# Caldor Fire
# Stormwater Impact Report

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## Introduction

The Caldor Fire began on August 14, 2021 near Little Mountain (Figure 1) in El Dorado County, California. The fire burned for 67 days with 100% containment occurring on October 21, 2021. It burned 221,835 acres in three counties; El Dorado, Amador, and Alpine. The cause is still under investigation but it was allegedly started by a projectile discharged from a firearm. The fire crested the ridgeline at Echo Summit into the Tahoe Basin on August 30, having traveled over 30 miles fueled by dry timber and high winds.

Fortunately, due to mechanical thinning and prescribed burns over the preceding decade that reduced the fuel load in the surrounding forests and tempered the fire's extreme behavior, firefighters were able to successfully defend all structures in South Lake Tahoe. However,

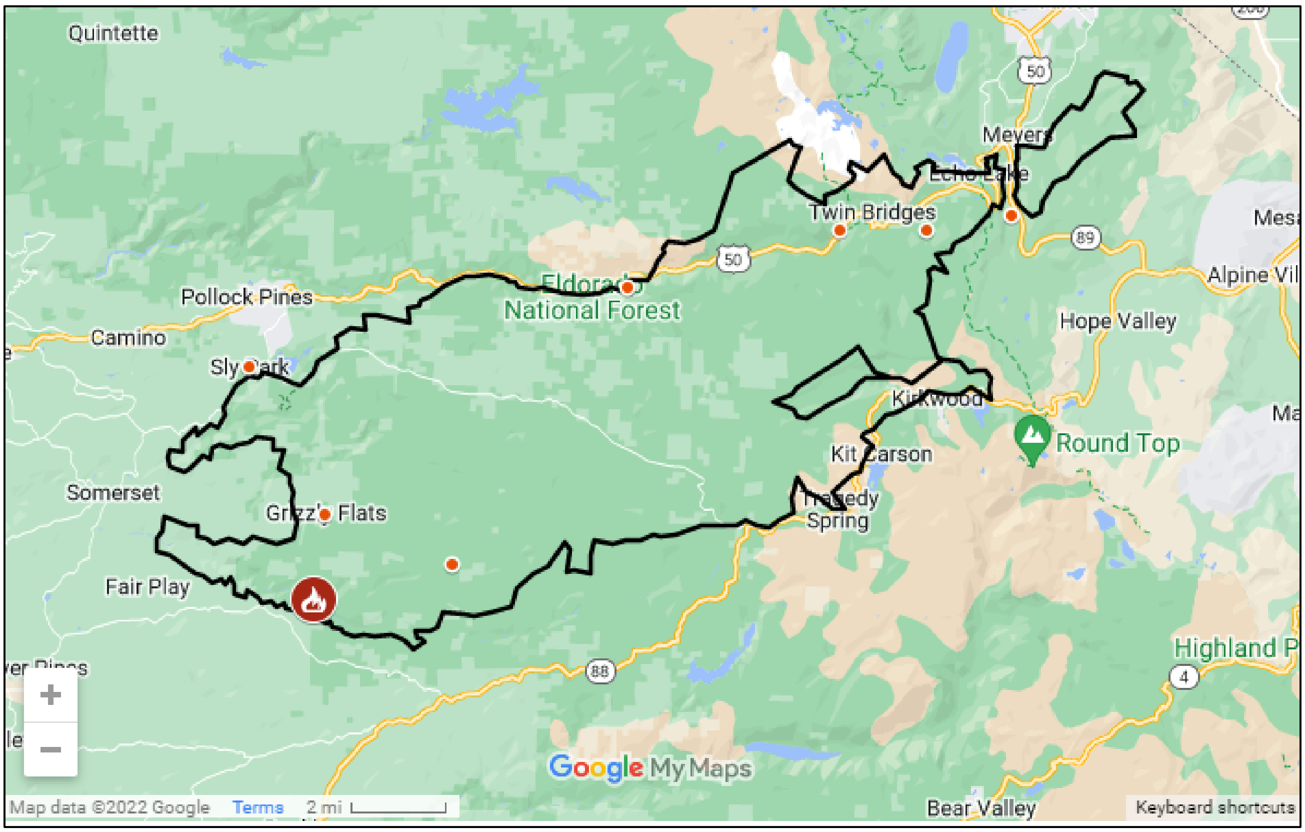


*Figure 1: Caldor Fire scar. Origin of fire near Little Mountain represented by red circle with fire symbol.*

approximately 35,000 acres of wildland in the Lake Tahoe Basin were consumed by the flames, destroying trees and other vegetation that otherwise minimize soil erosion in two primary watersheds, the Trout Creek watershed and the Upper Truckee River watershed. Steep slopes with denuded soil erode more easily and it is expected that post-fire precipitation events transported more soil through the watershed to Lake Tahoe, carrying nutrients and sediment particles that impacted the lake's already threatened clarity. Smoke and ash also deposited particles that jeopardize Lake Tahoe water quality. In early September, UC Davis Tahoe Environmental Research

Center measured 50 to 55 feet of clarity as opposed to the 65 feet they had been recording all summer due to a dramatic increase in particle concentrations. Smoke and ash were also deposited on solid surfaces, including urbanized and undeveloped land, where it could be mobilized during precipitation events and be transported to the Lake through streams and urban discharges. The objective was to determine whether urban runoff in the Tahoe Basin was enriched for elements characteristic of wildfire smoke and ash deposition events.

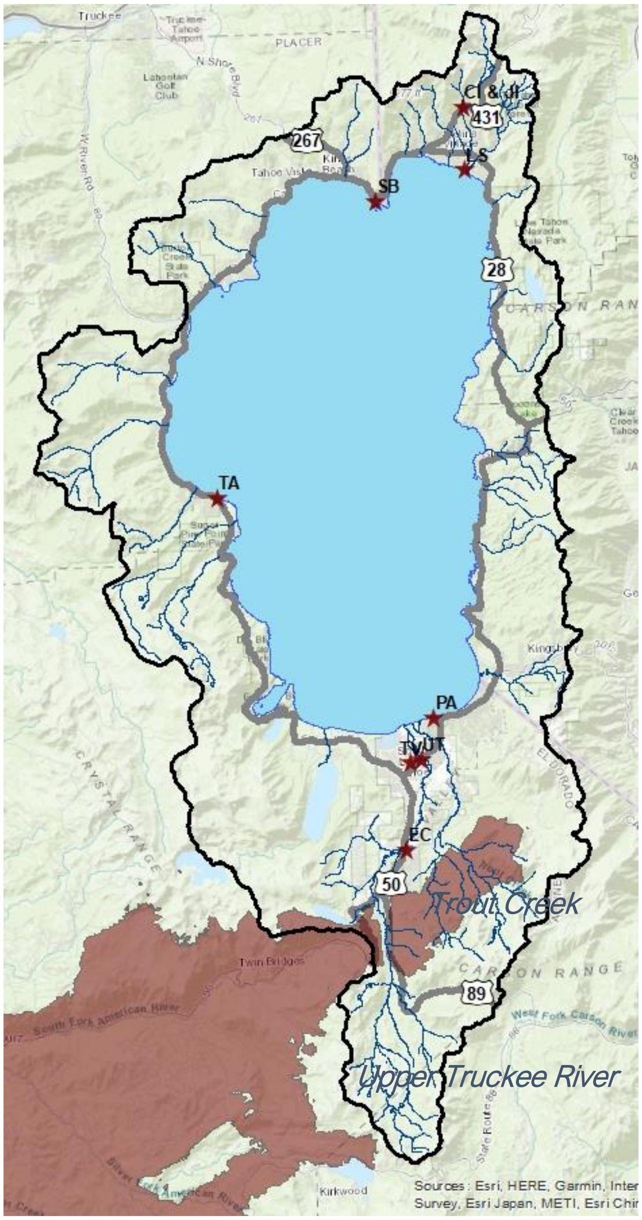


*Figure 2: Map of sampling locations (red stars) and burn scar (red shading).*

## Study

Urban runoff event mean concentration (EMC) samples collected during or immediately after the Caldor Fire in September and October of 2021 were processed and analyzed for comparison to EMC urban runoff samples collected the following year (August 2022).

These EMC samples were collected at stormwater monitoring sites located in the Tahoe Basin. The sites are part of the Lake Tahoe Regional Stormwater Monitoring Program (RSWMP). Several types of runoff were sampled during six distinct runoff events. Two events, a thunderstorm and a frontal rain storm, occurred during active burning of the Caldor Fire on September 9-10, 2021 and October 7-8, 2021 respectively, although the fire was 91% contained by October 2nd. One event, a frontal mixed rain and snow storm, occurred on October 23-24, shortly after the fire was fully contained. A post-precipitation snowmelt event occurred October 25-28, 2021. For comparison, urban stormwater runoff samples were also taken during two thunderstorm events a year later on August 5, 2022 and August 17, 2022. Figure 2 shows the locations of the monitoring sites and the burn scar. Table 1 lists the locations that were monitored, their abbreviation on the map in Figure 2, the event type, in what period the event occurred, and the event date.

*Table 1: Urban stormwater sites that were monitored, site abbreviation on Figure 2, event type, event period, and event date.*

| Monitoring Location | Map Abbreviation | Event Type | Event Period | Event Date |
|---|---|---|---|---|
| Tahoma | TA | thunderstorm | during fire | September 9-10, 2021 |
| Tahoe City | TC | thunderstorm | during fire | September 9-10, 2021 |
| Contech In | CI | thunderstorm | during fire | September 9-10, 2021 |
| Jellyfish In | JI | thunderstorm | during fire | September 9-10, 2021 |
| Speedboat | SB | thunderstorm | during fire | September 9-10, 2021 |
| Contech In | CI | rain | during fire | October 7-8, 2021 |
| Jellyfish In | JI | rain | during fire | October 7-8, 2021 |
| Tahoe City | TC | rain | during fire | October 7-8, 2021 |
| Tahoma | TA | rain | during fire | October 7-8, 2021 |
| Tahoe Valley | TV | rain | during fire | October 7-8, 2021 |
| Speedboat | SB | rain/snow | shortly after containment | October 21-24, 2021 |
| Elks Club | EC* | rain/snow | shortly after containment | October 21-24, 2021 |
| Elks Club | EC* | rain/snow | shortly after containment | October 21-24, 2021 |
| Tahoe Valley | TV | rain/snow | shortly after containment | October 21-24, 2021 |
| Upper Truckee | UT | rain/snow | shortly after containment | October 21-24, 2021 |
| Pasadena Out | PO | rain/snow | shortly after containment | October 21-24, 2021 |
| Lakeshore | LS | rain/snow | shortly after containment | October 21-24, 2021 |
| Pasadena Out | PO | post-event snowmelt | shortly after containment | October 25-28, 2021 |
| Tahoma | TA | thunderstorm | one year later | August 5, 2022 |
| Tahoe City | TC | thunderstorm | one year later | August 5, 2022 |
| Tahoe City | TC | thunderstorm | one year later | August 17, 2022 |
| Contech In | CI | thunderstorm | one year later | August 17, 2022 |
| Jellyfish In | JI | thunderstorm | one year later | August 17, 2022 |

**Two samples were taken at Elks Club between October 21 and October 24, 2021, this is not a repeat entry. (Also note that the Caldor Fire was 91% contained by October 2, 2021.)*

Wildland fires produce pyrogenic organic materials like charcoal fragments, which retain some of the physical and mineral properties of the biomass source, as well as mineral ash from more complete combustion in the presence of oxygen and higher temperatures (>450°C) while the fire spreads rapidly (Bodi et al. 2014). The small, light-weight particles of mineral ash are widely dispersed and remain mobile after deposition with subsequent redistribution by wind or water, often within days or weeks of deposition (Bodi et al. 2014, Cerda and Doerr 2008).

Gaber and Bookter (2011) found that elemental composition of mineral ash from a Ponderosa-dominated forest wildfire consisted mainly of Ca, K, Mg, P, Mn, Zn and Fe. The mean particle density of this mineral ash was 2.5 ±0.6 g $cm^{-2}$ with a particle size range of about 1–1000 µm, a mean particle diameter of 100 µm, and 26 ±3% of particles less than 50 µm.

Results obtained by Harper (2019) on the composition of wildfire ash from various global sources found that total dry composition from digested ash samples was dominated by oxides and hydroxides of Ca, Mg, Si, P, Al, Fe and Mn, along with lower concentrations of trace elements Zn, Cu, Pb, Ni, As and Cd. The concentration of Na was also high as a water-soluble component.

The Thomas Fire in Ventura County, California burned over 440 square miles in 2017, along with more than 1000 structures lost. When Wan et al. (2021) analyzed ash samples from orchards in that area they found significantly higher concentrations of Cd, Cr, Cu, Ni, Pb and Zn compared to concentrations from the underlying soil samples. In contrast, however, the As was not significantly different from the corresponding soil samples.

A characterization study of ashfall collected from the Caldor Fire in ash deposition buckets and from the ground around the Tahoe Basin by Brahey et al. (2022) looked at bioavailable nutrients (N and P) as well as some macronutrients (Na, K, Ca), micronutrients (Cu, Fe, Mn, Zn) and toxicants (As, Cd, Cr, Ni, Pb) in water-extractable and easily-oxidizable fractions of the ash. They found that most of the macro and micronutrients tended be present at higher concentration in the water-extractable fraction of less pyrolized (charcoal) samples, although Ca and K were present at higher concentration in the more highly pyrolized (mineral ash) samples. Higher toxicant concentrations were found in the north west basin sites.

## Methods

The elements of primary interest for this analysis of Caldor urban runoff samples were selected based on the references discussed above. These included magnesium (Mg), aluminum (Al), silica (Si), potassium (K), calcium (Ca), chromium (Cr), manganese (Mn), iron (Fe), nickel (Ni), copper (Cu), zinc (Zn), cadmium (Cd), lead (Pb), as well as sodium (Na) and arsenic (As). Several other elements of potential interest were included because they were present in the ICP-MS calibration solution and produced reliable results (e.g. lithium (Li), titanium (Ti), vanadium (V), cobalt (Co), molybdenum (Mo), barium (Ba), tungsten (W), cerium (Ce), and uranium (U).

Samples from ten different RSWMP runoff monitoring stations around the Tahoe Basin (Figure 2) were collected as event mean concentration samples from precipitation events during and after the Caldor Fire (Table 1). These samples spanned the time interval from September 9, 2021 through October 25, 2021 and were provided as sample volumes remaining after customary analyses by the RSWMP. Not all sites included repeat sampling or the necessary residual volumes for analyses described below. Runoff samples from August 2022 were also provided for these analyses from three of the sites to serve as comparison to the Caldor Fire ash deposition period from September and October of 2021.

Samples were received frozen in 500 mL or 1000 mL HDPE bottles and remained frozen at DRI until processed for analysis. Each of these samples was thawed, mixed well and then poured through a Teflon cone-splitter to create subsamples for separate analysis of specific conductivity (μS/cm), elemental composition by ICP-MS, and SEM imaging of particulates.

The electrical conductivity of each sample was measured as specific conductivity (SC) using an Oakton 2100 pH/EC meter, previously calibrated with three conductivity standards (Fisher Scientific) at 10 μm/cm, 84 μS/cm and 1413 μS/cm.

Samples were prepared for ICP-MS by dispensing a 40 mL aliquot into trace-metal clean 50 mL centrifuge tubes (Sarstedt). These were acidified to pH <2 with 0.8 mL Optima grade nitric acid (Fisher Scientific), shaken and then stored in the refrigerator at 4°C until analysis. Prior to analysis the tubes were centrifuged at 2600 rpm (RCF of approx. 1000) for ten minutes, then representative aliquots were pipetted into acid-cleaned HDPE centrifuge tubes for 1:100 dilution with ultra-pure deionized water (18.2 Megohm). The sample solutions were analyzed for element concentration via inductively coupled plasma mass spectrometry (ICP-MS, PerkinElmer Nexion 200). Procedural blanks remained below the lowest concentrations for all elements measured and reported in runoff samples, except for a few of the lowest concentrations of Mo. A custom standard solution was used for calibration (Inorganic Ventures), with a second set of standards used for verification (Certiprep). Sample concentrations of As were almost all below the average of procedural blanks, so were not included in the results shown here.

The microscopic features of some ash samples were characterized using scanning electron microscope (Hitachi TM4000plus) equipped with an Oxford energy dispersive X-ray spectroscopy (EDS) detector. Samples were dried and mounted with carbon tabs onto aluminum SEM stubs (Electron Microscopy Sciences) for imaging and analysis.

## Results

Twenty-three EMC samples were analyzed for total suspended solids (TSS), turbidity, fine sediment particles less than 16 microns in diameter (FSP), nitrate plus nitrite ($NO_3$+$NO_2$), total nitrogen (TN), and total phosphorus (TP). The EMCs are presented in Table 2. The analytes in Table 2 are the standard suite of analytes used to determine pollutant levels in RSWMP stormwater samples, therefore data exists from all EMC samples taken under regular RSWMP monitoring during two water years (water year 2021: October 1, 2020 – September 30, 2021 and water year 2022: October 1, 2021 – September 30, 2022) to compare to the 23 priority EMC samples listed in Table 2 used for this study. The charts for TSS, FSP, TN, and TP for each site over the two-year period are included in Appendix A, Figures A1 – A40. Red circles on these charts indicate priority events (EMC samples) chosen at each site for this study.

*Table 2: Event mean concentration results for the 23 samples included in this study. EMCs include runoff volume (cubic feet), total suspended sediment (mg/L), turbidity (NTU), fine sediment particles less than 16 um (mg/L), nitrate + nitrite (mg/L), total Kjeldahl nitrogen (mg/L), total nitrogen (mg/L), and total phosphorus (mg/L).*

| Location | Sample Start | Sample End | Runoff Volume (cf) | TSS >1.5μm (mg/L) | Turbidity (NTU) | FSP <16μm (mg/L) | NO3+NO2 (mg/L) | TKN (mg/L) | TN (mg/L) | TP (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| Tahoma | 9/9/2021 22:18 | 9/10/2021 3:26 | 195 | 280 | 263.0 | 136.4 | 1.794 | 14.491 | 16.285 | 2.194 |
| Tahoe City | 9/9/2021 23:33 | 9/10/2021 5:23 | 1,096 | 622 | 771.0 | 376.5 | 1.464 | 10.398 | 11.862 | 3.125 |
| Contech In | 9/9/2021 23:43 | 9/10/2021 4:17 | 232 | 424 | 438.0 | 251.5 | 0.505 | 10.690 | 11.195 | 2.131 |
| Jellyfish In | 9/9/2021 23:43 | 9/10/2021 4:59 | 302 | 460 | 394.0 | 259.8 | 0.482 | 8.923 | 9.405 | 2.087 |
| Speedboat | 9/10/2021 4:35 | 9/10/2021 4:11 | 15 | 1,798 | 998.0 | 692.5 | 0.161 | 16.909 | 17.070 | 5.434 |
| Contech In | 10/7/2021 11:11 | 10/8/2021 4:27 | 77 | 206 | 243.0 | 88.4 | 0.036 | 6.211 | 6.247 | 0.998 |
| Jellyfish In | 10/7/2021 11:11 | 10/8/2021 4:50 | 230 | 230 | 239.0 | 93.9 | 0.030 | 5.430 | 5.460 | 1.372 |
| Tahoe City | 10/8/2021 3:23 | 10/8/2021 8:31 | 932 | 46 | 45.2 | 0.5 | 1.161 | 3.746 | 4.907 | 0.617 |
| Tahoma | 10/8/2021 3:58 | 10/8/2021 8:11 | 622 | 83 | 57.5 | 5.2 | 0.015 | 3.847 | 3.862 | 1.036 |
| Tahoe Valley | 10/8/2021 6:06 | 10/8/2021 6:06 | 44 | 171 | 191.0 | 63.1 | 0.096 | 5.376 | 5.472 | 1.328 |
| Speedboat | 10/21/2021 21:11 | 10/22/2021 12:55 | 4,776 | 71 | 43.3 | 21.2 | 0.010 | 2.392 | 2.402 | 0.578 |
| Elks Club | 10/22/2021 9:55 | 10/22/2021 17:53 | 575 | 39 | 32.3 | 0.3 | 0.094 | 1.509 | 1.603 | 0.941 |
| Elks Club | 10/23/2021 22:16 | 10/25/2021 3:00 | 44,686 | 32 | 17.7 | 7.7 | 0.011 | 0.569 | 0.580 | 0.277 |
| Tahoe Valley | 10/23/2021 23:18 | 10/25/2021 8:55 | 815,931 | 38 | 24.8 | 4.7 | 0.007 | 0.951 | 0.958 | 0.402 |
| Upper Truckee | 10/23/2021 23:55 | 10/24/2021 23:26 | 66,473 | 55 | 36.1 | 17.3 | 0.010 | 0.994 | 1.004 | 0.376 |
| Pasadena Out | 10/24/2021 5:55 | 10/25/2021 3:10 | 113,855 | 80 | 47.4 | 9.2 | 0.257 | 3.453 | 3.710 | 0.693 |
| Lakeshore | 10/24/2021 8:11 | 10/25/2021 1:05 | 14,539 | 24 | 21.7 | 13.6 | 0.080 | 0.905 | 0.985 | 0.258 |
| Pasadena Out | 10/25/21 11:13 | 10/28/2021 20:46 | 9,911 | 33 | 36.8 | 10.5 | 0.059 | 1.407 | 1.466 | 0.446 |
| Tahoma | 8/5/22 7:01 | 8/5/2022 17:16 | 542 | 134 | 93.4 | 38.9 | 0.440 | 5.799 | 6.239 | 1.206 |
| Tahoe City | 8/5/22 7:10 | 8/5/2022 12:46 | 1,516 | 134 | 118.0 | 66.5 | 1.139 | 5.561 | 6.700 | 1.059 |
| Tahoe City | 8/17/22 20:05 | 8/17/2022 22:43 | 538 | 76 | 69.5 | 2.0 | 2.626 | 3.538 | 6.164 | 0.676 |
| Contech In | 8/17/22 20:22 | 8/17/2022 20:55 | 108 | 722 | 529.0 | 355.0 | 0.263 | 4.121 | 4.384 | 1.551 |
| Jellyfish In | 8/17/22 20:23 | 8/17/2022 20:55 | 101 | 714 | 541.0 | 335.1 | 0.288 | 4.198 | 4.486 | 1.704 |

The results for SC, Li, Na, Mg, Al, Si, K, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Mo, Cd, Ba, W, Pb, Ce, and U for the 23 EMC samples chosen for this study are shown in Table 3 for all sites. Charts for SC, Na, Mg, Al, Si, K, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ba, Pb, Ce, and U are included in Appendix B, Figures B1 – B40 for the two sites that had at least three samples in this study (Tahoma and Tahoe City only).

