STATE OF MAINE
DEPARTMENT OF ENVIRONMENTAL PROTECTION

IN THE MATTER OF

ARIES PINE TREE, LLC SANFORD, YORK COUNTY AIR EMISSION LICENSE APPLICATION (A-1195-71-A-N) AND SOLID WASTE PROCESSING FACILITY LICENSE APPLICATION (S-100033)	**PRE-FILED TESTIMONY OF KYLE DOUDRICK, PH.D., P.E.**

I, Kyle Doudrick, Ph.D., P.E., declare and state as follows:

1. I am an environmental engineer with expertise in thermal treatment of per- and polyfluoroalkyl substances ("PFAS"), including thermal decomposition chemistry, thermal treatment process development, and treatment system performance evaluation. My work addresses both the effectiveness of PFAS destruction technologies and their associated energy demands, emissions, and waste-management considerations. I am a tenured professor of environmental engineering at the University of Notre Dame. My curriculum vitae is attached as **Exhibit A**.

2. I have been retained by counsel for Sanford Clean Air and Water Coalition and Conservation Law Foundation to provide expert testimony in this proceeding concerning the pending applications of Aries Pine Tree, LLC ("Aries") for air emissions and solid waste facility licenses to construct and operate the Aries Pine Tree facility in Sanford, Maine (the "Facility").

3. This testimony addresses: (1) commercially available and emerging methods of PFAS destruction, with an emphasis on thermal treatment, and the challenges and limitations associated with existing thermal treatment methods; (2) standardized and emerging analytical methods for characterizing PFAS; (3) evaluation of Aries' claims regarding the capability of the

Facility to destroy PFAS; (4) comparison of Aries' proposed facility design, operating conditions, and claimed PFAS destruction effectiveness with existing facilities engaged in thermal destruction of PFAS; and (5) evaluation of Aries' proposed testing and monitoring requirements.

PROFESSIONAL BACKGROUND AND QUALIFICATIONS

4. I received my Bachelor of Science in Civil Engineering and Master of Science in Civil Engineering from the University of Memphis in 2006 and 2008, respectively.

5. I received my Ph.D. in Environmental Engineering from Arizona State University in 2013. I am also a licensed Professional Engineer in the State of Indiana.

6. I am currently the Rooney Family Collegiate Processor of Environmental Engineering and an associate professor in the Department of Civil and Environmental Engineering and Earth Sciences at the University of Notre Dame.

7. I run an environmental engineering research lab that develops physical-chemical treatment technologies for emerging contaminants such as PFAS as well as new analytical methods to better characterize the occurrence and fate of emerging contaminants in the natural and built environments.

8. I also teach both undergraduate and graduate courses on water treatment, solid and hazardous waste management, and water chemistry.

9. I have authored more than 50 peer-reviewed publications, which have been cited over 3,400 times. I serve as the principal investigator on five Department of Defense/War projects focused on PFAS, four of which involve thermal treatment.

10. I regularly present and lecture on issues related to thermal treatment of PFAS.

11. The central focus of my research is enhancing PFAS destruction and promoting the conversion of organic fluorine into innocuous inorganic forms (complete destruction or mineralization) through the use of calcium and other metal additives.

12. My work has examined thermal treatment of PFAS-contaminated granular activated carbon, concrete, biosolids, ion-exchange resins, soil, and plant biomass, with an emphasis on improving destruction efficiency, reducing required treatment temperatures, and minimizing products of incomplete destruction ("PIDs").

13. I also work on evaluating the broader environmental implications of thermal treatment, including a co-authored life-cycle assessment comparing thermal oxidation and regeneration of PFAS-loaded activated carbon with and without calcium additives.

14. I currently serve on the United States Environmental Protection Agency ("EPA") Science Advisory Board. The board consists of 37 scientists from a range of disciplines and provides scientific and technical advice to EPA leadership.

MATERIALS REVIEWED

15. In preparation for this testimony, I reviewed the Aries applications and relevant documents in the Maine Department of Environmental Protection ("DEP") Aries project folder,[1] and relevant scientific research.

16. Materials cited that are not in the DEP project folder are submitted concurrently with this testimony in the **Appendix**.

I. PFAS BACKGROUND

17. PFAS are a large group of synthetic organic chemicals containing a completely or partially fluorinated alkyl chain. A uniform characteristic among PFAS is the carbon-fluorine bond—"one of the strongest ever created"—that makes PFAS extremely persistent in the environment and difficult to break down or remediate.[2]

---

[1] *Aries Pine Tree LLC, Sanford*, Me. Dep't of Env't Prot., https://www.maine.gov/dep/projects/aries/index.html (last visited Nov. 9, 2026).

[2] *Examining the Federal Response to the Risks Associated with Per- and Polyfluoroalkyl Substances (PFAS): Hearing Before the S. Comm. on Env't & Pub. Works*, 116th Cong. 2 (2019)

18. Indeed, "[t]he most consistent feature within the class of PFAS is that their perfluorocarbon moieties do not break down, or do so very slowly, under natural conditions, which is why PFAS are often termed 'forever chemicals.'"[3]

19. Fluorine is strongly electronegative, causing a short bond length between the carbon (C) and fluorine (F). While these structures make many PFAS water-, oil- and grease-repelling as well as heat-resistant—and thus desirable for numerous industrial and commercial applications—C−F bonds are highly stable and thus poorly susceptible to degradation by hydrolysis, oxidation, photolysis, and biological processes.[4]

20. PFAS vary in size and structure. The PFAS alkyl "tails" can be long-chain or short-chain, and under treatment the bonds break down at different temperatures and rates. One method of destruction may be effective for short-chain bonds, but ineffective for long-chain bonds, and vice versa.

(testimony of Linda S. Birnbaum, Dir., Nat'l Inst. of Env't Health Scis. & Nat'l Toxicology Program, Nat'l Insts. of Health), https://www.epw.senate.gov/public/_cache/files/2/2/22ca7c4b-b1dc-4a12-9264-7a4f16608933/BF2D70A4FB747A3F61E584CC30D58D0A.birnbaum-testimony-03.28.2019.pdf; *see also* Changes to Reporting Requirements for Per- and Polyfluoroalkyl Substances and to Supplier Notifications for Chemicals of Special Concern; Community Right-to-Know Toxic Chemical Release Reporting, 87 Fed. Reg. 74379, 74382 (proposed Dec. 5, 2022).

[3] Kwiatkowski, C. F., Andrews, D. Q., Birnbaum, L. S., Bruton, T. A., DeWitt, J. C., Knappe, D. R. U., Maffini, M. V., Miller, M. F., Pelch, K. E., Reade, A., Soehl, A., Trier, X., Venier, M., Wagner, C. C., Wang, Z., & Blum, A. (2020). Scientific basis for managing PFAS as a chemical class. *Env't Sci. & Tech. Letters, 7*(8), 532–543. https://doi.org/10.1021/acs.estlett.0c00255.

[4] Wang, J., Lin, Z., He, X., Song, M., Westerhoff, P., Doudrick, K., & Hanigan, D. (2022). Critical review of thermal decomposition of per- and polyfluoroalkyl substances: Mechanism and implications for thermal treatment processes. *Env't Sci. & Tech., 56*(9), 5355–5370. https://doi.org/10.1021/acs.est.2c02251; Kim, M., Li, L. Y., Grace, J. R., & Yue, C. (2015). Selecting reliable physicochemical properties of perfluoroalkyl and polyfluoroalkyl substances (PFASs) based on molecular descriptors. *Env't Pollution, 196*, 462−72. https://doi.org/10.1016/j.envpol.2014.11.008.

21. PFAS are widely used in industrial processes and consumer products, including nonstick cookware, waterproof clothing, and firefighting foams. PFAS enter the environment through manufacturing, product use, and waste disposal, and have been detected in water, soil, air, food, and humans.[5]

22. EPA has identified more than 21,000 individual PFAS as of January 2026, with more discovered on an ongoing basis.[6]

23. The human health risks associated with several PFAS are well established and have been widely recognized by international scientific organizations,[7] federal and state regulatory agencies,[8] and other leading scientific bodies.[9]

---

[5] Agency for Toxic Substances & Disease Registry, *Toxicological Profile for Perfluoroalkyls* 3 (2021) ("PFAS Tox. Profile"), https://www.atsdr.cdc.gov/toxprofiles/tp200.pdf.

[6] *PFAS Structures in DSSTox (update January 2026)*, EPA: CompTox, https://comptox.epa.gov/dashboard/chemical-lists/PFASSTRUCTV6 (last updated Aug. 2026).

[7] *See* UN Env't Programme, *Risk Profile on Perfluorooctane Sulfonate* 25–26, 29 (2006), http://chm.pops.int/Portals/0/download.aspx?d=UNEP-POPS-POPRC.2-17-Add.5.English.PDF; UN Env't Programme, *Risk Profile on Pentadecafluorooctanoic Acid (PFOA, Perfluorooctanoic Acid), Its Salts and PFOA-related Compounds* 24–26 (2016), http://chm.pops.int/Portals/0/download.aspx?d=UNEP-POPS-POPRC.12-11-Add.2.English.PDF.

[8] PFAS Tox. Profile, *supra* note 5, at 4–21, 26–29; Off. of Env't Health Hazard Assessment, Cal. Env't Protection Agency, *Perfluorooctanoic Acid and Perfluorooctane Sulfonic Acid in Drinking Water (First Public Review Draft)* 62–166 (2021), https://oehha.ca.gov/sites/default/files/media/downloads/crnr/pfoapfosphgdraft061021.pdf.

[9] Nat'l Acads. of Sci., Eng'g, & Med., *Guidance on PFAS Exposure, Testing, and Clinical Follow-Up* 6–8 (2022), https://nap.nationalacademies.org/catalog/26156/guidance-on-pfas-exposure-testing-and-clinical-follow-up; *see also* Blum, A., Balan, S. A., Scheringer, M., Trier, X., Goldenman, G., Cousins, I. T., Diamond, M., Fletcher, T., Higgins, C., Lindeman, A. E., Peaslee, G., de Voogt, P., Wang, Z., & Weber, R. (2015). The Madrid statement on poly- and perfluoroalkyl substances (PFASs). *Env't Health Persps.*, *123*(5), A107–A111. https://doi.org/10.1289/ehp.1509934 (releasing a statement by more than 250 scientists expressing "concern[] about the production and release into the environment of an increasing number of [PFAS]").

24. PFAS that have been evaluated for toxicity are generally associated with significant and diverse adverse health effects that "include (but are not limited to): effects on the liver (e.g., liver cell death), growth and development (e.g., low birth weight), hormone levels, kidney, the immune system (reduced response to vaccines), lipid levels (e.g., high cholesterol), the nervous system, and reproduction, as well as increased risk of certain types of cancer."[10]

25. These harms do not appear solely at high levels of exposure. Many PFAS present health risks at the lowest measurable exposure levels, and recent studies link adverse health effects in both humans[11] and wildlife[12] to PFAS exposure levels occurring in the environment. Many PFAS bioaccumulate, or build up, through repeated exposures in people and animals, meaning even low-level releases can result in significant long-term exposures and harm.[13]

---

[10] PFAS National Primary Drinking Water Regulation, 89 Fed. Reg. 32532, 32536–37 (Apr. 26, 2024).

[11] *See* Yu, G., Jin, M., Huang, Y., Aimuzi, R., Zheng, T., Nian, M., Tian, Y., Wang, W., Luo, Z., Shen, L., Wang, X., Du, Q., Xu, W., Zhang, J., & Shanghai Birth Cohort Study. (2021). Environmental exposure to perfluoroalkyl substances in early pregnancy, maternal glucose homeostasis and the risk of gestational diabetes: A prospective cohort study. *Env't Int'l 156*, Article 106621. https://doi.org/10.1016/j.envint.2021.106621; *see also* Birru, R. L., Liang, H. W., Farooq, F., Bedi, M., Feghali, M., Haggerty, C. L., Mendez, D. D., Catov, J. M., Ng, C. A., & Adibi, J. J. (2021). A pathway level analysis of PFAS exposure and risk of gestational diabetes mellitus. *Env't Health, 20*(1), Article 63. https://doi.org/10.1186/s12940-021-00740-z.

[12] *See* Sonter, C. A., Rader, R., Stevenson, G., Stavert, J. R., & Wilson, S. C. (2021). Biological and behavioral responses of European honey bee (Apis mellifera) colonies to perfluorooctane sulfonate exposure. *Integrated Env't Assessment & Mgmt.*, *17*(4), 673–683. https://doi.org/10.1002/ieam.4421; *see also* Giesy, J. P., & Kannan, K. (2001). Global distribution of perfluorooctane sulfonate in wildlife. *Env't Sci. & Tech.*, *35*(7), 1339–1342. https://doi.org/10.1021/es001834k.

[13] Dimitrakopoulou, M. E., Karvounis, M., Marinos, G., Theodorakopoulou, Z., Aloizou, E., Petsangourakis, G., Papakonstantinou, M., & Stoitsis, G. (2024). Comprehensive analysis of PFAS presence from environment to plate. *NPJ Sci. of Food*, *8*(1), Article 80. https://doi.org/10.1038/s41538-024-00319-1 ("PFAS compounds possess a remarkable ability to bioaccumulate in organisms . . . .").

26. There is extensive scientific, public health, and industry interest in treatments to remove PFAS from environmental media and wastes.[14]

II. GASIFICATION WITH THERMAL OXIDATION IS NOT AN ESTABLISHED METHOD FOR THE EFFECTIVE DESTRUCTION OF PFAS

27. Gasification with thermal oxidation, as Aries proposes for the Facility, is not an established method of destroying PFAS.

28. There are no peer-reviewed studies or full-scale testing reports demonstrating the effectiveness of gasification with thermal oxidation in destroying PFAS in biosolids.

29. There has yet to be a single reported full-scale demonstration of gasification systems for biosolids, or any other waste, that uses established EPA methods both for identifying PFAS in the incoming biosolids (Method 1633) and determining the efficacy of PFAS destruction in the system exit (OTM-45, OTM-50, and OTM-55 (draft)).[15] For that reason, EPA characterizes gasification as an "emerging," not established, destruction technology.[16]

30. Few full-scale gasification systems have been tested for PFAS destruction at all. Other than the Aries Linden, New Jersey facility's demonstration (results addressed below), the

---

[14] Berg, C., Crone, B., Gullett, B., Higuchi, M., Krause, M. J., Lemieux, P. M., Martin, T., Shields, E. P., Struble, E., Thoma, E., & Whitehill, A. (2022). Developing innovative treatment technologies for PFAS-containing wastes. *J. of the Air & Waste Mgmt. Ass'n (1995)*, *72*(6), 540–555. https://doi.org/10.1080/10962247.2021.2000903.

[15] These methods are discussed in further detail below.

