Final Report
416 Fire Aquatic Monitoring, Year 3
WSRF Grant - POGGI PDAA


One year post-fire


Two years post-fire


Three years post-fire

April 2022

Prepared for: Colorado Water Conservation Board
Prepared by: Mountain Studies Institute

Publication Date: April 2022
Cover Photo Credit: Scott Roberts, Mandy Eskelson
Authors: Roberts, Scott[1]; Eskelson, Mandy[1]; Farwell, Haley[1]; Rust, Ashley[2]; Hogue, Terri[2]
[1] Mountain Studies Institute, Durango, CO
[2]Colorado School of Mines, Golden, CO

Table of Contents

Background 1

Summary 1

Objectives & Tasks 1

Accomplishments 2

Summary of Analysis 4

Budget Accounting 7

Appendix A: Map of monitoring locations........

Appendix B. Hydrograph of the Animas River at Rotary Park (1912-2021) ....

Appendix C. Mountain Studies Institute's post-416 summary infographic ....

Appendix D. Preliminary water quality results: descriptive statistics........

Appendix E. Preliminary water quality results: percent change in average concentration from pre-fire to post-fire periods ....

Appendix F. Preliminary water quality results: plots of select analytes depicting average concentration during pre-fire, post-fire 2018, 2019, 2020, and 2021........

Appendix G. Preliminary water quality results: compared to Colorado Department of Public Health & Environment water quality standards........

Appendix H. Preliminary post-fire physical habitat graphs ....

Appendix I. Preliminary benthic macroinvertebrate tissue metal concentrations ....

Appendix J. Preliminary benthic macroinvertebrate community composition plots ....

Background

During the summer of 2018, the 416 Fire burned over 54,000 acres in the Hermosa Creek drainage within the Animas River watershed (HUC 14080104), impacting local and downstream communities. The fire and smoke negatively impacted livelihoods, homeowners, and tourism. Several subsequent runoff events and debris flows occurred within the 416 Fire burn area, creating concern in southwest Colorado communities about the resulting impacts to water quality and aquatic life. Ash and sediment delivered from the burn area have been evident in changes in color, discharge, turbidity, and reports of fish kills in Hermosa Creek and the Animas River. Additionally, irrigators and ditch companies were impacted from sediment and debris flows that inhibited their ability to access and convey their water allocations.

Summary

Scientists from Mountain Studies Institute (MSI), Colorado School of Mines (CSM), and USFS Rocky Mountain Research Station (RMRS) formed a partnership called the 416 Fire Aquatic Monitoring Research Group to investigate the water quality and aquatic life impacts from the 416 Fire. These research efforts were supported by Colorado Water Conservation Board (CWCB) in 2019 and 2020, through the Water Supply Reserve Fund. Preliminary studies in 2018 captured the immediate impacts from the fire in Hermosa Creek and the Animas River, and the Research Group's continued sampling and analysis in 2019, 2020, and 2021 have allowed water users and providers to better understand how post-fire impacts have persisted during watershed recovery. Currently, the state of Colorado suggests rivers generally recover from wildfire impacts after five years. The Research Group is fortunate to have an abundance of pre-fire water quality and benthic macroinvertebrate data that provide a strong foundation for assessing impacts and recovery from the fire. Sharing the data and results of this study with agencies, research entities, and the public will provide additional evidence to determine if the state of Colorado's recovery timeline is reasonable.

Tracking local wildfire effects and recovery in the Animas River watershed offers benefits on a regional and state level as well. Both the CWCB and Southwest Basin Roundtable (SWBRT) Basin Implementation Plan (BIP) outline goals for watershed monitoring and recovery. For example, the BIP identified goals to monitor, protect, and improve water quality for all classified uses (F1) and maintain watershed health by protecting and/or restoring watersheds that could affect critical infrastructure and/or environmental and recreational areas (A5). This project's post-fire monitoring and sharing of results contributes to the BIP desired outcomes to monitor and protect water quality as well as support, "watershed/wildfire assessments that identify strategies/treatments necessary to mitigate impacts that occur to hydrology in a post-fire environment."

Objectives & Tasks

The Research Group employs a variety of activities to monitor and assess post-fire impacts. We use instrumentation, field surveys, and samples of surface water and benthic macroinvertebrates (BMIs, aquatic insects) to evaluate physical, biological, and chemical changes from the 416 Fire across spatial (different locations) and temporal scales (immediate vs. long-term). For example, results from instruments and collected water samples capture water quality conditions at a specific time, while evaluating the habitat and population of BMIs can serve as a longer-term biological indicator of water quality and riparian conditions.

When interpreting impacts to water quality and aquatic life, the Research Group also considers the context of existing watershed traits such as geology and hydrology, seasonal and annual variations, historical observations, and risks to designated water uses in the watershed. This helps us understand if post-fire conditions are unprecedented, pose risks to different water users or aquatic life, assess the duration of impacts, and track watershed recovery across multiple lines of evidence.

The primary objectives of this research are:

- Evaluate water quality impacts to Hermosa Creek and the Animas River from the 416 Fire in context of the use of these waters for irrigation, water supply, recreation, and aquatic life.

- Establish monitoring sites on Hermosa Creek and Junction Creek to serve as watershed comparisons in the future relating differing forest health, fire history, and forest health treatments.

- Document the recovery of water quality and aquatic life following the 416 Fire to share with communities, agencies, and researchers to further our understanding of the recovery of river condition after wildfire.

CWCB-funded tasks of this work include:

1) Water Quality Sampling and Analysis
2) Benthic Macroinvertebrate Analysis
3) Analysis, Reporting, Outreach

We have successfully completed all CWCB-funded tasks. This report serves to provide a summary of accomplishments related to the activities funded by CWCB in our third year of 416 Fire Aquatic Monitoring as well as to share monitoring results thus far. We hope to share subsequent technical reports with CWCB in the future.

Accomplishments

Task 1 - Water Quality Sampling

In 2021, MSI collected regular and opportunistic water quality samples from three locations; two locations downstream of the burn area and one location that was unaffected by the fire (Appendix A). We collected monthly samples from April through October of 2021. In addition to monthly samples, we collected opportunistic samples to characterize conditions during key hydrological events, such as the rising limb of spring runoff, and storm events that mobilized sediment and ash from the burn area into stream drainages. Capturing conditions during storm events required adequate preparation of sampling kits, readily available field staff, and monitoring of weather forecasts and radar.

In sum, we collected a total of 30 regular and opportunistic storm event water quality samples in 2021 to be analyzed for nutrients, dissolved organic carbon, suspended sediment, and metals. Water quality samples were analyzed by Green Analytical Laboratories, Colorado School of Mines, and Rocky Mountain Research Station.

Task 2 - Benthic Macroinvertebrate Assessment

To assess impacts and recovery of aquatic life following fire, we collected benthic macroinvertebrate (BMI) community samples at eighteen sites affected and unaffected by the 416 Fire (Appendix A). For a subset of seven sites, we collected samples of benthic tissue to analyze for potential bioaccumulating metal concentrations. In addition, we conducted physical habitat surveys at fifteen sites to evaluate changes to aquatic habitat including substrate composition and algae abundance. BMI tissue samples were submitted to ACZ Laboratories for metal analysis.

Task 3 - Analysis, Reporting, Outreach:

MSI is sharing analytical results and interpretation via several approaches and platforms to reach a variety of audiences including outreach materials, online resources, presentations, outdoor lessons, and social media posts. This work provided important information to a diverse set of water users and decision makers including ditch companies, irrigators, drinking water suppliers, emergency management, government agencies, river-oriented recreational businesses, and resource managers. A better understanding of river recovery helps inform land management agencies as to whether watershed health is recovering on its own or if intervening restoration projects may be necessary. On a local level, organizations use the information and results from this research in a variety of ways applicable to their needs. For example, the City of Durango utilized monitoring results to make educated operational decisions to provide clean drinking water to citizens and visitors. Colorado Parks & Wildlife rely on our observations of benthic macroinvertebrates community condition to improve fishery management. Organizations such as the Community Foundation and Five Rivers Chapter of Trout Unlimited recognize monitoring results keep stakeholders informed about river health and aware of actions that may be necessary for water users. The following are examples of recent outreach efforts we've employed:

- **Post-416 Fire aquatic monitoring summary flyer**
  MSI created a summary of our research tracking aquatic impacts and recovery following the 416 Fire, featuring an original illustration by staff member Artemis Eyster (Appendix C).

- **416 Fire Storymap**
  MSI will continue to update an online StoryMap to convey current post-fire condition of forests, water quality, and aquatic life to the public available here. This education tool allows MSI and its partners to discuss post-fire research efforts as well as the interactions between forest health, wildfires, and water supplies to help enhance understanding of these complex issues, track watershed recovery, assist communities in developing mitigation strategies to protect natural resources, and help prepare for future disturbances.

- **Our Animas Storymap**
  Additional partner outreach of post-416 Fire observations from 2018 were included in the collaborative publication, *Our Animas*, developed by the Animas River Community Forum (ARCF). This document is available in print form and in an online Story Map to ARCF partners and the public at www.animasrivercommunity.org/our-animas. The second edition, available summer of 2022, will include updates on post-416 Fire monitoring to ensure both community members and visitors alike can learn about post-wildfire impacts in the broader context of the Animas River watershed.

- **Public and student presentations**
  MSI, CSM, and RMRS researchers provided several presentations on the post-fire recovery of water quality and aquatic life to the following community groups and organizations: San Juan Watershed Group, Animas Valley Grange, Animas River Community Forum, local chapters of Trout Unlimited (Dolores and 5 Rivers), Fort Lewis College guest lectures (departments of Biology, Environmental Studies, and Geosciences), and the public Forest and Fire Learning Series in Durango, CO.

- **Peer reviewed publication**
  Findings from this research have been published in the Science of The Total Environment journal, contributing to the global and regional understanding of post-wildfire impacts on streams and aquatic life. To read the full article entitled "Forest fire mobilization and uptake of metals by biota temporarily exacerbates impacts of legacy mining" at https://doi.org/10.1016/j.scitotenv.2022.155034.

- **Graphs, charts, and tables to be used in future outreach**
  Appendices B-J contain graphs, charts, and tables that will be used for additional outreach and reporting efforts to relay research findings to partners, the public, and our community.

Summary of Analysis

We compared 2021 results to pre- and post-fire observations with the intention of assessing the impacts from the fire as well as the trajectory of recovery across the post-fire period from 2018-2021. We previously reported signs of post-fire recovery in 2019 and 2020. A focus of our 2021 analysis was to examine whether a recovery trend continued in 2021, three years after the 416 Fire.

Water Quality:

We documented elevated levels of potential contaminants following the 416 Fire, with possibly unprecedented levels in the Durango reach of the Animas River for some metals (e.g., aluminum, manganese, iron, and mercury). For most parameters, the highest observed levels occurred in 2018 during storm events immediately after the fire.

A main objective for post-fire monitoring in 2021 was to evaluate whether evidence of recovery noted in 2019-20 continued through 2021. Our data demonstrate that many water quality parameters, especially those that had substantially elevated concentrations immediately after the fire (e.g., total aluminum, total iron, total lead, etc.), decreased incrementally from 2018 to 2019 to 2020 to 2021, indicating a recovery trajectory toward pre-fire conditions (see Appendices C-F).

At our Hermosa Creek monitoring site downstream of the burn area, some water quality parameters appear to have returned to closer pre-fire conditions (e.g., ammonia; calcium; copper; hardness; magnesium; nitrate/nitrite; and zinc) while other parameters were still elevated above pre-fire conditions (e.g., total aluminum; total iron; total manganese; total phosphorus; and total suspended solids). In 2021, three years after the fire, the degree to which parameters were still elevated above pre-fire conditions was reduced compared to previous post-fire years.

We present results in context of water quality standards to evaluate risks to designated water uses for agriculture, domestic water supply, and aquatic life. Fortunately, even with observed elevated or even unprecedented concentrations after the 416 Fire, our results show very few analytes that exceeded water quality standards frequently enough to be of concern or are becoming less of a concern over time as recovery occurs. Fewer water quality standard exceedances occurred with each year following the fire. For example, levels of aluminum, iron, and mercury in Hermosa Creek below the burn area were high enough to be of concern for chronic risk to aquatic life in 2018 immediately following the fire, but by 2021 iron and mercury concentrations were no longer a concern. In 2021, the remaining analytes of concern at sites downstream of the burn area were for chronic aquatic life standards of aluminum (Hermosa and Animas at Rotary) and iron (Animas at Rotary).

Aquatic Habitat:

During physical habitat surveys, we measure substrate size distribution and embeddedness, which is a quantification of how much substrate surface area is covered or sunken into the silt, sand, or mud of the stream bottom. This measurement allows us to assess the type of habitat that is available to BMIs and fish to shelter, feed, and reproduce. In the initial year following the 416 Fire, we demonstrated substantial changes to the stream bottom habitat of Hermosa Creek, transitioning from cobble-dominated with abundant algae prior to the fire (2016) to higher abundance of sand and fines substrate and decreased algae after the fire (2018-19). In 2021, burned tributaries and sites downstream of the burn scar, have stream bottoms that are generally returning back to pre-fire substrate compositions with a higher abundance of pebbles and cobbles; decreased percentage of fines, sands, gravel; and a reduction in embedded substrate (Appendix H). This is evident at the “Big Bend Creek - middle” site where the proportion of the substrate comprised of fine and sand sized substrate decreased from 79% in 2019 to 13% in 2021. We documented an increase in algae coverage of substrate at many sites (e.g., Clear Creek), which at least in part could be attributable to post-fire increases in surface water nutrients and increased solar radiation from reduced riparian canopy cover. However, we also observed an increase in algae at some reference sites (e.g., Junction Creek), that would not have been directly affected by the fire. This pattern may be reflective of the region-wide frequent drought conditions in recent years with warmer temperature and reduced stream flows leading to stabilization of substrate and decreased high-flow events.

Benthic Macroinvertebrates:

Prior to the fire, Hermosa Creek supported diverse benthic communities dominated by mayflies, stoneflies, and caddisflies, which are groups of aquatic insects known to be excellent indicators of high-quality aquatic habitat conditions and good water quality. Following the fire, there was a distinct shift in benthic community composition in fire-affected Hermosa Creek and Animas River sites downstream of the burn area. In the fall of 2018, after the fire, the benthic community was markedly less diverse and became dominated by sediment-tolerant midges. These impacts dissipated at sites further downstream of the burn area. By 2021, community composition of Hermosa and Animas River sites in closest downstream proximity to the burn area have incrementally shifted back toward pre-fire observations with increased diversity, reduced abundance of midges, and increased relative abundance of caddisflies and stoneflies and mayflies. However, in 2019 and 2020, benthic communities were dominated by

Baetis mayflies and Simulidae blackflies, which due to their high fecundity and ability to complete multiple life cycles per year, are able to readily colonize and become dominant shortly after disturbance events. The dominance of these early colonizers in 2019 and 2020 suggest that benthic communities were in an early successional stage. In 2021, with a reduction of the early colonizing *Baetis* mayflies and Simulidae blackflies, benthic communities transitioned further back toward the observed pre-fire condition.

The Multi-Metric Index (MMI) is a bioassessment tool developed by Colorado Water Quality Control Division and the Environmental Protection Agency (CDPHE 2017). MMI quantifies the extent to which biological communities may have been altered by environmental stressors. MMI scores are evaluated in context to MMI scores from known reference sites and stressed sites in Colorado. CDPHE (2017) provides MMI thresholds that can be used to evaluate whether a water body is in attainment or impairment of designated aquatic life use. A MMI score that is below the attainment threshold is evidence that the site is not supportive of aquatic life use. Additional metrics (e.g., Hilsenhoff Biotic Index) are used to determine whether a site with a MMI score that falls between the attainment and impairment threshold should be considered impaired. The attainment threshold varies dependent on the biotype and class of the water body. In 2018, the benthic sample from the Animas River at 32^{nd} Street in Durango (downstream of the burn area) indicated impairment of aquatic life use according to MMI. The benthic community at Hermosa Creek below the burn area also had a drop in MMI scores following the fire but remained above attainment thresholds. MMI scores at Animas River at 32^{nd} Street and Hermosa Creek rebounded in 2020-2021 closer to pre-fire MMI scores. Results from 2019, 2020, and 2021 demonstrate that recovery is occurring with BMI communities trending back toward pre-fire community composition (Appendix C and I).

One method of assessing potential non-lethal impacts is to determine whether contaminants are accumulating in insect body tissue, which can result in cascading accrual up through higher trophic levels. In 2019, one year after the fire, we demonstrated that contaminants were accumulating in benthic macroinvertebrate body tissue in sites downstream of the burn area. In 2021, three years after the fire, we found that aluminum and iron in benthic tissue downstream of the burn area continued to be elevated above pre-fire levels (Appendix I).

MSI added the collection of algae samples in 2020 to investigate if benthic tissue metal absorption may be derived from the river's water column or algal sources. Preliminary data analysis so far indicates metals that were higher in post-fire surface water and post-fire benthic tissue (e.g., aluminum, iron, etc.) were lower in algae tissue from burned sites than unburned sites, suggesting the dietary uptake of fire-related metals by benthic insects is more closely associated with metals in the water column and suspended sediment rather than metals in algae. Due to limited algae available at each location and a small sample size, expanded sampling and analysis would be necessary for more rigorous and thorough analysis of this research question. Because benthic macroinvertebrates and other aquatic organisms are critical components of aquatic and terrestrial food webs, there is also interest in investigating potential impacts of metals absorption in benthic tissue consumed by taxa in different trophic levels. For example, aluminum would be toxic to birds or mammals if tissue concentrations in insect prey were greater than 1,000 mg/kg (Scheuhammer 1991). Fortunately, our highest measured aluminum benthic tissue concentration 458 mg/kg benthic tissue aluminum from the Animas River at 32nd street in 2020, well below the 1,000 mg/kg toxic assumption.

<u>Conclusion thus far:</u>

Following the 416-fire, we observed profound impacts to water quality, aquatic life, and aquatic habitat conditions downstream of the fire. In 2021, three years following the fire, conditions have improved incrementally, indicating a recovery trajectory toward pre-fire conditions. However, a full recovery has yet to occur, and continued monitoring is necessary to further track recovery and better understand the potential long-term impacts to aquatic ecosystems. In the coming months we will be completing additional statistical analysis and will continue relaying our findings to the public and our community.

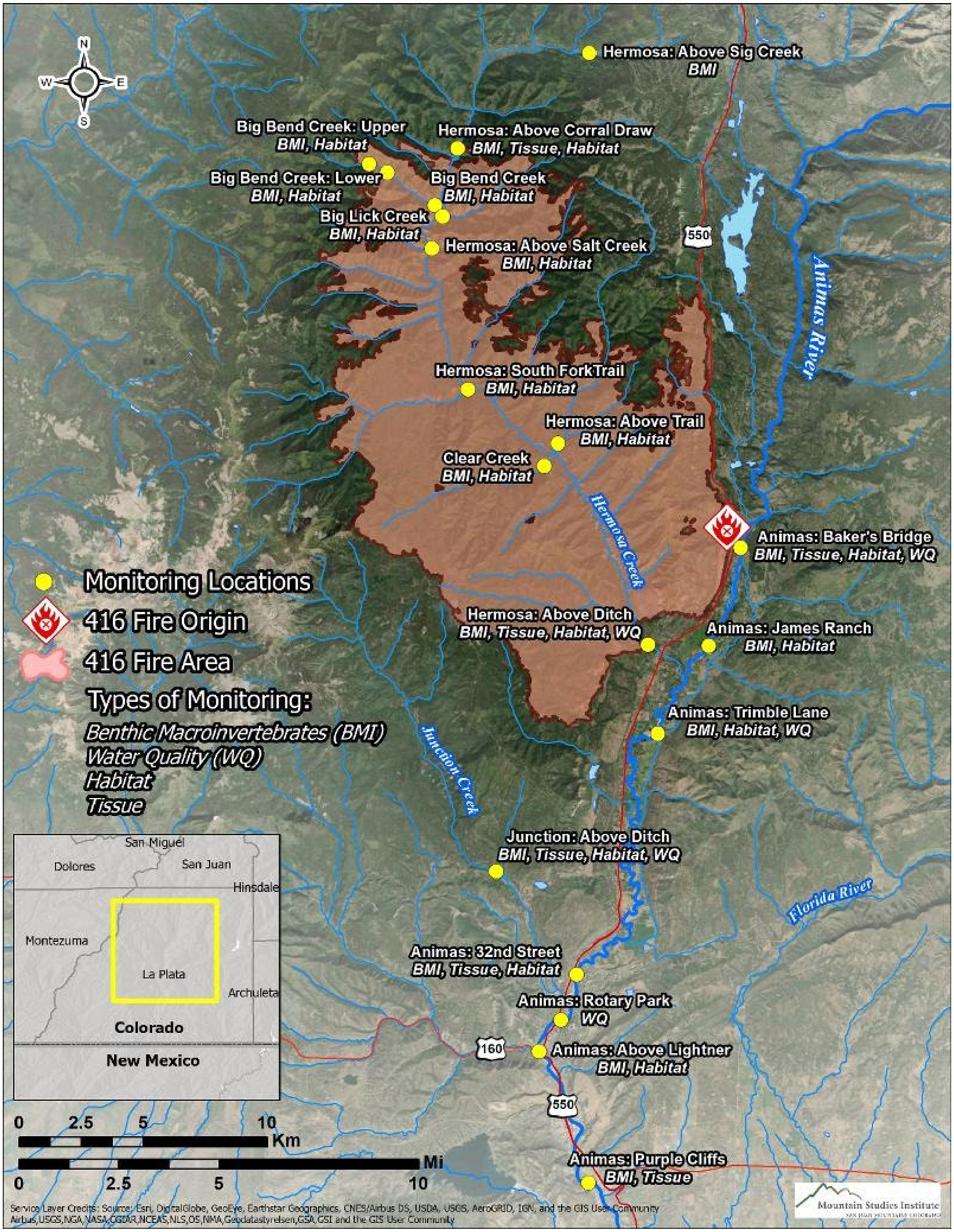
Budget Accounting

The CWCB and Southwest Basin Roundtable generously provided $18,900 in funding towards three activities of our broader research effort: water quality sampling; benthic macroinvertebrate (BMI) analysis; and analysis, reporting and outreach (Table 1). These project components were successful. The 416 Fire Aquatic Monitoring Research Group greatly appreciates the support of the CWCB and other partners, allowing us to conduct these critical steps to understanding the watershed's recovery from wildfire.

