TECHNICAL REPORT
OF
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Mount Rushmore National Memorial Independence Day Holiday Fireworks Event Environmental Assessment

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Executive Summary

At the request of National Parks Conservation Association, (NPCA), CEA Engineers, P.C. (CEAPC) evaluated the United States Department of Interior, National Parks Service (NPS) Environmental Assessment on the Mount Rushmore Fireworks Event dated February 2020, (EA) to assist NPCA in submission of public comments. CEAPC's evaluation relates to the potential for adverse environmental impacts resulting from the proposed July 3, 2020, Mount Rushmore National Memorial Independence Day Holiday Fireworks Event (Mount Rushmore Fireworks Event) and potential future firework displays at the Mount Rushmore National Memorial (Memorial), with a focus on potential surface water, groundwater, and drinking water impacts and their associated risks to human health and aquatic species. CEAPC's evaluation includes identification of the EA's shortcomings to adequately define and quantify factors potentially impacting the risk of adverse environmental impacts to surface waters and groundwater and their potential associated risks to human health and aquatic species from the Mount Rushmore Fireworks Event and potential future firework displays at the Memorial.

The EA is generally vague and often lacking details regarding such essential topics to ascertaining the potential for adverse environmental impacts as the scope of and potential contaminants that could result from the Mount Rushmore Fireworks Events. The EA frequently relies on assumptions without defining a basis for reliance upon those assumptions. The EA fails to adequately define pollution prevention control measures to be employed in response to the Mount Rushmore Fireworks Event. An increased level of groundwater, drinking water, and surface water contamination is accepted in the EA as a result of the 2020 Mount Rushmore Fireworks Event and potential future firework displays, but no threshold levels are defined to prevent increased risks to human health and aquatic species or that would result in the cessation of firework displays.

Previous investigations of perchlorate and metals concentrations in the surface, groundwater, drinking water, and soils by the United States Geological Survey between 2011 and 2015 linked past fireworks displays that occurred at the Memorial between 1998 and 2009 as the probable cause of elevated perchlorate concentrations of these environmental media and drinking water, which is sourced from groundwater at the Memorial. Perchlorate is a persistent environmental contaminant. Elevated perchlorate levels in surface water pose risks to aquatic species health. Elevated perchlorate levels in surface water, groundwater, and especially drinking water at the Memorial pose human health risks, especially to populations most sensitive to perchlorate exposure including infants, young children, and the fetuses of pregnant mothers.

A full Environmental Impact Statement is required for the Mount Rushmore Fireworks Event due to the risk of adverse environmental impacts to surface water, groundwater, and drinking water, and the corresponding risks to human and aquatic health.

Background

Under the proposed action in the EA, Independence Day firework displays at the Memorial would resume, after being stopped 2009. NPS prepared the EA to assess the potential environmental impacts from the Mount Rushmore Fireworks Event.[1]

The United States Geological Survey (USGS) in cooperation with NPS and the National Water Quality Program National Park Service Water Quality Partnership conducted a study between 2011 and 2015 of surface water, groundwater, and soil for contamination of perchlorate, a fireworks oxidizing agent, and metals commonly associated with fireworks to assess the environmental impacts of the firework displays at the Memorial that occurred between 1998 and 2009 (USGS Study).[2] The USGS Study linked past fireworks displays at the Memorial as the probable cause of perchlorate contamination in groundwater and surface water within the Memorial. Groundwater is used as the drinking water source at the Memorial.[3]

Water quality monitoring programs are currently underway at the Memorial or are proposed in the EA. Currently, there is an ongoing groundwater and drinking water monitoring program at the Memorial, though the EA provides limited information on the contaminant analysis or sampling frequency. As part of its environmental assessment of the impact of the Mount Rushmore Fireworks Event and future fireworks display at the Memorial, if they occur, NPS and USGS plan to conduct water quality and soil monitoring to collect baseline data prior to the Mount Rushmore Fireworks Event in the spring or early summer 2020 and after the event on a schedule to be determined by NPS and USGS (Monitoring Program) to evaluate the environmental impacts of firework related contaminants. The Monitoring Program would evaluate the Mount Rushmore Fireworks Event's impacts on levels of potassium perchlorate and possibly other chemicals or metals in soils and surface water and groundwater typically present in fireworks.[4]

Mount Rushmore Fireworks Event Scope and Potential Environmental Impact

The EA fails to define the scope of the Mount Rushmore Fireworks Event in terms of firework number, type, size, and quality. According to the EA, "the size of the fireworks display would be comparable to those previously conducted at the Memorial." The EA fails to define the terms "size" from a scoping perspective and provides no reference to the size of previous fireworks display at the Memorial. The specific firework shell size in terms of dimensions is currently

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1 The United States Department of Interior, National Parks Service Environmental Assessment on the Mount Rushmore Fireworks Event, February 2020, Section 3.4.2, Page 30. (Hereafter, "EA")

2 No fireworks display was held in 2002 due to excessively dry conditions (EA, Page 1).

3 United States Geological Survey, Perchlorate and Selected Metals in Water and Soil within Mount Rushmore National Memorial, South Dakota, 2011-15, Scientific Investigations Report 2016-5030, 2016. (Hereafter, "USGS Study")

4 EA, Section 2.1.3, Page 8.

undefined and left to the discretion of the fireworks operator. The types of fireworks to be used during the Mount Rushmore Fireworks Events is assumed to be of similar composition, with similar impacts, to those used in previous fireworks displays at the Memorial.[5] Different types of fireworks contain different chemical compositions and varying chemical concentrations.[6] The EA provides no details on the composition of the fireworks used during previous fireworks displays at the Memorial for reference to the composition of the fireworks to be used at the Mount Rushmore Fireworks Event.

