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SAUGET INDUSTRIAL CORRIDOR SITES NATURAL RESOURCE DAMAGE ASSESSMENT

SURFACE WATER RESOURCES INJURY DETERMINATION

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CHAPTER 1 | INTRODUCTION

The Sauget Industrial Corridor (SIC) is located within the municipalities of Sauget, Cahokia, and East St. Louis directly adjacent to and located within the floodplain of the East Bank of the Mississippi River, known as the American Bottoms. The SIC provides important habitat for a variety of fish and wildlife species and is situated within the Mississippi River Flyway. Millions of birds, including 40 percent of all North American waterfowl, and 60 percent of all North American bird species, use the Mississippi flyway to forage, rest and breed (McGuiness 2000, Wiener et al. 1998). An estimated 292 migratory bird species utilize the Upper Mississippi River (an area from the mouth of the Ohio River at Cairo, Illinois, to the beginning of the commercial shipping channel at Minneapolis, Minnesota), which includes the reach along the SIC (Korschgen and Hill 1996). The American Bottoms are also home to numerous species of endangered and threatened aquatic birds. The Mississippi River flyway provides significant economic benefits to surrounding states through waterfowl hunting and bird watching activities.

Other biological resources in the SIC include aquatic and terrestrial plants and microorganisms, aquatic and terrestrial mammals, fish and amphibians. The Upper Mississippi River supports a diverse fishery of indigenous fishes as well as a variety of recreational sport and commercial fish species. Recreational fishing in the Upper Mississippi River provides significant economic benefits to the bordering states (Trustees 2013). Priority resource needs that have been identified for the SIC include conserving and enhancing fishery habitat, nesting and rearing habitat for migratory wildlife, migratory birds, waterfowl, wading birds, and associated habitat.

The SIC also comprises numerous hazardous waste disposal sites, back-filled former wastewater impoundments, and adjacent contaminated areas, including natural wetlands and waterways contaminated through releases of hazardous substances. Given the long history of industrial development and unpermitted releases and dumping of hazardous substances within the assessment area, natural resources have been exposed to and injured by hazardous substances throughout much of the last century, and injury is expected to continue into the future.

The responsibility for restoring natural resources that have been injured by hazardous substances lies with certain governmental agency heads known as Trustees. Trustees include the heads of certain State agencies, Indian Tribes, and Federal governmental agencies. These officials act as stewards of natural resources and are responsible for holding these resources in trust for the public. Acting under their authority as natural resource trustees pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), the United States Department of the Interior through the United States Fish and Wildlife Service (FWS), the State of Illinois through the

Illinois Environmental Protection Agency (IEPA), and the Illinois Department of Natural Resources (IDNR), and the State of Missouri through the Missouri Department of Natural Resource (MDNR) (collectively, the "Trustees") are conducting a natural resource damage assessment (NRDA) within the Sauget Industrial Corridor (SIC), in Sauget, Cahokia, and East St. Louis, St. Clair County, Illinois. The Trustees are implementing the NRDA pursuant to the U.S. Department of Interior (DOI) NRDA regulations at 43 C.F.R. Section 11.

In January 2013, the Trustees released an Assessment Plan to guide the NRDA, which outlines the process the Trustees will follow for assessing natural resource injuries attributable to releases of hazardous substances at the SIC, and ultimately identifying and scaling environmental restoration to compensate the public for those injuries (Trustees 2013). As outlined in the Assessment Plan, the State of Illinois and Federal Trustees are leading the effort to assess aquatic and terrestrial resources in the SIC, while the State of Illinois Trustee is primarily responsible for assessment of groundwater resources, and the Trustees from the States of Illinois and Missouri are focusing on assessment of natural resources in the Mississippi River.

As an initial step in the NRDA process, the Trustees documented the pathways through which hazardous substances were released and came to be located in aquatic and terrestrial resources within the SIC, and thus where natural resource exposures have occurred ("Pathways Report"; Lewis and Arthur 2016).[1] The Pathways Report documents historical site ownership, land use, and disposal practices over time; describes the major classes of hazardous substances over time; and discusses the extent of contamination at the SIC.

The State of Illinois released its Phase 1 groundwater injury assessment report in February 2018 (Abt Associates 2018).[2] Separate reports are being developed to document baseline conditions, address exposure pathways and injury for the Mississippi River, and evaluate the presence of threatened and endangered bat species within the SIC, among other topics. The generation and public release of these reports are intended to advance and keep the public apprised of the assessment of natural resources at the SIC.

The Surface Water Resources Injury Determination report fulfills the requirements for surface water injury determination, as set forth in the NRDA regulations (43 C.F.R. §§11.61 and 11.62). This report describes how hazardous substances released at the SIC have adversely affected the surface water resources at the SIC by documenting injuries to surface water resources (inclusive of sediment resources) within the SIC, incorporating data and

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[1] The Sauget Industrial Corridor Pathways Report can be accessed at the following link: https://www.fws.gov/midwest/es/ec/nrda/Sauget/pdf/SaugetPathwayReport20160715final.pdf.

[2] The Sauget Industrial Corridor groundwater injury assessment can be accessed at the following link: https://www.fws.gov/midwest/es/ec/nrda/Sauget/pdf/GroundWaterReport15Feb2018SaugetPhase1.pdf.

information obtained through the 2018 sediment and macroinvertebrate field sampling (IEc 2018) and historical data. **The limited focus of this report on surface water resources is not intended to foreclose the assessment of other types or categories of resource injury.** Future assessment activities may target the evaluation of injuries to other resources, such as terrestrial and biological resources, including birds and other wildlife. In addition, based in part on the results of this surface water injury determination report, the extent and magnitude of natural resource injury will be quantified and documented in a subsequent report or reports. As the assessment proceeds, the Trustees may incorporate into the assessment new information as it becomes available, as well as other historical information not relied upon explicitly herein.

ASSESSMENT AREA AND ANALYTICAL SCOPE

The assessment area for this report is a relatively flat area of land in the municipalities of Sauget, Cahokia, and East St. Louis directly adjacent to and located within the floodplain of the East Bank of the Mississippi River, known as the American Bottoms. The American Bottoms and the SIC are a part of an important natural, historical, and cultural resource. The ecological significance of this area has been detailed elsewhere, including in the Assessment Plan (Trustees 2013), as well as in documents such as US ACE (2003, 2013), and from a regional perspective (IEc 1999). In particular, the SIC provides important habitat for a variety of fish and wildlife species and is situated within the Mississippi River Flyway. The aquatic areas of the SIC that are the focus of this report provide important ecological services to both local and migratory animals.

This area also comprises numerous hazardous waste disposal sites, back-filled former wastewater impoundments, and adjacent contaminated areas, including natural wetlands and waterways contaminated through releases of hazardous substances. As part of remedial investigation and response under CERCLA, the U.S. Environmental Protection Agency (USEPA) grouped these features into two areas ("Area 1" and "Area 2"), each comprising multiple sub-units delineated on the basis of geographic features, historical aerial photographs, magnetometer surveys, soil gas surveys, and test trenches. For purposes of this surface water injury determination report, the Trustees focus on sub-units with delineated or readily apparent current or historical surface water features (freshwater wetland, pond, or riverine habitat; Exhibit 1).