*Table 3: Specific conductance and ICP-MS results for the 23 samples included in this study. ICP-MS results include concentrations of Li, Na, Mg, Al, Si, K, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Mo, Cd, Ba, W, Pb, Ce, and U.*

| Location | Sample Start | Sample End | SC (µS/cm) | Li (ppb) | Na (ppb) | Mg (ppb) | Al (ppb) | Si (ppb) | K (ppb) | Ca (ppb) |
|---|---|---|---|---|---|---|---|---|---|---|
| Tahoma | 9/9/2021 22:18 | 9/10/2021 3:26 | 526 | 7.01 | 67,465 | 5,973 | 2,892 | 3,387 | 11,815 | 24,591 |
| Tahoe City | 9/9/2021 23:33 | 9/10/2021 5:23 | 431 | 6.62 | 69,196 | 4,933 | 5,929 | 7,324 | 4,865 | 14,296 |
| Contech In | 9/9/2021 23:43 | 9/10/2021 4:17 | 1,087 | 7.81 | 189,457 | 3,120 | 5,795 | 7,428 | 3,893 | 22,553 |
| Jellyfish In | 9/9/2021 23:43 | 9/10/2021 4:59 | 981 | 11.3 | 188,884 | 2,962 | 5,602 | 7,778 | 3,918 | 21,719 |
| Speedboat | 9/10/2021 4:35 | 9/10/2021 4:11 | 178 | 10.6 | 7,405 | 8,918 | 11,692 | 9,824 | 9,296 | 24,271 |
| Contech In | 10/7/2021 11:11 | 10/8/2021 4:27 | 1,892 | 8.21 | 338,259 | 3,034 | 3,207 | 6,321 | 3,829 | 23,057 |
| Jellyfish In | 10/7/2021 11:11 | 10/8/2021 4:50 | 1,681 | 6.81 | 307,321 | 2,709 | 2,813 | 6,431 | 3,408 | 21,119 |
| Tahoe City | 10/8/2021 3:23 | 10/8/2021 8:31 | 231 | 2.53 | 38,842 | 745 | 929 | 2,351 | 1,713 | 2,552 |
| Tahoma | 10/8/2021 3:58 | 10/8/2021 8:11 | 153 | 3.17 | 21,906 | 1,429 | 763 | 1,544 | 6,808 | 4,869 |
| Tahoe Valley | 10/8/2021 6:06 | 10/8/2021 6:06 | 147 | 4.86 | 11,822 | 3,628 | 3,323 | 3,540 | 5,376 | 16,196 |
| Speedboat | 10/21/2021 21:11 | 10/22/2021 12:55 | 79 | 1.79 | 12,093 | 701 | 869 | 1,620 | 2,538 | 2,591 |
| Elks Club | 10/22/2021 9:55 | 10/22/2021 17:53 | 224 | 2.95 | 30,799 | 2,905 | 465 | 3,380 | 3,635 | 9,378 |
| Elks Club | 10/23/2021 22:16 | 10/25/2021 3:00 | 48 | 0.55 | 4,770 | 657 | 34 | 1,352 | 1,019 | 2,628 |
| Tahoe Valley | 10/23/2021 23:18 | 10/25/2021 8:55 | 36 | 0.76 | 4,789 | 571 | 517 | 980 | 1,959 | 2,124 |
| Upper Truckee | 10/23/2021 23:55 | 10/24/2021 23:26 | 58 | 1.10 | 7,911 | 502 | 516 | 1,450 | 955 | 2,860 |
| Pasadena Out | 10/24/2021 5:55 | 10/25/2021 3:10 | 46 | 6.67 | 2,490 | 1,268 | 1,300 | 1,387 | 4,518 | 4,242 |
| Lakeshore | 10/24/2021 8:11 | 10/25/2021 1:05 | 67 | 2.15 | 6,154 | 1,503 | 142 | 3,448 | 3,715 | 3,387 |
| Pasadena Out | 10/25/21 11:13 | 10/28/2021 20:46 | 42 | 1.17 | 3,097 | 1,078 | 371 | 1,505 | 2,547 | 3,742 |
| Tahoma | 8/5/22 7:01 | 8/5/2022 17:16 | 195 | 4.04 | 27,560 | 1,752 | 1,841 | 1,840 | 5,257 | 7,571 |
| Tahoe City | 8/5/22 7:10 | 8/5/2022 12:46 | 508 | 4.44 | 84,299 | 2,470 | 1,953 | 3,372 | 3,057 | 8,911 |
| Tahoe City | 8/17/22 20:05 | 8/17/2022 22:43 | 391 | 9.41 | 68,068 | 1,751 | 952 | 5,021 | 2,137 | 5,486 |
| Contech In | 8/17/22 20:22 | 8/17/2022 20:55 | 2,007 | 58.5 | 317,717 | 5,530 | 7,603 | 41,872 | 6,244 | 154,391 |
| Jellyfish In | 8/17/22 20:23 | 8/17/2022 20:55 | 2,063 | 56.4 | 296,882 | 5,322 | 7,580 | 41,311 | 6,040 | 152,394 |

*Table 3 continued:*

| Location | Sample Start | Sample End | Ti (ppb) | Cr (ppb) | Mn (ppb) | Fe (ppb) | Co (ppb) | Ni (ppb) | Cu (ppb) | Zn (ppb) |
|---|---|---|---|---|---|---|---|---|---|---|
| Tahoma | 9/9/2021 22:18 | 9/10/2021 3:26 | 85.9 | 3.83 | 614 | 4,805 | 11.2 | 43.8 | 34.4 | 318 |
| Tahoe City | 9/9/2021 23:33 | 9/10/2021 5:23 | 154 | 7.66 | 284 | 4,221 | 12.4 | 31.7 | 52.4 | 305 |
| Contech In | 9/9/2021 23:43 | 9/10/2021 4:17 | 100 | 5.86 | 414 | 3,151 | 7.53 | 24.0 | 46.1 | 185 |
| Jellyfish In | 9/9/2021 23:43 | 9/10/2021 4:59 | 104 | 10.9 | 408 | 2,688 | 8.84 | 25.6 | 46.9 | 194 |
| Speedboat | 9/10/2021 4:35 | 9/10/2021 4:11 | 354 | 12.1 | 1,181 | 16,436 | 21.1 | 43.8 | 76.1 | 908 |
| Contech In | 10/7/2021 11:11 | 10/8/2021 4:27 | 70.6 | 5.07 | 275 | 1,922 | 4.98 | 16.3 | 25.8 | 61.5 |
| Jellyfish In | 10/7/2021 11:11 | 10/8/2021 4:50 | 68.7 | 4.61 | 254 | 2,081 | 4.38 | 14.6 | 27.6 | 147 |
| Tahoe City | 10/8/2021 3:23 | 10/8/2021 8:31 | 17.3 | 13.1 | 28.9 | 507 | 1.71 | 9.41 | 21.6 | 84.0 |
| Tahoma | 10/8/2021 3:58 | 10/8/2021 8:11 | 15.2 | 2.00 | 124 | 880 | 2.30 | 12.3 | 10.4 | 95.7 |
| Tahoe Valley | 10/8/2021 6:06 | 10/8/2021 6:06 | 85.5 | 5.32 | 590 | 3,410 | 6.71 | 20.0 | 35.7 | 216 |
| Speedboat | 10/21/2021 21:11 | 10/22/2021 12:55 | 24.4 | 8.06 | 58.7 | 497 | 1.34 | 3.54 | 19.6 | 54.4 |
| Elks Club | 10/22/2021 9:55 | 10/22/2021 17:53 | 18.5 | 0.85 | 229 | 400 | 1.13 | 5.23 | 7.89 | 19.7 |
| Elks Club | 10/23/2021 22:16 | 10/25/2021 3:00 | 5.9 | 0.03 | 42.0 | 133 | 0.39 | 1.68 | 2.07 | 6.93 |
| Tahoe Valley | 10/23/2021 23:18 | 10/25/2021 8:55 | 10.0 | 3.88 | 65.1 | 341 | 0.71 | 2.42 | 6.46 | 50.7 |
| Upper Truckee | 10/23/2021 23:55 | 10/24/2021 23:26 | 20.4 | 3.26 | 61.6 | 434 | 0.89 | 3.06 | 6.08 | 27.2 |
| Pasadena Out | 10/24/2021 5:55 | 10/25/2021 3:10 | 23.2 | 17.2 | 114 | 728 | 1.70 | 4.84 | 19.8 | 159 |
| Lakeshore | 10/24/2021 8:11 | 10/25/2021 1:05 | 10.4 | 3.22 | 41.8 | 602 | 1.82 | 34.3 | 6.92 | 88.8 |
| Pasadena Out | 10/25/21 11:13 | 10/28/2021 20:46 | 14.9 | 2.15 | 44.9 | 336 | 0.44 | 2.88 | 4.41 | 7.08 |
| Tahoma | 8/5/22 7:01 | 8/5/2022 17:16 | 42.8 | 4.01 | 238 | 1,960 | 4.29 | 15.5 | 20.3 | 280 |
| Tahoe City | 8/5/22 7:10 | 8/5/2022 12:46 | 61.2 | 38.9 | 145 | 1,392 | 5.27 | 15.6 | 35.3 | 202 |
| Tahoe City | 8/17/22 20:05 | 8/17/2022 22:43 | 39.3 | 29.0 | 53.2 | 770 | 6.70 | 15.9 | 28.7 | 178 |
| Contech In | 8/17/22 20:22 | 8/17/2022 20:55 | 436 | 27.6 | 661 | 7,926 | 11.7 | 43.3 | 34.1 | 189 |
| Jellyfish In | 8/17/22 20:23 | 8/17/2022 20:55 | 447 | 27.0 | 693 | 7,906 | 11.2 | 42.5 | 34.6 | 164 |

*Table 3 continued:*

| Location | Sample Start | Sample End | As (ppb) | Mo (ppb) | Cd (ppb) | Ba (ppb) | W (ppb) | Pb (pb) | Ce (ppb) | U (ppb) |
|---|---|---|---|---|---|---|---|---|---|---|
| Tahoma | 9/9/2021 22:18 | 9/10/2021 3:26 | 0.00 | 4.20 | 0.16 | 131 | 2.37 | 5.12 | 10.5 | 0.60 |
| Tahoe City | 9/9/2021 23:33 | 9/10/2021 5:23 | 0.39 | 2.71 | 0.38 | 148 | 12.9 | 8.78 | 31.9 | 0.83 |
| Contech In | 9/9/2021 23:43 | 9/10/2021 4:17 | 0.00 | 14.0 | 0.31 | 130 | 1.65 | 8.69 | 28.0 | 1.08 |
| Jellyfish In | 9/9/2021 23:43 | 9/10/2021 4:59 | 11.2 | 14.0 | 5.41 | 133 | 1.54 | 12.0 | 31.9 | 3.67 |
| Speedboat | 9/10/2021 4:35 | 9/10/2021 4:11 | 0.86 | 0.30 | 1.12 | 438 | 1.05 | 53.2 | 61.5 | 1.76 |
| Contech In | 10/7/2021 11:11 | 10/8/2021 4:27 | 3.05 | 9.00 | 0.25 | 80.4 | 1.73 | 4.93 | 13.1 | 0.89 |
| Jellyfish In | 10/7/2021 11:11 | 10/8/2021 4:50 | 2.09 | 8.28 | 0.21 | 71.2 | 1.61 | 4.40 | 13.7 | 0.75 |
| Tahoe City | 10/8/2021 3:23 | 10/8/2021 8:31 | 0.00 | 1.03 | 0.06 | 19.9 | 10.9 | 1.04 | 2.71 | 0.18 |
| Tahoma | 10/8/2021 3:58 | 10/8/2021 8:11 | 0.00 | 0.00 | 0.12 | 28.8 | 0.68 | 1.89 | 2.40 | 0.44 |
| Tahoe Valley | 10/8/2021 6:06 | 10/8/2021 6:06 | 0.00 | 3.08 | 0.13 | 171 | 0.94 | 15.6 | 12.5 | 2.10 |
| Speedboat | 10/21/2021 21:11 | 10/22/2021 12:55 | 0.00 | 0.15 | 0.07 | 29.4 | 1.24 | 6.56 | 3.49 | 0.20 |
| Elks Club | 10/22/2021 9:55 | 10/22/2021 17:53 | 0.00 | 0.66 | 0.08 | 73.4 | 0.97 | 1.07 | 2.66 | 0.35 |
| Elks Club | 10/23/2021 22:16 | 10/25/2021 3:00 | 0.00 | 0.07 | 0.09 | 14.4 | 0.97 | 0.52 | 1.10 | 0.14 |
| Tahoe Valley | 10/23/2021 23:18 | 10/25/2021 8:55 | 0.00 | 0.22 | 0.61 | 17.4 | 1.38 | 3.09 | 1.80 | 0.25 |
| Upper Truckee | 10/23/2021 23:55 | 10/24/2021 23:26 | 0.00 | 0.32 | 0.10 | 25.0 | 0.67 | 2.13 | 2.29 | 0.15 |
| Pasadena Out | 10/24/2021 5:55 | 10/25/2021 3:10 | 6.85 | 0.00 | 0.90 | 29.9 | 0.33 | 6.80 | 3.53 | 2.15 |
| Lakeshore | 10/24/2021 8:11 | 10/25/2021 1:05 | 0.00 | 1.18 | 0.21 | 17.0 | 1.40 | 1.15 | 0.92 | 1.86 |
| Pasadena Out | 10/25/21 11:13 | 10/28/2021 20:46 | 0.00 | 0.14 | 0.07 | 16.8 | 0.72 | 2.79 | 1.27 | 0.22 |
| Tahoma | 8/5/22 7:01 | 8/5/2022 17:16 | 0.00 | 0.50 | 0.20 | 56.6 | 1.66 | 2.81 | 5.72 | 0.35 |
| Tahoe City | 8/5/22 7:10 | 8/5/2022 12:46 | 1.38 | 3.16 | 0.19 | 85.0 | 8.86 | 2.76 | 8.42 | 0.33 |
| Tahoe City | 8/17/22 20:05 | 8/17/2022 22:43 | 0.80 | 2.63 | 13.3 | 49.5 | 9.34 | 7.01 | 13.8 | 5.02 |
| Contech In | 8/17/22 20:22 | 8/17/2022 20:55 | 9.79 | 13.0 | 0.41 | 249 | 4.25 | 25.4 | 31.7 | 2.19 |
| Jellyfish In | 8/17/22 20:23 | 8/17/2022 20:55 | 11.8 | 14.2 | 0.39 | 254 | 3.93 | 25.5 | 31.3 | 2.12 |

Concentrations of major, minor and several trace elements were elevated in urban runoff around the Tahoe Basin during the active Caldor wildfire period. These concentrations dropped rapidly as the fire was contained and remained low during subsequent sampling at sites revisited in August of 2022. It should be noted, however, that results from samples collected at the CI and JI sites in 2022 were not used for this comparison because of extensive road repairs, excavation, construction and paving in progress along SR 431 above these sites when the samples were collected in August 2022.

Total suspended solids (TSS), fine sediment particles (FSP <20 µm), and turbidity are all closely related characteristics that collectively show how particulate concentrations were elevated during the fire but rapidly decreased as fire containment efforts progressed through October 2021. Elevated concentrations from wildfire deposition were particularly evident for Al, Ca, Ti, V, Fe, Co, Ni, Cu, Ba, and Ce. Examples are shown in Figure 3. Although not shown below, Ca demonstrated a particularly large range of concentrations in the second sampling period during early October 2021, but decreased thereafter.

Although the concentrations of Mg, Si, K, Mn, Zn, and Pb also dropped as fire containment was near or at completion, there was more overlap with concentrations seen during earlier sampling periods. The concentrations of Li, Na, Cr, Mo, Cd, Cs, W, and U in runoff samples did not show definitive decreased concentrations subsequent to the wildfire, suggesting that these elements were not much enhanced by mineral ash deposition and washoff during precipitation events. Some examples from both these cases are shown in Figure 4. The boxplots for Na and SC suggest that concentrations of elements with high ionic solubility did not change much with wildfire containment.

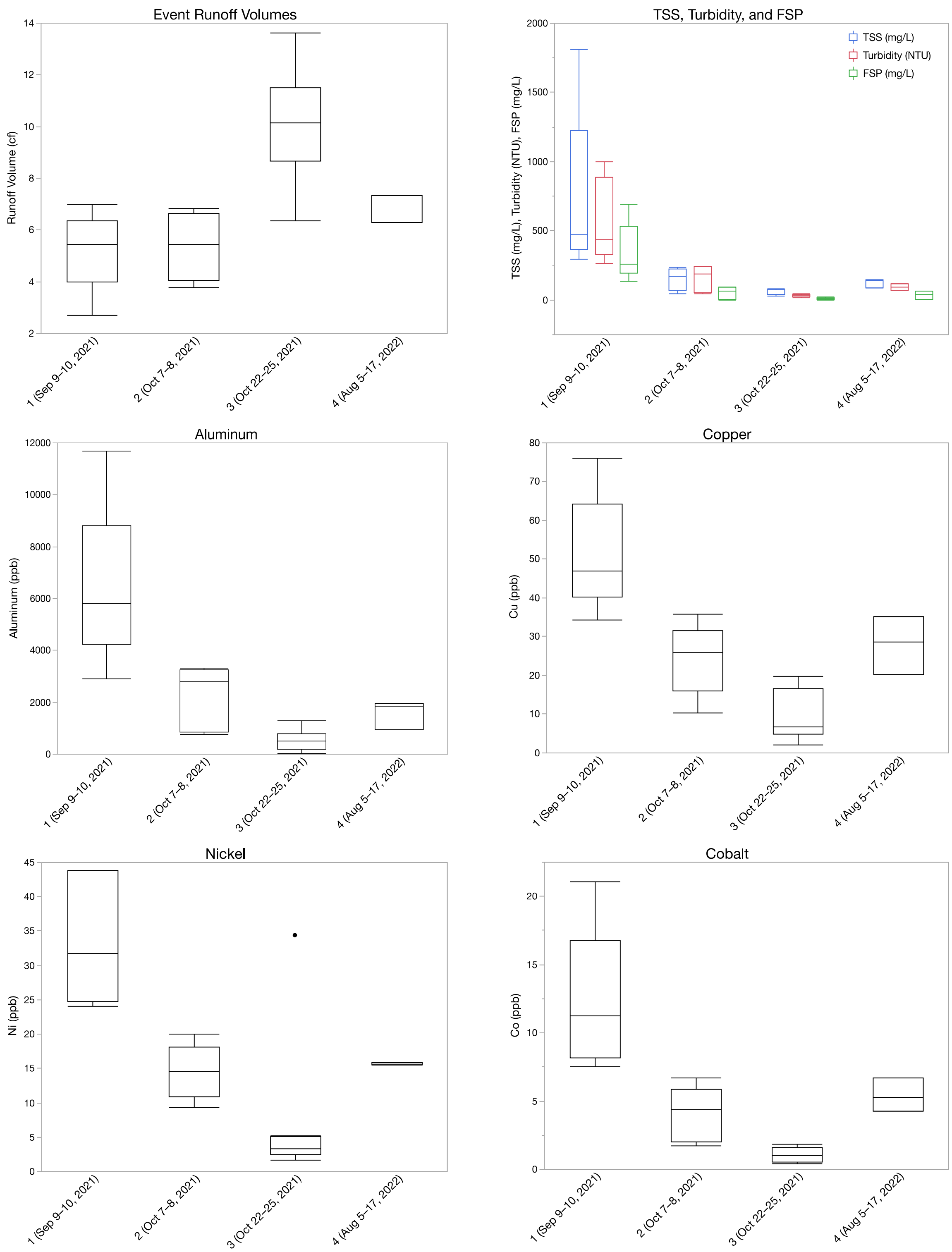


*Figure 3: Boxplots for event runoff volumes and event concentrations enriched by Caldor Fire ash deposition. Data represent ten sites and 21 samples collected over 4 different sampling periods: (1) during the Caldor Fire, (2 and 3) near final containment, and (4) in the subsequent year.*

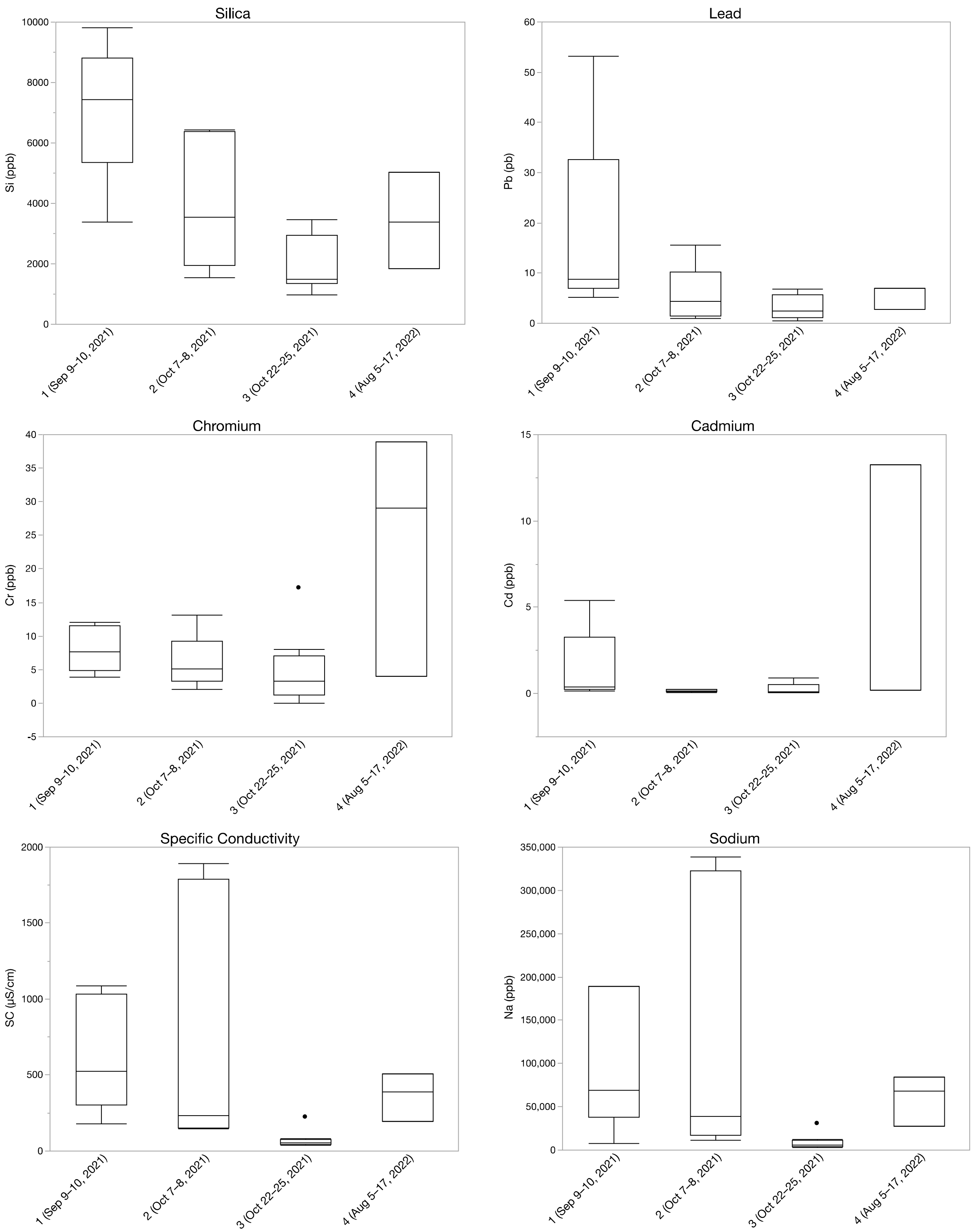


*Figure 4: Boxplots for runoff event concentrations that were not significantly enriched by Caldor Fire ash deposition. Data represent ten sites and 21 samples collected over 4 different sampling periods: (1) during the Caldor Fire, (2 and 3) near final containment, and (4) in the subsequent year.*

A principal component analysis was conducted on the full set of samples (excluding two suspect samples from CI and JI in 2022). Variables were log-normalized and then standardized by centering to their respective medians and scaling by their standard deviations. Although the number of samples (n=21) was low for the number of variables introduced (8), introducing potential issues with dimensionality, the PCA results demonstrate that most variability in these concentrations appears to be associated with event runoff volumes, relative solubility and particle sorption characteristics (Figure 5). For log-transformed variables included in this graph, the first component explains almost 65% of the total data variability, and the second component explains another 18%. The five samples collected during the first runoff event (September 2021, while the fire was still active) are clustered near the high score range of the first principal component.

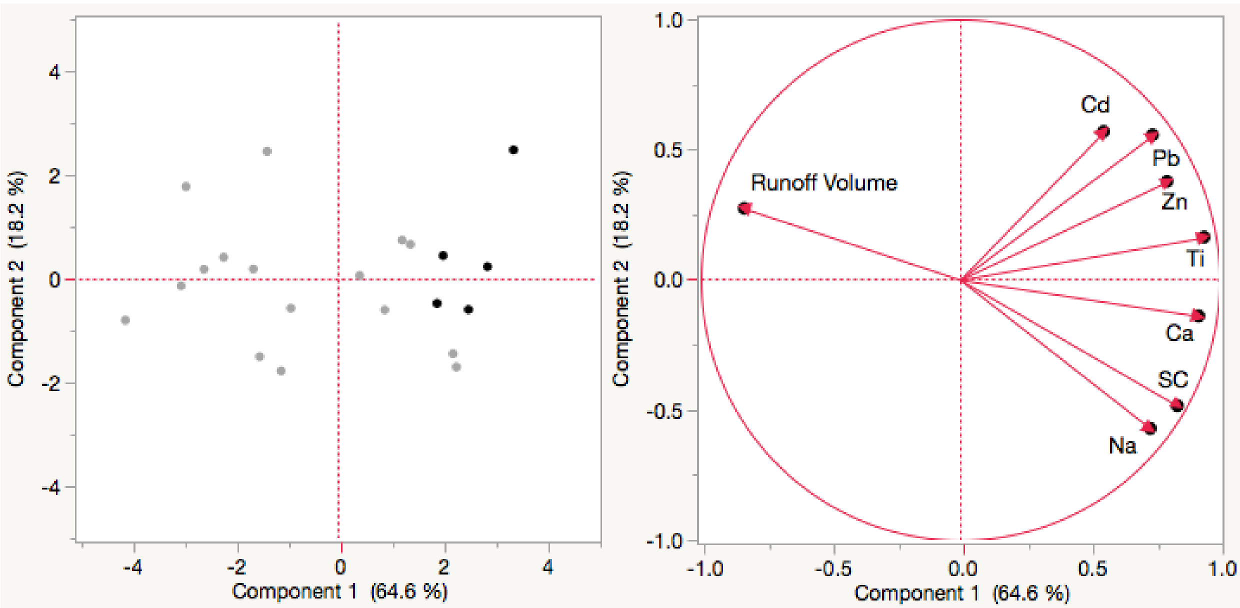


*Figure 5: Ordination in the first two axes (PC1 and PC2) resulting from principal component analysis of log-transformed Caldor Fire urban runoff sample data. The darker highlighted points in the left hand plot indicate samples collected while the fire was actively burning in the Lake Tahoe basin (September 2021). SC is specific (electrical) conductivity.*

Two SEM images of representative ash samples from Caldor Fire in urban runoff samples are shown in Figure 6. Overall, this ash was primarily comprised of carbon (C), oxygen (O), and silicon dioxide ($SiO_2$) when evaluated by energy dispersive x-ray spectroscopy. In many cases, though not shown here, the overall composition of larger particles included inorganic soil particles and unidentified organic fragments embedded within the char or ash particle.

