May 16, 2025

VIA ONLINE PORTAL & ELECTRONIC MAIL
Office of Legal Affairs
Department of Environmental Protection
401 East State Street, 7th Floor
Mail Code 401-04L
Trenton, New Jersey 08625-0402

Re: NJDEP RULE PROPOSAL NO. PRN 2025-028, DEP DOCKET NO. 02-25-02

To Whom It May Concern:

On behalf of our members, the Chemistry Council of New Jersey (CCNJ) and the Site Remediation Industry Network (SRIN) appreciate the opportunity to provide comments to the New Jersey Department of Environmental Protection (NJDEP) on the above-mentioned rule proposal, which was published in the New Jersey Register (NJR) on March 17, 2025.

This rulemaking proposes to replace the interim specific Ground Water Quality Criterion (GWQC) for hexafluoropropylene oxide dimer acid (HFPO-DA) and its ammonium salt with a specific number and replace the interim remediation standards for soil and soil leachate for the Migration to Ground Water (MGW) exposure pathway for perfluorononanoic acid (PFNA), perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), HFPO-DA and its ammonium salt, and methanol. It also proposes to amend the Technical Requirements for Site Remediation, N.J.A.C. 7:26E (Tech Regs) to add PFNA, PFOA, PFOS, HFPO-DA and its ammonium salt, and 2,3,7,8-tetrachlorodibenzo-p-dioxin to the list of contaminants that must be analyzed in all media when contaminants in an area of concern are unknown or not well-documented.

We would like to reiterate some of our pre-proposal comments that we submitted to the NJDEP on October 30, 2023 in anticipation of amendments to the Tech Regs, as well as offer supplementary arguments and recommendations on the NJDEP's MGW exposure pathway assessment. In addition, we would like to highlight two (2) recent studies from June 2024 regarding HFPO-DA.

General

First and foremost, the NJDEP mis-characterizes HFPO-DA and its ammonium salt as "GenX" and incorrectly characterize the uses of "GenX". While HFPO-DA is a component of the GenX technology platform, it is inaccurate to equate HFPO-DA to "GenX". CCNJ/SRIN request that this distinction be made in the final rulemaking.

While we appreciate the NJDEP engaging with stakeholders and noting the July 12, 2023 meeting in this rule proposal, CCNJ/SRIN did not receive any response or feedback after submittal of our October 2023 comments.

Chemistry Council OF NEW JERSEY

During the July 2023 stakeholder meeting, the NJDEP proposed that PFNA, PFOA, PFOS, and "GenX" be included on the list of contaminants in the Tech Regs that must be analyzed. CCNJ/SRIN request that the NJDEP please clarify when the decision was made to also include 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), and the reasoning behind it.

The inclusion of 2,3,7,8-TCDD (a well-known historical feature in environmental investigations since the Love Canal) will change all the technical thinking as it is "essentially insoluble" (IARC, 2012) in water (2 X 10^{-7} g/L), hence unlikely to leach or be relevant to the MGW pathway (OEHHA). Dioxins also have a well-known anthropogenic (man-made) component that will not easily lend itself to distinction between generalized, diffuse environmental presence as a result of industrialization, versus some sort of site-related impact.

Further, an addition of 2,3,7,8-TCDD to every site's analytical suite will surely increase site costs to an unsustainable economic burden that will impact Brownfields progress. The United States Environmental Protection Agency (USEPA) estimated this to average $487 per sample for soil and water in its fixed-price negotiated laboratory contracts (USEPA, 2019). To embark on, likely necessary, more detailed analyses of congeners to distinguish 2,3,7,8-TCDD levels from diffuse anthropogenic pollution, or to position respondents to report TCDD equivalents, advanced analytical technique costs are higher. These are not costs for trying to make 2,3,7,8-TCDD leach from soil in some analytical context. Synthetic Precipitation Leaching Procedure (SPLP) or Toxicity Characteristic Leaching Procedure (TCLP) leaching data for 2,3,7,8-TCDD are few and far between because of the well-understood lack of solubility of this dioxin.