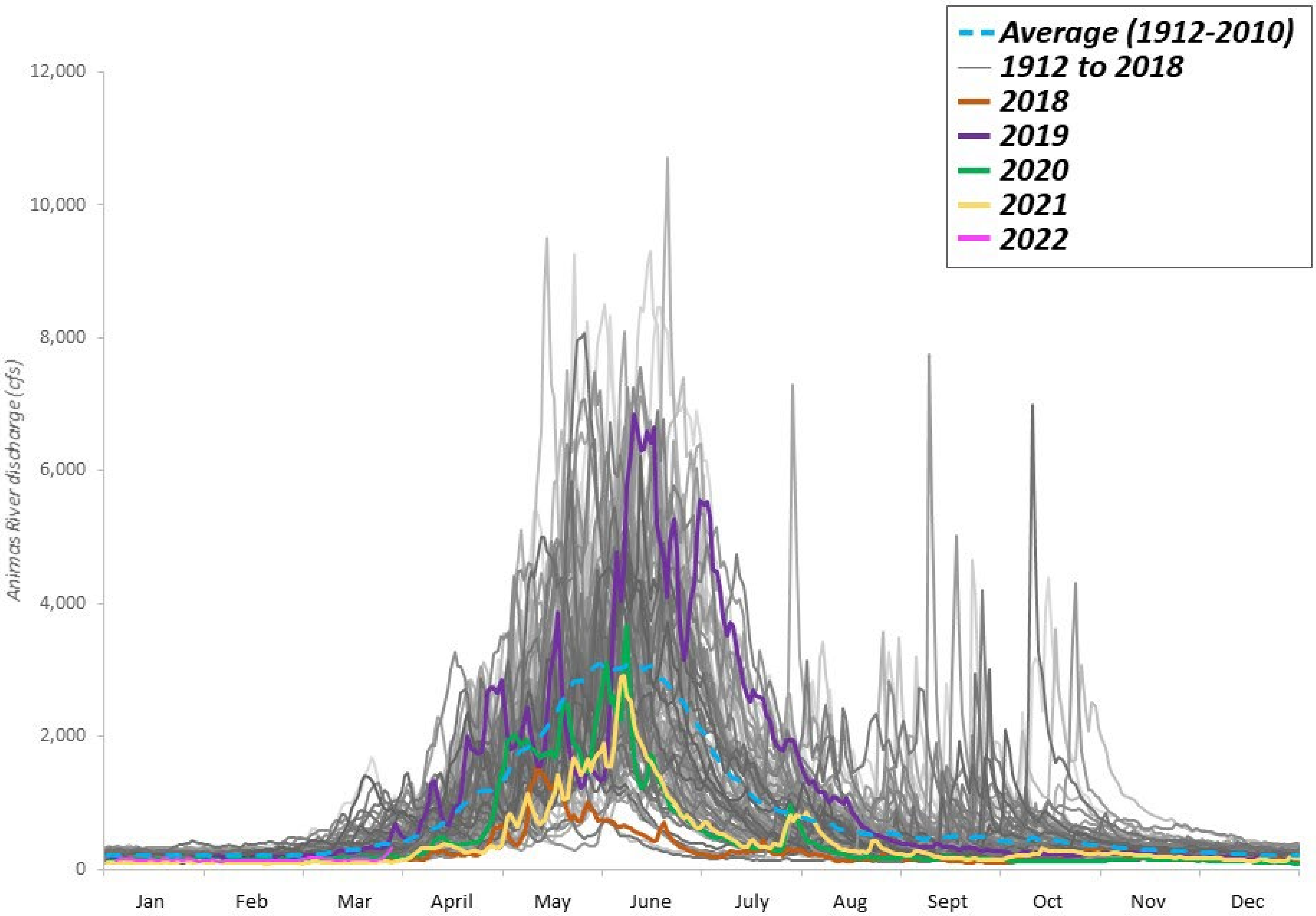
Table 1: Cost distribution of CWCB project funds

Task #	Task Description	CWCB Funds Awarded	CWCB Funds Utilized		
			MSI Aquatic Ecologist / Project Manager	MSI Research Associates	Expense (Supplies & Lab Analyses)
Task 1	Water Quality Sampling	$ 2,000	$ 543.75	$1,215.00	$ 1475.59
Task 2	Benthic Macroinvertebrate Assessment	$ 12,400	$ 1856.25	$ 6198.75	$ 1671.25
Task 3	Analysis, Reporting, and Outreach	$ 4,500	$ 4297.50	$ 1641.91	$ 0
Total		**$ 18,900**	**$ 6697.50**	**$ 9055.66**	**$ 3146.84**

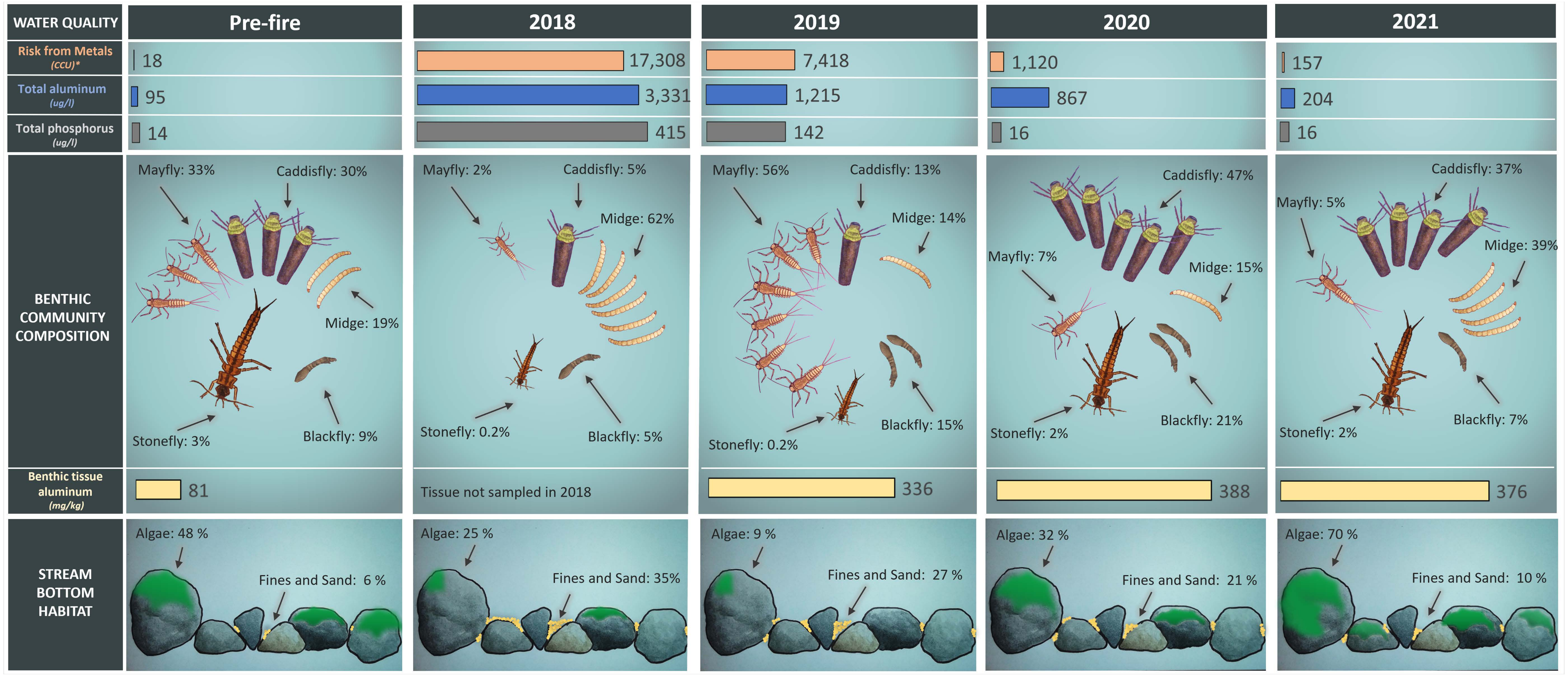
Appendix A: Map of monitoring locations



Appendix B. Hydrograph of the Animas River at Rotary Park (1912-2021)



Appendix C. Mountain Studies Institute's post-416 summary infographic



Illustrated average conditions observed at Hermosa Creek and Animas River sites downstream of the burn area from Hermosa through Durango. Note: CCU (Cumulative Criteria Unit) representes overall risk to aquatic life from metals and is the sum of the ratio of measured exposure to CDPHE water quality standards for metals. [Art courtesy of Artemis Eyster]

Appendix D. Preliminary water quality results: descriptive statistics

Analysis and interpretation of our broader post-fire research is ongoing. These results are preliminary and not meant for publication.

Hermosa Creek above CR 203

Analyte	Pre-Fire				Post-Fire 2018				Post-Fire 2019				Post-Fire 2020				Post-Fire 2021			
	N	*Avg*	*Median*	*Max*	*N*	*Avg*	*Median*	*Max*	*N*	*Avg*	*Median*	*Max*	*N*	*Avg*	*Median*	*Max*	*N*	*Avg*	*Median*	*Max*
Aluminum, Filter .45	65	27	25	147	12	113	85	321	15	47	25	210	15	25	25	25	10	32	25	79
Aluminum, Unfiltered	65	99	24	1,009	13	418,053	5,940	2,560,000	15	120,633	1,161	1,520,000	15	16,507	2,316	77,152	10	877	186	2,709
Ammonia, Unfiltered	61	48	45	90	4	309	45	1,100	15	234	45	1,100	15	113	45	875	10	45	45	45
Arsenic, Filter .45	65	12	12	12	4	12	12	12	15	17	13	27	15	29	30	46	10	27	24	42
Arsenic, Unfiltered	65	12	12	12	4	19	17	31	15	33	17	110	15	72	30	271	10	35	30	56
Cadmium, Filter .45	65	1	1	1	4	1	1	1	15	1	1	1	15	1	1	1	10	1	1	1
Cadmium, Unfiltered	65	1	1	1	1	1	1	1	15	2	1	24	15	2	1	7	10	1	1	1
Calcium, Filter .45	64	79,330	79,768	140,831	4	93,935	100,000	129,942	15	63,950	56,658	127,484	15	86,776	94,054	136,137	10	71,034	76,302	105,372
Calcium, Unfiltered	65	82,929	83,350	143,456	10	1,221,882	126,512	5,750,000	15	68,150	54,830	159,100	15	69,828	64,606	172,600	10	46,184	48,765	59,960
Copper, Filter .45	65	6	6	6	5	6	6	6	15	6	6	6	15	6	6	8	10	6	6	6
Copper, Unfiltered	65	6	6	6	2	93	93	180	15	28	6	182	15	27	20	69	10	6	6	6
Dissolved Organic Carbon					12	30,835	3,775	165,000	15	6,142	4,385	23,290	15	2,162	1,542	4,274	10	2,118	1,705	3,730
Hardness (calc), Unfiltered	66	254	251	449	13	3,470	404	20,823	15	206	164	478	15	281	283	448	10	140	148	183
Iron, Filter .45	65	28	28	48	12	65	28	204	15	47	28	187	15	30	28	57	10	34	28	71
Iron, Unfiltered	65	75	17	1,205	13	365,385	4,880	2,510,000	15	127,698	1,367	1,620,000	15	13,977	547	66,125	10	935	230	2,747
Lead, Filter .45	65	5	5	5	13	5	5	5	15	6	5	9	15	5	5	5	10	5	5	8
Lead, Unfiltered	65	5	5	5	13	934	14	6,060	15	311	7	4,170	15	15	5	87	10	6	5	10
Magnesium, Filter .45	64	11,009	11,135	21,921	4	12,299	12,900	17,187	15	8,602	6,522	19,292	15	12,169	13,013	19,664	10	9,428	9,950	14,089
Magnesium, Unfiltered	65	11,349	11,550	22,051	10	322,751	17,785	1,570,000	15	8,645	7,048	20,760	15	10,368	9,590	18,040	10	5,996	6,290	7,990
Manganese, Filter .45	65	5	5	5	13	475	120	3,720	15	23	14	97	15	43	10	303	10	7	5	18
Manganese, Unfiltered	65	7	5	52	13	22,672	467	141,000	15	5,348	179	68,200	15	468	24	2,577	10	46	15	137
Mercury, Unfiltered					12	1	0	6	11	0	0	0	8	0	0	0	3	0	0	0
Molybdenum, Filter .45					4	4	4	6	15	2	2	4	15	4	4	11	10	4	3	6
Molybdenum, Unfiltered					1	6	6	6	15	2	2	4	15	4	3	21	10	2	2	5
Nitrate/Nitrite as N, Unfiltered	41	238	29	6,670	12	155	41	1,000	15	544	100	2,280	15	131	42	838	10	53	20	167
Phosphate, Unfiltered					9	36,248	1,300	208,000	15	149	10	1,830	15	17	10	109	10	10	10	10
Phosphorus, Unfiltered	30	13	11	30	11	12,476	620	67,900	15	8,021	187	56,500	15	400	16	2,200	10	47	16	124
Potassium, Filter .45	65	818	832	1,497	4	3,607	1,830	9,450	15	1,935	1,021	7,201	15	1,059	1,071	1,446	10	1,084	1,017	1,704
Potassium, Unfiltered	65	880	871	2,607	1	1,614	1,614	1,614	15	1,916	1,128	7,764	15	1,054	1,095	1,366	10	863	865	1,130
Selenium, Filter .45	65	8	8	8	4	8	8	8	15	9	8	17	15	14	11	29	10	11	10	17
Selenium, Unfiltered	65	8	8	8	1	23	23	23	15	10	10	14	15	15	10	35	10	15	11	25
Sulfate, Unfiltered	65	117,100	121,000	235,000	4	142,326	150,152	210,000	15	69,392	37,947	226,270	15	119,492	110,270	240,635	10	113,297	118,190	168,770
Total Kjeldahl nitrogen, Unfiltered					9	73,413	1,240	537,000	15	15,436	784	154,000	15	1,400	500	7,840	10	500	500	500
Total Nitrogen (calc), Unfiltered					9	73,495	1,272	537,485	15	15,980	1,320	156,280	15	1,531	542	7,950	10	553	520	667
Total Suspended Solids, Unfiltered	65	6,589	4,000	51,700	1	25,600	25,600	25,600	15	5,495,898	170,400	45,402,000	15	849,442	26,000	5,532,000	10	63,620	17,300	177,800
Zinc, Filter .45	65	6	5	17	5	73	13	305	15	37	13	407	15	5	5	9	10	5	5	5
Zinc, Unfiltered	65	9	5	60	2	848	848	1,410	15	181	20	1,064	15	59	8	309	10	7	5	17

Notes: Blanks indicate insufficeint data preventing assessment. Average, Median, and Maximum result units = ug/l.

Junction Creek at Colorado Trailhead																				
Analyte	Pre-Fire				Post-Fire 2018				Post-Fire 2019				Post-Fire 2020				Post-Fire 2021			
	N	*Avg*	*Median*	*Max*	*N*	*Avg*	*Median*	*Max*	*N*	*Avg*	*Median*	*Max*	*N*	*Avg*	*Median*	*Max*	*N*	*Avg*	*Median*	*Max*
Aluminum, Filter .45	31	26	25	50					15	31	25	74	15	25	25	25	10	25	25	25
Aluminum, Unfiltered	31	113	24	1,737					15	99	24	689	15	250	49	1,700	10	48	24	261
Ammonia, Unfiltered	2	45	45	45					15	45	45	45	15	45	45	45	10	45	45	45
Arsenic, Filter .45	31	12	12	12					15	13	12	18	15	19	21	23	10	21	16	37
Arsenic, Unfiltered	31	12	12	12					15	14	12	20	15	14	12	20	10	19	18	27
Cadmium, Filter .45	31	1	1	1					15	1	1	1	15	1	1	1	10	1	1	1
Cadmium, Unfiltered	31	1	1	1					15	1	1	1	15	1	1	1	10	1	1	1
Calcium, Filter .45	31	41,968	44,348	56,603					15	35,243	34,554	50,543	15	43,338	48,299	52,255	10	44,363	42,570	74,840
Calcium, Unfiltered	31	46,462	46,158	60,033					15	43,446	46,396	61,750	15	38,145	40,805	58,285	10	25,576	27,710	37,400
Copper, Filter .45	31	6	6	6					15	6	6	6	15	6	6	12	10	6	6	6
Copper, Unfiltered	31	6	6	15					15	6	6	6	15	13	10	48	10	6	6	6
Dissolved Organic Carbon									15	2,502	1,811	4,917	15	1,365	1,248	2,897	10	1,524	1,240	2,550
Hardness (calc), Unfiltered	32	144	145	186					15	135	144	193	15	121	132	179	10	79	86	112
Iron, Filter .45	31	34	28	131					15	28	28	28	15	28	28	28	10	28	28	28
Iron, Unfiltered	31	125	29	1,527					15	99	22	717	15	57	21	496	10	42	17	264
Lead, Filter .45	31	5	5	5					15	6	5	9	15	5	5	5	10	5	5	7
Lead, Unfiltered	31	5	5	6					15	5	5	7	15	5	5	5	10	5	5	6
Magnesium, Filter .45	29	6,997	6,960	8,880					15	5,533	5,083	8,521	15	7,090	7,810	8,789	10	6,858	6,709	9,780
Magnesium, Unfiltered	31	7,229	7,353	9,483					15	6,391	5,793	10,980	15	7,027	9,015	10,140	10	3,790	4,110	5,280
Manganese, Filter .45	31	5	5	10					15	5	5	5	15	5	5	5	10	5	5	5
Manganese, Unfiltered	31	12	5	91					15	16	5	110	15	6	5	17	10	6	5	16
Mercury, Unfiltered									15	0	0	0	8	0	0	0	3	0	0	0
Molybdenum, Filter .45									15	2	1	3	15	2	2	4	10	3	2	13
Molybdenum, Unfiltered									15	2	1	3	15	4	3	20	10	3	3	12
Nitrate/Nitrite as N, Unfiltered									15	25	20	50	15	26	20	83	10	24	20	50
Phosphate, Unfiltered									15	10	10	10	15	10	10	10	10	10	10	10
Phosphorus, Unfiltered	2	11	11	11					15	46	16	326	15	16	16	16	10	13	16	16
Potassium, Filter .45	31	791	765	1,209					15	721	758	944	15	824	860	1,003	10	853	815	1,208
Potassium, Unfiltered	31	880	789	1,506					15	748	830	995	15	845	952	1,064	10	751	730	1,030
Selenium, Filter .45	31	8	8	8					15	9	8	13	15	11	8	26	10	15	10	45
Selenium, Unfiltered	31	8	8	8					15	11	10	22	15	13	11	20	10	13	10	39
Sulfate, Unfiltered	2	9,140	9,140	15,400					15	8,986	7,746	22,293	15	10,999	9,653	24,124	10	12,414	11,245	21,870
Total Kjeldahl nitrogen, Unfiltered									15	536	500	734	15	500	500	500	10	500	500	500
Total Nitrogen (calc), Unfiltered									15	562	520	773	15	526	520	583	10	524	520	550
Total Suspended Solids, Unfiltered	2	4,900	4,900	5,800					15	13,187	4,000	67,600	15	6,960	4,000	31,600	10	6,160	4,000	25,600
Zinc, Filter .45	31	5	5	10					15	53	11	651	15	5	5	5	10	5	5	5
Zinc, Unfiltered	31	8	5	30					15	9	6	15	15	7	5	21	10	5	5	5

Notes: Blanks indicate insufficeint data preventing assessment. Average, Median, and Maximum result units = ug/l.

Animas River at Rotary Park																				
Analyte	**Pre-Fire**				**Post-Fire 2018**				**Post-Fire 2019**				**Post-Fire 2020**				**Post-Fire 2021**			
	N	*Avg*	*Median*	*Max*	*N*	*Avg*	*Median*	*Max*	*N*	*Avg*	*Median*	*Max*	*N*	*Avg*	*Median*	*Max*	*N*	*Avg*	*Median*	*Max*
Aluminum, Filter .45	362	42	25	3,306	13	174	25	1,400	15	252	25	3,410	15	25	25	25	10	63	38	176
Aluminum, Unfiltered	407	527	170	26,210	15	63,937	721	374,000	15	12,935	1,492	95,233	15	14,137	794	160,852	10	1,237	300	8,597
Ammonia, Unfiltered	34	73	45	490	4	4,537	52	18,000	15	121	45	451	15	62	45	219	10	45	45	45
Arsenic, Filter .45	348	14	12	270	4	13	12	13	15	14	12	21	15	26	28	38	10	22	20	42
Arsenic, Unfiltered	382	16	12	305	4	13	13	16	15	24	19	70	15	44	24	257	10	33	26	104
Cadmium, Filter .45	313	1	1	2	4	1	1	1	15	1	1	1	15	1	1	1	10	1	1	1
Cadmium, Unfiltered	346	1	1	5	1	1	1	1	15	1	1	3	15	2	1	11	10	1	1	2
Calcium, Filter .45	315	65,192	68,000	181,929	4	93,298	93,550	107,000	15	47,514	42,555	90,315	15	69,628	70,248	122,277	10	60,627	61,453	100,548
Calcium, Unfiltered	401	63,881	64,283	183,415	13	233,379	90,300	981,000	15	47,213	50,460	63,312	15	49,093	48,170	100,270	10	59,845	50,145	106,410
Copper, Filter .45	368	6	6	84	4	6	6	6	15	6	6	6	15	6	6	10	10	6	6	6
Copper, Unfiltered	401	12	6	652	1	6	6	6	15	23	10	104	15	25	16	97	10	7	6	12
Dissolved Organic Carbon					16	9,141	1,405	41,000	15	2,878	3,112	4,832	15	1,592	1,209	2,870	10	1,294	1,125	2,300
Hardness (calc), Unfiltered	416	199	198	937	16	735	293	3,528	15	147	167	192	15	209	184	423	10	182,657	149,755	316,851
Iron, Filter .45	356	60	28	7,929	14	140	28	977	15	282	28	3,809	15	54	28	199	10	83	45	224
Iron, Unfiltered	409	1,935	295	182,000	16	67,541	536	471,000	15	13,650	3,172	80,969	15	11,109	329	119,437	10	1,583	459	8,552
Lead, Filter .45	376	5	5	108	15	5	5	12	15	6	5	9	15	5	5	5	10	5	5	8
Lead, Unfiltered	409	28	5	2,620	16	156	5	885	15	39	30	114	15	22	5	164	10	8	6	14
Magnesium, Filter .45	315	9,593	9,500	115,625	4	12,705	12,300	15,800	15	6,570	6,077	12,855	15	9,652	9,415	18,147	10	7,795	7,756	14,224
Magnesium, Unfiltered	401	9,308	8,890	116,422	13	56,036	12,700	262,000	15	7,081	5,670	14,620	15	10,593	12,212	19,400	10	8,068	5,960	13,960
Manganese, Filter .45	349	89	68	972	15	268	213	928	15	122	105	345	15	90	94	157	10	82	74	118
Manganese, Unfiltered	382	142	110	1,910	15	2,972	268	14,800	15	859	619	3,697	15	444	128	2,216	10	174	148	314
Mercury, Unfiltered	142	0	0	0	12	0	0	1	11	0	0	0	8	0	0	0	3	0	0	0
Molybdenum, Filter .45	112	2	1	12	3	4	3	6	15	2	2	4	15	3	3	5	10	3	3	5
Molybdenum, Unfiltered	142	2	1	26	1	2	2	2	15	2	1	3	15	10	4	102	10	3	3	4
Nitrate/Nitrite as N, Unfiltered	44	159	123	1,370	15	107	51	551	15	200	93	728	15	101	93	278	10	92	90	138
Phosphate, Unfiltered	14	99	102	192	8	26,058	1,780	106,000	15	10	10	10	15	17	10	122	10	10	10	10
Phosphorus, Unfiltered	23	36	30	100	13	5,598	210	34,600	15	843	114	6,350	15	183	16	1,560	10	43	16	220
Potassium, Filter .45	248	2,870	2,801	10,000	4	5,636	4,520	10,100	15	1,891	1,384	4,365	15	2,627	2,421	5,746	10	2,769	2,099	7,243
Potassium, Unfiltered	278	2,912	2,794	9,900	1	3,581	3,581	3,581	15	2,245	1,356	6,700	15	2,377	2,388	5,630	10	2,552	2,505	5,600
Selenium, Filter .45	348	9	8	80	4	8	8	8	15	10	8	14	15	12	9	24	10	12	10	20
Selenium, Unfiltered	381	9	8	90	1	10	10	10	15	10	10	10	15	12	10	26	10	12	10	21
Sulfate, Unfiltered	26	92,512	75,700	210,000	4	165,704	165,000	182,815	15	77,821	68,769	153,154	15	109,196	120,911	203,155	10	104,135	91,250	161,580
Total Kjeldahl nitrogen, Unfiltered	33	559	500	1,340	11	19,336	988	79,200	15	3,129	840	22,300	15	970	500	6,440	10	512	500	620
Total Nitrogen (calc), Unfiltered	21	636	634	849	11	19,421	1,073	79,220	15	3,329	970	22,462	15	1,071	593	6,544	10	604	590	729
Total Suspended Solids, Unfiltered	38	57,400	5,550	816,000	1	9,000	9,000	9,000	15	489,333	122,000	2,816,000	15	163,907	9,400	1,443,000	10	32,080	15,900	170,400
Zinc, Filter .45	368	42	38	276	4	127	58	376	15	63	25	621	15	20	10	55	10	32	34	50
Zinc, Unfiltered	409	78	63	1,240	1	324	324	324	15	197	190	495	15	131	42	732	10	73	65	137

Notes: Blanks indicate insuffiiceint data preventing assessment. Average, Median, and Maximum result units = ug/l.