[16] EPA, *Interim Guidance on the Destruction and Disposal of PFAS and Materials Containing Perfluoroalkyl and Polyfluoroalkyl Substances—2026 Version*, at 3 (Apr. 20, 2026), https://www.epa.gov/system/files/documents/2026-04/2026-interim-guidance-on-pfas-destruction-and-disposal.pdf ("EPA partnered with industry and academia to collect data on emerging technologies for PFAS destruction, such as mechanochemical degradation, *gasification* and pyrolysis, and supercritical water oxidation. While the results from these studies show promise for PFAS destruction, further work using newly available methods is needed to more fully characterize the outputs of these processes and to evaluate their performance for a wider range of PFAS-containing materials." (emphasis added)).

only other full-scale documented gasification demonstrations that have been publicly reported are for the Ecoremedy facility in Edmonds, Washington and the Loganholme facility in Australia. However, no data have been published from the Ecoremedy test, and very limited data has been provided for the Loganholme test(s),[17] so the PFAS destruction claims from those facilities are not verifiable. Aries admits that the Ecoremedy facility "is . . . not being considered a successful test case for purposes of" their Best Available Control Technology ("BACT") analysis due to significant issues with its construction and commissioning.[18]

31. Both the Ecoremedy facility in Edmonds, Washington and Aries facility in Linden, New Jersey facilities are nonoperational. The Ecoremedy facility has been "marred by significant delays and technical failures since construction began."[19] The Aries Linden facility never achieved consistent operations and has been idled since 2025 due to equipment issues and insufficient funding.[20]

32. Gasification facilities in Morrisville, Pennsylvania (Ecoremedy); Nashville, Tennessee (Stircor); and Bethel, Pennsylvania (Earthcare) lack sufficient reported information (i.e., on temperatures, residence times, and metrics of success) to make conclusions about these

---

[17] Logan City Council, *Technical Report Longalholme Wastewater Treatment Plant: Biosolids Gasification Demonstration Plant (PBE-075)* (Mar. 2021), https://www.arena.gov.au/assets/2021/03/loganholme-wastewater-treatment-plant.pdf.

[18] Supplemental Best Available Control Technology (BACT) Analysis at 6, *In re Aries Pine Tree LLC, Sanford, York County, Air Emission License Application* (A-1195-71-A-N) (Me. Dep't Env't Prot. Sept. 15, 2026) ("Suppl. BACT Analysis").

[19] Larry Vogel, *City of Edmonds Update: Resolution of Wastewater Treatment Plan Operational Issues Ongoing*, MyEdmondsNews (May 7, 2026), https://myedmondsnews.com/2026/05/city-of-edmonds-update-resolution-of-wastewater-treatment-plant-operational-issues-ongoing/.

[20] Aries Linden LLC, *Notice of Idling of Operations* (Dec. 4, 2025); *see also* Jacob Wallace, *Aries Clean Technologies Looks for Fresh Start with Funding Infusion*, WasteDive (May 2, 2026), https://www.wastedive.com/news/aries-clean-technologies-facility-update-line-new-jersey-sanford-maine/820871/.

systems. Furthermore, results from one thermal treatment system cannot reliably predict performance at another facility because operating conditions, feedstocks, and system configurations differ. Each facility therefore needs its own performance demonstration.

33. Aries claims that its system is proprietary and "the only directly comparable process is at the Aries facility in Linden, NJ."[21] However, the PFAS testing at the Aries Linden facility did not use all EPA-approved test methods, did not adequately characterize fluorinated PIDs, and did not provide a comprehensive measurement of all fluorinated emissions.[22] Available data from the Linden facility indicates that PFAS loss occurred to the dryer condensate,[23] and that PFAS were being formed in the thermal treatment process.[24] Furthermore, in that report, PFAS in the non-condensable portion of the dryer exhaust was not measured so it is unclear whether and to what extent PFAS may have existed in this stream. Additionally, Aries Linden's stated performance (95.9% "destruction and removal" ("DRE") of PFAS) is both unsupported and worse than results at other thermal treatment facilities handling PFAS-laden waste.[25] Each of these issues is addressed later in this testimony.

34. Indeed, due to the lack of full-scale testing and robust analytics, there is currently no fully established method for the effective destruction of PFAS. To be fully established requires several demonstrations of a technology at full scale with rigorous assessment of effectiveness using comprehensive analytical methods.

---

[21] Aries Pine Tree LLC Minor Source Air License Application at 4-1, *In re Aries Pine Tree LLC, Sanford, York County, Air Emission License Application* (A-1195-71-A-N) (Me. Dep't Env't Prot. Jan. 2026) ("Air Permit Application").

[22] *See infra* Sections III(A)–(B), IV(B)–(C).

[23] *See infra* Section III(B).

[24] *See infra* Section IV(C).

[25] *See infra* Section IV(C).

35. Many thermal treatment technologies have shown promising laboratory scale results, but their effectiveness, cost, and scalability remain uncertain. Major challenges have emerged regarding thermal treatment of PFAS.

36. First, PFAS are not easily destroyed, or mineralized. Full destruction, or mineralization, means that the parent compound(s) (i.e., the PFAS present in the incoming sludge or other waste) have been fully decomposed into mineralized products, such as carbon dioxide (CO_2), water (H_2O), and mineral ash. When PFAS are not destroyed completely, they can transform into different forms of PFAS that can present risks similar to or worse than the parent compound and can be highly mobile in the environment. These and other harmful byproducts are called products of incomplete destruction, or PIDs.[26]

37. Aries defines "complete destruction" incorrectly as "[b]reaking all carbon-fluorine bonds in a PFAS molecule."[27] Breaking all carbon-fluorine bonds is complete defluorination, not complete destruction/mineralization. Breaking all C–F bonds could result in formation of C–Cl or C–H bonds, creating other halogenated or hydrocarbon compounds. As explained, complete destruction is converting the organic compound into CO_2, H_2O, and mineral ash.

38. Second, identifying and measuring fluorinated PIDs is challenging because of the wide range of PFAS that exist. Current methods are only capable of identifying a small fraction of known and unknown PFAS, making it difficult to determine whether complete PFAS

[26] Many publications use "products of incomplete destruction" or "PIDs" interchangeably with "products of incomplete combustion" or "PICs." However, as used here, PICs refer to the results of combusting a product, while PIDs specifically refer to a contaminant and its destruction efficiency. In the Aries system, biosolids combusted at the facility would produce PICs, and PFAS would produce PIDs.

[27] Suppl. BACT Analysis at 8.

destruction has taken place, or merely transformation of the parent compounds and the creation of PIDs.

39. Third, many variables influence the effectiveness of thermal treatment, including temperature, residence time, turbulence (also known as mixing, which ensures that every molecule is exposed equally to the heat, oxygen, etc.), oxygen availability, feed characteristics, and other system-specific operating conditions.

40. Fourth, thermal treatment creates significant air emissions, which are difficult to control and limit, especially at very high operating temperatures.

41. Fifth, ensuring consistent performance under full-scale operating conditions is challenging, because operating conditions such as temperature, turbulence, and the presence of oxygen can fluctuate.

42. Thermal treatment in a permitted hazardous waste incinerator ("HWI") optimized for destruction of halogenated compounds (including PFAS) is currently the thermal treatment technology used for PFAS destruction that has the most available data and the most successful documented results.

43. HWIs are Resource Conservation and Recovery Act ("RCRA")-permitted facilities that incinerate biohazardous, pathological, or other regulated waste in solid, sludge, or liquid form. HWIs operate at very high temperatures and combust waste in two stages: a primary combustion chamber and a secondary combustion chamber, called an afterburner or thermal oxidizer.

44. The temperature of the primary chamber has a significant impact on the effectiveness of the secondary chamber (and overall destruction), with lower temperatures in the primary chamber decreasing effectiveness in the secondary chamber.

45. Several permitted hazardous waste incinerators, including the Veolia HWI in Port Arthur, Texas and the Clean Harbors Aragonite HWI in Grantsville, Utah, have operated with PFAS-laden wastes in their feed. Reports of these facilities' PFAS destruction effectiveness have been published at both the pilot- and full-scales, though data remains limited.

46. Both systems have achieved up to 99.9999% DRE for select PFAS, which are the best destruction results published so far. For the OTM analyses that were conducted—OTM-45 and 50—the only compound detected after treatment was CF_4. At the Clean Harbors site, when C_2F_6 was injected into the system, >99.99% DRE was observed in the select PFAS, indicating the ability of these optimized HWIs to significantly reduce thermally stable PIDs.[28] However, even at the high temperatures HWIs operate at, PFAS destruction can produce other unknown or known PIDs.[29]

47. Like the thermal treatment process in HWIs, gasification with thermal oxidation is a two-stage thermal treatment process, but the primary chamber (the gasifier) differs from that of a HWI with respect to oxygen availability, temperature, and extent of combustion. A gasifier typically operates at a lower temperature than a primary chamber in an HWI as a matter of design choice, though a gasifier could be operated at temperatures comparable to a HWI's primary combustion chamber if appropriate refractory materials were selected. A gasification facility's second combustion chamber, the thermal oxidizer, is comparable to an HWI's secondary combustion chamber.

---

[28] EPA, *PFAS Destruction by a Hazardous Waste Incinerator: Testing Results* 92–93, tbl. 10-4, tbl. 10-5 (Sept. 2025) ("Clean Harbors").

[29] Meegoda, J., Teymourian, T., & Perera, D. (2026). Incineration of PFBA with temperature: Reaction mechanisms, kinetics, and residence time from molecular level simulations. *Chemosphere, 401*, Article 144914. https://doi.org/10.1016/j.chemosphere.2026.144914.

48. Overall, the most established method for thermal treatment of PFAS currently available is combustion under conditions similar to an HWI optimized for destruction of halogenated wastes, with very high temperatures in both the primary and secondary chambers.

49. Gasification as a treatment technology lacks comparable data and evidence of successful performance.

III. ARIES' APPLICATION IS MISSING CRITICAL INFORMATION NECESSARY TO SUPPORT ITS PFAS DESTRUCTION CLAIMS.

A. The Aries Application Does Not Include Residence Times.

50. Aries' pending air and solid waste permit applications do not disclose the design residence times in either the gasifier (solid and gas phase) or the thermal oxidizer (gas phase), making it impossible to validate Aries' claims about PFAS destruction. The applications say only that Aries will employ "sufficient residence time and temperature to destroy volatile organic compounds (VOCs), CO, PFAS, and odors."[30] The supplemental BACT analysis uses identical language.[31]

51. As mentioned above, the effectiveness of PFAS destruction through thermal treatment is dependent on a number of variables, including temperature, residence time, turbulence, oxygen availability, feed characteristics, and other system-specific design features and operating conditions.

52. Residence time, in combination with temperature and turbulence, is one of the critical variables for effective PFAS destruction. Residence time is how long the treated medium is exposed to high temperature conditions in the combustion chambers. Longer residence times

[30] Air Permit Application at 2-8; Facility Application Solid Waste Processing at 3-7 to 3-8, *In re Aries Pine Tree LLC, Sanford, York County, Solid Waste Processing Application* (S-100033) (Me. Dep't Env't Prot. Jan. 7, 2026).

[31] Suppl. BACT Analysis at 3.

generally favor destruction, though at some point there are diminishing returns. The residence time required for PFAS destruction depends on temperature and other conditions, as well as the specific PFAS present in the treated medium.

53. Residence time is determined by chamber geometry and gas flow rate. Because it is determined largely by system design, residence time can be adjusted only to a limited degree after a system is built; it is more difficult to modify than operating temperature. Increasing residence time after construction may require reducing throughput or modifying the combustion chamber. By comparison, temperature can often be adjusted within the installed equipment's operating limits.

54. Aries provides no information about the solid- or gas-phase residence times of the gasifier either proposed for Sanford or from the Linden facility.

55. Solid-phase residence time is equally important as gas-phase residence time because the solids need sufficient time to reach the desired temperature in the gasifier. Solid-phase residence time generally affects the overall destruction efficiency of the gasifier and what PIDs are being formed in the gasification step.

56. Aries also has not disclosed the design gas-phase residence time for its Sanford thermal oxidizer but states that its Linden facility is comparable. If one assumes that the Facility will adopt the same residence time, the Barr PFAS emissions testing report from the Linden facility (the "Barr Report") states that the gas-phase (thermal oxidizer) residence time was approximately 1 second during that testing.[32]

[32] PFAS Stack Test Report (Linden NJ) at 5, Attachment H to Aries Pine Tree LLC Minor Source Air License Application, *In re Aries Pine Tree LLC, Sanford, York County, Air Emission License Application* (A-1195-71-A-N) (Me. Dep't Env't Prot. Jan. 2026) ("Barr Report").

57. One second at the temperatures proposed for the Aries' thermal oxidizer is less than what is standard in HWIs optimized to destroy halogenated wastes. HWIs with evidence for PFAS destruction, which currently reflect the most successful practice for comparable thermal treatment systems, all have a gas phase residence time of >2 seconds, though some are longer.

58. A residence time of >2 seconds is also consistent with federal guidelines for similar proxy recalcitrant halogenated compounds like polychlorinated biphenyls ("PCBs") unless the incinerator maintains a temperature of 1600 °C (nearly 3000 °F). 40 C.F.R. § 761.70. However, PFAS are more recalcitrant than PCBs, dioxins, or other halogenated compounds. Residence times shorter than those required under similar incinerator conditions for these less recalcitrant compounds are therefore unsupported.

59. Molecular-level simulations of incineration of PFBA—a type of short-chain PFAS—predict that certain fluorinated compounds, including carbon tetrafluoride (CF_4), difluroethyne (C_2F_4), and carbonyl fluoride (COF_2), that can form as PIDs in the primary combustion chamber may require residence times in minutes, not seconds.[33] These studies suggest that achieving complete mineralization can require more demanding conditions than would be required to destroy the parent compounds.

60. Current evidence therefore supports requiring a gas-phase residence time greater than 2 seconds for PFAS destruction, though that alone is not sufficient, by itself, to guarantee complete destruction.

61. Without information about the design residence times for the gasifier and the thermal oxidizer, none of Aries' claims about the PFAS destruction capacity of the Facility are supported.

[33] Meegoda et al., *supra* note 29.

B. Aries Does Not Provide Sufficient Information About Managing PFAS Loss in the Dryer.

62. The Facility incorporates a drying system that will heat incoming biosolids before they enter the gasifier and the thermal oxidizer.

63. There is published evidence that drying at the temperatures stated for the Facility (the temperature the biosolids will reach is unknown, but the source heat is stated as 250 °C) will result in a mass loss of PFAS that go unmeasured and untreated, which may include PFAS that are not reported in the limited list included in Method 1633A.[34]

64. During the biosolids drying process, gas emissions are produced. Two streams, or fractions, are created from the off-gas: the condensate and the non-condensate fractions.

65. The condensate fraction is the liquid formed when the off-gas cools. In the condensate will be "water-loving," larger semi-volatile compounds and ionic PFAS (like PFOA and PFOS) that readily dissolve back into the water phase during condensation. Aries' permit applications indicate that this condensate will be sent to publicly owned treatment works.

66. Conversely, the non-condensate fraction is the off-gas that does not turn back into a liquid. In the non-condensate gas will be volatile and semi-volatile PFAS (like fluorotelomer alcohols, FTOHs) that do not "like" water and will escape entirely as an air emission. Aries' permit applications indicate this non-condensate will be sent to either the thermal oxidizer or a carbon bed.

[34] McNamara, P., Calteux, J., Redman, E., McKnight, T., Moss, L., Hoener, W., Carr, S., & Liu, Z. (2025). Drying reduces the total PFAS concentration in biosolids and alters the PFAS profile. *Env't Sci.: Water Rsch, & Tech., 11*(4), 1007–1015. https://doi.org/10.1039/d4ew00890a.