Over 20 years ago, the USEPA released its Final Decision Not to Regulate Dioxins in Sewage Sludge | US EPA (USEPA, 2003), including supporting scientific materials that state:

> *Volatilization, leaching, degradation, and erosion are considered loss mechanisms from soil. Leaching losses are, for all intents and purposes, zero for dioxin-like constituents because of the very high Koc values for these constituents. Koc indicates the tendency of these constituents to remain bound to soil particles and not to leach into the groundwater... Models that do not consider facilitated transport indicate no movement at all to groundwater. There are no measurement data to indicate that groundwater contamination by dioxins may be a potential concern.*

We can only assume that 2,3,7,8-TCDD (dioxin) was included in this proposal in error, as there is no scientific support for mandatory sampling of 2,3,7,8-TCDD in the MGW context.

MGW Exposure Pathway

The overall approach for the NJDEP's assessment of the soil-to-groundwater migration pathway overlooks the complex sorption mechanisms of per- and polyfluoroalkyl substances (PFAS) in soil, including compound-specific properties (e.g. hydrophobicity, solubility, molecular weight and structure) and soil-specific properties (e.g. soil type, surface area, heterogeneities, organic content). These concerns would equally apply for 2,3,7,8-TCDD, though differently due to additional variation disparate from PFAS. Due to the unique properties of PFAS relative to other organics, modeled estimates derived from compilations of values for other organics are unlikely to be predictive for PFAS (Silva et al., 2021; Sima & Jaffé, 2021). Therefore, modeled PFAS estimates do not appropriately characterize risk from soil to groundwater.

Similarly, the USEPA determined 2,3,7,8-TCDD is unlikely to leach (and found "no measurement data to indicate that groundwater contamination by dioxins may be a potential concern"). Direct measures of soil-to-groundwater PFAS mass discharge methods should be an authoritative metric relative to all other methodologies (please see *Mass Discharge Within the Vadose Zone* section for further discussion). At a minimum, the NJDEP's Soil Remediation Standards (SRS)-MGW and Soil Leachate Remediation Standards (SLRS)-MGW calculations should be revised to include an air-water interface (AWI) sorption mechanism.

Mechanisms of PFAS Retention in Soil

Generic soil-water partition coefficient (K_d) values were not used by the NJDEP due to the high variability in reported PFAS values on a chemical-specific basis; this is an appropriate conclusion. However, what was not addressed by the NJDEP is, in addition to PFAS-specific variability, there is soil-specific variation of K_d values. As reported in Anderson (2021) and others, the primary mechanisms of PFAS retention in soil are:

- Sorption to soil organic carbon due to PFAS hydrophobicity;
- Electrochemical sorption to surfaces of variably charged clay minerals due to PFAS surface charge and porewater chemistry; and
- AWI sorption due to PFAS amphiphilicity.

Overall, there is a wide array of parameters influencing PFAS transport in porous media. For example, the AWI varies across a site based on soil characteristics and climactic conditions such as wet and dry seasons (Wallis et al., 2022). Further, sorption is competitive and potentially rate-limited relative to hydraulic flux under variable saturation (Brusseau et al., 2019).

Synthetic Precipitation Leaching Procedures (SPLP)

The mechanisms of PFAS retention in soil are not preserved by SPLP methodology. The use of large liquid to solid ratios that exceed pore volume eliminate all AWI sorption. As noted in SPLP guidance (NJDEP, 2013), results "do not necessarily represent leachate concentrations that would be observed in the field because the water to soil ratio affects the resulting leachate concentration". Additionally, aggressive agitation disperses aggregates and colloids that would be stable under normal site conditions. This artificially enhances desorption as contaminants sorbed to what would be stable surfaces are extracted and erroneously attributed to the truly dissolved phase (Imoto et al., 2018).