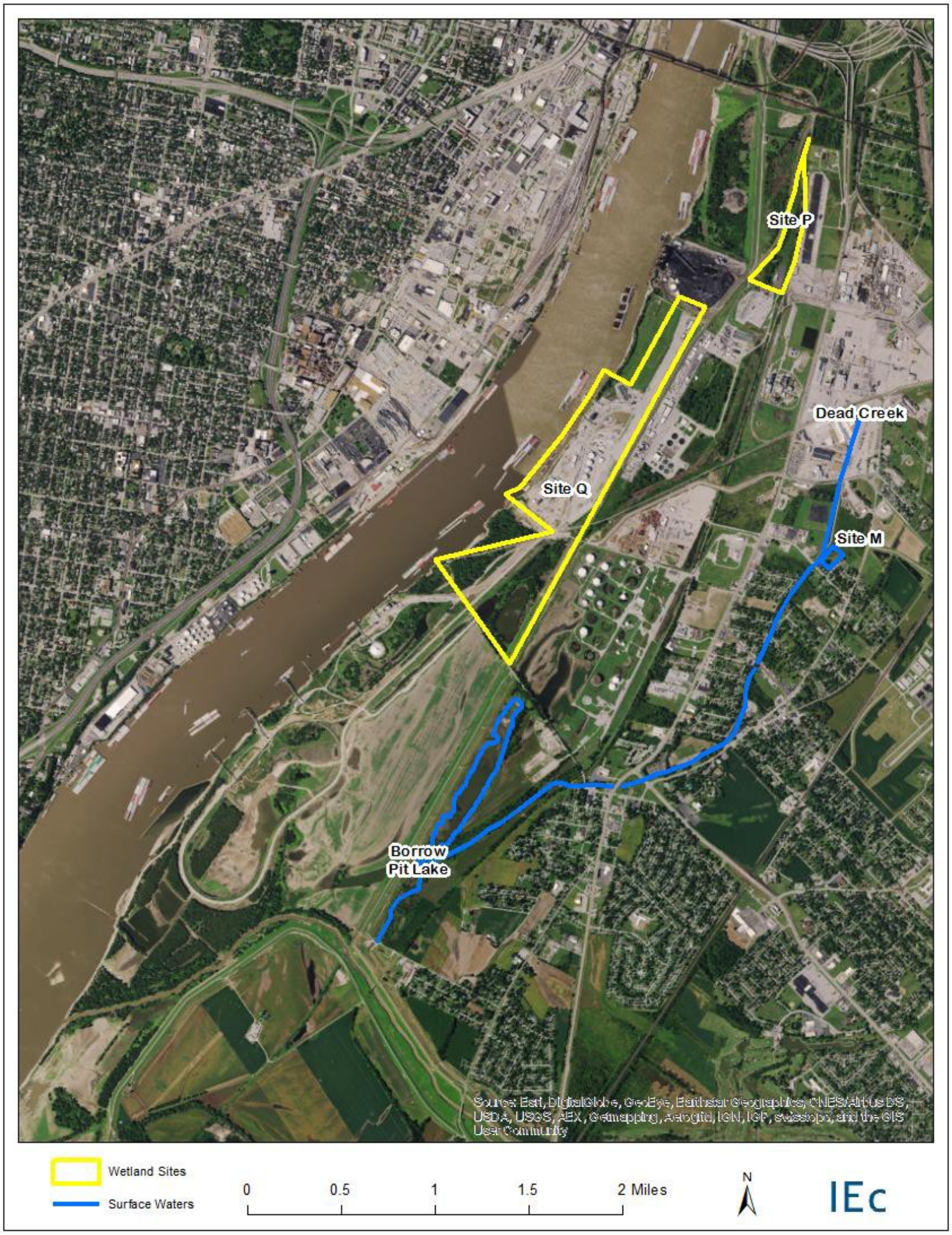
This includes:

- Dead Creek (inclusive of Site M),
- Borrow Pit Lake,
- The southern portion of Site Q, and
- Site P.

Given the long history of industrial development and unpermitted releases and dumping of hazardous substances within the assessment area, natural resources have been exposed to and injured by hazardous substances throughout much of the last century, and injury is expected to continue into the future. The Trustees anticipate assessing damages for injuries occurring after the promulgation of CERCLA in December 1980. While injuries to natural resources within the SIC occurred prior to December 1980, and the Trustees may evaluate those injuries (e.g., to evaluate trends over time), this report focuses on documentation of injury to surface water resources between 1981 and the present, based on available information.

The following sections describe surface water resources within the SIC, outline the Trustees' approach to injury determination, and document injuries to surface waters and sediments at relevant SIC sites.

EXHIBIT 1 SIC SUB- AREAS WITH SURFACE WATER FEATURES DISCUSSED WITHIN THIS REPORT



CHAPTER 2 | SURFACE WATER RESOURCES WITHIN THE SIC

Much of the SIC assessment area was historically within the floodplain of the Mississippi River. Local topography ranges from 400 to 410 feet above mean sea level and is characterized by the presence of intermittent wetlands. Due to industrialization of the area, some areas were filled when levees were constructed in an effort to protect low-lying bottomlands from Mississippi River flood waters.

For purposes of this report, the Trustees focus on areas where surface water resources have persisted, albeit sometimes intermittently, within the assessment area. Surface water resources are defined in the DOI NRDA regulations as:

> The waters of the United States, including the sediments suspended in water or lying on the bank, bed, or shoreline and sediments in or transported through coastal and marine areas (43 C.F.R. Section §11.14 (pp)).

Surface water resources within the assessment area include:

- **Dead Creek** is approximately 17,000 feet in length and historically flowed from the Village of Sauget near the Alton & Southern Railroad line just east of the Cerro Copper facility and south of the W.G. Krummrich Chemical Plant[3] to Borrow Pit Lake; ultimately discharging to the Mississippi River via Prairie du Pont Creek and the Cahokia Chute. Prior to 1930, Dead Creek received direct industrial and municipal wastewater discharges, and until 1990, wastewater discharges from industries, municipalities, and residences through the Village of Sauget sewer system (USEPA 1999; Solutia/GSI 2012). Due to hydrological controls (e.g., the Metro East Sanitary District pumping station) and general flow patterns, Dead Creek now functions as an intermittent stream and provides wetland and riparian habitat to a range of wildlife (USEPA 2013a; Trustees 2013, 2016). For remedial purposes, Dead Creek was divided into six creek segments (CS). CS-A, was dredged and capped with an High-density Polyethylene (HDPE) vapor barrier, backfilled, and covered with crushed gravel in 1990 (USEPA 2013a). Creek Segments B, C, D, E, and F were dredged from June 2000 through February 2002. Additional soil removal occurred in 2005 and 2006 to address remaining hot spots of contaminated soils and place them, along with previously dredged sediments, in a containment cell adjacent to CS-B (USEPA 2013a, Solutia 2008). Currently, the USEPA considers the Dead Creek remedy complete and is not planning further remedial actions (USEPA 2013a).

[3] This facility is currently owned and operated by the Eastman Chemical Company, which purchased Solutia, Inc. in 2012.

- **CS-A** (Alton & Southern Railroad to Queeny Avenue), the northernmost portion of Dead Creek, was approximately 1,800 feet in length and 100 feet in width (4.1 acres).[4] This segment consisted of two ponds that were used by the Village of Sauget municipal sewer system as surcharge basins. The ponds were directly connected to downstream sections until 1968. In 1990, the ponds were dredged and capped with an HDPE vapor barrier and gravel as part of remedial actions completed by Cerro Copper. The site is currently covered by gravel, and its historical use as habitat for various wildlife has been lost.
- **CS-B** (Queeny Avenue to Judith Lane) is approximately 1,800 feet in length and covers approximately 2.8 acres. Historically CS-B was hydrologically connected to an adjacent former borrow pit located in Site M. In 2008, a polysynthetic liner was installed in CS-B as part of remedial actions to reduce leaching from Site M (USEPA 2013a). The segment currently appears to be lined with concrete blocks and gravel that are somewhat overlain by sediment and partially vegetated (Exhibit 2). **Site M**, adjacent to CS-B, comprised an additional 1.6 acres of ponded surface water habitat until 2001, when sediments were removed and the borrow pit was filled to grade with soil as part of remedial actions in Dead Creek (Trustees 2013). Site M currently appears to be somewhat below grade and may still be considered wetland (Exhibit 3).
- **CS-C** (Judith Lane to Cahokia Street) is approximately 1,300 feet in length and covers approximately 1.8 acres. CS-C, as well as segments further downstream, appear to have robust vegetated buffers, in contrast to CS-B (Exhibit 4).
- **CS-D** (Cahokia Street to Jerome Lane) is approximately 1,100 feet in length and covers approximately 0.9 acres (Exhibit 5).
- **CS-E** (Jerome Lane to Route 157) is 4,300 feet in length and covers 3.1 acres (Exhibit 6).
- **CS-F** (Route 157 to Borrow Pit Lake) is the southernmost section of Dead Creek (Exhibit 7). It is 6,500 feet in length and covers approximately 4.0 acres. The inlet to Borrow Pit

[4] Length and width measurements for the creek segments are as reported in USEPA 1999. The area of CS-A is based on the stated width and length measures. Remaining measures of area for creek segments are Geographical Information Systems (GIS)-based measurements of digitized aerial photographs; and include only visible surface water. The actual area of influence of Dead Creek, including riparian fringe and floodplain habitat is larger than the areas reported herein.

Lake is approximately located at the mid-point of the creek segment.

- **Borrow Pit Lake** is fed by Dead Creek, drains into Prairie du Pont Creek, and is hydrologically controlled, such that it drains whenever the water level reaches approximately seven feet. Originally constructed in the 1950s along with the Mississippi River flood control levee, the Borrow Pit Lake pond and contiguous wetlands cover an area approximately 6,000 feet by 500 feet (70 acres; Exhibit 8).

- **Wetlands occur within the SIC, including portions of Sites Q and P**. The presence of wetland habitat reflects the low-lying terrain of SIC Areas 1 and 2 within the floodplain of the Mississippi River.

    - **Site Q** is approximately 90 acres (Exhibit 9), a portion of which is classified as wetland (Exhibit 10; FWS 2016). In addition to containing wetland and Mississippi River floodplain habitat, it includes two ephemeral ponds approximately 8.6 and 2.6 acres in size. Site Q was used as a municipal and industrial waste disposal area from the 1960s until 1975 and underwent heavy remediation from 1993 to 2000 (AMEC 2008, IEPA undated, URS 2008).