The State of South Dakota Office of Procurement Management has issued a Request for Proposal (RFP) for firework contractors to submit bids to perform the firework display during the Mount Rushmore Fireworks Event. The RFP does not contain details on the number, size, type, anticipated efficiency of combustion and quality of fireworks to be used during the Mount Rushmore Fireworks Display. Bid selection is not anticipated until the week of March 30, 2020.[7] The public comment period on the EA closes March 30, 2020, meaning the public is unlikely to have information related to the accepted bid that may contain information on the number, size, type, anticipated efficiency of combustion, and quality of fireworks to be used during the Mount Rushmore Fireworks Event.[8] The RFP includes a best practices evaluation for bidding contractors, which also does not contain detailed information on the number, size, type, anticipated efficiency of combustion and quality of fireworks to be used during the Mount Rushmore Fireworks Event.[9]

The number, size, type, anticipated efficiency of combustion, and quality of the fireworks used during the Mount Rushmore Fireworks Event will impact the types and quantities of contaminants produced and released into the environment.[10] For example, research performed in Massachusetts on firework-related contamination shows that elevated perchlorate contamination was dependent on the amount and type of perchlorate in the fireworks used at firework displays.[11] Since these factors are currently unknown and not included in the EA, the totality of the specific types environmental contaminants to be released and an estimate their potential quantities is not included in the EA. Instead of defining the scope of the Mount Rushmore Fireworks Event and estimating the potential quantity of contaminants to be released into the environment, the EA assumes that the release of contaminants and amounts produced would be

5 EA, Section 3.4.2, Page 30.
6 EA, Section 3.4.2.1, Pages 31.
7 State of South Dakota, Office of Procurement Management, South Dakota's Mount Rushmore Fireworks Celebration.
8 National Park Service, Mount Rushmore Nation Memorial Independence Day Holiday Fireworks Event Environmental Assessment, https://parkplanning.nps.gov/document.cfm?parkID=152&projectID=89009&documentID=100890. Accessed March 12, 2020.
9 Weeth Associates, LLC, Mount Rushmore (MORU) Fireworks & Pyrotechnics Code and Best Practices Evaluation, November 2019, Updated by National Parks Service, January 30, 2020.
10 EA, Section 3.4.2.1, Pages 30-31.
11 USGS Study, Page 2.

the same as previous fireworks displays, however, it provides no details on the amounts of contaminants produced during previous fireworks displays as a reference.[12]

Comment: Without a defined scope for the Mount Rushmore Fireworks Event that allows for defining the specific types of environmental contaminants that will be produced and for estimating contaminant quantities, the risk of adverse impacts to the environment as a whole and, more specifically, surface waters, groundwater, and drinking water, cannot be properly evaluated. The magnitude and composition of contaminants resulting from the Mount Rushmore Fireworks Events relates directly to the risk and magnitude of potential adverse environmental impacts, including surface water, groundwater, and drinking water impacts. In turn, these factors relate directly to human health and aquatic species health risks from exposure to the contaminants resulting from the Mount Rushmore Fireworks Event.

The EA needs to define the scope of the Mount Rushmore Fireworks Events inclusive of the number, size, type, and quality of fireworks to be used. The EA needs to define an anticipated firework combustion efficiency based on type, size, and quality of the fireworks to be used. Using this information, the EA needs to fully define the potential contaminants that could result from the Mount Rushmore Fireworks Events and estimate the quantity of each potential contaminant that could be released to the environment in order to adequately evaluate the potential adverse impacts to the environment, human health and aquatic species health.

Expected Contaminant Release

NPS assumes in the EA that the firework composition would be similar to previous firework displays at the Memorial, and the amount of contaminant release during the Mount Rushmore Fireworks Event is not expected to exceed and would be comparable to levels released in previous years.[13]

Comment: NPS' assertion in the EA on the expected levels of contaminant release from the Mount Rushmore Fireworks Event relies entirely on assumptions. As previously discussed, NPS has not defined the scope of the Mount Rushmore Fireworks Event in terms of the number, size, type, anticipated efficiency of combustion, and quality of the fireworks. The lack of scope represents a data gap that renders NPS's assumption on expected contaminant levels resulting from the Mount Rushmore Fireworks Event, and their potential adverse environmental impacts on surface waters, groundwater, and drinking water and associated risks to human health and aquatic species, baseless.

In order to adequately ascertain the potential adverse environmental impacts on surface waters, groundwater and drinking water, and resulting potential health risks to humans and aquatic

[12] EA, Section 3.4.2.1, Pages 31.
[13] EA, Section 3.4.2.1, Pages 30-31.

species, the EA cannot rely on assumptions lacking sound basis in the scope of the Mount Rushmore Fireworks Event and science. The fact that USGS determined that previous fireworks events resulted in increased contaminants levels in soil, surface waters, groundwater, and drinking water makes clearly defined estimates of contaminant release to the environment from the Mount Rushmore Fireworks Event based as much as possible on facts, not assumptions, and sound scientific principles all the more imperative in order to adequately identify and mitigate the potential for adverse impacts to soils, surface waters, groundwater and drinking water and the resulting potential health risks to humans and aquatic species.[14]

Environmental Contaminants of Concern

Fireworks contain chemical combinations of fuel (usually a metal or metalloid base), oxidizer (typically perchlorate or nitrate-based salts), binders, stabilizers, anticaking agents, and propellants. Firework combustion, including partial combustion, results in release of all the chemical constituents in fireworks and the chemicals that result from firework combustion.[15]

The EA discusses contaminants released to the environment as a result of firework displays, but fails to include specific details on all the possible contaminants that could impact the environment, surface waters, and groundwater in the Memorial from the Mount Rushmore Fireworks Event, including combustion-related contaminants and contaminants related to incomplete firework combustion. The EA specifically discusses only perchlorate, nitrates, and thiocyanates, and generically discusses metals.[16]

Known Firework Contaminants

Perchlorate

Perchlorate is a the most commonly used oxidizer in fireworks to enhance combustion. Perchlorate is a stable compound that does not degrade for decades in groundwater and surface water, making it persistent in the environment and especially problematic as a pollutant once groundwater is contaminated.[17,18,19,20] Perchlorate released to the atmosphere, as would occur during the Mount Rushmore Fireworks Event, readily deposits into the environment. Due to its