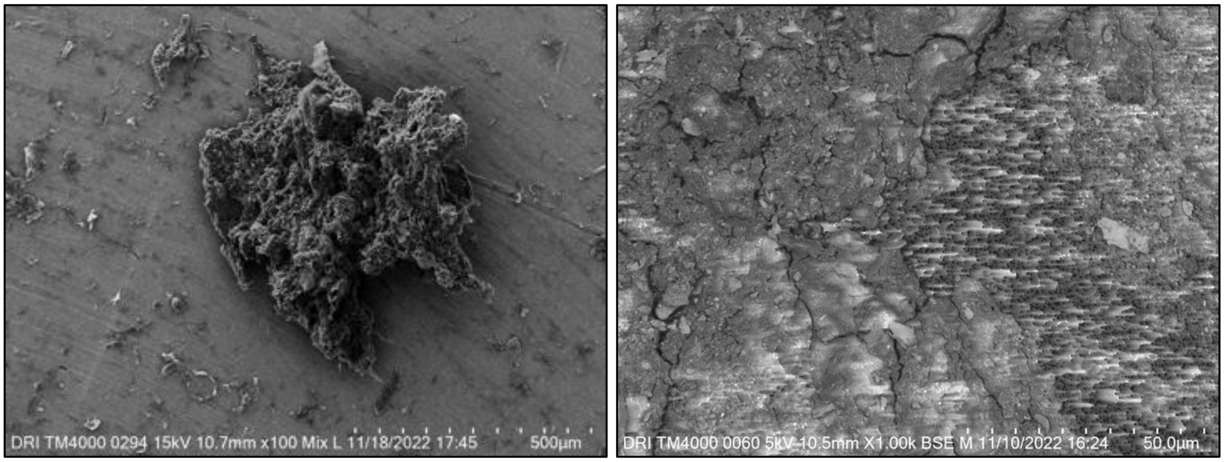


*Figure 6: Scanning electron microscope images of Caldor Fire ash samples in urban runoff from Tahoma demonstrating characteristic morphological and compositional features of ash at two magnifications (100x and 1000x). Size scales are provided in the bottom right corner of each panel showing (left) 500 µm and (right) 50 µm overall (with hash marks at every 1/10 distance).*

## Conclusion

Consistent with other projects, elevated concentrations of several elements associated with smoke and ash were detected in samples taken during the Caldor Fire. These concentrations dropped quickly as containment of the wildfire progressed in the Tahoe Basin. Likewise, the concentrations of suspended sediments, fine sediment particles (<20 µm), and nutrients were generally higher in the samples taken during the fire. This indicates that the Caldor Fire had a relatively transitory impact on urban stormwater quality but likely delivered pollutants into Lake Tahoe, contributing to changes documented by rapid-response investigations on lake ecology and aquatic conditions conducted during and after entry of the Caldor Fire into the Tahoe Basin (Chandra et al. 2022).

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# Appendix A

## Tahoma

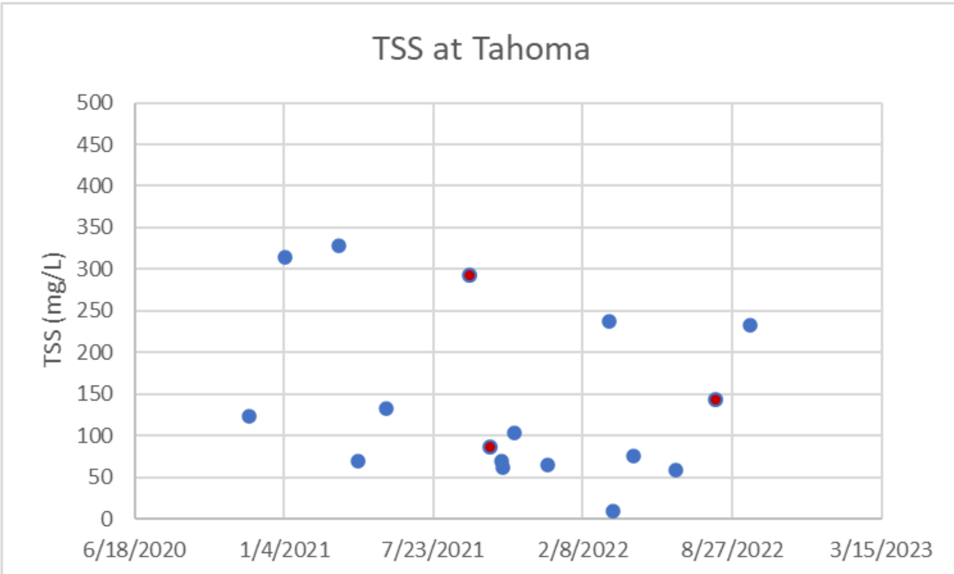


*Figure A1: Total suspended solid concentrations at Tahoma for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

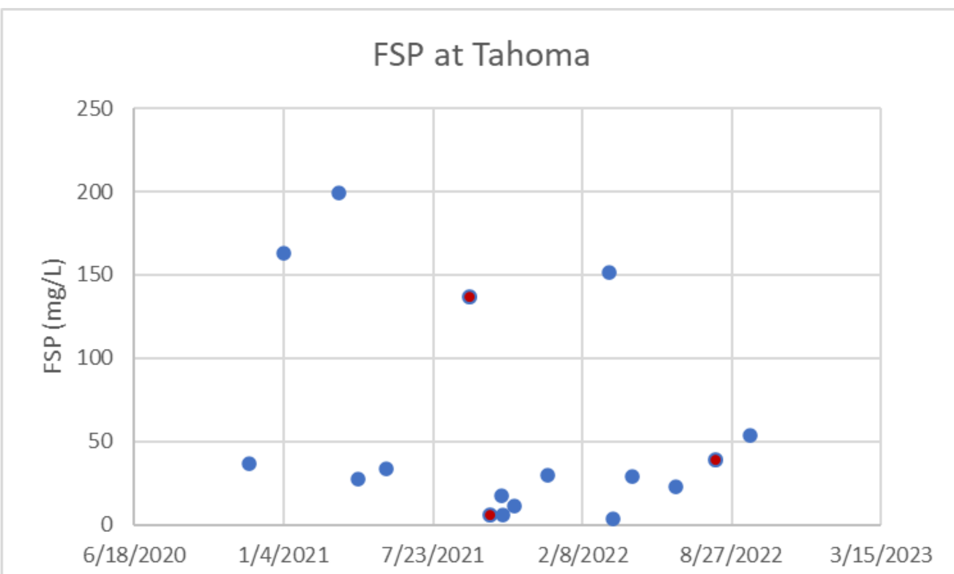


*Figure A2: Fine sediment particle concentrations at Tahoma for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

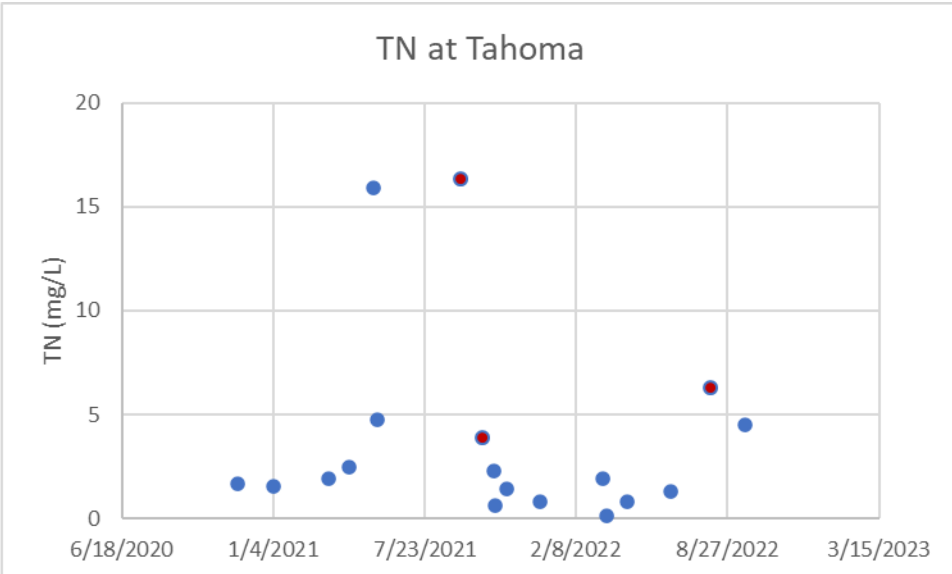


*Figure A3: Total nitrogen concentrations at Tahoma for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

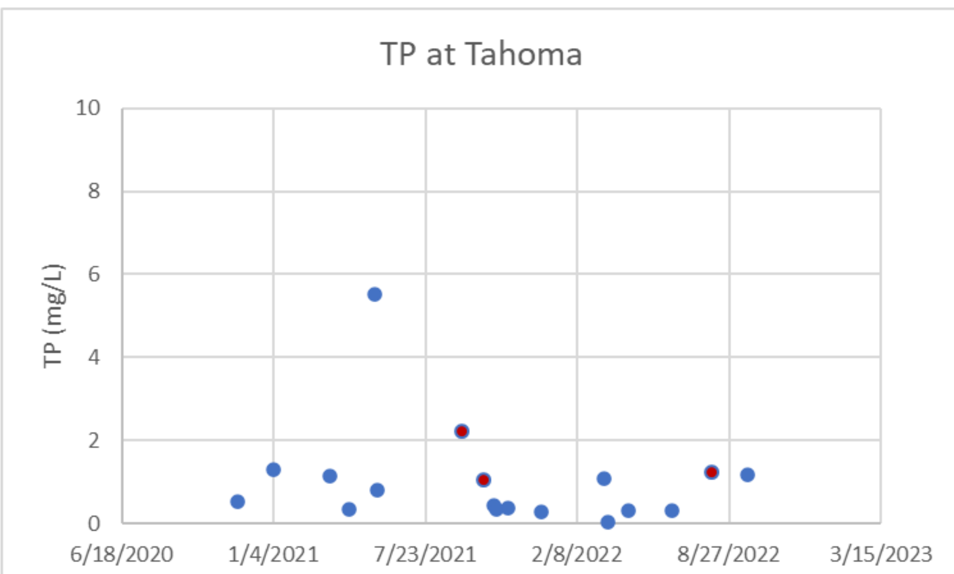


*Figure A4: Total phosphorus concentrations at Tahoma for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

## Tahoe City

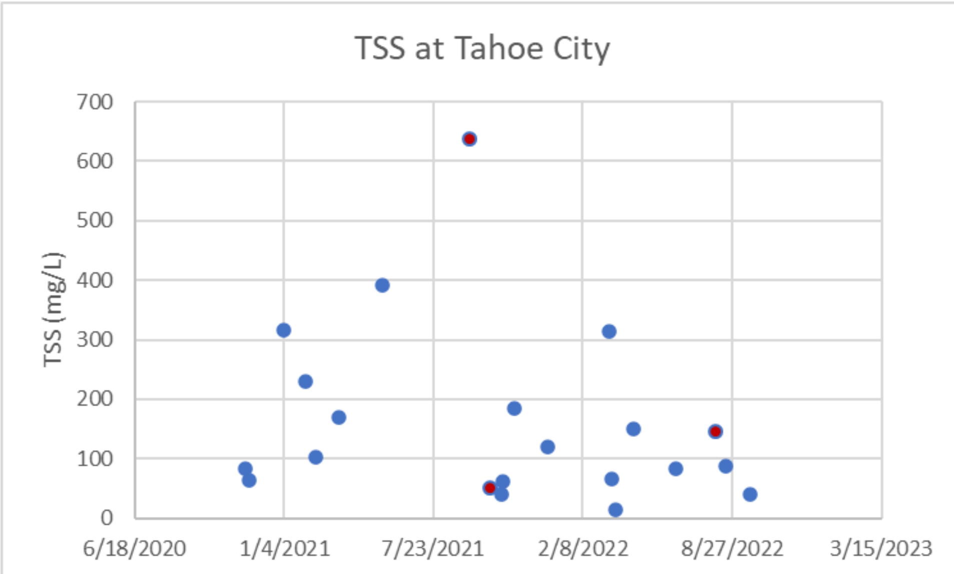


*Figure A5: Total suspended solid concentrations at Tahoe City for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

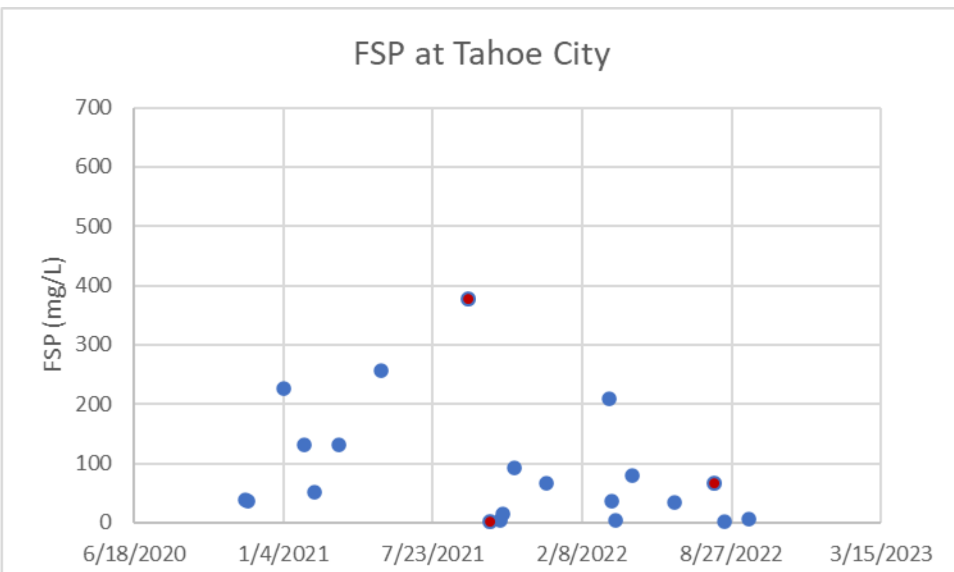


*Figure A6: Fine sediment particle concentrations at Tahoe City for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

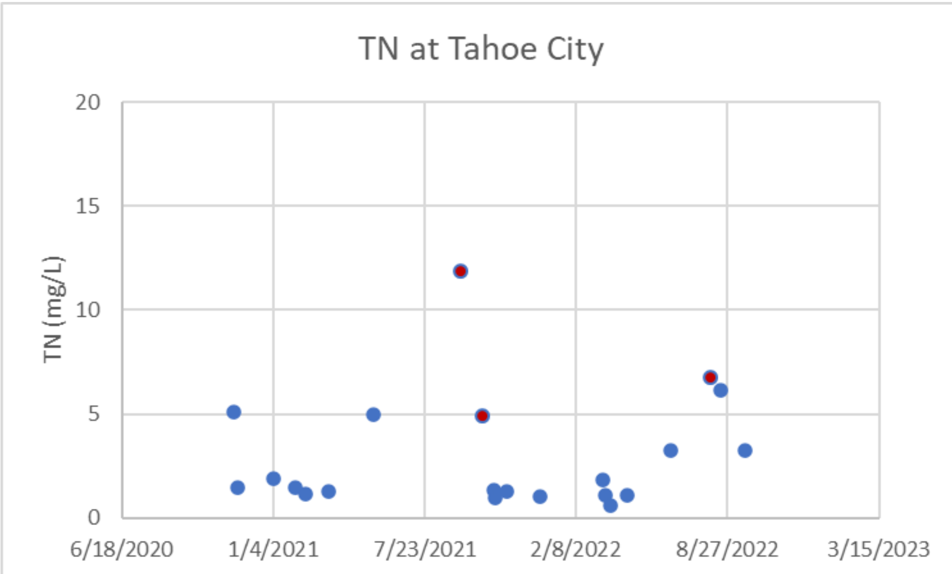


*Figure A7: Total nitrogen concentrations at Tahoe City for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

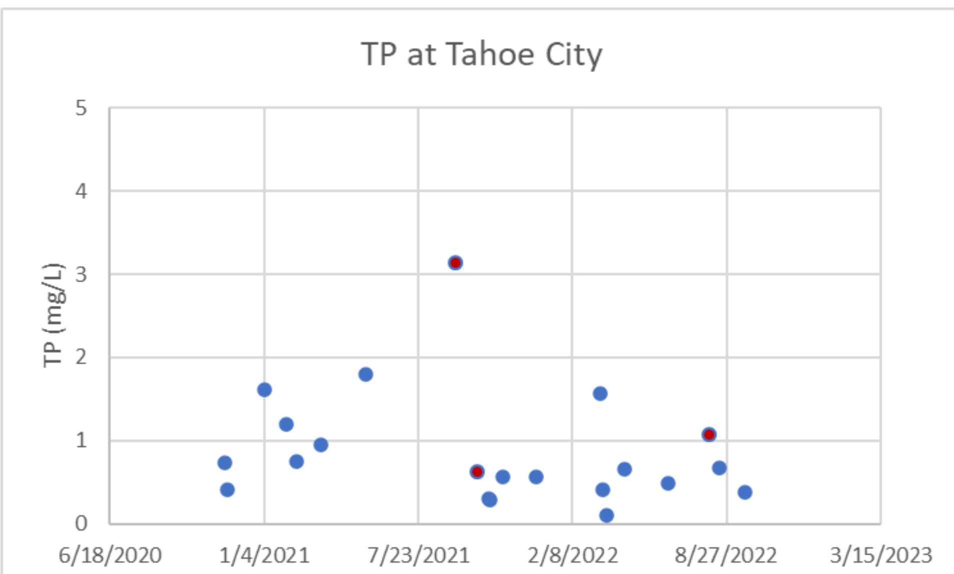


*Figure A8: Total phosphorous concentrations at Tahoe City for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

## Contech Inflow

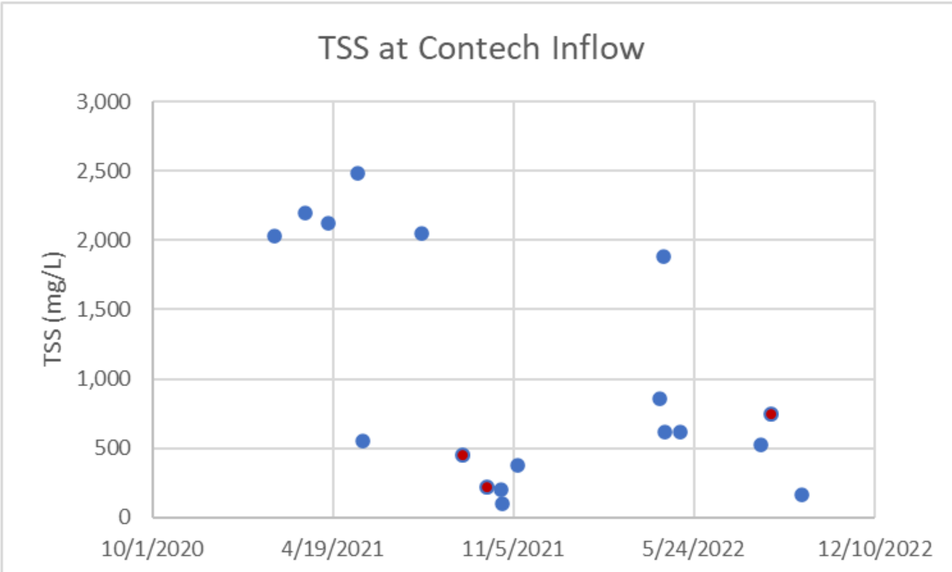


*Figure A9: Total suspended solid concentrations at Contech Inflow for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

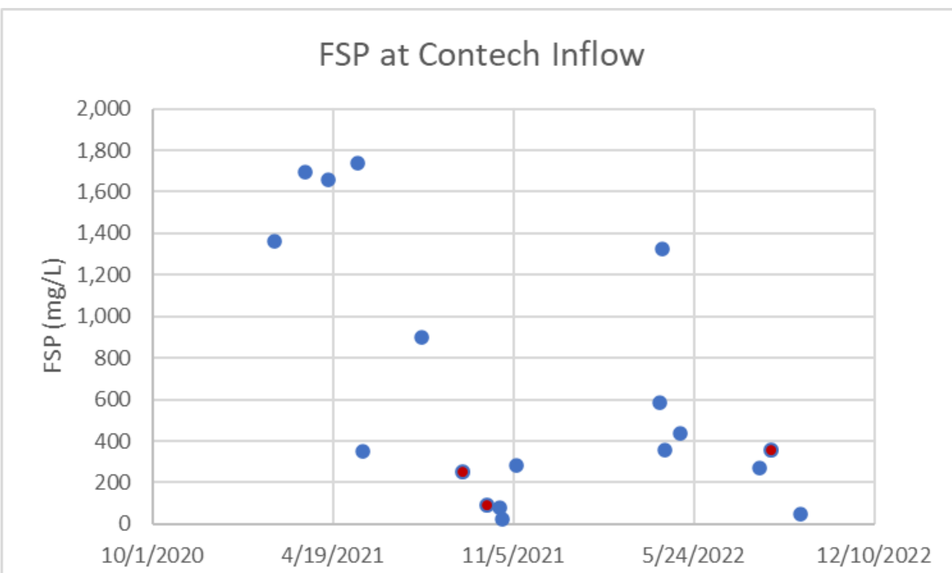


*Figure A10: Fine sediment particle concentrations at Contech Inflow for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

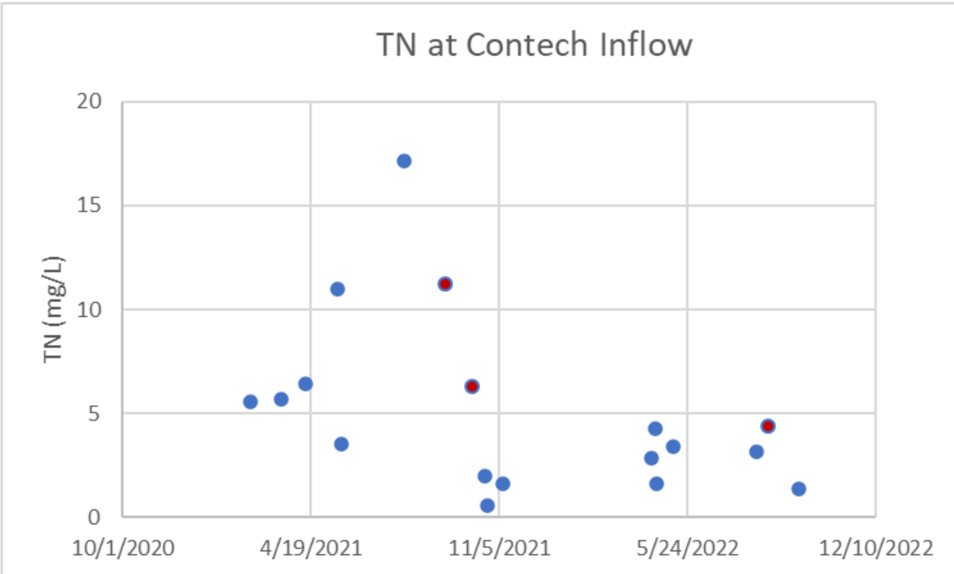


*Figure A11: Total nitrogen concentrations at Contech Inflow for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

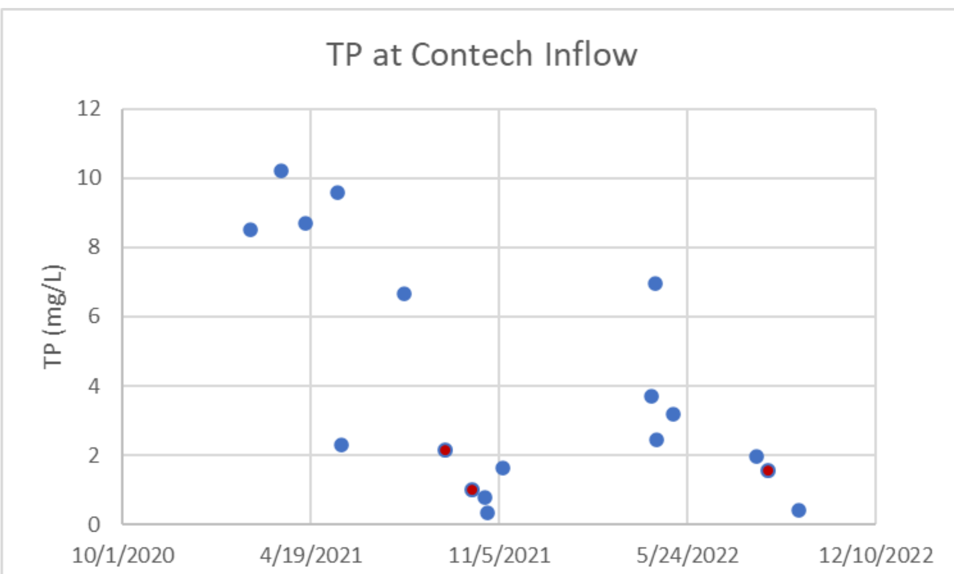


*Figure A12: Total phosphorous concentrations at Contech Inflow for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

## Jellyfish Inflow

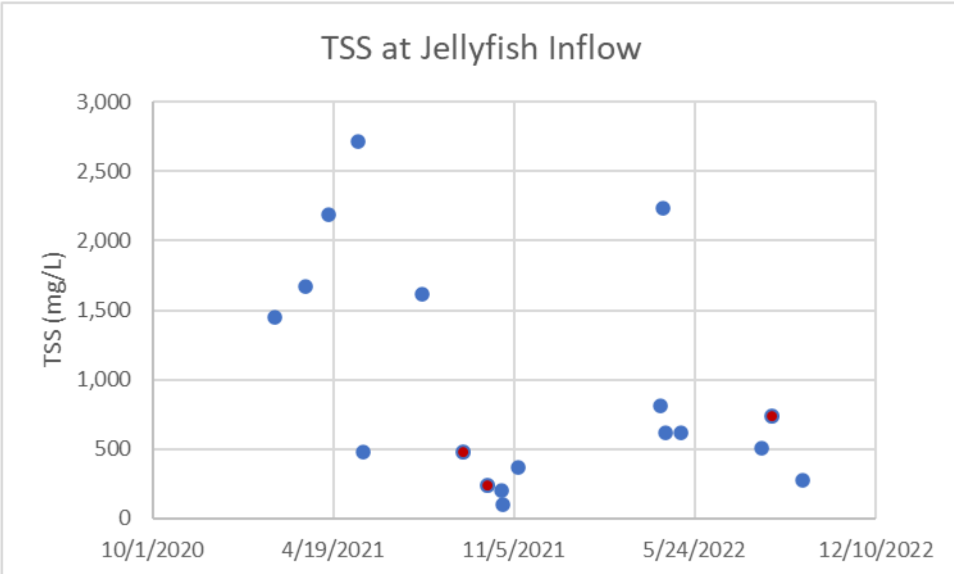


*Figure A13: Total suspended solid concentrations at Jellyfish Inflow for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