    - **Site P** covers approximately 20 acres and has intermittent wetlands covering approximately seven acres in Area 2 (Exhibit 11). It includes a portion of relatively flat ground, as well as two ravines (gullies) classified as wetlands by the FWS; one located in the south-center portion of the disposal area, and the other located near the eastern site boundary (FWS 2016). Despite these areas Site P has been considered a terrestrial site in previous site reports and investigations. The site was operated as an IEPA-permitted landfill for general wastes by Sauget and Company from 1973 to approximately 1984 and received Notice of Violation letters from IEPA for waste drums and metal cans containing phosphorus pentasulfide (USEPA 2000, URS 2008, AMEC 2008).

EXHIBIT 2 DEAD CREEK CS - B (LOOKING SOUTH FROM QUEENY AVENUE ; 29 JUNE 2017)

EXHIBIT 3 SITE M (AERIAL ORTHOPHOTO (9 OCTOBER 2017) AND GROUND - LEVEL PHOTOGRAPH LOOKING EAST (7 AUGUST 2018))

(Orthophoto from Google Earth, 9 October 2017)

EXHIBIT 4 DEAD CREEK CS - C (LOOKING SOUTH FROM JUDITH LANE ; 29 JUNE 2017)

EXHIBIT 5 DEAD CREEK CS - D (LOOKING SOUTH ; 9 AUGUST 2018)

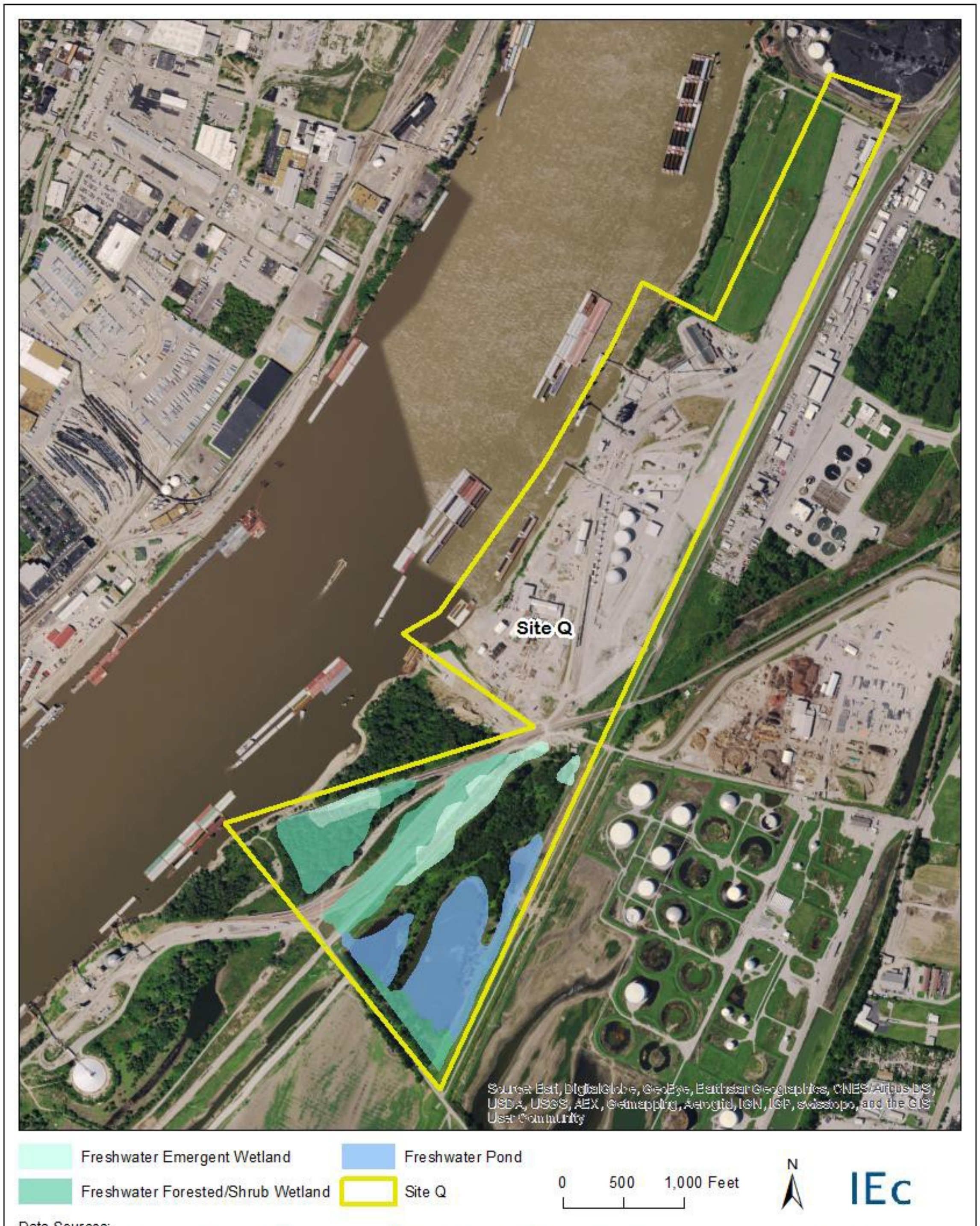
EXHIBIT 6 DEAD CREEK CS - E (LOOKING SOUTH ; 9 AUGUST 2018)

EXHIBIT 7 DEAD CREEK CS- F (LOOKING EAST; 7 AUGUST 2018)

EXHIBIT 8 BORROW PIT LAKE (LOOKING EAST; 29 JUNE 2017)

EXHIBIT 9 SITE Q (LOOKING WEST; 10 AUGUST 2018)

EXHIBIT 10 DELINEATED WETLANDS AT SITE Q (FWS 2016)



Data Sources:
U.S. Fish & Wildlife Service National Wetland Inventory, Wetlands Mapper. Updated July 2016 https://www.fws.gov/wetlands/Data/Mapper.html

EXHIBIT 11 DELINEATED WETLANDS AT SITE P (FWS 2016)

CHAPTER 3 | SURFACE WATER INJURY DETERMINATION

The DOI NRDA regulations define injury to natural resources as:

> *A measurable adverse change, either long- or short-term, in the chemical or physical quality or the viability of a natural resource resulting either directly or indirectly from exposure to a…release of a hazardous substance* (43 C.F.R. §11.14 (v)).

In specific reference to surface water, the regulations state that injury has occurred if concentrations of hazardous substances are:

> *Concentrations and duration of substances in excess of applicable water quality criteria established by section 304(a)(1) of the CWA, or by other Federal or State laws or regulations that establish such criteria, in surface water that before the discharge or release met the criteria and is a committed use, as that phrase is used in this part, as a habitat for aquatic life, water supply, or recreation. The most stringent criterion shall apply when surface water is used for more than one of these purposes…* (43 C.F.R. Section §11.62 (b)(iii)).

Illinois Administrative Code, Title 35, Section 303.201 designates "all waters of the State" not otherwise designated as General Use Waters that are subject to restrictions on the presence of chemical constituents and toxic substances "in concentrations toxic or harmful to human health, or to animal, plant or aquatic life" (IAC 35 § 302.210). For purposes of the acceptance criteria for injury to surface waters in the DOI NRDA regulations, the Trustees consider all SIC surface water resources in aggregate (see 43 C.F.R. 11.62(b)(2)(i)).

To determine injury to surface waters within the assessment area, the Trustees rely on readily available existing information on hazardous substances in environmental media reported in a range of documents, include existing remedial investigation, risk assessment documents, and data from the Trustees' 2018 sediment sampling event (IEc 2018; IEc 2020).[5]

In particular, the Trustees consider four lines of evidence related to surface water resource injury; these include:

1. Contaminant concentrations in surface water.
2. Contaminant concentrations in sediment.
3. Results from laboratory toxicity tests in which biological test organisms were exposed to site sediment.
4. The adverse impacts of remedial actions that caused collateral injuries

[5] The Trustees did not attempt to perform an exhaustive search for available data and instead focused on readily available data. Nevertheless, in many cases data are lacking. In particular, the number of samples representing relatively large areas is small. Further, analytical approaches and data are sometime incomplete or not fully transparent (see, for example, MacDonald 2008).

to surface water resources.

These lines of evidence for surface water resource injury are explored in the sections that follow.

