City should establish pre-established decision criteria identifying when additional evaluation, maintenance, treatment-media replacement, operational changes, enhanced monitoring, temporary suspension of infiltration, retrofit, or other corrective measures should be considered.

Decision criteria may include increasing PFAS concentration trends or changes in PFAS profiles; evidence of treatment breakthrough or declining pretreatment performance; changes in source-water quality; detections at relevant downgradient groundwater or receiving-water monitoring locations; or exceedance of applicable criteria for the environmental medium being evaluated. The appropriate response should depend on the weight of evidence, the location and significance of the monitoring result, and the potential pathway to sensitive receptors.

Because generally applicable PFAS action levels have not been established for municipal stormwater in the Deer Creek CARA, the City should not rely on a single universal stormwater concentration threshold as the sole basis for corrective action. Instead, decision criteria should combine trends, treatment performance, applicable groundwater or drinking-water criteria where relevant, source and pathway information, and other lines of evidence appropriate to the management objective.

Table 7. Summary of recommended PFAS risk-reduction measures for the Deer Creek CARA.

Recommendation	Timing	Technical Basis	Implementation Consideration
Prioritize PFAS source control for major weather-exposed and high-surface-area materials.	Near-term	PFAS use is documented in multiple built-environment and outdoor product categories, including coatings, sealants, waterproofing products, roofing materials, specialty surface treatments, turf, and other weather-exposed materials. Source control reduces potential PFAS loading before stormwater enters either groundwater or surface-water pathways.	Could be implemented through contractor certification, manufacturer documentation, product specification sheets, procurement requirements, or project conditions focused on major materials with direct rainfall or runoff contact. Requirements should define covered materials, acceptable documentation, treatment of minor components, and appropriate verification procedures.
Establish a certification and documentation framework for covered materials.	Near-term	Manufacturer and contractor documentation may provide a practical screening mechanism for manufactured products where routine laboratory testing of every product would be impractical.	Define covered materials, acceptable certifications, supporting manufacturer information, treatment of minor components, and verification procedures. For manufactured products, an "intentionally added PFAS" criterion may be more readily implemented than a single numerical concentration threshold across dissimilar material types.
Apply targeted source-control requirements to compost and other bulk organic amendments where appropriate.	Near-term	Compost is applied directly to the land surface in relatively large quantities and may have direct contact with precipitation, runoff, and infiltrating water. Where PFAS are present, this creates a relatively direct soil and recharge pathway.	The City could consider treating compost as a potential PFAS source unless acceptable documentation or analytical information demonstrates otherwise. Any analytical acceptance criterion should define the PFAS analytes or measurement approach, sampling method, reporting limits, and applicable material matrix.
Manage untreated infiltration based on pathway risk and site conditions.	Near-term	Engineered infiltration is a potential PFAS transport pathway, but prohibiting an infiltration facility does not necessarily eliminate subsurface recharge in closed-basin areas. The protective value of restriction depends on infiltration configuration, source-water quality, hydrogeology, and the ultimate disposition of stormwater.	Restrict untreated infiltration where pathway risk is comparatively high or unresolved. In closed-basin settings, also consider whether eliminating engineered infiltration would result in natural ponding and infiltration or require new collection and conveyance infrastructure.
Distinguish shallow infiltration and shallow Class V UIC configurations from deeper UIC systems.	Near-term	Systems within the Class V regulatory category may have substantially different physical relationships to groundwater. Deeper systems may bypass greater portions of the unsaturated zone and shorten the potential transport pathway.	Base the level of technical review on system depth and construction, vadose-zone separation, hydrostratigraphy, preferential pathways, source-water quality, and receptor proximity rather than regulatory classification alone.
Use site-specific hydrogeologic and PFAS-risk information to support conditional infiltration decisions.	Conditional	Infiltration risk depends on hydrostratigraphy, groundwater depth, travel time, preferential pathways, source-water PFAS concentrations, and hydraulic connection to drinking-water receptors.	Most appropriate for larger projects, deeper or higher-risk UIC configurations, substantial impervious areas, or projects near sensitive receptors. A hydrogeologic report should inform the decision but should not be considered protective solely because it has been prepared.
Evaluate PFAS-relevant pretreatment where it is	Conditional	Conventional stormwater BMPs provide important sediment and runoff-quality control but generally have	Evaluate available performance data under representative stormwater conditions, including