Appendix E. Preliminary water quality results: percent change in average concentration from pre-fire to post-fire periods

Analysis and interpretation of our broader post-fire research is ongoing. These results are preliminary and not meant for publication.

Hermosa Creek above CR 203									
Analyte	**Pre vs. Post-Fire change in average**	**Pre-Fire**				**Post-Fire**			
	%	*N*	*Avg*	*Median*	*Max*	*N*	*Avg*	*Median*	*Max*
Aluminum, Filter .45	97	65	27	25	147	52	53	25	321
Aluminum, Unfiltered	142,208	65	99	24	1,009	53	141,520	1,798	2,560,000
Ammonia, Unfiltered	228	61	48	45	90	44	156	45	1,100
Arsenic, Filter .45	84	65	12	12	12	44	23	21	46
Arsenic, Unfiltered	268	65	12	12	12	44	46	24	271
Cadmium, Filter .45	2	65	1	1	1	44	1	1	1
Cadmium, Unfiltered	194	65	1	1	1	41	2	1	24
Calcium, Filter .45	-4	64	79,330	79,768	140,831	44	76,068	75,314	136,137
Calcium, Unfiltered	256	65	82,929	83,350	143,456	50	295,007	58,750	5,750,000
Copper, Filter .45	1	65	6	6	6	45	6	6	8
Copper, Unfiltered	347	65	6	6	6	42	26	6	182
Dissolved Organic Carbon	-	-	-	-	-	52	9,919	2,933	165,000
Hardness (calc), Unfiltered	299	66	254	251	449	53	1,015	237	20,823
Iron, Filter .45	54	65	28	28	48	52	44	28	204
Iron, Unfiltered	172,953	65	75	17	1,205	53	129,896	1,367	2,510,000
Lead, Filter .45	7	65	5	5	5	53	5	5	9
Lead, Unfiltered	6,313	65	5	5	5	53	322	5	6,060
Magnesium, Filter .45	-6	64	11,009	11,135	21,921	44	10,342	9,887	19,664
Magnesium, Unfiltered	530	65	11,349	11,550	22,051	50	71,453	7,813	1,570,000
Manganese, Filter .45	2,632	65	5	5	5	53	137	14	3,720
Manganese, Unfiltered	100,248	65	7	5	52	53	7,216	99	141,000
Mercury, Unfiltered	-	-	-	-	-	34	0	0	6
Molybdenum, Filter .45	-	-	-	-	-	44	3	3	11
Molybdenum, Unfiltered	-	-	-	-	-	41	3	2	21
Nitrate/Nitrite as N, Unfiltered	1	41	238	29	6,670	52	241	55	2,280
Phosphate (PO4), Unfiltered	-					49	6,711	10	208,000
Phosphorus, Unfiltered	40,524	30	13	11	30	51	5,177	81	67,900
Potassium, Filter .45	95	65	818	832	1,497	44	1,595	1,123	9,450
Potassium, Unfiltered	52	65	880	871	2,607	41	1,336	1,030	7,764
Selenium, Filter .45	36	65	8	8	8	44	11	8	29
Selenium, Unfiltered	65	65	8	8	8	41	14	10	35
Sulfate, Unfiltered	-12	65	117,100	121,000	235,000	44	103,080	95,265	240,635
Total Kjeldahl nitrogen, Unfiltered	-	-	-	-	-	49	18,740	500	537,000
Total Nitrogen (calc), Unfiltered	-	-	-	-	-	49	18,972	572	537,485
Total Suspended Solids, Unfiltered	35,376	65	6,589	4,000	51,700	41	2,337,607	48,000	45,402,000
Zinc, Filter .45	290	65	6	5	17	45	23	5	407
Zinc, Unfiltered	1,267	65	9	5	60	42	128	9	1,410
Notes: Red font indicates increase; green font indicates decrease.									
Blanks indicate insufficeint data preventing assessment. Average, Median, and Maximum result units = ug/l.									

Junction Creek at Colorado Trailhead									
Analyte	Pre vs. Post-Fire change in average	Pre-Fire				Post-Fire			
	%	*N*	*Avg*	*Median*	*Max*	*N*	*Avg*	*Median*	*Max*
Aluminum, Filter .45	0	31	26	25	50	40	27	25	74
Aluminum, Unfiltered	0	31	113	24	1,737	40	143	24	1,700
Ammonia, Unfiltered	0	2	45	45	45	40	45	45	45
Arsenic, Filter .45	21	31	12	12	12	40	17	15	37
Arsenic, Unfiltered	0	31	12	12	12	40	15	12	27
Cadmium, Filter .45	0	31	1	1	1	40	1	1	1
Cadmium, Unfiltered	0	31	1	1	1	40	1	1	1
Calcium, Filter .45	-7	31	41,968	44,348	56,603	40	40,559	41,452	74,840
Calcium, Unfiltered	-17	31	46,462	46,158	60,033	40	36,991	38,500	61,750
Copper, Filter .45	0	31	6	6	6	40	6	6	12
Copper, Unfiltered	0	31	6	6	15	40	8	6	48
Dissolved Organic Carbon						40	1,831	1,376	4,917
Hardness (calc), Unfiltered	-22	32	144	145	186	40	116	113	193
Iron, Filter .45	0	31	34	28	131	40	28	28	28
Iron, Unfiltered	-41	31	125	29	1,527	40	69	17	717
Lead, Filter .45	0	31	5	5	5	40	5	5	9
Lead, Unfiltered	0	31	5	5	6	40	5	5	7
Magnesium, Filter .45	-4	29	6,997	6,960	8,880	40	6,448	6,709	9,780
Magnesium, Unfiltered	-30	31	7,229	7,353	9,483	40	5,979	5,145	10,980
Manganese, Filter .45	0	31	5	5	10	40	5	5	5
Manganese, Unfiltered	0	31	12	5	91	40	10	5	110
Mercury, Unfiltered						26	0	0	0
Molybdenum, Filter .45						40	2	2	13
Molybdenum, Unfiltered						40	3	2	20
Nitrate/Nitrite as N, Unfiltered						40	25	20	83
Phosphate (PO4), Unfiltered						40	10	10	10
Phosphorus, Unfiltered	49	2	11	11	11	40	27	16	326
Potassium, Filter .45	4	31	791	765	1,209	40	793	792	1,208
Potassium, Unfiltered	7	31	880	789	1,506	40	785	845	1,064
Selenium, Filter .45	0	31	8	8	8	40	11	8	45
Selenium, Unfiltered	21	31	8	8	8	40	12	10	39
Sulfate, Unfiltered	2	2	9,140	9,140	15,400	40	10,598	9,365	24,124
Total Kjeldahl nitrogen, Unfiltered						40	514	500	734
Total Nitrogen (calc), Unfiltered						40	539	520	773
Total Suspended Solids, Unfiltered	-18	2	4,900	4,900	5,800	40	9,095	4,000	67,600
Zinc, Filter .45	0	31	5	5	10	40	23	5	651
Zinc, Unfiltered	0	31	8	5	30	40	7	5	21
Notes: Red font indicates increase; green font indicates decrease.									
Blanks indicate insufficeint data preventing assessment. Average, Median, and Maximum result units = ug/l.									

Animas River at Rotary Park									
Analyte	Pre vs. Post-Fire change in average	Pre-Fire				Post-Fire			
	%	N	Avg	Median	Max	N	Avg	Median	Max
Aluminum, Filter .45	0	362	42	25	3,306	53	133	25	3,410
Aluminum, Unfiltered	345	407	527	170	26,210	55	25,046	757	374,000
Ammonia, Unfiltered	0	34	73	45	490	44	485	45	18,000
Arsenic, Filter .45	34	348	14	12	270	44	20	17	42
Arsenic, Unfiltered	69	382	16	12	305	44	32	21	257
Cadmium, Filter .45	0	313	1	1	2	44	1	1	1
Cadmium, Unfiltered	21	346	1	1	5	41	1	1	11
Calcium, Filter .45	-13	315	65,192	68,000	181,929	44	62,195	58,935	122,277
Calcium, Unfiltered	-13	401	63,881	64,283	183,415	53	95,792	55,780	981,000
Copper, Filter .45	0	368	6	6	84	44	6	6	10
Copper, Unfiltered	100	401	12	6	652	41	20	11	104
Dissolved Organic Carbon	-	-	-	-	-	56	4,040	1,545	41,000
Hardness (calc), Unfiltered	-3	416	198,559	198,259	937,413	56	338,036	191,958	3,528,473
Iron, Filter .45	0	356	60	28	7,929	54	145	28	3,809
Iron, Unfiltered	121	409	1,935	295	182,000	56	26,212	653	471,000
Lead, Filter .45	0	376	5	5	108	55	5	5	12
Lead, Unfiltered	35	409	28	5	2,620	56	62	7	885
Magnesium, Filter .45	-24	315	9,593	9,500	115,625	44	8,456	7,224	18,147
Magnesium, Unfiltered	11	401	9,308	8,890	116,422	53	20,269	9,860	262,000
Manganese, Filter .45	43	349	89	68	972	55	146	97	928
Manganese, Unfiltered	88	382	142	110	1,910	55	1,197	206	14,800
Mercury, Unfiltered	0	142	0	0	0	34	0	0	1
Molybdenum, Filter .45	88	112	2	1	12	43	3	2	6
Molybdenum, Unfiltered	52	142	2	1	26	41	5	2	102
Nitrate/Nitrite as N, Unfiltered	-31	44	159	123	1,370	55	128	85	728
Phosphate (PO4), Unfiltered	-90	14	99	102	192	48	4,354	10	106,000
Phosphorus, Unfiltered	139	23	36	30	100	53	1,671	71	34,600
Potassium, Filter .45	-23	248	2,870	2,801	10,000	44	2,682	2,154	10,100
Potassium, Unfiltered	-17	278	2,912	2,794	9,900	41	2,401	2,330	6,700
Selenium, Filter .45	8	348	9	8	80	44	11	9	24
Selenium, Unfiltered	21	381	9	8	90	41	11	10	26
Sulfate, Unfiltered	49	26	92,512	75,700	210,000	44	102,487	112,422	203,155
Total Kjeldahl nitrogen, Unfiltered	0	33	559	500	1,340	51	5,477	500	79,200
Total Nitrogen (calc), Unfiltered	-5	21	636	634	849	51	5,601	602	79,220
Total Suspended Solids, Unfiltered	412	38	57,400	5,550	816,000	41	247,034	28,400	2,816,000
Zinc, Filter .45	-37	368	42	38	276	44	47	24	621
Zinc, Unfiltered	19	409	78	63	1,240	41	146	75	732

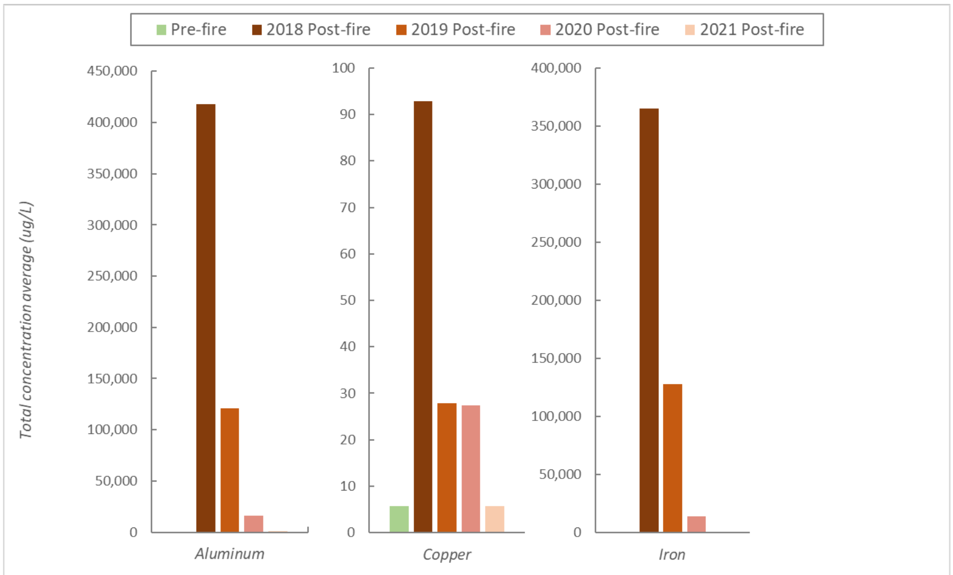
Hermosa Creek above CR 203								
Analyte	*Percent change in average from…*							
	Pre-Fire to Post-Fire	**Pre-Fire to 2018 Post-Fire**	**Pre-Fire to 2019 Post-Fire**	**Pre-Fire to 2020 Post-Fire**	**Pre-Fire to 2021 Post-Fire**	**2018 Post-Fire to 2019 Post-Fire**	**2019 Post-Fire to 2020 Post-Fire**	**2020 Post-Fire to 2021 Post-Fire**
	%	*%*	*%*	*%*	*%*	*%*	*%*	*%*
Aluminum, Filter .45	97	320	73	-7	20	-59	-47	29
Aluminum, Unfiltered	142,208	420,282	121,205	16,499	782	-71	-86	-95
Ammonia, Unfiltered	228	547	390	136	-6	-24	-52	-60
Arsenic, Filter .45	84	0	37	132	114	37	69	-8
Arsenic, Unfiltered	268	57	165	484	185	69	120	-51
Cadmium, Filter .45	2	0	0	0	11	0	0	11
Cadmium, Unfiltered	194	0	317	208	9	317	-26	-65
Calcium, Filter .45	-4	18	-19	9	-10	-32	36	-18
Calcium, Unfiltered	256	1,373	-18	-16	-44	-94	2	-34
Copper, Filter .45	1	0	0	3	0	0	3	-3
Copper, Unfiltered	347	1,529	389	380	0	-70	-2	-79
Dissolved Organic Carbon	-	-	-	-	-	-80	-65	-2
Hardness (calc), Unfiltered	299	1,264	-19	10	-45	-94	36	-50
Iron, Filter .45	54	129	65	5	18	-28	-36	12
Iron, Unfiltered	172,953	486,680	170,025	18,521	1,145	-65	-89	-93
Lead, Filter .45	7	0	19	0	6	19	-16	6
Lead, Unfiltered	6,313	18,469	6,088	199	18	-67	-95	-61
Magnesium, Filter .45	-6	12	-22	11	-14	-30	41	-23
Magnesium, Unfiltered	530	2,744	-24	-9	-47	-97	20	-42
Manganese, Filter .45	2,632	9,400	366	757	44	-95	84	-83
Manganese, Unfiltered	100,248	315,190	74,278	6,410	535	-76	-91	-90
Mercury, Unfiltered	-	-	-	-	-	-93	0	0
Molybdenum, Filter .45	-	-	-	-	-	-45	81	-15
Molybdenum, Unfiltered	-	-	-	-	-	-66	110	-48
Nitrate/Nitrite as N, Unfiltered	1	-35	128	-45	-78	251	-76	-60
Phosphate (PO4), Unfiltered	-	-	-	-	-	-100	-89	-40
Phosphorus, Unfiltered	40,524	97,800	62,840	3,041	269	-36	-95	-88
Potassium, Filter .45	95	341	137	30	33	-46	-45	2
Potassium, Unfiltered	52	83	118	20	-2	19	-45	-18
Selenium, Filter .45	36	0	12	69	36	12	51	-19
Selenium, Unfiltered	65	177	27	86	78	-54	46	-4
Sulfate, Unfiltered	-12	22	-41	2	-3	-51	72	-5
Total Kjeldahl nitrogen, Unfiltered	-	-	-	-	-	-79	-91	-64
Total Nitrogen (calc), Unfiltered	-	-	-	-	-	-78	-90	-64
Total Suspended Solids, Unfiltered	35,376	289	83,307	12,791	866	21,368	-85	-93
Zinc, Filter .45	290	1,122	518	-11	-17	-49	-86	-6
Zinc, Unfiltered	1,267	8,967	1,832	534	-20	-79	-67	-87
Notes: Red font indicates increase; green font indicates decrease.								
Blanks indicate insufficeint data preventing assessment.								

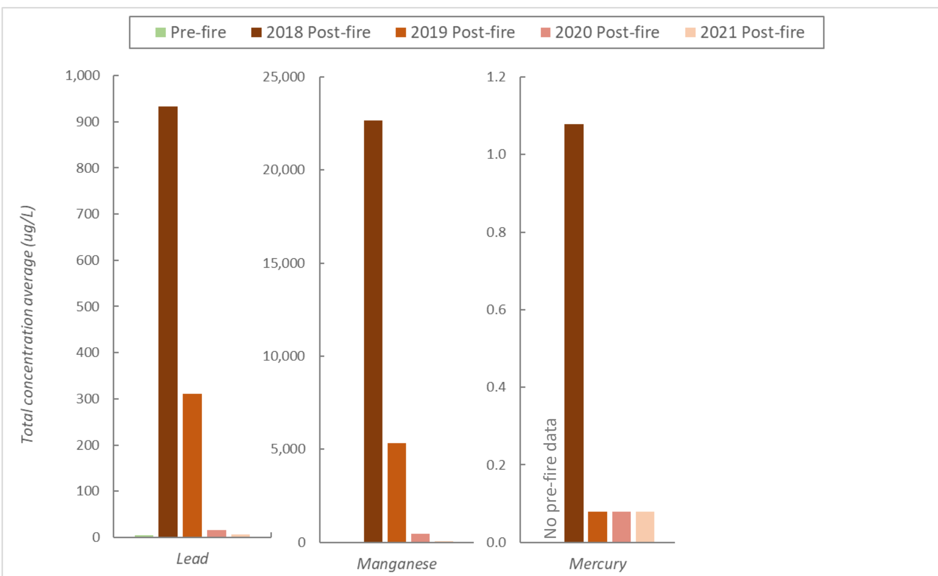
Junction Creek at Colorado Trailhead								
Analyte	*Percent change in average from…*							
	Pre-Fire to Post-Fire	Pre-Fire to 2018 Post-Fire	Pre-Fire to 2019 Post-Fire	Pre-Fire to 2020 Post-Fire	Pre-Fire to 2021 Post-Fire	2018 Post-Fire to 2019 Post-Fire	2019 Post-Fire to 2020 Post-Fire	2020 Post-Fire to 2021 Post-Fire
	%	*%*	*%*	*%*	*%*	*%*	*%*	*%*
Aluminum, Filter .45	0	-	17	-5	-5	-	-19	0
Aluminum, Unfiltered	0	-	-12	122	-58	-	152	-81
Ammonia, Unfiltered	0	-	0	0	0	-	0	0
Arsenic, Filter .45	21	-	8	54	71	-	43	11
Arsenic, Unfiltered	0	-	12	10	51	-	-1	37
Cadmium, Filter .45	0	-	6	0	20	-	-5	20
Cadmium, Unfiltered	0	-	2	11	19	-	9	7
Calcium, Filter .45	-7	-	-16	3	6	-	23	2
Calcium, Unfiltered	-17	-	-6	-18	-45	-	-12	-33
Copper, Filter .45	0	-	0	8	0	-	8	-7
Copper, Unfiltered	0	-	-5	116	-5	-	127	-56
Dissolved Organic Carbon	0	-	-	-	-	-	-45	12
Hardness (calc), Unfiltered	-22	-	-6	-16	-45	-	-10	-34
Iron, Filter .45	0	-	-18	-18	-18	-	0	0
Iron, Unfiltered	-41	-	-21	-54	-66	-	-42	-26
Lead, Filter .45	0	-	15	0	4	-	-13	4
Lead, Unfiltered	0	-	7	-1	1	-	-7	2
Magnesium, Filter .45	-4	-	-21	1	-2	-	28	-3
Magnesium, Unfiltered	-30	-	-12	-3	-48	-	10	-46
Manganese, Filter .45	0	-	-9	-9	-9	-	0	0
Manganese, Unfiltered	0	-	31	-52	-50	-	-63	4
Mercury, Unfiltered	0	-	-	-	-	-	0	0
Molybdenum, Filter .45	0	-	-	-	-	-	26	63
Molybdenum, Unfiltered	0	-	-	-	-	-	144	-27
Nitrate/Nitrite as N, Unfiltered	0	-	-	-	-	-	1	-5
Phosphate (PO4), Unfiltered	0	-	-	-	-	-	0	0
Phosphorus, Unfiltered	49	-	321	49	19	-	-65	-20
Potassium, Filter .45	4	-	-9	4	8	-	14	4
Potassium, Unfiltered	7	-	-15	-4	-15	-	13	-11
Selenium, Filter .45	0	-	8	38	83	-	27	33
Selenium, Unfiltered	21	-	34	55	62	-	16	5
Sulfate, Unfiltered	2	-	-2	20	36	-	22	13
Total Kjeldahl nitrogen, Unfiltered	0	-	-	-	-	-	-7	0
Total Nitrogen (calc), Unfiltered	0	-	-	-	-	-	-6	0
Total Suspended Solids, Unfiltered	-18	-	169	42	26	-	-47	-11
Zinc, Filter .45	0	-	882	-7	-7	-	-90	0
Zinc, Unfiltered	0	-	12	-7	-38	-	-17	-33
Notes: Red font indicates increase; green font indicates decrease.								
Blanks indicate insufficeint data preventing assessment.								