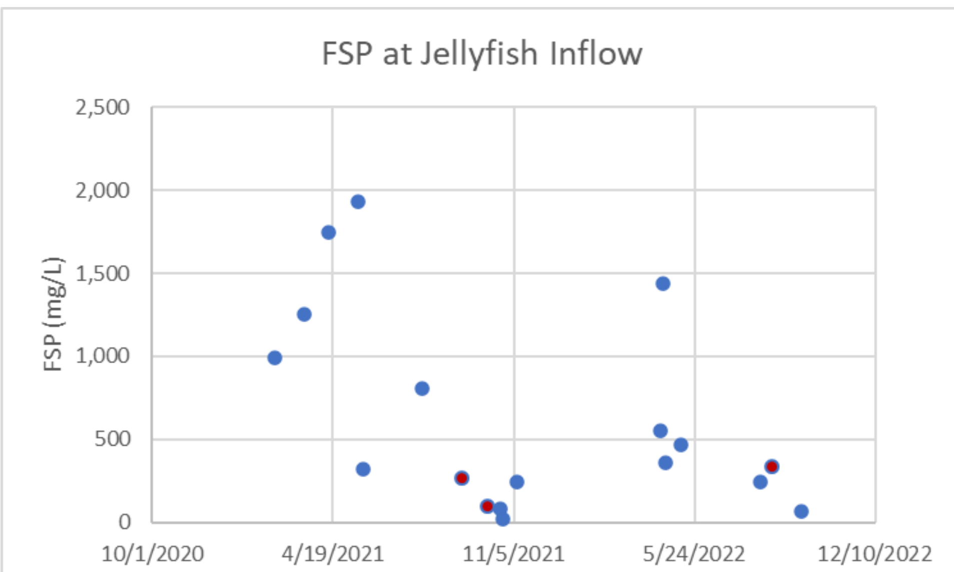


*Figure A14: Fine sediment particle concentrations at Jellyfish Inflow for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

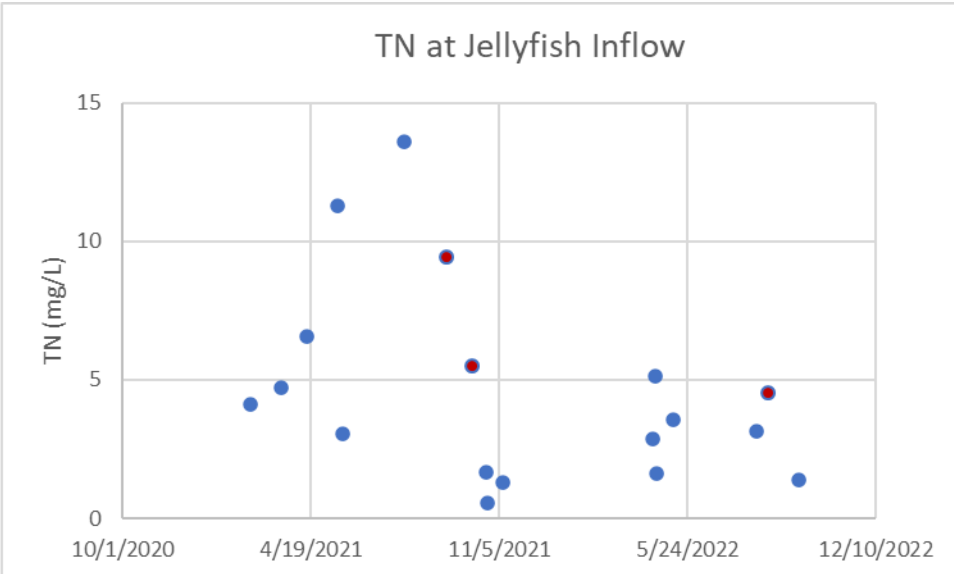


*Figure A15: Total nitrogen concentrations at Jellyfish Inflow for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

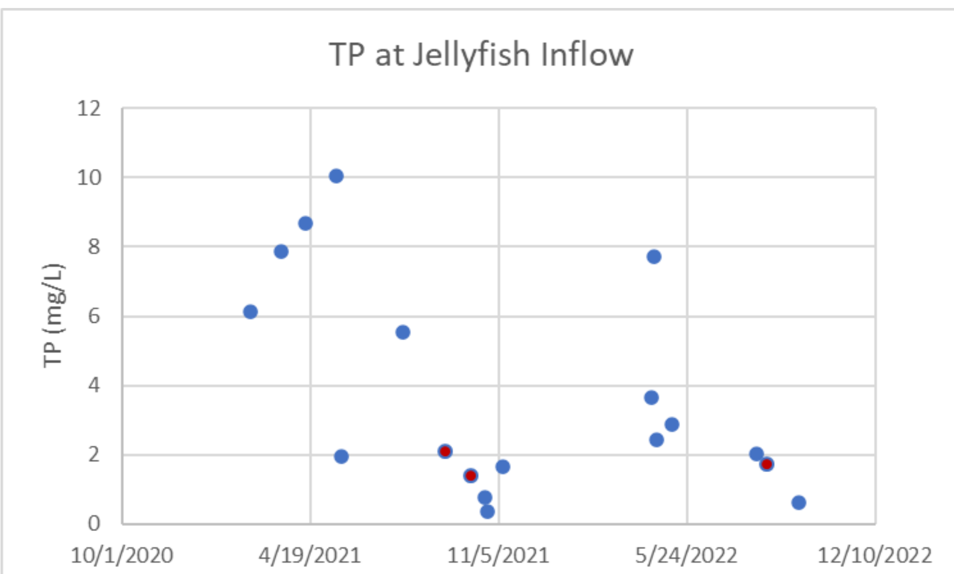


*Figure A16: Total phosphorous concentrations at Jellyfish Inflow for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

## Speedboat

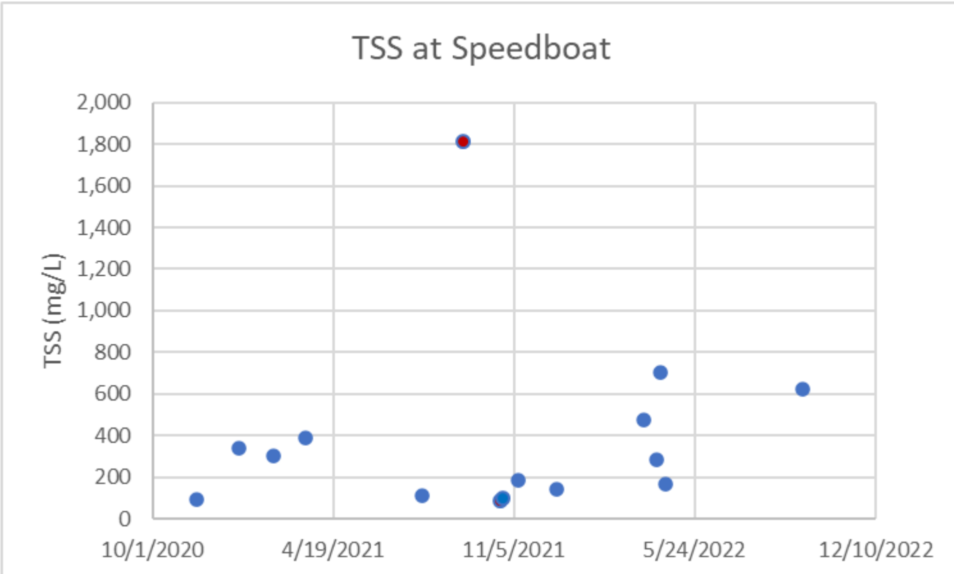


*Figure A17: Total suspended solid concentrations at Speedboat for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

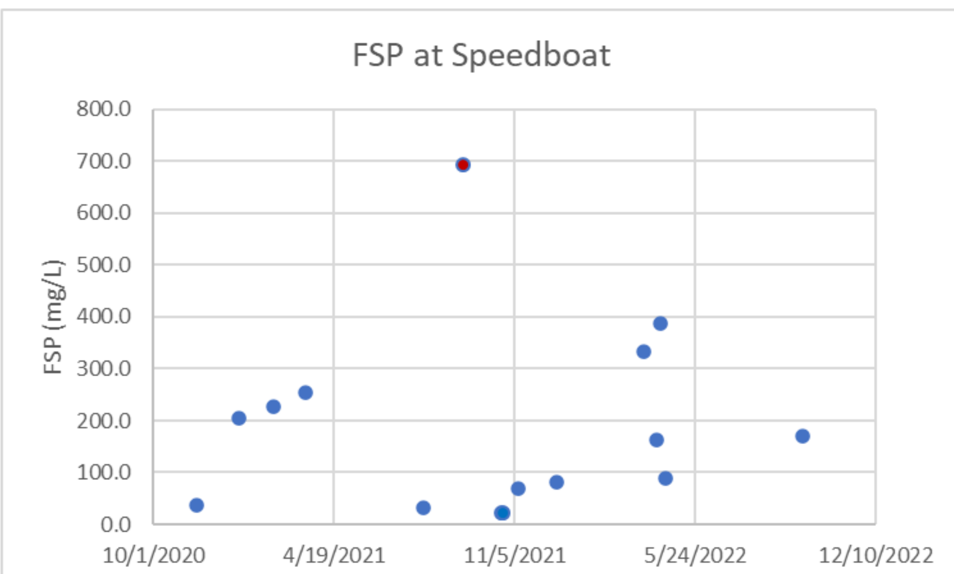


*Figure A18: Fine sediment particle concentrations at Speedboat for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

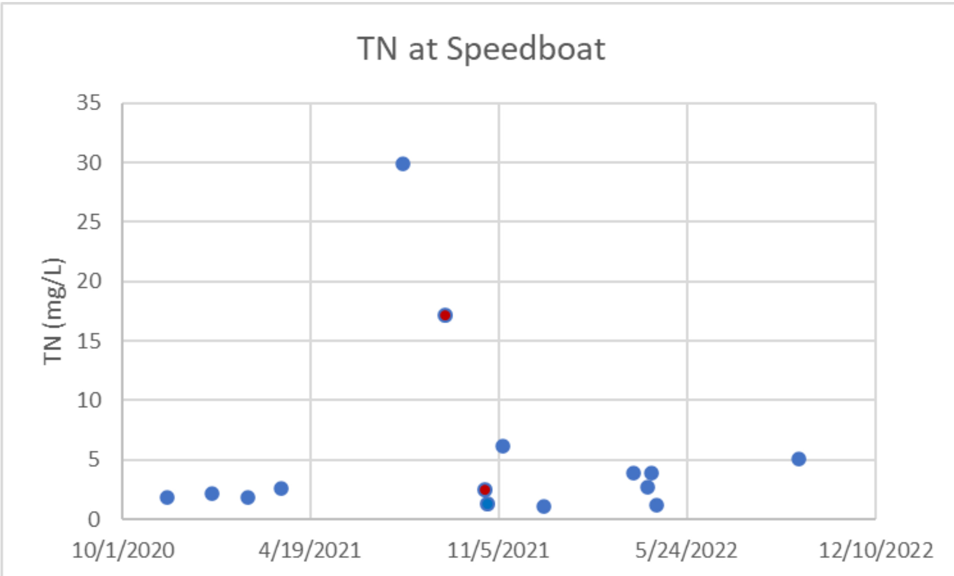


*Figure A19: Total nitrogen concentrations at Speedboat for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

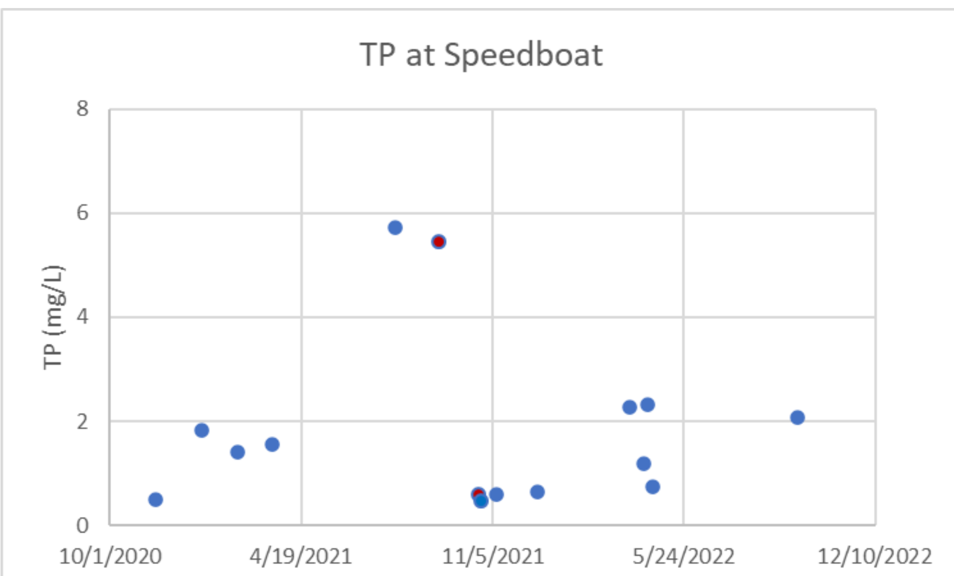


*Figure A20: Total phosphorous concentrations at Speedboat for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

## Tahoe Valley

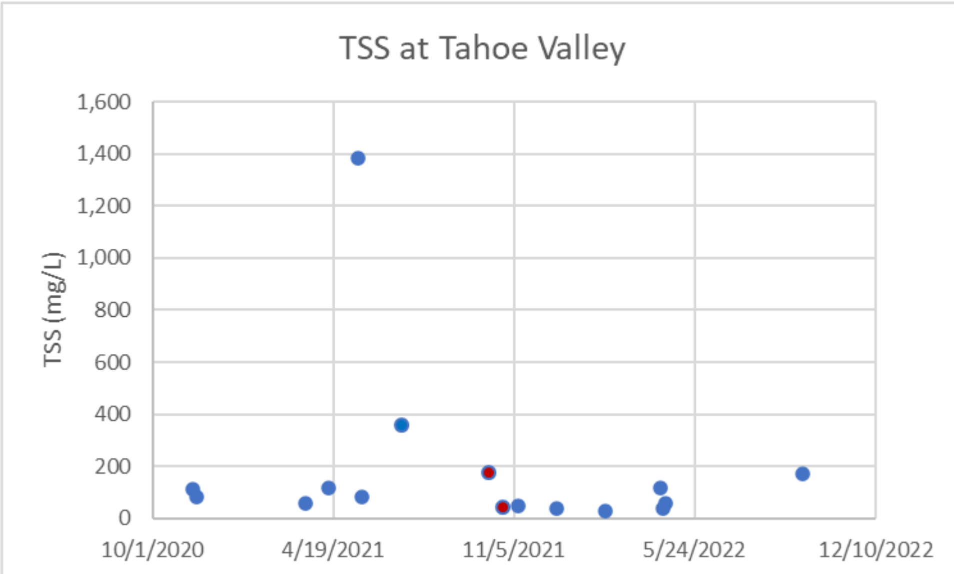


*Figure A21: Total suspended solid concentrations at Tahoe Valley for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

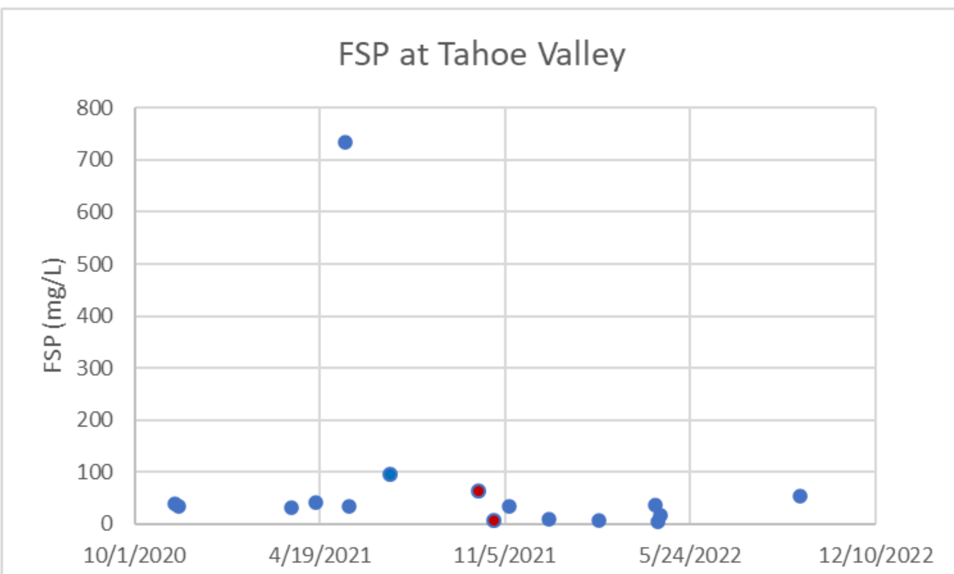


*Figure A22: Fine sediment particle concentrations at Tahoe Valley for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

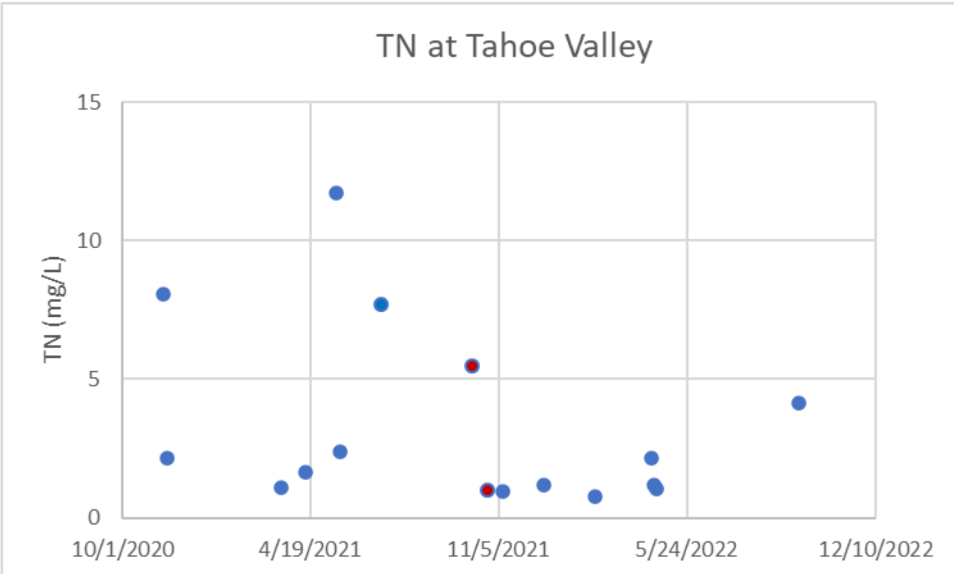


*Figure A23: Total nitrogen concentrations at Tahoe Valley for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

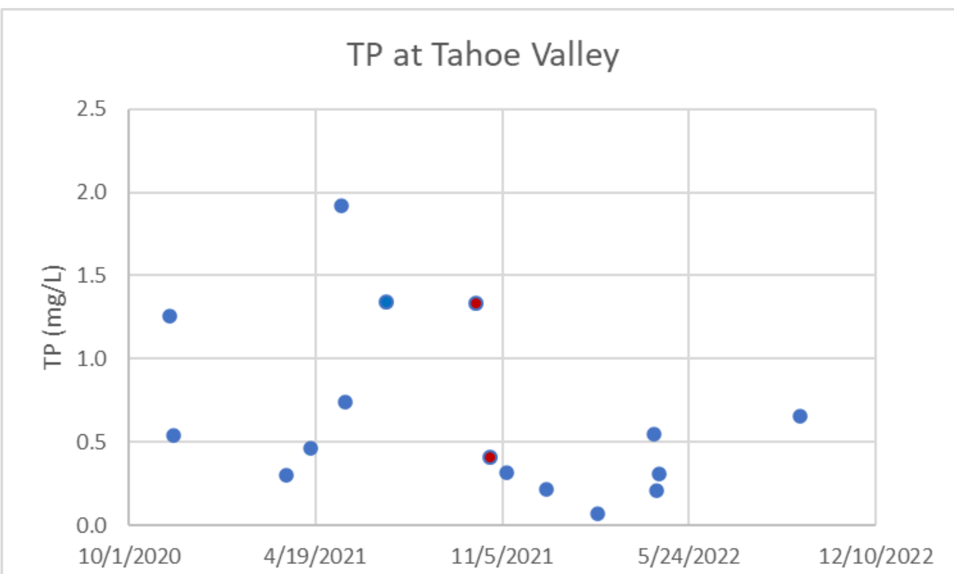


*Figure A24: Total phosphorous concentrations at Tahoe Valley for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

## Elks Club

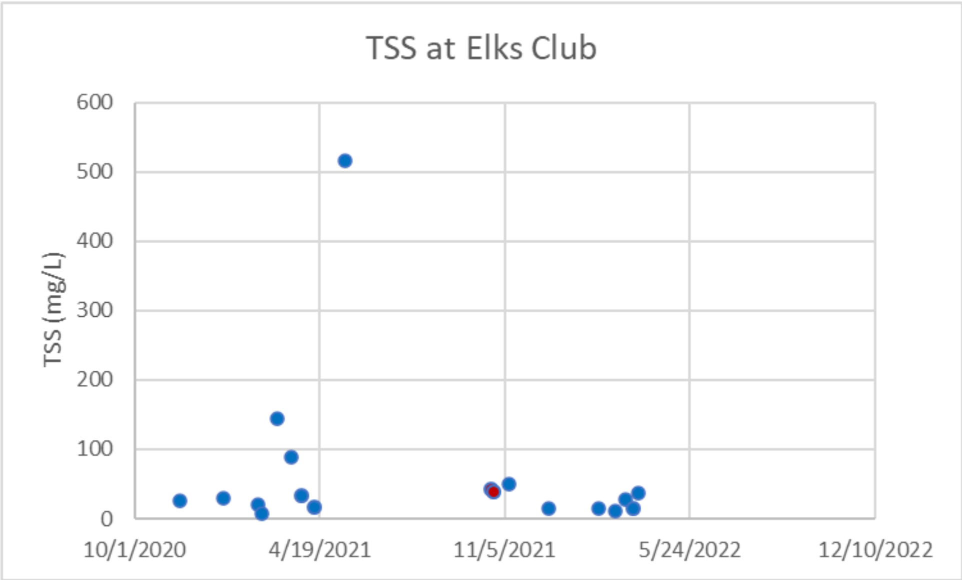


*Figure A25: Total suspended solid concentrations at Elks Club for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

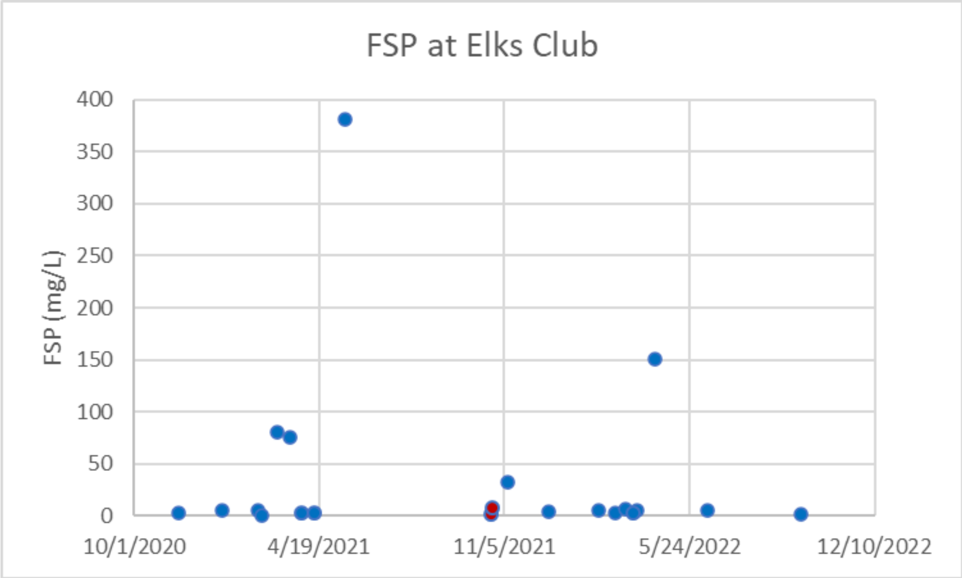


*Figure A26: Fine sediment particle concentrations at Elks Club for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