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14 USGS Study, Page 1.
15 EA, Section 3.4.1.1.2, Pages 27.
16 EA, Sections 3.4.1.1.2 – 3.4.1.1.6, Pages 27 – 30.
17 USGS Study, Page 2.
18 EA, Section 3.4.1.1.3, Pages 27 - 28.
19 United States Environmental Protection Agency, Technical Fact Sheet – Perchlorate, January 2014. (Hereafter, "USEPA Perchlorate Fact Sheet")
20 U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, Toxicological Profile for Perchlorates, September 2008, Page 3. (Hereafter, "Perchlorate Toxicological Profile")

low vapor pressure, once it is deposited on soil, water, or vegetative surfaces, it does not volatilize.[21] Perchlorate is highly soluble in water, making it easily transported in surface water and groundwater flows. Due to its high solubility in water and poor adsorption to soils and other geologic material, perchlorate can rapidly migrate through soil as water from precipitation infiltrates through soils.[22,23,24]

Perchlorate can be naturally attenuated in anaerobic soil conditions with adequate underlying conditions for perchlorate microbial biodegradation, however, soils in the Memorial are aerobic and not conducive to microbial degradation of perchlorate.[25,26] The inability of soils in the Memorial to naturally attenuate perchlorate and its rapid rate of transport in soil-infiltrating waters reinforces perchlorates persistent presence once introduced into the environment in the Memorial.

The primary pathways of human exposure to perchlorate that is a concern at the Memorial is exposure through drinking water. The potential also exists for human contact or ingestion from contact with perchlorate-contaminated surface waters or soils. If ingested, such as through drinking water exposure, perchlorate readily migrates from the stomach or intestines into the bloodstream.[27,28]

Perchlorate exposure presents numerous health risks to humans. Short-term exposure to high doses can result in eye and skin irritation, coughing, nausea, vomiting and diarrhea. If ingested at high enough levels, perchlorate can interfere with thyroid function in humans through interference with iodine uptake, resulting in a reduction in the production of thyroid hormones. Decreases in bodyweight and thyroid growth can also occur.[29,30,31] The United States Environmental Protection Agency (EPA) has developed a perchlorate reference dose, the daily oral exposure that is likely to be without appreciable risk of adverse health effects during a lifetime, that equates to drinking water equivalent of 24.5 ug/l.[32] Thyroid hormone is critical to numerous essential functions of the human body, including brain and neurological development. Infants and fetuses may be especially susceptible to perchlorate exposure and any alteration of thyroid hormone production due to being in a highly developmental stage of their brain and nervous systems and possessing lower reserves of thyroid hormone levels, which make them less

21 USEPA Perchlorate Fact Sheet.
22 EA, Section 3.4.1.1.3, Page 27.
23 USEPA Perchlorate Fact Sheet.
24 Perchlorate Toxicological Profile, Page 3.
25 USGS Study, Page 4.
26 Perchlorate Toxicological Profile, Page 3.
27 USEPA Perchlorate Fact Sheet.
28 Perchlorate Toxicological Profile, Page 6.
29 USEPA Perchlorate Fact Sheet.
30 USGS Study, Page 4.
31 Perchlorate Toxicological Profile, Page 7.
32 Perchlorate Toxicological Profile, Page 12.

able to adapt to periods of low thyroid hormone production caused by exposure to perchlorate.[33,34]

Perchlorate exposure also poses risks to aquatic species, such as fish, amphibians, and invertebrates, including disruption of iodine uptake in the thyroid, thyroid hormone production, metabolism, reproduction, and growth processes and can target muscle and bone marrow at high concentrations.[35] Irreversible damage is possible if aquatic species biological processes are interfered with by perchlorate exposure.[36]

The USGS Study linked past fireworks displays at the Memorial as the probable cause of perchlorate contamination in groundwater, drinking water, and surface water at the Memorial. Surface water perchlorate concentrations were found as high as 54 ug/l. Groundwater perchlorate concentrations were found as high as 38 ug/l and were collected from one of the Memorial's drinking water production wells. Groundwater and surface water samples from the Memorial were approximately ten times higher than in reference samples collected outside the Memorial.[37] As detailed in the Potential for Drinking Water Contamination section of this report (see pages 17 through 21), the maximum concentrations observed in surface water and groundwater at the Memorial exceed numerous established standards for perchlorate in drinking water. During USGS sample collection between 2011 and 2015, perchlorate concentrations in surface waters and groundwater showed no decrease over time, despite no additional environmental deposition from firework displays over this time period. The current monitoring program at the Memorial continues to show elevated levels of perchlorate in groundwater at the Memorial.[38] These results are indicative of the persistent nature of perchlorate once it gets into the environment as a whole, and specifically, into groundwater and surface waters.[39]

Soil perchlorate concentrations in the top eight inches of soil layers in the Memorial were found as high as 2.3 ug/kg, approximately ten times higher than in reference samples.[40]

Comment: Previous firework events at the Memorial have resulted in elevated levels of perchlorate that continue to persist over a decade after the last firework display was held at the Memorial in 2009. The Mount Rushmore Fireworks Event will result in an additional load of perchlorate into the environment that will increase perchlorate concentrations in soils, surface

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33 State of California, Office of Environmental Health Hazard Assessment, Updated Public Health Goal for Drinking Water: Perchlorate, A fact sheet by the Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, February 2015.
34 Perchlorate Toxicological Profile, Page .9
35 USGS Study, Page 4.
36 EA, Section 3.4.2.3, Page 32.
37 USGS Study, Pages 1 and 25.
38 EA, Section 3.4.1.1.3, Figure 9, Page 29.
39 USGS Study, Page 25.
40 USGS Study, Pages 19 and 25.

waters, groundwater, and drinking water. Future firework displays will result in additional perchlorate loads to the environment that will further increase perchlorate concentrations in soils, surface waters, groundwater, and drinking water, thus presenting an ever-increasing risk to the health of humans and aquatic species.

Nitrate

Various nitrate salts are used in fireworks as oxidizers. The USGS Study did not analyze for nitrates and no soil or groundwater samples have been collected. Limited surface water sampling for nitrates was performed at the Memorial in 2006. The average concentration in a stream known to be impacted by previous firework events at the Memorial, Lafferty Gulch, was 1.87 mg/L. The EA did not include the full results of the samples collected or the range of nitrate concentrations observed in Lafferty Gulch. Nitrate concentrations in two streams in the Memorial known to not be heavily impacted by previous firework displays, if they are impacted at all, had average nitrate concentrations below 0.10 mg/l.[41,42] The 2006 surface water sampling results for nitrate indicate that previous firework events increased nitrate concentrations in Lafferty Gulch.