3.1 CONTAMINANT CONCENTRATIONS IN SURFACE WATER

Readily available data from site reports on concentrations of contaminants in surface water and sediment, when compared to Illinois Aquatic Life Criteria (IALC) or Federal Ambient Water Quality Criteria (AWQC) (USEPA 2016; IPCB 2013) indicate that surface water resources exceed water quality criteria, and thus, have been injured. Contaminant concentration data in surface water are readily available for Dead Creek (including Site M), Borrow Pit Lake, and the Site Q Ponds (AMEC 2008; Menzie-Cura et al. 2001; Menzie-Cura et al. 2002); though in some cases the number of samples available is relatively few.

Surface water data used for this assessment include:

- *Revised baseline ecological risk assessment. Sauget Area 2 Sites (Sites O, P, Q, R, and S). Volumes I, II, and III* (AMEC 2008)
- *Baseline Ecological Risk Assessment for Sauget Area 1. Sauget, St. Clair County, Illinois* (Menzie-Cura et al. 2001)
- *Sauget Area 1 Dead Creek Final Remedy. Volume 1: Engineering Evaluation/Feasibility Study* (Menzie-Cura et al. 2002)

The Trustees focus herein on hazardous substances (as defined in 42 U.S.C. § 9601 et seq.) representative of classes of chemicals found within the SIC: volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides, metals, and polychlorinated biphenyls (PCBs).[6] In addition, the evaluated hazardous substances are those for which ambient water quality criteria are available from USEPA or the State of Illinois: for example, aluminum, lead, mercury, nickel, zinc, arsenic, total PCBs, bis(2- ethylhexyl) phthalate, 4-chloroaniline, 2,4-D, endosulfan II, dieldrin, 4,4’-DDT, and chlorobenzene.

Water quality criteria were obtained from Federal (USEPA 2016) and state sources (IPCB 2013). Water quality criteria are derived according to Stephan et al. (1985) and are designed to be protective of freshwater organisms from short-term (acute) and long-term (chronic) exposure to toxic chemicals. Criteria for toxic chemicals are the highest concentration of specific pollutants or parameters in water that are not expected to pose a significant risk to the majority of species in a given environment.

Trustees used acute and chronic water quality criteria for each hazardous substance, where available. The acute value, or criterion maximum concentration (CMC), is an estimate of the highest concentration of a material in

[6] For details about hazardous substances manufactured, produced, and released in the Sauget Industrial Corridor see Trustees 2009, Trustees 2013, Lewis and Arthur 2016 (some information from which is reproduced in Appendix 1 of this document) and Abt Associates 2018.

the water column to which an aquatic community can be briefly exposed without resulting in an unacceptable effect. The chronic value, or criterion continuous concentration (CCC), is an estimate of the highest concentration of a material in the water column to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect.

Examples of exceedances of water quality criteria are summarized below for Borrow Pit Lake (Exhibit 12), Dead Creek (Exhibit 13), and the Site Q Ponds (Exhibit 14). At Site M, water samples were rarely collected prior to the site being filled to grade. For example, only two water samples were collected in 1980 by IEPA, which exceeded water quality criteria for copper and zinc (Ecology and Environment 1988), and only one water sample was collected and analyzed in 1992 (Geraghty and Miller 1992).

In all evaluated areas, one or more contaminants are/were present in surface water at concentrations greater than promulgated ambient water quality criteria.[7] Thus, based on 43 C.F.R. Section §11.62 (b)(1)(iii), surface waters present within the SIC have been injured by the hazardous substances. In addition, although numerous contaminants of concern have been documented in SIC surface waters, many do not have promulgated surface water criteria. Other contaminants that were not the focus of this analysis and contaminants that do not have promulgated ambient water quality criteria may have added to that injury.

Due to the lack of water quality criteria for all contaminants, the damage assessment may underestimate natural resource injuries caused by contaminants that cannot be evaluated against a nonexistent criterion. Additionally, comparing chemical concentrations to their respective criterion ignores any potential mixture effects that may or may not be present from co-occurring contaminants. Therefore, focusing on a subset of contaminants can potentially result in an underestimation of damages. One approach that considers the cumulative effects of all contaminants present in the system is toxicity testing that exposes laboratory test organisms to site sediment. These toxicity tests integrate and represent site-specific sediment conditions and their impact on standard test species. In the course of the SIC remedial process, toxicity tests have been conducted to better characterize the effects of the suite of contaminants present within the SIC and document natural resource injuries. Contaminant concentrations in sediment and sediment toxicity tests are described in the following sections.

[7] Surface water concentrations were measured before major remedial actions took place within the SIC.

EXHIBIT 12 EXCEEDANCE OF WATER QUALITY STANDARDS BY MEAN AND MAXIMUM CONCENTRATIONS OF BORROW PIT LAKE SURFACE WATER

CONTAMINANT	UNITS	NUMBER OF NON-DETECTS[1]	MEAN CONC.	MAX. CONC.	ACUTE CRITERION[2]	CHRONIC CRITERION[2]	CRITERIA SOURCE
Aluminum	mg/L	0	***1.6***	***3.4***	0.75	0.087	USEPA 1988
Iron	mg/L	0	*3.9*	*8.7*	--	1	USEPA 1986
Lead	mg/L	0	*0.0083*	*0.02*	0.065	0.0025	USEPA 1984

Notes.

Data source: Menzie-Cura et al. 2001 and confirmed in Solutia/GSI 2012. Mean or maximum concentrations in italics with gray shading indicates a concentration exceeds the chronic criterion. Mean or maximum concentrations in bold italics with red shading indicates a concentration exceeds the acute criterion and the chronic criterion.

1. Three samples were collected and analyzed for all contaminants listed in this table.
2. Ambient Water Quality Criteria, promulgated by USEPA under section 304(a)(1) of the Clean Water Act. Concentrations exceeding the acute criterion (CMC) and the chronic criterion (CCC) indicate injury to surface water resources (43 C.F.R. 11.62(b)(1)(iii)). Illinois Administrative Code, Title 35, Section 303.201 designates "all waters of the State" not otherwise designated as General Use Waters that are subject to restrictions on the presence of chemical constituents and toxic substances "in concentrations toxic or harmful to human health, or to animal, plant or aquatic life" (IAC 35 § 302.210). For purposes of the acceptance criteria for injury to surface waters in the DOI NRDA regulations, the Trustees consider all SIC surface water resources in aggregate (see 43 C.F.R. 11.62(b)(2)(j)).

EXHIBIT 13 EXCEEDANCE OF WATER QUALITY STANDARDS BY MEAN AND MAXIMUM CONCENTRATIONS OF DEAD CREEK SURFACE WATER

CONTAMINANT	UNITS	CREEK SEGMENT	NUMBER OF NON-DETECTS[1]	MEAN CONC.[2]	MAX. CONC.	ACUTE CRITERION[3]	CHRONIC CRITERION[3]	CRITERIA SOURCE
4,4'-DDT	µg/L	CS-B	2	--[2b]	*0.004*	1.1	0.001	USEPA 1980a
		CS-D	0	*0.00447*	*0.0071*			
Gamma Chlordane	µg/L	CS-B	1	0.00405 [2a]	*0.0054*	2.4	0.0043	USEPA 1980b
		CS-D	2	--[2b]	*0.005*			
Heptachlor	µg/L	CS-B	1	0.0032 [2a]	*0.0048*	0.52	0.0038	USEPA 2016
		CS-D	0	*0.00878*	*0.012*			
Heptachlor epoxide	µg/L	CS-B	1	*0.00465 2a*	*0.0077*	0.52	0.0038	USEPA 2016[5]
		CS-D	0	*0.014*	*0.017*			

CONTAMINANT	UNITS	CREEK SEGMENT	NUMBER OF NON-DETECTS[1]	MEAN CONC.[2]	MAX. CONC.	ACUTE CRITERION[3]	CHRONIC CRITERION[3]	CRITERION SOURCE
Aluminum	mg/L	CS-D	0	*0.69*	***1.4***	0.75	0.087	USEPA 1988
		CS-F	0	*0.246*	*0.55*			
Copper	mg/L	CS-B	0	***0.0783***	***0.13***	0.0073	0.0067	IPCB [4]
		CS-D	0	***0.0188***	***0.026***	0.0068	0.0062	IPCB [4]
Iron	mg/L	CS-D	0	*1.29*	*1.8*	–	1	USEPA 1986
		CS-E	0	--	*1.2*			
		CS-F	0	0.683	*1*			
Lead	mg/L	CS-B	0	*0.0046*	*0.0066*	0.065	0.0025	USEPA 1984
		CS-D	0	*0.0106*	*0.016*			
		CS-F	1	*0.0028*	*0.0037*			
Zinc	mg/L	CS-B	0	0.085	***0.13***	0.12	0.12	USEPA 1996
		CS-D	0	0.0838	***0.15***			
Total PCBs	µg/L	CS-D	2	--[2b]	*0.055*	–	0.014	USEPA 2016

Notes.

