

PFAS Comparison of Surface Water and Surface Water Foam: Van Etten Lake and Cedar Lake

Background

Van Etten Lake

Van Etten Lake is a 1,320-acre lake in Oscoda, Michigan that was created by the damming of the Pine River. It flows into Lake Huron via Van Etten Creek and the Au Sable River. The Oscoda-Wurtsmith Airport is located on the southwest bank of Van Etten Lake. The airport formerly operated as the Wurtsmith Air Force Base from 1923 to 1993, housing B-52, KC-135, and other aircraft over the years of its operation. In 2010, per- and polyfluoroalkyl substances (PFAS) were discovered in groundwater samples at the site. In July 2017, PFAS-contaminated surface water foam (SWF) was found on Van Etten Lake. Aqueous film-forming foams (AFFF) used in firefighting activities and training at the former Wurtsmith Air Force Base has been identified as the primary cause of PFAS contamination at this site.

On March 31st, 2020, foam and surface water samples were collected from three different sampling locations on Van Etten Lake: Ken Ratliffe Memorial Park (VAN ETTEN LK-12), near the Van Etten Lake Dam (VAN ETTEN LK-13), and the boat launch at Van Etten Lake State Forest Campground (VAN ETTEN LK-14) (**Figure 1**). Since contaminated groundwater from the former Wurtsmith Air Force Base enters Van Etten Lake at Ratliffe Park, this sampling is expected to exhibit the highest PFAS concentrations. The boat launch is expected to have lower PFAS concentrations because it is located upstream from the Air Force base and is the furthest away.

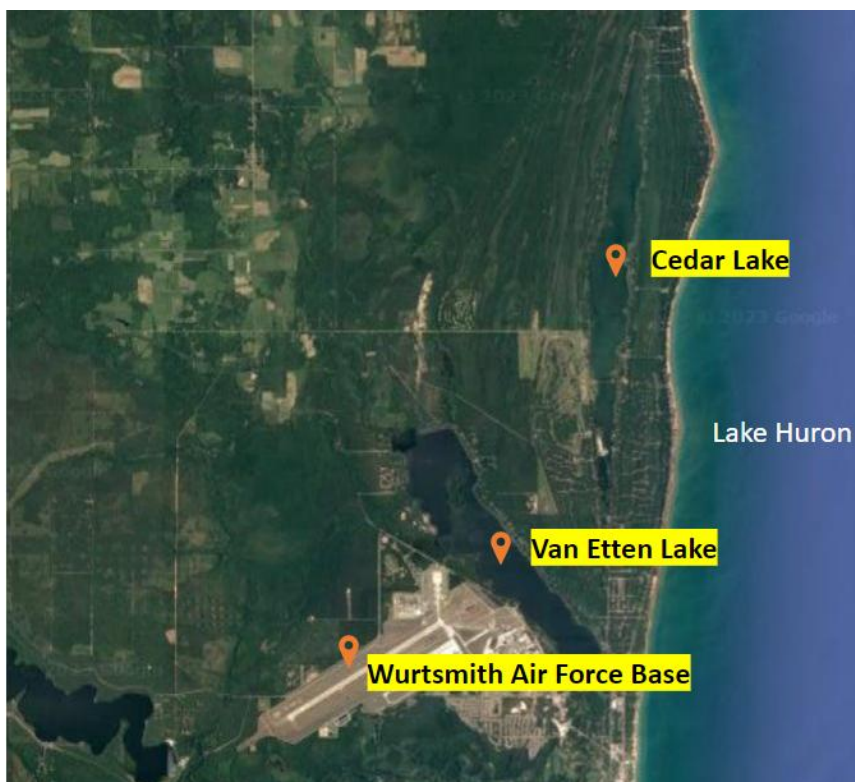
Figure 1. Van Etten Lake sampling location map. Surface water and foam samples were taken from each location. Orange outline indicates Former Wurtsmith Airforce Base boundary.



Cedar Lake

Cedar Lake is a shallow, very narrow, 5-7 miles long lake that is located roughly 1.5 miles northeast of Van Etten Lake. On April 8th, 2020, surface water and foam samples were collected at one location on Cedar Lake (CEDAR LK-16). While preliminary evaluations of potential sources have occurred, no high-strength PFAS sources have been identified near Cedar Lake.

Figure 2. Map of the Wurtsmith Air Force Base, Van Etten Lake, and Cedar Lake.



Purpose

The purpose of this document is to evaluate similarities and differences in PFAS types and concentrations between surface water foam and surface water samples between Van Etten Lake and Cedar Lake.

Results

The results from these sampling events indicated that ten PFAS analytes were detected across the three foam samples taken from Van Etten Lake, while twelve PFAS analytes were detected in the single foam sample from Cedar Lake (**Figure 3**). Nine PFAS analytes were detected across the three surface water samples taken from Van Etten Lake, while only four analytes were detected in the surface water sample from Cedar Lake (**Figure 4**). The presence of several PFAS compounds at Cedar Lake that were not detected at any location on Van Etten Lake suggests that there may not be an obvious relationship between the two lakes.

Between the surface water and foam samples collected at Cedar Lake, a total of five PFAS compounds were detected that did not appear in any of the Van Etten samples, including: PFDoA, PFTeDA, PFTrDA, EtFOSAA, and MeFOSAA. These compounds were detected only in the foam at Cedar Lake and are commonly used in consumer products such as surface treatments for carpets and fabrics, stain and greaseproof coatings on food packaging, and insecticides (**Table 1**). While two of these compounds (PFDoA and PFTeDA) can be found in AFFF, their absence at Van Etten Lake suggests that they do not share the same source. The known uses of these compounds in conjunction with their unique detection at Cedar Lake suggest that the two lakes may not have an obvious relationship. While previous sampling events in the years 2017 and 2018 showed all five of these compounds in foam samples at Van Etten Lake, no samples were taken from Cedar Lake during the same time period.

When examining the PFAS compositions at each lake, it is clear that in this sampling event, Van Etten Lake and Cedar Lake had distinct PFAS signatures in both foam and surface water samples. PFHxS comprised 26-38% of the total PFAS detected among each of the three Van Etten Lake surface water samples but was absent from the Cedar Lake sample (**Figures 9-10**). Perfluorohexanesulfonic acid (PFHxS) is commonly used in aqueous film-forming foams (AFFF), which is used by airports and municipalities for fire suppression (**Table 2**). In addition to PFHxS, 6:2 FTS, PFHpA, PFHxA, PFPeA, and PFOA were detected in Van Etten Lake surface water samples and were not detected in the Cedar Lake surface water sample (**Figure 4**). These six PFAS compounds are also commonly used in AFFF (**Table 2**).

Limitations

It is important to note that all discussions and theories in this report were created using one set of data made up of only one sampling event per location. The sample results represent only the conditions present in the surface water/foam at the time and location they were collected. It cannot be assumed that the results indicated from the distinct locations can be applied to the entire lake, nor can it be assumed that these results would be the same if another sampling event occurred. This evaluation is purely comparative and should not be used for health purposes.

These findings suggest that there may not be an obvious relationship that can be associated between Van Etten and Cedar Lake. Although they did not appear in surface water at Cedar Lake, PFHpA and PFOA did appear in foam at both Cedar Lake and Van Etten Lake.

Additional comparison between the PFAS analyte profiles of Cedar Lake and Van Etten Lake further demonstrates that each lake exhibited a unique PFAS signature in the 2020 sampling events. When displaying PFAS analytes by their concentration in ng/L, equivalent to ppt (parts per trillion), (**Figures 5-8**) or by percentage of total PFAS (**Figures 9-12**), distinctions between the two lakes become clear. For example, the appearance of MeFOSAA and EtFOSAA in significant concentrations in the Cedar Lake foam sample in **Figure 8** illustrates a clear difference from Van Etten Lake foam samples in **Figure 7**.

In conclusion, the findings of this report demonstrate that the PFAS signature detected in the 2020 sampling event at Cedar Lake is significantly different from that of Van Etten Lake. This suggests that there is no obvious relationship that can be associated in this sampling event between the two lakes. While preliminary evaluations of potential sources have occurred, no high-strength or obvious PFAS sources have been identified at Cedar Lake.

Figure 3. Venn diagram depicting PFAS analytes detected in Van Etten Lake and Cedar Lake foam samples. Six unique PFAS compounds were detected in the Cedar Lake foam sample that were not detected in Van Etten Lake's foam.

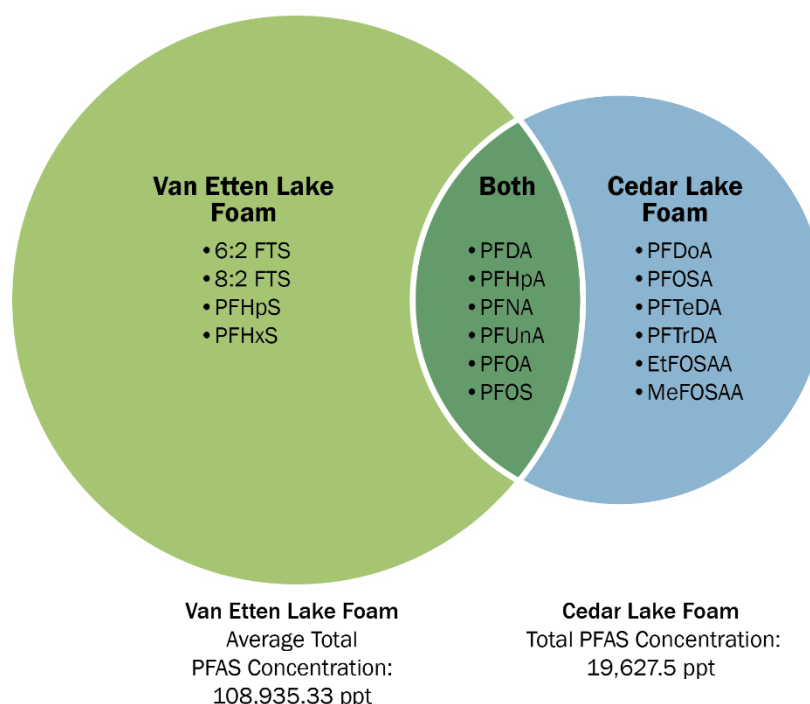


Figure 4. Venn diagram depicting PFAS analytes detected in Van Etten Lake and Cedar Lake surface water samples. One unique PFAS compound (PFNA) was detected in the Cedar Lake surface water sample that was not detected in Van Etten Lake's surface water.