Nitrate is water soluble and does not bind to soil particles, indicating that deposition of nitrates from firework events in the environment can rapidly migrate through soil as water from precipitation infiltrates, thus impacting groundwaters. It is persistent in water, unless consumed by plants or microorganisms.[43]

The primary path of exposure resulting in potential human health risk at the Memorial is in drinking water. Excessive nitrate in drinking water can result in restriction of oxygen transport in the bloodstream, which can most acutely affect young children or infants.[44] The current Maximum Contaminant Level (MCL) for nitrates in drinking water is 10 mg/l. Treated drinking water at the Memorial is monitored for nitrate and has been since 1991, with sample results ranging from 0.5 to 1.35 mg/l.[45]

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41 EA, Section 3.4.1.1.4, Page 29.

42 As referenced in the EA, nitrate surface water samples were collected by: Rust, J. 2006. Establishing Baseline Data for Aquatic Resources in National Parks of the Northern Great Plains Network. Thesis submitted in partial fulfillment of the requirements for the degree of Masters of Science, South Dakota State University.

43 Center for Disease Control and Prevention, Community Water, Nitrate and Your Health, October 26, 2016. https://ephtracking.cdc.gov/showNitrateHealth.action. Accessed March 12, 2020.

44 USGS, Water Science School, Nitrogen and Water, https://www.usgs.gov/special-topic/water-science-sschool/science/nitrogen-and-water?qt-science_center_objects=0#qt-science_center_objects. Accessed March 12, 2020.

45 EA, Section 3.4.1.1.4, Page 29.

High levels of nitrate exposure to aquatic species can inhibit iodine uptake in the thyroid and adversely impact thyroid function similar in manner to perchlorate.[46] High levels of nitrates in surface waters increase the potential for production of algal blooms, however, algal blooms are unlikely to occur in the surface water streams at the Memorial.[47]

Comment: Due to previous surface water sampling at the Memorial indicating increased nitrate concentrations in an area impacted by previous firework events, surface water, soil, and groundwater, nitrate monitoring needs to be included in the Monitoring Program.

The recommended safe level to be protective of freshwater aquatic organisms for nitrate is 2 mg/l.[48] The recommended safe nitrate level was potentially exceeded in individual samples during sampling in 2006 in Lafferty Gulch, where average nitrate concentrations equaled 1.87 mg/l, just slightly below the recommended safe level. The EA needs to include all the results of the samples collected during the 2006 analysis of nitrate concentrations in Lafferty Gulch in order to determine if, and by what magnitude, the recommended safe nitrate level was exceeded, and to allow for adequate assessment of the potential for adverse ecological impacts to aquatic species from nitrate contamination resulting from the Mount Rushmore Fireworks Event and potential future firework displays at the Memorial.

Thiocyanate

Thiocyanate is the sulfur cyanate anion (negatively charged ion) with the chemical formula SCN^- and is associated with fireworks as part of the propellant potassium thiocyanate. The USGS Study did not analyze samples for thiocyanate. A sample of groundwater from drinking water production wells at the Memorial was analyzed for thiocyanate in December 2019, and it was not detected. No other samples have been analyzed for thiocyanate at the Memorial. No samples of soil, groundwater, or surface waters have been analyzed for potential thiocyanate breakdown products, such as cyanide (CN).[49]

Thiocyanate exposure presents multiple human health risks. Skin or eye contact can cause irritation requiring immediate medical attention. Ingestion can result in the release of cyanide into the body, which can result in symptoms ranging headaches and dizziness to potentially death

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46 EA, Section 3.4.2.3.2, Page 33.

47 USGS, Water Science School, Nitrogen and Water, https://www.usgs.gov/special-topic/water-science-school/science/nitrogen-and-water?qt-science_center_objects=0#qt-science_center_objects. Accessed March 12, 2020.

48 EA, Section 3.4.2.3.2, Page 33.

49 EA, Section 3.4.1.1.5, Pages 29-30.

depending on degree of exposure.[50] Thiocyanates are known to adversely impact thyroid function in humans.[51]

Thiocyanate is water soluble and harmful to aquatic species, with the potential to cause long-term adverse impacts to aquatic environments.[52] Thiocyanate can interfere with iodine uptake by the thyroid, disrupt thyroid function, and reduce blood hemoglobin levels in aquatic species.[53]

Comment: Due to its water-soluble nature and potential adverse impacts to aquatic species and human health, the Monitoring Program needs to monitor for the presence of thiocyanate in surface water, groundwater, and drinking water samples.

Metals

Metals are used as coloring agents and fuels in fireworks.[54] Lead salts are commonly used as igniters to initiate firework explosions. Manganese and manganese oxides are used as fuel and oxidizers to result in brighter light displays. Chromium is used as a burn catalyst for propellants. Nickel serves as an electric firing device. Copper is used to produce blue colors. Strontium and bismuth are used to produce red colors. Rubidium and potassium are used to produce purple colors.[55]

Metals are released into the atmosphere during fireworks displays and settle with particulate matter. Metals including lead, chromium, manganese, cadmium, nickel, arsenic, bismuth, strontium, potassium, copper, zinc, magnesium and barium have been related to environmental release from firework displays.[56]

In the environment, metals have low water solubility and typically adsorb to particulate matter, such as soils, and can accumulate in surface water sediments. As a result, metals were not found in high concentrations in surface waters, groundwater, or drinking water at the Memorial during the USGS Study, however, of the 25 metals analyzed, 22 were found in higher concentrations in soils at the Memorial relative to reference sites. Most notably, soil copper and lead concentrations were found to be an order of magnitude higher in the sampling location closest to the firework launch site from previous firework displays relative to reference sites. Titanium and

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50 ThermoFisher Scientific, Safety Data Sheet, Potassium thiocyanate, January 23, 2018.

51 Department of Health and Human Services, Public Health Service Agency for Toxic Substances and Disease Registry, Public Health Statement, Cyanide, July 2006.