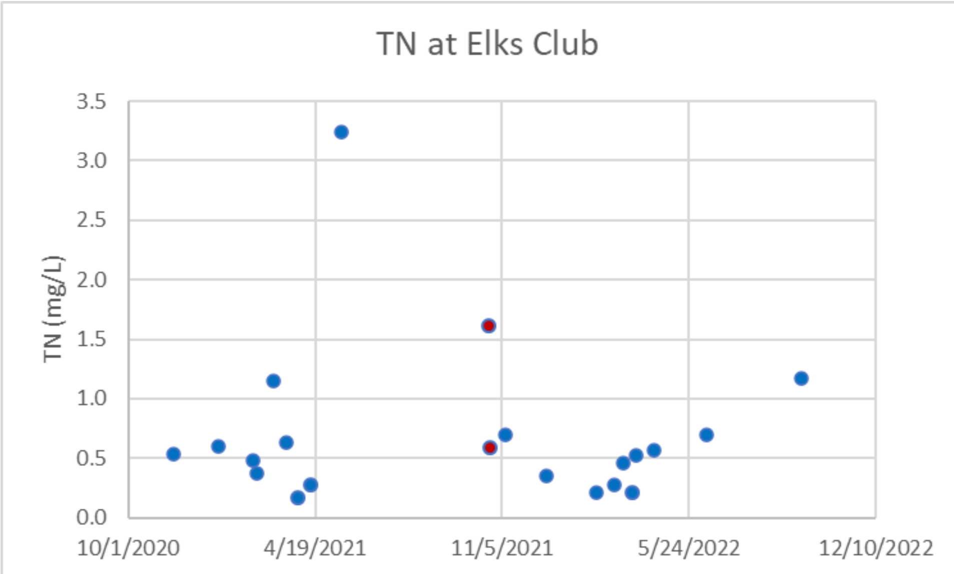


*Figure A27: Total nitrogen concentrations at Elks Club for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

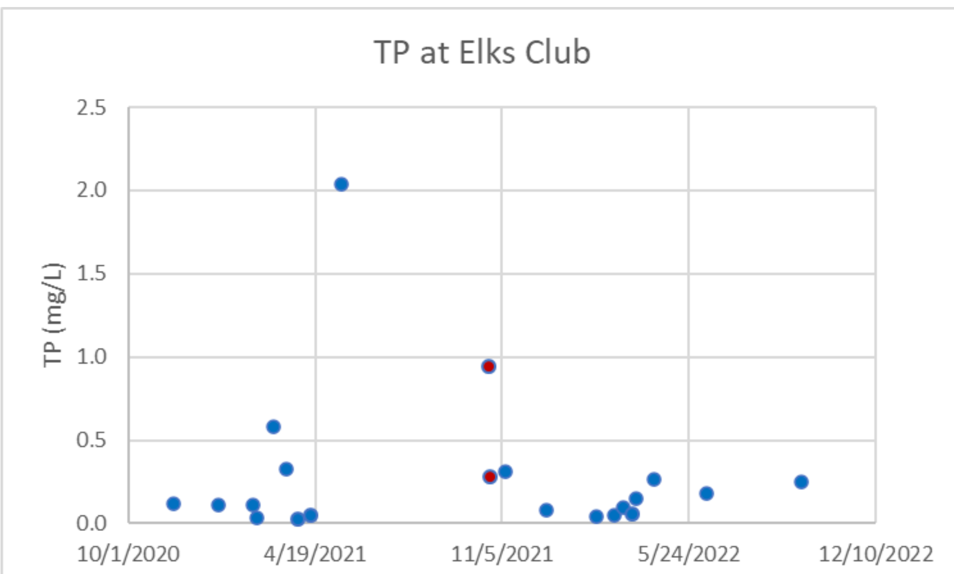


*Figure A28: Total phosphorous concentrations at Elks Club for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

## Pasadena

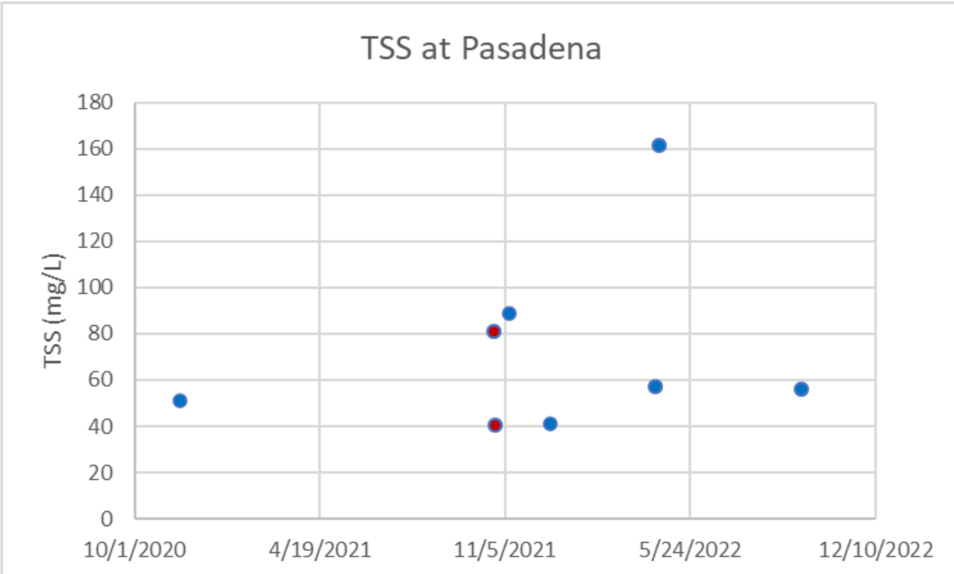


*Figure A29: Total suspended solid concentrations at Pasadena for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

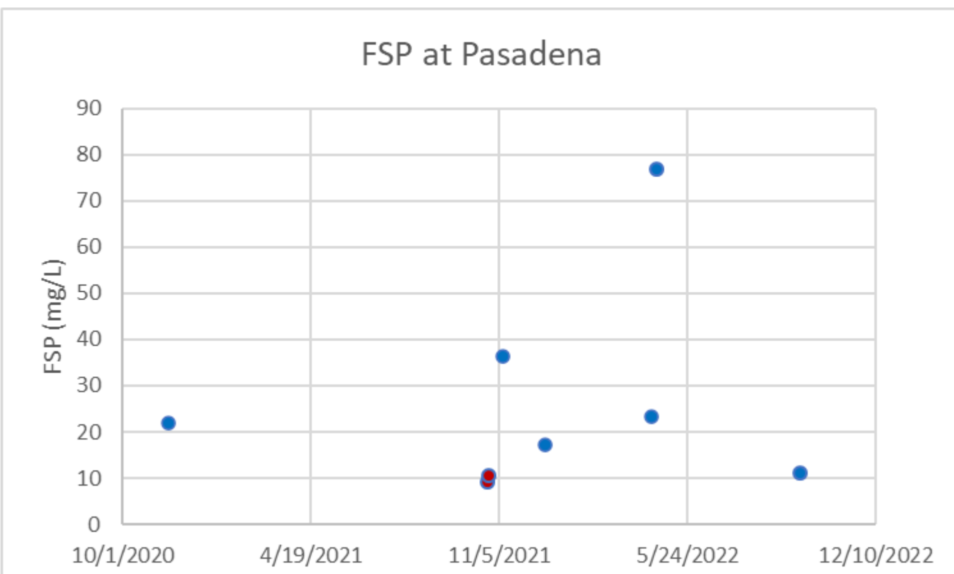


*Figure A30: Fine sediment particle concentrations at Pasadena for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

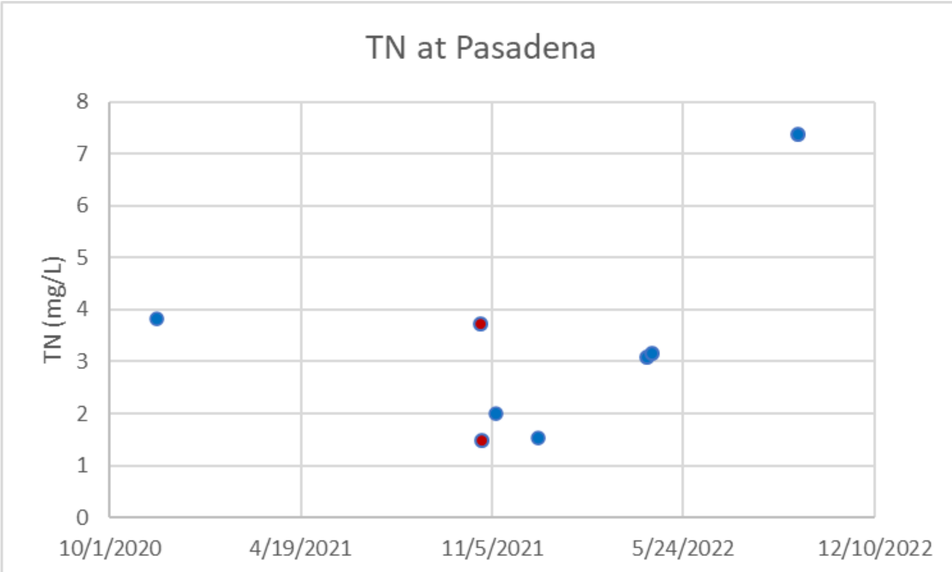


*Figure A31: Total nitrogen concentrations at Pasadena for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

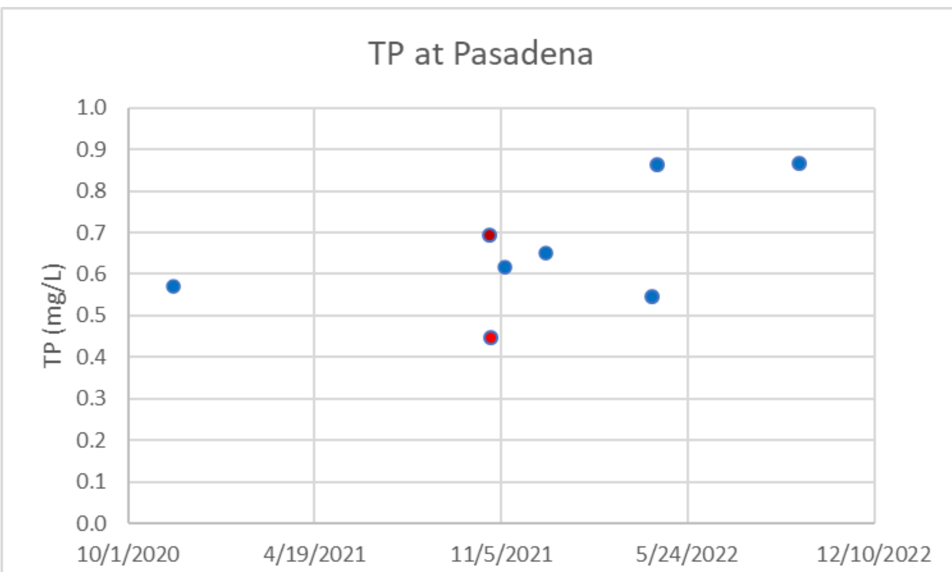


*Figure A32: Total phosphorous concentrations at Pasadena for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

## Upper Truckee

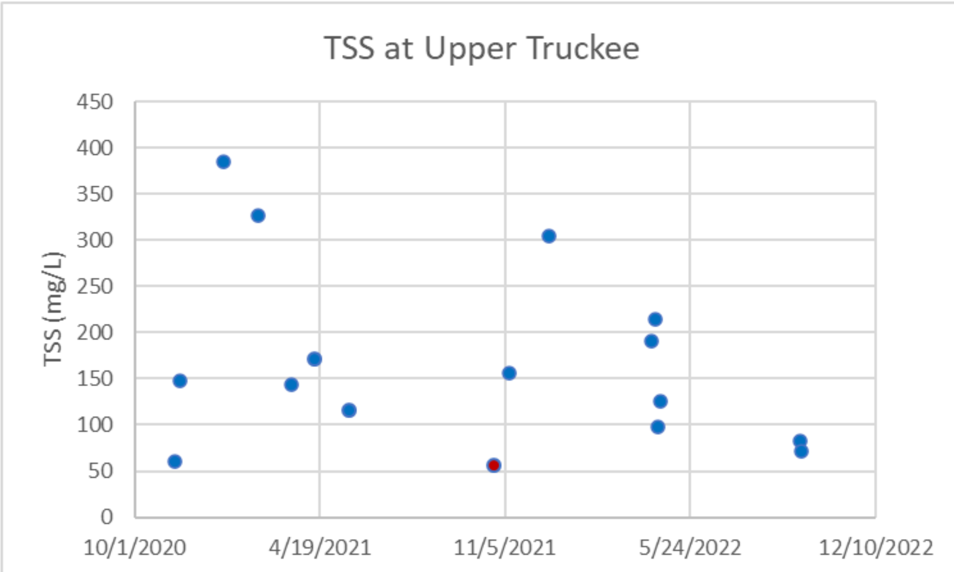


*Figure A33: Total suspended solid concentrations at Upper Truckee for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

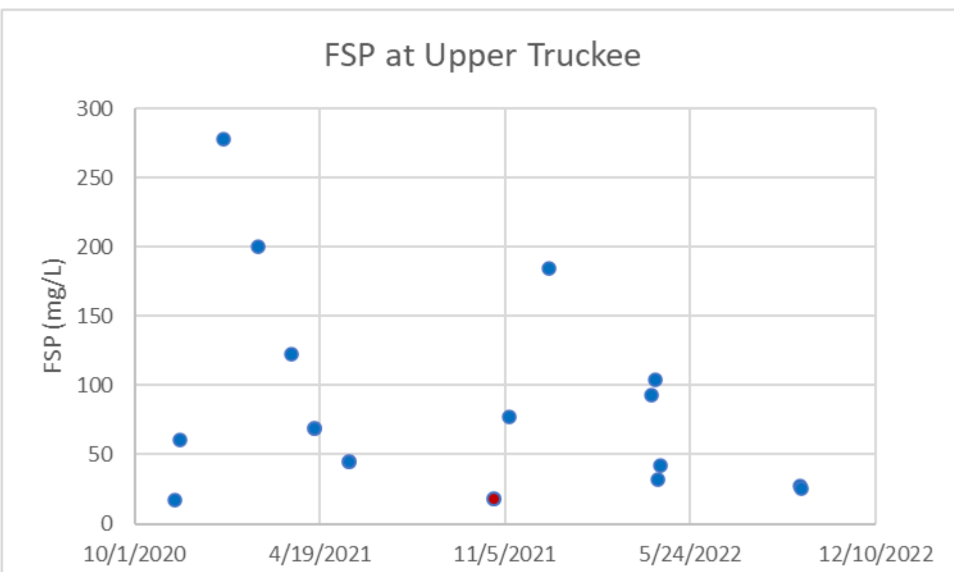


*Figure A34: Fine sediment particle concentrations at Upper Truckee for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

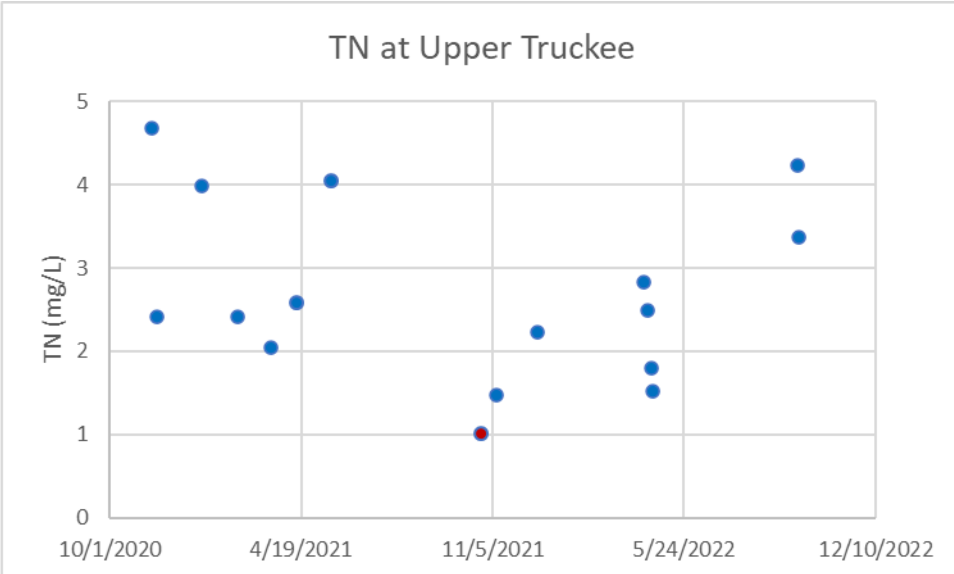


*Figure A35: Total nitrogen concentrations at Upper Truckee for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

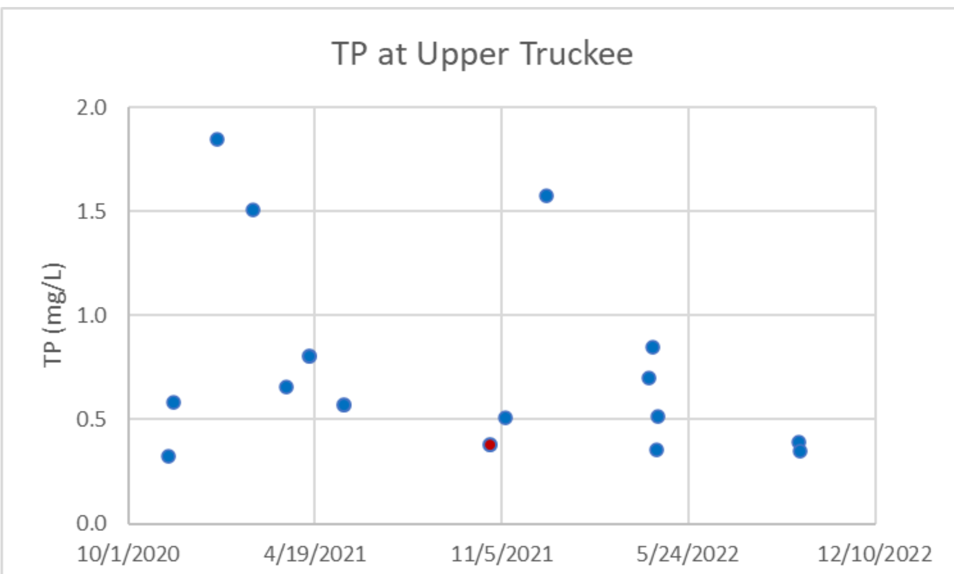


*Figure A36: Total phosphorous concentrations at Upper Truckee for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

## Lakeshore

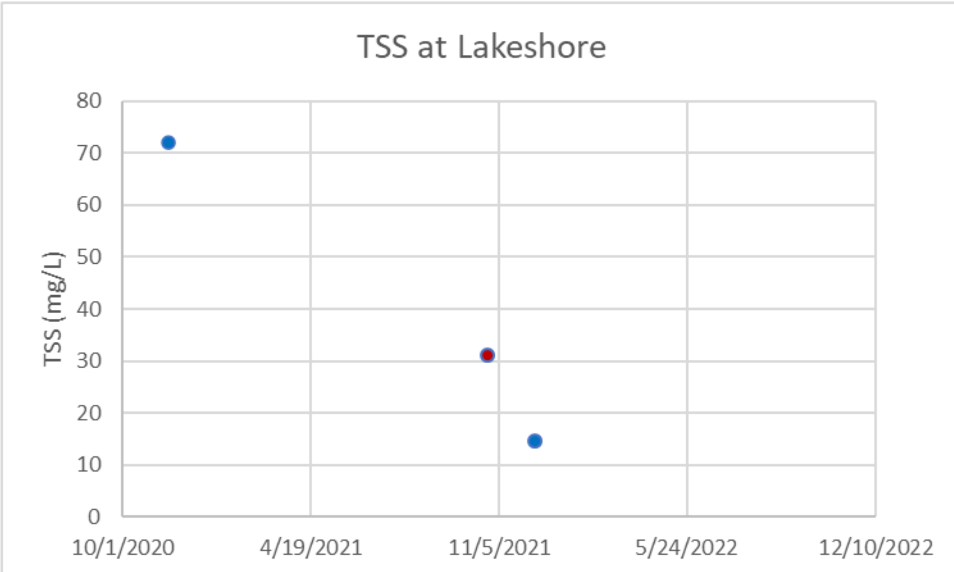


*Figure A37: Total suspended solid concentrations at Lakeshore for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

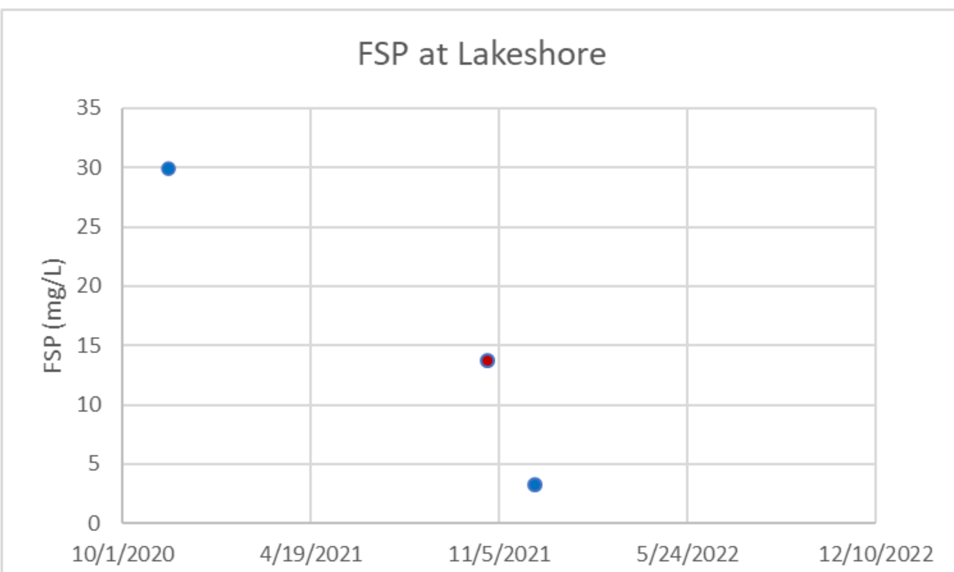


*Figure A38: Fine sediment particle concentrations at Lakeshore for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

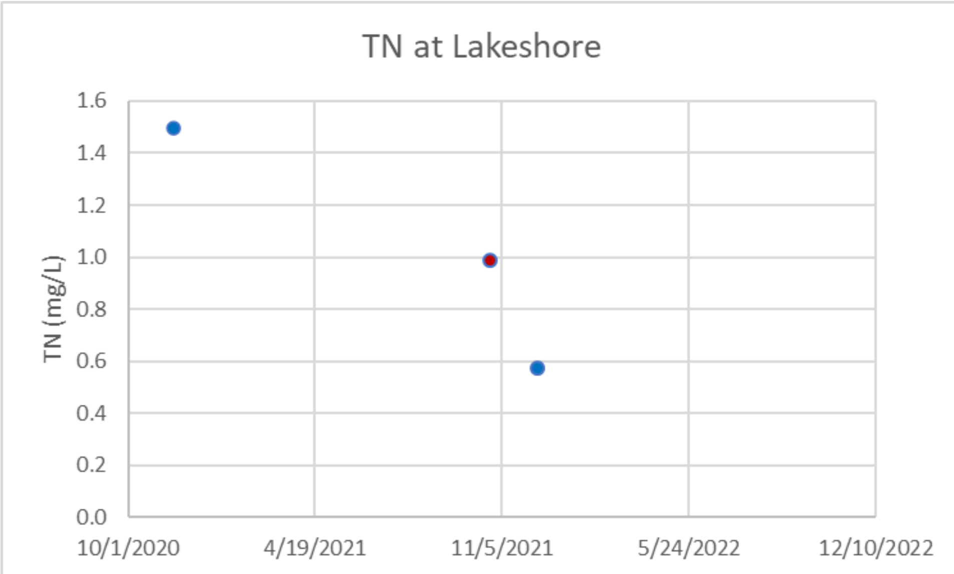


*Figure A39: Total nitrogen concentrations at Lakeshore for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

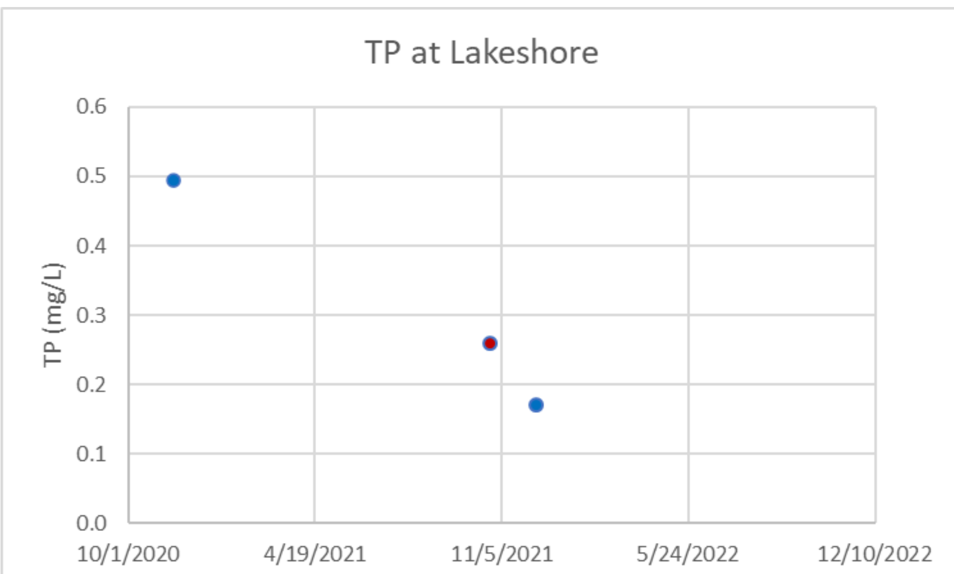


*Figure A40: Total phosphorous concentrations at Lakeshore for all sampled events in water years 2021 and 2022. Red circles indicate priority samples included in this study.*