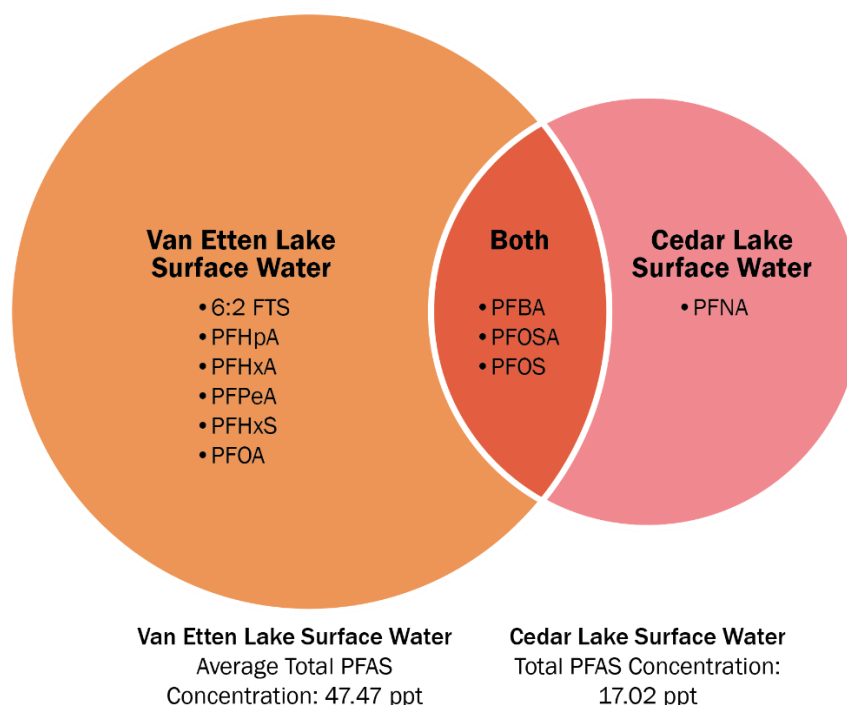


Table 1. PFAS compounds detected exclusively at Cedar Lake and their commercial uses according to Gluge et al. (2020).

PFAS Compound	Use
Perfluorododecanoic acid (PFDoA) CAS: 307-55-1	Paper and food packaging, soft furniture, treated apparel, carpets, dish and glass cleaner, AFFF, floor polishes, leather, personal care products and cosmetics, ski wax
Perfluorotetradecanoic acid (PFTeDA) CAS: 376-06-7	AFFF, detergents, insecticides, paper and food packaging, photographic films, water resistant fabrics, carpets, leather, personal care products and cosmetics, ski wax
Perfluorotridecanoic acid (PFTTrDA) CAS: 72629-94-8	Treated apparel, leather, food packaging materials, personal care products and cosmetics, textiles and upholstery
N-ethyl perfluorooctane sulfonamidoacetate (EtFOSAA) CAS: 2991-50-6	Carpets, insecticides, paper and food packaging (Zhang et al., 2023), dispersions (magnetic fluids, clinical laboratories)
2-(N-methyperfluorooctane sulfonamido) acetic acid (MeFOSAA) CAS: 2355-31-9	Surface treatment for carpets and textiles

Table 2. PFAS compounds detected exclusively at Van Etten Lake and their commercial uses according to Gluge et al. (2020).

PFAS Compound	Use
6:2 Fluorotelomer sulfonic acid (6:2 FTS) CAS: 27619-97-2	Greenhouse windows, electrical equipment, metal products, chrome plating, plastic manufacturing, anti-reflective coating, semiconductors, treated apparel, AR-FFFP firefighting foam, AFFF, carpets, artificial turf, cosmetics and personal care products
8:2 Fluorotelomer sulfonic acid (8:2 FTS) CAS: 39108-34-4	Greenhouse windows, electrical equipment, metal products, plastic manufacturing, anti-reflective coating, semiconductors, treated apparel, AR-FFFP firefighting foam, carpets, cosmetics and personal care products
Perfluoroheptanesulfonic acid (PFHpS) CAS: 375-92-8	Wooden building material, AFFF, textiles and upholstery
Perfluoroheptanoic acid (PFHpA) CAS: 375-85-9	Wooden building material, treated apparel, AFFF, carpets, leather, paper and food packaging, personal care products and cosmetics, ski wax, bicycle lubricants, textiles and upholstery
Perfluorohexanoic acid (PFHxA) CAS: 307-24-4	Wooden building material, automotive waxes and polishes, carpets, floor polishes, shoe wax, paper and food packaging, consumer care products and cosmetics, boating equipment, textiles and upholstery, AFFF
Perfluoropentanoic acid (PFPeA) CAS: 2706-90-3	Anti-reflective coating, wooden building material, treated apparel, AFFF, carpets, resilient linoleum, floor polishes, leather, paper and food packaging, personal care products and cosmetics, ski wax, textiles and upholstery
Perfluorohexanesulfonic acid (PFHxS) CAS: 355-46-4	Wooden building material, treated apparel, AFFF, carpets, leather, rubber insulation, textiles and upholstery

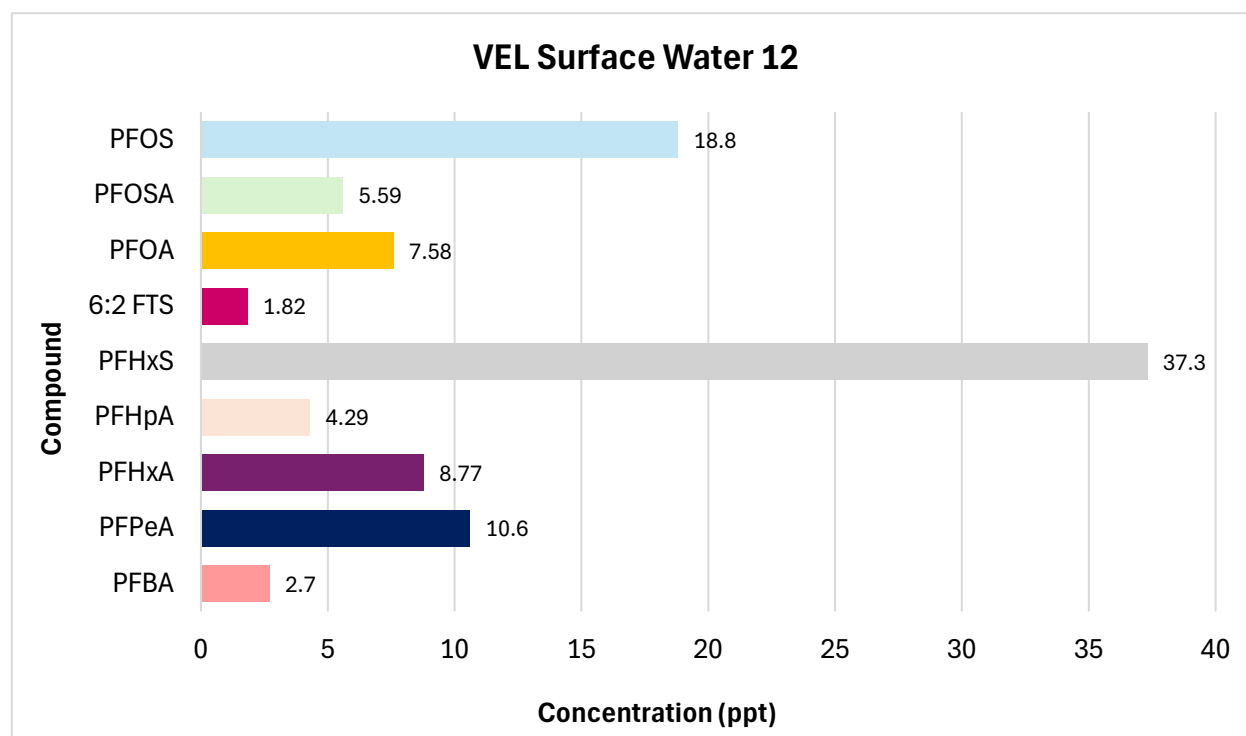
Table 3. PFAS compounds detected at both Van Etten Lake and Cedar Lake and their commercial uses according to Gluge et al. (2020).