Data source: Menzie-Cura et al. 2002, and confirmed in Solutia/GSI 2012. Mean or maximum concentrations in italics with gray shading indicates a concentration exceeds the chronic criterion. Mean or maximum concentrations in bold italics with red shading indicates a concentration exceeds the acute criterion and the chronic criterion.

1. Three samples were collected and analyzed for all contaminants listed in this table, except for iron at CS-E, for which data from only one sample were available.
2. Mean concentrations are calculated based on data presented in Menzie-Cura et al. 2002. Due to the inclusion of non-detect concentrations at the detection limits presented in that report, mean values that included both detected and non-detected samples occasionally exceeded the maximum measured concentrations. When the mean exceeded the maximum concentration and at least two detected sample concentrations were available, means were calculated from detected values (2a). When the mean exceeded the maximum concentration but only one detected sample concentration was available, a mean was not calculated (2b).
3. The criteria listed here are Ambient Water Quality Criteria, established by the USEPA and promulgated by section 304(a)(1) of the Clean Water Act. Concentrations exceeding the acute criterion (the CMC) and the chronic criterion (the CCC) indicate an injury to surface water resources for the purposes of NRDA (43 C.F.R. 11.62(b)(1)(iii)). Illinois Administrative Code, Title 35, Section 303.201 designates "all waters of the State" not otherwise designated as General Use Waters that are subject to restrictions on the presence of chemical constituents and toxic substances "in concentrations toxic or harmful to human health, or to animal, plant or aquatic life" (IAC 35 § 302.210). For purposes of the acceptance criteria for injury to surface waters in the DOI NRDA regulations, the Trustees consider all SIC surface water resources in aggregate (see 43 C.F.R. 11.62(b)(2)(i)).
4. Criteria were derived according to IEPA statutes (35 IAC 302.208), using water hardness measurements reported for each creek segment in Menzie-Cura et al. 2002.
5. USEPA Water Quality Criteria for heptachlor were used for heptachlor epoxide (USEPA 2016).

EXHIBIT 14 EXCEEDANCE OF WATER QUALITY STANDARDS BY MEAN AND MAXIMUM CONCENTRATIONS OF SITE Q PONDS SURFACE WATER

CONTAMINANT	UNITS	SAMPLE SIZE[1]	MEAN CONC.	MAX. CONC.	ACUTE CRITERION	CHRONIC CRITERION	CRITERION SOURCE
4,4'-DDT (ug/L)	µg/L	9 (1)	NA	*0.5*	1.1	0.001	USEPA 1980
Total PCBs (ug/L)	µg/L	9 (1)	NA	*0.25*	NA	0.014	USEPA 2016
Aluminum (ug/L)	µg/L	8 (2)	***1,100***	***7,700***	750	87	USEPA 1988
Iron (ug/L)	µg/L	8 (8)	*1,200*	*8,900*	NA	1,000	USEPA 1986
Lead (ug/L)	µg/L	8 (2)	*4*	*14*	65	2.5	USEPA 1984

Notes.

Data source: AMEC 2008. Mean or maximum concentrations in italics with gray shading indicates a concentration exceeds the chronic criterion. Mean or maximum concentrations in bold italics with red shading indicates a concentration exceeds the acute criterion and the chronic criterion.

1. Sample size is reported with the number of detected concentrations in parentheses.

3.2 CONTAMINANT CONCENTRATIONS IN SEDIMENT

In the DOI NRDA regulations, sediment is considered as part of surface water resources (43 C.F.R. Section §11.14(pp)). Surface waters (including sediments) are considered injured when:

> *Concentrations and duration of substances sufficient to have caused injury ... to ground water, air, geologic, or biological resources, when exposed to surface water, suspended sediments, or bed, bank, or shoreline sediments.* (43 C.F.R. Section §11.62(b)(1)(v))

The Trustees determine injury to sediment by comparing contaminant concentrations in assessment area sediment to peer-reviewed, consensus-based sediment quality guidelines. Numerical sediment quality guidelines have been developed by regulatory agencies, resource managers, and academics in order to evaluate contaminants in freshwater sediments for a variety of purposes, including but not limited to conducting ecological risk assessment, NRDA, identifying contaminants of concern, and setting clean-up goals. Two commonly utilized criteria in the field of NRDA include the threshold effects concentration (TEC) and probable effects concentration (PEC), developed by MacDonald et al. (2000).

The TEC is considered a threshold below which adverse effects to sediment-dwelling species are not expected to occur, and the PEC is considered a threshold above which adverse effects are expected to occur in sediment-dwelling species.

MacDonald et al.'s (2000) guidelines were derived as the geometric mean of numerous similar published sediment quality guidelines, so therefore are characterized as "consensus-based" thresholds.

Where applicable in this report, the SIC Trustees compared sediment concentrations to these consensus-based sediment quality guidelines and supplemented as needed with additional studies that provided similar guidelines for freshwater sediment for a number of chemicals not addressed by MacDonald et al. (2000).

Classes of hazardous substances found at SIC Sites and evaluated herein included: VOCs, SVOCs, pesticides, metals, and PCBs. The specific suite of hazardous substances for which sediment benchmarks are currently available are: benzene, chlorobenzene, bis(2-ethylhexyl) phthalate, arsenic, cadmium, copper, lead, mercury, nickel, zinc, total PCBs, total PAHs, dieldrin, endosulfan II, and 4,4'-DDT. Additional contaminants of concern have been documented in SIC sediments, however in this report the Trustees focus on the injuries caused by the above hazardous substances and have not assessed all contaminants.

Contaminant concentration data are primarily drawn from more recent reports; sediment contaminant concentrations presented in earlier reports (not presented) in many cases are even higher than in the data presented herein.

Sediment data used for this assessment include:

- Pre-remedial sediment concentrations (Menzie-Cura et al. 2001)
- Post-remedial sediment concentrations (Solutia 2008)
- 2018 Sauget sediment sampling program (IEc 2018; IEc 2020)

Sediment concentrations and relevant literature-based benchmarks are presented for Borrow Pit Lake in Exhibits 15 (historical data) and 16 (2018 sediment data; IEc 2020). For Dead Creek, pre- and post-remediation values for industry-specific contaminants are presented in Exhibits 17 and 18, respectively; and recent Dead Creek sediment data (IEc 2020) are presented in Exhibit 19. Available soil and sediment data, summarized in Exhibits 20 (historical data) and 21 (2018 sediment data; IEc 2020), indicate that maximum concentrations of hazardous substances at Site Q South exceed consensus-based sediment thresholds. For all sites, hazardous substances are included in exhibits when maximum concentrations exceed literature-based benchmarks.

In all areas evaluated, hazardous substances are/were present at concentrations exceeding sediment thresholds above which toxicity to sediment-dwelling organisms is likely.

Contaminant concentrations in Borrow Pit Lake sediment are lower than those in Dead Creek, but still exceed thresholds indicative of injury to sediment resources. Within Borrow Pit Lake, sediment concentrations generally fall between the TEC and PEC (Exhibit 15), and recent sampling found exceedances of the TEC for a suite of metals as well as PCBs (Exhibit 16).

In Dead Creek and Site M sediments, concentrations of copper, lead, and zinc were historically high enough to cause adverse effects to sediment-dwelling organisms. Post- remediation levels appear to continue to pose a threat, as levels remain above thresholds in some areas (Exhibit 18). Recent sampling documented exceedances of PECs for both Total PAHs and Total PCBs (Exhibit 19). At Site Q, higher concentrations tend to be in areas delineated as wetlands. A previous remedial investigation reported that the average PCB concentration of two sediment samples from the larger of the two ponds was 667 ppb, which exceeds the TEC and is on par with the PEC (676 ppb) for total PCBs in sediment (URS 2004, MacDonald et al. 2000). Recent sediment sampling at the Site Q ponds documented PCB concentrations that far exceed the PEC in several locations (13,800 ppb; Exhibit 21).

EXHIBIT 15 A SUMMARY OF EXCEEDANCES OF SCREENING BENCHMARKS FOR HISTORICAL BORROW PIT LAKE SEDIMENT SAMPLES

CONTAMINANT	UNITS	NUMBER OF NON-DETECTS[1]	MEAN CONC.[2]	MAX. CONC.	TEC[3]	PEC[3]
Arsenic	mg/kg	0	*16*	*17*	9.79	33.00
Cadmium	mg/kg	0	*2.1*	*2.7*	0.99	4.98
Copper	mg/kg	1	*49*	*64*	31.60	149.00
Iron	mg/kg	1	*34,000*	*38,000*	20,000	40,000
Lead	mg/kg	1	*48*	*58*	35.80	128.00
Manganese	mg/kg	0	***1,213***	***1,400***	460	1,100
Nickel	mg/kg	1	*47*	***54***	22.70	48.60
Zinc	mg/kg	0	*310*	*370*	121	459
Total DDT	µg/kg	0	*6.0*	*13*	5.28	62.90
gamma-BHC	µg/kg	2	NA	*4.8*	2.37	4.99
Heptachlor epoxide	µg/kg	2	NA	*4.8*	2.47	16.00

Notes.