On November 10, 2022, the NJDEP conducted a training on the "PFAS Interim Soil Remediation Standards" and discussed their SPLP study to validate this method for PFAS (NJDEP, 2022). To date, the NJDEP has not published the SPLP study to the regulated community. It is vital for stakeholders to have all the basis and background documents, including the NJDEP's studies, in the development of test methods and remediation standards. **CCNJ/SRIN strongly recommend that the NJDEP publish the SPLP study with the adoption of the final rule package.**

Mass Discharge Within the Vadose Zone

To account for cumulative complexity, the concept of directly measuring mass discharge within the vadose zone to assess the soil-to-groundwater migration pathway has been promoted by Anderson (2021). Multiple sites (Anderson et al., 2022; Eun et al., 2022; Lämmer et al., 2022; Schaefer et al., 2022) have utilized field lysimeters to collect porewater concentrations, which are used to assess the mobile mass fraction at depth providing an accurate representation of the risk to groundwater. Standardized methods for estimating groundwater rechange have recently been reviewed and compiled in Table 3 (Newell et al., 2023); please see attached study.

AWI Sorption and Dilution-Attenuation Soil Screening

Brusseau and Guo (2023) recently revised the USEPA's dilution-attenuation (DAF) soil screening model (USEPA, 1996) for PFAS to include AWI sorption. The modified conservative model approach only addresses the distribution term that utilizes soil porewater concentrations to soil concentrations, not accounting for retention and associated attenuation during transport.

At a minimum, CCNJ/SRIN recommend that the NJDEP's SRS-MGW and SLRS-MGW calculations be revised to include an AWI sorption mechanism. However, direct measures of soil-to-groundwater PFAS mass discharge methods should be given an authoritative metric relative to all other methodologies.

<u>Tech Regs</u>

CCNJ/SRIN believe that the NJDEP's proposed amendment to the Tech Regs to list PFNA, PFOA, PFOS, HFPO-DA and its ammonium salt, and 2,3,7,8-tetrachlorodibenzo-p-dioxin under Section 2.1(c)1ii when determining the list of target compounds to analyze for during an investigation/remediation project will result in:

- The removal of a Licensed Site Remediation Professional (LSRP)'s mandated use of "Independent Professional Judgment (IPJ)"; and
- Ambiguous, unnecessary, and potentially overly burdensome requirements for LSRPs and, potentially, Persons Responsible for Conducting Remediation (PRCRs).

Below are CCNJ/SRIN's more detailed comments on the above points.

Removal of LSRPs' Mandated Use of IPJ

The NJDEP specifying that PFNA, PFOA, PFOS, HFPO-DA and its ammonium salt, and 2,3,7,8-tetrachlorodibenzo-p-dioxin need to be evaluated when contaminants in an area of concern are "unknown or not well documented" removes/reduces the LSRP's use of IPJ, which is mandated in the Site Remediation Reform Act, N.J.S.A. 58:10C (SRRA). According to the Code of Ethics in SRRA, it is incumbent that LSRPs exercise IPJ to identify and obtain the data necessary to support conclusions about a site, contamination, potential environmental concerns, and remediation. This obligation is irrespective of what compounds may be present, so unduly saddling the LSRP with the additional focus on these specific chemicals potentially biases the likelihood that they may be included in an investigation.

Given the widespread use of PFAS, for example, they are often detected in soil, sediment, surface water, rainwater, air, dust, and groundwater world-wide (Agency for Toxic Substances and Disease Registry (ATSDR), 2021). Similarly, 2,3,7,8-TCDD has also been demonstrated as a diffuse anthropogenic contaminant, and was found to be "ubiquitous in soil, sediments and air" (IARC, 2012). Samples collected from different media in even remote locations showed detectable levels of several PFAS and 2,3,7,8-TCDD, suggesting widespread transport mechanisms via airborne deposition. Therefore, PFAS and 2,3,7,8-TCDD may be present at a site due to airborne deposition or other transport mechanisms, and not from current or historic site-specific operations. Their prevalence in the environment further obfuscates the blanket call to analyze for these compounds despite the LSRP's understanding of site history and exercising IPJ. The fact that this rule proposal states that "the Department is proposing these chemicals for inclusion because they have been widely used or are prevalent in the State" is illogical.

It is our belief that, under the effective use of IPJ currently embodied in the LSRP program, these or other constituents would appropriately be included in the list of analytes for a site investigation based on information obtained during the preliminary site assessment or other remediation information, without the NJDEP's amendment.

For example, the historical uses of PFNA, PFOA, and PFOS are well-documented as fluoropolymer processing or polymerization aids, or direct use in surface coating applications, and are well-known constituents associated with legacy aqueous film-forming foam formulation. These uses would be well-documented in manufacturing history and/or emergency response incident records for the site.