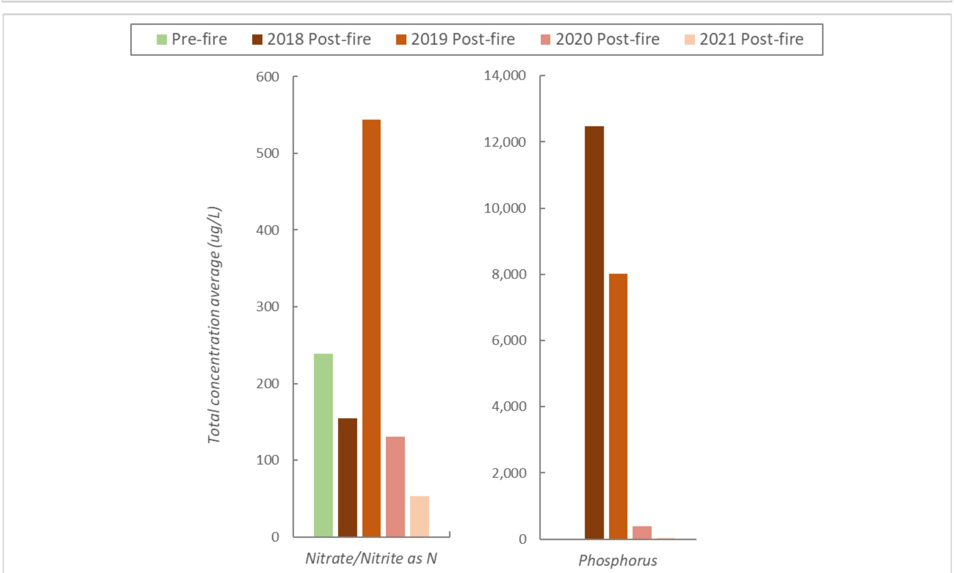
Animas River at Rotary Park								
Analyte	*Percent change in average from…*							
	Pre-Fire to Post-Fire	Pre-Fire to 2018 Post-Fire	Pre-Fire to 2019 Post-Fire	Pre-Fire to 2020 Post-Fire	Pre-Fire to 2021 Post-Fire	2018 Post-Fire to 2019 Post-Fire	2019 Post-Fire to 2020 Post-Fire	2020 Post-Fire to 2021 Post-Fire
	%	%	%	%	%	%	%	%
Aluminum, Filter .45	0	314	500	-41	50	45	-90	153
Aluminum, Unfiltered	345	12,041	2,356	2,584	135	-80	9	-91
Ammonia, Unfiltered	0	6,106	66	-15	-38	-97	-49	-28
Arsenic, Filter .45	34	-8	4	92	59	12	85	-17
Arsenic, Unfiltered	69	-15	53	178	111	81	81	-24
Cadmium, Filter .45	0	-1	5	-1	33	7	-6	35
Cadmium, Unfiltered	21	-6	78	184	45	88	60	-49
Calcium, Filter .45	-13	43	-27	7	-7	-49	47	-13
Calcium, Unfiltered	-13	265	-26	-23	-6	-80	4	22
Copper, Filter .45	0	-8	-8	0	-8	0	9	-8
Copper, Unfiltered	100	-51	100	114	-37	311	7	-71
Dissolved Organic Carbon	-	-	-	-	-	-69	-45	-19
Hardness (calc), Unfiltered	-3	270	-26	5	91,891	-80	42	87,346
Iron, Filter .45	0	132	368	-10	38	102	-81	53
Iron, Unfiltered	121	3,391	605	474	-18	-80	-19	-86
Lead, Filter .45	0	3	9	-6	1	6	-13	7
Lead, Unfiltered	35	451	37	-24	-73	-75	-44	-65
Magnesium, Filter .45	-24	32	-32	1	-19	-48	47	-19
Magnesium, Unfiltered	11	502	-24	14	-13	-87	50	-24
Manganese, Filter .45	43	202	37	1	-8	-55	-26	-9
Manganese, Unfiltered	88	1,989	504	212	22	-71	-48	-61
Mercury, Unfiltered	0	136	-2	-2	-2	-59	0	0
Molybdenum, Filter .45	88	92	2	60	38	-47	58	-13
Molybdenum, Unfiltered	52	-6	-17	406	32	-11	509	-74
Nitrate/Nitrite as N, Unfiltered	-31	-33	25	-37	-42	87	-50	-9
Phosphate (PO4), Unfiltered	-90	26,336	-90	-82	-90	-100	75	-43
Phosphorus, Unfiltered	139	15,649	2,270	414	21	-85	-78	-76
Potassium, Filter .45	-23	96	-34	-8	-4	-66	39	5
Potassium, Unfiltered	-17	23	-23	-18	-12	-37	6	7
Selenium, Filter .45	8	-3	12	41	41	15	27	0
Selenium, Unfiltered	21	16	16	41	43	0	21	2
Sulfate, Unfiltered	49	79	-16	18	13	-53	40	-5
Total Kjeldahl nitrogen, Unfiltered	0	3,358	460	73	-8	-84	-69	-47
Total Nitrogen (calc), Unfiltered	-5	2,956	424	68	-5	-83	-68	-44
Total Suspended Solids, Unfiltered	412	-84	752	186	-44	5,337	-67	-80
Zinc, Filter .45	-37	203	49	-52	-23	-51	-68	61
Zinc, Unfiltered	19	313	152	67	-7	-39	-34	-44
Notes: Red font indicates increase; green font indicates decrease.								
Blanks indicate insufficeint data preventing assessment.								

Appendix F. Preliminary water quality results: plots of select analytes depicting average concentration during pre-fire, post-fire 2018, 2019, 2020, and 2021

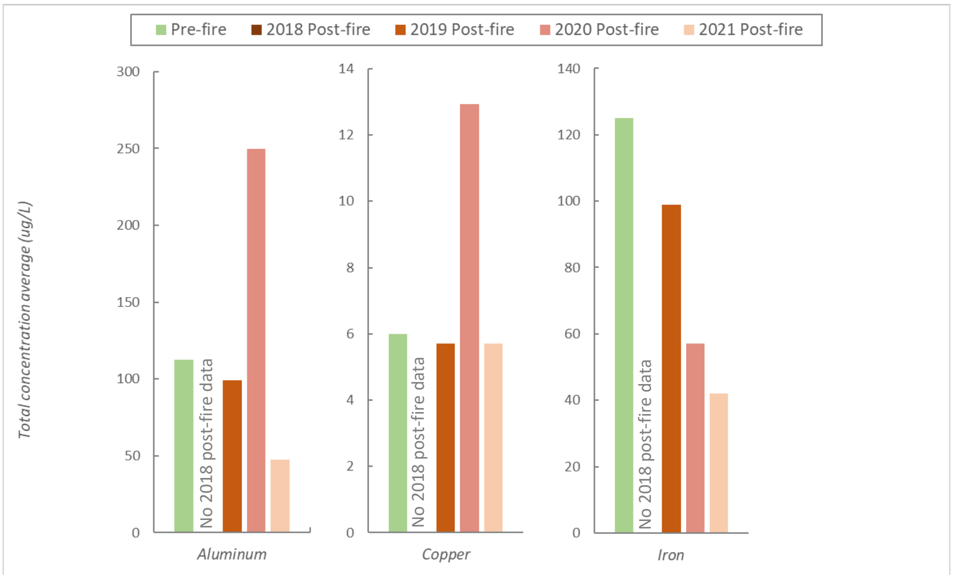
Hermosa Creek at CR 203

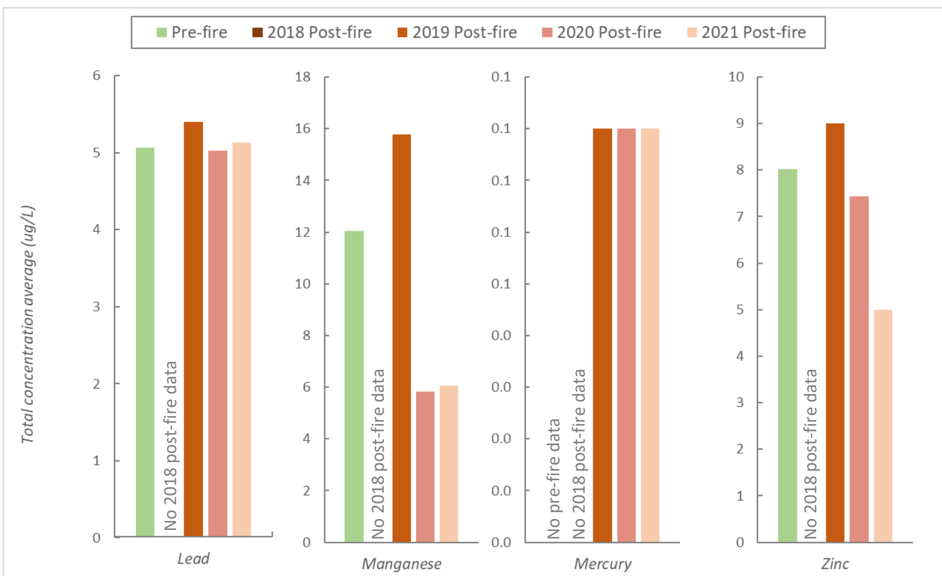


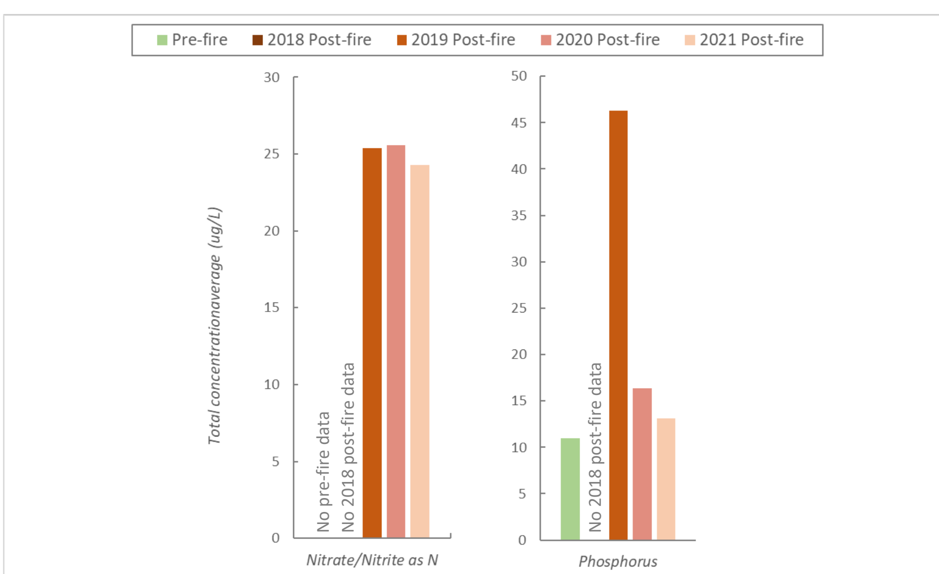




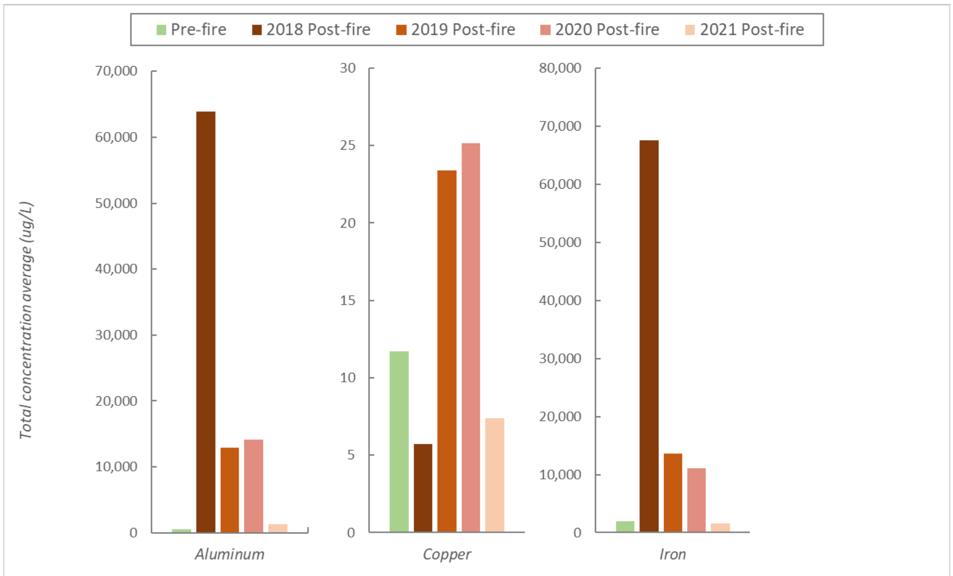
Junction Creek

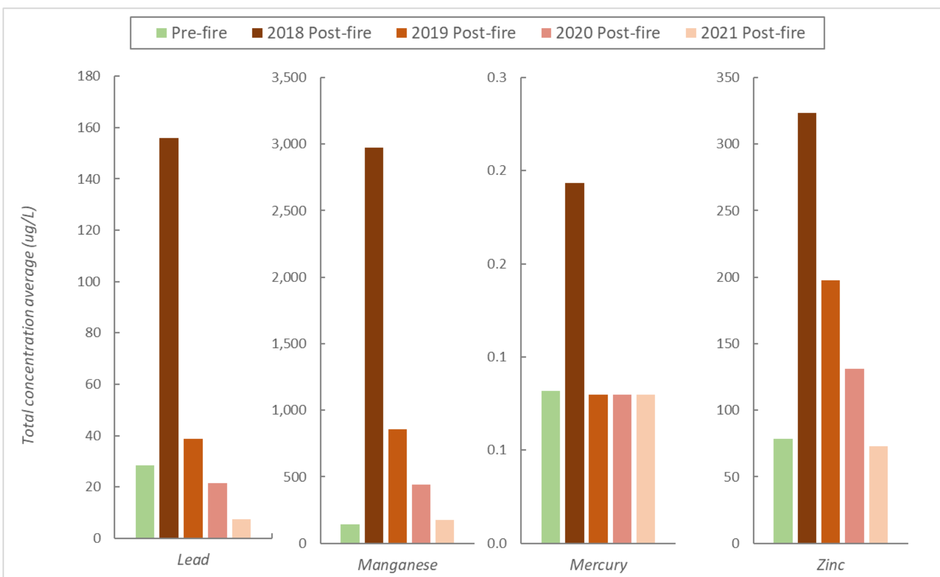


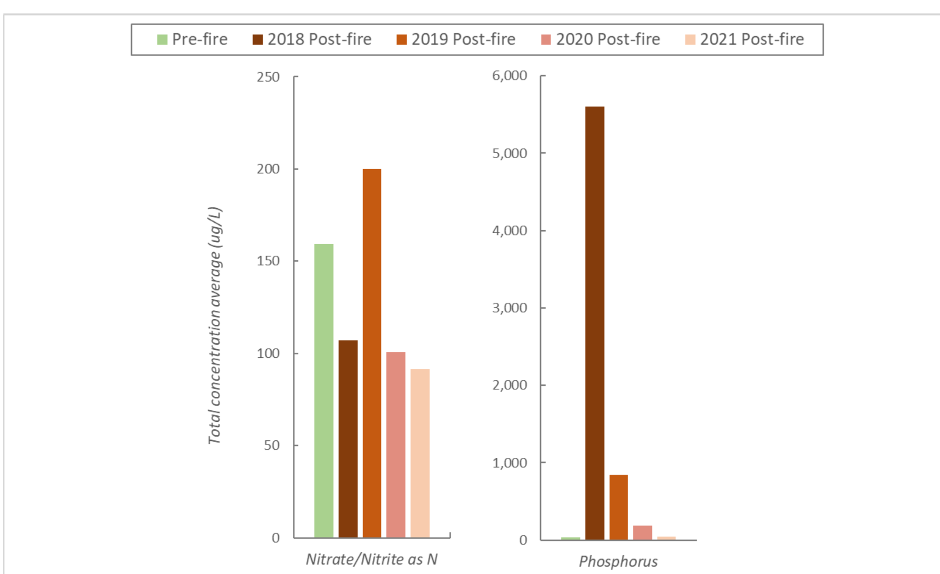




Animas River at Rotary Park







Note: Graphed post-fire 2018 results for copper and zinc are limited for Animas River at Rotary Park (n=1).

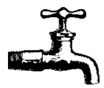
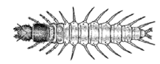
Appendix G. Preliminary water quality results: compared to Colorado Department of Public Health & Environment water quality standards

Analysis and interpretation of our broader post-fire research is ongoing. These results are preliminary and not meant for publication.

Summary

Post-416 Fire water quality compared to CDPHE water quality standards

Summary of concern for each site, time period, and water quality standard based on whether average Hazard Quotients (HQs) were greater than 1.0.

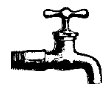
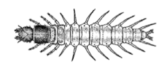
						
Site		**CDPHE Domestic Water Supply Standard^**	**CDPHE Agriculture Chronic Standard**	**CDPHE Aquatic Life Acute Standard**	**CDPHE Aquatic Life Chronic Standard**	**Interim CDPHE Nutrient Standard**
Hermosa Creek above CR 203	Pre-fire	no concern	no concern	no concern	no concern	no concern
	Post-fire 2018	Pb	Pb	Al	Al, Fe, Hg	TN, TP
	Post-fire 2019	Ba, Pb	Pb	Al	Al, Fe	TN, TP
	Post-fire 2020	no concern	no concern	Al	Al, Fe	TN, TP
	Post-fire 2021	**no concern**	**no concern**	**no concern**	**Al**	**no concern**
Junction Creek at CO trailhead	Pre-fire	no concern	no concern	no concern	no concern	-
	Post-fire 2018	no concern	no concern	no concern	no concern	no concern
	Post-fire 2019	no concern	no concern	no concern	no concern	no concern
	Post-fire 2020	no concern	no concern	no concern	no concern	no concern
	Post-fire 2021	**no concern**	**no concern**	**no concern**	**Pb**	**no concern**
Animas at Rotary Park	Pre-fire	no concern	no concern	no concern	Fe	no concern
	Post-fire 2018	Pb	Pb	Al	Al, Fe, Hg	TN, TP
	Post-fire 2019	no concern	no concern	Al	Al, Fe	TN, TP
	Post-fire 2020	no concern	no concern	Al	Al, Fe	TP
	Post-fire 2021	**no concern**	**no concern**	**no concern**	**Al, Fe**	**no concern**

^ = the purpose of the domestic water supply standard is to assess the suitability of surface water as a domestic drinking water source and is applicable to surface water prior to treatment. In some cases, there are exceedances of this standard. However, City of Durango water is thoroughly treated and meets all drinking water quality standards prior to public consumption.

Hermosa Creek

% of samples that surpassed water quality standards; average Hazard Quotients (HQ)

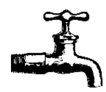
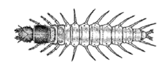
HQs are calculated as the ratio of measured exposure (concentration) to water quality standards.
HQ values equal to or greater than one indicate a potential for risk and HQ values below one indicate a low probability of risk.

					
Parameter	**Time period**	**CDPHE Domestic Water Supply Standard^**	**CDPHE Agriculture Chronic Standard**	**CDPHE Aquatic Life Acute Standard**	**CDPHE Aquatic Life Chronic Standard**
Metals					
Aluminum	Pre-fire	-	-	0/65=0%; HQ=0.02	2/65=3%; HQ=0.15
	Post-fire 2018	-	-	7/13=54%; HQ=41.73	10/13=77%; HQ=292.29
	Post-fire 2019	-	-	3/15=20%; HQ=23.60	8/15=53%; HQ=165.32
	Post-fire 2020	-	-	5/15=33%; HQ=1.74	8/15=53%; HQ=12.17
	Post-fire 2021	**-**	**-**	**0/10=0%; HQ=0.24**	**4/10=40%; HQ=1.71**
Barium	Pre-fire	-	-	-	-
	Post-fire 2018	0/1=0%; HQ=0.27	-	-	-
	Post-fire 2019	3/15=20%; HQ=1.67	-	-	-
	Post-fire 2020	3/15=20%; HQ=0.54	-	-	-
	Post-fire 2021	**0/10=0%; HQ=0.26**	**-**	**-**	**-**
Cadmium	Pre-fire	0/65=0%; HQ=0.00	0/65=0%; HQ=0.00	0/65=0%; HQ=0.00	0/65=0%; HQ=0.00
	Post-fire 2018	0/1=0%; HQ=0.00	0/1=0%; HQ=0.00	0/4=0%; HQ=0.00	0/4=0%; HQ=0.00
	Post-fire 2019	1/15=7%; HQ=0.43	1/15=7%; HQ=0.21	0/15=0%; HQ=0.00	0/15=0%; HQ=0.00
	Post-fire 2020	2/15=13%; HQ=0.33	0/15=0%; HQ=0.17	0/15=0%; HQ=0.01	0/15=0%; HQ=0.02
	Post-fire 2021	**0/10=0%; HQ=0.05**	**0/10=0%; HQ=0.03**	**0/10=0%; HQ=0.25**	**0/10=0%; HQ=0.65**
Copper	Pre-fire	0/65=0%; HQ=0.00	0/65=0%; HQ=0.00	0/65=0%; HQ=0.00	0/65=0%; HQ=0.01
	Post-fire 2018	0/2=0%; HQ=0.09	0/2=0%; HQ=0.45	0/5=0%; HQ=0.01	0/5=0%; HQ=0.01
	Post-fire 2019	0/15=0%; HQ=0.02	0/15=0%; HQ=0.12	0/15=0%; HQ=0.00	0/15=0%; HQ=0.00
	Post-fire 2020	0/15=0%; HQ=0.03	0/15=0%; HQ=0.14	0/15=0%; HQ=0.03	0/15=0%; HQ=0.04
	Post-fire 2021	**0/10=0%; HQ=0.00**	**0/10=0%; HQ=0.00**	**0/10=0%; HQ=0.00**	**0/10=0%; HQ=0.00**
Iron	Pre-fire	0/65=0%; HQ=0.01	-	-	1/65=2%; HQ=0.07
	Post-fire 2018	0/12=0%; HQ=0.17	-	-	9/13=69%; HQ=365.38
	Post-fire 2019	0/15=0%; HQ=0.10	-	-	9/15=60%; HQ=127.70
	Post-fire 2020	0/15=0%; HQ=0.03	-	-	7/15=47%; HQ=13.98
	Post-fire 2021	**0/10=0%; HQ=0.06**	**-**	**-**	**4/10=40%; HQ=0.93**
Lead	Pre-fire	0/65=0%; HQ=0.00	0/65=0%; HQ=0.00	0/65=0%; HQ=0.00	0/65=0%; HQ=0.00
	Post-fire 2018	5/13=38%; HQ=18.65	5/13=38%; HQ=9.33	0/13=0%; HQ=0.00	0/13=0%; HQ=0.01
	Post-fire 2019	3/15=20%; HQ=6.18	3/15=20%; HQ=3.09	0/15=0%; HQ=0.02	5/15=33%; HQ=0.56
	Post-fire 2020	1/15=7%; HQ=0.22	0/15=0%; HQ=0.11	0/15=0%; HQ=0.00	0/15=0%; HQ=0.00
	Post-fire 2021	**0/10=0%; HQ=0.06**	**0/10=0%; HQ=0.03**	**0/10=0%; HQ=0.01**	**2/10=20%; HQ=0.37**

Hermosa Creek

% of samples that surpassed water quality standards; average Hazard Quotients (HQ)

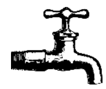
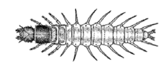
HQs are calculated as the ratio of measured exposure (concentration) to water quality standards.
HQ values equal to or greater than one indicate a potential for risk and HQ values below one indicate a low probability of risk.