67. As a result, PFAS loss into both the condensable and non-condensable streams during drying is a significant concern and appears to have taken place at the Linden facility.[35]

68. Aries also provides no information on the temperature the biosolids reach in the dryer. Higher temperatures in the dryer can drive PFAS into the gas phase before they reach the gasification chamber.

69. PFAS have been detected in condensate from biosolids drying,[36] and studies of landfill gas condensate have also identified semi-volatile PFAS precursors.[37] In the former study, PFAS mass was reduced 43–74% during drying with only 12–22% of total incoming mass recovered in the condensate.

70. First, volatile and semi-volatile PFAS can transfer from the drying bed into the exhaust gas and subsequently partition into the condensed water as the gas cools.

71. Second, PFAS dissolved in water or associated with fine particles may be mechanically carried out of the drying bed in entrained droplets or aerosols, which are subsequently captured in the condensate.

72. PFAS dissolving in water is particularly important for less volatile, water-soluble PFAS, which would not readily evaporate with water vapor on their own. Consequently, PFAS detected in the condensate may result from either gas-to-water partitioning or physical

---

[35] *Compare* Barr Report tbl. 4, *with id.* tbl. 5 (showing higher PFAS removal efficiency when not considering condensate).

[36] Calteux, J., Moss, L., Ayala, R., Baza, A., Liu, Z., Redman, E., McKnight, T., Sabba, F., Downing, L., & McNamara, P. (2026). PFAS reduction during biosolids drying correlates to initial moisture content and is accompanied by detection of PFAS in dryer condensate. *Env't Sci.: Water Rsch. Tech., 12*(4), 1105–1115. https://doi.org/10.1039/D5EW01120E.

[37] Smallwood, T. J., Robey, N. M., Liu, Y., Bowden, J. A., Tolaymat, T. M., Solo-Gabriele, H. M., & Townsend, T. G. (2023). Per- and Polyfluoroalkyl Substances (PFAS) Distribution in Landfill Gas Collection Systems: Leachate and Gas Condensate Partitioning. *J. of Hazardous Materials, 448*, Article 130926. https://doi.org/10.1016/j.jhazmat.2023.130926.

entrainment, and the relative importance of these mechanisms will depend on the PFAS present and the drying and exhaust handling conditions, which are largely undisclosed.

73. Aries states that non-condensable gas, which may also contain PFAS, goes to the thermal oxidizer, but the Facility also utilizes a carbon bed "for part of the flow since the thermal oxidizer will not accommodate all of the exhaust from the receiving building."[38] However, the application does not clarify how much is diverted from the thermal oxidizer nor provide any details about the design or treatment effectiveness of the carbon bed.

74. The application lacks sufficient information about whether the proposed routing to the carbon beds is effective at removing PFAS from the non-condensable stream. The distribution of flow between those treatments and the carbon-bed performance under expected conditions are not established.

75. Data from the Linden facility indicates that PFAS loss occurred in the dryer, but the quantity and fate of those PFAS are not described. The applications do not adequately quantify PFAS in either the condensable or non-condensable streams, or demonstrate removal performance for those diverted to condensate treatment or carbon adsorption.

76. Characterizing PFAS in incoming and dried biosolids, together with relevant dryer discharge streams, would help identify losses before gasification and help inform optimization of downstream treatment.

77. In short, Aries' application raises serious concerns of PFAS loss in the dryer and does not include sufficient testing or characterization to determine the extent of that loss, or design or planning to destroy PFAS lost from biosolids during the drying process.

[38] Air Permit Application at 2-1.

C. The Aries Application's Reliance on the Barr Report Does Not Address Critical Gaps.

78. The Barr Report, which is the primary evidence Aries cites to support its PFAS destruction claims for the Facility, is missing significant critical information.

79. First, no appendices to the Barr report are included in the DEP project file, so it is not possible to evaluate the validity of the assumptions and calculations underlying the report. It is not clear whether Aries appropriately accounted for PFAS that appear to have been formed in the gasifier, thermal oxidizer, dryer or other regions of the system (discussed further below in section IV(C) on the Facility's purported PFAS destruction and removal efficiency).

80. Second, the Barr Report does not include the broadest possible PFAS testing. At Linden, Aries relied only on OTM-45 to analyze PFAS air emissions, without also including OTM-50 and OTM-55 (draft). As discussed below in section IV(B), testing for only a small number of PFAS is likely to miss many PFAS PIDs.

81. The Barr report itself identifies low DREs and possible negative values for some PFAS, consistent with the formation of PFAS during thermal treatment, but does not investigate or adequately explain those results. Without the underlying calculations, an assessment of analytical uncertainty, and a more comprehensive characterization of PIDs, it is not possible to determine whether the observed discrepancies reflect actual PFAS formation or measurement limitations. Either explanation raises serious questions about the reliability and interpretation of the reported destruction performance, particularly when those results are used to predict PFAS emissions from the proposed Facility.

IV. THE FACILITY'S DESIGN AND OPERATING CONDITIONS ARE NOT THE BEST AVAILABLE FOR MINIMIZING PFAS EMISSIONS.

82. The information Aries does provide reveals multiple sources of PFAS emissions from the Facility that Aries does not account for and multiple ways in which Aries' proposed design and/or operational conditions fall short of the best currently available technology for thermal treatment of PFAS-laden wastes.

A. The Low Temperatures in Both the Gasifier and Thermal Oxidizer Are Likely to Generate Significant PIDs.

1. Gasifier

83. The gasification chamber operates to separate, or desorb, PFAS from the biosolids by creating syngas that is combusted in the thermal oxidizer.

84. Even though the gasifier is not intended to destroy PFAS on its own, its operating conditions cause significant thermal decomposition of PFAS, which in turn impacts the efficacy of PFAS destruction in the thermal oxidizer.

85. New evidence shows that having a higher primary chamber temperature can significantly reduce downstream PIDs and provide for a higher destruction efficiency.[39] This is because a lower temperature in the primary chamber is suspected to lead to the formation of more thermally stable PIDs (such as CF_4, a PFAS) that are even more resistant to thermal treatment in the secondary chamber. Even a temperature of 1204 °C, the highest end of the temperature range that Aries proposes to use in the thermal oxidizer, is too low to destroy CF_4 formed in the gasifier.

[39] *See* Clean Harbors, *supra* note 28, at pp. 51–52, 86–87 (high temperature HWI incineration resulting in 99.95% to 99.9999% DRE and only one compound PID).

86. When temperatures in the gasifier or thermal oxidizer are set too low or the residence time too short, PFAS will not be completely destroyed, but rather may transform into shorter-chain PFAS and other harmful byproducts, i.e. PIDs.

87. Aries proposes to operate the gasifier at 677–732 °C (1250–1350 °F) with no stated residence times. This temperature is likely to lead to an increase in downstream PIDs, reducing PFAS destruction effectiveness and potentially forming transformed PFAS and other byproducts.

88. By comparison, the Veolia HWI operates its primary combustion chamber at approximately 815–870 °C (1499–1598 °F) with a solids residence time of approximately 1–2 hours followed by 2.5 seconds for the gas phase in the thermal oxidizer.[40]

89. The Clean Harbors/EPA HWI demonstration involved operation of the primary chamber at 1097–1223 °C (2006–2233 °F) with a solids residence time of approximately 60 minutes.

90. With the correct refractory materials and other high temperature components, there is no inherent technical limitation that precludes a gasifier reaching substantially higher temperatures comparable to the primary chamber temperatures in the HWIs discussed above.

91. Aries offers no support or rationale to explain its choice of proposed temperature in the gasifier that departs from the temperatures established in current literature.

2. Thermal Oxidizer

92. The EPA has stated that treatment temperatures exceeding 1400 ºC (2552 ºF) are required to destroy the most recalcitrant PFAS.[41]

---

[40] *Id.* at 8.

[41] EPA, Technical Brief, *Per- and Polyfluoroalkyl Substances (PFAS): Incineration to Manage PFAS Waste Streams* 1 (2019), https://www.epa.gov/sites/default/files/2019-

93. Aries proposes to operate the thermal oxidizer at 982–1204 °C (1800–2200 °F).

94. Even assuming that the thermal oxidizer is consistently operated at the top of this range, the proposed temperature is not sufficient to destroy all PFAS that may be present in the syngas. Furthermore, Aries has never demonstrated that it can continuously operate a comparable facility at that temperature nor appropriately characterized PFAS destruction effectiveness at that temperature and the undisclosed residence time.

95. Even if Aries consistently maintained the highest temperature of that range, 1204 °C is too low to destroy CF_4 and other PFAS that may be present in the syngas that are highly resistant to thermal degradation. CF_4 has been observed in PFAS thermal treatment studies and can form as PIDs during thermal treatment.[42]

96. The Veolia HWI operates its secondary combustion chamber at approximately 1115–1150° C (2030–2102 °F) with a residence time of approximately 2.3 seconds.[43]

97. The Clean Harbors/EPA HWI demonstration operated its secondary chamber at 1120–1147 °C (2048–2096 °F).[44] The gas phase residence time is not stated but is very likely >2 seconds, similar to the Veolia HWI, because HWIs are operated to meet the minimum residence

09/documents/technical_brief_pfas_incineration_ioaa_approved_final_july_2019.pdf; Veolia Env't SA, *PFAS Destruction Testing at Veolia's Port Arthur Incinerator* 4 (June 2025) ("Veolia"), https://info.veolianorthamerica.com/hubfs/offers/reports/vna/pfas/pfas-destruction-testing-veolia-port-arthur-incinerator-study.pdf.

[42] EPA, *Interim Guidance on the Destruction and Disposal of Perfluoroalkyl and Polyfluoroalkyl Substances and Materials Containing Perfluoroalkyl and Polyfluoroalkyl Substances – Version 2 (2024)*, at 42, A-2 (2024) ("2024 EPA PFAS Disposal Guidance"), https://www.epa.gov/system/files/documents/2024-04/2024-interim-guidance-on-pfas-destruction-and-disposal.pdf.

[43] Veolia, *supra* note 41, at 21.

[44] Clean Harbors, *supra* note 28, at 8.

time necessary to destroy recalcitrant, halogenated compounds pursuant to federal law, such as PCBs (2 seconds at 1200 °C). 40 CFR § 761.70.

98. Aries states in its supplemental BACT analysis that "[i]ncreasing oxidizer temperature or residence time would have diminishing returns and have energy and environmental impacts (e.g., NOx formation)."[45] However, as discussed above, Aries has not proposed any residence time, nor an enforceable requirement to continuously operate the thermal oxidizer at temperatures comparable to thermal treatment facilities with the best available evidence of PFAS destruction.

99. Even if the Facility operated its thermal oxidizer at temperatures comparable to the secondary combustion chamber at the Veolia or Clean Harbors HWIs, Aries has not provided sufficient information to determine whether it could perform comparably. Residence time, turbulence, oxygen availability, differences in primary chamber operation, and facility-specific testing also affect PFAS destruction.

B. The Facility's Proposed Testing and Monitoring Are Insufficient.

100. Any facility intending to do full-scale operations should do an extensively monitored and controlled demonstration to determine actual effectiveness under the proposed conditions before proceeding with operations.

101. A full-scale demonstration involves robust testing and monitoring of inputs and outputs to accurately assess PFAS destruction.

102. EPA provides clear guidance on how to conduct PFAS Emissions Field Testing at Commercial Thermal Destruction Sources.[46] Comprehensive air emission source characterization

[45] Suppl. BACT Analysis at 9.

[46] 2024 EPA PFAS Disposal Guidance, *supra* note 42, at A-1 to A-4.

should include a combination of EPA methods to ensure measurement of all PIDs for which analytical methods are available.

103. First, it is essential to characterize PFAS in the biosolids prior to treatment. EPA Method 1633A is a validated method for quantifying 40 targeted PFAS in biosolids, other solid matrices, and aqueous samples. It should be used to characterize incoming biosolids and relevant liquid and solid residuals, but it does not measure stack emissions or all PFAS precursors and transformation products.

104. Aries relies on Linden's Method 1633 results, but those results are not comparable to the Sanford facility. The Linden facility was accepting sludge from a single wastewater treatment plant ("WWTP") whereas the Facility may draw from an undefined/open set of WWTPs in the northeast. Those different WWTPs may have very different PFAS profiles in their sludge, including because of variation in the nature and number of indirect industrial dischargers for a specific WWTP. Aries would need to do sampling representative of the range of feedstocks it might accept for treatment. In the absence of sampling and a complete characterization, Aries must assume that the hardest-to-destroy PFAS would be present.

105. Second, it is essential to characterize PIDs in the flue exhaust, particularly PIDs that include transformed PFAS. There is currently no single analytical method that comprehensively measures all possible PFAS and PIDs in incineration emissions. However, combining the available methods provides reasonably comprehensive information.

106. The recommended methods to measure fluorinated compounds in stack exhaust to determine treatment effectiveness from stack emissions are EPA's OTM-45, OTM-50, and draft OTM-55. These methods determine whether compounds of concern are present and at what levels.

107. OTM-45 Revision 1 measures 50 target semi-volatile and particulate-bound PFAS, including compounds such as perfluorooctanoic acid ("PFOA"), perfluorooctane sulfonate ("PFOS"), and all other PFAS that are also listed on Method 1633A. It is useful for determining whether parent PFAS remain in the exhaust but does not adequately capture volatile fluorinated compounds or nonpolar semi-volatile compounds.

108. OTM-50 measures 30 target volatile fluorinated compounds, including smaller fluorocarbons such as CF_4 and C_2F_6. These compounds are important because they can be formed as PIDs and may be highly resistant to further degradation. These measurements complement OTM-45 but do not cover every possible volatile fluorinated compound that can form.

109. OTM-55, currently under development, can be performed while performing OTM-45 and is built on the widely used Method 0010/8270 for semi-volatiles. EPA has nearly completed development of draft OTM-55, designed to measure approximately 30 nonpolar, semi-volatile PFAS, such as FTOHs. While awaiting EPA's draft version of OTM-55, operating facilities can use the 0010/8270 method in combination with known target lists of semi-volatile PFAS.[47]

110. Solid, liquid, and gas concentrations should be paired to calculate compound-specific destruction and removal efficiencies for PFAS that can be quantified in the feed, condensate, and exhaust streams. The analysis should characterize relevant residuals, including condensate from drying beds (or quench water from scrubbers), spent granulated activated carbon from the carbon bed, and biochar (ash), to distinguish destruction from transfer into

[47] Lin, A. M., Thompson, J. T., Koelmel, J. P., Liu, Y., Bowden, J. A., & Townsend, T. G. (2024). Landfill gas: A major pathway for neutral per- and polyfluoroalkyl substance (PFAS) release. *Env't Sci. & Tech. Letters, 11*(7), 730–737. https://doi.org/10.1021/acs.estlett.4c00364.

another waste stream. PIDs measured by OTM-50 should be evaluated separately, rather than treated as parent-compound DRE measurements. OTM-55 or a validated alternative should be added to characterize relevant nonpolar semi-volatile compounds as methods become available.