PFAS Compound	Use
Perfluorodecanoic acid (PFDA) CAS: 335-76-2	Treated apparel, dish and glass cleaner, AFFF, carpets, floor polishes, leather, paper and food packaging, personal care products and cosmetics, ski wax, textiles and upholstery
Perfluorononanoic acid (PFNA) CAS: 375-95-1	Lithium-ion batteries, AFFF, carpets, floor polishes, leather, paper and food packaging, personal care products and cosmetics, ski wax, textiles and upholstery
Perfluoroundecanoic acid (PFUnA) CAS: 2058-94-8	Treated apparel, carpets, floor polishes, paper and food packaging, personal care products and cosmetics, textiles and upholstery, carpets, floor polishes, paper and food packaging, personal care products and cosmetics, textiles and upholstery
Perfluorooctanoic acid (PFOA) CAS: 335-67-1	Oil recovery, photographic material, wooden building material, treated apparel, automotives waxes and polishes, dish and glass cleaner, paints, cooking and bakeware, AFFF, carpets, floor polishes, leather, paper and food packaging, personal care products and cosmetics, pesticides, ski wax, boat equipment, bicycle lubricants, textiles and upholstery
Perfluorooctanesulfonic acid (PFOS) CAS: 1763-23-1	Brake and hydraulic fluids, chrome plating, electronics, artificial turf, photo-acid generator, wooden building material, treated apparel, AFFF, floor coatings and polishes, leather, medical utensils, dispersant, paper and food packaging, rubber insulation, printing, ski wax, textiles and upholstery
Perfluorobutanoic acid (PFBA) CAS: 375-22-4	Electronics, photographic material, Wooden building material, treated apparel, dish and glass cleaner, AFFF, carpet, floor coatings and polishes, laboratory instrumentation (LC-MS solvent), leather, paper and food packaging, personal care products and cosmetics, ski wax, bicycle lubricants, textiles and upholstery,
Perfluorooctanesulfonamide (PFOSA) CAS: 754-91-6	Chrome plating, electronics, oil production, treated apparel, AFFF, textiles and upholstery

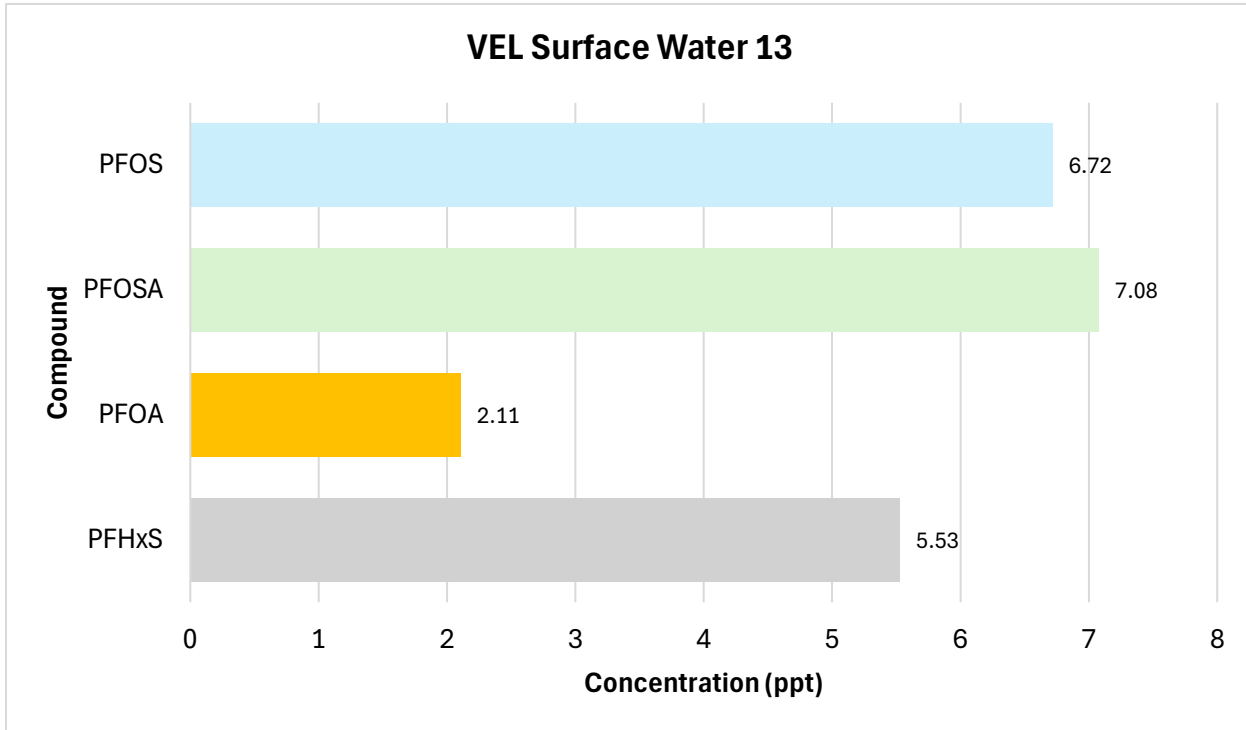
The following horizontal bar charts (Figures 5-8) depict PFAS analytes on the y-axis and concentration measured in parts per trillion (ppt) on the x-axis.

Figure 5. Figure 5 (A-C) Van Etten Lake Surface Water PFAS levels detected at each sampling location. VEL Surface Water 12 was obtained from Ratliffe Park, VEL Surface Water 13 was obtained near the Van Etten Lake Dam, and VEL Surface Water 14 was obtained from the Van Etten Lake State Forest Campground boat launch. PFOS, PFOA, PFHxS, and PFOSA were detected at all three sampling locations. Figure 5 (D) Summary of PFAS findings across all three sampling locations at Van Etten Lake. For PFAS compounds detected at more than one sampling location, concentrations are reported as an average between the sampling locations.

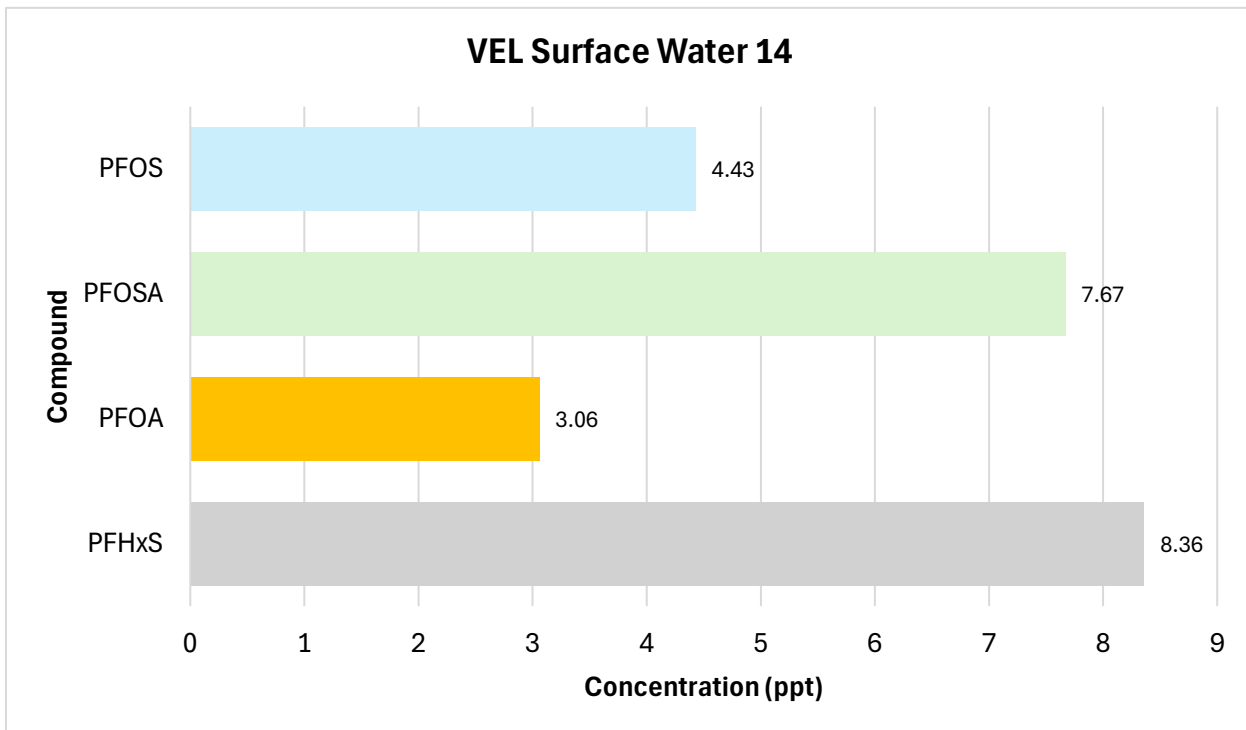
(A) VEL Surface Water 12 PFAS levels detected – sample from Ratliffe Park.



(B) VEL Surface Water 13 PFAS levels detected – sample near Van Etten Lake Dam.



(C) VEL Surface Water 14 PFAS levels detected – sample from Van Etten Lake State Forest Campground boat launch.



(D) Summary of PFAS findings across all three sampling locations at Van Etten Lake.

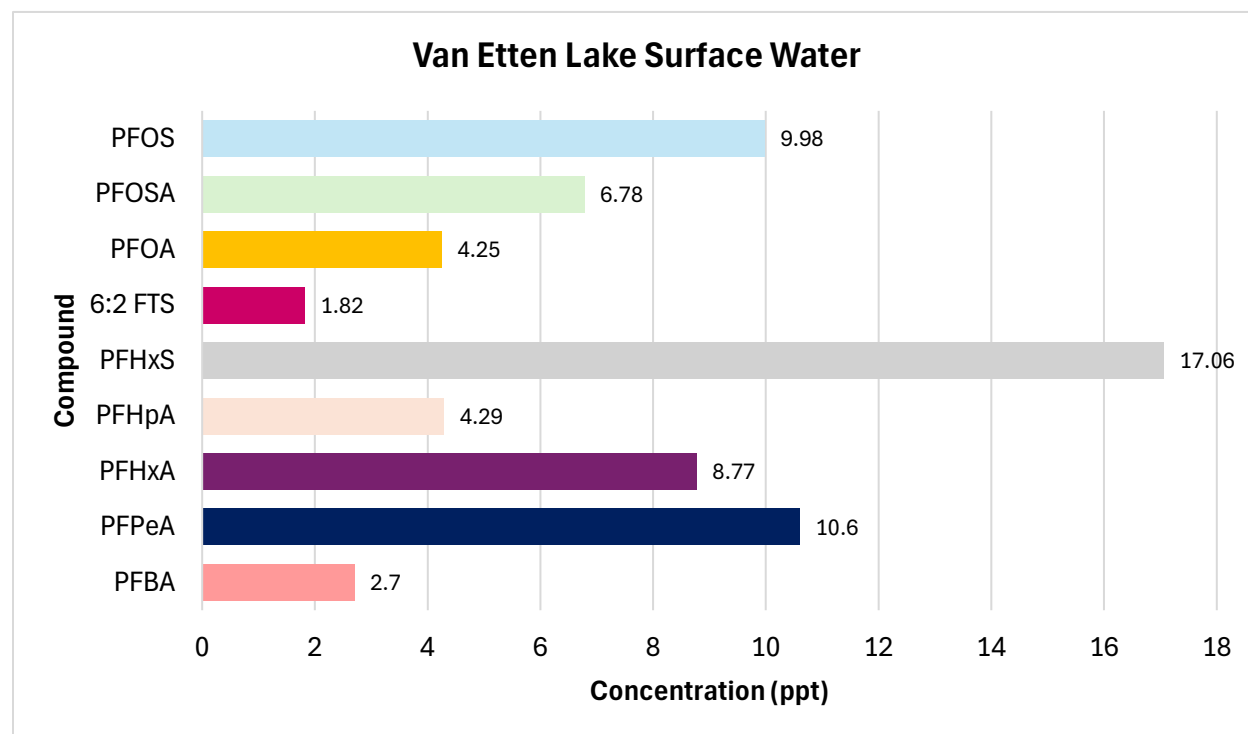


Figure 6. Horizontal bar chart depicting Cedar Lake Surface Water PFAS levels.