52 ThermoFisher Scientific, Safety Data Sheet, Potassium thiocyanate, January 23, 2018.

53 EA, Section 3.4.2.3.3, Page 34.

54 EA, Section 3.4.1.1.6, Page 30.

55 Licudine, Jocelyn, A., et. al., Hazardous Metals in Ambient Air Due to New Year Fireworks During 2004-2011 Celebrations in Pearl City, Hawaii, Public Health Reports, Volume 127, July-August 2012.

56 *Ibid.*

barium soil concentrations were also observed to be highest in sample locations in areas known to be impacted by firework related contamination.[57,58,59]

The primary potential for human exposure to metals from the Mount Rushmore Fireworks Event and future firework displays are the Memorial is through drinking water consumed by staff and visitors. Reverse osmosis systems in staff residences reduces the metals exposure risk from drinking water in staff residences, however, drinking water in other areas of the Memorial, such as the Visitor Center, is not treated by reverse osmosis. The possibility for ingestion also exists through soil exposure, especially for young children who often put their hands in their mouth.[60]

Chronic exposure to high doses of metals can be harmful to human health. For example, chronic exposure to manganese in high doses can have adverse neurological effects in humans.[61] Other metals associated with firework contamination, such as lead, can be toxic to humans. Lead is especially harmful to the developing brains and nervous systems of children and infants.[62]

In the aquatic environment, metals adsorbed to particulate matter typically accumulate in surface water sediments. Metal accumulation in sediments can adversely impact the aquatic organisms that live in the benthic sediment layer.[63]

Comment: The Monitoring Program needs to include sampling for all metals commonly associated with environmental release from firework displays, and at a minimum, needs to include all 22 metals that were identified in elevated concentrations in soil samples in the USGS Study. Drinking water from both the current on-site drinking water treatment plant and after reverse osmosis treatment in staff residences needs to be included in the Monitoring Program.

The Monitoring Program needs to include surface water sediment sampling for metals, due to the potential for metals accumulation in surface water sediments and their potential adverse impacts to aquatic organisms that live in the benthic sediment layer.

Unknown Firework Contaminants

The EA fails to include specific details on all the possible contaminants that could adversely impact the environment, surface waters, groundwater and drinking water in the Memorial from

57 EA, Section 3.4.1.1.6, Page 30.
58 EA, Section 3.4.2.2.2, Page 32.
59 USGS Study, Pages 19 - 21.
60 United States Environmental Protection Agency, Learn About Lead, https://www.epa.gov/lead/learn-about-lead. Accessed March 16, 2020.
61 United States Environmental Protection Agency, Drinking Water Health Advisory for Manganese, EPA - 822-R-04-003, January 2004.
62 United States Environmental Protection Agency, Learn About Lead, https://www.epa.gov/lead/learn-about-lead. Accessed March 16, 2020.
63 EA, Section 3.4.2.3.4, Page 34.

the Mount Rushmore Fireworks Event and present a health risk to humans and aquatic species, including combustion-related contaminants and contaminants related to incomplete firework combustion. Specifically, the EA states that, "Combustion products are released that include numerous metals and metal compounds used as fuels and coloring agents as well as numerous salts used as oxidizers. Environmental contaminants associated with fireworks include…in addition to numerous other compounds…"[64] The EA does not discuss the chemicals associated with binders, stabilizers, anti-caking agents, and combustion-related products, with the exception of perchlorate, nitrate, thiocyanate, and the metals barium, copper, lead and titanium, that could be released as a result of the Mount Rushmore Fireworks Event.

Comment: The EA needs to include a complete accounting of the potential contaminants that could be released to the environment from the Mount Rushmore Fireworks Event. Without detailing all of the potential firework related contaminants that could result from the Mount Rushmore Fireworks Event, the potential for adverse impacts to soils, surface waters, surface water sediments, groundwater, and drinking water, and the potential for increased health risks to humans and aquatic species, cannot be properly ascertained.

The Monitoring Program needs to include sampling and analysis for all potential firework related contaminants that could result from the Mount Rushmore Fireworks Event.

Acceptance of Environmental Contamination to Undefined Levels

The EA assumes that contaminant release during the Mount Rushmore Fireworks Event will be comparable to and is not expected to exceed previous firework displays at the Memorial, that contamination in soils, groundwater, and surface water will gradually increase each year that fireworks displays occur, and that since previous contamination levels were the result of ten years of firework displays, contaminant levels would not be expected to exceed previous levels for several years. The EA acknowledges the long-term continuation of firework displays will result in an increased risk of adverse environmental impacts and reversal of any natural attenuation of firework-related environmental contamination that has occurred since firework displays ceased in 2009. Future perchlorate levels exceeding previously observed concentrations would result in reassessing the environmental impacts of firework displays at the Memorial.[65,66]

Comment: The EA accepts that firework related contamination in the environment and drinking water will increase and is either silent or vague on observed contaminant concentrations that will cause firework events to cease, or at a minimum, to reassess the analysis in the EA. For example, though stating that exceedances of previously observed perchlorate levels would result in reassessment of the EA analysis, it does not define the perchlorate concentration previously

64 EA, Section 3.4.1.1.2, Page 27.
65 EA, Section 3.4.2.1, Page 31.
66 EA, Section 3.4.2.4, Page 35.

observed that would result in such action. The EA needs to define clear action levels for contamination concentrations, especially perchlorate, in soils, surface waters, groundwater, and drinking water that will result in cessation of firework displays, reassessment of the adverse environmental impacts of firework displays, or additional drinking water treatment processes at the Memorial.

Furthermore, the assumptions and expectations in the EA on the quantities of potential contaminants released, timeframe for reaching previous contaminant levels of "several years", and subsequent potential adverse impacts on soil, surface water, groundwater and drinking water from the Mount Rushmore Fireworks Event and future firework displays at the Memorial are without sound basis. The current scope for the Mount Rushmore Fireworks Event in terms of firework quantity, quality, size, and type is currently unknown and an estimation of the contaminant quantity cannot be made according to NPS. The EA's assumptions and expectations ignore the persistent nature of the firework related contamination in the environment, especially perchlorate in surface waters and groundwater, which results in a baseline contaminant level in the soils, surface water, groundwater, and drinking water that is higher than when previous firework events began in 1998. As a result, contaminant concentrations can potentially exceed previously observed levels much quicker than "several years," as expected by the EA.