111. Permit conditions must specify monitoring frequency, operating conditions (including temperature and residence time), and the approach for reporting compound-specific results including a set DRE. As described, the proposed monitoring for this Facility does not adequately demonstrate that PFAS emissions are minimized across the range of compounds entering the Facility.

112. The application of each method and quality requirements should be specified in the Facility's permit. Similarly, the permit should specify the analytes, emission limits or performance criteria, reporting requirements, and testing frequency.

113. Testing should be done under representative operating conditions and the *least* favorable conditions under which the Facility would be permitted to operate, including relevant limits on temperature, residence time, throughput, and feedstock moisture. The testing plan should document operating conditions and stack gas flow so that compound-specific mass emission rates can be calculated.

114. Aries proposes biennial stack testing for only two PFAS chemicals: PFOA and PFOS using OTM-45.[48]

115. Aries proposes only a single mass balance use of OTM-50 in an initial test and no adoption of OTM-55, deeming them infeasible without further explanation.[49] However, without these methods, there can be no meaningful or accurate assessment of whether the Facility is

[48] Suppl. BACT Analysis at 10.

[49] *Id.* at 9.

destroying PFAS or releasing it through stack emissions. OTM-50 serves a complementary purpose of characterizing selected PIDs, which should be evaluated separately from parent-compound DRE calculations based on Method 1633A and OTM-45.

116. Biennial stack testing is also inadequate, as it is not frequent enough to capture the variability of biosolids sources and stack emissions and ensure compliance with PFAS emission limits. Best practice is a performance test followed by at least annual testing with OTM-45, OTM-50, and OTM-55 during the initial operating years, with additional stack testing following significant process changes or evidence of reduced performance, and continuous parametric monitoring to ensure operational conditions that maximize PFAS destruction are continuously maintained.

117. Second, Aries' proposal to only test for PFOA and PFOS is far too limited. Both can degrade and the products react into other forms of PFAS as a result of thermal degradation.[50]

118. Measuring only PFOA and PFOS using OTM-45 would track only the presence of these two parent compounds and would not account for other PFAS in the biosolids or PIDs, misleadingly implying that PFAS have been completely destroyed when they are only converted into other PFAS. This limited information does not establish the performance of the system across the broader range of PFAS likely to be present in the feedstock.

119. Effectiveness of PFAS destruction should be evaluated by the extent of *complete* PFAS destruction rather than disappearance of only two parent compounds.

120. OTM-45, OTM-50, and OTM-55 in combination are essential to determine complete PFAS destruction to the extent possible with available analytical methods. Successful

[50] Barr Report at tbl. 4, tbl. 5.

performance under one method does not necessarily indicate successful performance under the other.

121. For example, a gasification system may effectively decompose PFOA and PFOS, resulting in nondetectable emissions under OTM-45, while simultaneously generating smaller, volatile fluorinated compounds that are detectable under OTM-50. Conversely, low OTM-50 emissions do not establish that larger, semi-volatile or particulate-bound PFAS have been eliminated.

122. Therefore, low emissions measured by OTM-45, OTM-50, and OTM-55 provide substantially stronger evidence of effective PFAS treatment than any one method alone. Even their combined use does not establish complete PFAS destruction or mineralization, because these methods do not measure all fluorinated compounds or provide a complete fluorine mass balance. However, the combination is the best currently available approach to determine PFAS destruction.

C. Aries' Stated PFAS Destruction and Removal Efficiency Is Unsupported and Misleading.

123. Two key metrics should be used together to assess the efficacy of PFAS destruction: DRE and measurement of PIDs.

124. DRE compares "the mass feed rate" for specific compounds to "mass emissions rate through the stack exhaust" for the same "parent" compound and accounts for the loss of the individual PFAS parent compound between the two.[51] In other words, it only measures the

[51] Silsby, S., Sühnholz, S., Qanbarzadeh, M., Silsby, N., Hao, S., Shields, E., Jackson, S., Mills, M. A., Doudrick, K., Young, C., Strathmann, T. J., Ghosh, R. S., Willey, J., Fedick, P. W., Blotevogel, J., Knappe, D. R. U., & Higgins, C. P. (2026). Air emissions during destruction of PFAS-containing materials. *Nature Revs. Earth & Env't, 7*(3), 181–198. https://doi.org/10.1038/s43017-025-00755-x.

percentage of specific parent compounds that are removed in the treatment process and is not a measure of complete destruction.

125. DRE does not reflect PFAS conversion into fluorinated PIDs as a result of insufficient destruction.[52] While an important metric, DRE on its own is therefore insufficient to determine the efficacy of thermal treatment,[53] and must be used in combination with measuring PIDs to determine whether PFAS have mineralized or merely converted into other PFAS.

126. A high DRE in addition to no or limited PIDs indicates a high degree of mineralization is possible.

127. Flaws in the Aries Linden facility's testing protocol and treatment process raise significant concerns about the reliability of DRE information from that demonstration test.

128. Aries inconsistently asserts that "the process of drying, gasifying and oxidizing biosolids" will "destroy[] or remove[]" PFAS "at rates exceeding 95%."[54] The supplemental BACT analysis does not offer a DRE.

129. A 95% DRE is low compared to results achieved at other thermal treatment facilities. A recent EPA study performed with Clean Harbors demonstrated DREs ranging from 99.95% to 99.9999% for some PFAS.[55] PFAS were identified using OTM-45, OTM-50, and

---

[52] *Id*. at 2 ("Destruction and removal efficiency (DRE) calculations, which simply account for the loss of individual PFASs by comparing the mass feed rate to the mass emissions rate through the stack exhaust, fail to account for the potential release of fluorinated PIDs to the air and for the potential presence of the parent compound or PIDs in residual solids and liquids." (citations omitted)).

[53] *Id.* at 13 ("DREs alone are insufficient to ensure the absence of harmful air emissions and residuals from destructive technologies.").

[54] Air Permit Application at 6-2.

[55] Clean Harbors, *supra* note 28, at ES-2 (stating an exit temperature from the kiln of 2006 °F–2233 °F at a solids residence time of approximately 60 minutes and an exit temperature of the afterburner of 2048 °F–2096 °F).

Method 0010 sampling. A DRE of only 95% means it is known that 5% of parent PFAS will be present in the stack emissions, in addition to PIDs, which as noted are not fully accounted for in a DRE calculation.

130. The Facility should be required to achieve the DREs demonstrated at comparable thermal treatment facilities for all compounds covered by OTM-45.

131. The Barr report indicates that approximately 95.9% overall DRE was achieved during the testing in the Linden facility.[56] However, this result cannot be validated because of Aries' failure to provide the underlying mass balance calculations in the missing Appendix A. Furthermore, the feedstock for the Linden test was limited, coming from a single wastewater treatment plant, whereas the Sanford facility is likely to receive a much higher variability of waste than represented in the Linden test because its biosolids will be received from an undisclosed set of wastewater treatment plants in New England. Variation in incoming PFAS concentrations and compound profiles will change the quantity and potentially the types of fluorinated products emitted, even if the underlying DREs were unchanged.

132. Because the Linden test did not use OTM-50 or OTM-55 (draft), the Barr Report does not provide a comprehensive measurement of all fluorinated emissions that could be captured with current analytical methods. The reported stack mass-emission rate represents only the targeted compounds measured. The reported aggregate DRE should be interpreted within these analytical limitations.

133. In addition, the Barr Report indicates with asterisks that PIDs were in fact formed.[57] The Linden test reveals a very concerning increase in some PFAS. PFBA, PFPeA,

[56] Barr Report at 4 tbl. 2-2.

[57] *Id.* at tbl. 4, tbl. 5.

PFHpA, PFBS, and PFHxS all had a measured mass leaving the system (the combined output streams) exceeding the mass entering the system (the input streams).[58] This is significant because, under a complete and accurate mass balance, a compound cannot have more mass leaving a system than entering it unless that compound is being formed within the system. Alternatively, the discrepancy could reflect limitations in sampling, analytical measurements, or the mass-balance calculations, which would bring into question the entire analysis.

134. These results are consistent with the formation of PFAS during thermal treatment, but Aries does not investigate or adequately explain those results. Without the underlying calculations, an assessment of analytical uncertainty, and a more comprehensive characterization of PIDs, it is not possible to determine whether the observed discrepancies reflect actual PFAS formation or measurement limitations. Either explanation raises questions about the reliability and interpretation of the reported destruction performance, particularly when those results are used to predict PFAS emissions from the proposed Facility.

135. For compounds with greater measured output than input, the calculated individual DRE would be negative, indicating apparent net formation rather than destruction. The Barr Report shows these compounds with asterisks rather than numerical DREs, making the magnitude of the discrepancies difficult to evaluate.

136. In addition, while the aggregate DRE may be mathematically correct based on the measured mass of targeted PFAS entering and leaving the system, it can obscure substantial differences in the behavior of individual compounds. Some PFAS exhibited very low DREs even as measured at Linden. For example, PFHxA's average DRE was only 24.3%, and PFOA's DRE was only 68.6%. The substantial variability in individual compound DREs and missing DREs for

[58] *Id.* at tbl. 4 (compounds with an asterisk).

several compounds indicate formation of PFAS during treatment. It is unclear how these compounds were accounted for in calculating the overall DRE or whether the reported value represents a mass-weighted calculation.

137. Without compound-specific input and output masses and supporting calculations, the accuracy and representativeness of the reported 95.9% DRE remain uncertain. The exclusion of target PFAS from OTM-45 may have resulted in an overestimation of the reported DRE.

138. Moreover, the reported DRE does not account for PFAS outside the scope of the analytical methods used. The omission of OTM-55 limits additional PFAS likely present in biosolids, particularly nonpolar semi-volatile compounds, that could contribute to a more comprehensive assessment of emissions and DRE. Also critical, the omission of OTM-50 prevents assessment of PIDs, and thus the DRE does not establish complete destruction.

139. Aries does not propose to cure those deficiencies in its current application through compound-specific DREs for PFAS quantifiable in the feedstock, dried biosolids, and exhaust. Instead, the proposed testing is limited to PFOA and PFOS. There is no technical justification for restricting emissions testing to these two compounds when established analytical methods can characterize a substantially broader range of PFAS and PIDs. Initial testing should encompass all applicable target analytes under OTM-45 and OTM-55, with enforceable emission limits established based on the resulting characterization. OTM-50 should be used to establish complete destruction.

140. The Linden test does not demonstrate complete PFAS mineralization or adequately characterize PID emissions from the process. A more comprehensive initial assessment using Method 1633A, OTM-45, OTM-55 when available, OTM-50, and appropriate supplemental methods is necessary to evaluate both PFAS DRE and the formation of PIDs.

These results should provide the technical basis for an enforceable ongoing emissions monitoring program.

141. The Facility has the potential to accept up to 500 tons/day and process 450 tons/day over 30 years,[59] meaning it could process approximately 4.9 million tons of sludge over the 30-year life of the facility, so even low emissions per ton could accumulate substantially over the Facility's lifetime.

142. The BACT analysis proposes a limit of 5.3×10^{-6} lb/hr for PFOA, and 1×10^{-5} lb/hr for PFOS. Over the course of 30 years, that would permit 1.393 lbs of PFOA and 2.628 lbs of PFOS (or ~60 g/yr combined) to be emitted from the stack and potentially deposited in and around the facility. Based on a process rate of 450 tons/day, that would result in 0.37 mg combined PFOA and PFOS per ton of material treated. And that does not include any other PFAS/PIDs. With just PFOA and PFOS, those numbers are substantial enough that an American Meteorological Society/Environmental Protection Agency Regulatory Model ("AERMOD") analysis should be done to evaluate the wet and dry deposition rates, the 30-year loading in the surrounding soils, the potential for deposition in nearby surface waters with an impact assessment on drinking water sources, and establishing background PFAS concentrations and contributions from other sources in the area.

143. Fugitive emissions could also contribute to total releases beyond those measured at the stack.

144. Even emission rates that may appear "low" can amount to substantial cumulative releases over a 30-year operating life, depending on throughput and operating conditions. The significance depends on the identities and masses of the emitted compounds.

[59] Air Permit Application at 1-1.

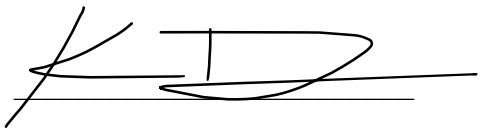
145. Some PIDs are volatile PFAS, such as CF_4 and C_2F_6, which are potent greenhouse gases. CF_4 has more than 7,000 times more warming potential than CO_2, while C_2F_6 has approximately 12,000 times more warming potential.[60]

V. CONCLUSION

146. Overall, Aries fails to provide basic information that is critical to evaluating the claims in its applications and has not demonstrated that its proposed system will achieve the PFAS destruction performance it promises, let alone performance comparable to the best-performing PFAS-destruction facilities currently operating. Aries proposes operating parameters that published evidence shows will lead to PFAS loss, incomplete PFAS destruction, and, ultimately, unnecessary and potentially harmful PFAS emissions.

I affirm that, to the best of my knowledge and belief, the foregoing is true and correct.

Dated: November 13, 2026
Notre Dame, IN



[60] Greenhouse Gas Protocol, *Global Warming Potential Values* (Feb. 16, 2016), https://ghgprotocol.org/sites/default/files/Global-Warming-Potential-Values%20%28Feb%2016%202016%29_1.pdf.

Exhibit A

KYLE DOUDRICK, Ph.D., P.E.

Department of Civil and Environmental Engineering and Earth Sciences
University of Notre Dame, Notre Dame, IN 46556
Email: kdoudrick@nd.edu; Phone: 574-631-0305
Doudrick Research Group Website

1. Education

Ph.D. in Environmental Engineering, Arizona State University, Tempe, Arizona (May 2013)

M.S. in Civil Engineering, University of Memphis, Memphis, Tennessee (May 2008)

B.S. in Civil Engineering, University of Memphis, Memphis, Tennessee (May 2006)

2. Previous Positions, Academic, Administrative, Professional, and Other

Rooney Family Collegiate Professor of Environmental Engineering (*2026–Present*)

Department of Civil and Environmental Engineering and Earth Sciences, University of Notre Dame, Notre Dame, IN

Associate Professor *(2020–Present)*

Department of Civil and Environmental Engineering and Earth Sciences, University of Notre Dame, Notre Dame, IN

Member, U.S. Environmental Protection Agency (EPA) Science Advisory Board *(2026–Present)*

EPA, Washington, D.C.