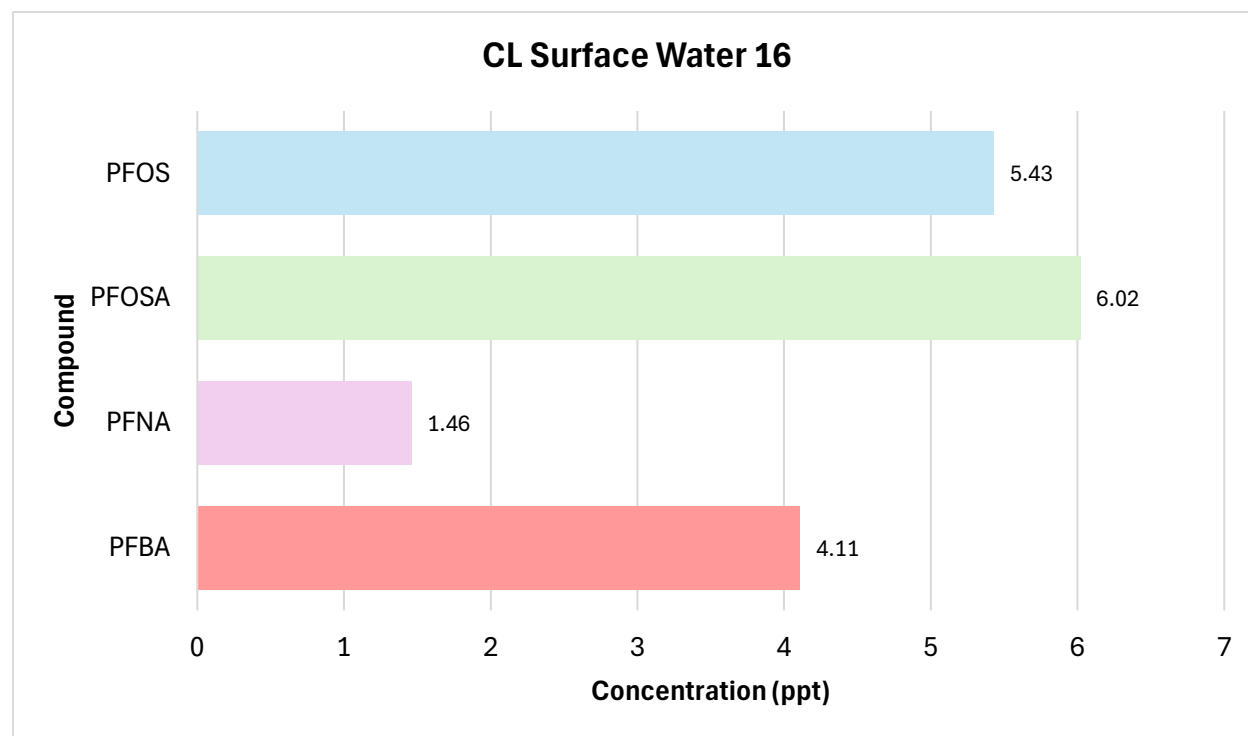
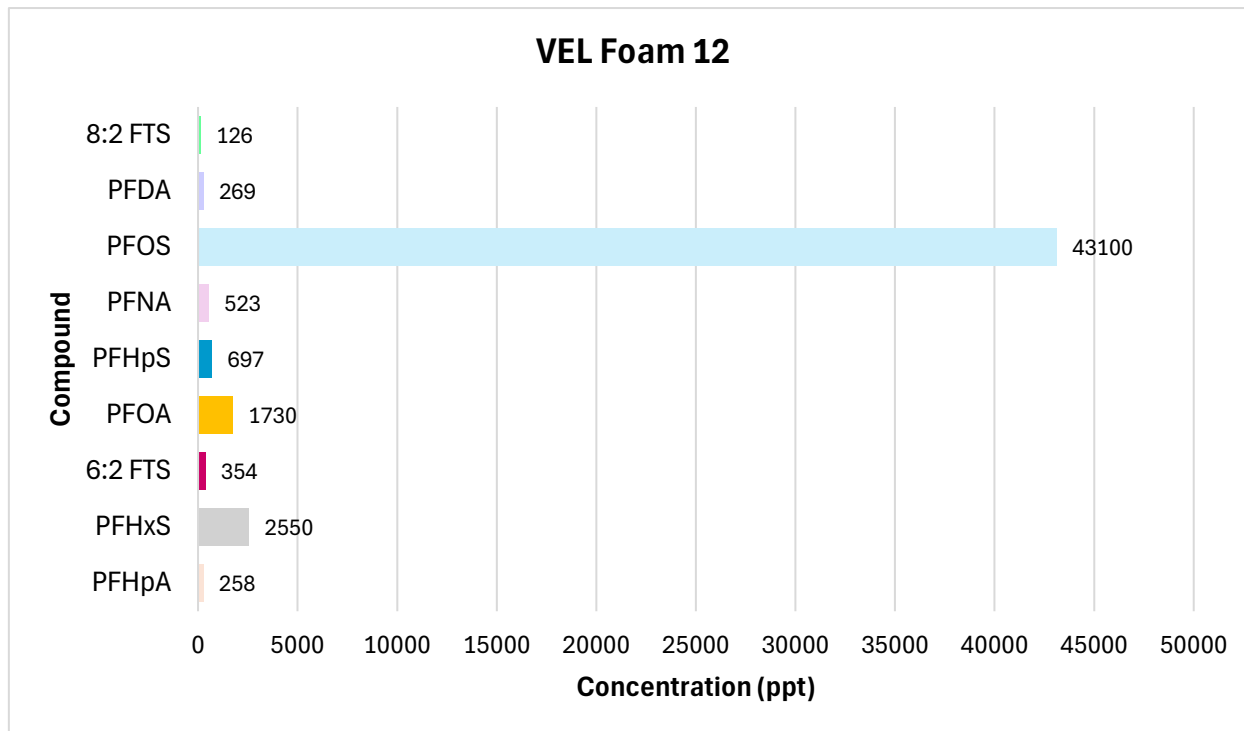
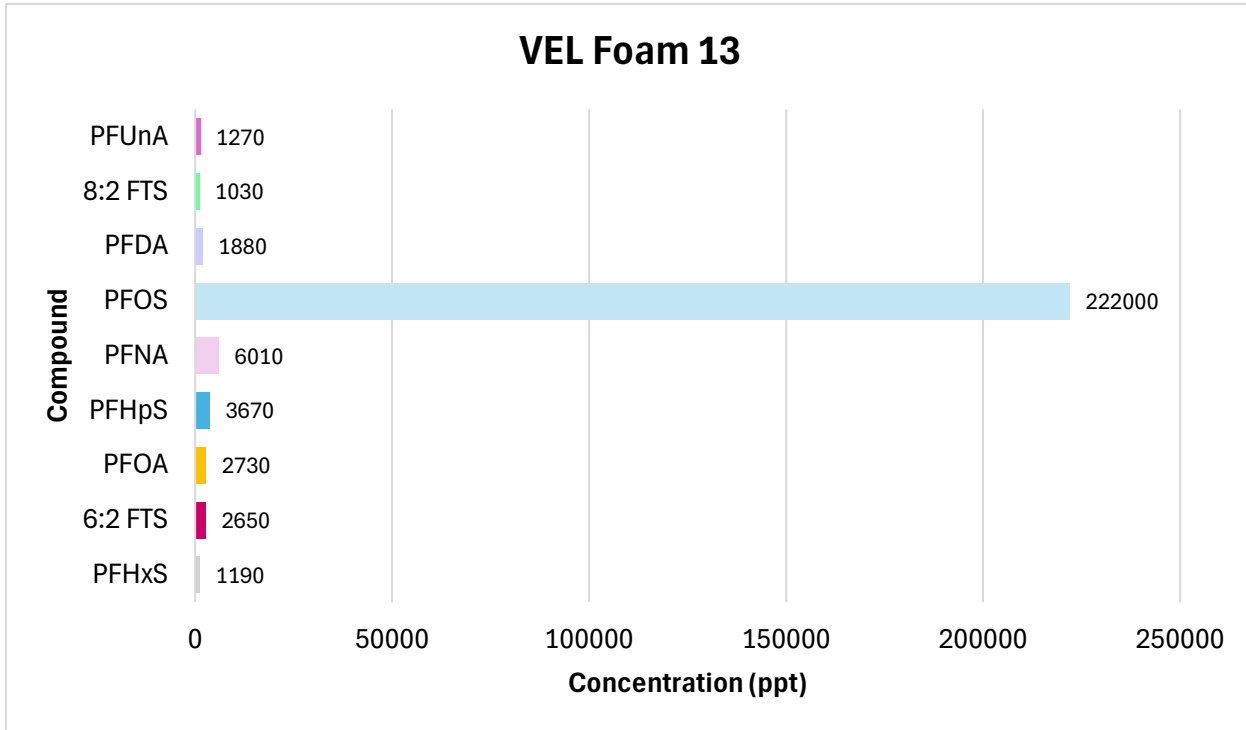


Figure 7. Figure 7 (A-C) Van Etten Lake Foam PFAS levels detected at each sampling location. VEL Foam 12 was obtained from Ratliffe Park, VEL Foam 13 was obtained near the Van Etten Lake Dam, and VEL Foam 14 was obtained from the Van Etten Lake State Forest Campground boat launch. PFOS, PFOA, PFHxS, PFNA, and PFHpS were detected at each sampling location. (D) Summary of PFAS findings across all three sampling locations at Van Etten Lake. For PFAS compounds detected at more than one sampling location, concentrations are reported as an average between the sampling locations.