Data Source: Menzie-Cura et al. 2001. Data reflect pre-remedial sediment concentrations. Post-remedial sampling indicates that no contaminants in this list exceed benchmark concentrations (Solutia 2008). Mean or maximum concentrations in italics with gray shading indicates a concentration exceeds the TEC. Mean or maximum concentrations in bold italics with red shading indicates a concentration exceeds the PEC.

1. Three samples were collected and analyzed for all contaminants listed in this table.
2. The means reported here are averages of the three analyzed samples; for non-detected samples, the value reported by Menzie-Cura et al. (2001) is used.
3. The TEC and PEC are reported from MacDonald et al. 2000, with the exception of the criteria for manganese and iron, which are reported from Persaud 1993.

EXHIBIT 16 EXCEEDANCES OF SCREENING BENCHMARKS FOR 2018 BORROW PIT LAKE SEDIMENT SAMPLES (SED09, SED10, SED17, SED19, SED20, SED21)

CONTAMINANT[1,2]	SED09	SED10	SED17	SED19	SED20	SED21	TEC[3]	PEC[3]
Arsenic (mg/kg)	*24.4*	2.26	0.872	6.96	4.9	2.75	9.79	33
Cadmium (mg/kg)	0.694	*1.41*	0.122	*1.43*	*1.21*	0.681	0.99	4.98
Copper (mg/kg)	16.7	*36.8*	9.77	*40.1*	*34.4*	19.1	31.6	149
Iron (mg/kg)	***57,200***	*33100*	10100	***43,000***	*38,600*	*28,600*	20,000	40,000
Lead (mg/kg)	25.7	28.7	9.07	*40.9*	33.4	23.5	35.8	128
Manganese (mg/kg)	*854*	*1060*	339	***1,640***	***1,220***	*655*	460	1,100
Mercury (mg/kg)	0.113	*0.19*	0.0475	0.153	0.162	0.112	0.18	1.06
Nickel (mg/kg)	*28.3*	*32.6*	10	*45.1*	*38.8*	*31.7*	22.7	48.6
Zinc (mg/kg)	*202*	*285*	46.5	*322*	*278*	*213*	121	459
Total PCB[4] (mg/kg)	0.028	*0.069*	0.002	*0.063*	*0.071*	0.023	0.0598	0.676

Notes.

1. Data were collected as part of the 2018 Sauget sediment sampling program (IEc 2018; IEc 2020). Mean or maximum concentrations in italics with gray shading indicates a concentration exceeds the TEC. Mean or maximum concentrations in bold italics with red shading indicates a concentration exceeds the PEC.
2. Contaminant data in this table are reported in units of mg/kg (ppm). Concentrations not measured above the analytical detection limit are denoted "nd" for "not detected." Instances where the detection limit exceeded the threshold are indicated with a caret symbol (^).
3. The TEC and PEC are reported from MacDonald et al. 2000, with the exception of the criteria for manganese and iron, which are reported from Persaud 1993; 1,2-dichlorobenzene and bis(2-ethylhexyl)phthalate, which are reported from Jones et al. 1997; and 2,3,7,8-TCDD, which is reported from USEPA 1993. Gray shading indicates a concentration exceeds the TEC. Red shading indicates a concentration exceeds the PEC.
4. Total PCBs were calculated by two methods, depending on the available data (for details, see IEc 2020).

EXHIBIT 17 SUMMARY OF EXCEEDANCES OF SCREENING BENCHMARKS FOR DEAD CREEK SEDIMENT, PRE - REMEDIATION

COC[1]	UNIT	TEC[2]	PEC[2]	CS-B		CS-C		CS-D		CS-E		CS-F		Site M [3]	
				MEAN CONC.	MAX. CONC.	MEAN CONC.	MAX. CONC.	MEAN CONC.	MAX. CONC.	MEAN CONC.	MAX. CONC.	MEAN CONC.	MAX CONC.	MEAN CONC.	MAX. CONC.
Copper (mg/kg)	mg/kg	31.6	149	***7,600***	***11,000***	***1,900***	***2,200***	***597***	***730***	***357***	***570***	***270***	***410***	***8,163***	***21,000***
Lead (mg/kg)	mg/kg	35.8	128	***793***	***1,000***	***360***	***480***	***220***	***260***	***213***	***310***	***180***	***320***	***572***	***1,910***
Nickel (mg/kg)	mg/kg	22.7	48.6	***323***	***500***	***500***	***580***	***223***	***260***	***124***	***190***	***197***	***390***	***1,270***	***2,490***
Zinc (mg/kg)	mg/kg	121	459	***4,900***	***7,900***	***3,567***	***4,500***	***2,333***	***2,700***	***1,693***	***2,300***	***2,083***	***3,700***	***8,831***	***31,600***
Total PCBs (mg/kg)	mg/kg	0.0598	0.676	***152***	***226***	***2.6***	***4.6***	***0.9***	***1.2***	NA	***1***	NA	***0.083***	***262***	***505***

Notes.

Data Sources: Menzie-Cura et al. 2002 (Dead Creek) and Ecology and Environment 1998 (Site M). Mean or maximum concentrations in italics with gray shading indicates a concentration exceeds the TEC. Mean or maximum concentrations in bold italics with red shading indicates a concentration exceeds the PEC.

1. Three samples were analyzed for each Creek Segment. A variable number of samples were collected and analyzed over time from Site M; mean calculations average between 6 and 12 sample concentrations, depending on the COC.
2. Sediment Quality Guidelines are Threshold Effect Concentrations (TECs) and Probable Effect Concentrations (PECs) from MacDonald et al. 2000.
3. Site M received extensive remedial actions and was filled to grade in 2001.

EXHIBIT 18 SUMMARY OF EXCEEDANCES OF SCREENING BENCHMARKS FO R DEAD CREEK SEDIMENT, POST- REMEDIATION

COC	UNIT	TEC [1]	PEC [1]	CS-B [2]		CS-C [2]		CS-D [2]		CS-E [2]		CS-F [2]	
				MEAN CONC.	MAX. CONC.	MEAN CONC.	MAX. CONC.	MEAN CONC.	MAX. CONC.	MEAN CONC.	MAX. CONC.	MEAN CONC.	MAX. CONC.
Arsenic	mg/kg	9.79	33	9.72	***44***	9.70	*14*	*11.40*	*18*	8	*20*	*9.89*	*19*
Cadmium	mg/kg	0.99	4.98	***8.3***	***54.0***	***13.3***	***24.0***	***19.8***	***40.0***	***14.2***	***38.0***	***20.3***	***57***
Copper	mg/kg	31.6	149	***484***	***10,000***	*109*	***250***	***386***	***1,600***	***425***	***4,300***	*120*	***505***
Lead	mg/kg	35.8	128	*75*	***700***	*43*	***140***	*98*	***280***	*79*	***400***	*58*	***450***
Mercury	mg/kg	0.18	1.06	0.13	*0.84*	0.10	*0.31*	*0.24*	*0.71*	*0.41*	***1.60***	*0.19*	*0.82*
Nickel	mg/kg	22.7	48.6	***192***	***630***	***263***	***570***	***287***	***530***	***181***	***600***	***167***	***630***
Zinc	mg/kg	121	459	***2,161***	***10,450***	***2,137***	***3,400***	***4,100***	***8,200***	***1,924***	***5,900***	***2,238***	***15,000***
4,4'-DDT	mg/kg	0.00528	0.0629	*0.02*	***0.16***	*0.01*	*0.03*	***0.07***	***0.24***	*0.01*	*0.03*	*0.01*	*0.02*
Benzene	mg/kg	0.16	--	0.011	*0.180*	0.007	0.008	0.007	0.008	0.007	0.011	0.007	0.010
Chlorobenzene	mg/kg	0.41	--	*0.45*	*9.70*	0.13	*0.70*	0.03	0.15	0.02	0.21	0.01	0.01
Dieldrin	mg/kg	0.00324	0.0618	*0.02*	***0.12***	*0.006*	*0.02*	***0.14***	***0.69***	*0.006*	*0.03*	0.003	*0.009*

COC	UNIT	TEC [1]	PEC [1]	CS-B [2]		CS-C [2]		CS-D [2]		CS-E [2]		CS-F [2]	
				MEAN CONC.	MAX. CONC.	MEAN CONC.	MAX. CONC.	MEAN CONC.	MAX. CONC.	MEAN CONC.	MAX. CONC.	MEAN CONC.	MAX. CONC.
Endosulfan II	mg/kg	0.0055	--	*0.02*	*0.12*	*0.014*	*0.03*	*0.04*	*0.11*	*0.009*	*0.03*	*0.008*	*0.02*
Total PCBs	mg/kg	0.0598	0.676	***2.93***	***88.49***	*0.12*	*0.18*	*0.53*	***2.45***	*0.23*	***1.26***	*0.13*	*0.36*

Notes.