Assistant Professor *(2014–2020)*

Department of Civil and Environmental Engineering and Earth Sciences, University of Notre Dame, Notre Dame, IN

NSF/ASEE Small Business Postdoctoral Research Diversity Fellow *(August 2013–July 2014)*

Integrated Surface Technologies, Inc., Menlo Park, CA

3. Scholarships and Fellowships

NSF/ASEE Small Business Postdoctoral Research Diversity Fellowship, 2013-2014

NRC Postdoctoral Fellowship, 2013 (Declined for current position)

Science Foundation Arizona Fellowship, 2008-2010

Ira A. Fulton Fellowship, 2013

AZ Water Scholarship, 2013

AZ Water Scholarship, 2010

Elyse and Paul Johnson Scholarship, 2009

Associated General Contractors Scholarship, 2004

4. Distinctions, Honors, and Awards

NSF CAREER Award, 2019-2024

Fulbright Scholar Award, 2019 (CNRS in Nancy, France)

Best Paper Award, Environmental Science & Technology: Engineering, 2024

Excellence in Review Award, Environmental Science & Technology, 2018

Excellent in Review Award, Environmental Science & Technology: Engineering, 2025

Simon Karecki Award, Semiconductor Research Corporation, 2013

Top Poster Award at Gordon Research Conference on Environmental Nanotechnology, 2013

Travel Award for Gordon Research Conference on Environmental Nanotechnology, 2013

Honorable Mention Poster Award at Sustainable Nanotechnology Organization Conference, 2012

Travel Award from Sustainable Nanotechnology Organization, 2012

Travel Award from Graduate and Professional Student Association, 2012

3rd Place Paper for Geosyntec Student Paper Contest, 2011

Travel Award at Gordon Research Conference on Environmental Nanotechnology, 2011

Travel Award from Graduate and Professional Student Association, 2010

5. Referred Publications

Google Scholar (10/2026): 3471 Citations, h-Index = 27, i10-Index = 42
Ph.D. Advisor: Westerhoff; Post-Doc Advisor: Rykaczewski
**Graduate student*
†*Undergraduate student*
#Postdoc
^*Visiting Scholar*

Journals

1. Gu, S.#, Li, A., Jiang, M.*, Phillip, W., **Doudrick, K**. Performance and Mechanistic Insights of an Efficient Adsorptive Membrane for PFAS Removal from Water. *Environ. Sci. & Technol.*, 2026. *In review*. (IF: 12.2)
2. Zhao, Y., Thakur, N., Kim, H., Fuller, M., Abou Khalil, C.#, **Doudrick, K**., Hedman, P., Soto, A., Koster van Groos, P., Pham, A. Hydrotalcite as a Thermally Regenerable Adsorbent for Perfluoroalkyl Acids. *Environ. Sci. & Technol.*, 2026. *Accepted.* (IF: 12.2)
3. Lin, Z., Chernysheva, L.*, Serpa, M., Herckes, P., **Doudrick, K.**, Westerhoff, P. Analytical Barriers to Fluorine Mass Balance: Matrix Effects from PFAS Laden Adsorbents and Soil Matrices on HF Measurement During Simulated Incineration. *NPJ Emerging Contam.*, 2026, 2, 26. (IF: not yet assigned)
4. Tomsovic, Y., Gu, S.#, **Doudrick, K**., Straub, A. Mechanistic Insights into PFAS Rejection in Nanofiltration and Reverse Osmosis from Data-Driven Analysis. *Environ. Sci. & Technol.*, 2026, 60, 18 (IF: 12.2)
5. Jiang, M.*, Curtis, E.G.*, Abou-Khalil, C.#, Corcoran, A.*, **Doudrick, K**. Low-temperature Thermal Treatment of Portland Cement Concrete Contaminated with Per- and Polyfluoroalkyl Substances. *J. Haz. Mat.*, 2026, 514, 142809. (IF: 10.6)
6. Cronmiller, L.E., Muhumuza, E., Abou Khalil, C.#, Curtis, E.G.*, **Doudrick. K.**, Hao, S., and Strathmann, T. Hydrothermal Decomposition of Perfluoroalkyl Sulfonic Acids with Ruthenium on Carbon Catalyst. *Appl. Catal. B: Energy & Environ.*, 2026, 396, 126926. (IF: 19.7)
7. Chernysheva, L.* and **Doudrick, K**. Hydroxide-Promoted Transformation of Fluorotelomer Carboxylic Acids at Ambient Temperature. *Environ. Sci.: Processes and Impacts*, 2026. 28, 5, 1511–1520. (IF: 4.2)
8. Abou-Khalil, C.,# Jiang, M.,* Gerges, F., Curtis, E.G.,* Chernysheva, L.,* Kim, J.,* **Doudrick, K.** PFAS in Wastewater Treatment Plants: A Critical Review, Meta-Analysis, and Open-Source Mapping of Global Occurrence and Fate. *Environ. Sci. & Technol.: Eng.*, 2026, 6, 1, 17–45. (IF: 6.3)

9. Silsby, S. et al. Characterizing Atmospheric Emissions During the Destruction of Per- and Polyfluoroalkyl Substances (PFAS)-Impacted Materials. *Nature Reviews: Earth & Environment*, 1–18, 2026. (IF: 74.1)
10. Gokhale, D. et al. Challenges and Opportunities in PFAS Waste Management for Semiconductor Manufacturing. *Environ. Sci. & Technol.*, 2026. (IF: 12.2)
11. Harrison, B., Major, D., Kinsman, L., Brown, J., Gabayet, J., Gerhard, J., Patch, D., Weber, K., Chernysheva, L., * Brown, G., **Doudrick, K**., Abarca-Perez, A.,* Peaslee, G., Pennell, K., Manz, K. Smoldering Treatment of PFAS: Investigation of Mass Balance and Volumetric Scale Up for Field Implementation. *ACS Omega*, 2025, 10, 28, 30489–30500. (IF: 5.2)
12. Soker, O., Tajdini, B., Abarca-Perez, A.,* Wadia, A., Bellona, C., **Doudrick, K.**, Strathmann, T. Reuse of Spent Granular Activated Carbon for PFAS Removal following Hydrothermal Alkaline Treatment. *Water Research*, 2025, 123794. (IF: 12.8)
13. Lin, Z., **Doudrick, K.**, Herckes, P., Chester, M., Westerhoff, P., Boyer, TH. Life Cycle Assessment of the Thermal Oxidation and Pyrolysis of Granular Activated Carbon Loaded with Perfluorooctane Sulfonic Acid (PFOS). *J. of Cleaner Production*. 2025, 145325. (IF: 10.7)
14. Johnson, G., Bailey, T., Hatinoglu, D., Nwachukwu, O.,* Peller, J., **Doudrick, K.**, Dam, B., Smith, S., Ross, L. Apul, O. Land-Sea Connection of Microplastic Fiber Pollution in Frenchman Bay, Maine. *Environ. Eng. Sci***.** 2024 (IF: 1.7)
15. Abou-Khalil, C.,# Chernysheva, L.,* Miller, A., Abarca-Perez,* A., Peaslee, G., Herckes, P., Westerhoff, P., **Doudrick, K**. Enhancing the Thermal Mineralization of Perfluorooctane Sulfonate on Granular Activated Carbon using Additive-Assisted Treatment. *Environ. Sci. Technol.*, 2024, 58, 25, 11162–11174. (IF: 12.2)
16. Kim, J.,* Chernysheva, L.,* Xu, J., McClure, M., Latulippe, D., Phillip, W., **Doudrick, K.** Microfiltration membranes as a mass-transfer efficient structure for the adsorption of per- and polyfluoroalkyl substances (PFASs) from drinking water. *Environ. Sci. Technol.: Eng***.** 2024, 4, 5, 995–1006. (IF: 6.3)
17. Coelho, PB, Fitzgerald, G, Isaacson, K, Diop, R, Prabhakar, Heffner, GS, Verma, A, Youngblood, JP, Choi, YJ, Surdyka, S, Spears, SA, Frisbee, MD, Del Real, KR, Gustafson, LA, Torrez, AM, Proctor, CR, Lee, LS, Whitehead, HD, **Doudrick**, K., Harpur, BA, and Whelton, AJ. Environmental and private property contamination following the Norfolk Southern chemical spill and chemical fires in Ohio. *Environ. Sci.: Wat. Res. and Technol*. 2024. (IF: 3.5)
18. Nwachukwu, O.,* Kniazev, K., Abarca-Perez, A.,* Kuno, M., **Doudrick, K.** Single-Particle Analysis of the Photodegradation of Submicron Polystyrene Particles Using Infrared Photothermal Heterodyne Imaging. *Environ. Sci. Technol***.** 2024 58, 2, 1312-1230. (IF: 12.2)
19. Peller, J.R., Tabor, G., Davis, C., Iceman, C., Nwachukwu, O.,* **Doudrick, K.**, Wilson, A., Suprenant, A., Dabertin, D., McCool, J.P. Distribution and Fate of Polyethylene Microplastics Released by a Portable Toilet Manufacturer into a Freshwater Wetland and Lake. 2024. *Wat.*, 16(1), 11. (IF: 3.5)
20. Kim, J.,* Roche, K.R., Bolster, D., **Doudrick, K**. The impact of biofilms and dissolved organic matter on the transport of nanoparticles in field-scale streams. *Wat. Res*. 2022, 226, 119206. (IF: 12.8)
21. Wang, J., Lin, Z., He, X., Song, M., Westerhoff, P., **Doudrick, K**., and Hanigan, D. Critical Review of Thermal Decomposition of Per- and Polyfluoroalkyl Substances: Mechanisms and Implications for Thermal Treatment Processes. *Environ. Sci. Technol*. 2022, 56, 9, 5355-5370. (IF: 12.2)
22. Kniazev, K., Pavlovets, I., Zhang, S., Kim, J.,* Stevenson, R., **Doudrick, K.**, Kuno, M. Using Infrared Photothermal Heterodyne Imaging to Characterize Micro- and Nano-Plastics in Complex Environmental Matrices. *Environ. Sci. Technol.* 2021, 55, 23, 15891-15899. (IF: 12.2)

23. Aquino de Carvalho, N., Wang, Y., Morales-Soto, N., Waldeck, D., Bibby, K., **Doudrick**, K. Gilbertson, LM. Using C-doping to Identify Photocatalytic Properties of Graphitic Carbon Nitride that Govern Antibacterial Efficacy. *Environ. Sci. Technol. Wat.* 2020, 1, 2, 269-280. (IF: 4.5)
24. Mousset, E. and **Doudrick, K**. A review of electrochemical reduction processes to treat oxidized contaminants in water. *Current Opinion in Electrochem***.** 2020, 22, 221-227. (IF: 6.5)
25. Kang, D., Park, N., Choi, Y., **Doudrick, K.**, Jeon, J. Identification of transformation products to characterize the ability of a natural wetland to degrade synthetic organic pollutants. *Wat. Res.* 2020, 187, 116425. (IF: 12.8)
26. Zak, N.,* Marks, R.,* Perez-Calleja, P., Nerenberg, R., and **Doudrick, K.** A computational model for the catalytic hydrogel membrane reactor. *Wat. Res.* 2020, 185, 116199. (IF: 12.8)
27. Marks, R.,* Schranck, A.,* **Doudrick, K.** Stability of 2H-and 1T-MoS_2 in the presence of aqueous oxidants and its protection by a carbon shell. *RSC Adv*. 2020, 10, 9324-9334. (IF: 6.1).
28. Marks, R.,* Seaman, J.,† **Doudrick, K.** Activity and stability of the catalytic hydrogel membrane reactor under realistic operating and aqueous conditions. *Wat. Res.* 2020, 174, 1151593*.* (IF: 12.8)
29. Schranck, A.,* and **Doudrick, K.** Effect of reactor configuration on the kinetics and nitrogen byproduct selectivity of urea electrolysis using a boron doped diamond electrode. *Wat. Res.* 2020, 168, 115130. (IF: 12.8)
30. Kim, J.,* Roche, K., Sticha, J.,† Shogren, A., Bolster, D., **Doudrick, K.** Transport of food- and catalytic-grade titanium dioxide nanoparticles in controlled field streams with varying streambed and biofilm conditions. *Environ. Sci.: Nano*. 2019, 6, 3454-3466. (IF: 5.6)
31. Marks, R.* and **Doudrick, K.** Photocatalytic reduction of chlorite in water using bismuth vanadate ($BiVO_4$): Effect of irradiance conditions and presence of oxalate on the reactivity and by-product selectivity. *Environ. Sci.: Wat. Res. and Technol*. 2019, 5, 2015-2026. (IF: 3.5)
32. Marks, R.,* Seaman, J.,† Perez-Calleja, P., Kim, J.*, Nerenberg, R., **Doudrick, K.** Catalytic hydrogel membrane reactor for treatment of aqueous contaminants. *Environ. Sci. Technol***.** 2019, 53(11), 6492-6500. (IF: 12.2)
33. Kim, J.* and **Doudrick, K.** *Emerging Investigator Series*: Protein adsorption and transformation on catalytic and food-grade TiO_2 nanoparticles in the presence of dissolved organic carbon. *Environ. Sci.: Nano***.** 2019, 6, 1688-1703. (IF: 5.6)
34. Kim, T.,^ Lee, S., Kim, H., **Doudrick, K.**, Yu, S., Kim, S. Decomposition of perfluorooctane sulfonate (PFOS) using a hybrid process with electron beam and chemical oxidants. *Chem. Eng. J.* 2019, 361, 1363-1370. (IF: 12.5)
35. Schranck, A.,* Marks, R.,* Yates, E.,† **Doudrick, K.** Effect of urine compounds on the electrochemical oxidation of urea using a nickel cobaltite catalyst: An electroanalytical and spectroscopic investigation. *Environ. Sci. Technol.* 2018, 52 (15), 8638-8648. (IF: 12.2)
36. Faust, JJ, Christenson, W., **Doudrick, K.**, Ros, R., Ugarova, T. Development of fusogenic glass surfaces that impart spatiotemporal control over macrophage fusion: Direct visualization of multinucleated giant cell formation. *Biomaterials*, 128, 160-171. 2017**.** (IF: 13.6)
37. Faust, JJ, **Doudrick, K.**, Yang, Y., Capco, DG, Westerhoff, P. A facile method for separating and enriching nano and submicron particles from titanium dioxide found in food and pharmaceutical products. *PLOS One*, 10(11). 2016. [a]Shared First Author. (IF: 2.8)
38. Marks, R.,* Yang, T., Westerhoff, P., **Doudrick, K.** Comparative analysis of the photocatalytic reduction of drinking water oxoanions using titanium dioxide. *Water Res*. 104 (11), 11-19. 2016. (IF: 12.8)

39. Yang, Y., Zicheng, Y., Nosaka, T., **Doudrick, K.**, Hristovski, K., Herckes, P., Westerhoff, P. Interaction of carbonaceous nanomaterials with wastewater biomass. *Front. Environ. Sci. Eng.* 9(5), 823-831, 2015. (IF: 7.1)

40. Cheng, Q., Wang, C., **Doudrick, K.**, Chan, C. Hexavalent chromium removal using metal oxide photocatalysts. *Appl. Catal. B: Environ.*, 176-177, 740-748, 2015. (IF: 19.7)

41. **Doudrick, K.**, Chinn, J., Williams, J., Chawla, N., Rykaczewski, K. Rapid Method for Testing Efficacy of Nano-Engineered Coatings for Mitigating Tin Whisker Growth. *Microelec. Reliability*. 55 (5), 832-837 2015. (IF: 2.5)

42. Damle, VG, Tummala, A., Chandrashekar, S., Kido, C., Roopesh, A., Sun, X., **Doudrick, K.**, Chinn, J., Lee, JR, Burgin, TP, Rykaczewski, K. 'Insensitive'to touch: Fabric-supported lubricant-swollen polymeric films for omniphobic personal protection gear. *ACS Appl. Mat. Interfaces.* 7(7), 4224-4232, 2015. (IF: 7.8)