We are, again, making the NJDEP aware that the proposed amendment mis-characterizes HFPO-DA and its ammonium salt as "GenX" and incorrectly characterize the uses of "GenX". "GenX" is not a commercial product and is not used in firefighting foams or consumer products. Additionally, while the GenX technology platform was developed by DuPont as part of that company's participation in the USEPA's PFOA Voluntary Stewardship Program (USEPA), other participating companies developed their own polymerization aid technology in response to this USEPA program.

CCNJ/SRIN believe that the preliminary site assessment information will clearly define the locations with a potential site history that would include manufacturing processes or use/releases of products that might have contained these constituents.

Ambiguous, Unnecessary, and Potentially Overly Burdensome Requirements for LSRPs and PRCRs

The NJDEP's proposal to require inclusion of PFNA, PFOA, PFOS, HFPO-DA and its ammonium salt, and 2,3,7,8-tetrachlorodibenzo-p-dioxin in a sampling and analysis plan under a very ambiguous condition (i.e. "when contaminants in an area of concern are unknown or not well documented") is unnecessary and potentially overly burdensome. As described above, the use of these constituents in their respective industries is understood and well-documented given the intense regulatory scrutiny given to these compounds over the last five (5) to 10 years, and LSRPs will have a clear indication when a site's history may have included processes that used and/or generated any of these chemicals or potentially released them into the environment. By virtue of the LSRP program requirements, the LSRP would have the ability to include these constituents into the site investigation.

Moreover, sampling for the proposed PFAS compounds and 2,3,7,8-tetrachlorodibenzo-p-dioxin will require separate and costly analytical methods and sampling techniques/equipment. Without historical information informing past potential use of these chemicals, low-level detection may also be challenging to interpret and could require a much larger sampling area. Chasing a plume or trying to address other issues that may not truly be site-related would require an onerous burden of proof to show that the constituents are, in fact, not related to the site. As a result, this is trying to prove a negative for the "unknown or not well documented" technical requirement.

Additionally, PFNA, PFOA, and PFOS as well as 2,3,7,8-TCDD (USEPA, 2003) have been reported to have anthropogenic background levels in the United States, resulting in levels in the environment that may exceed regulatory limits, despite having no direct association with a known site release. The U.S. Geological Survey (USGS) reports that well and public supply water in presumed areas of "low impact" exceeded the proposed USEPA drinking water advisory in some samples, and that the distance to probable source(s) was not a strong predictor of concentration (Smalling et al., 2023). This requirement creates a burden for a party that is not responsible for environmental releases to, nonetheless, assume the cost for both characterization and remediation of background (i.e. non-site-related) conditions, regardless of its potential historical use at a given site.

At the SRAG meeting dated October 17, 2023, the NJDEP presented "Statewide Survey of PFAS in New Jersey Soils" (NJDEP, 2023). The primary objectives of this study are to 1) determine if there is anthropogenic PFAS soil contamination in NJ soils from non-localized atmospheric deposition and 2) gain a better scientific understanding of PFAS adsorption by soils. The "current status" slide states **"**initial results being reviewed by the Office of Data Quality". To date, the NJDEP has not published the results of the statewide survey of PFAS. This study is critical and essential to assist the regulated community in the understanding of "anthropogenic background levels" and another line of evidence to prove the negative of "unknown or not well documented" technical requirement. **We strongly recommend that the NJDEP issue the results of the Statewide Survey of PFAS in New Jersey Soils prior to the adoption of the final rule.**

Furthermore, the NJDEP does not adequately address the distinction between background (i.e. ambient) and site-specific contamination (as each PFAS compound is specific to the product applied at the site), and how it impacts the remediation standards. The NJDEP does not incorporate background considerations in this proposed sampling or acknowledge that quantifying background is important at determining site-specific impacts/risk. Also, the proposal lacks clear guidance on establishing background and low level detections, which could lead to unnecessary remediation where PFAS (in the broad definition to include the family) is present regionally.