					
Parameter	**Time period**	**CDPHE Domestic Water Supply Standard^**	**CDPHE Agriculture Chronic Standard**	**CDPHE Aquatic Life Acute Standard**	**CDPHE Aquatic Life Chronic Standard**
Manganese	Pre-fire	0/65=0%; HQ=0.00	0/65=0%; HQ=0.01	0/65=0%; HQ=0.00	0/65=0%; HQ=0.00
	Post-fire 2018	9/13=69%; HQ=9.50	9/13=69%; HQ=113.36	0/13=0%; HQ=0.10	1/13=8%; HQ=0.18
	Post-fire 2019	2/15=13%; HQ=0.46	6/15=40%; HQ=26.74	0/15=0%; HQ=0.01	0/15=0%; HQ=0.01
	Post-fire 2020	3/15=20%; HQ=0.85	5/15=33%; HQ=2.34	0/15=0%; HQ=0.01	0/15=0%; HQ=0.02
	Post-fire 2021	**0/10=0%; HQ=0.10**	**0/10=0%; HQ=0.23**	**0/10=0%; HQ=0.00**	**0/10=0%; HQ=0.00**
Mercury	Pre-fire	-	-	-	-
	Post-fire 2018	2/12=17%; HQ=0.51	-	-	4/12=33%; HQ=102.50
	Post-fire 2019	0/11=0%; HQ=0.00	-	-	0/11=0%; HQ=0.00
	Post-fire 2020	0/8=0%; HQ=0.00	-	-	0/8=0%; HQ=0.00
	Post-fire 2021	**0/3=0%; HQ=0.00**	**-**	**-**	**0/3=0%; HQ=0.00**
Molybdenum	Pre-fire	-	-	-	-
	Post-fire 2018	0/1=0%; HQ=0.03	0/1=0%; HQ=0.02	-	-
	Post-fire 2019	0/15=0%; HQ=0.01	0/15=0%; HQ=0.01	-	-
	Post-fire 2020	0/15=0%; HQ=0.02	0/15=0%; HQ=0.01	-	-
	Post-fire 2021	**0/10=0%; HQ=0.01**	**0/10=0%; HQ=0.01**	**-**	**-**
Nickel	Pre-fire	-	-	-	-
	Post-fire 2018	0/1=0%; HQ=0.00	0/1=0%; HQ=0.00	0/4=0%; HQ=0.00	0/4=0%; HQ=0.00
	Post-fire 2019	3/15=20%; HQ=0.34	0/15=0%; HQ=0.17	0/15=0%; HQ=0.00	0/15=0%; HQ=0.00
	Post-fire 2020	0/15=0%; HQ=0.18	0/15=0%; HQ=0.09	0/15=0%; HQ=0.00	0/15=0%; HQ=0.03
	Post-fire 2021	**0/10=0%; HQ=0.03**	**0/10=0%; HQ=0.01**	**0/10=0%; HQ=0.00**	**0/10=0%; HQ=0.03**
Zinc	Pre-fire	0/65=0%; HQ=0.00	0/65=0%; HQ=0.00	0/65=0%; HQ=0.01	0/62=0%; HQ=0.01 0/3=0%; HQ=0.45
	Post-fire 2018	0/2=0%; HQ=0.17	0/2=0%; HQ=0.42	0/5=0%; HQ=0.15	0/4=0%; HQ=0.20 0/1=0%; HQ=0.33
	Post-fire 2019	0/15=0%; HQ=0.04	0/15=0%; HQ=0.09	1/15=7%; HQ=0.10	1/14=7%; HQ=0.14 0/1=0%; HQ=0.00
	Post-fire 2020	0/15=0%; HQ=0.01	0/15=0%; HQ=0.03	0/15=0%; HQ=0.01	0/14=0%; HQ=0.01 0/1=0%; HQ=0.08
	Post-fire 2021	**0/10=0%; HQ=0.00**	**0/10=0%; HQ=0.00**	**0/10=0%; HQ=0.00**	**0/8=0%; HQ=0.00 0/2=0%; HQ=0.01**

Hermosa Creek

% of samples that surpassed water quality standards; average Hazard Quotients (HQ)

HQs are calculated as the ratio of measured exposure (concentration) to water quality standards.
HQ values equal to or greater than one indicate a potential for risk and HQ values below one indicate a low probability of risk.

					
Parameter	**Time period**	**CDPHE Domestic Water Supply Standard^**	**CDPHE Agriculture Chronic Standard**	**CDPHE Aquatic Life Acute Standard**	**CDPHE Aquatic Life Chronic Standard**
			Nutrients		
Ammonia	Pre-fire	-	-	0/61=0%; HQ=0.00	0/61=0%; HQ=0.00
	Post-fire 2018	-	-	0/4=0%; HQ=0.01	0/4=0%; HQ=0.05
	Post-fire 2019	-	-	0/15=0%; HQ=0.01	0/15=0%; HQ=0.04
	Post-fire 2020	-	-	0/15=0%; HQ=0.00	0/15=0%; HQ=0.01
	Post-fire 2021	**-**	**-**	**0/10=0%; HQ=0.00**	**0/10=0%; HQ=0.00**
Nitrate		*Acute standard*	*Acute standard*		
	Pre-fire	-	-	-	-
	Post-fire 2018	0/1=0%; HQ=0.02	0/1=0%; HQ=0.00	-	-
	Post-fire 2019	1/15=7%; HQ=0.21	0/15=0%; HQ=0.02	-	-
	Post-fire 2020	0/15=0%; HQ=0.07	0/15=0%; HQ=0.01	-	-
	Post-fire 2021	**0/10=0%; HQ=0.05**	**0/10=0%; HQ=0.01**	**-**	**-**
Nitrate/ Nitrite		*Acute standard*	*Acute standard*		
	Pre-fire	0/41=0%; HQ=0.02	0/41=0%; HQ=0.00	-	-
	Post-fire 2018	0/12=0%; HQ=0.01	0/12=0%; HQ=0.00	-	-
	Post-fire 2019	0/15=0%; HQ=0.05	0/15=0%; HQ=0.01	-	-
	Post-fire 2020	0/15=0%; HQ=0.01	0/15=0%; HQ=0.00	-	-
	Post-fire 2021	**0/10=0%; HQ=0.00**	**0/10=0%; HQ=0.00**	**-**	**-**
			Interim CDPHE Standard		
Total Nitrogen	Pre-fire	-			
	Post-fire 2018	5/9=56%; HQ=58.80			
	Post-fire 2019	8/15=53%; HQ=12.78			
	Post-fire 2020	4/15=27%; HQ=1.22			
	Post-fire 2021	**0/10=0%; HQ=0.44**			
Total Phosphorus	Pre-fire	0/30=0%; HQ=0.04			
	Post-fire 2018	10/11=91%; HQ=113.40			
	Post-fire 2019	8/15=53%; HQ=72.88			
	Post-fire 2020	5/15=33%; HQ=3.56			
	Post-fire 2021	**1/10=10%; HQ=0.35**			

- = no water quality benchmark available or assessment was not possible due to data availability or laboratory detection limits.

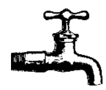
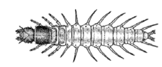
^ = the purpose of the domestic water supply standard is to assess the suitability of surface water as a domestic drinking water source and is applicable to surface water prior to treatment. In some cases, there are exceedances of this standard. However, City of Durango water is thoroughly treated and meets all drinking water quality standards prior to public consumption.

**Zinc chronic standard if hardness is >102 (top row)*	*** Zinc chronic standard if hardness is <102 (bottom row)*

Junction Creek

% of samples that surpassed water quality standards; average Hazard Quotients (HQ)

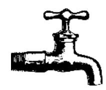
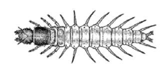
HQs are calculated as the ratio of measured exposure (concentration) to water quality standards.
HQ values equal to or greater than one indicate a potential for risk and HQ values below one indicate a low probability of risk.

					
Parameter	**Time period**	**CDPHE Domestic Water Supply Standard^**	**CDPHE Agriculture Chronic Standard**	**CDPHE Aquatic Life Acute Standard**	**CDPHE Aquatic Life Chronic Standard**
			Metals		
Aluminum	Pre-fire	-	-	0/31=0%; HQ=0.02	1/31=3%; HQ=0.17
	Post-fire 2018	-	-	-	-
	Post-fire 2019	-	-	0/15=0%; HQ=0.02	1/15=7%; HQ=0.14
	Post-fire 2020	-	-	0/15=0%; HQ=0.05	2/15=13%; HQ=0.38
	Post-fire 2021			**0/10=0%; HQ=0.03**	**1/10=10%; HQ=0.22**
Barium	Pre-fire	-	-	-	-
	Post-fire 2018	-	-	-	-
	Post-fire 2019	0/15=0%; HQ=0.23	-	-	-
	Post-fire 2020	0/15=0%; HQ=0.26	-	-	-
	Post-fire 2021	**0/10=0%; HQ=0.24**			
Cadmium	Pre-fire	0/31=0%; HQ=0.00	0/31=0%; HQ=0.00	0/31=0%; HQ=0.00	0/31=0%; HQ=0.00
	Post-fire 2018	-	-	-	-
	Post-fire 2019	0/15=0%; HQ=0.01	0/15=0%; HQ=0.01	0/15=0%; HQ=0.06	2/15=13%; HQ=0.15
	Post-fire 2020	0/15=0%; HQ=0.08	0/15=0%; HQ=0.04	0/15=0%; HQ=0.02	0/15=0%; HQ=0.06
	Post-fire 2021	**0/10=0%; HQ=0.09**	**0/10=0%; HQ=0.05**	**0/10=0%; HQ=0.37**	**5/10=50%; HQ=0.87**
Copper	Pre-fire	0/31=0%; HQ=0.00	0/31=0%; HQ=0.01	0/31=0%; HQ=0.00	0/31=0%; HQ=0.00
	Post-fire 2018	-	-	-	-
	Post-fire 2019	0/15=0%; HQ=0.00	0/15=0%; HQ=0.00	0/15=0%; HQ=0.00	0/15=0%; HQ=0.00
	Post-fire 2020	0/15=0%; HQ=0.01	0/15=0%; HQ=0.06	0/15=0%; HQ=0.04	0/15=0%; HQ=0.06
	Post-fire 2021	**0/10=0%; HQ=0.00**	**0/10=0%; HQ=0.00**	**0/10=0%; HQ=0.00**	**0/10=0%; HQ=0.00**
Iron	Pre-fire	0/31=0%; HQ=0.04	-	-	1/31=3%; HQ=0.12
	Post-fire 2018	-	-	-	-
	Post-fire 2019	0/15=0%; HQ=0.01	-	-	0/15=0%; HQ=0.09
	Post-fire 2020	0/15=0%; HQ=0.01	-	-	0/15=0%; HQ=0.05
	Post-fire 2021	**0/10=0%; HQ=0.00**	**-**	**-**	**0/10=0%; HQ=0.03**
Lead	Pre-fire	0/31=0%; HQ=0.01	0/31=0%; HQ=0.00	0/31=0%; HQ=0.00	0/31=0%; HQ=0.00
	Post-fire 2018	-	-	-	-
	Post-fire 2019	0/15=0%; HQ=0.03	0/15=0%; HQ=0.02	0/15=0%; HQ=0.03	6/15=40%; HQ=0.70
	Post-fire 2020	0/15=0%; HQ=0.00	0/15=0%; HQ=0.00	0/15=0%; HQ=0.00	0/15=0%; HQ=0.00
	Post-fire 2021	**0/10=0%; HQ=0.02**	**0/10=0%; HQ=0.01**	**0/10=0%; HQ=0.04**	**4/10=40%; HQ=1.05**

Junction Creek

% of samples that surpassed water quality standards; average Hazard Quotients (HQ)

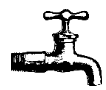
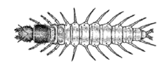
HQs are calculated as the ratio of measured exposure (concentration) to water quality standards.
HQ values equal to or greater than one indicate a potential for risk and HQ values below one indicate a low probability of risk.

					
Parameter	**Time period**	**CDPHE Domestic Water Supply Standard^**	**CDPHE Agriculture Chronic Standard**	**CDPHE Aquatic Life Acute Standard**	**CDPHE Aquatic Life Chronic Standard**
Manganese	Pre-fire	0/31=0%; HQ=0.02	-	0/31=0%; HQ=0.00	0/31=0%; HQ=0.00
	Post-fire 2018	-	-	-	-
	Post-fire 2019	0/15=0%; HQ=0.02	-	0/15=0%; HQ=0.00	0/15=0%; HQ=0.00
	Post-fire 2020	0/15=0%; HQ=0.01	-	0/15=0%; HQ=0.00	0/15=0%; HQ=0.00
	Post-fire 2021	**0/10=0%; HQ=0.00**	**-**	**0/10=0%; HQ=0.00**	**0/10=0%; HQ=0.00**
Mercury	Pre-fire	-	-	-	-
	Post-fire 2018	-	-	-	-
	Post-fire 2019	0/15=0%; HQ=0.00	-	-	0/15=0%; HQ=0.00
	Post-fire 2020	0/8=0%; HQ=0.00	-	-	0/8=0%; HQ=0.00
	Post-fire 2021	**0/3=0%; HQ=0.00**	**-**	**-**	**0/3=0%; HQ=0.00**
Molybdenum	Pre-fire	-	-	-	-
	Post-fire 2018	-	-	-	-
	Post-fire 2019	0/15=0%; HQ=0.01	0/15=0%; HQ=0.00	-	-
	Post-fire 2020	0/15=0%; HQ=0.02	0/15=0%; HQ=0.01	-	-
	Post-fire 2021	**0/10=0%; HQ=0.01**	**0/10=0%; HQ=0.01**	**-**	**-**
Nickel	Pre-fire	-	-	-	-
	Post-fire 2018	-	-	-	-
	Post-fire 2019	0/15=0%; HQ=0.00	0/15=0%; HQ=0.00	0/15=0%; HQ=0.00	0/15=0%; HQ=0.00
	Post-fire 2020	0/15=0%; HQ=0.03	0/15=0%; HQ=0.02	0/15=0%; HQ=0.01	0/15=0%; HQ=0.05
	Post-fire 2021	**0/10=0%; HQ=0.02**	**0/10=0%; HQ=0.01**	**0/10=0%; HQ=0.01**	**0/10=0%; HQ=0.06**
Zinc	Pre-fire	0/31=0%; HQ=0.00	0/31=0%; HQ=0.00	0/31=0%; HQ=0.00	0/29=0%; HQ=0.01 0/2=0%; HQ=0.00
	Post-fire 2018	-	-	-	- -
	Post-fire 2019	0/15=0%; HQ=0.00	0/15=0%; HQ=0.00	1/15=7%; HQ=0.18	1/12=8%; HQ=0.30 0/3=0%; HQ=0.00
	Post-fire 2020	0/15=0%; HQ=0.00	0/15=0%; HQ=0.00	0/15=0%; HQ=0.00	0/10=0%; HQ=0.00 0/5=0%; HQ=0.00
	Post-fire 2021	**0/10=0%; HQ=0.00**	**0/10=0%; HQ=0.00**	**0/10=0%; HQ=0.00**	**0/2=0%; HQ=0.00** **0/8=0%; HQ=0.00**

Junction Creek

% of samples that surpassed water quality standards; average Hazard Quotients (HQ)

HQs are calculated as the ratio of measured exposure (concentration) to water quality standards.
HQ values equal to or greater than one indicate a potential for risk and HQ values below one indicate a low probability of risk.

					
Parameter	**Time period**	**CDPHE Domestic Water Supply Standard^**	**CDPHE Agriculture Chronic Standard**	**CDPHE Aquatic Life Acute Standard**	**CDPHE Aquatic Life Chronic Standard**
Nutrients					
Ammonia	Pre-fire	-	-	0/2=0%; HQ=0.00	0/2=0%; HQ=0.00
	Post-fire 2018	-	-	-	-
	Post-fire 2019	-	-	0/15=0%; HQ=0.00	0/15=0%; HQ=0.00
	Post-fire 2020	-	-	0/15=0%; HQ=0.00	0/15=0%; HQ=0.00
	Post-fire 2021	**-**	**-**	**0/10=0%; HQ=0.00**	**0/10=0%; HQ=0.00**
Nitrate		*Acute standard*	*Acute standard*		
	Pre-fire	-	-	-	-
	Post-fire 2018	-	-	-	-
	Post-fire 2019	0/15=0%; HQ=0.02	0/15=0%; HQ=0.00	-	-
	Post-fire 2020	0/15=0%; HQ=0.03	0/15=0%; HQ=0.00	-	-
	Post-fire 2021	**0/10=0%; HQ=0.03**	**0/10=0%; HQ=0.00**	**-**	**-**
Nitrate/ Nitrite		*Acute standard*	*Acute standard*		
	Pre-fire	-	-	-	-
	Post-fire 2018	-	-	-	-
	Post-fire 2019	0/15=0%; HQ=0.00	0/15=0%; HQ=0.00	-	-
	Post-fire 2020	0/15=0%; HQ=0.00	0/15=0%; HQ=0.00	-	-
	Post-fire 2021	**0/10=0%; HQ=0.00**	**0/10=0%; HQ=0.00**	**-**	**-**
Interim CDPHE Standard					
Total Nitrogen	Pre-fire	-			
	Post-fire 2018	-			
	Post-fire 2019	0/15=0%; HQ=0.45			
	Post-fire 2020	0/15=0%; HQ=0.42			
	Post-fire 2021	**0/10=0%; HQ=0.42**			
Total Phosphorus	Pre-fire	0/2=0%; HQ=0.00			
	Post-fire 2018	-			
	Post-fire 2019	1/15=7%; HQ=0.31			
	Post-fire 2020	0/15=0%; HQ=0.00			
	Post-fire 2021	**0/10=0%; HQ=0.00**			

- = no water quality benchmark available or assessment was not possible due to data availability or laboratory detection limits.

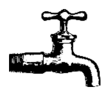
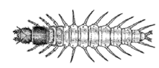
^ = the purpose of the domestic water supply standard is to assess the suitability of surface water as a domestic drinking water source and is applicable to surface water prior to treatment. In some cases, there are exceedances of this standard. However, City of Durango water is thoroughly treated and meets all drinking water quality standards prior to public consumption.

**Zinc chronic standard if hardness is >102 (top row)*	*** Zinc chronic standard if hardness is <102 (bottom row)*

Animas River at Rotary Park

% of samples that surpassed water quality standards; average Hazard Quotients (HQ)

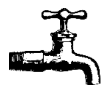
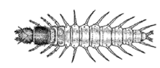
HQs are calculated as the ratio of measured exposure (concentration) to water quality standards.
HQ values equal to or greater than one indicate a potential for risk and HQ values below one indicate a low probability of risk.

					
Parameter	**Time period**	**CDPHE Domestic Water Supply Standard^**	**CDPHE Agriculture Chronic Standard**	**CDPHE Aquatic Life Acute Standard**	**CDPHE Aquatic Life Chronic Standard**
			Metals		
Aluminum	Pre-fire	-	-	9/398=2%; HQ=0.10	68/398=17%; HQ=0.72
	Post-fire 2018	-	-	4/15=27%; HQ=6.35	7/15=47%; HQ=44.50
	Post-fire 2019	-	-	4/15=27%; HQ=1.97	10/15=67%; HQ=13.78
	Post-fire 2020	-	-	5/15=33%; HQ=2.04	8/15=53%; HQ=14.32
	Post-fire 2021	**-**	**-**	**1/10=10%; HQ=0.23**	**2/10=20%; HQ=1.59**
Barium	Pre-fire	0/138=0%; HQ=0.11	-	-	-
	Post-fire 2018	0/1=0%; HQ=0.11	-	-	-
	Post-fire 2019	2/15=13%; HQ=0.53	-	-	-
	Post-fire 2020	1/15=7%; HQ=0.27	-	-	-
	Post-fire 2021	**0/10=0%; HQ=0.11**	**-**	**-**	**-**
Cadmium	Pre-fire	1/337=0%; HQ=0.02	0/337=0%; HQ=0.01	0/304=0%; HQ=0.00	2/304=1%; HQ=0.01
	Post-fire 2018	0/1=0%; HQ=0.00	0/1=0%; HQ=0.00	0/4=0%; HQ=0.02	0/4=0%; HQ=0.06
	Post-fire 2019	0/15=0%; HQ=0.16	0/15=0%; HQ=0.08	0/15=0%; HQ=0.07	1/15=7%; HQ=0.17
	Post-fire 2020	1/15=7%; HQ=0.33	1/15=7%; HQ=0.17	0/15=0%; HQ=0.04	0/15=0%; HQ=0.11
	Post-fire 2021	**0/10=0%; HQ=0.17**	**0/10=0%; HQ=0.08**	**0/10=0%; HQ=0.27**	**2/10=20%; HQ=0.72**
Copper	Pre-fire	0/401=0%; HQ=0.01	3/401=1%; HQ=0.05	3/368=1%; HQ=0.09	7/368=2%; HQ=0.15
	Post-fire 2018	0/1=0%; HQ=0.00	0/1=0%; HQ=0.00	0/4=0%; HQ=0.00	0/4=0%; HQ=0.00
	Post-fire 2019	0/15=0%; HQ=0.02	0/15=0%; HQ=0.11	0/15=0%; HQ=0.00	0/15=0%; HQ=0.00
	Post-fire 2020	0/15=0%; HQ=0.03	0/15=0%; HQ=0.13	0/15=0%; HQ=0.07	1/15=7%; HQ=0.11
	Post-fire 2021	**0/10=0%; HQ=0.00**	**0/10=0%; HQ=0.02**	**0/10=0%; HQ=0.01**	**0/10=0%; HQ=0.02**
Iron	Pre-fire	3/356=1%; HQ=0.14	-	-	67/401=17%; HQ=1.95
	Post-fire 2018	2/14=14%; HQ=0.40	-	-	7/16=44%; HQ=67.54
	Post-fire 2019	1/15=7%; HQ=0.91	-	-	10/15=67%; HQ=13.65
	Post-fire 2020	0/15=0%; HQ=0.15	-	-	6/15=40%; HQ=11.11
	Post-fire 2021	**0/10=0%; HQ=0.26**	**-**	**-**	**3/10=30%; HQ=1.58**
Lead	Pre-fire	16/401=4%; HQ=0.52	10/401=2%; HQ=0.26	0/368=0%; HQ=0.01	9/368=2%; HQ=0.16
	Post-fire 2018	4/16=25%; HQ=3.08	4/16=25%; HQ=1.54	0/15=0%; HQ=0.00	1/15=7%; HQ=0.08
	Post-fire 2019	5/15=33%; HQ=0.76	1/15=7%; HQ=0.38	0/15=0%; HQ=0.02	6/15=40%; HQ=0.63
	Post-fire 2020	2/15=13%; HQ=0.35	1/15=7%; HQ=0.18	0/15=0%; HQ=0.00	0/15=0%; HQ=0.00
	Post-fire 2021	**0/10=0%; HQ=0.13**	**0/10=0%; HQ=0.06**	**0/10=0%; HQ=0.02**	**3/10=30%; HQ=0.60**

Animas River at Rotary Park

% of samples that surpassed water quality standards; average Hazard Quotients (HQ)

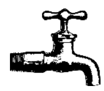
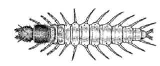
HQs are calculated as the ratio of measured exposure (concentration) to water quality standards.
HQ values equal to or greater than one indicate a potential for risk and HQ values below one indicate a low probability of risk.