The EA should not base future reassessments of its analysis on exceedances of previously observed contaminant levels at the Memorial, but needs to rely on clearly defined, safe or regulatory standards for all of the contaminants in the Monitoring Program to be protective of human health and the environment. Some contaminants, such as thiocyanate, were not previously analyzed for and thus have no previously observed levels for which to apply the EA's reassessment criteria. Additionally, as detailed in the Potential for Drinking Water Contamination section of this report (see pages 17 through 21), perchlorate concentrations in the drinking water at the Memorial already exceed some state regulatory standards and may exceed the EPA MCL that is expected to be finalized in June 2020. Such exceedances should result in immediate action including cessation of firework displays and additional drinking water treatment at the Memorial to prevent the potential adverse human health impacts from exposure to perchlorate in drinking water and not require further reassessment of the EA analysis.

Unexploded Fireworks

Unexploded fireworks and firework debris (e.g. mortar shrapnel) will land, and if unretrieved, will degrade over time, releasing their contaminant loads to the environment.[67] As a result of the rugged terrain of the Memorial, NPS does not anticipate that full retrieval of unexploded fireworks and debris is possible.[68] NPS will require the fireworks contractor to monitor for

[67] EA, Section 3.4.1.1.2, Page 27.
[68] EA, Section 3.5.2, Page 38.

unexploded fireworks and to retrieve unexploded fireworks "to the extent possible".[69,70] The EA fails to define "extent possible" and does not attempt to quantify how many unexploded fireworks are likely to be unretrieved.

Previous firework displays at the Memorial resulted in unexploded fireworks and debris that by this time have likely fully degraded and released the contaminants they contain to the environment.[71,72] USGS observed deposition of fireworks debris during its field work performed for the USGS Study.[73] The aerial extent of unexploded firework and firework debris deposition depends on wind conditions and topographic features.[74]

Comment: A failure to adequately monitor for and retrieve unexploded fireworks and fireworks debris from the Mount Rushmore Fireworks Event will result in future and persistent contaminant releases to the environment, including to surface waters and groundwaters. Persistent, future contaminant releases to the environment and their potential adverse impacts will continue for an unknown time period, especially if firework displays at the Memorial continue into future years beyond 2020.

The EA needs to define the specific monitoring protocol to be used by the fireworks contractor to observe the number of unexploded fireworks during the Mount Rushmore Fireworks Event and ensure that subsequent searches for unexploded fireworks result in complete recovery of unexploded fireworks in order to prevent the persistent release of contaminants in unexploded fireworks in the environment. Fireworks debris also needs to be collected from the Memorial and properly disposed of to prevent release of contaminants in fireworks debris to the environment. As part of the monitoring protocol, the direction and intensity of wind conditions needs to be monitored to better inform the firework contractor where unexploded fireworks and firework debris is mostly likely to be present in the Memorial.

Direct landing of unexploded fireworks and debris into streams at the Memorial will make identification and retrieval difficult and directly expose streams and their aquatic species to firework-related contamination. The presence of flowing water in streams will make unexploded firework and debris identification and retrieval more difficult relative to land-based identification and retrieval. The unexploded firework monitoring and retrieval protocol needs to include protocols for inspecting streams to ensure retrieval of unexploded fireworks and debris from impacted surface waters.

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69 EA, Section 2.1.2, Page 8.
70 EA, Section 3.4.2.2.1, Page 32.
71 EA, Section 3.2.1.1.1, Page 12.
72 EA, Section 3.4.3, Page 35.
73 USGS Study, Page 1.
74 USGS Study, Page 2.

The EA needs to include protocols to mitigate the impact of firework debris on surface waters and prevent floatable debris from traveling downstream, outside of the areas of the Memorial that will be inspected after the Mount Rushmore Fireworks Event. Measures such as containment booms at downstream locations in streams likely to be impacted by firework debris are a viable containment and capture option for floatable debris.

Extent of Aerial Deposition

Aerial deposition of particulate matter resulting from firework explosions is a primary manner that firework related contamination is dispersed to the environment.[75] Particulate matter deposition occurs in a relatively uniform manner and can occur over a wide area.[76] Wind conditions during the fireworks display would influence the extent and location of particulate aerial deposition.

Comment: Surface waters, groundwater, and soils in the areas of the Memorial where aerial deposition occurs will be impacted by firework related contamination. NPS should perform aerial deposition monitoring to estimate the aerial extent and magnitude of firework particulate deposition as a result of the Mount Rushmore Fireworks Event. Collection of aerial deposition data will help NPS understand the extent of firework contamination and inform the Monitoring Program on required soil, groundwater, and surface water sampling locations. If firework displays at the Memorial continue in future years, aerial deposition monitoring can inform future water quality and soil monitoring programs and assist in understanding concentration trends and potential for natural attenuation of persistent environmental contaminants, such as perchlorate. Since the EA details no mitigation techniques to prevent or reduce the quantity of aerial deposition of particulate matter resulting from firework displays, learning the aerial extent of particulate deposition can help NPS develop potential mitigation alternatives if future firework displays are held at the Memorial.

Current Groundwater and Drinking Water Monitoring Program

There is currently an ongoing groundwater and drinking water monitoring program at the Memorial.[77] The EA provides limited information on the full extent of contaminants that are being monitored, monitoring frequency, monitoring locations, and monitoring results. Only Figure 9 of the EA shows perchlorate sample results from the ongoing groundwater and drinking water monitoring program., however, it does not detail precise sampling dates, frequency and results. Additionally, the EA notes nitrate sampling that has been ongoing since 1991 in treated water from the water treatment plant, but provides only a range of results over that time period

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75 Licudine, Jocelyn, A., et. al., Hazardous Metals in Ambient Air Due to New Year Fireworks During 2004-2011 Celebrations in Pearl City, Hawaii, Public Health Reports, Volume 127, July-August 2012.

76 USGS Study, Page 2.

77 EA, Section 2.1.3, Page 8.

and no information on sampling frequency or any changes in treated water effluent concentrations that occurred as a result of prior firework displays at the Memorial between 1998 and 2009.