CCNJ/SRIN strongly urge the NJDEP to conduct a pilot study of specific sites (i.e. NJDEP lead orphan sites) and evaluate whether PFNA, PFOA, PFOS, HFPO-DA and its ammonium salt, and 2,3,7,8-tetrachlorodibenzo-p-dioxin are present above background when they are not expected per site history. Based on that pilot study, the NJDEP can then assess if a blanket mandate is actually warranted.

However, if the NJDEP does intend to promulgate these amendments regardless, we recommend that the Tech Regs be modified to only require an initial sampling of a small subset of sample locations for these compounds. Based on this initial screening assessment, the LSRP would then have information to evaluate the need for further assessment at the site.

Chemistry Council OF NEW JERSEY

Additional Studies on HFPO-DA

The NJDEP utilizes the oral toxicity information for GenX compounds from the USEPA's Office of Water. The reference dose developed by their Office of Water in 2021 contains significant deviations from standard USEPA toxicity assessment methods and is not supported by the weight of scientific evidence. The process that the USEPA undertook to develop the Toxicity Assessment was procedurally flawed.

Further, there have been relevant studies that have been published since the conclusion of the USEPA's 2021 literature search that should be considered by the NJDEP. Below is a list of the relevant studies since 2021:

- Thompson et al. (2023): Assessment of Mouse Liver Histopathology Following Exposure to HFPO-DA With Emphasis on Understanding Mechanisms of Hepatocellular Death;
- Heintz et al. (2022): Evaluation of Transcriptomic Responses in Livers of Mice Exposed to the Short-Chain PFAS Compound HFPO-DA;
- Klaren et al. (2023): In vitro transcriptomic analyses informing the mode of action of HFPO-DA (GenX) in the liver;
- Heintz et al. (2023): Assessment of the mode of action underlying development of liver lesions in mice following oral exposure to HFPO-DA and relevance to humans;
- Lea et al. (2022): Assessment of the applicability of the threshold of toxicological concern for per- and polyfluoroalkyl substances;
- Chappell et al. (2020) Assessment of the Mode of Action Underlying the Effects of GenX in Mouse Liver and Implications for Assessing Human Health Risks;
- Heintz et al (2024) Comparison of transcriptomic profiles between HFPO-DA and prototypical PPARα, PPARγ, and cytotoxic agents in wild-type and PPARα knockout mouse hepatocytes; and
- Heintz et al (2024) Comparison of transcriptomic profiles between HFPO-DA and prototypical PPARα, PPARγ, and cytotoxic agents in mouse, rat, and pooled human hepatocytes.

We encourage the consideration of the entirety of peer-reviewed scientific data available and application of established and vetted toxicity assessment procedures in determining the underlying reference dose for HFPO-DA in the formal adoption of SRS and GWQ Standards (GWQS) for HFPO-DA.

On behalf of our CCNJ/SRIN members, I thank you for your consideration of our concerns and review of our comments. Together, we believe we can improve the quality of life for all New Jersey residents.

Sincerely,

Dennis Hart
Executive Director

Attachment

Chemistry Council OF NEW JERSEY

References

Agency for Toxic Substances and Disease Registry (ATSDR), 2021. Toxicological Profile for Perfluoroalkyls. Center for Disease Control. US Department of Health and Human Services. May.

Anderson, R. H. (2021). The Case for Direct Measures of Soil-to-Groundwater Contaminant Mass Discharge at AFFF-Impacted Sites. *Environmental Science & Technology*, *55*(10), 6580–6583. https://doi.org/10.1021/acs.est.1c01543

Anderson, R. H., Feild, J. B., Dieffenbach-Carle, H., Elsharnouby, O., & Krebs, R. K. (2022). Assessment of PFAS in collocated soil and porewater samples at an AFFF-impacted source zone: Field-scale validation of suction lysimeters. *Chemosphere*, *308*, 136247. https://doi.org/10.1016/j.chemosphere.2022.136247

Brusseau, M. L., Khan, N., Wang, Y., Yan, N., Van Glubt, S., & Carroll, K. C. (2019). Nonideal Transport and Extended Elution Tailing of PFOS in Soil. *Environmental Science & Technology*, *53*(18), 10654–10664. https://doi.org/10.1021/acs.est.9b02343

Brusseau, M. L., & Guo, B. (2023). Revising the EPA dilution-attenuation soil screening model for PFAS. *Journal of Hazardous Materials Letters*, *4*, 100077. https://doi.org/10.1016/j.hazl.2023.100077

Chappell GA, Thompson CM, Wolf JC, Cullen JM, Klaunig JE, Haws LC. 2020. Assessment of the Mode of Action Underlying the Effects of GenX in Mouse Liver and Implications for Assessing Human Health Risks. Toxicol Pathol. 48(3):494-508.