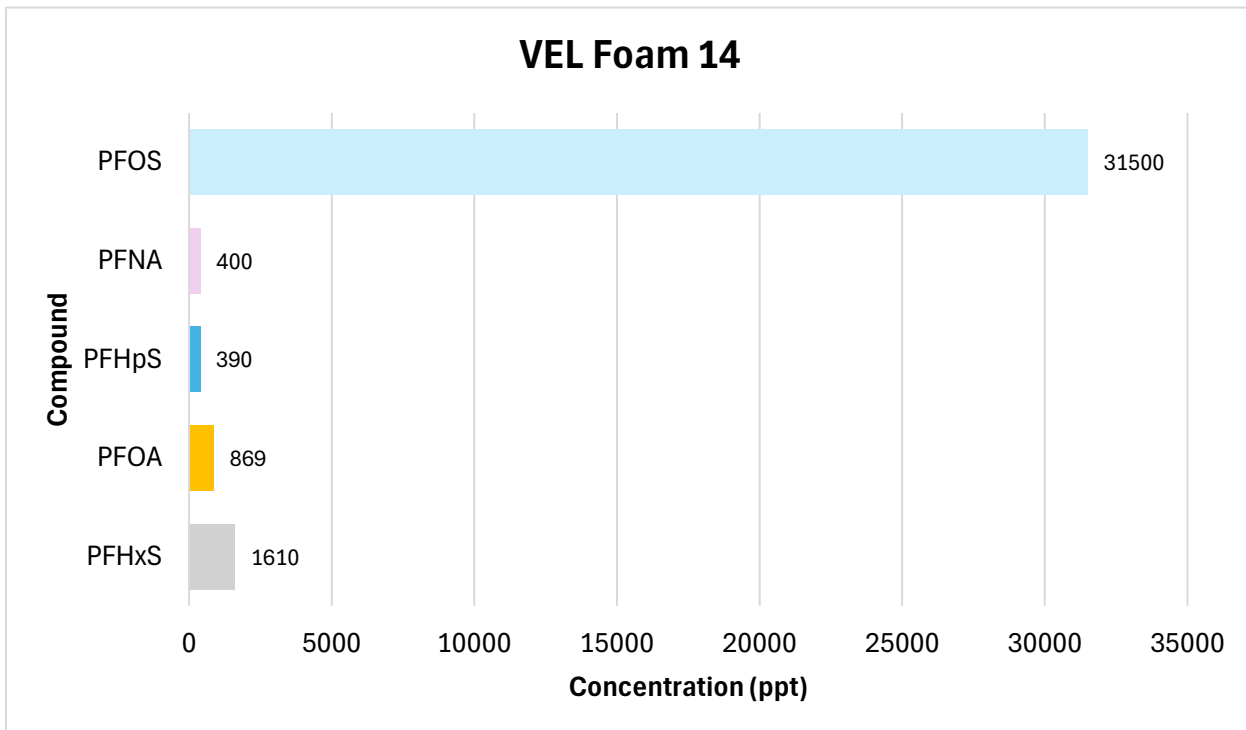
(A) VEL Foam 12 PFAS levels detected – sample from Ratliffe Park



(B) VEL Foam 13 PFAS levels detected – sample near Van Etten Lake Dam.



(C) VEL Foam 14 PFAS levels detected – sample from Van Etten Lake State Forest Campground boat launch.



(D) Summary of PFAS findings across all three sampling locations at Van Etten Lake.

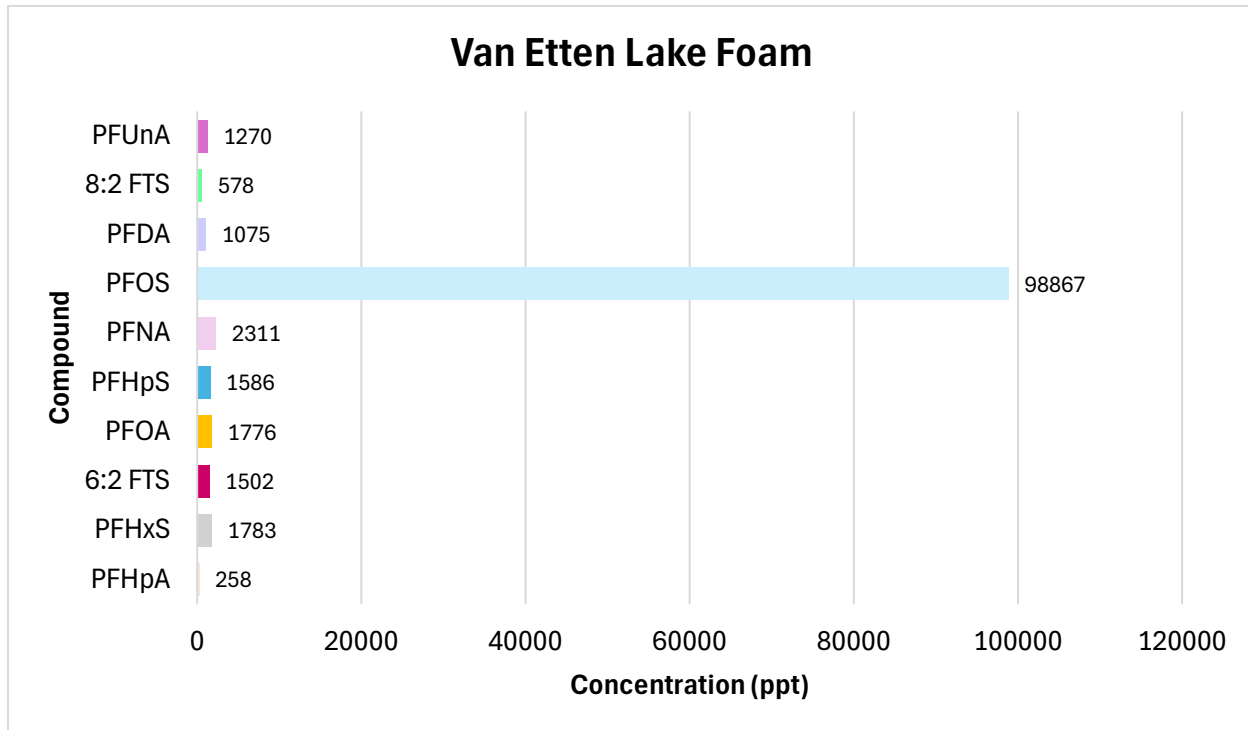


Figure 8. Horizontal bar chart depicting Cedar Lake Foam PFAS levels.