# Appendix B

## Tahoma

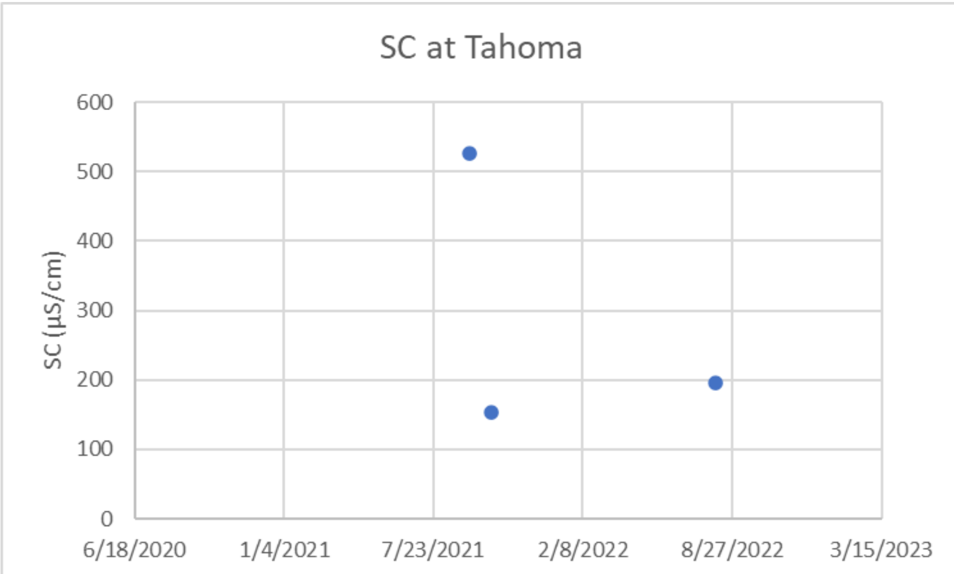


*Figure B1: Specific conductance at Tahoma for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), and August 5, 2022 (one year later).*

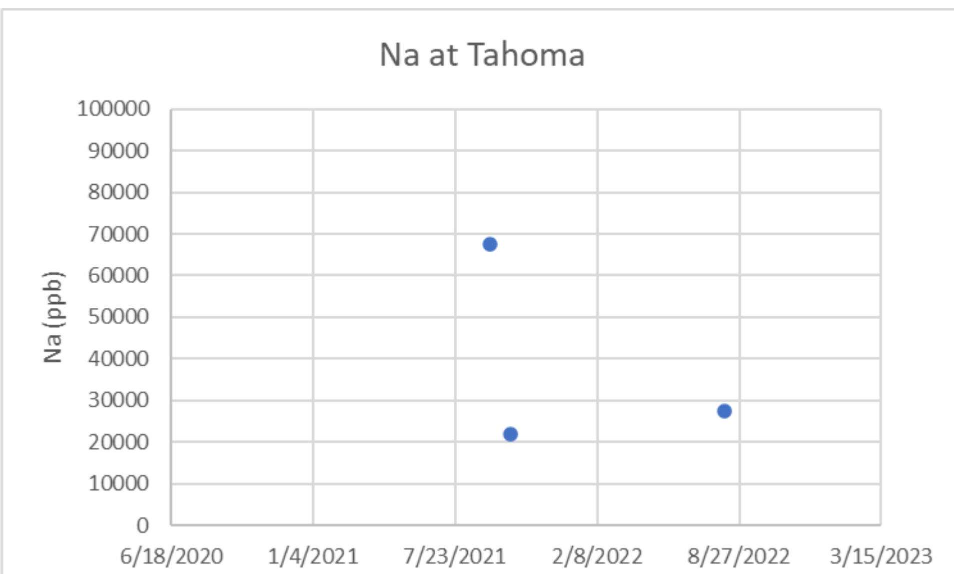


*Figure B2: Sodium concentration at Tahoma for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), and August 5, 2022 (one year later).*

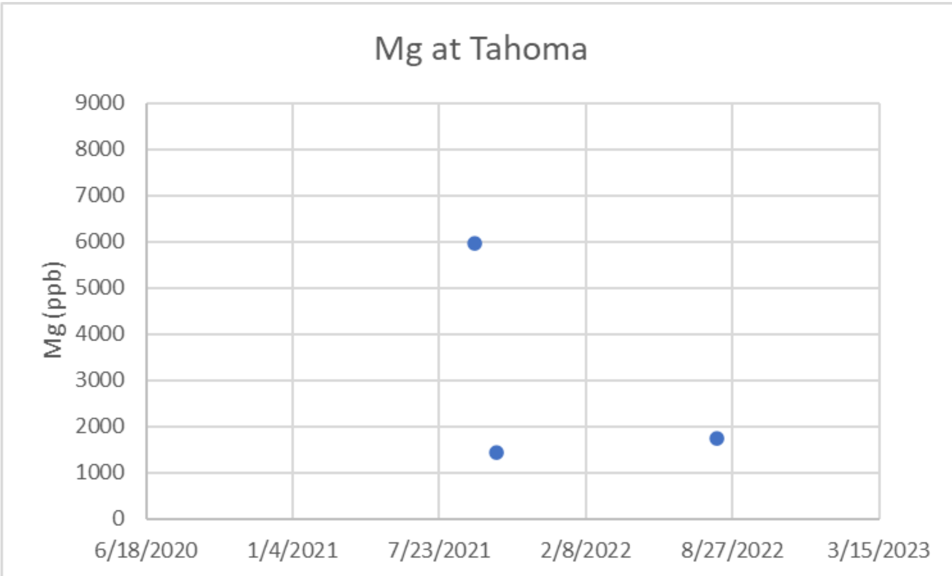


*Figure B3: Magnesium concentration at Tahoma for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), and August 5, 2022 (one year later).*

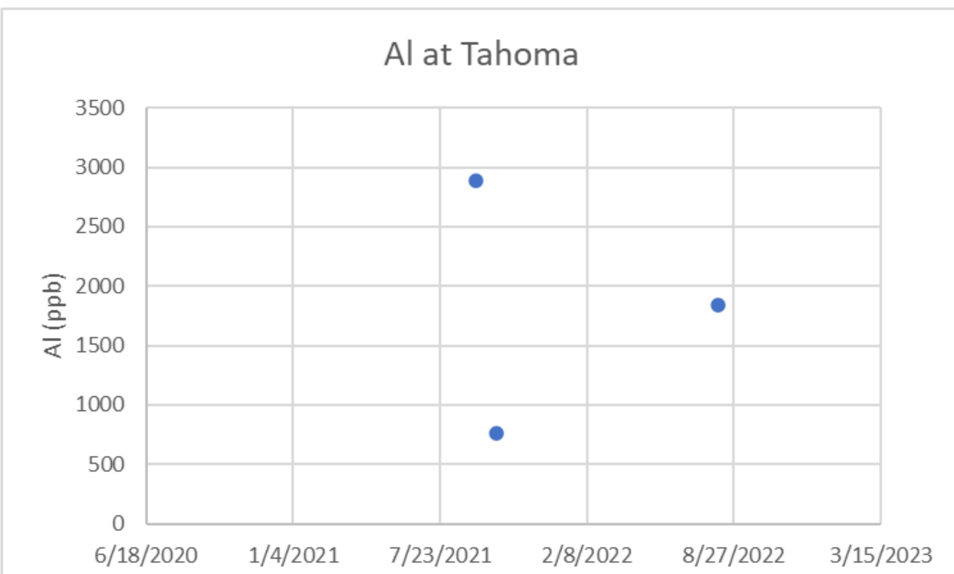


*Figure B4: Aluminum concentration at Tahoma for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), and August 5, 2022 (one year later).*

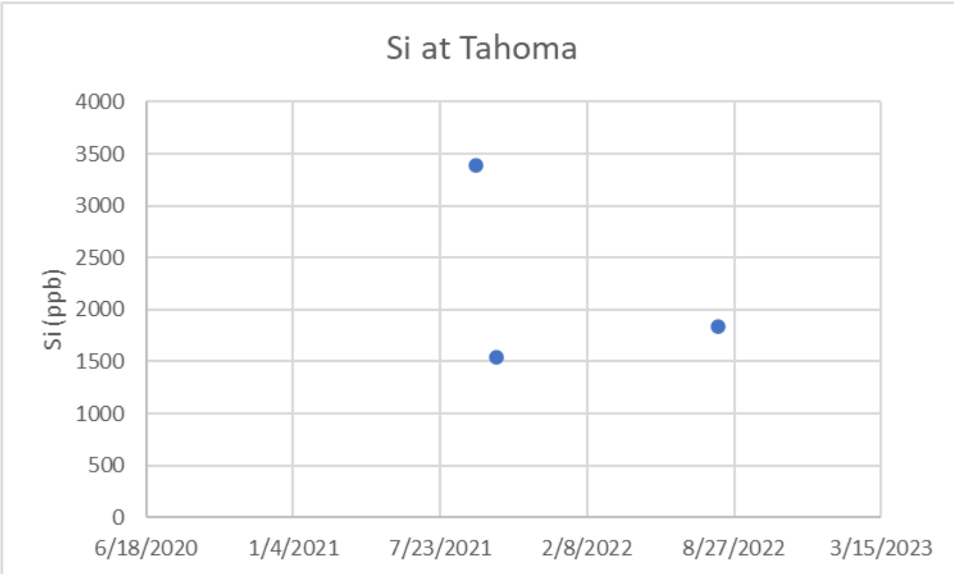


*Figure B5: Silica concentration at Tahoma for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), and August 5, 2022 (one year later).*

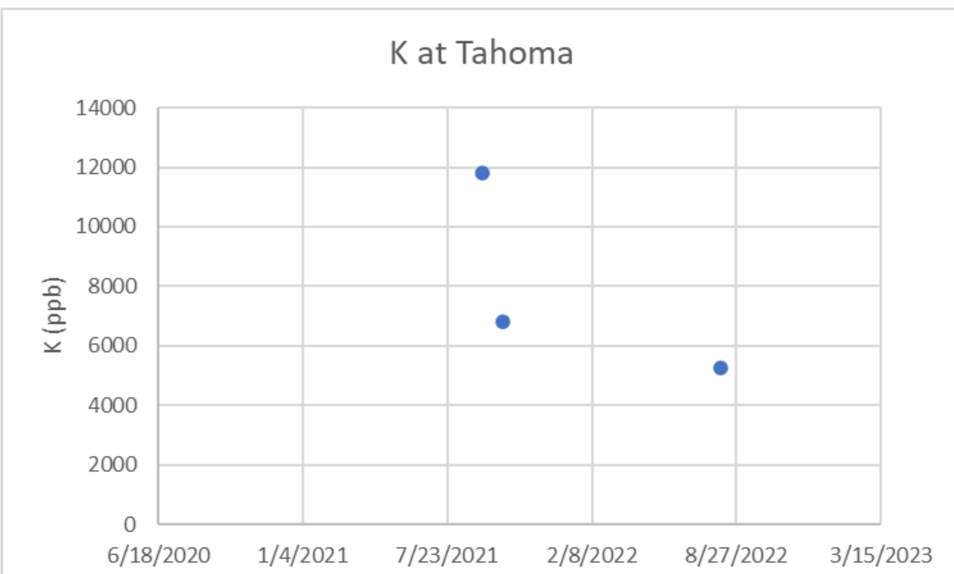


*Figure B6: Potassium concentration at Tahoma for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), and August 5, 2022 (one year later).*

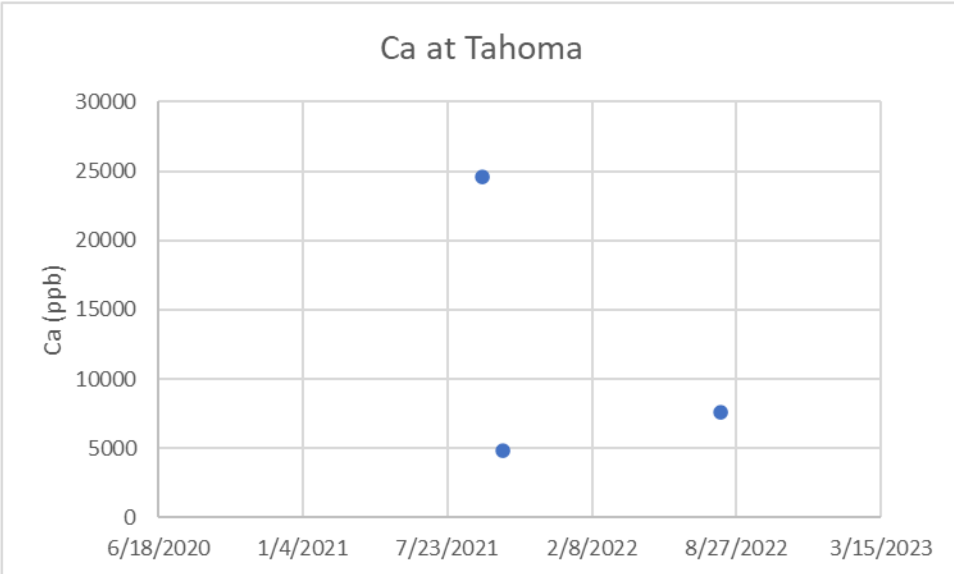


*Figure B7: Calcium concentration at Tahoma for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), and August 5, 2022 (one year later).*

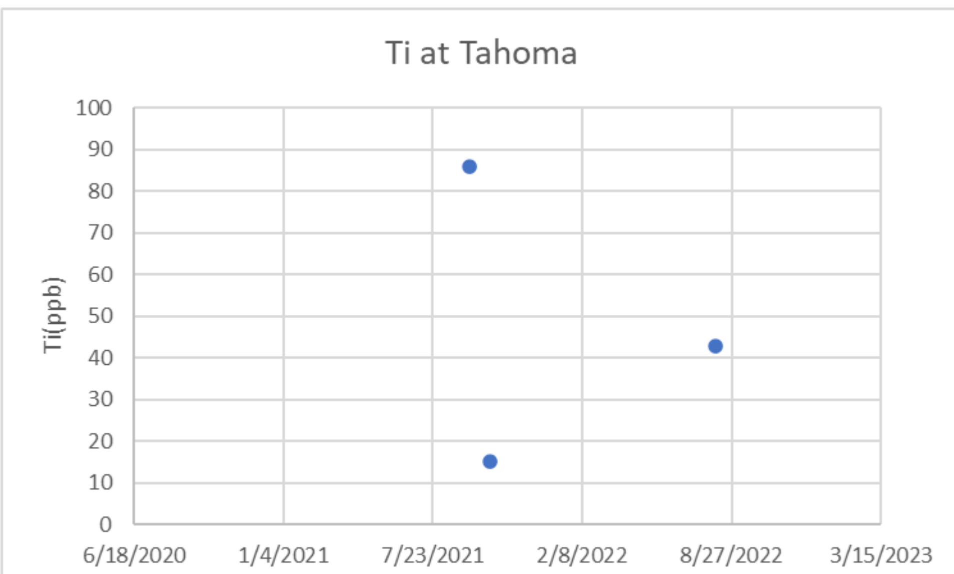


*Figure B8: Titanium concentration at Tahoma for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), and August 5, 2022 (one year later).*

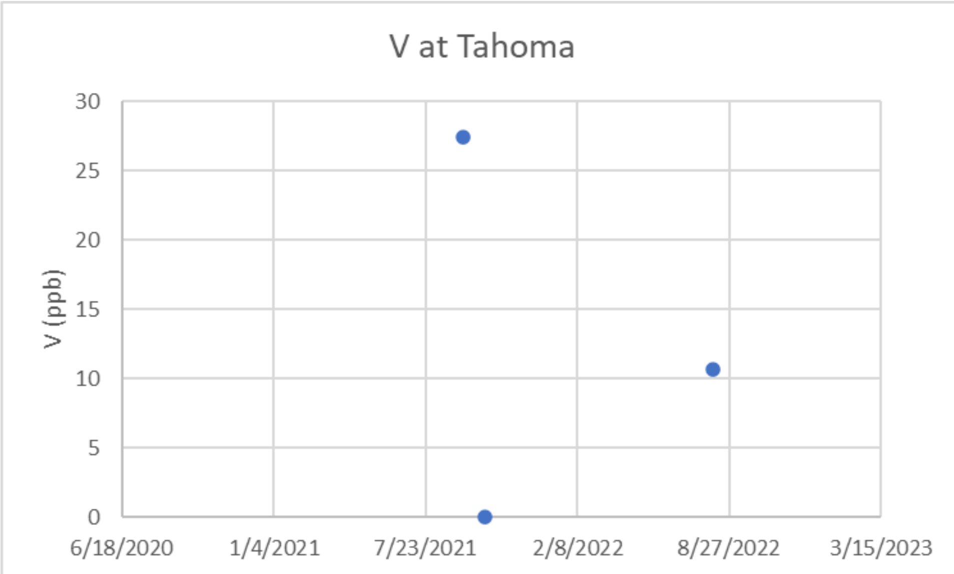


*Figure B9: Vanadium concentration at Tahoma for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), and August 5, 2022 (one year later).*

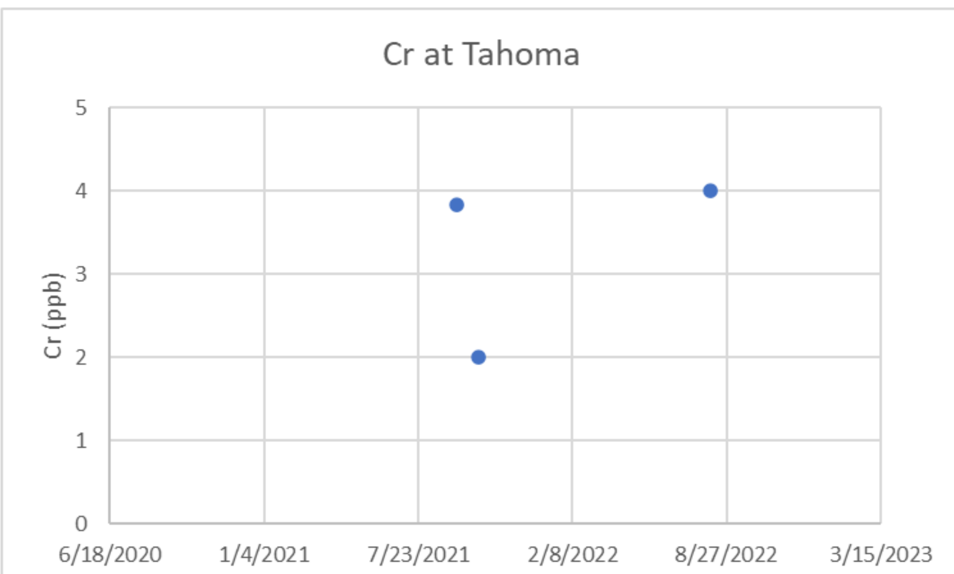


*Figure B10: Chromium concentration at Tahoma for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), and August 5, 2022 (one year later).*

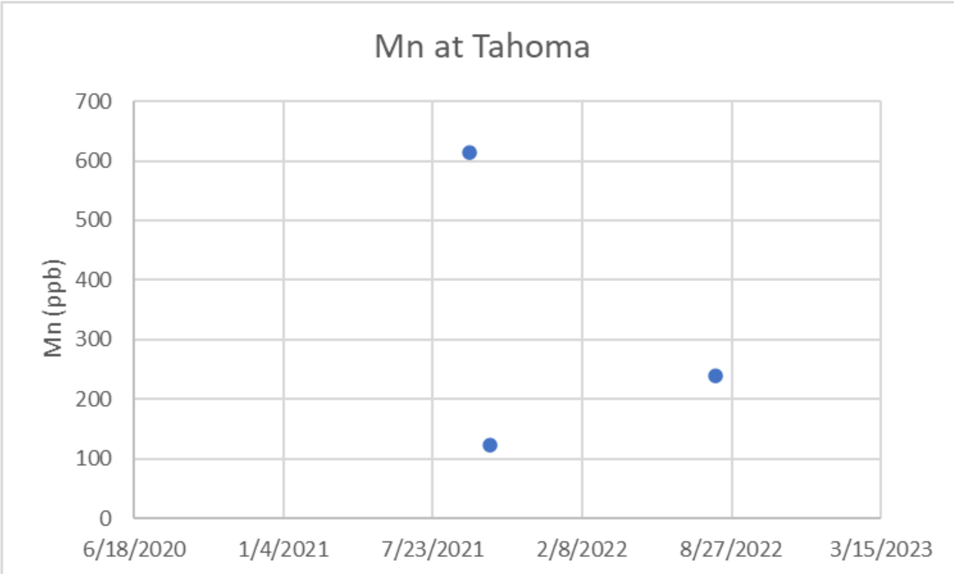


*Figure B11: Manganese concentration at Tahoma for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), and August 5, 2022 (one year later).*

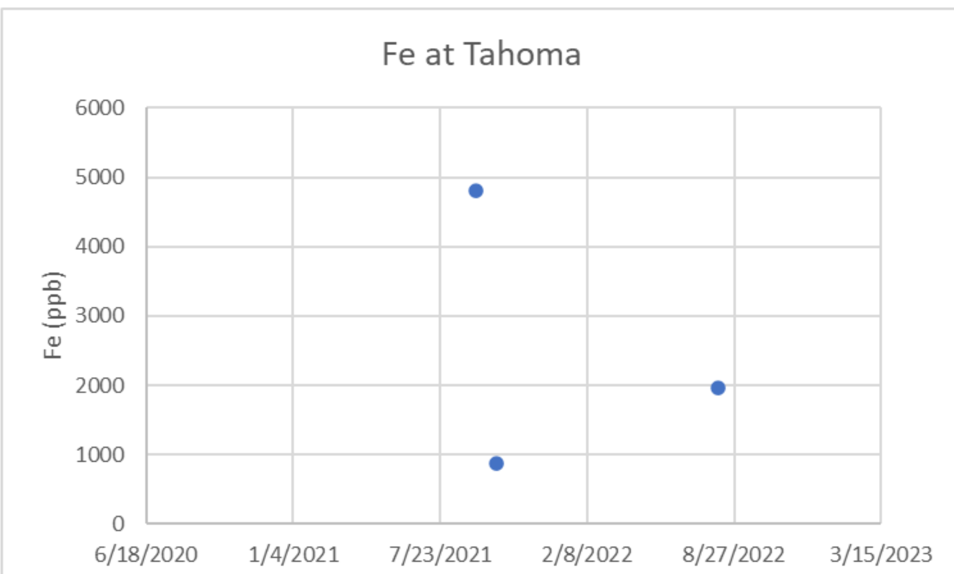


*Figure B12: Iron concentration at Tahoma for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), and August 5, 2022 (one year later).*

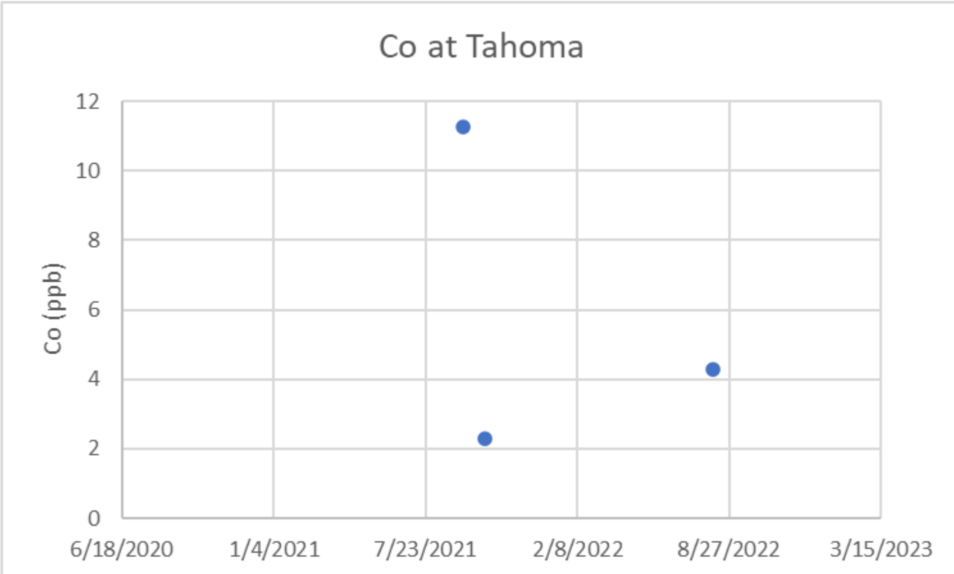


*Figure B13: Cobalt concentration at Tahoma for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), and August 5, 2022 (one year later).*