Eun, H., Yamazaki, E., Pan, Y., Taniyasu, S., Noborio, K., & Yamashita, N. (2022). Evaluating the Distribution of Perfluoroalkyl Substances in Rice Paddy Lysimeter with an Andosol. *International Journal of Environmental Research and Public Health*, *19*(16), 10379. https://doi.org/10.3390/ijerph191610379

Heintz MM, Chappell GA, Thompson CM, Haws LC. 2022. Evaluation of Transcriptomic Responses in Livers of Mice Exposed to the Short-Chain PFAS Compound HFPO-DA. Front Toxicol. 4:937168.

Heintz MM, Haws LC, Klaunig JE, Cullen JM, Thompson CM. 2023. Assessment of the mode of action underlying development of liver lesions in mice following oral exposure to HFPO-DA and relevance to humans. Toxicol Sci. 192(1):15-29.

Heintz MM, Klaren WD, East AW, Haws LC, McGreal SR, Campbell RR, Thompson CM. Comparison of transcriptomic profiles between HFPO-DA and prototypical PPARα, PPARγ, and cytotoxic agents in wild-type and PPARα knockout mouse hepatocytes. Toxicol Sci. 2024 Jun 26;200(1):183-198. doi: 10.1093/toxsci/kfae045. PMID: 38574385; PMCID: PMC11199908.

Heintz MM, Klaren WD, East AW, Haws LC, McGreal SR, Campbell RR, Thompson CM. Comparison of transcriptomic profiles between HFPO-DA and prototypical PPARα, PPARγ, and cytotoxic agents in mouse, rat, and pooled human hepatocytes. Toxicol Sci. 2024 Jun 26;200(1):165-182. doi: 10.1093/toxsci/kfae044. PMID: 38574381; PMCID: PMC11199992.

150 West State Street. Trenton, New Jersey 08608 609-392-4214 FAX 609-392-4816 www.chemistrycouncilnj.org

IARC Working Group on the Evaluation of Carcinogenic Risks to Humans. Chemical Agents and Related Occupations. Lyon (FR): International Agency for Research on Cancer; 2012. (IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, No. 100F.) 2,3,7,8-TETRACHLORODIBENZO-para-DIOXIN, 2,3,4,7,8-PENTACHLORODIBENZOFURAN, AND 3,3′,4,4′,5-PENTACHLOROBIPHENYL. Available from: https://www.ncbi.nlm.nih.gov/books/NBK304398/

Imoto, Y., Yasutaka, T., Someya, M., & Higashino, K. (2018). Influence of solid-liquid separation method parameters employed in soil leaching tests on apparent metal concentration. *Science of The Total Environment*, *624*, 96–105. https://doi.org/10.1016/j.scitotenv.2017.12.048

Lämmer, R., Weidemann, E., Göckener, B., Stahl, T., Breuer, J., Kowalczyk, J., Just, H., Boeddinghaus, R. S., Gassmann, M., Kling, H.-W., & Bücking, M. (2022). Evaluation of the Transformation and Leaching Behavior of Two Polyfluoroalkyl Phosphate Diesters in a Field Lysimeter Study. *Journal of Agricultural and Food Chemistry*, *70*(45), 14329–14338. https://doi.org/10.1021/acs.jafc.2c03334

Lea IA, Pham LL, Antonijevic T, Thompson C, Borghoff SJ. 2022. Assessment of the applicability of the threshold of toxicological concern for per- and polyfluoroalkyl substances. Regul Toxicol Pharmacol. 133:105190.

Klaren WD, Heintz MM, East AW, Thompson CM, Haws LC. 2023. In vitro transcriptomic analyses informing the mode of action of HFPO-DA (GenX) in the liver. Poster presented at Society of Toxicology Annual Meeting, Nashville, TN, March 2023.