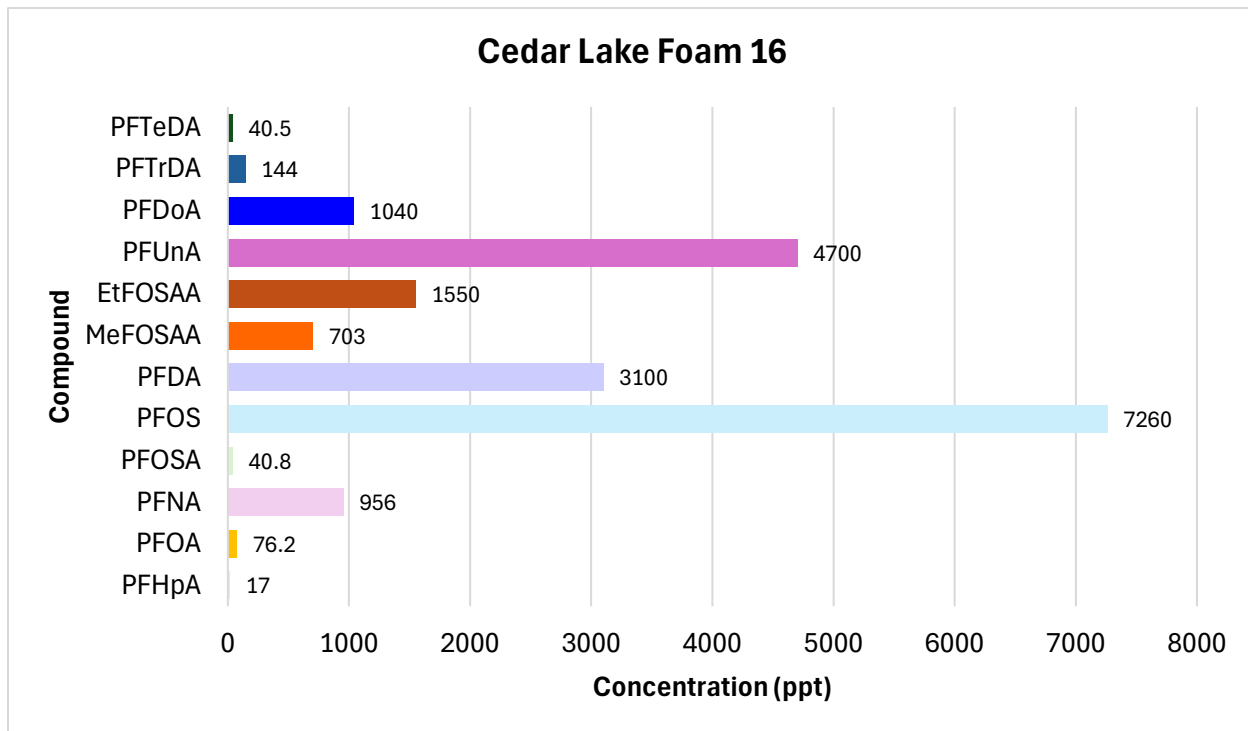
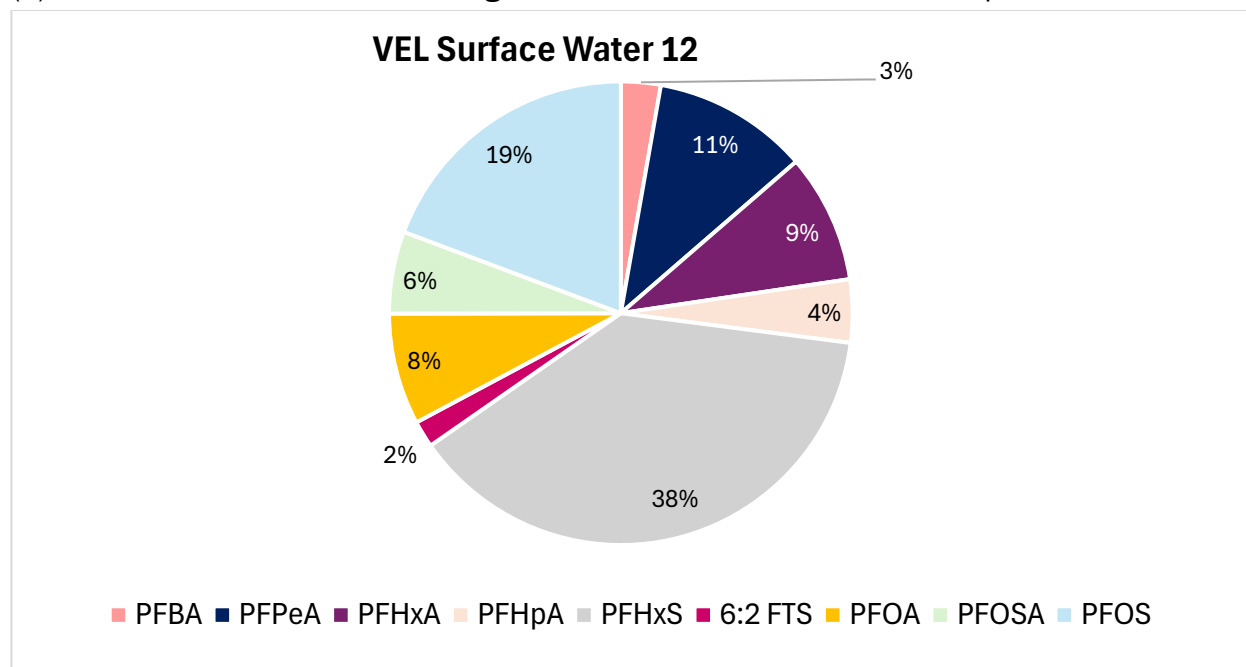
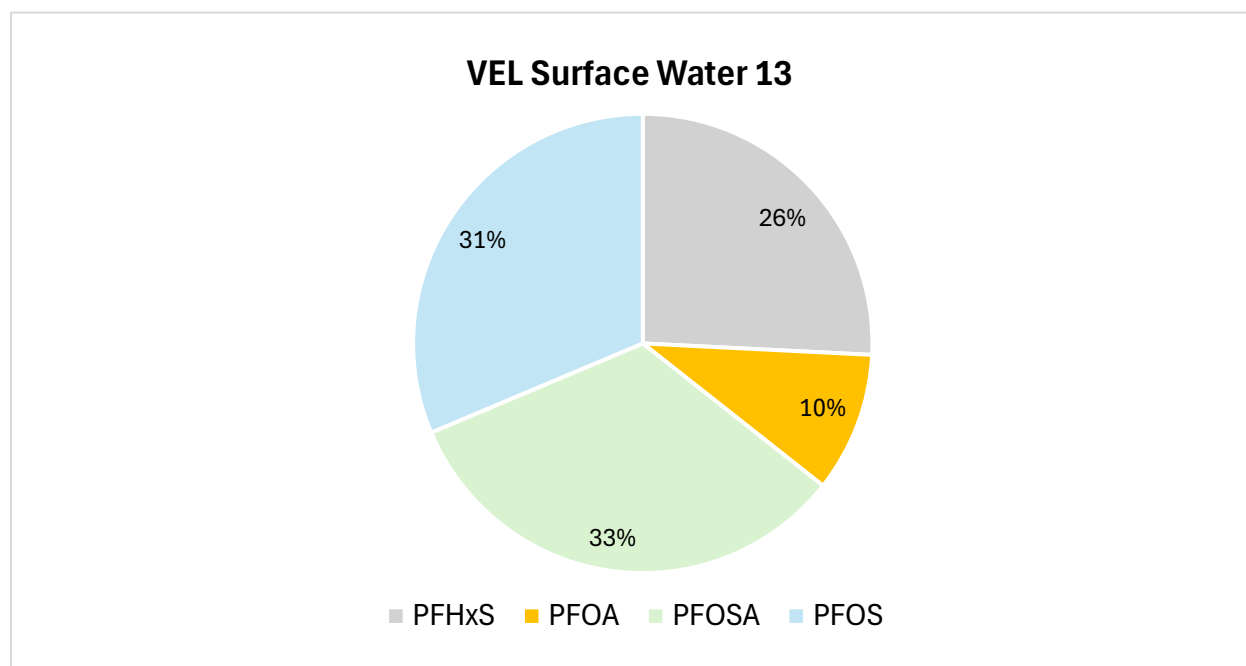


Figure 9. Pie charts depict PFAS analytes as a percentage of total PFAS concentration at each sampling location. Figure (A-C) Van Etten Lake surface water samples at each sampling location. VEL Surface Water 12 was obtained from Ratliffe Park, VEL Surface Water 13 was obtained near the Van Etten Lake Dam, and VEL Surface Water 14 was obtained from the Van Etten Lake State Forest Campground boat launch. (D) Surface water across all sampling locations at Van Etten Lake. For PFAS compounds detected at more than one sampling location, concentrations are reported as an average between the sampling locations.

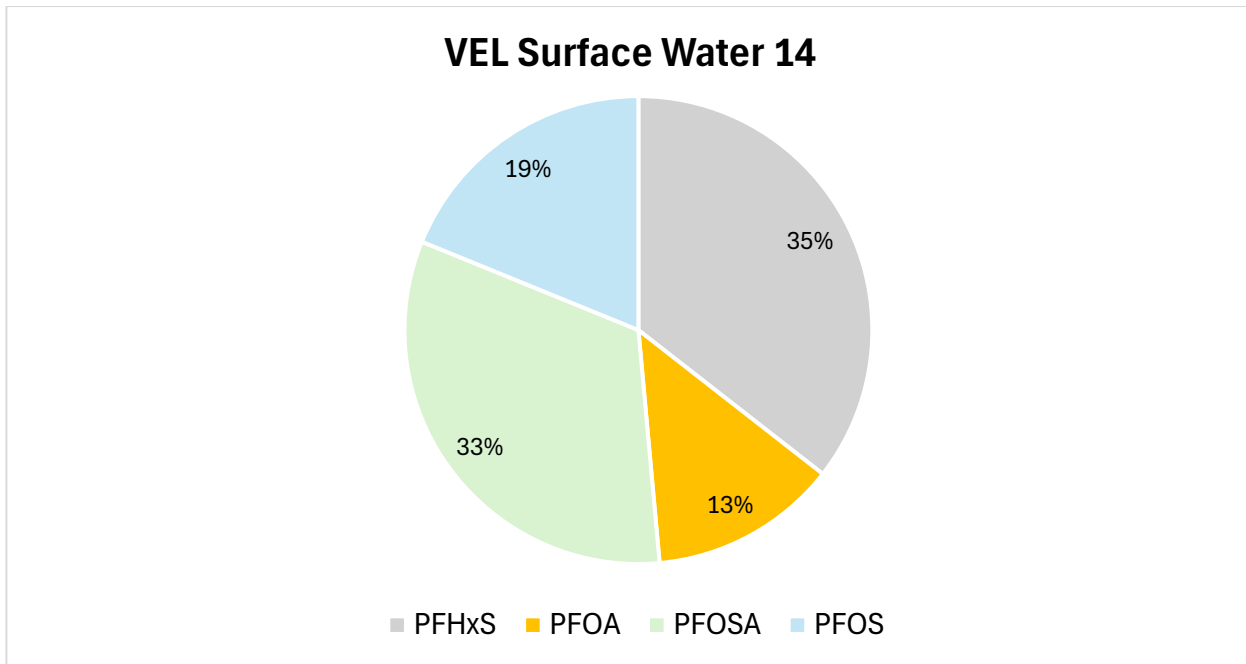
(A) VEL Surface Water 12 Percentage of total PFAS concentration – sample from Ratliffe Park.



(B) VEL Surface Water 13 Percentage of total PFAS concentration – sample near Van Etten Lake Dam.



(C) VEL Surface Water 14 Percentage of total PFAS concentration – sample from Van Etten Lake State Forest Campground boat launch.



(D) Summary of percentage across all three sampling locations at Van Etten Lake.