Data Sources: Solutia 2008. Mean or maximum concentrations in italics with gray shading indicates a concentration exceeds the TEC. Mean or maximum concentrations in bold italics with red shading indicates a concentration exceeds the PEC.

1. Sediment Quality Guidelines are Threshold Effect Concentrations (TECs) and Probable Effect Concentrations (PECs) from MacDonald et al. 2000.
2. The sample size for each creek segment is as follows: CS-B, n=49; CS-C, n=9; CS-D, n=6; CS-E, n=17; CS-F, n=16. Duplicate analytical measurements were averaged prior to calculating the mean and maximum concentrations for each creek segment.

EXHIBIT 19 EXCEEDANCES OF SCREENING BENCHMARKS FOR 2018 DEAD CREEK SEDIMENT SAMPLES (SED 01, SED 03, SED 04, SED 15, SED 16, SED 18)

COC[1,2]	TEC[3]	PEC[3]	Site M (SED03)	CS-C (SED04)	CS-D (SED15)	CS-E (SED16)	CS-F (SED01)	CS-F (SED18)
Cadmium	0.99	4.98	nd	***8.17***	***10.3***	***7.07***	*2.69*	***5.98***
Copper	31.6	149	*50.8*	*132*	***156***	*122*	*42.3*	*51.7*
Lead	35.8	128	0.0412	*54.4*	*45.1*	*60*	*60.1*	33
Mercury	0.18	1.06	0.0862	0.165	*0.19*	*0.529*	*0.23*	*0.288*
Nickel	22.7	48.6	0.00476	***143***	***87.4***	***60.9***	*23.9*	***74.3***
Zinc	121	459	*381*	***1620***	***1630***	***921***	***529***	***712***
Total PAH[4]	1.61	22.8	0.303	0.236	*1.962*	*6.828*	***37.3***	0.333
Total PCB[5]	0.0598	0.676	*0.64*	*0.23*	*0.45*	***1.01***	*0.35*	*0.14*
2,3,7,8-TCDD	2.50E-06	2.50E-05	*2.99E-06*	1.76E-06	2.44E-06	*7.21E-06*	*4.43E-06*	*6.23E-06*
Dieldrin	0.0019	0.0618	nd	nd	*0.0021*	nd	nd	nd

COC[1,2]	TEC[3]	PEC[3]	Site M (SED03)	CS-C (SED04)	CS-D (SED15)	CS-E (SED16)	CS-F (SED01)	CS-F (SED18)

Notes.

1. Data were collected as part of the 2018 Sauget sediment sampling program (IEc 2018; IEc 2020). Sample concentrations in italics with gray shading indicates a concentration exceeds the TEC. Sample concentrations in bold italics with red shading indicates a concentration exceeds the PEC.
2. Contaminant data in this table are reported in units of mg/kg (ppm). Concentrations not measured above the analytical detection limit are denoted "nd" for "not detected." Instances where the detection limit exceeded the threshold are indicated with a caret symbol (^).
3. The TEC and PEC are reported from MacDonald et al. 2000, with the exception of the criteria for manganese and iron, which are reported from Persaud 1993; 1,2-dichlorobenzene and bis(2-ethylhexyl)phthalate, which are reported from Jones et al. 1997; and 2,3,7,8-TCDD, which is reported from USEPA 1993. Gray shading indicates a concentration exceeds the TEC. Red shading indicates a concentration exceeds the PEC.
4. Total PAHs include acenaphthylene, acenaphthene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, fluoranthene, fluorene, naphthalene, phenanthrene, and pyrene. Total PAHs were calculated by summing detected PAH compounds for each sample. Non-detects were treated as zero.
5. Total PCBs were calculated by two methods, depending on the available data (for details, see IEc 2020).

EXHIBIT 20 EXCEEDANCES OF SCREENING BENCHMARKS IN HISTORICAL SITE Q SOILS/ SEDIMENTS

CONTAMINANT	UNITS	SAMPLE SIZE [1]	MEAN CONC.	MAX. CONC.	TEC [2]	PEC [2]	CRITERION SOURCE
Napthalene *	µg/kg	26 (5)	*269*	***1,950***	176	561	MacDonald et al. 2000
Dieldrin *	µg/kg	24 (16)	***62***	***400***	3.24	61.8	MacDonald et al. 2000
Endosulfan II *	µg/kg	24 (2)	*13*	*48*	5.5	--	Jones et al. 1997
Total PCBs *	µg/kg	24 (19)	***2,428***	***13,815***	59.8	676	MacDonald et al. 2000
Arsenic *	mg/kg	26 (26)	9	***33***	9.79	33	MacDonald et al. 2000
Cadmium *	mg/kg	26 (26)	***314***	***8,000***	0.99	4.98	MacDonald et al. 2000
Copper *	mg/kg	26 (26)	***308***	***2,600***	31.6	149	MacDonald et al. 2000
Lead *	mg/kg	26 (26)	***499***	***3,100***	35.8	128	MacDonald et al. 2000
Mercury *	mg/kg	25 (25)	***6.3***	***140***	0.18	1.06	MacDonald et al. 2000
Nickel *	mg/kg	26 (26)	***50***	***500***	22.7	48.6	MacDonald et al. 2000
Zinc *	mg/kg	26 (26)	***1,295***	***12,000***	121	459	MacDonald et al. 2000

Notes.

Data Source: AMEC 2008. Mean or maximum concentrations in italics (subtle emphasis font style) with gray shading indicates a concentration exceeds the TEC. Mean or maximum concentrations in bold italics (emphasis font style) with red shading indicates a concentration exceeds the PEC.

*Maximum concentrations located in areas delineated as wetlands.

1. Sample size is reported with the number of detected samples in parentheses.

2. Criteria from MacDonald et al. (2000) are threshold effect concentrations (TECs) and probable effect concentrations (PECs). Criteria from Jones et al. 1997 are secondary chronic values derived from equilibrium partitioning.

EXHIBIT 21 EXCEEDANCES OF SCREENING BENCHMARKS FOR 2018 SITE Q SEDIMENT SAMPLES (SED22, SED23,SED24, SED25)

CONTAMINANT[1,2]	SED22	SED23	SED24	SED25	TEC[3]	PEC[3]
Zinc	75.9	88	*127*	55.3	121	459
Total PCB[4]	***13.8***	***10.5***	***2.85***	*0.39*	0.0598	0.676

Notes.

1. Data were collected as part of the 2018 Sauget sediment sampling program (IEc 2018; IEc 2020). Sample concentrations in italics with gray shading indicates a concentration exceeds the TEC. Sample concentrations in bold italics with red shading indicates a concentration exceeds the PEC.
2. Contaminant data in this table are reported in units of mg/kg (ppm). Concentrations not measured above the analytical detection limit are denoted "nd" for "not detected." Instances where the detection limit exceeded the threshold are indicated with a caret symbol (^).
3. The TEC and PEC are reported from MacDonald et al. 2000, with the exception of the criteria for manganese and iron, which are reported from Persaud 1993; 1,2-dichlorobenzene and bis(2-ethylhexyl) phthalate, which are reported from Jones et al. 1997; and 2,3,7,8-TCDD, which is reported from USEPA 1993. Gray shading indicates a concentration exceeds the TEC. Red shading indicates a concentration exceeds the PEC.
4. Total PCBs were calculated by two methods, depending on the available data (for details, see IEc 2020).

SITE P

Only limited data are available for Site P. In site-specific remedial documents, Site P is treated as a terrestrial environment in that soil concentrations are reported without reference to water content, even though, as noted above, a significant portion of the site is classified as wetland. Very limited surface soil sampling has been conducted at Site P, and the Trustees are not aware of any surface water samples that may have been collected. In this analysis, the Trustees compare Site P soil concentrations of hazardous substances to literature-based sediment thresholds indicative of a likelihood of injury to biological resources (Exhibit 22). Exhibit 22 indicates measured concentrations of chlorobenzene, 4,4'-DDT, dieldrin, total PCBs, arsenic, cadmium, copper, lead, mercury, nickel, and zinc from wetland soils are sufficient to cause or have caused injury to biological and therefore sediment resources.