					
Parameter	**Time period**	**CDPHE Domestic Water Supply Standard^**	**CDPHE Agriculture Chronic Standard**	**CDPHE Aquatic Life Acute Standard**	**CDPHE Aquatic Life Chronic Standard**
Manganese	Pre-fire	213/341=62%; HQ=1.77	-	0/341=0%; HQ=0.02	0/341=0%; HQ=0.04
	Post-fire 2018	10/15=67%; HQ=5.37	-	0/15=0%; HQ=0.06	0/15=0%; HQ=0.11
	Post-fire 2019	13/15=87%; HQ=2.43	-	0/15=0%; HQ=0.04	0/15=0%; HQ=0.06
	Post-fire 2020	12/15=80%; HQ=1.80	-	0/15=0%; HQ=0.03	0/15=0%; HQ=0.05
	***Post-fire 2021**	**9/10=90%; HQ=1.64**	**-**	**0/10=0%; HQ=0.02**	**0/10=0%; HQ=0.04**
Mercury	Pre-fire	0/141=0%; HQ=0.00	-	-	2/141=1%; HQ=0.29
	Post-fire 2018	0/12=0%; HQ=0.07	-	-	3/12=25%; HQ=13.33
	Post-fire 2019	0/11=0%; HQ=0.00	-	-	0/11=0%; HQ=0.00
	Post-fire 2020	0/8=0%; HQ=0.00	-	-	0/8=0%; HQ=0.00
	Post-fire 2021	**0/3=0%; HQ=0.00**	**-**	**-**	**0/3=0%; HQ=0.00**
Molybdenum	Pre-fire	0/135=0%; HQ=0.01	0/135=0%; HQ=0.00	-	-
	Post-fire 2018	0/1=0%; HQ=0.01	0/1=0%; HQ=0.01	-	-
	Post-fire 2019	0/15=0%; HQ=0.00	0/15=0%; HQ=0.00	-	-
	Post-fire 2020	0/15=0%; HQ=0.05	0/15=0%; HQ=0.03	-	-
	Post-fire 2021	**0/10=0%; HQ=0.01**	**0/10=0%; HQ=0.01**	**-**	**-**
Nickel	Pre-fire	0/129=0%; HQ=0.01	0/129=0%; HQ=0.01	0/101=0%; HQ=0.00	0/101=0%; HQ=0.01
	Post-fire 2018	0/1=0%; HQ=0.00	0/1=0%; HQ=0.00	0/4=0%; HQ=0.00	0/4=0%; HQ=0.00
	Post-fire 2019	1/15=7%; HQ=0.14	0/15=0%; HQ=0.07	0/15=0%; HQ=0.00	0/15=0%; HQ=0.00
	Post-fire 2020	0/15=0%; HQ=0.12	0/15=0%; HQ=0.06	0/15=0%; HQ=0.01	0/15=0%; HQ=0.04
	Post-fire 2021	**0/10=0%; HQ=0.03**	**0/10=0%; HQ=0.02**	**0/10=0%; HQ=0.00**	**0/10=0%; HQ=0.03**
Zinc	Pre-fire	0/401=0%; HQ=0.02	0/401=0%; HQ=0.04	0/368=0%; HQ=0.16	2/331=1%; HQ=0.18 3/37=8%; HQ=0.82
	Post-fire 2018	0/1=0%; HQ=0.06	0/1=0%; HQ=0.16	1/4=25%; HQ=0.32	1/4=25%; HQ=0.43 -
	Post-fire 2019	0/15=0%; HQ=0.04	0/15=0%; HQ=0.10	1/15=7%; HQ=0.23	1/12=8%; HQ=0.35 0/3=0%; HQ=0.23
	Post-fire 2020	0/15=0%; HQ=0.03	0/15=0%; HQ=0.07	0/15=0%; HQ=0.09	0/11=0%; HQ=0.08 0/4=0%; HQ=0.31
	Post-fire 2021	**0/10=0%; HQ=0.01**	**0/10=0%; HQ=0.04**	**0/10=0%; HQ=0.13**	**0/8=0%; HQ=0.13** **0/2=0%; HQ=0.40**

Animas River at Rotary Park

% of samples that surpassed water quality standards; average Hazard Quotients (HQ)

HQs are calculated as the ratio of measured exposure (concentration) to water quality standards.
HQ values equal to or greater than one indicate a potential for risk and HQ values below one indicate a low probability of risk.

					
Parameter	**Time period**	**CDPHE Domestic Water Supply Standard^**	**CDPHE Agriculture Chronic Standard**	**CDPHE Aquatic Life Acute Standard**	**CDPHE Aquatic Life Chronic Standard**
Nutrients					
Ammonia	Pre-fire	-	-	0/21=0%; HQ=0.00	0/21=0%; HQ=0.01
	Post-fire 2018	-	-	0/4=0%; HQ=0.21	1/4=25%; HQ=0.80
	Post-fire 2019	-	-	0/15=0%; HQ=0.00	0/15=0%; HQ=0.02
	Post-fire 2020	-	-	0/15=0%; HQ=0.00	0/15=0%; HQ=0.00
	Post-fire 2021	**-**	**-**	**0/10=0%; HQ=0.00**	**0/10=0%; HQ=0.00**
Nitrate		*Acute standard*	*Acute standard*		
	Pre-fire	-	-	-	-
	Post-fire 2018	0/1=0%; HQ=0.08	0/1=0%; HQ=0.01	-	-
	Post-fire 2019	0/15=0%; HQ=0.12	0/15=0%; HQ=0.01	-	-
	Post-fire 2020	0/15=0%; HQ=0.06	0/15=0%; HQ=0.01	-	-
	Post-fire 2021	**0/10=0%; HQ=0.06**	**0/10=0%; HQ=0.01**	**-**	**-**
Nitrate/ Nitrite		*Acute standard*	*Acute standard*		
	Pre-fire	0/22=0%; HQ=0.02	0/22=0%; HQ=0.00	-	-
	Post-fire 2018	0/15=0%; HQ=0.01	0/15=0%; HQ=0.00	-	-
	Post-fire 2019	0/15=0%; HQ=0.02	0/15=0%; HQ=0.00	-	-
	Post-fire 2020	0/15=0%; HQ=0.01	0/15=0%; HQ=0.00	-	-
	Post-fire 2021	**0/10=0%; HQ=0.01**	**0/10=0%; HQ=0.00**	**-**	**-**
Interim CDPHE Standard					
Total Nitrogen	Pre-fire	-			
	Post-fire 2018	5/11=45%; HQ=15.54			
	Post-fire 2019	6/15=40%; HQ=2.66			
	Post-fire 2020	2/15=13%; HQ=0.86			
	Post-fire 2021	**0/10=0%; HQ=0.48**			
Total Phosphorus	Pre-fire	0/21=0%; HQ=0.29			
	Post-fire 2018	7/13=54%; HQ=50.85			
	Post-fire 2019	8/15=53%; HQ=7.62			
	Post-fire 2020	4/15=27%; HQ=1.57			
	Post-fire 2021	**1/10=10%; HQ=0.32**			

- = no water quality benchmark available or assessment was not possible due to data availability, laboratory detection limits, or soil pH levels

^ = the purpose of the domestic water supply standard is to assess the suitability of surface water as a domestic drinking water source and is applicable to surface water prior to treatment. In some cases, there are exceedances of this standard. However, City of Durango water is thoroughly treated and meets all drinking water quality standards prior to public consumption.

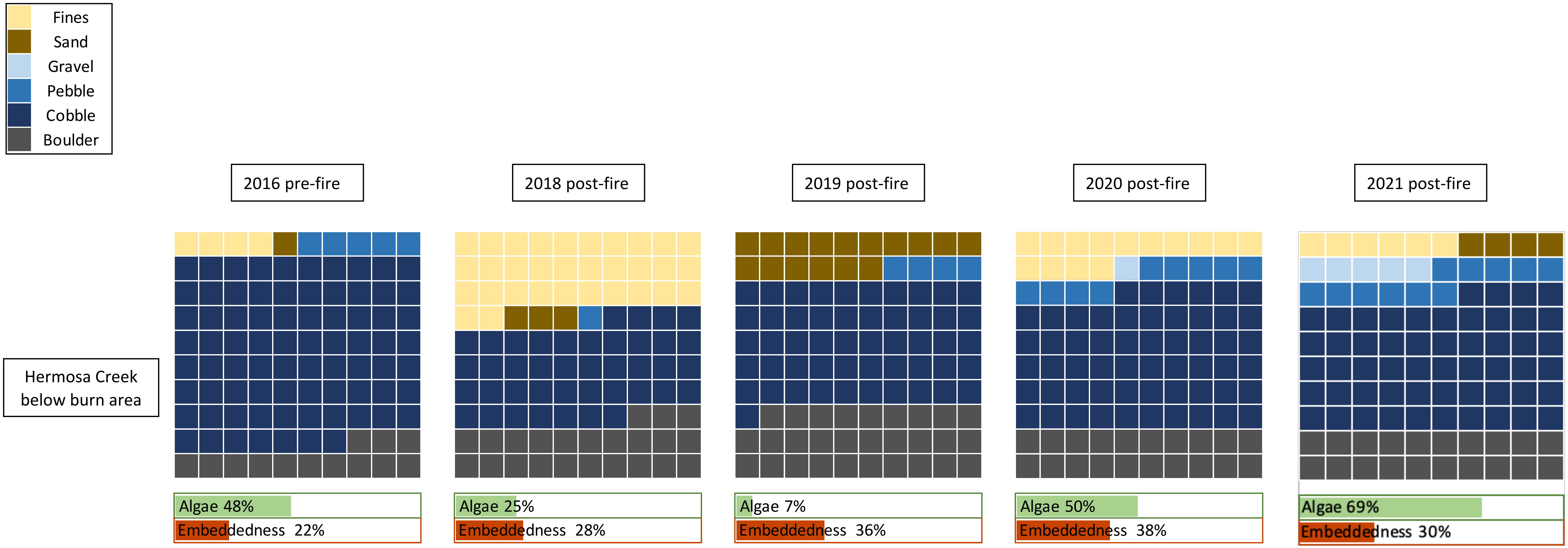
**Manganese at this level is not of concern for human health. The concern is associated with aesthetic effects such as staining of appliances.*

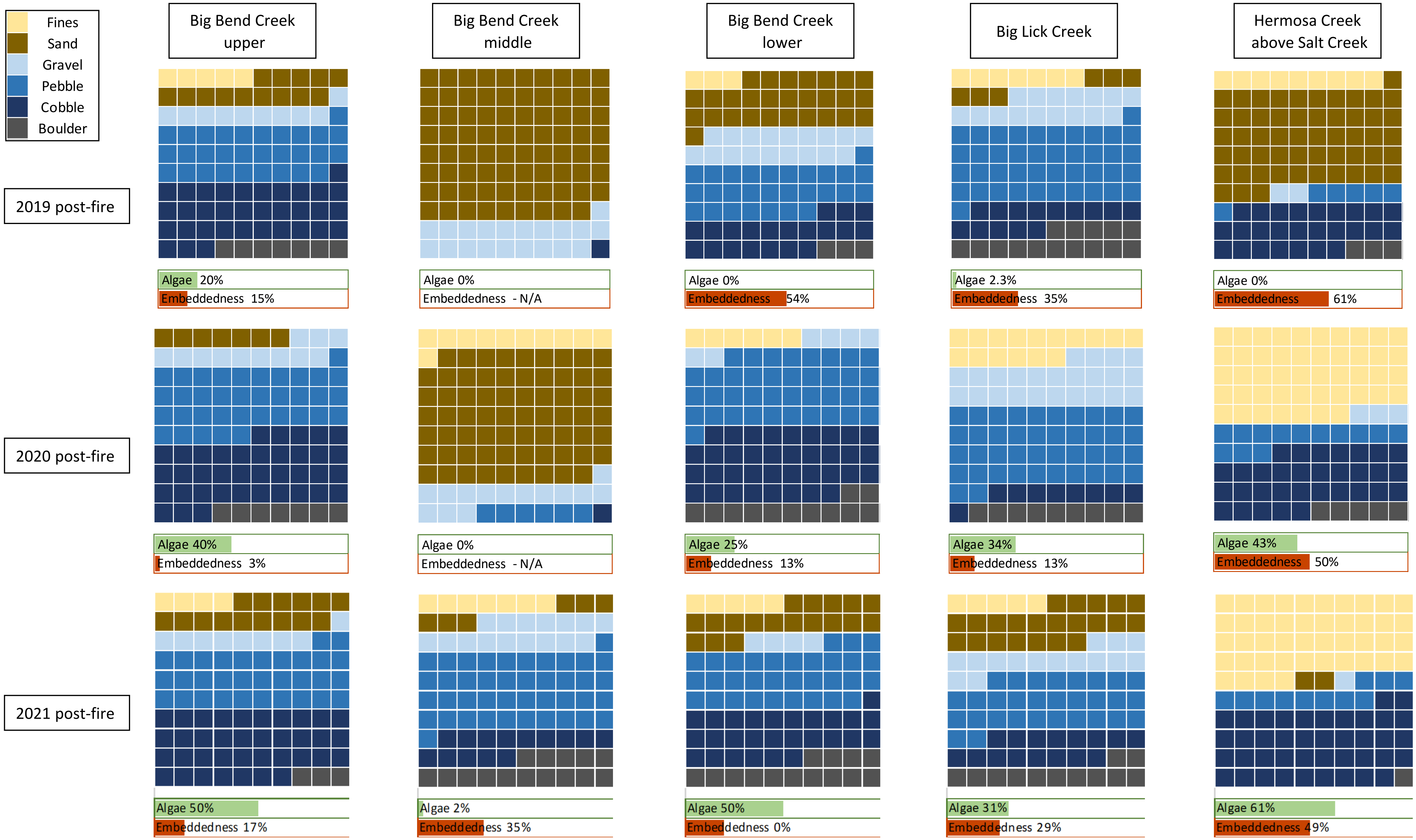
Zinc chronic standard if hardness is >102 (top row)	*Zinc chronic standard if hardness is <102 (bottom row)*

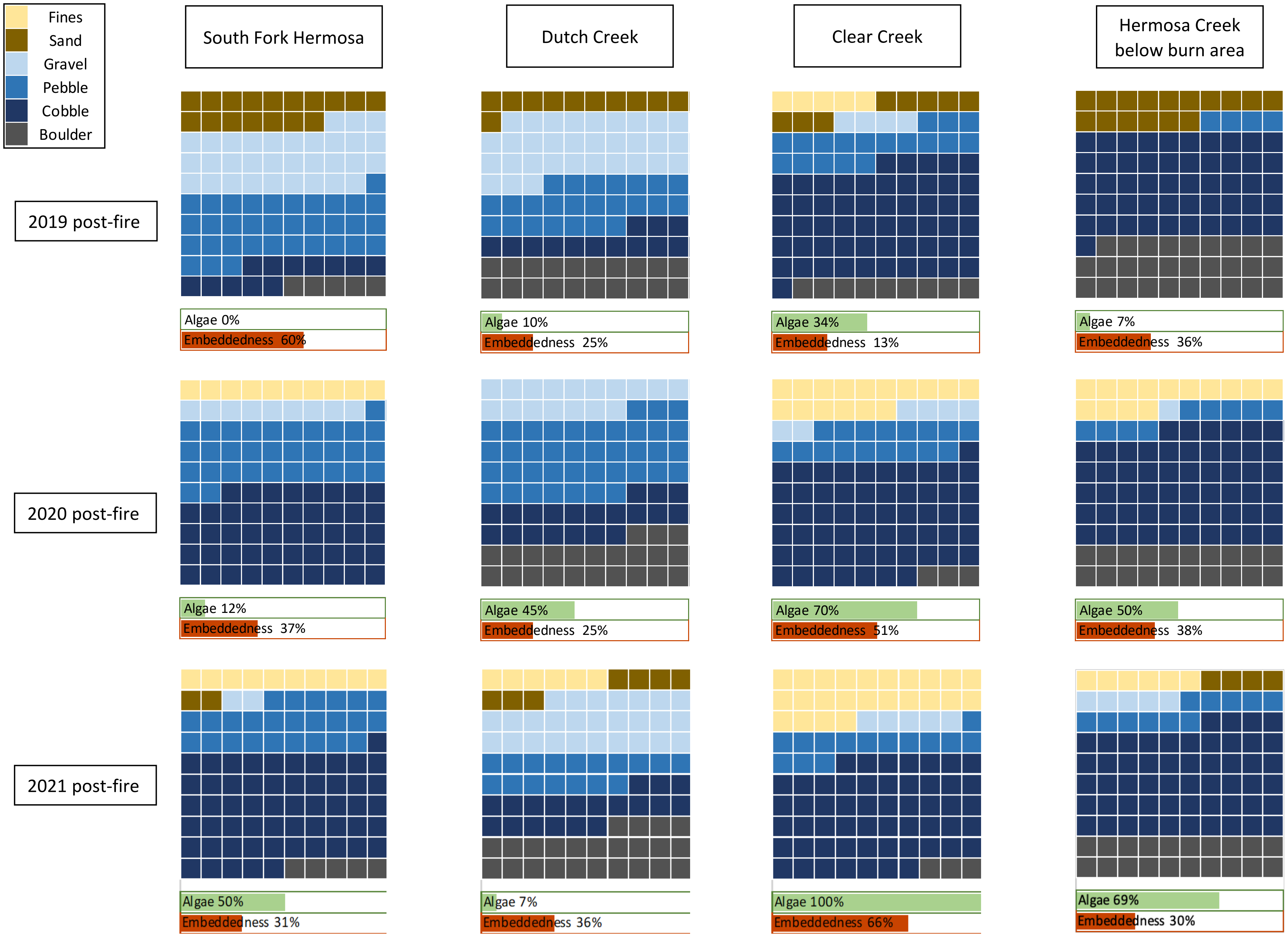
Appendix H. Preliminary post-fire physical habitat graphs

Analysis and interpretation of our broader post-fire research is ongoing. These results are preliminary and not meant for publication.