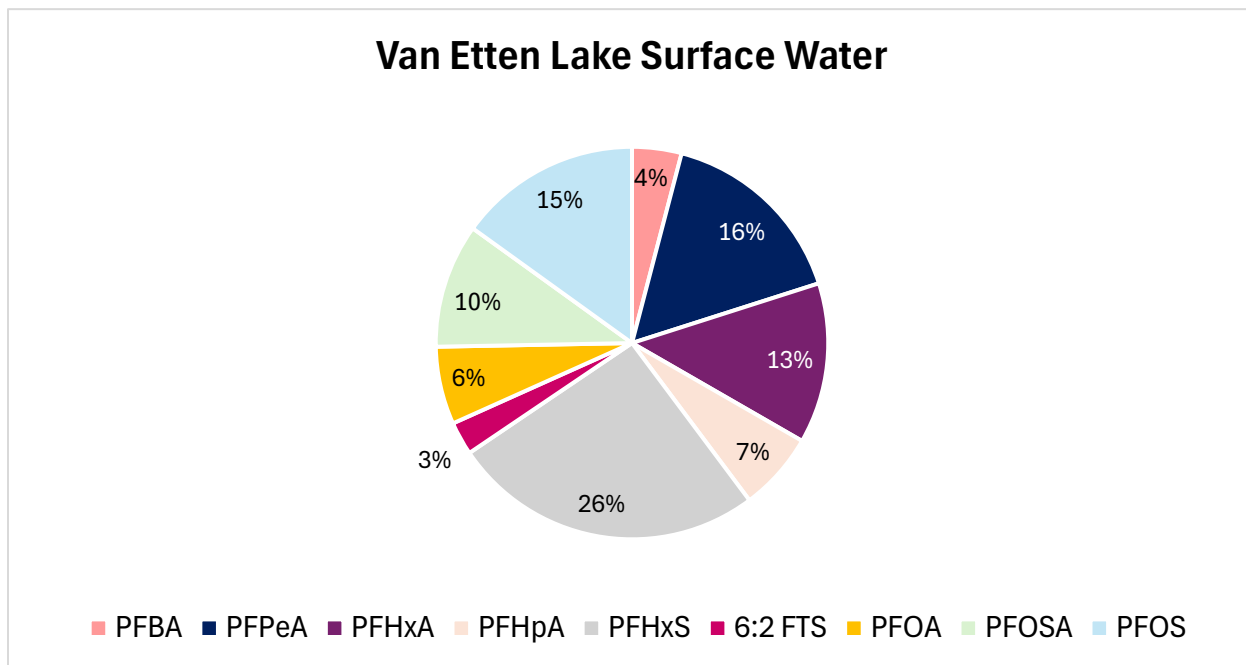


Figure 10. Pie chart depicting PFAS analytes as a percentage of total PFAS concentration in the Cedar Lake surface water sample.

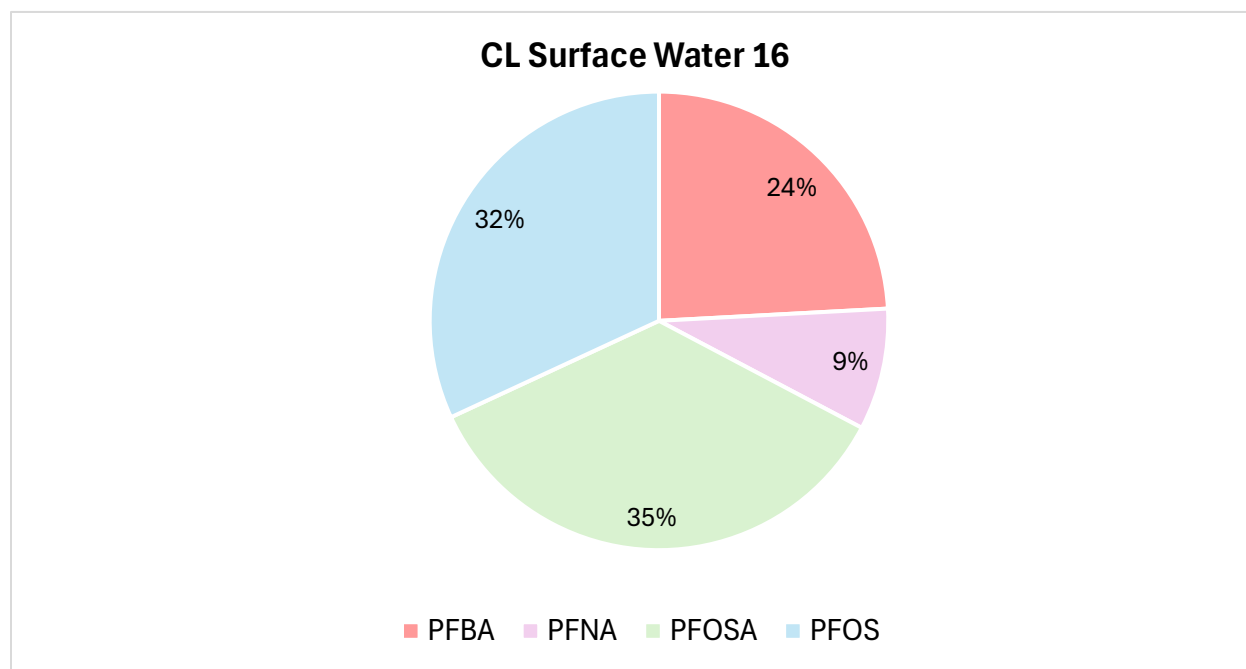
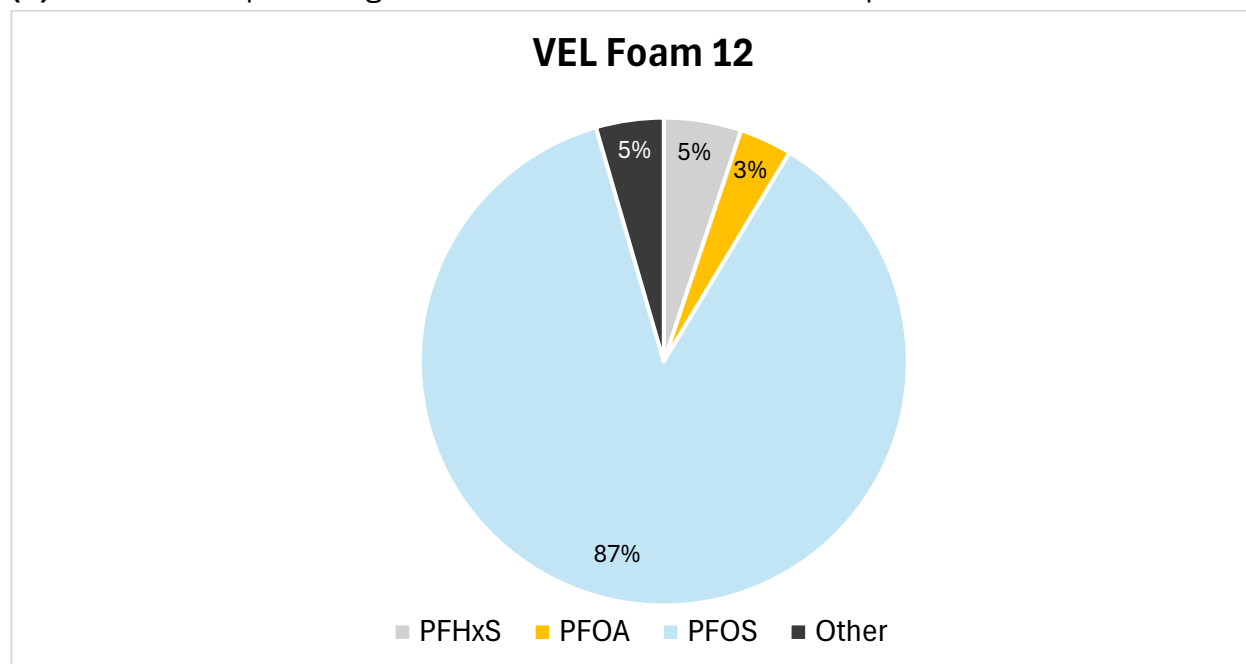


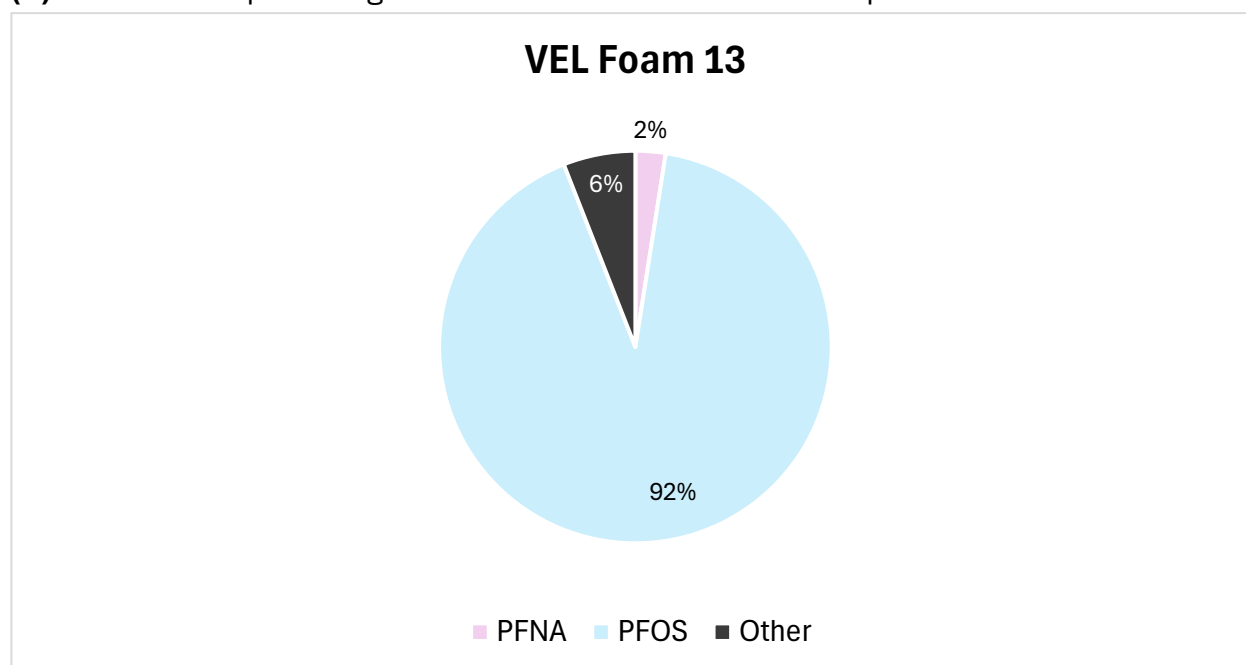
Figure 11. Pie charts depict PFAS analytes as a percentage of total PFAS concentration in Van Etten Lake foam samples at each sampling location.