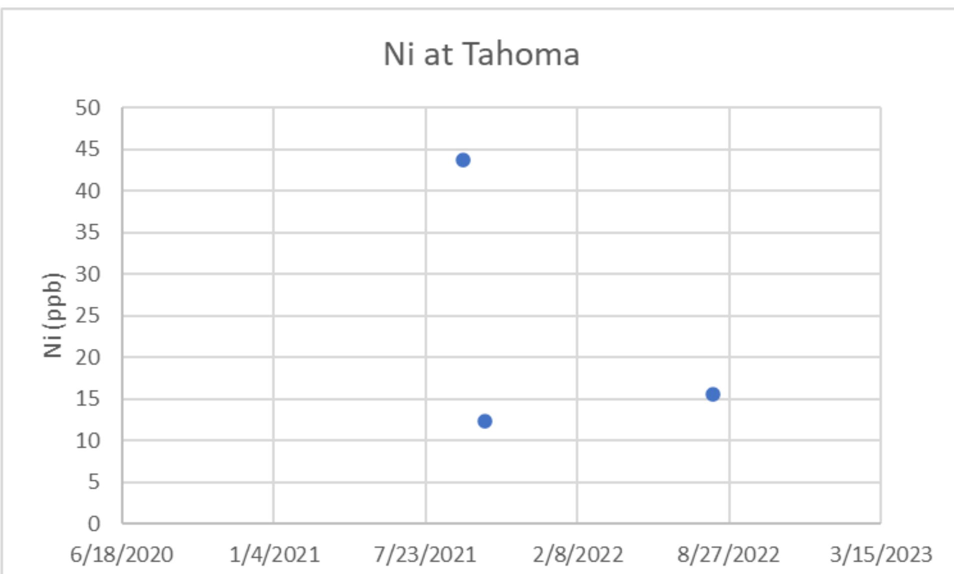


*Figure B14: Nickel concentration at Tahoma for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), and August 5, 2022 (one year later).*

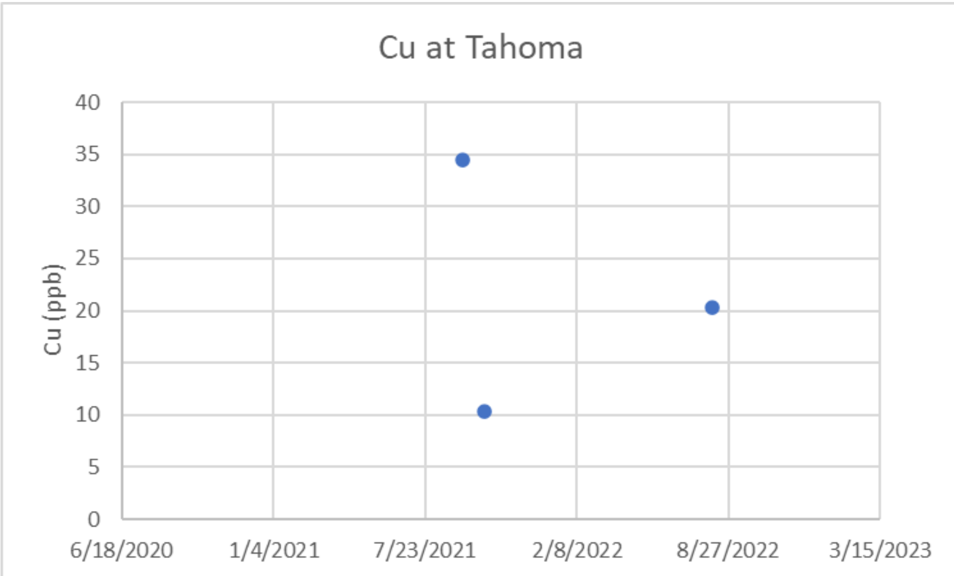


*Figure B15: Copper concentration at Tahoma for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), and August 5, 2022 (one year later).*

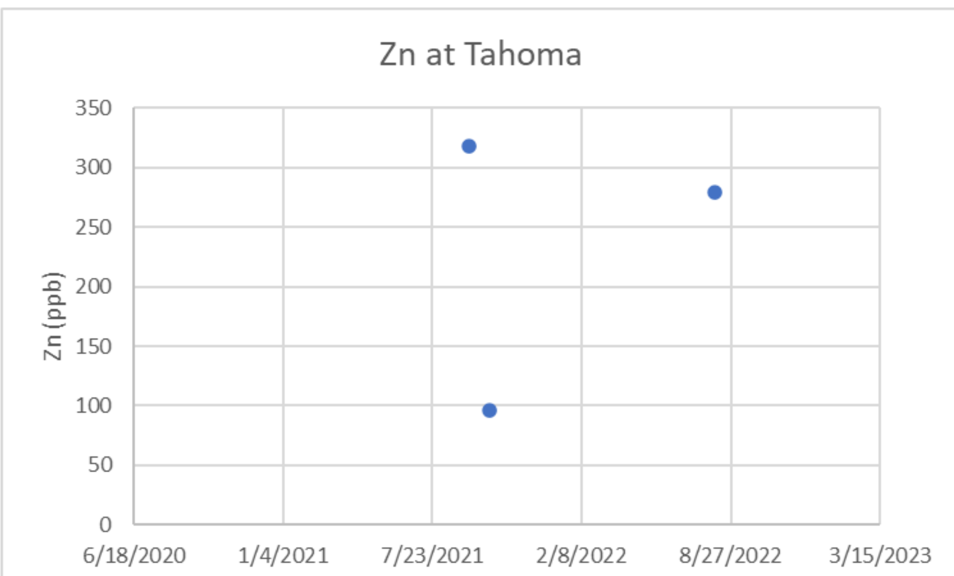


*Figure B16: Zinc concentration at Tahoma for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), and August 5, 2022 (one year later).*

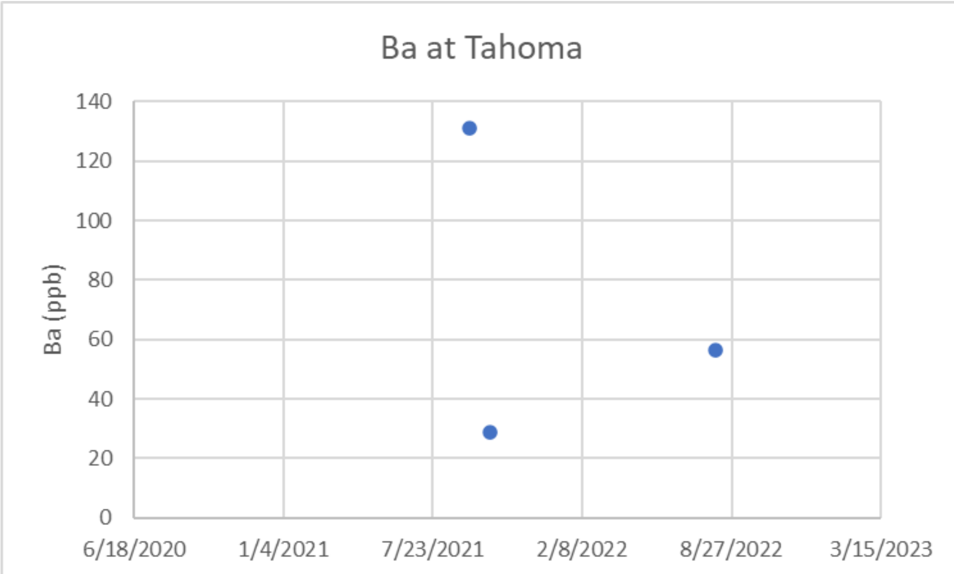


*Figure B17: Barium concentration at Tahoma for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), and August 5, 2022 (one year later).*

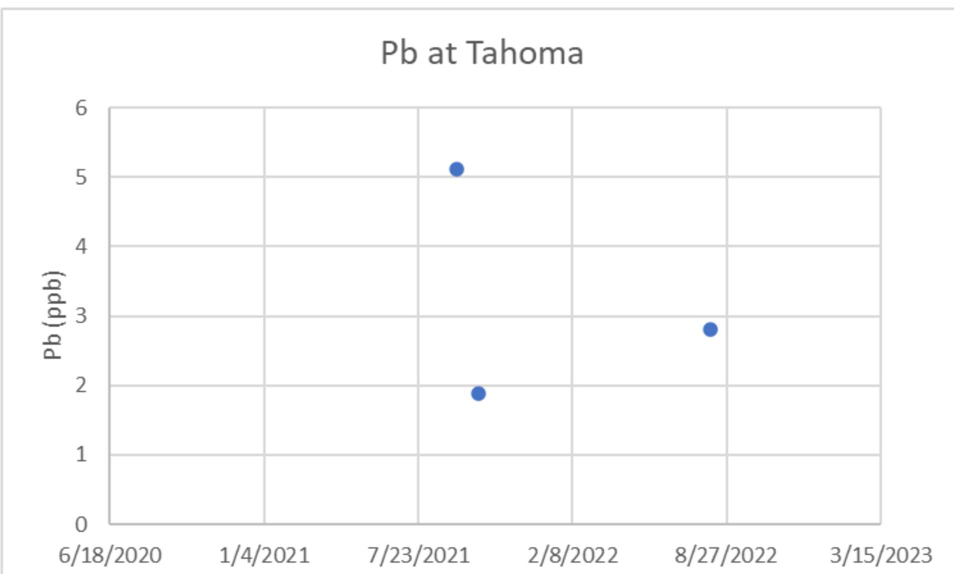


*Figure B18: Lead concentration at Tahoma for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), and August 5, 2022 (one year later).*

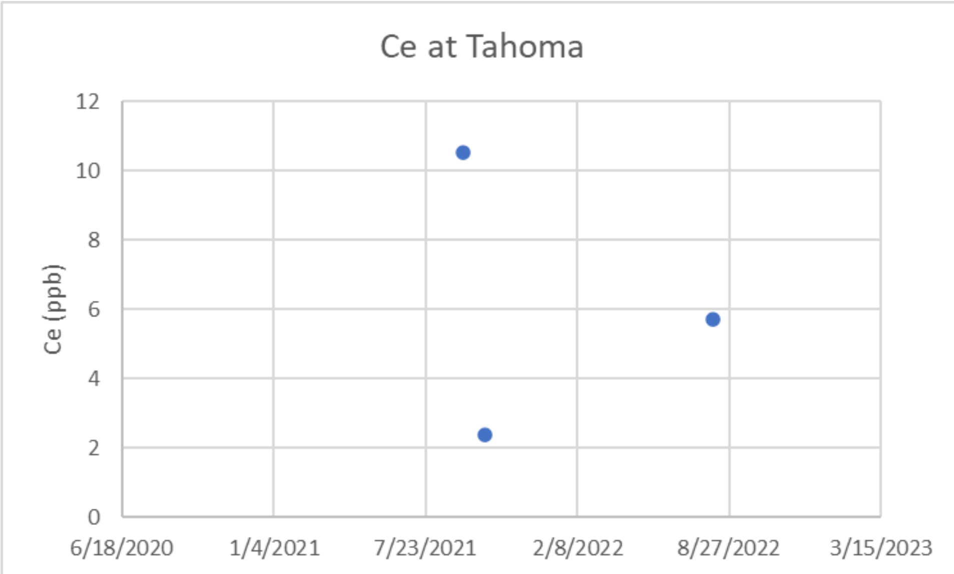


*Figure B19: Cerium concentration at Tahoma for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), and August 5, 2022 (one year later).*

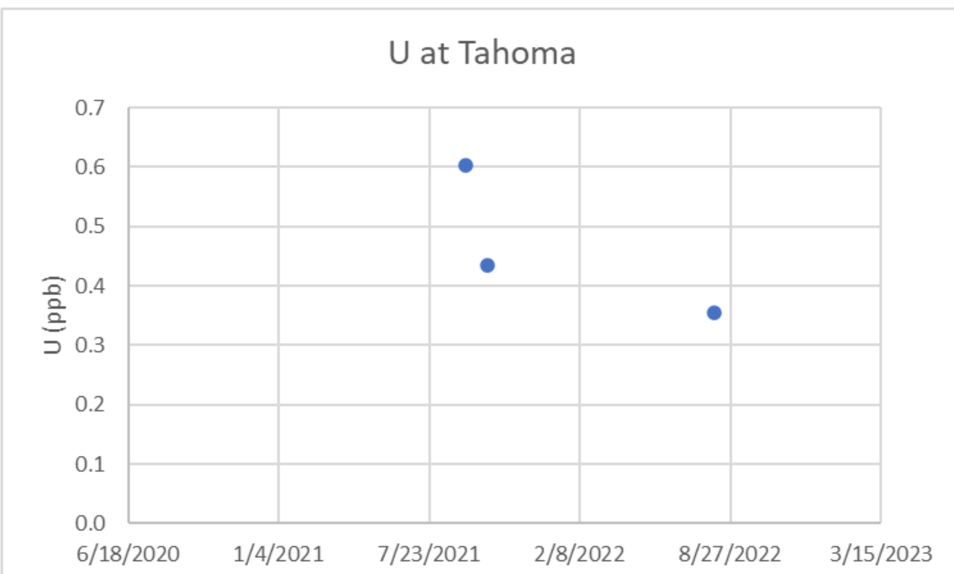


*Figure B20: Uranium concentration at Tahoma for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), and August 5, 2022 (one year later).*

## Tahoe City

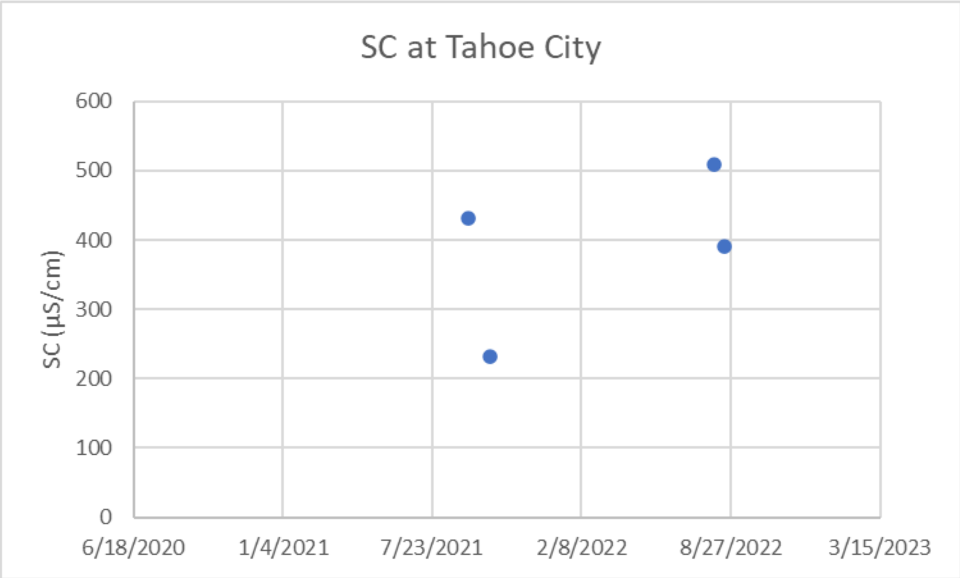


*Figure B21: Specific conductance at Tahoe City for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), August 5, 2022 (one year later), and August 17, 2022 (one year later).*

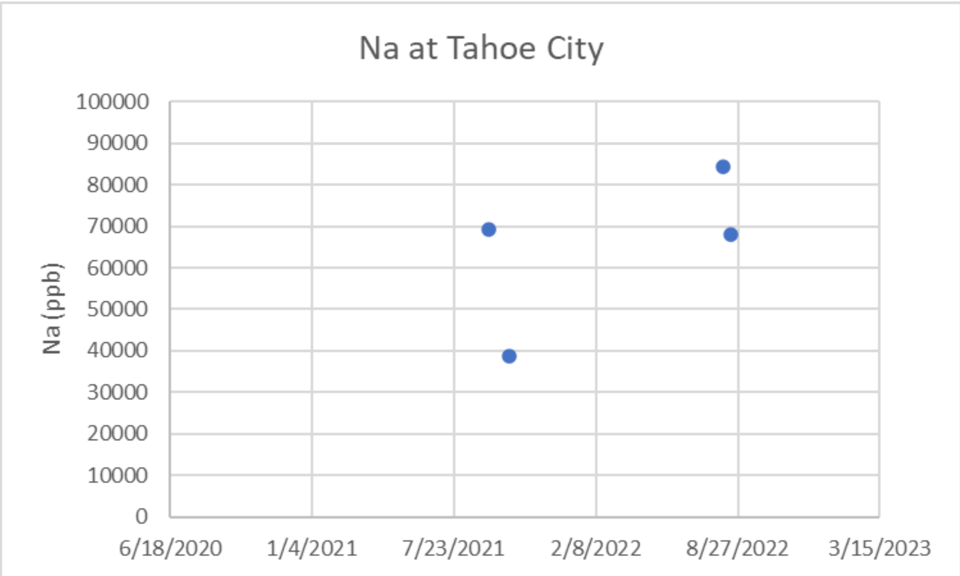


*Figure B22: Sodium concentration at Tahoe City for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), August 5, 2022 (one year later), and August 17, 2022 (one year later).*

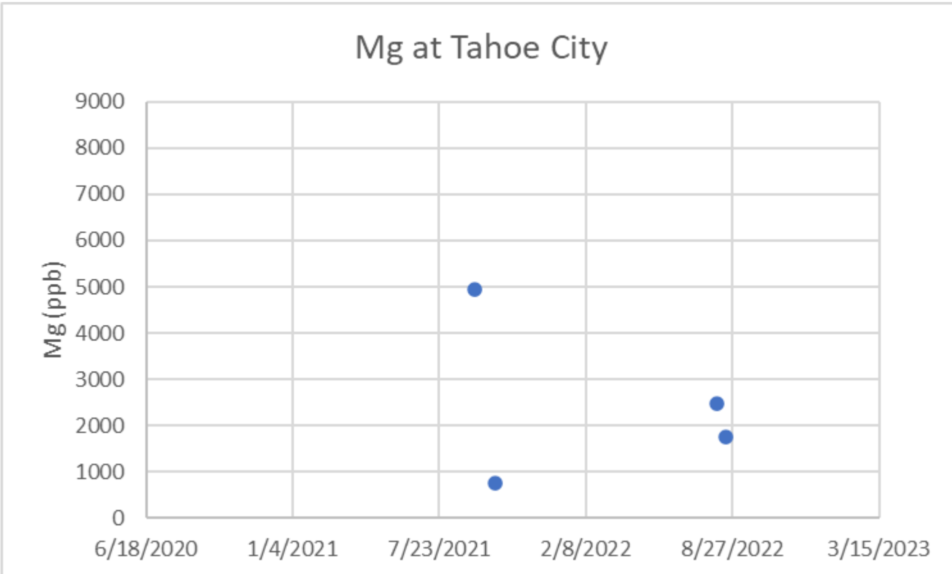


*Figure B23: Magnesium concentration at Tahoe City for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), August 5, 2022 (one year later), and August 17, 2022 (one year later).*

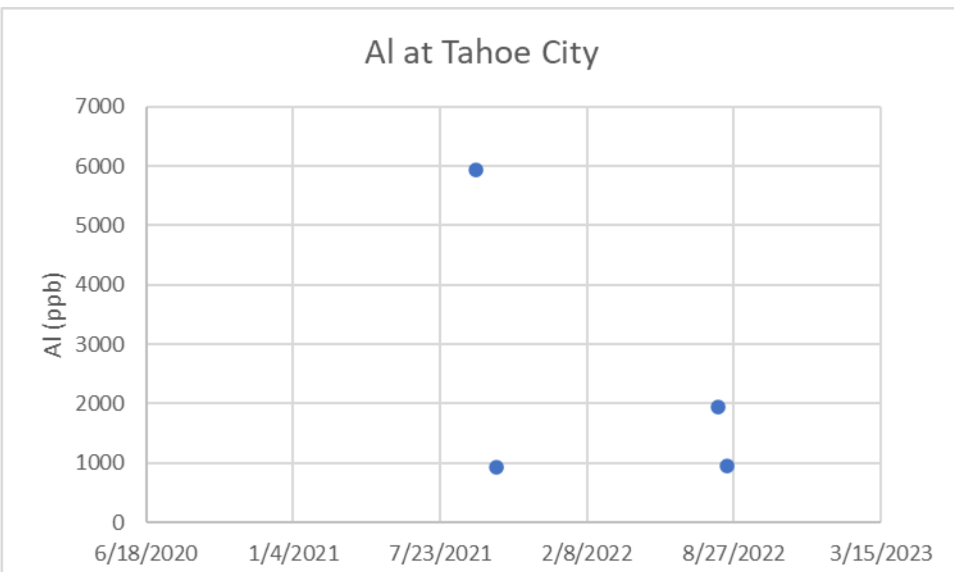


*Figure B24: Aluminum concentration at Tahoe City for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), August 5, 2022 (one year later), and August 17, 2022 (one year later).*

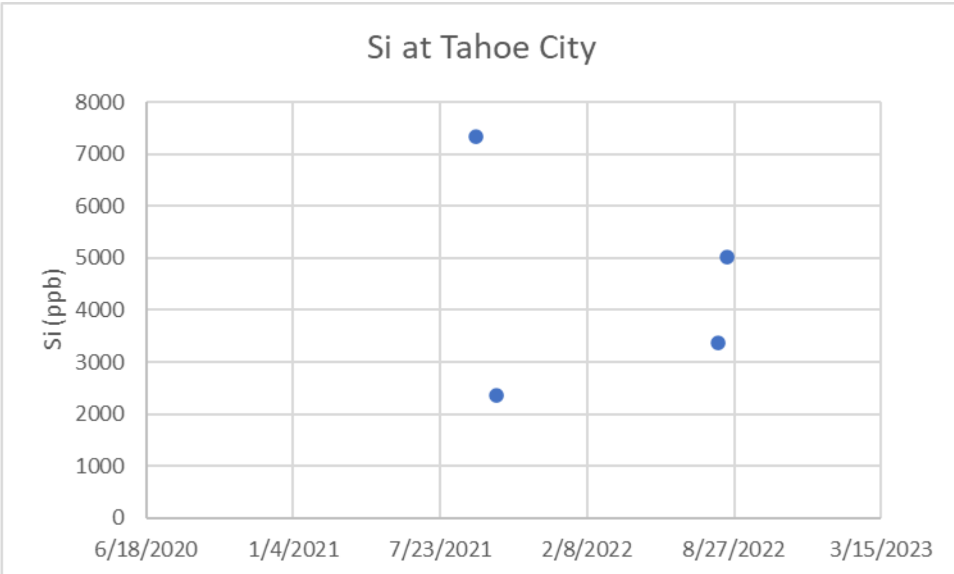


*Figure B25: Silica concentration at Tahoe City for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), August 5, 2022 (one year later), and August 17, 2022 (one year later).*

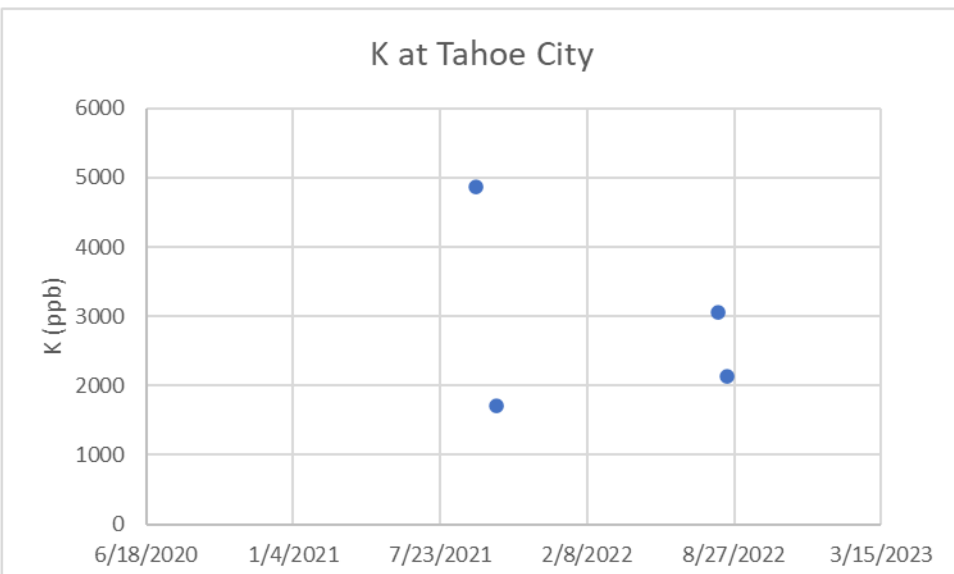


*Figure B26: Potassium concentration at Tahoe City for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), August 5, 2022 (one year later), and August 17, 2022 (one year later).*

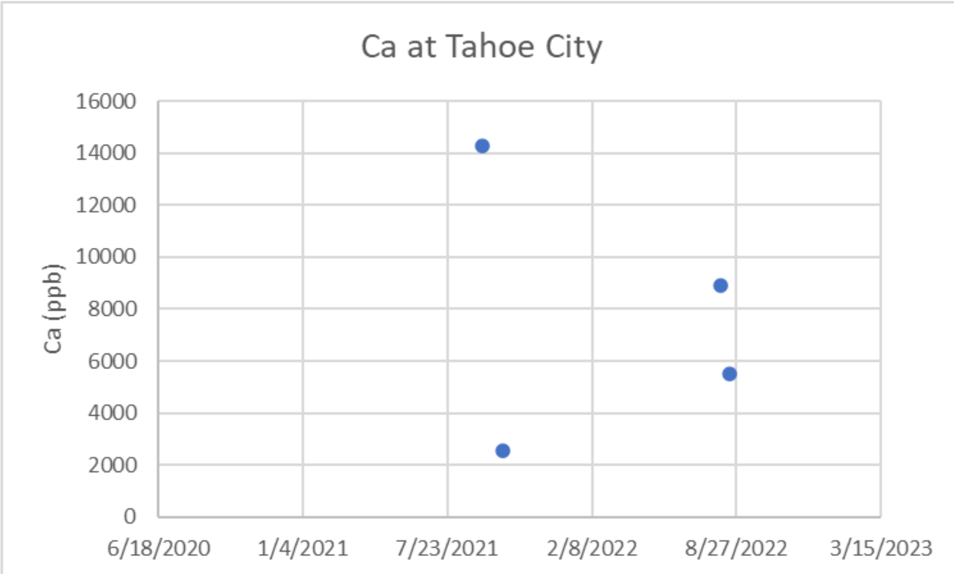


*Figure B27: Calcium concentration at Tahoe City for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), August 5, 2022 (one year later), and August 17, 2022 (one year later).*