Burned Tributaries

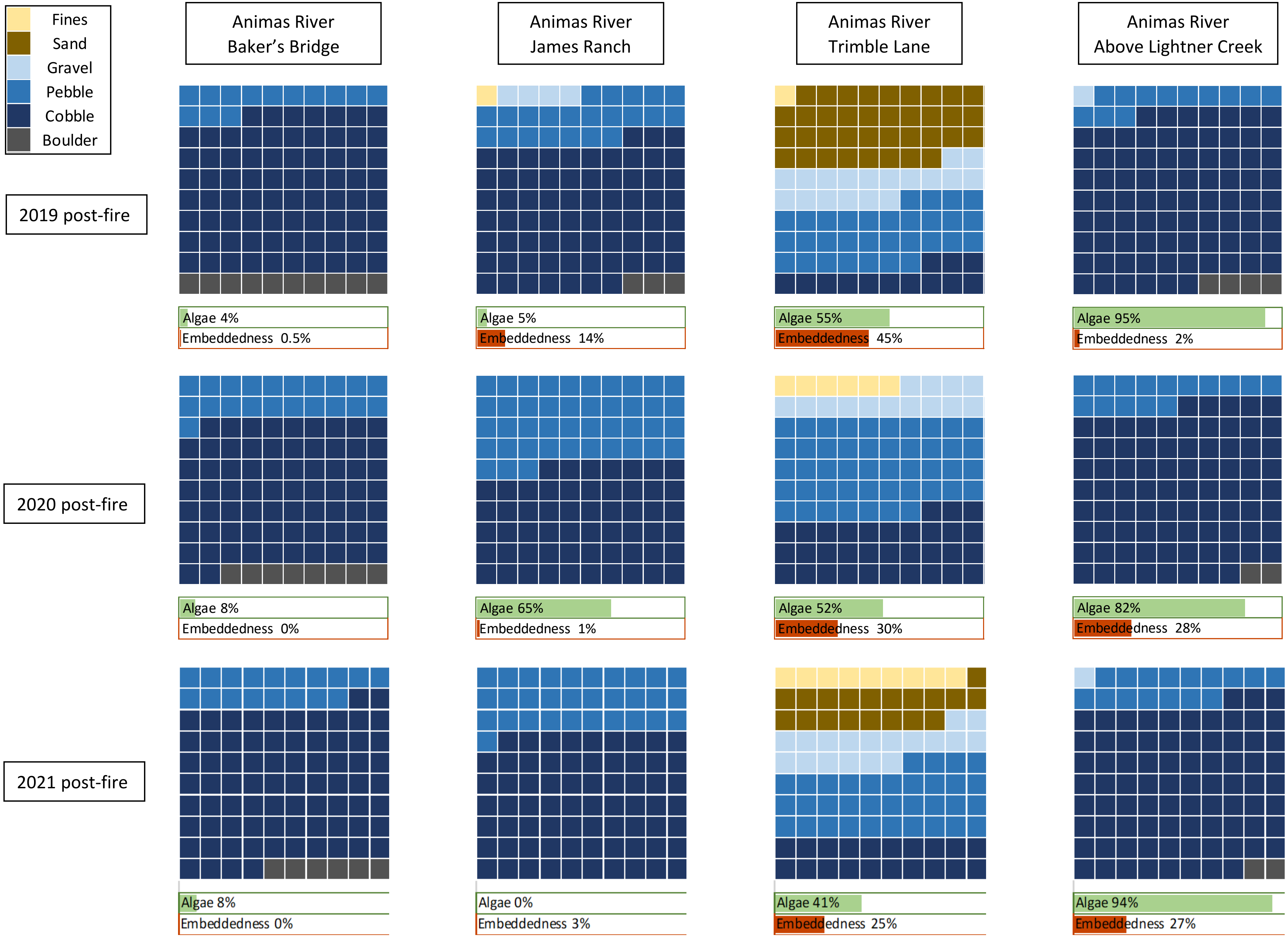

Fines
Sand
Gravel
Pebble
Cobble
Boulder
2016 pre-fire
2018 post-fire
2019 post-fire
2020 post-fire
2021 post-fire
Hermosa Creek below burn area
Algae 48%
Embeddedness 22%
Algae 25%
Embeddedness 28%
Algae 7%
Embeddedness 36%
Algae 50%
Embeddedness 38%
Algae 69%
Embeddedness 30%


Fines
Sand
Gravel
Pebble
Cobble
Boulder
Big Bend Creek upper
Big Bend Creek middle
Big Bend Creek lower
Big Lick Creek
Hermosa Creek above Salt Creek
2019 post-fire
Algae 20%
Embeddedness 15%
Algae 0%
Embeddedness - N/A
Algae 0%
Embeddedness 54%
Algae 2.3%
Embeddedness 35%
Algae 0%
Embeddedness 61%
2020 post-fire
Algae 40%
Embeddedness 3%
Algae 0%
Embeddedness - N/A
Algae 25%
Embeddedness 13%
Algae 34%
Embeddedness 13%
Algae 43%
Embeddedness 50%
2021 post-fire
Algae 50%
Embeddedness 17%
Algae 2%
Embeddedness 35%
Algae 50%
Embeddedness 0%
Algae 31%
Embeddedness 29%
Algae 61%
Embeddedness 49%



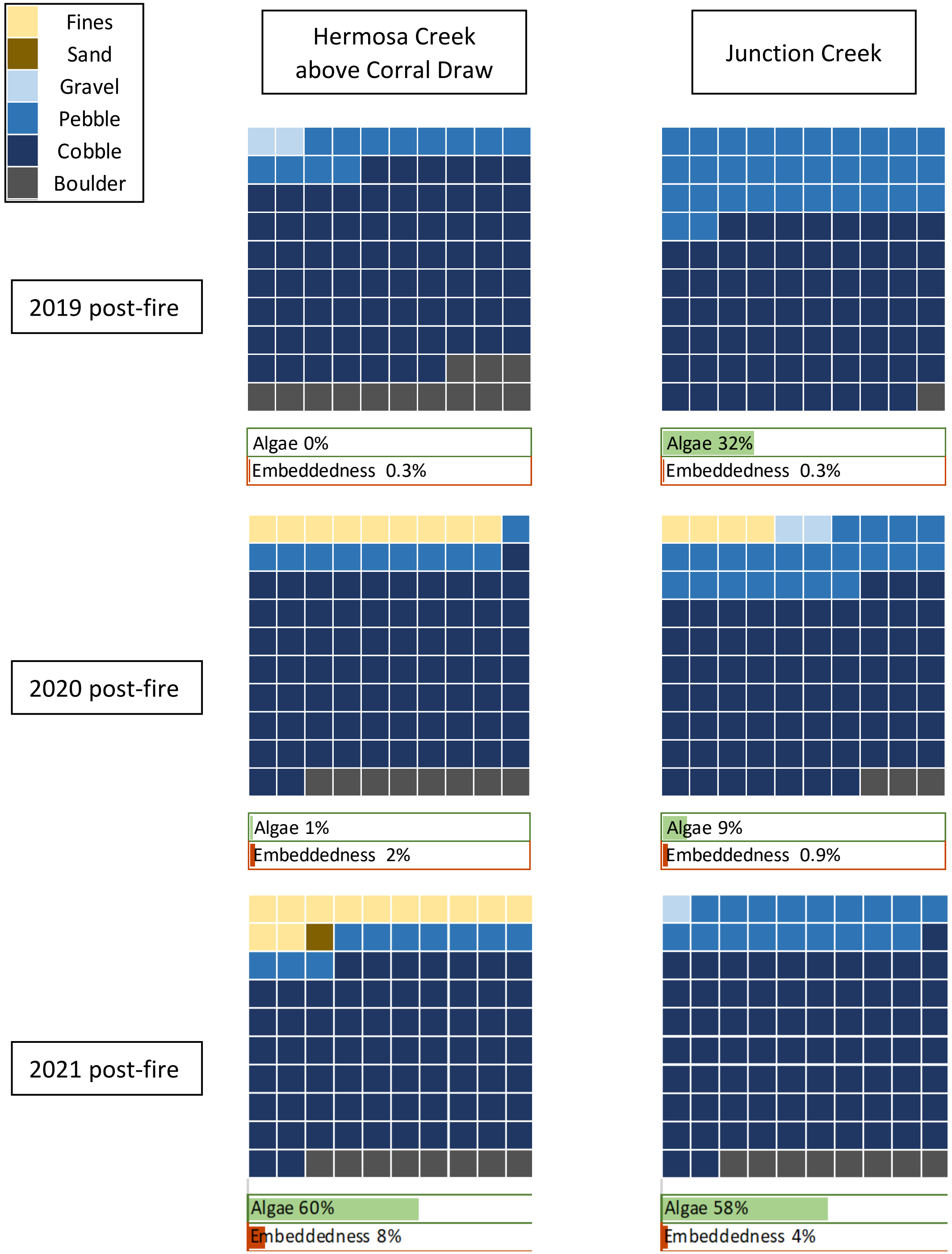
Fines
Sand
Gravel
Pebble
Cobble
Boulder
South Fork Hermosa
Dutch Creek
Clear Creek
Hermosa Creek below burn area
2019 post-fire
2020 post-fire
2021 post-fire
Algae 0%
Embeddedness 60%
Algae 10%
Embeddedness 25%
Algae 34%
Embeddedness 13%
Algae 7%
Embeddedness 36%
Algae 12%
Embeddedness 37%
Algae 45%
Embeddedness 25%
Algae 70%
Embeddedness 51%
Algae 50%
Embeddedness 38%
Algae 50%
Embeddedness 31%
Algae 7%
Embeddedness 36%
Algae 100%
Embeddedness 66%
Algae 69%
Embeddedness 30%

Animas



Fines
Sand
Gravel
Pebble
Cobble
Boulder
Animas River Baker's Bridge
Animas River James Ranch
Animas River Trimble Lane
Animas River Above Lightner Creek
2019 post-fire
2020 post-fire
2021 post-fire
Algae 4%
Embeddedness 0.5%
Algae 5%
Embeddedness 14%
Algae 55%
Embeddedness 45%
Algae 95%
Embeddedness 2%
Algae 8%
Embeddedness 0%
Algae 65%
Embeddedness 1%
Algae 52%
Embeddedness 30%
Algae 82%
Embeddedness 28%
Algae 8%
Embeddedness 0%
Algae 0%
Embeddedness 3%
Algae 41%
Embeddedness 25%
Algae 94%
Embeddedness 27%

Unburned

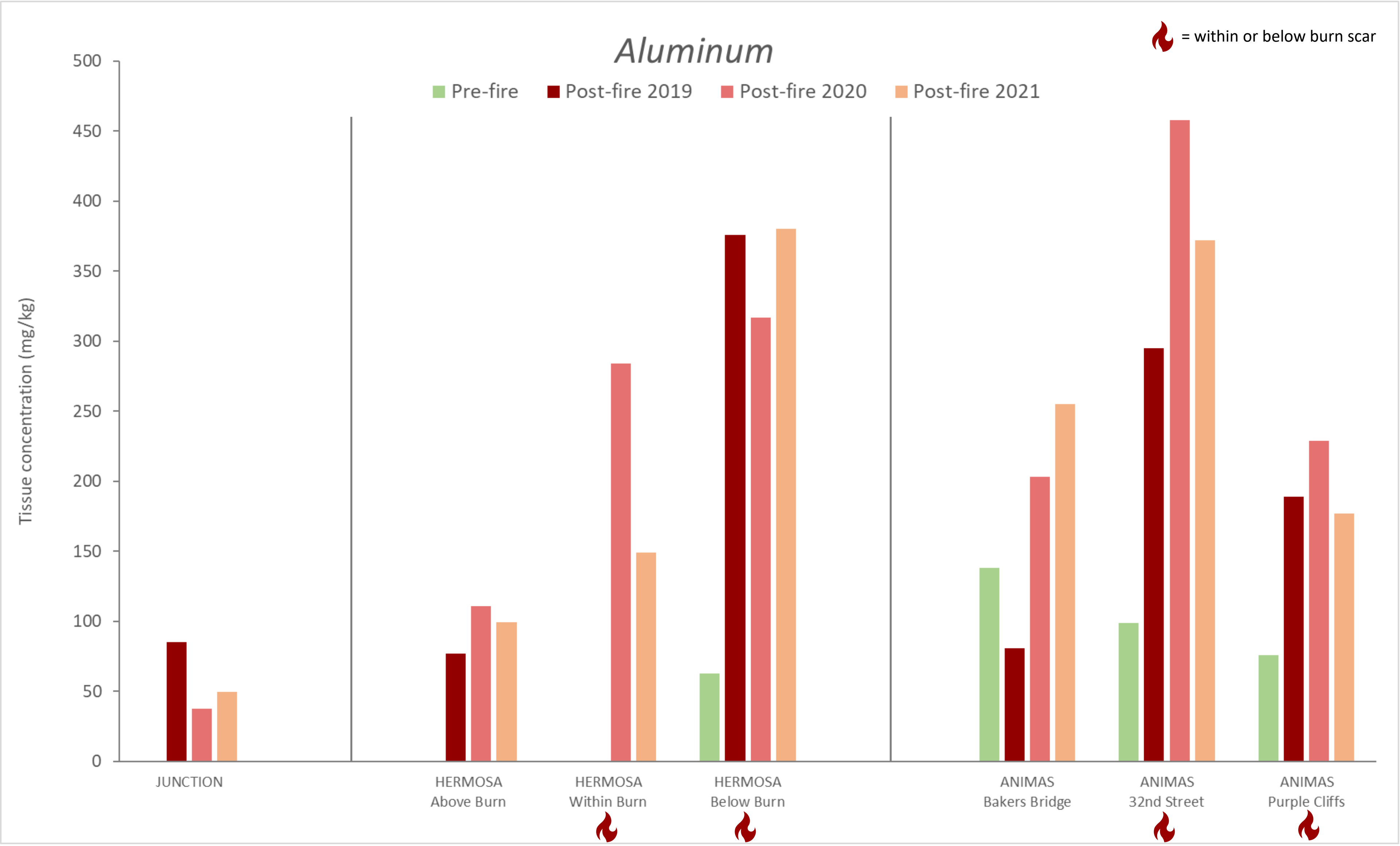


Fines
Sand
Gravel
Pebble
Cobble
Boulder
Hermosa Creek above Corral Draw
Junction Creek
2019 post-fire
Algae 0%
Embeddedness 0.3%
Algae 32%
Embeddedness 0.3%
2020 post-fire
Algae 1%
Embeddedness 2%
Algae 9%
Embeddedness 0.9%
2021 post-fire
Algae 60%
Embeddedness 8%
Algae 58%
Embeddedness 4%

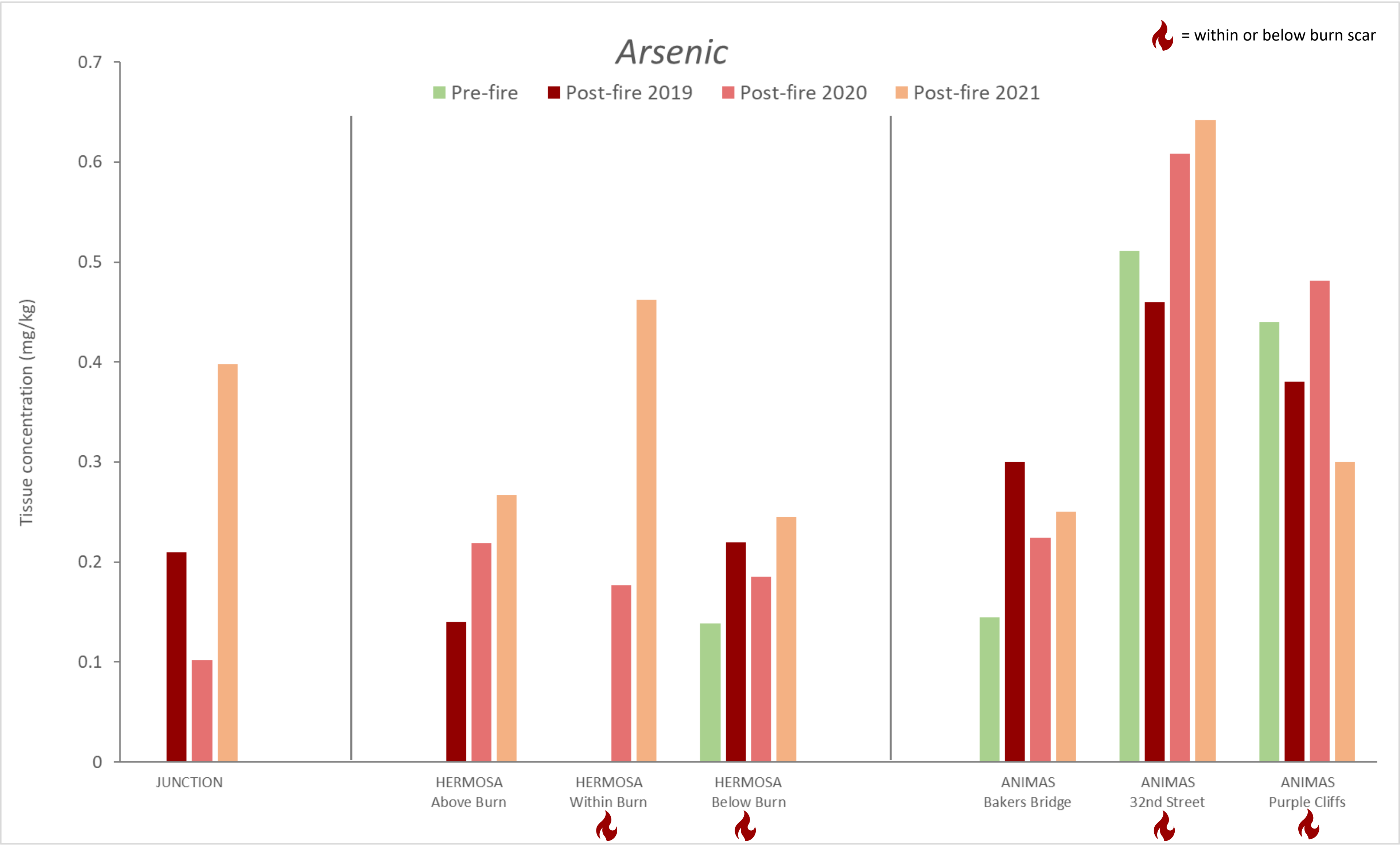
Appendix I. Preliminary benthic macroinvertebrate tissue metal concentrations

Analysis and interpretation of our broader post-fire research is ongoing. These results are preliminary and not meant for publication.

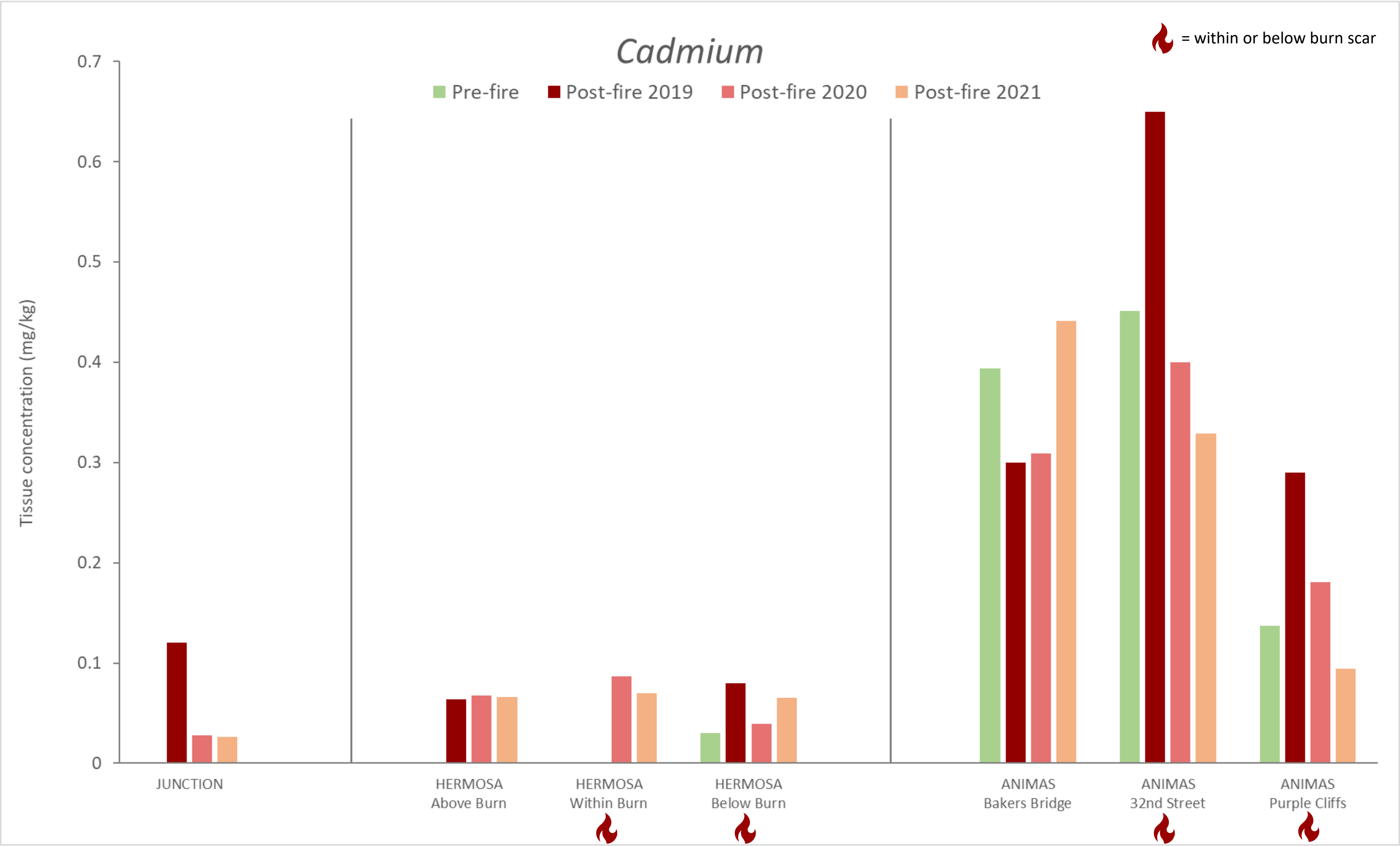
Benthic Tissue

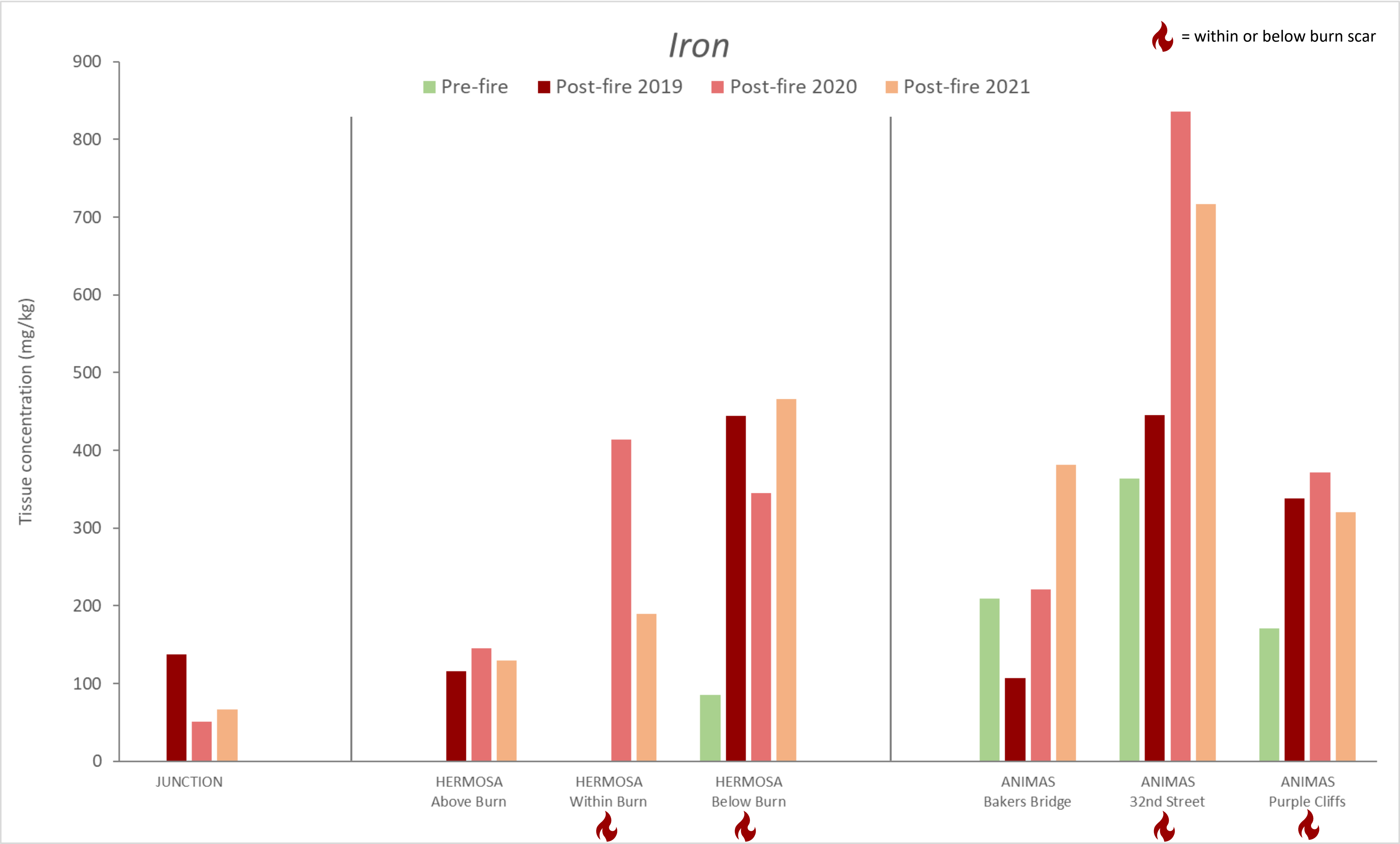


Aluminum
= within or below burn scar
Pre-fire
Post-fire 2019
Post-fire 2020
Post-fire 2021
Tissue concentration (mg/kg)
500
450
400
350
300
250
200
150
100
50
0
JUNCTION
HERMOSA Above Burn
HERMOSA Within Burn
HERMOSA Below Burn
ANIMAS Bakers Bridge
ANIMAS 32nd Street
ANIMAS Purple Cliffs