Figure 11 (A-C) VEL SW 12 was obtained from Ratliffe Park, VEL SW 13 was obtained near the Van Etten Lake Dam, and VEL SW 14 was obtained from the Van Etten Lake State Forest Campground boat launch. Figure 11 (D) Percentage of total PFAS concentration across all sampling locations. For PFAS compounds detected at more than one sampling location, concentrations are reported as an average between the sampling locations.

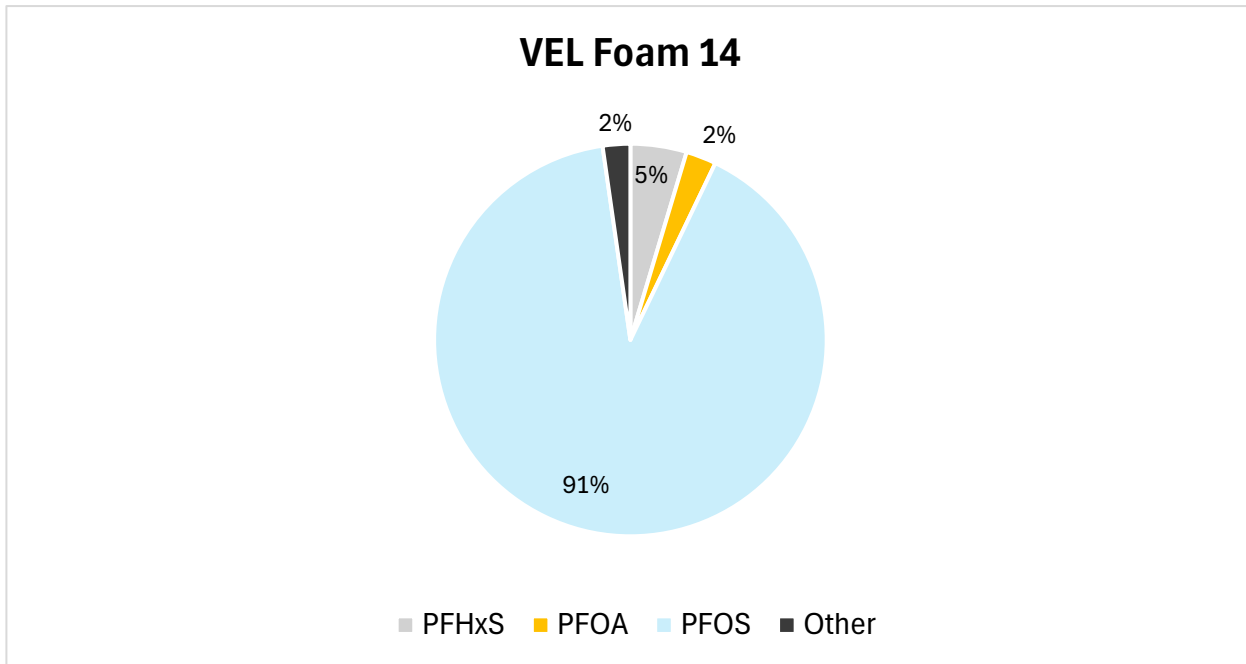
(A) VEL Foam 12 percentage of total PFAS concentration – sample from Ratliffe Park.



(B) VEL Foam 13 percentage of total PFAS concentration – sample near Van Etten Lake Dam.



(C) VEL Foam 14 percentage of total PFAS concentration – sample from Van Etten Lake State Forest Campground boat launch



(D) Summary of percentage across all three sampling locations at Van Etten Lake.

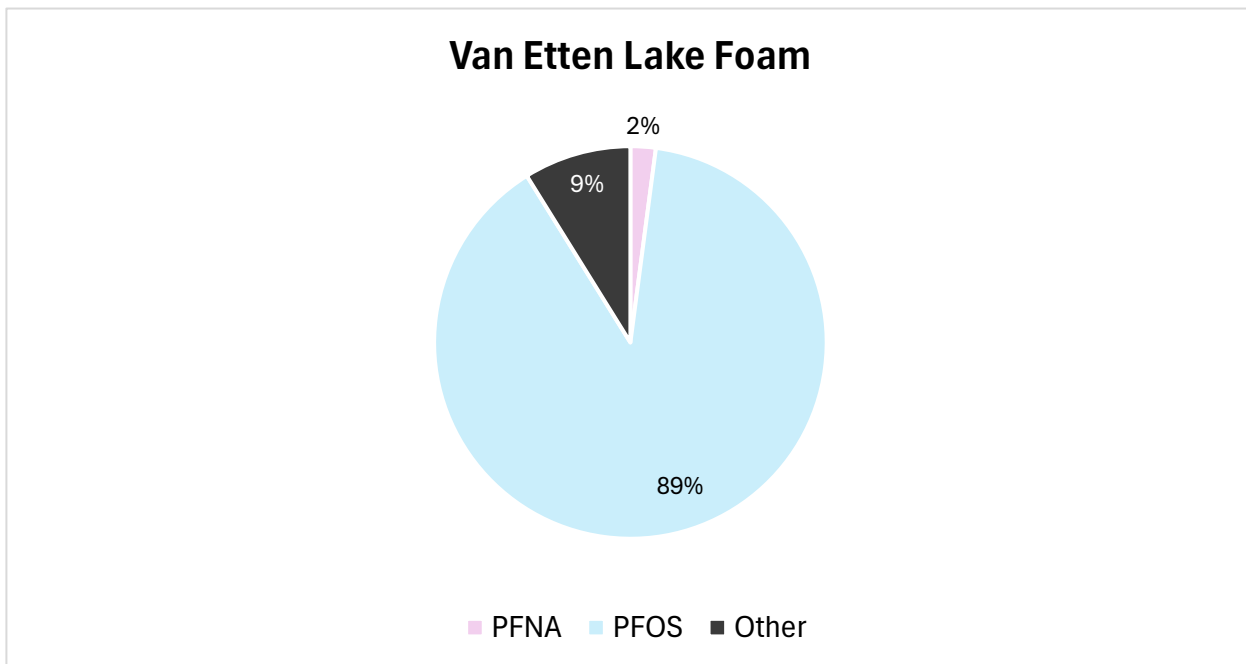
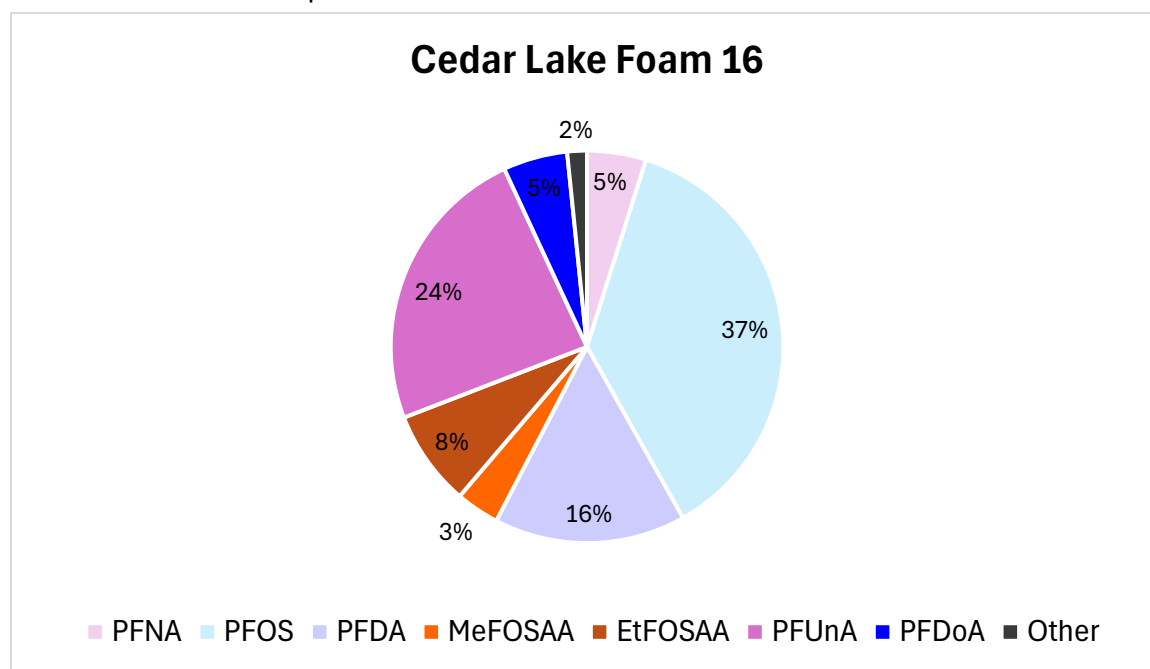


Figure 12. Pie chart depicting PFAS analytes as a percentage of total PFAS concentration in the Cedar Lake foam sample.



Prepared by:

Michigan Department of Environment, Great Lakes, and Energy (EGLE) as part of the, [Michigan PFAS Action Response Team \(MPART\)](#)

A summary of data is available on [MPART's Surface Water and Foam Results Page](#)

Laboratory results available upon request

Works Cited:

Glüge J , Scheringer M , Cousins IT , et al. An overview of the uses of per- and polyfluoroalkyl substances (PFAS). *Environ Sci Process Impacts*. 2020;22(12):2345-2373.
doi:10.1039/d0em00291g

EGLE does not discriminate on the basis of race, sex, religion, age, national origin, color, marital status, disability, political beliefs, height, weight, genetic information, or sexual orientation in the administration of any of its programs or activities, and prohibits intimidation and retaliation, as required by applicable laws and regulations.

Individuals with disabilities may request this material in an alternative format by emailing EGLE-Accessibility@Michigan.gov or calling 800-662-9278.