Recommendation	Timing	Technical Basis	Implementation Consideration
relied upon to support conditional infiltration.		not been demonstrated to provide consistent removal of dissolved PFAS. PFAS stormwater-treatment performance remains an evolving area.	hydraulic loading, sediment and organic matter loading, media life, breakthrough, maintenance, replacement, and monitoring. Pretreatment should not be treated as a stand-alone assurance of PFAS protection.
Use a tiered, risk-based development-review framework.	Near-term / Conditional	Projects with different source materials, infiltration configurations, hydrogeologic settings, and receptor relationships do not present equivalent PFAS pathway risks.	Match source-control documentation, hydrogeologic review, pretreatment, monitoring, and other safeguards to project risk. Include closed-basin versus direct-discharge setting, shallow versus deeper infiltration, project scale, source materials, and receptor proximity as screening factors.
Conduct rainwater monitoring.	Near-term / ongoing	Establishes atmospheric deposition and regional/background PFAS input and provides context for interpreting stormwater concentrations.	Already included in the current project scope, pending suitable storm conditions. Interpret in conjunction with stormwater and source-area results rather than as a stand-alone indicator of local source strength.
Conduct targeted stormwater and source-area monitoring.	Future phase	Needed to refine source attribution, characterize PFAS concentrations and profiles in runoff, and compare potential contributions from different weather-exposed surfaces and land uses.	Could focus on roofing, paved surfaces, landscaping areas, school/recreational surfaces, and other priority source categories. Where stormwater is conveyed to surface water, monitoring can also help evaluate whether PFAS loading is being redirected to Deer Creek or another receiving water.
Monitor pretreatment performance where treatment is relied upon for conditional infiltration.	Future phase / Conditional	Paired influent and pretreatment-effluent data can determine whether treatment is reducing PFAS loading and identify declining performance or media breakthrough.	Highest priority for larger or higher-risk systems where treatment performance is an important basis for continued infiltration. Monitoring frequency should reflect stormwater variability, treatment design, and pathway risk.
Use groundwater monitoring where technically warranted.	Future phase / Conditional	Groundwater data can help determine whether infiltrated stormwater is hydraulically and chemically linked to groundwater conditions and sensitive drinking-water receptors.	Highest priority for larger or higher-risk infiltration systems, existing UIC systems of concern, or locations where hydrogeologic information indicates a plausible connection to sensitive receptors. Groundwater monitoring is not necessarily warranted for every individual project.
Use pre-established decision criteria and adaptive management.	Ongoing	PFAS science, treatment performance, product use, analytical methods, and regulatory requirements continue to evolve. Monitoring provides a basis for adjusting controls as additional information becomes available.	Decision criteria may consider PFAS trends or profile changes, treatment breakthrough, source-water changes, downgradient detections, and applicable criteria for the relevant environmental medium. Avoid reliance on a single universal municipal-stormwater PFAS threshold where one has not been established.

Based on the current desktop review, the most technically defensible approach for the Deer Creek CARA is a tiered framework that combines PFAS source control, risk-based stormwater pathway management, site-specific review where infiltration risk is elevated or uncertain, PFAS-relevant pretreatment where relied upon as a protective measure, and monitoring and adaptive management to reduce uncertainty over time. Source control is particularly important because it can reduce PFAS loading before stormwater enters either groundwater or surface-water pathways.

The appropriate stormwater-management approach should account for site-specific hydrology, infiltration configuration, source-water quality, available controls, and the ultimate receiving pathway. Additional Deer Creek-specific PFAS, drainage, and hydrogeologic data would improve the City's ability to quantify source contributions and compare pathway-specific risks; however, the available information is sufficient to support the risk-differentiated source-control and stormwater-management framework described in this report.

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