43. **Doudrick, K.**, Nosaka, T., P. Herckes, Westerhoff, P. Quantification of graphene and graphene oxide in complex organic matrices. *Environ. Sci Nano.*, 2, 60-67, 2015. Selected for Cover Image. Hot article 2015. (IF: 5.6)

44. Silva, RM; **Doudrick, K.**; Franzi, LM; TeeSy, C.; Anderson, DS; Zheqiong, W.; Mitra, S.; Vu, V.; Dutrow, G.; Evans, JE; Westerhoff, P.; Van Winkle, LS; Raabe, OG; Pinkerton, KE. Instillation versus inhalation of multiwalled carbon nanotubes: Exposure-related health effects, clearance, and the role of particle characteristics. *ACS Nano*, 8(9), 2014. (IF: 17.3)

45. **Doudrick, K.**; Liu, S.; Klein, K. L.; Mutunga, E. M.; Varanasi, K. K.; Rykaczewski, K., Different Shades of Oxide: from Nanoscale Wetting to Imprinting of Gallium-based Liquid Metals. *Langmuir*, 30 (23), 6867-6877, 2014. (IF: 4.4)

46. Yang, Y.,[a] **Doudrick, K.**,[a] Bi, X., Westerhoff, P. Characterization of food-grade titanium dioxide. *Environ. Sci. Technol***.**, 48(11), 6391-6400, 2014. [a]Shared first author. (IF: 12.2)

47. Reed, R., Faust, J.; Yang, Yu; **Doudrick, K.**, Capco, D., Hristovski, K., Westerhoff, P. Characterization of nanomaterials in dietary supplement drinks and assessment of biological interactions across their life cycle. *ACS Sustain. Chem. Eng***.**, 2(7), 1616-1624, 2014. (IF: 7.6)

48. Faust, J., **Doudrick, K.**, Yang, Y., Westerhoff, P., Capco, DG. Food grade titanium dioxide disrupts intestinal brush border microvilli in vitro independent of sedimentation. *Cell Bio. Toxicol***.**, 30, 169-188, 2014. (IF: 5.7)

49. **Doudrick, K.**, Corson, N., Oberdörster, G., Elder, A., Herckes, P., Westerhoff, P. Extraction and quantification of carbon nanotubes in complex matrices with application to rat lung tissue. *ACS Nano,* 7 (10), 8849-8856, 2013. (IF: 17.3)

50. Corredor, C.; Hou, W.C.; Klein, S.; Moghadam, B.; Goryll, M.; **Doudrick, K.**; Westerhoff, P.; Posner, J. Disruption of model cell membranes induced by carbon nanotubes. *Carbon,* 60, 67-75, 2013. (IF: 12.7)

51. **Doudrick, K.**, Yang, T., Hristovski, K., Westerhoff, P. Photocatalytic nitrate reduction: Managing the hole scavenger and by-product selectivity. *Appl. Catal. B: Environ.,* 136-137, 40-47, 2013. (IF: 19.7)

52. Yang, T., **Doudrick, K.**, Westerhoff, P. Photocatalytic reduction of nitrate using titanium dioxide for regeneration of ion exchange brine. *Water Res.*, 47(3), 1299–1307, 2013. (IF: 12.8)

53. Chiu, C., Hristovski, K., Dockery, R., **Doudrick, K.**, Westerhoff, P. Modeling temperature and reaction time impacts on hematite nanoparticle size during forced hydrolysis of ferric chloride. *Chem. Eng. J***.,** 210, 357–362, 2012. (IF: 12.5)

54. **Doudrick, K.**, Herckes, P., Westerhoff, P. Detection of carbon nanotubes in environmental matrices using programmed thermal analysis. *Environ. Sci. Technol.*, 46(22), 12246–12253, 2012. (IF: 12.2)

55. **Doudrick, K.**, Monzón, O., Mangonon, A., Hristovski, K., Westerhoff, P. Nitrate reduction in water using commercial titanium dioxide photocatalysts (P25, P90, and Hombikat UV100). *ASCE J. Environ. Eng.,* 138(8), 852–861, 2012. (IF: 1.8)

Book Chapters

1. **Doudrick, K.**; Jones, D. B.; Kalinowski, T.; Hartmann, E. M.; Halden, R. U., Assessment of the Contribution of Triclosan to Dioxin Emissions from Sludge Incineration in the US Using a Mathematical Model. In *Contaminants of Emerging Concern in the Environment: Ecological and Human Health Considerations*, Halden, R. U., Ed. Amer Chemical Soc, 1155 Sixteenth St Nw, Washington, Dc 20036 USA: 2010; Vol. 1048, pp 469-481.

6. Unreferred Publications

1. Westerhoff, P. and **Doudrick, K.** Nitrates in Groundwater: Treatment Technologies for Today and Tomorrow. *Southwest Hydrology*, 2009, 8(4): 31.
2. Matsen, S. and **Doudrick, K.** Independent Lead Testing in Flint, Michigan. National Resource Defense Council, 2019.
3. **Doudrick, K**. Removing PFAS from public water systems will cost billions and take time – here are ways you can filter out harmful 'forever chemicals' at home. The Conversation. April 17, 2024.

7. Patents

1. **Doudrick, K.** Low-Temperature Thermal Treatment of PFAS-Contaminated Wastes. Filed October 28, 2025. Patent Application: PCT/US25/52940
2. **Doudrick, K.**, Marks, R.,* Nerenberg, R. Catalytic Hydrogel Membrane Reactor. US Patent Number 11,926,545.
3. Faust, J., **Doudrick, K.**, Christenson, W., Ros, R., Ugarova, T. An optical-quality glass surface that enables spatial control of macrophage fusion. US Patent Number US11591574B2.
4. Rykaczewski, K. and **Doudrick, K.** Methods of Rapid 3D Nano/Microfabrication of Multifunctional Shell-Stabilized Liquid Metal Pipe Networks and Insulating/Metal Liquids Electro-Mechanical Switch and Capacitive Strain Sensor. US Patent Number WO2015175989.
5. Westerhoff, P., **Doudrick, K.**, Hristovski, H. Concept of a System for Photocatalytic Reduction of Nitrate in Water. US Patent Number WO2008011650A2.

8. Invited Talks

1. *Current Perspectives and Emerging Approaches in PFAS Remediation*. Indiana PFAS Network Fall 2026 Meeting. Indiana University Indianapolis, Indianapolis, IN, October 30, 2026.
2. *Low-temperature thermal PFAS mineralization process using thermal activation coupled with a gas-solid contactor containing a calcium-based reagent*. NATO PFAS Treatment Technology Test Bed and Seminar (AVT-451), Technology Testing Session 2. Canadian Forces Base Edmonton, Edmonton, Alberta, Canada, October 20, 2026.
3. *Removing Micro- and Nanoplastics from Water Systems*. Indiana Water Summit, Addressing Emerging Concerns: Microplastics and Pharmaceuticals session. Indianapolis, IN, August 20, 2026.
4. *Real-time Analysis of Gas-phase Products of Incomplete Destruction During the Thermal Treatment of PFAS*. SERDP & ESTCP Annual Meeting on Management of PFAS in the Environment. Long Beach, CA, July 22, 2026.

5. *Leaching from Concrete & Asphalt* (Invited Discussion Panel). SERDP & ESTCP Annual Meeting on Management of PFAS in the Environment. Long Beach, CA, July 21, 2026.
6. *PFAS Destruction Technologies: Promise, Performance, and What to Ask. 5th Biennial National PFAS Conference*. University of Arizona, Tucson, AZ, June 10, 2026.
7. *Management of Concrete and Asphalt Construction Materials Impacted by PFAS*. SERDP/ESTCP Webinar, March 26, 2026. https://serdp-estcp.mil/events/details/b4313d33-66a7-4112-9abb-3f09cb1987e1/management-of-concrete-and-asphalt-construction-materials-impacted-by-pfas
8. *PFAS-Impacted Concrete and Asphalt at DoW sites*. DoW Applied Innovation Workshop. Washington, D.C., March 4, 2026.
9. *Leaching from Concrete and Asphalt*. Long Beach, CA, August 4, 2025.
10. *PFAS Thermal Treatment: State of the Practice and Advances in Managing Impacted Wastes Using Low-Temperature Incineration*. REMTEC. Westminster, CO, October 16, 2024.
11. *Managing Pavement Waste Contaminated with PFAS using Low-Temperature Incineration*. Transportation Research Board Symposium Denver, CO, August 26, 2024.
12. Seminar at the University of Nevada-Reno. April 2026.
13. Seminar at New Jersey Institute of Technology. *Adsorptive Porous Membranes for Removing PFAS from Drinking Water*. Newark, NJ. March 24, 2025.
14. Track Keynote at REMTEC. *PFAS Thermal Treatment: State of the Practice and Advances in Managing Impacted Wastes Using Low-Temperature Incineration*. Westminster, CO, October 16, 2024.
15. Seminar at the Colorado School of Mines. *Enhancing the Thermal Mineralization of Per-and Polyfluoroalkyl Substances using Alkali and Alkaline-Earth Metal Additives*. Golden, CO, October 4, 2024
16. Talk at the Transportation Research Board Symposium. *Managing Pavement Waste Contaminated with PFAS using Low-Temperature Incinerati*on. Denver, CO, August 26, 2024.
17. Invited talk at the Indiana Water Summit. *Managing PFAS in our Drinking Water*. Indianapolis, IN, August 22, 2024.
18. Warren Distinguished Lecture at the University of Minnesota. *Enhancing the Thermal Mineralization of Per- and Polyfluoroalkyl Substances Using Alkali and Alkaline-Earth Metal Additives*. Minneapolis, MN, April 5, 2024.
19. Seminar at Eidgenössische Technische Hochschule (ETH). *Nanotechnology for Water Treatment: Are we Creating a Solution or Problem?* Zürich, Switzerland, July 8, 2019.
20. Seminar for the Laboratoire Réactions et Génie des Procédés (LRGP) at the Centre National de la Recherche Scientifique (CNRS). *Nanotechnology for Water Treatment: Are we Solving the Problem or Creating a New One?* Nancy, France, July 5, 2019.
21. Seminar at Université Paris-Est Marne-la-Vallée. *Analysis of Electrochemical Systems for the Decomposition of Urea in Urine*. June 27, 2019.
22. Seminar at Valparaiso University. *Nanotechnology: The Next "Industrial Revolution" or Environmental Disaster?* Valparaiso, IN. November 30, 2018.
23. Seminar at the University of Wisconsin-Madison: *Dealing with the Increased Complexity of Nanoparticle Behavior in the Environment.* Madison, WI, September 28, 2018.
24. Sloan Foundation Workshop on Nanochemistry in the Indoor Environment. *Journey to the Center of the Room*. New York, NY, July 13, 2018.

25. Seminar at Marquette University, Dept. of Civil, Construction, and Environmental Engineering. *Can we use nanotechnology to solve our water problems or are we creating future pollution?* Milwaukee, WI, November 15, 2017.
26. Seminar at Northwestern University, Dept. of Civil and Environmental Engineering. *Photocatalysis as a Sustainable Waste-to-Value Water Treatment Technology*. October 23, 2015.
27. Panel committee member on *nanotechnology in water*. Futurescape City Tours – Water and Emerging Technologies, Center for Nanotechnology in Society. Phoenix, AZ, December 1, 2012.

9. Conference Presentations

1. **Doudrick, K.**, Markad, U., Sin, A., Corcoran, A., Hana, G. *Low-Temperature Thermal Destruction of PFAS Using a Gas-Solid Contactor Containing Calcium Oxide* (Oral). 42nd International Conference on Thermal Treatment Technologies & Hazardous Waste Combustors (IT3/HWC), Salt Lake City, UT, October 28, 2026.
2. Nwachukwu, O. and Doudrick, K. *Single Particle Tracking and Analysis of the Photodegradation of Sub-Micron Polystyrene Particles* (Poster). AEESP Distinguished Lecturer Event, March 31, 2023, Notre Dame, IN.
3. Nwachukwu, O. and Doudrick, K. *Single Particle Analysis of the Photodegradation of Submicron Polystyrene Particles* (Poster). Colleges of Science & Engineering Research Horizon Symposium, December 8, 2023, Notre Dame, IN.
4. Abarca-Perez, Angela; Xu, Jialing; Phillip, William; Doudrick, Kyle. *Catalytic Membranes for Drinking Water Treatment* (Oral). The Colleges of Science & Engineering Research Symposium, December 2023. Notre Dame, IN.
5. Abarca-Perez, Angela; Xu, Jialing; Phillip, William; Doudrick, Kyle. *Rational Design of Catalytic Polymeric Membranes for Treating Nitrite in Drinking Water* (Poster). Borchardt Conference on Advances in Water and Wastewater, May 2023, Ann Arbor, MI.
6. Abou-Khalil, C., and Doudrick, K. *The Use of Additives for Enhancing the Thermal Treatment of PFAS-Laden Adsorbents* (Oral). ND PFAS Workshop, January 31, 2023, South Bend, IN.
7. Abou-Khalil, C., Chernysheva, L., and Doudrick, K. *Enhanced Thermal Treatment of PFAS-Laden Granular Activated Carbon with Additives* (Poster). Borchardt Conference, May 23-24, 2023, Ann Arbor, MI.
8. Abou-Khalil, C., Chernysheva, L., and Doudrick, K. *Enhanced Thermal Treatment of PFAS-Laden Granular Activated Carbon with Additives* (Oral). International Conference on Thermal Treatment Technologies & Hazardous Waste Combustors, September 13-14, 2023, Charlotte, NC.
9. Abou-Khalil, C., and Doudrick, K. *Enhancing the Thermal Treatment of Adsorbents Contaminated by Per- and Polyfluoroalkyl Substances (PFAS)* (Oral). ND PFAS Workshop, September 28-29, 2023, South Bend, IN.
10. Abou-Khalil, C., and Doudrick, K. *Enhancing the Thermal Mineralization of PFOS on Granular Activated Carbon using Additive-Assisted Treatment* (Poster). Department of Defense's (DoD) Energy and Environment Innovation Symposium, November 28, 2023- December 1, 2023, Arlington, VA.
11. Kim, J., Chernysheva, L., Xu, J., Phillip, W., Doudrick, K. *Adsorbent membranes for removing per- and polyfluoroalkyl substances* (PFAS) (Poster). Borchardt Conference, May 23, 2023, University of Michigan, Ann Arbor, MI.
12. Doudrick, K., Westerhoff, P., Peaslee, G., Herckes, P. Hristovski, K., Boyer, T. *Using Total Fluorine Analyses to Assess the Fate of PFAS in Thermal Treatment Systems* (Oral). SERDP Symposium, November 29-December 2, 2022, Arlington, VA.