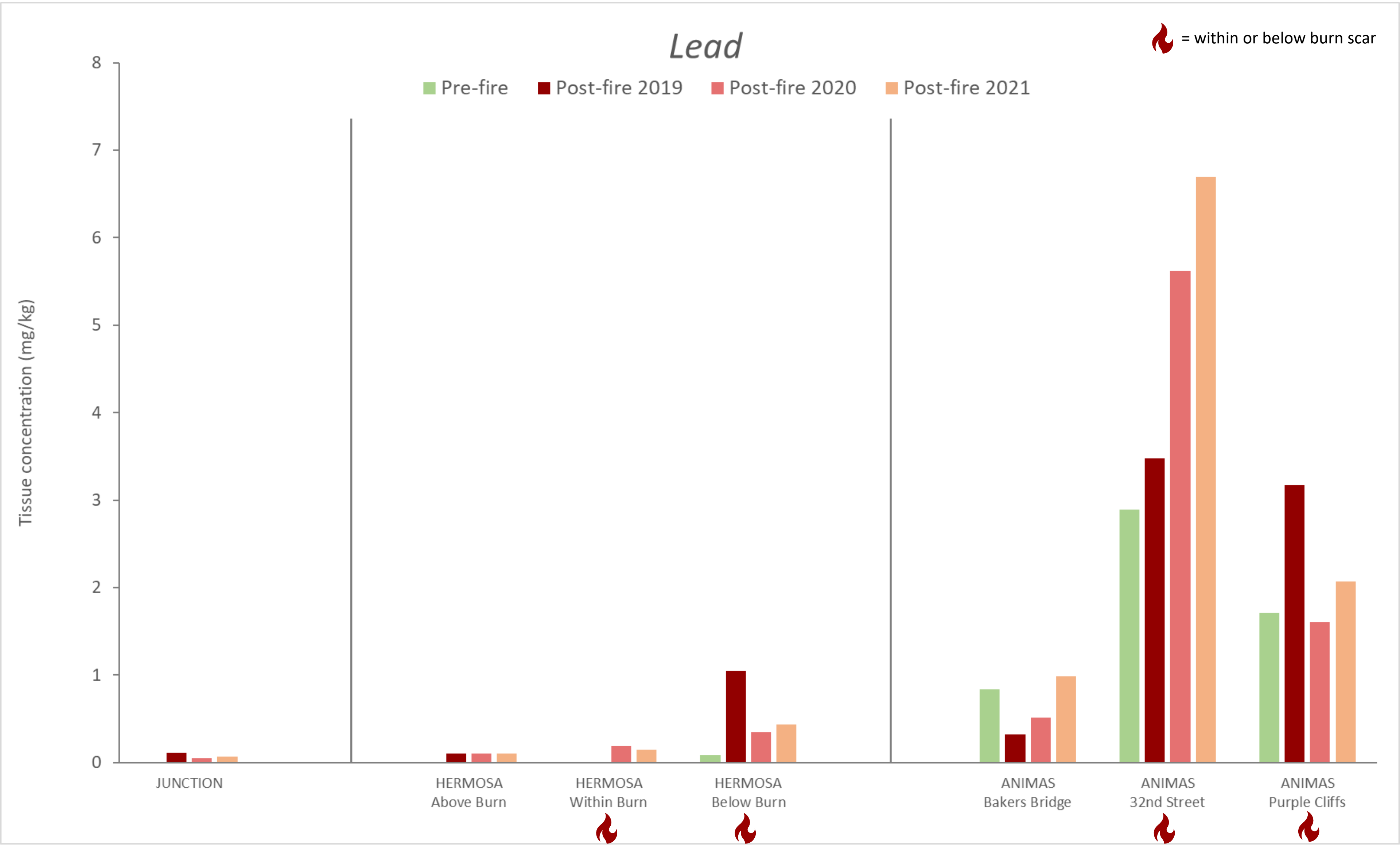


= within or below burn scar
Arsenic
Pre-fire
Post-fire 2019
Post-fire 2020
Post-fire 2021
Tissue concentration (mg/kg)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
JUNCTION
HERMOSA
Above Burn
HERMOSA
Within Burn
HERMOSA
Below Burn
ANIMAS
Bakers Bridge
ANIMAS
32nd Street
ANIMAS
Purple Cliffs

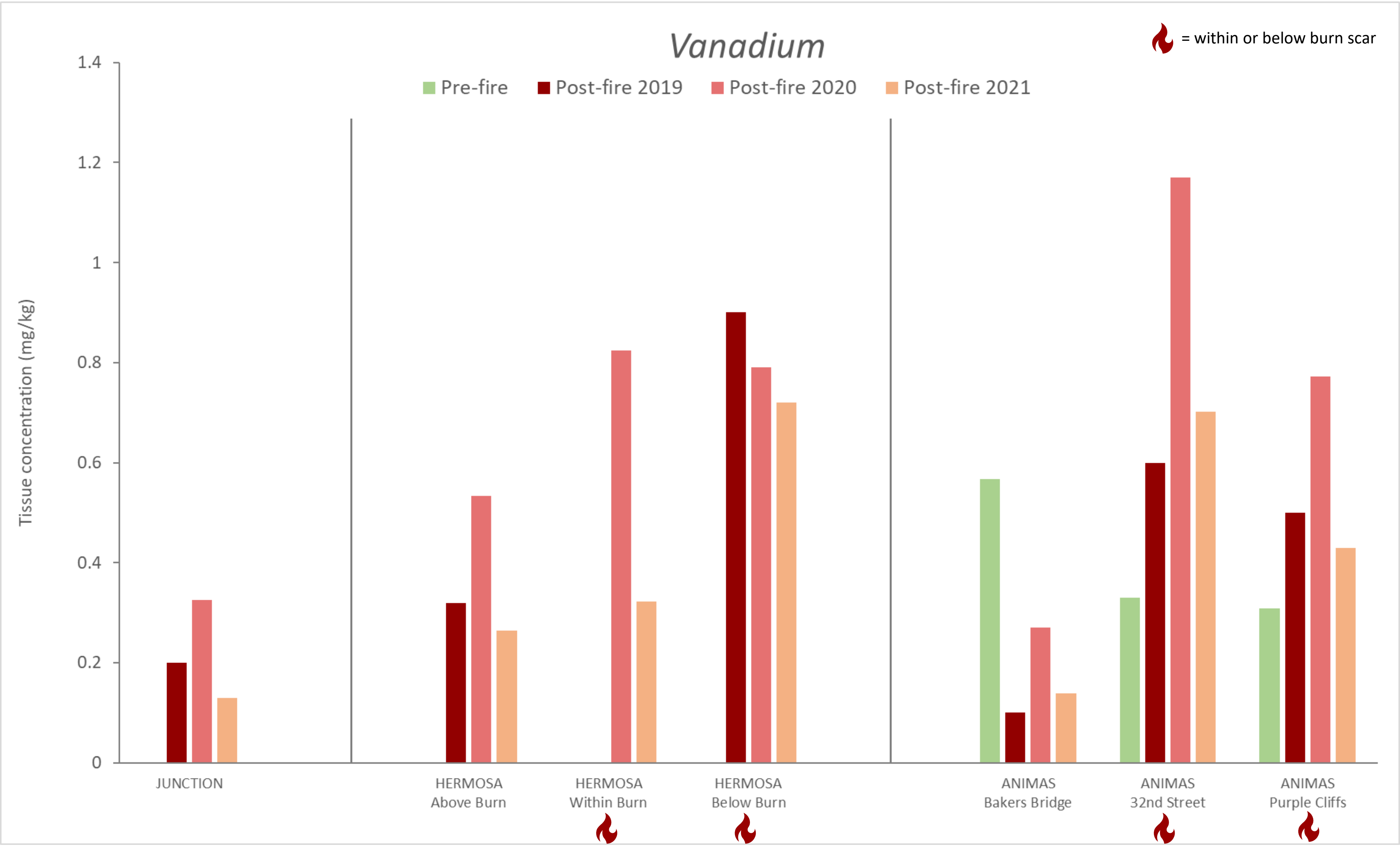

= within or below burn scar
Cadmium
Pre-fire
Post-fire 2019
Post-fire 2020
Post-fire 2021
Tissue concentration (mg/kg)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
JUNCTION
HERMOSA Above Burn
HERMOSA Within Burn
HERMOSA Below Burn
ANIMAS Bakers Bridge
ANIMAS 32nd Street
ANIMAS Purple Cliffs



Iron
= within or below burn scar
Pre-fire
Post-fire 2019
Post-fire 2020
Post-fire 2021
Tissue concentration (mg/kg)
900
800
700
600
500
400
300
200
100
0
JUNCTION
HERMOSA Above Burn
HERMOSA Within Burn
HERMOSA Below Burn
ANIMAS Bakers Bridge
ANIMAS 32nd Street
ANIMAS Purple Cliffs



Lead
= within or below burn scar
Pre-fire
Post-fire 2019
Post-fire 2020
Post-fire 2021
Tissue concentration (mg/kg)
8
7
6
5
4
3
2
1
0
JUNCTION
HERMOSA Above Burn
HERMOSA Within Burn
HERMOSA Below Burn
ANIMAS Bakers Bridge
ANIMAS 32nd Street
ANIMAS Purple Cliffs

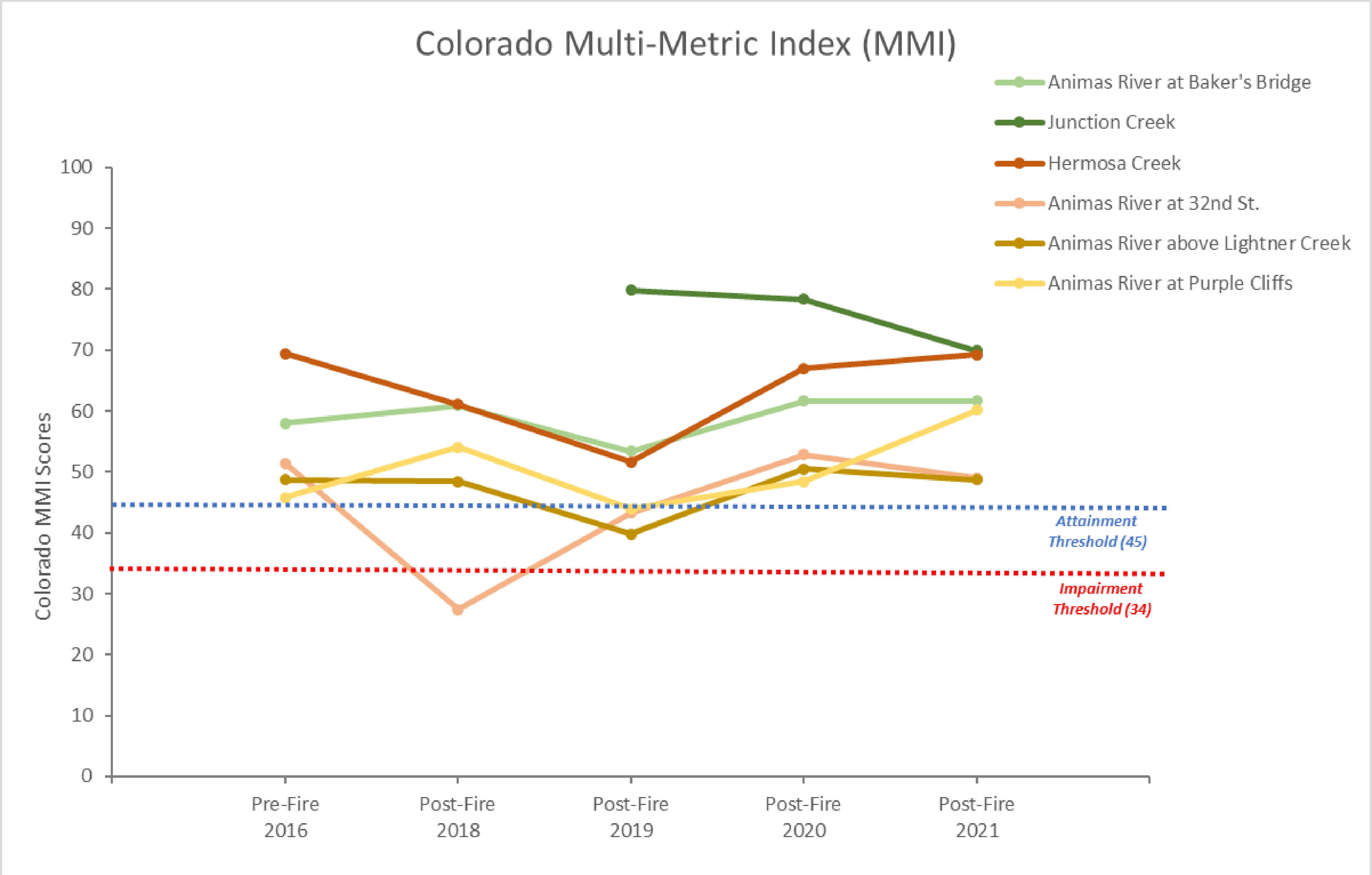


Vanadium
= within or below burn scar
Pre-fire
Post-fire 2019
Post-fire 2020
Post-fire 2021
Tissue concentration (mg/kg)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
JUNCTION
HERMOSA Above Burn
HERMOSA Within Burn
HERMOSA Below Burn
ANIMAS Bakers Bridge
ANIMAS 32nd Street
ANIMAS Purple Cliffs

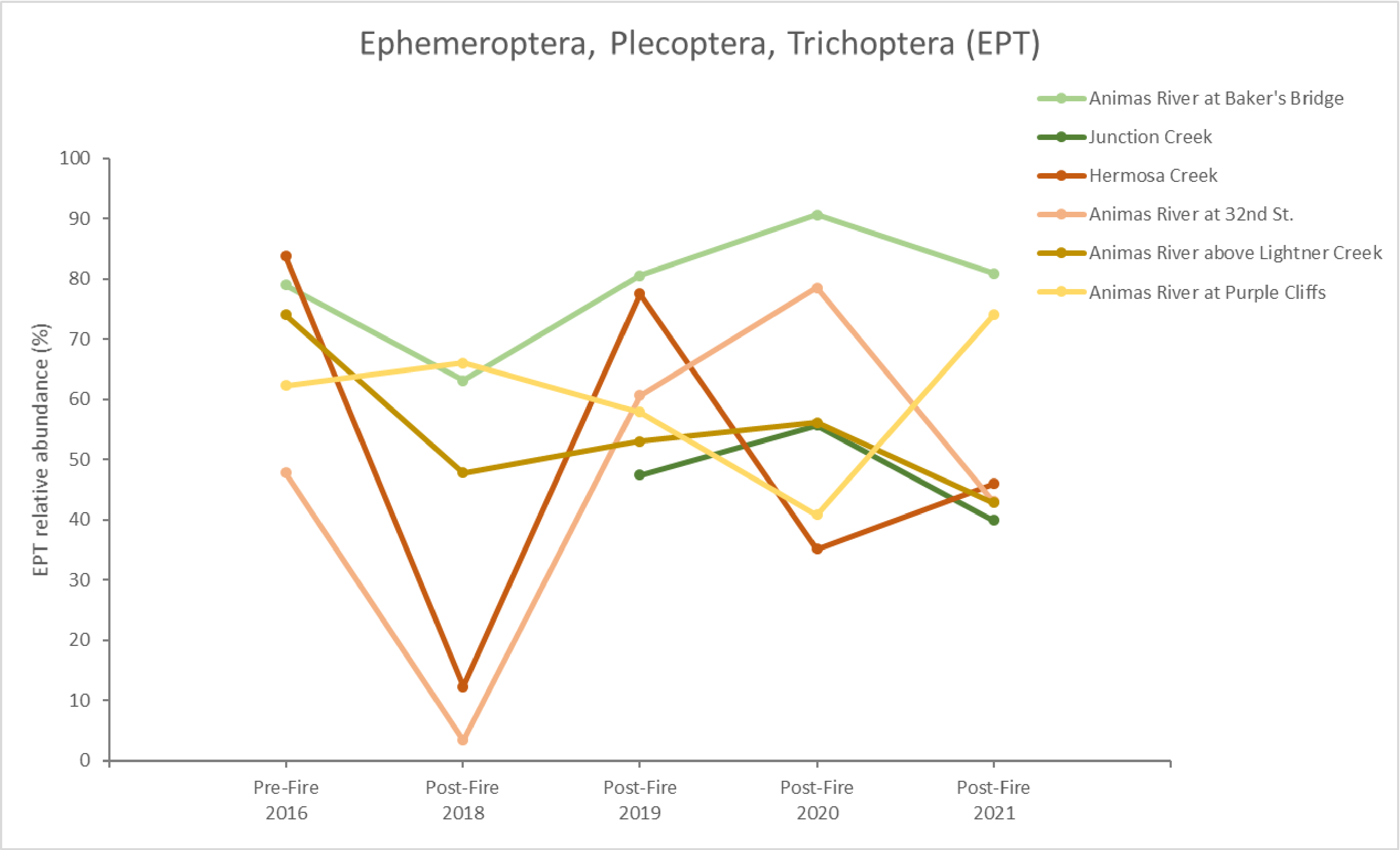
Appendix J. Preliminary benthic macroinvertebrate community composition plots

Analysis and interpretation of our broader post-fire research is ongoing. These results are preliminary and not meant for publication.

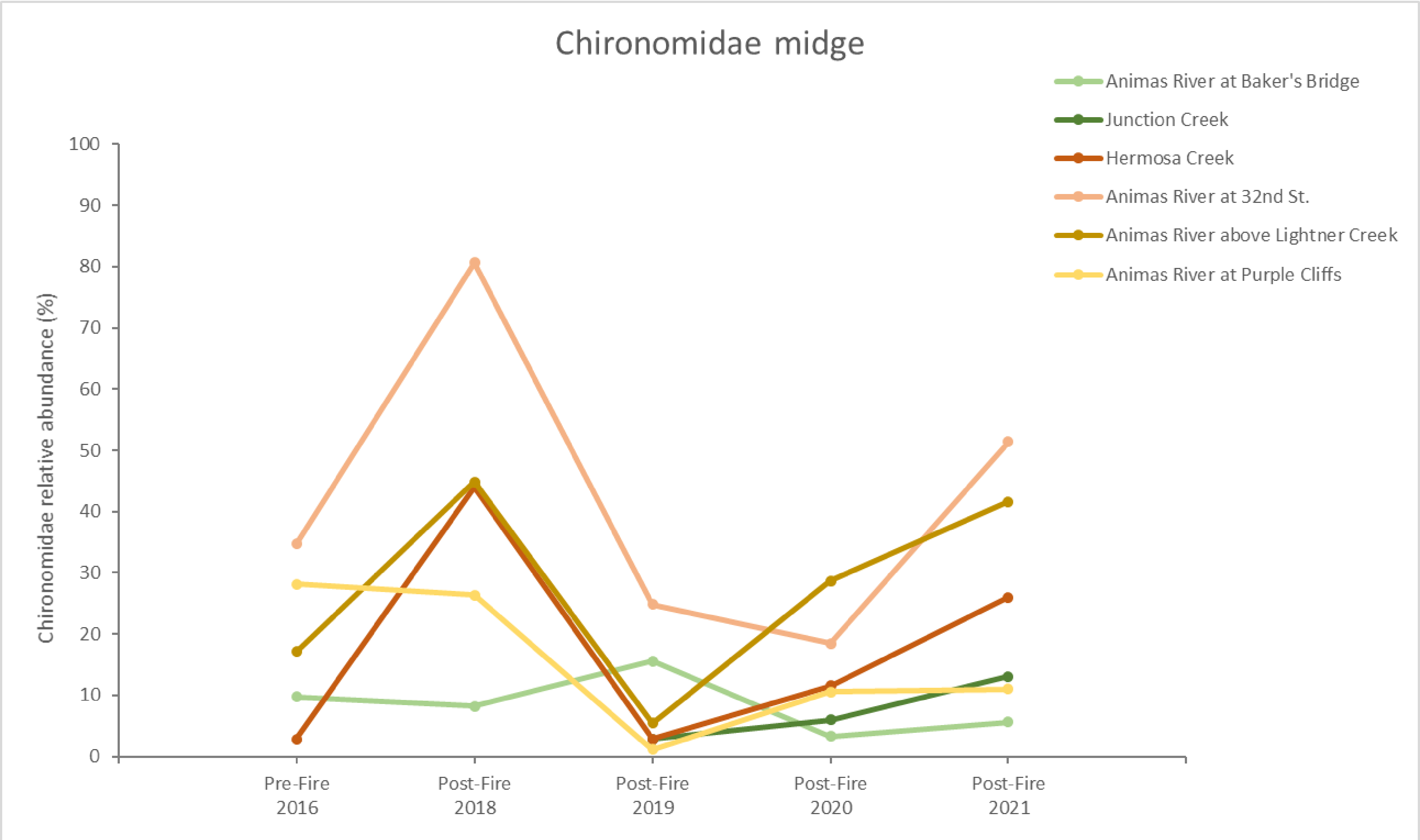
Benthic Community Composition



The Multi-Metric Index (MMI) is a bioassessment tool developed by Colorado Water Quality Control Division and the Environmental Protection Agency (CDPHE 2017). MMI quantifies the extent to which biological communities may have been altered by environmental stressors. MMI scores are evaluated in context to MMI scores from known reference sites and stressed sites in Colorado. CDPHE (2017) provides MMI thresholds that can be used to evaluate whether a water body is in attainment or impairment of designated aquatic life use. A MMI score that is below the attainment threshold is evidence that the site is not supportive of aquatic life use. Additional metrics (e.g., Hilsenhoff Biotic Index) are used to determine whether a site with a MMI score that falls between the attainment and impairment threshold should be considered impaired. The attainment threshold varies according to biotype and class.



EPT relative abundance measures the percent of individuals in a sample that are members of the orders Ephemeroptera (mayfly), Plecoptera (stonefly), and Trichoptera (caddisfly). This metric is generally reflective of overall water quality and habitat conditions.



Chironomidae midge relative abundance measures the percent of individuals in a sample that are members of the family Chironomidae (midge). This metric is generally considered to be more tolerant of degraded habitat conditions.