Comment: In order to understand current groundwater and drinking water contaminant levels, and the corresponding risk to human health at the Memorial from exposure in drinking water, the EA needs to detail the full scope and results of the current groundwater and drinking water monitoring program.

Monitoring Program

According to the EA, NPS and USGS plan to conduct water quality and soil monitoring prior to the Mount Rushmore Fireworks Event to collect baseline data and after the event on a schedule to be determined by NPS and USGS to evaluate impacts on soils, groundwater, and surface water. The Monitoring Program would evaluate the Mount Rushmore Fireworks Event's impact on levels of potassium perchlorate and possibly other chemicals or metals in soils and surface water and groundwater typically present in fireworks. According to the EA, if monitoring results show that conditions in surface waters, groundwater and soils change meaningfully, additional analysis may be required to evaluate future firework events.[78]

Comment: In order to ascertain the adequacy of the Monitoring Program, the EA needs to include its full scope, inclusive of the full suite of chemicals that will be analyzed for and the monitoring schedule. The Monitoring Program needs to include sampling and analysis of drinking water at the Memorial, a primary source of exposure that can adversely impact human health.

The EA needs to clearly define the criteria it will apply to determine if "meaningful" changes to soil, surface water, groundwater, or drinking water contaminant levels have occurred as a result of the Mount Rushmore Fireworks Event and potential future firework displays. NPS needs to clearly define the additional analysis it would perform in response to a meaningful change in soil, surface water, groundwater or drinking water conditions, and define a threshold that would lead to the cessation of future firework events at the Memorial.

The Monitoring Program needs to include surface water sediment sampling, most notably for metals, due to the potential for metals accumulation in surface water sediments and their potential adverse impacts to aquatic organisms that live in the benthic sediment layer.

[78] EA, Section 2.1.3, Page 8.

Potential for Drinking Water Contamination

The Memorial provides approximately 7 million gallons of drinking water to over 3 million annual visitors and park personnel, including to staff residences at the Memorial, from two groundwater production wells.[79,80] Well 1 is 200-feet deep and has operated since 1967. Well 2 is 500-feet deep and has operated since 2010, when it was installed to supplement production from Well 1.[81] Drinking water provides the primary exposure routes for firework-related contaminants, especially perchlorate, to adversely impact human health.[82]

Groundwater in the Memorial is highly susceptible to persistent environmental contamination due to several factors. Soils in the Memorial rapidly infiltrate water. The geological formations where aquifers exist are fractured, porous, and conducive to recharge. A geological formation of granite or pegmatite acts as an underground dam to restrict groundwater flows out of the groundwater aquifers in the Memorial used to supply drinking water.[83,84] As a result, contaminants on land surfaces, such as perchlorate, with its unique properties of high water solubility, low soil/geological absorptivity, and inability to biodegrade in Memorial soils, can be readily transported into the Memorial's groundwater aquifers and will accumulate and persist due to the damming action of the geological formation restricting groundwater flows.

During the USGS Study, perchlorate concentrations in Well 1ranged from 17 ug/l to 38 ug/l and in Well 2 ranged from 2.1 ug/l to 17 ug/l. Median concentrations in Well 1 were 23 ug/l and median concentrations in Well 2 were 6.1 ug/l. Perchlorate concentrations in treated drinking water ranged from 12 ug/l to 29 ug/l.[85] The observed drinking water perchlorate concentration range was similar to concentrations from Well 1 but were lower as a result of blending of water supplies from Well 1 and Well 2.[86]

Drinking water treatment at the Memorial consists of an on-site water treatment plant with microfiltration. Drinking water treatment in the Memorial's on-site water treatment plant is designed primarily to remove arsenic and to chlorinate the water for disinfection. It does not include treatment processes to remove perchlorate.[87] Secondary treatment is provided in staff

79 USGS Study, Page 2.
80 EA, Section 3.4.2.2.1, Page 32.
81 USGS Study, Pages 2 and 6.
82 EA, Section 3.4.2.2.1, Page 32.
83 USGS Study, Pages 2 and 6.
84 EA, Section 3.4.1.1.3, Pages 27 - 28.
85 EA, Section 3.4.1.1.3, Page 28.
86 USGS Study, Page 17.
87 USGS Study, Page 6.

residences for perchlorate by local reverse osmosis systems.[88] Monitoring location L-7 represent drinking water samples collected after microfiltration.[89,90]

Based on Figure 9 of the EA showing results of the current drinking water monitoring program at the Memorial, drinking water sourced from Well 1 and treated via microfiltration at the on-site water treatment resulted in perchlorate concentrations reductions ranging from approximately zero ug/l to 10 ug/l. It is unclear to what degree lower perchlorate concentrations resulted from blending of drinking water supplies with Well 2. Based on Figure 9, there were occasions when drinking water perchlorate concentrations after treatment were higher than from Well 1 before treatment. These results indicate that the treatment process at the Memorial's on-site water treatment is inconsistent and is of limited effectiveness at removing perchlorate from drinking water at the Memorial. The EA claims that the reverse osmosis systems in staff residences is effective at removing perchlorate from drinking water but provides no monitoring data to support this claim.[91]

The Section of this report on Environmental Contaminants of Concern (see pages 5 through 8) that relates to perchlorate discusses the numerous health risks to humans from perchlorate exposure. Short-term exposure high doses of perchlorate in the Memorial's drinking water potentially result can result in nausea, vomiting and diarrhea. If ingested at high enough levels, which can potentially result from chronic perchlorate exposure in staff or frequent visitors, perchlorate can interfere with thyroid function, with the greatest potential risks to infants and fetuses.[92]

In February 2011, EPA determined that perchlorate meets the standards of the Safe Drinking Water Act for regulation due to the potential for adverse health impacts to humans from exposure in drinking water.[93] The EPA's current Interim Drinking Water Health Advisory for perchlorate is 15 ug/l.[94,95] In 2013 EPA calculated a tap water screening level of 11 ug/l for perchlorate and perchlorate salts.[96] EPA is currently in the rulemaking process to establish a Maximum Contaminant Level (MCL) for perchlorate. The MCL is the maximum level of a contaminant in drinking water at which no known or anticipated adverse human health effects would occur.[97] MCL concentrations under consideration are 18 ug/l, 56 ug/l, and 90 ug/l. A