13. Nwachukwu, O.,* Kniazev, K., Kuno, M., and Doudrick, K. *Characterizing the degradation of micro- and nano-plastics in the environment using infrared photothermal heterodyne imaging and spectroscopy (IR-PHI)* (Oral). American Chemical Society National Meeting and Exposition (Oral), August 21-25, 2022, Chicago, IL.
14. Kim, J.,* Phillip, W., and Doudrick, K. *Adsorbent membranes for removing per- and polyfluoroalkyl substances.* American Chemical Society National Meeting and Exposition (Oral), August 21-25, 2022, Chicago, IL.
15. Abarca-Perez, A.,* Phillip, W., and Doudrick, K. *Catalytic membranes as an efficient and scalable technology for treating oxidized contaminants in drinking water* (Oral). American Chemical Society National Meeting and Exposition, August 21-25, 2022, Chicago, IL.
16. Abarca-Perez, A.,* Xu, J., Senn, L., Phillip, W., and Doudrick, K. *Nanostructured catalytic membrane for the treatment of drinking water contaminants* (Oral). American Chemical Society National Meeting and Exposition, March 20-25, 2022, San Diego, CA.
17. Kim, J.,* Chernysheva, L.,* Abarca Perez, A.,* Xu, J., Philip, W., and Doudrick, K. *Polymer-based adsorbent membrane for removing Per- and Polyfluoroalkyl Substances (PFAS)* (Oral). American Chemical Society National Meeting and Exposition, March 20-25, 2022, San Diego, CA.
18. Chernysheva, L.*, Whitehead, H., Peaslee, G., and Doudrick, K. *Abiotic transformation of perfluoroalkyl acid (PFAA) precursors found indoors to terminal products* (Oral). American Chemical Society National Meeting and Exposition, March 20-25, 2022, San Diego, CA.
19. Chernysheva, L., Bailey, A., Peaslee, G., and Doudrick, K. *Analytical method for total per- and polyfluorinated substances (PFAS) found in wastewater using particle-induced gamma-ray emission (PIGE) spectroscopy* (Poster). Borchardt Conference, February 25-26, 2020, Ann Arbor, MI.
20. Doudrick, K. and Marks, R.* *The Catalytic Hydrogel Membrane Reactor: Treating Aqueous Contaminants with Hydrogenation Nanocatalysts* (Oral). 8th Sustainable Nanotechnology Organization Conference, November 7–8, 2019, San Diego, CA.
21. Kim, J.* and Doudrick, K. *Transport of Titanium Dioxide Nanoparticles in Hydraulically Controlled Field Streams* (Oral). 8th Sustainable Nanotechnology Organization Conference, November 7–8, 2019, San Diego, CA.
22. Doudrick, K. and Marks, R.* *Catalytic Hydrogel Membrane Reactor for Treating Aqueous Contaminants* (Oral). 258th American Chemical Society National Meeting and Exposition, August 25–29, 2019, San Diego, CA.
23. Kim, J.,* Roche, K., Bolster, D., and Doudrick, K. *Transport of Catalytic and Food-grade TiO_2 Nanoparticles in a Hydraulically Controlled Model Stream* (Poster). Association of Environmental Engineering and Science Professors (AEESP), May 2019, Tempe, AZ.
24. Schranck, A.* and Doudrick, K. *Electrolytic Conversion of Urea in Urine using Boron Doped Diamond: Effect of Operational Conditions and Cell Configuration* (Poster). 25th Topical International Society of Electrochemistry Meeting, Toledo, Spain, May 12–15, 2019.
25. Kim, J.* and Doudrick, K. *Stream Transport Behavior of Titanium Dioxide Nanoparticles in a Hydraulically Controlled Model System* (Oral). 7th Sustainable Nanotechnology Organization Conference, November 5–7, 2018, Boston, MA.
26. Marks, R.* and Doudrick, K. *Catalytic Advancements for Water Treatment* (Oral). 7th Sustainable Nanotechnology Organization Conference, November 5–7, 2018, Boston, MA.
27. Doudrick, K. and Kim, J.* *Formation and transformation of the protein corona on catalytic and food-grade TiO_2 nanoparticles in the presence of pre-adsorbed dissolved organic matter* (Oral). 256th American Chemical Society National Meeting and Exposition, August 19–23, 2018, Boston, MA.

28. Doudrick, K., Schranck, A.,* Marks, R.,* Yates, E.† *Electroanalytical and spectroscopic investigation of urine electrooxidation: The effect of major urine compounds on the activity of a nanostructured nickel cobaltite electrode.* 256th American Chemical Society National Meeting and Exposition (Oral), August 19–23, 2018, Boston, MA.

29. Doudrick, K., Schranck, A.* *Effect of Urine Compounds on the Electrochemical Oxidation of Urea Using a Nickel Cobaltite Catalyst: An Electroanalytical and Spectroscopic Investigation* (Poster). GRC Environmental Science: Water, Plymouth, NH, June 17–22, 2018.

30. Marks, R.,* Doudrick, K. *Investigation of nanostructured MoS_2 as an earth abundant catalyst for nitrite hydrogenation* (Oral). 255th ACS National Meeting and Exhibition, New Orleans, LA, March 18, 2018.

31. Kim, J.,* Doudrick, K., *Effects of environmental parameters on the protein corona of TiO_2 nanoparticles in the presence of natural organic matter* (Oral). Colleges of Science & Engineering Joint Annual Meeting, Notre Dame, IN, Dec. 8, 2017.

32. Schranck, A.,* Marks, R.,* Yates, E.,† Clark, D.,† Doudrick, K., *Teasing Apart Urine to Improve Advanced Wastewater Treatment and Resource Recovery* (Oral). Colleges of Science and Engineering Joint Annual Meeting, Notre Dame, IN, Dec. 8, 2017.

33. Kim, J.,* Doudrick, K., *Effects of environmental parameters on the protein corona of TiO_2 nanoparticles in the presence of natural organic matter* (Oral). 6th Sustainable Nanotechnology Organization (Oral), Los Angeles, CA, Nov. 5–7, 2017.

34. Kim, J.,* Doudrick, K., *Stream transport behavior of food-grade titanium dioxide nanoparticles in a hydraulically controlled, model system* (Poster). Science Sunday, South Bend, IN, Oct. 22, 2017.

35. Marks, R.,* Doudrick, K., *Earth Abundant Hydrogenation Catalysts for the Reduction of Nitrite* (Oral). ND Energy Postdoc and Grad Student Luncheon, Notre Dame, IN, October 18, 2017

36. Schranck, A.,* Clark, D.,† Lee, B.,† Rosas Villalva, D.,† Doudrick, K., *Sustainable treatment of wastewater and generation of electricity using a solar photocatalytic fuel cell* (Poster). Association of Environmental Engineering and Science Professors Research and Education Conference, Ann Arbor, Michigan, June 22, 2017.

37. Marks, R.,* Doudrick, K., *Time resolved in situ ATR-FTIR monitoring of nitrate waste reduction on supported metal catalysts* (Poster). AEESP Research and Education Conference, Ann Arbor, MI, June 20-22, 2017.

38. Kim, J.,* Doudrick, K., *Time-resolved in-situ ATR-FTIR investigation of macromolecular corona formation and transformation on nanoparticles upon environmental perturbations* (Poster). AEESP Research and Education Conference, Ann Arbor, MI, Jun 20–22, 2017.

39. Kim, J.,* Doudrick, K., *Investigation of macromolecular corona formation and transformation on TiO_2 nanoparticles using time-resolved in-situ ATR-FTIR* (Poster). NDnano Symposium, Notre Dame, IN, March 30, 2017.

40. Schranck, A.,* Clark, D.,† Lee, B.,† Rosas Villalva, D.,† Doudrick, K., *Sustainable treatment of wastewater and generation of electricity using a solar photocatalytic fuel cell* (Poster). Borchardt Conference, Ann Arbor, Michigan, February 22, 2017.

41. Kim, J.,* Doudrick, K., *Investigation of macromolecular corona formation and transformation on TiO_2 nanoparticles using time-resolved in-situ ATR-FTIR* (Poster). Borchardt Conference, Ann Arbor, MI, Feb. 21–22, 2017.

42. Marks, R.,* Doudrick, K., *Time resolved in situ ATR-FTIR monitoring of nitrite sorption on supported metal catalysts* (Poster). Borchardt Conference, Ann Arbor, MI, February 21–22, 2017.

43. Doudrick, K., Clark, D.,† Schranck, A.* *Urine as a Commodity: Potential and Challenges of Electrochemical Cells* (Oral). AEESP Conference, Ann Arbor, MI, June 20-22, 2017.

44. Marks, R.,* Czarnecki, A.,† Doudrick, K. (2016) *Removal of Oxoanion Disinfection Byproducts Using Visible-Light Photocatalysts* (Poster). Water Quality Technology Conference. Indianapolis, IN.

45. Kim, J.,* Doudrick, K. *Time-Resolved In-Situ ATR-FTIR Investigation of Environmental Corona Formation and Transformation on TiO_2 Nanoparticles* (Oral). 5th Sustainable Nanotechnology Organization Conference, Orlando, FL, Nov. 10–12, 2016.

46. Schranck, A.,* Clark, D.,† Lee, B.,† Rosas Villalva, D.,† Doudrick, K. *Sustainable treatment of wastewater and generation of electricity using a solar photocatalytic fuel cell* (Poster). IWA Leading Edge Conference on Water and Wastewater Technologies (Poster), Jerez, Spain, June 13–16, 2016.

47. Doudrick, K., Schranck, A.,* Villalva, DR,† Clark, D.† *Sustainable Treatment of Wastewater and Generation of Electricity Using a Solar Photocatalytic Fuel Cell* (Oral). International Water Association Nano and Water Specialist Conference, Houston, TX, Rice University, May 16–18, 2016.

48. Stancl, H., Doudrick, K., Hristovski, K., Westerhoff, P. *Nano-coated fiber optics for photocatalytic drinking water treatment* (Oral). American Chemical Society National Meeting and Exposition, Boston, MA, August 16–20, 2015.

49. Marks, R., Yang, T., Westerhoff, P., Doudrick, K. *Photocatalytic reduction of oxoanions in water using titanium dioxide* (Poster). Gordon Research Conference: Environmental Nanotechnology, Mt. Mount Snow, VT, June 21–26, 2015 *GRC Poster Award Winner.

50. Marks, R., Yang, T., Westerhoff, P., Doudrick, K. *Photocatalytic reduction of oxoanions in water using titanium dioxide* (Poster). Association for Environmental Engineering and Science Professors Annual Conference, June 13–16, 2015.

51. Doudrick, K., Nosaka, T., P. Herckes, Westerhoff, P. *Quantification of graphene and graphene oxide in complex organic matrices* (Poster). 3rd Sustainable Nanotechnology Organization Conference, Boston, MA, November 2–4, 2014.

52. Doudrick, K., Faust, JJ, Yang, Y., Capco, DG, Westerhoff, P. *A Facile Method for Separating and Enriching Nano and Submicron Particles from Titanium Dioxide Found in Food and Pharmaceutical Products* (Poster). 3rd Sustainable Nanotechnology Organization Conference, Boston, MA, November 2–4, 2014.

53. Westerhoff, P., Yang, Y., Nosaka, T., Doudrick, K., Yu, Z., Herckes, P., Hristovski, K. *Interaction of carbon nanotubes and graphene nanoplatelets with wastewater biomass* (Oral). American Chemical Society National Meeting and Exposition, San Francisco, CA, August 10–14, 2014.

54. Faust, JJ, Doudrick, K., Yang, Y., Westerhoff, P., Capco, DG. *Food grade titanium dioxide disrupts brush border microvilli in vitro independent of sedimentation* (Poster). Arizona Imaging and Microanalysis Society. 2014, March 20–21; Tempe, AZ. *Electron Microscopy Sciences Best Poster Award

55. Doudrick, K., Liu, S., Klein, K., Mutunga, E., Varanasi, K., Rykaczewski, K. *Methodology for imaging of nano-to-microscale wetting and dewetting dynamics of liquid metals* (Oral). Materials Research Society, Boston, MA, December 1–6, 2013.

56. Doudrick, K. and Westerhoff, P. *Framework for developing photocatalysts for nitrate reduction in water* (Oral). American Chemical Society National Meeting and Exposition, Indianapolis, IN, September 8–12, 2013.

57. Doudrick, K. and Westerhoff, P. *Safe use of nanomaterial composites: Detecting carbon nanotubes and graphene throughout product life* (Poster). Gordon Research Conference: Environmental Nanotechnology, Stowe, VT, June 2–7, 2013. *Top Poster Award

58. Doudrick, K., Yang, T., Geiger, N., Hristovski, K., Westerhoff, P. *Photocatalytic reduction of nitrate* (Poster). 1st Sustainable Nanotechnology Organization Conference, Arlington, VA, November 3–6, 2012. *Honorable Mention Award

59. Westerhoff, P., Doudrick, K., Herckes, P. *Detection of carbon nanotubes in environmental and biological matrices using programmed thermal analysis* (Oral). American Chemical Society National Meeting and Exposition, Philadelphia, PA, August 19–23, 2012.
60. Westerhoff, P., Ranville, J., Herckes, P., Halden, R, Doudrick, K., Lee, S. *Analytical techniques for measurement of carbonaceous nanomaterials in diverse media* (Oral). American Chemical Society National Meeting and Exposition, Philadelphia, PA, August 19–23, 2012.
61. Westerhoff, P., Doudrick, K., Oberdörster, G., Elder, A. *Carbon nanotube method development and application to lung tissue analysis* (Poster). Engineered Nanomaterials Grand Opportunity Consortium Meeting, Durham, NC, December 8–9, 2011.
62. Doudrick, K., Yang, T., Hristovski, K., Westerhoff, P. *Photocatalysis: A new treatment option for nitrate* (Oral). 16th International Conference on TiO_2: Fundamental and Applications, San Diego, CA, November 7–10, 2011.
63. Doudrick, K., Herckes, P., Westerhoff, P. *Quantification of Carbon Nanotubes using Programmed Thermal Analysis (PTA)* (Poster). Gordon Research Conference: Environmental Nanotechnology, Waterville Valley, NH, May 29–June 3, 2011.
64. Doudrick, K., Yang, T., Hristovski, K., Westerhoff, P. *Photocatalytic Reduction of Nitrate in Water* (Poster). AZ Water 84th Annual Conference and Exhibition, Glendale, AZ, May 4–6.
65. Doudrick, K., Yang, T., Hristovski, K., Westerhoff, P. *Photocatalytic Reduction of Nitrate in Water* (Oral). 1st Annual SSEBE Graduate Student Symposium, Arizona State University, Tempe, AZ, March 10, 2011.
66. Doudrick, K., Venkatesan, A., Kalinowski, T., Hartmann, E., Halden, R. *Assessment of the Contribution of Triclosan to Dioxin Emissions from Sludge Incineration in the U.S. Using a Mathematical Model* (Oral). Water Environment Federation: Industrial Wastewater Seminar 2011, Atlantic City, NJ, May 9–10, 2011.
67. Doudrick, K., Monzón, O., Mangonon, A., Hristovski, K., Westerhoff, P. *Selective Reduction of Nitrate to Dinitrogen in Groundwater Utilizing Commercial Titanium Dioxide Photocatalysts* (Oral). 15th International Conference on TiO_2: Fundamental and Applications, San Diego, CA, November 15–18, 2010.
68. Westerhoff, P., Benn, T., Pycke, B., Chao, T., Doudrick, K., Halden, R., Herckes, P. *Characterization of fullerols and fullerenes in complex matrices* (Oral). SETAC North America 31stAnnual Meeting, Nov. 7–10, Portland, OR, 2010.
69. Doudrick, K., Monzón, O., Hernandez, A., Westerhoff, P. *Selective reduction of nitrate to dinitrogen in water utilizing photocatalytic nanocomposites* (Oral). American Chemical Society National Meeting and Exposition, Boston, MA, August 22–26, 2010.
70. Doudrick, K., Hristovski, K., Moussett, M., Luque, H., Westerhoff, P., Posner, J. *Sorption of engineered nanomaterials to soils* (Oral). American Chemical Society National Meeting and Exposition, Boston, MA, August 22–26, 2010.