Newell, C. J., Stockwell, E. B., Alanis, J., Adamson, D. T., Walker, K. L., & Anderson, R. H. (2023). Determining groundwater recharge for quantifying PFAS mass discharge from unsaturated source zones. *Vadose Zone Journal*, *22*(4), e20262. https://doi.org/10.1002/vzj2.20262

NJDEP. (2013). *Development of Site-Specific Impact on Ground Water Soil Remediation Standards Using The Synthetic Precipitation Leaching Procedure*.

NJDEP. (2022). https://dep.nj.gov/wp-content/uploads/srp/pfas_interim_soil_slides.pdf

NJDEP. (2023). https://www.nj.gov/dep/srp/srra/background/cvp_srag/2023/cvp_srag_pfas_study_101723.pdf

OEHHA Public Health Goal for TCDD in Drinking Water

Schaefer, C. E., Lavorgna, G. M., Lippincott, D. R., Nguyen, D., Christie, E., Shea, S., O'Hare, S., Lemes, M. C. S., Higgins, C. P., & Field, J. (2022). A field study to assess the role of air-water interfacial sorption on PFAS leaching in an AFFF source area. *Journal of Contaminant Hydrology*, *248*, 104001. https://doi.org/10.1016/j.jconhyd.2022.104001

Silva, A. O. D., Armitage, J. M., Bruton, T. A., Dassuncao, C., Heiger-Bernays, W., Hu, X. C., Kärrman, A., Kelly, B., Ng, C., Robuck, A., Sun, M., Webster, T. F., & Sunderland, E. M. (2021). PFAS Exposure Pathways for Humans and Wildlife: A Synthesis of Current Knowledge and Key Gaps in Understanding. *Environmental Toxicology and Chemistry*, *40*(3), 631–657. https://doi.org/10.1002/etc.4935

Sima, M. W., & Jaffé, P. R. (2021). A critical review of modeling Poly- and Perfluoroalkyl Substances (PFAS) in the soil-water environment. *Science of The Total Environment*, *757*, 143793. https://doi.org/10.1016/j.scitotenv.2020.143793

Smalling et al., 2023. Per- and polyfluoroalkyl substances (PFAS) in United States tapwater: Comparison of underserved private-well and public supply exposures and associated health implications. Environment International. 178 (2023) 108033. https://doi.org/10.1016/j.envint.2023.108033

Thompson CM, Heintz MM, Wolf JC, Cheru R, Haws LC, Cullen JM. 2023. Assessment of Mouse Liver Histopathology Following Exposure to HFPO-DA With Emphasis on Understanding Mechanisms of Hepatocellular Death. Toxicol Pathol. 1926233231159078.

USEPA. (1996). *Soil Screening Guidance: Technical Background Document, Second Edition. EPA/540/R95/128*. Office of Solid Waste and Emergency Response, Washington, DC.

USEPA. (2003). Exposure and Human Health Reassessment Of 2,3,7,8-Tetrachlorodibenzo-P-Dioxin TCDD and related compounds, U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C., (EPA/600/P-00/001). https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=87843.

USEPA. (2003). Final Decision Not to Regulate Dioxins in Sewage Sludge | US EPA; supporting documents also at this link P:\8317 - ICF (Opt1)\8317.001.023-Dioxin\Deliverables\Final TBD\Sections\3-28-03 version\REPORT COVER.wpd

USEPA. (2019). Dioxins, Furans, PCBs, and Congeners Analytical Service Costs | Superfund Analytical Services and Contract Laboratory Program | US EPA https://19january2021snapshot.epa.gov/clp/dioxins-furans-pcbs-and-congeners-analytical-service-costs_.html

USEPA. Fact Sheet: 2010/2015 PFOA Stewardship Program | US EPA (https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/fact-sheet-20102015-pfoa-stewardship-program)

Wallis, I., Hutson, J., Davis, G., Kookana, R., Rayner, J., & Prommer, H. (2022). Model-based identification of vadose zone controls on PFAS mobility under semi-arid climate conditions. *Water Research*, *225*, 119096. https://doi.org/10.1016/j.watres.2022.119096