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88 EA, Section 3.4.1.1.1, Page 25 and Section 3.4.2.2.1, Page 32.
89 EA, Section 3.4.1.1.1, Page 25.
90 USGS Study, Page 6.
91 EA, Section 3.4.2.2.1, Page 32.
92 Perchlorate Toxicological Profile, Page 7.
93 USEPA, Perchlorate in Drinking Water Frequent Questions, January 27, 2020. shttps://www.epa.gov/sdwa/perchlorate-drinking-water-frequent-questions. Accessed March 5, 2020.
94 USGS Study, Pages 4 and 25.
95 USEPA Perchlorate Fact Sheet.
96 *Ibid*.
97 USEPA, Perchlorate in Drinking Water Frequent Questions, January 27, 2020. shttps://www.epa.gov/sdwa/perchlorate-drinking-water-frequent-questions. Accessed March 5, 2020.

final determination on a perchlorate MCL is anticipated by June 19, 2020.[98] EPA's perchlorate MCL will set the regulatory standard for drinking water used at the Memorial and would influence any future changes to drinking water treatment at the Memorial.[99]

Numerous states have set enforceable perchlorate standards in drinking water, including some standards much lower than EPA's Interim Drinking Water Health Advisory and potential MCLs under consideration. Massachusetts Department of Environmental Protection (MADEP) has established a perchlorate limit of 2 ug/l.[100,101] California has an MCL of 6 ug/l and reduced its drinking water standard Public Health Goal from 6 ug/l to 1 ug/l in 2015, based on new research on the effects of perchlorate on infants.[102,103] In addition to Massachusetts and California, twelve other states have established non-enforceable guidance, action or advisory levels for perchlorate.[104]

Comment: The primary exposure pathway for humans to firework related contaminants is through drinking water at the Memorial, especially perchlorate, which has been found at elevated levels in drinking water groundwater sources and in treated drinking water. The current drinking water treatment system is not designed for perchlorate removal. Visitors and staff, especially long-term staff that reside at the Memorial and visiting infants, young children, and the fetuses of pregnant women, are at an elevated risk of perchlorate exposure when ingesting the Memorial's drinking water and its potential adverse human health impacts.

Based on Figure 9 of the EA, perchlorate concentrations observed in drinking water at the Memorial ranged from between approximately 12 ug/l and 29 ug/l between approximately March 2013, and January 2020, when treated water at the Memorial was monitored for perchlorate. Over that approximately seven-year time period, perchlorate concentrations have only slightly trended downward, even though the last firework display at the Memorial occurred over a decade ago. The slow downward trend in drinking water perchlorate concentrations at the Memorial is indicative of the persistent nature of perchlorate in groundwater.

Observed perchlorate concentrations in drinking water between approximately 12 ug/l and 29 ug/l exceed numerous established human health standards and guidelines for perchlorate

98 EA, Section 3.4.1.1.3, Page 28.
99 EA, Section 3.4.2.1, Page 31.
100 USGS Study, Page 4.
101 USEPA Perchlorate Fact Sheet.
102 *Ibid.*
103 California Office of Environmental Health Hazard Assessment, OEHHA Adopts Updated Public Health Goal for Perchlorate, February 27, 2015. https://oehha.ca.gov/water/press-release/press-release-water/oehha-adopts-updated-public-health-goal-perchlorate-0. Accessed March 12, 2020.
104 USEPA, Perchlorate in Drinking Water Frequent Questions, January 27, 2020. shttps://www.epa.gov/sdwa/perchlorate-drinking-water-frequent-questions. Accessed March 5, 2020.

concentrations in drinking water, as determined by environmental and toxic health hazard regulatory agencies, including:

- MADEP enforceable drinking water standard of 2 ug/l
- CA Environmental Protection Agency (CA EPA) MCL of 6 ug/l
- CA Public Health Goal of 1 ug/l
- USEPA Interim Drinking Water Health Advisory standard of 15 ug/l
- USEPA calculated tap water screening level of 11 ug/l

Most notably, Memorial drinking water was between 6 times and nearly 15 times higher than the MADEP drinking water standard and was between 2 times and nearly 5 times the CA EPA MCL. If EPA sets its perchlorate MCL at 18 ug/l, drinking water at the memorial is likely to routinely exceed EPA's MCL.

The Mount Rushmore Fireworks Event will result in release of perchlorate to the environment that will subsequently enter the drinking water groundwater sources at the Memorial, increase perchlorate concentrations in groundwater, and ultimately increase already elevated drinking water perchlorate concentrations. The result of increased drinking water perchlorate concentrations at the Memorial will be an increase in the risk of human exposure and adverse human health impacts. Any future firework displays after the Mount Rushmore Fireworks Events will only act to increase groundwater and drinking water perchlorate concentrations and exasperate the human health risk they present, not only in the near-term, but in the long-term due to the persistent nature of perchlorate in groundwater and the Memorial's failure to treat drinking water at its treatment plant for perchlorate removal.

Memorial staff, especially those that reside at the Memorial, are at an increased risk of long-term perchlorate exposure and adverse health impacts due to the extended time they are at the Memorial and likely ingesting Memorial drinking water. The EA claims that staff residence reverse osmosis systems effectively remove perchlorate from staff residence drinking water. Though reverse osmosis is known to be effective at removing perchlorate from drinking water, the EA provides no data of staff residence drinking water perchlorate concentrations to support its claim and identify if drinking water perchlorate concentrations at the staff residences still exceed established human health standards and guidelines, thus presenting increased human health risk to resident staff. The Monitoring Program needs to include analysis of staff residence drinking water for perchlorate in order to adequately evaluate the health risk to Memorial staff.

The EA needs to clearly define a threshold perchlorate concentration for drinking water at the Memorial that will result in concrete measures to reduce drinking water perchlorate concentrations and their associated risks to human health. Such measures could include:

- modification of the water treatment plant to include a treatment system effective at perchlorate removal in all the drinking water distributed in the Memorial.
- installation of local reverse osmosis systems in all locations drinking water is used or can be ingested at the Memorial.
- cessation of all firework displays at the Memorial to stop putting additional perchlorate loads into the environment and subsequently groundwater used as drinking water.