10. Grants and Sponsored Programs

1. Kyle **Doudrick** (PI). 2026-2029. Demonstration of Low-Temperature PFAS Mineralization Using a Calcium Oxide Gas-Solid Contactor. Department of Defense. **$1,457,546.**
2. Kyle Doudrick (PI). 2024-2025. Thermal treatment of fluorinated organic chemicals in waste streams from semiconductor fab processes. Semiconductor Research Corporation. **$27,000**.
3. Kyle **Doudrick** (PI). 2024. Analysis of total PFAS on parts from AFFF trucks. Arcadis. **$10,000**.
4. Kyle Doudrick (PI). 2024. Analysis of PFAS in soil and granular activated carbon. Geosyntec. **$10,000.**

5. Kyle **Doudrick** (PI). 2024. Characterization of micro- and nano-plastic (MNP) particles released from food and beverage containers composed of polymers. Compostable Pak. **$27,459**.
6. Kyle **Doudrick** (PI), Graham Peaslee (UND), David Hanigan (UNR), Cora Young (York). 2024-2028. *A Real-Time Analysis of Gas-Phase Products of Incomplete Destruction During the Thermal Treatment of PFAS*. Department of Defense. **$1,354,047**.
7. Kyle **Doudrick** (PI), Graham Peaslee, Braden Giordano (Navy). Recommended for funding, awaiting contract. 2023-2024. *Analytical Methods for the Determination of Total Per- and Polyfluoroalkyl Substances (PFAS) in PFAS-Free Firefighting Formulas.* Department of Defense. **$337,253**.
8. Kyle **Doudrick** (PI), Graham Peaslee, David Hanigan (UNR), Elie Hajj (UNR), Adam Hand (UNR), Chris Griggs (Army). 2023-2027. *A Complete Strategy for Pavements Impacted with PFAS: Rapid Quantification, Leaching Kinetics, In Situ Stabilization, Thermal Treatment, and Reusability*. Department of Defense. **$1,404,300**.
9. Kyle **Doudrick** (PI), Graham Peaslee, Paul Westerhoff (ASU), Pierre Herckes, Kiril Hristovski, Treavor Boyer, Huwei Gu, Paul Dahlen. 5/1/2021-12/31/2025. Department of Defense. *Improved Understanding of Thermal Destruction Technologies For Materials Laden With Per- And Polyfluoroalkyl Substances*. **$1,250,000**.
10. Kyle **Doudrick** (PI), Graham Peaslee, and Marina Vance (Boulder). 1/1/2020-12/31/2020. Sloan Foundation. *Presence and transformation of PFAS in indoor athletic facilities*. **$50,000**.
11. Kyle **Doudrick** (PI). 7/1/2019–6/30/2024. National Science Foundation (NSF) Environmental Engineering. *CAREER: Catalytic Hollow-Fiber Membranes as an Efficient and Scalable Technology for Water Treatment*. **$500,000**.
12. Kyle **Doudrick** (PI). 5/1/2020–7/31/2020. Fulbright Scholar Program. *Electrochemical Treatment of Source-Separate Urine: Developing a Kinetic Model*. **~$11,500**.
13. Kyle **Doudrick** (PI) and Diogo Bolster (coPI). 8/15/2017-7/31/2020. National Science Foundation (NSF) Biological and Environmental Interfaces of Nanomaterials*. A Multi-Scale Investigation of Transport of Complex Nanoparticles in Complex Flows: Integrating Lab, Field, and Models to Simplify Complexity*. **$330,000**.
14. Kyle **Doudrick** (coPI) and Susan Matsen (coPI; Michigan State University). National Resources Defense Council (NRDC). *NRDC Flint Sampling Project*. **$20,000**.
15. Rein Ulijn (PI; CUNY), Kyle **Doudrick** (co-PI), Vicki Grassian (co-PI; UC San Diego), Marina Vance (co-PI; CU Boulder). Sloan Foundation Workshop on Chemistry of Indoor Environments. *Nanoscale chemistry of indoor environments*. **$50,000**.
16. Kyle **Doudrick** (PI) and Prakash Nallathamby (co-PI). 8/1/2017-1/1/2018. ND Environmental Change Initiative Seed Grant. *A real-time, in-situ spectroscopic investigation of aquatic natural organic matter adsorption onto engineered nanomaterials.* **$20,000**.

11. Doctoral Dissertations Directed

Veronica Kowalewski, Ph.D. Candidate, Fall 2025-present (Expected 2031)

Aebin Sin, Ph.D. Candidate, Fall 2024-present (Expected 2030)

Ana Corcoran, Ph.D. Candidate, Fall 2024-present (Expected 2030)

Elizabeth Grace Curtis, Ph.D. Candidate, Fall 2023–present (Expected 2029)

Thermal Destruction of PFAS with Low-Temperature Catalysts

Menglin Jiang, Ph.D. Candidate, Fall 2022–present (Expected 2028)

Leaching of PFAS from Pavements

Ozioma Nwachukwu, Ph.D. Student, Graduated (2021–2025)

Micro- and Nanoplastics Leaching from Consumer Products

Jeein Kim, Ph.D. Student, Graduated (2021–2025)

Adsorptive Membranes for Removal of PFAS from Water

Angela Abarca Perez, Ph.D. Student, Graduated (2021–2025)

Catalytic Membranes for treating Emerging Contaminants

Liliya Chernysheva, Ph.D. Student, Graduated (2019–2024)

Thermal Treatment of Materials Laden with PFAS

Nicolas Zak, M.S. Student, Graduated (2019–2021)

Treating Emerging Contaminants using the Catalytic Hydrogel Membrane Reactor

Junyeol Kim, Ph.D. Student, Graduated (2015–2021). CEST Fellow.

Lab- and Field-Scale Studies on the Fate and Transport Of Nanoparticles in Streams: Influence of Nanoparticle Characteristics, Macromolecules, and Environmental Parameters

Randal Marks, Ph.D. Student, Graduated (2014–2019). GRC poster award winner; ND Energy Eilers Fellowship; CEST Fellowship.

A Catalytic Hydrogel Membrane Reactor to Treat Oxidized Contaminants in Drinking Water

Andrew Schranck, Ph.D. Student, Graduated (2014–2019). NCAA and A&WM scholarship winner; ND Energy Eilers Fellowship.

Analysis of Electrochemical Systems for Decomposition of Urea in Urine

12. Other Advising

Research Scientists

Uddhav Markad (2026-)

Postdoctoral Scholars

George Hana (2026-)

Uddhav Markad (2024–2026)

Charbel Abou-Khalil (2022–2025)

Siwei Gu (2023–2025)

Master's or Doctoral Committee Member

Frances Zengotita, Ph.D. CEEES

Kyson Smith, Ph.D. CEEES

Emily Clements, Ph.D. CEEES

Zhenyu Wu, Ph.D. CEEES

Brooke Stemple, Ph.D. CEEES

Meenu Garg, M.S. defense, CEEES

Margaret Butzen, Ph.D. candidacy, CEEES

Aleksandar Dimkovikj, Ph.D. candidacy, CEEES

Nicole Moore, Ph.D. candidacy, CEEES

Clayton Johnson, Ph.D. dissertation defense, CEEES

Melika Sharifironizi, Ph.D. dissertation defense, CEEES

Andrew DeVries, M.S. defense, CEEES

Samuel Bruce, M.S. thesis defense, CEEES

UND Undergraduate Researchers

Katherine Heitmann (CBE). PFAS

Flora Wang (CEEES). PFAS

Kate Drab (CBE). Micro- and nanoplastics

Billy Crutchlow (Anthropology). PFAS

Megan McGuckin (CEEES). PFAS

Elena Que (CEEES). PFAS

Elena Herberg (CEEES). PFAS

Lillian Montabon (CEEES). PFAS

Andrea Reisinger (CEEES). Catalytic membranes

Collin Kemper (CBE). PFAS

Joseph Seaman (CBE). Performance of the catalytic hydrogel membrane reactor. *Co-author of two publications.

Ashley Finster (CEEES). Synthesis of catalytic hydrogel membranes.

John Sticha (CEEES). Transport of nanoparticles in streams; analysis of PFAS. *Co-author of one publication.

Emily Black (CEEES). Investigating discrepancies in using dyes as model photocatalysts. *Lead author of one publication in preparation.

Marisa Ross (CEEES). Investigating discrepancies in using dyes as model photocatalysts.

David Clark (CEEES). Electroanalytical characterization of electrodes for urea oxidation.

Hamish McFarlane (CEEES). Transport of nanoparticles in columns.

Juan Velazquez (CBE). Synthesis of graphene-based electrodes for wastewater treatment.

Brian Lee (CBE). Synthesis of visible light photocatalysts.

Alicia Czarnecki (CEEES). Photocatalytic reduction of chlorite.

Monika Bueltel (CEEES). Photocatalytic reduction of chlorite.

Visiting Scholars

Dr. Taehun Kim. Principal Researcher, Korea Atomic Energy Research Institute.

Dr. Junho Jeon. Assistant Professor, Department of Environmental Engineering, Changwon National University.

Visiting Undergraduate/High School Researchers

Madeleine Schor

Aaron Peaslee (ND Nano NURF program; Michigan Tech). PFAS removal using adsorptive membranes.

Sebastian Muniz (Graduate School Summer Research Program; Polytechnic University of Puerto Rico). Synthesis of earth-abundant catalysts for oxoanion hydrogenation.

Elon Yates (Graduate School Summer Research Program; Florida A&M). Electrolytic decomposition of urea. *Paper co-author

Yukun Du (iSURE program; Zhejiang University). Synthesis of visible light photocatalysts.

Marina Dragicevic (CONICTY REU Program; Pontificia Universidad Católica de Chile). Photocatalysis of oxoanions.

Angela Abarca-Perez (ND Nano NURF program; Universidad de las Americas Puebla). Attachment of dissolved organic matter to nanoparticles.

Diego Rosas Villalva (ND Nano NURF program; Universidad de las Americas Puebla). Synthesis of bismuth vanadate electrodes.

Darragh Lombard (ND Nano NURF program; University College Cork). Synthesis of bismuth iodate electrodes.

Zhaoyun Zeng (iSURE program; Zhejiang University). Synthesis of carbon nitride photocatalysts.

13. Professional Memberships

- Air & Waste Management Association (AWMA)
- American Chemical Society (ACS)
- American Water Works Association (AWWA)
- American Society of Civil Engineers (ASCE)
- Association of Environmental Engineering and Science Professors (AEESP)
- Order of the Engineers
- Sustainable Nanotechnology Organization (SNO)

14. Service

Broader Scientific Service

- ES&T Editorial Advisory Board, 2025–Present
- Newsletter Editor, Association for Environmental Engineering and Science Professors (AEESP), 2021–Present
- Guest Editor for Sus. Sci. Tech. Special Issue on Thermal Treatment of PFAS (2027)
- Guest Editor for Water Research X Special Issue on Destruction of PFAS (2026)
- Journal reviewer for: *Environmental Science & Technology, Environmental Science: Nano, Water Research, Environmental Science & Technology Letters, Environmental Engineering Science*, *Physical Chemistry, Applied Catalysis A, Applied Catalysis B, WEF, Applied Surface Science, ACS Catalysis, Industrial and Engineering Chemistry Research, Bulgarian Chemical Communications, Water Science and Technology, Water Environment Research, RCS Advances, ASCE Environmental Engineering*.
- Agency (Proposal) Reviewer: National Science Foundation (NSF), United States Department of Agriculture (USDA), Department of Defense (DoD), United States Geological Survey (USGS)
- Board Member, Sustainable Nanotechnology Organization, 2018–2023
- Scholarship Reviewer American Waterworks Association, 2014–2021
- Newsletter Editor and Photographer, Sustainable Nanotechnology Organization, 2013–2018
- President, Association of Graduate Civil Engineers, School of Sustainable Engineering and the Built Environment, Arizona State University, 2009–2010

  Organized community outreach events related to science and engineering, including trail rehabilitations and cleanups; assisted with the departmental Open House for recruitment of new graduate students; organized meetings and wrote monthly newsletter for the organization.

- Treasurer, Association of Graduate Civil Engineers, School of Sustainable Engineering and the Built Environment, 2008–2009

  Performed all accounting related tasks; collected membership dues; maintained the budget; fundraising.
- Senior Project Mentor, 2011–2012, Natalie Geiger. *Water-splitting semiconductors for photocatalytic reduction of nitrate in water*.
- Senior Project Mentor, 2009–2010, Alex Mangonon. *Reduction of nitrate utilizing commercial titanium dioxide nano-photocatalysts*.
- Obama Scholars Mentor, Arizona State University, 2009–2011
- President, American Society of Civil Engineers Student Chapter, University of Memphis, 2005–2006

  Organized student meetings and departmental events such as the annual job fair; helped organize the annual ASCE conference that hosted by the University of Memphis that year.
- Conference Chair, American Society of Civil Engineers Student Chapter, University of Memphis, 2004–2005

  Conducted all relevant tasks associated with the annual ASCE conference competition.

University Service

- Materials Science & Engineering Committee, 2022–Present
- Served the Future Faculty Workshop 2024: attended the poster sessions and served on a discussion panel called "The Academic Search Process"
- Gave two talks in the summer of 2024 for a CoE summer camp for high school students
- Served on the department Strategy Committee
- Served as the Chair of the Search Committee for new Environmental Engineering faculty hire in 2024
- Served on the Diversity, Equity, and Inclusion (DEI) Committee in CEEES
- Served on the Build, Break, Perfect Committee in CEEES
- Served on the Undergraduate Curriculum Committee in CEEES
- Served on the Resiliency Minor Committee in CEEES
- Served on the Website Committee in CEEES
- Served on the Teaching Evaluation Committee in CEEES
- Participant in the first-year engineering recruitment events for CEEES, including guest lectures, lab tours, department info nights, and individual student meetings/tours
- Mentored Marisa Ross through the Building Bridges program, 2016–2107
- Faculty search committee for Environmental group, 2016

15. Professional Development

- Professional Engineering (PE) License in the State of Indiana
- Department of Defense Workshop on Vapor-Phase Measurement of Products of Incomplete Destruction for PFAS, 2024
- American Society for Engineering Education National Effective Teaching Institute (NETI) Workshop, 2015
- Preparing for Future Faculty–Exploratory Phase (2nd Year), 2010–2011
- Preparing for Future Faculty–Preparatory Phase (1st Year), 2009–2010
- MIT EdX Course 3.091x: Solid State Chemistry, Oct. 2012–Jan. 2013 (Passed)
- Nano and the City workshop, Center for Nanotechnology in Society, Arizona State University, December 2012
- Finding Funding workshop sponsored by the Science Foundation Arizona, February 2009
- Modeling Flow and Contaminant Transport in the Subsurface, 5-day short course by Jacob Bear, October 2006
- Fundamentals of Engineering (EIT), 2005