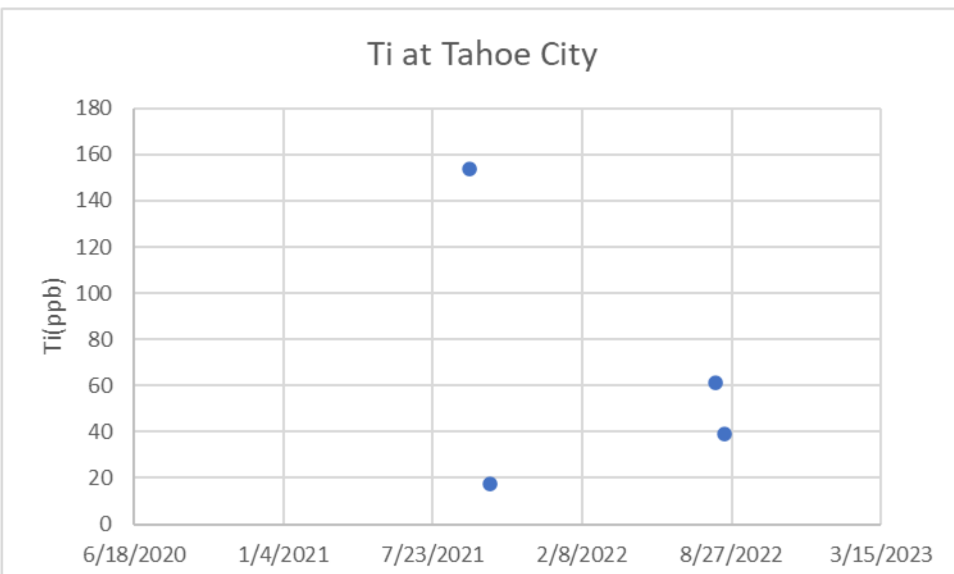


*Figure B28: Titanium concentration at Tahoe City for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), August 5, 2022 (one year later), and August 17, 2022 (one year later).*

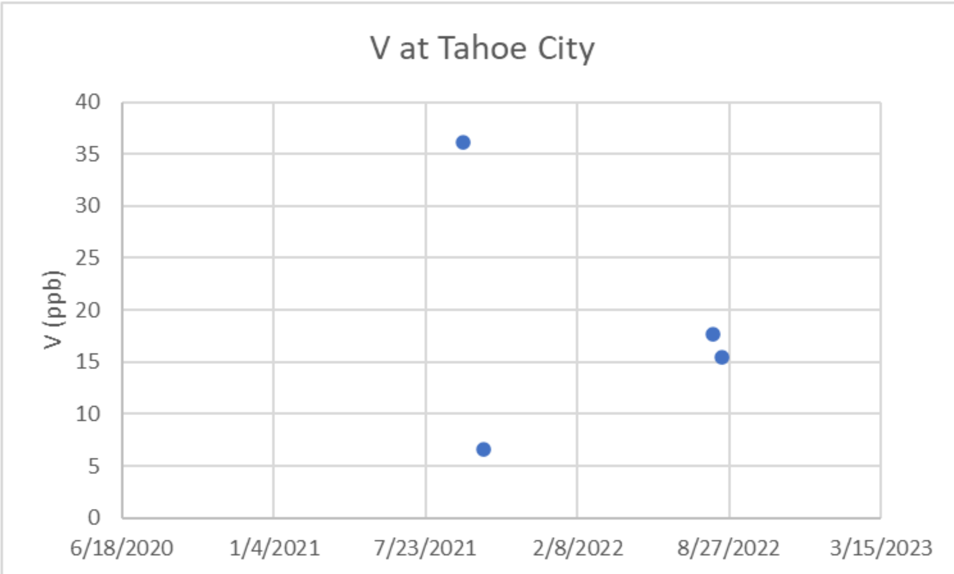


*Figure B29: Vanadium concentration at Tahoe City for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), August 5, 2022 (one year later), and August 17, 2022 (one year later).*

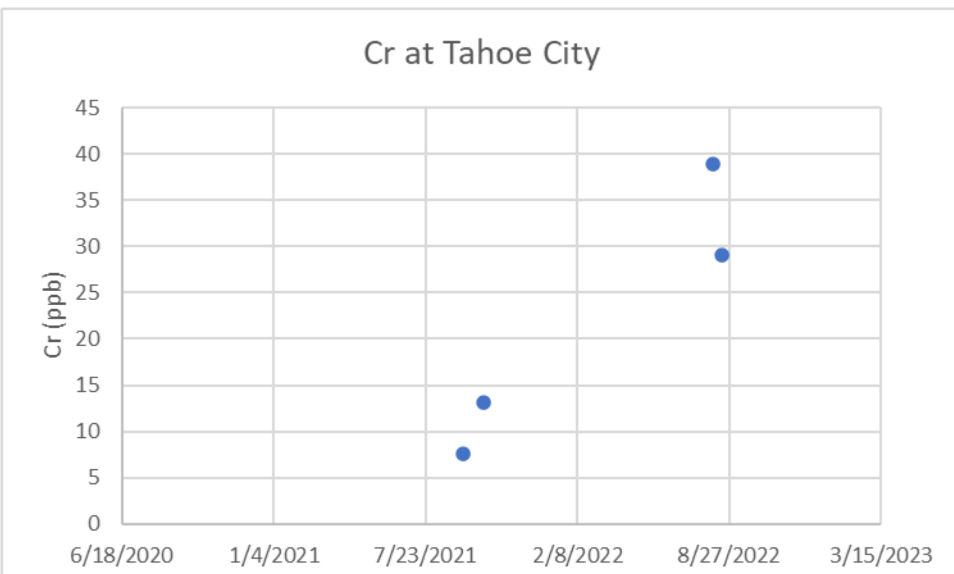


*Figure B30: Chromium concentration at Tahoe City for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), August 5, 2022 (one year later), and August 17, 2022 (one year later).*

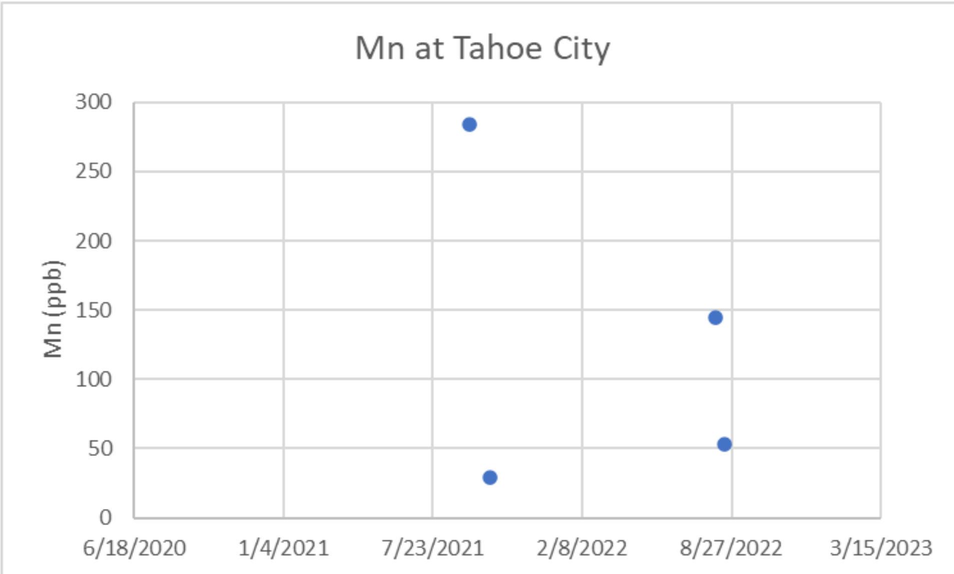


*Figure B31: Manganese concentration at Tahoe City for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), August 5, 2022 (one year later), and August 17, 2022 (one year later).*

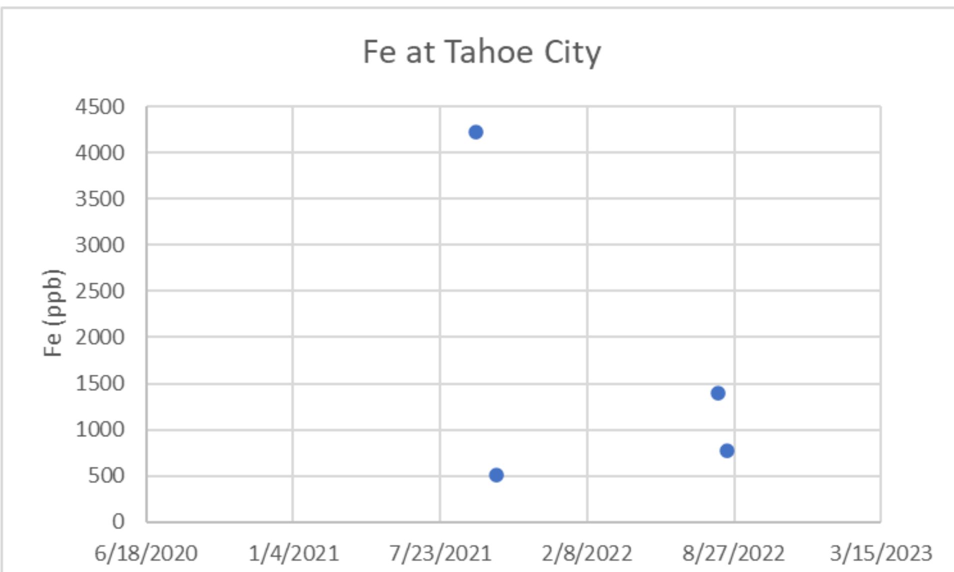


*Figure B32: Iron concentration at Tahoe City for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), August 5, 2022 (one year later), and August 17, 2022 (one year later).*

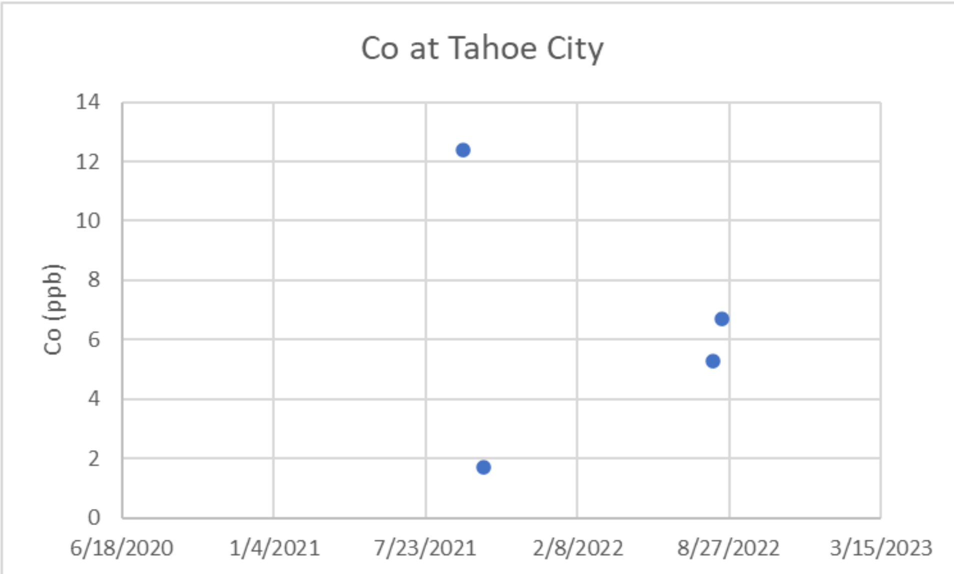


*Figure B33: Cobalt concentration at Tahoe City for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), August 5, 2022 (one year later), and August 17, 2022 (one year later).*

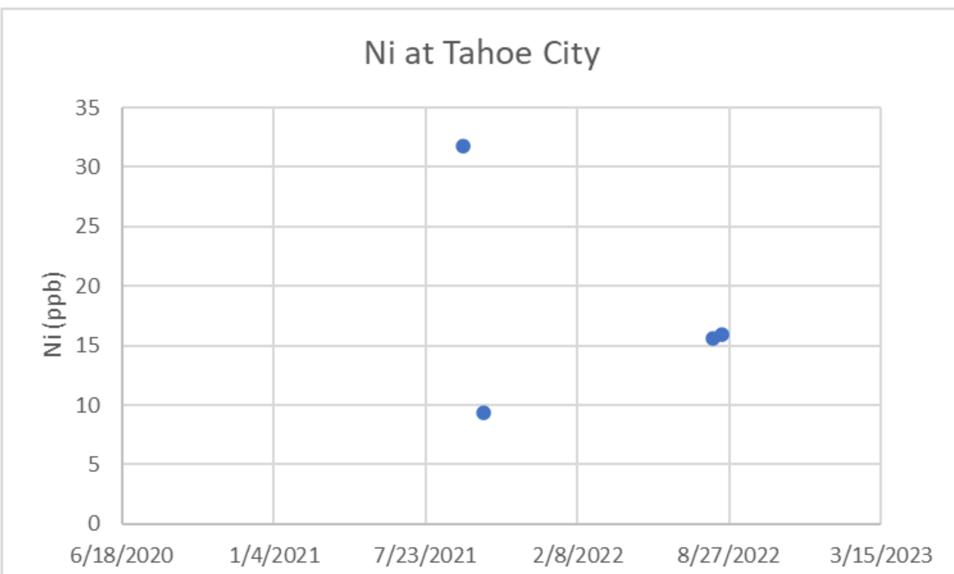


*Figure B34: Nickel concentration at Tahoe City for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), August 5, 2022 (one year later), and August 17, 2022 (one year later).*

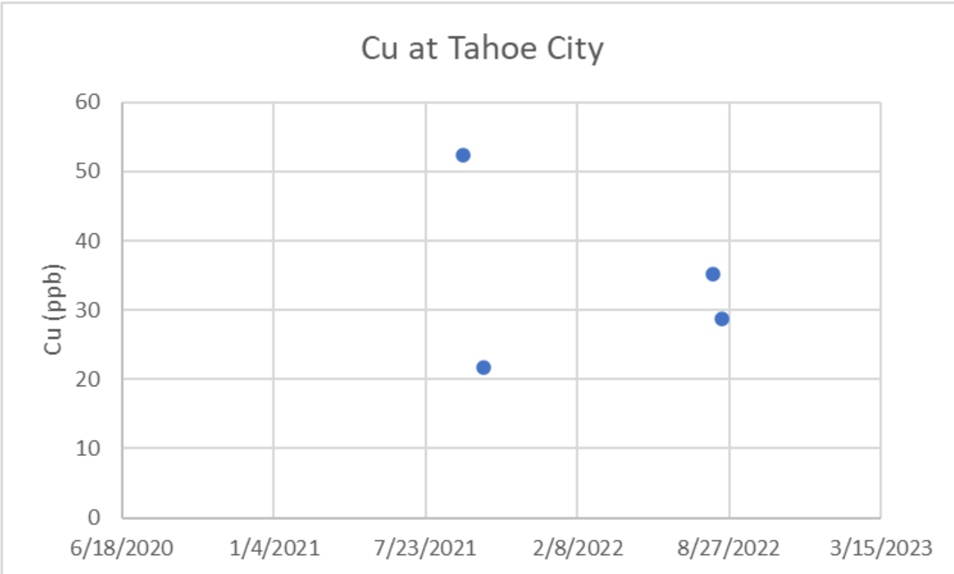


*Figure B35: Copper concentration at Tahoe City for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), August 5, 2022 (one year later), and August 17, 2022 (one year later).*

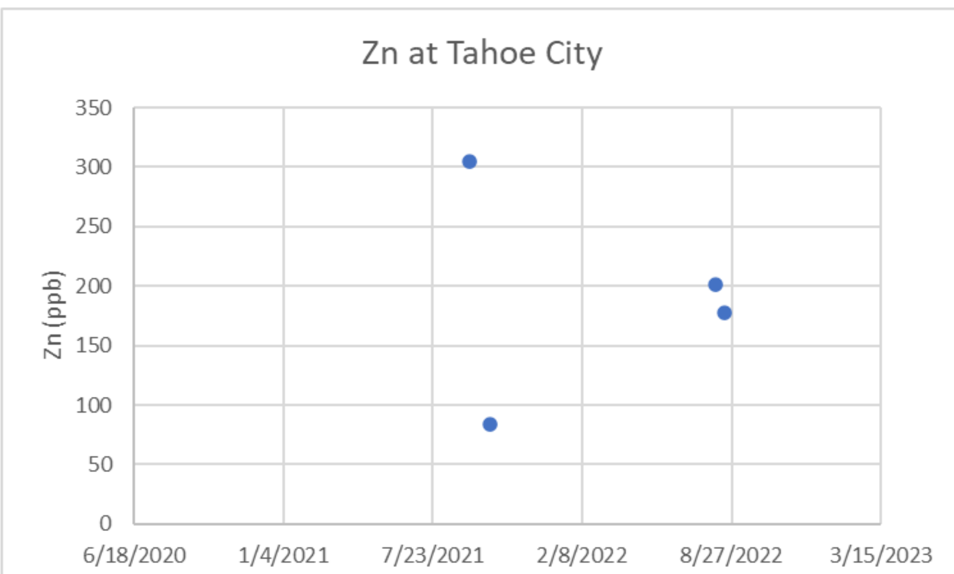


*Figure B36: Zinc concentration at Tahoe City for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), August 5, 2022 (one year later), and August 17, 2022 (one year later).*

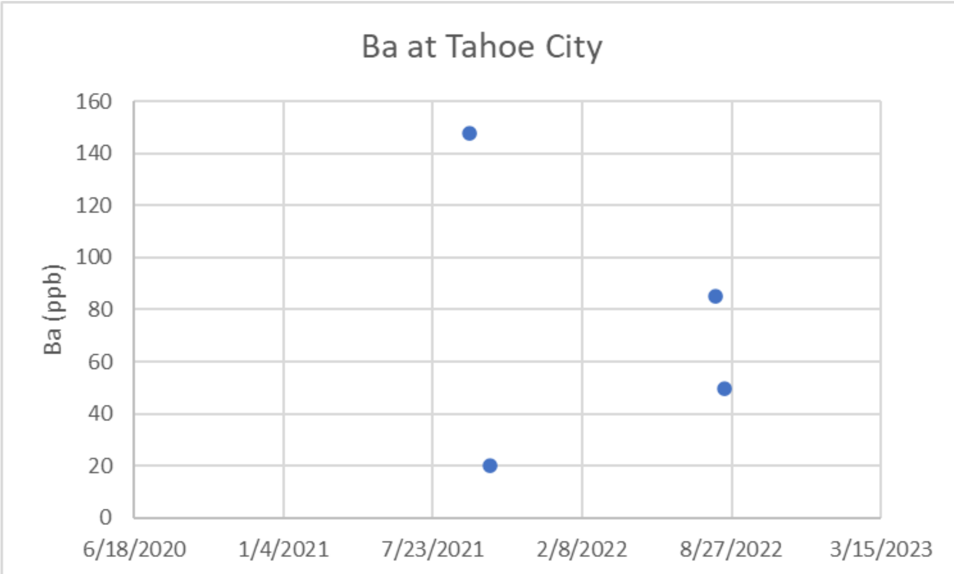


*Figure B37: Barium concentration at Tahoe City for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), August 5, 2022 (one year later), and August 17, 2022 (one year later).*

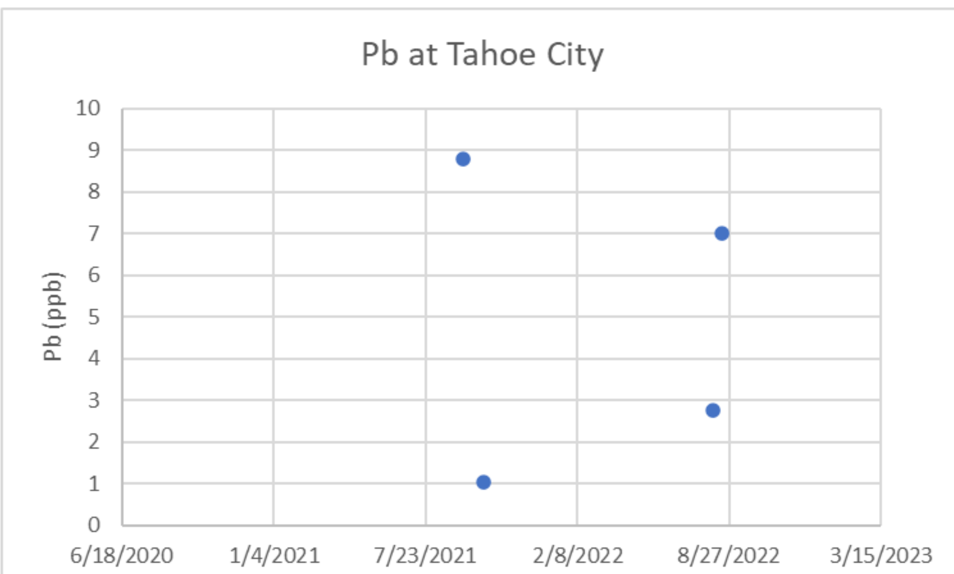


*Figure B38: Lead at Tahoe City for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), August 5, 2022 (one year later), and August 17, 2022 (one year later).*

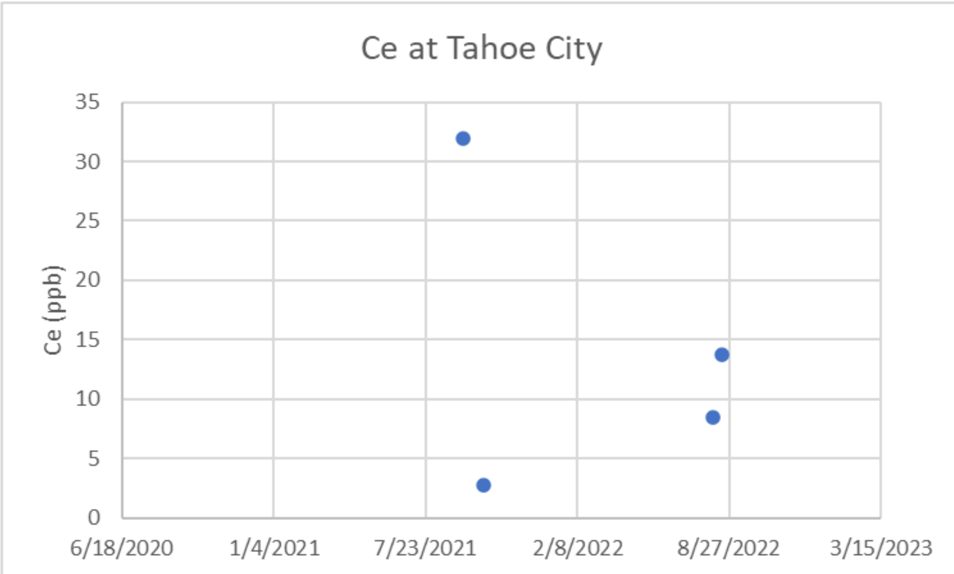


*Figure B39: Cerium at Tahoe City for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), August 5, 2022 (one year later), and August 17, 2022 (one year later).*

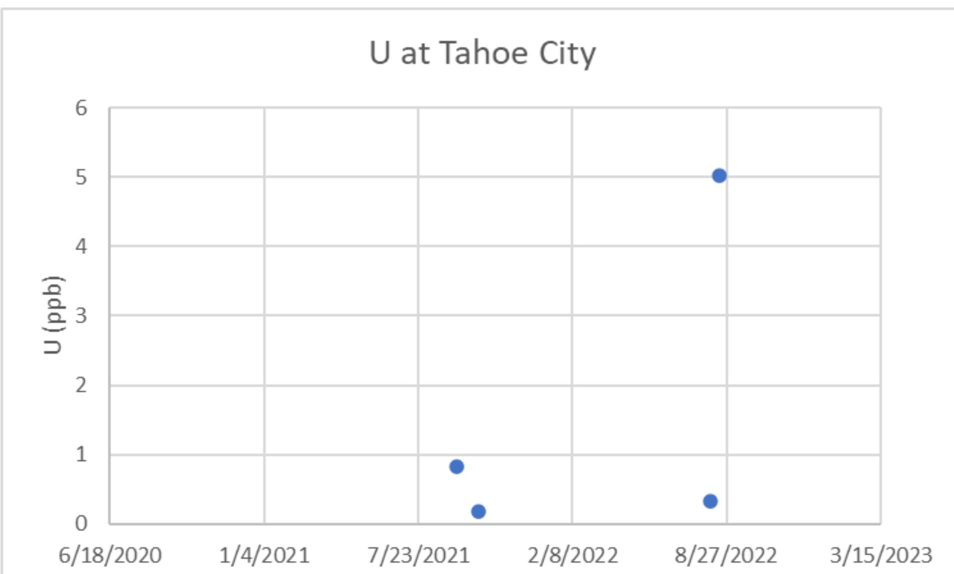


*Figure B40: Uranium concentration at Tahoe City for the events from this site included in the study. Samples were taken September 9, 2021 (during fire), October 8, 2021 (during fire), August 5, 2022 (one year later), and August 17, 2022 (one year later).*