EXHIBIT 22 EXCEEDANCES OF SCREENING BENCHMARKS IN SITE P SOILS/ SEDIMENTS

CONTAMINANT	UNITS	SAMPLE SIZE[1]	MEAN CONC.	MAX. CONC.	TEC [2]	PEC [2]	CRITERION SOURCE
Chlorobenzene *	µg/kg	12 (4)	49	*540*	410	--	Jones et al. 1997
4,4'-DDT *	µg/kg	4 (4)	***284***	***1,100***	5.28	62.9	MacDonald et al. 2000
Dieldrin	µg/kg	4 (2)	*21*	*41*	3.24	61.8	MacDonald et al. 2000
Total PCBs *	µg/kg	4 (3)	***1,764***	***7,020***	59.8	676	MacDonald et al. 2000
Arsenic	mg/kg	12 (12)	*11*	*26*	9.79	33	MacDonald et al. 2000
Cadmium	mg/kg	12 (12)	*4.4*	***25***	0.99	4.98	MacDonald et al. 2000
Copper	mg/kg	12 (12)	*67*	***250***	31.6	149	MacDonald et al. 2000
Lead	mg/kg	12 (12)	***260***	***2,000***	35.8	128	MacDonald et al. 2000
Mercury	mg/kg	12 (12)	*0.80*	***6***	0.18	1.06	MacDonald et al. 2000
Nickel *	mg/kg	12 (12)	*30*	***130***	22.7	48.6	MacDonald et al. 2000
Zinc	mg/kg	12 (12)	***728***	***3,100***	121	459	MacDonald et al. 2000

Notes.

Data Source: AMEC 2008. Mean or maximum concentrations in italics with gray shading indicates a concentration exceeds the TEC. Mean or maximum concentrations in bold italics with red shading indicates a concentration exceeds the PEC.

*Maximum concentrations located in areas delineated as wetlands. Gray shading indicates a concentration exceeds the TEC. Mean or maximum concentrations in italics with gray shading indicates a concentration exceeds the TEC. Mean or maximum concentrations in bold italics red shading indicates a concentration exceeds the PEC.

1. Sample size is reported with the number of detected concentrations in parentheses.
2. Criteria from MacDonald et al. (2000) are threshold effect concentrations (TECs) and probable effect concentrations (PECs). Criteria from Jones et al. 1997 are secondary chronic values derived through equilibrium partitioning.

ADDITIONAL LOCATIONS SAMPLED IN 2018

In 2018 the Trustees collected and analyzed sediment from locations adjacent to the delineated SIC Sites, to assess whether contamination is present outside of the delineated SIC Site boundaries. Four samples were collected in the agricultural field adjacent to Borrow Pit Lake (SED05, SED06, SED07, SED08), and one sample was collected in a wetland adjacent to Dead Creek Segment F (SED02). Exceedances of screening benchmarks are shown in Exhibit 23. Exhibit 23 indicates measured concentrations of
cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, zinc, Total PAH, Total PCB, and 2,3,7,8-TCDD are sufficient to cause or have caused injury to biological and therefore sediment resources.

3.3 SEDIMENT TOXICITY TESTS

The Trustees also rely on information on the adverse effects of hazardous substances in sediment on sediment-dwelling biota indicated through sediment toxicity tests.

As indicated in the DOI NRDA regulations:

> *Injury [to biological resources] has occurred when a statistically significant difference can be measured in the total mortality and/or mortality rates between population samples of the test organisms placed in exposure chambers containing concentrations of oil or hazardous substances and those in a control chamber.* (43 C.F.R. Section §11.62(f)(4)(i)(E))

Such results are available for samples taken from Borrow Pit Lake, Dead Creek, and Site M within the SIC. Specifically, toxicity tests have been performed on the midge *Chironomus tentans* and the amphipod *Hyalella azteca,* two common sediment-dwelling test organisms. Under controlled laboratory conditions, organisms were exposed to contaminated sediment for ten days (acute) or 42 days (chronic). Results for survival of organisms in the field-collected sediment were then compared to a survival of organisms in a reference/control sediment to determine if survival was significantly lower than in the reference/control sediment.
Results from the tests reveal statistically significant lower survival rates as compared to controls (Exhibit 24), therefore establishing injury to biologic and sediment resources (43
C.F.R. Section 11.62(f)(4)(i)). In addition, given these results, higher trophic level organisms (e.g., birds, bats, etc.) feeding on aquatic invertebrates have the potential to be exposed to hazardous substances that can build-up in tissue, via the food web and injured; however, data are currently unavailable to evaluate potential higher trophic level biological injuries. Furthermore, sediment toxicity to sediment-dwelling organisms can reduce populations of aquatic invertebrates and that could have negative effects on organisms that rely on them as a food source.

EXHIBIT 23 EXCEEDANCES OF SCREENING BENCHMARKS FOR 2018 ADDITIONAL SEDIMENT SAMPLES (SED 02, SED 05 , SED 06 , SED 07 , SED 08)

CONTAMINANT[1,2]	SED02	SED05	SED06	SED07	SED08	TEC[3]	PEC[3]
Cadmium	***8.29***	0.0341	0.462	0.61	0.354	0.99	4.98
Chromium	*105*	9.62	22.8	21	19.6	43.4	111
Copper	***481***	7.55	22.1	20.3	18.2	31.6	149
Iron	*23100*	8890	19600	19100	18900	20,000^	40,000^
Lead	***272***	6.61	23.6	*46.5*	*41.5*	35.8	128
Manganese	362	259	*503*	*522*	*501*	460^	1,100^
Mercury	*0.803*	0.0199	0.091	0.0973	0.0742	0.18	1.06
Nickel	***395***	8.84	16.2	16.1	16.6	22.7	48.6
Zinc	***3440***	41.2	*128*	*147*	99.4	121	459
Total PAH[4]	*1.908*	nd	0.299	0.519	0.258	1.61	22.8
Total PCB[5]	***4.14***	nd	0.053	*0.11*	0.036	0.0598	0.676
2,3,7,8-TCDD	*1.29E-05*	nd	nd	1.04E-06	nd	2.50E-06^	2.50E-05^

Notes.

1. Data were collected as part of the 2018 Sauget sediment sampling program (IEc 2018; IEc 2020).
2. Contaminant data in this table are reported in units of mg/kg (ppm). Concentrations not measured above the analytical detection limit are denoted "nd" for "not detected." Instances where the detection limit exceeded the threshold are indicated with a caret symbol (^).
3. The TEC and PEC are reported from MacDonald et al. 2000, with the exception of the criteria for manganese and iron, which are reported from Persaud 1993; 1,2-dichlorobenzene and bis(2-ethylhexyl) phthalate, which are reported from Jones et al. 1997; and 2,3,7,8-TCDD, which is reported from USEPA 1993. Sample concentrations in italics with gray shading indicates a concentration exceeds the TEC. Sample concentrations in bold italics with red shading indicates a concentration exceeds the PEC.
4. Total PAHs include acenaphthylene, acenaphthene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, fluoranthene, fluorene, naphthalene, phenanthrene, and pyrene. Total PAHs were calculated by summing detected PAH compounds for each sample. Non-detects were treated as zero.
5. Total PCBs were calculated by two methods, depending on the available data (for details, see IEc 2020).

EXHIBIT 24 SUMMARY OF SEDIMENT TOXICITY DATA FROM SITES WITHIN ASSESSMENT AREA

SITE [1]	NUMBER OF SEDIMENT SAMPLES (N) [2]	TEST ORGANISM [3]	TEST TYPE [4]	PERCENT MORTALITY [5]
Dead Creek CS-B	3	*H. azteca*	Acute	73.0 *
	2	*H. azteca*	Chronic	76.5 *
	3	*C. tentans*	Acute	66.7 *
	1	*C. tentans*	Chronic	48.0
Dead Creek CS-C	3	*H. azteca*	Acute	23.7 *
	3	*H. azteca*	Chronic	21.3
	3	*C. tentans*	Acute	58.0 *
	1	*C. tentans*	Chronic	37.0
Dead Creek CS-D	3	*H. azteca*	Acute	10.7
	3	*H. azteca*	Chronic	18.7
	3	*C. tentans*	Acute	45.7 *
	1	*C. tentans*	Chronic	58.0 *
Dead Creek CS-E	3	*H. azteca*	Acute	38.7 *
	3	*H. azteca*	Chronic	34.3 *
	3	*C. tentans*	Acute	32.0 *
	2	*C. tentans*	Chronic	73.0 *
Dead Creek CS-F	3	*H. azteca*	Acute	13.3
	3	*H. azteca*	Chronic	23.3
	3	*C. tentans*	Acute	81 *
	0	*C. tentans*	Chronic	N/A
Site M	1	*H. azteca*	Acute	90.0 *
	1	*H. azteca*	Chronic	15.0
	1	*C. tentans*	Acute	4.0
	1	*C. tentans*	Chronic	60.0

SITE [1]	NUMBER OF SEDIMENT SAMPLES (N) [2]	TEST ORGANISM [3]	TEST TYPE [4]	PERCENT MORTALITY [5]
Borrow Pit Lake	3	*H. azteca*	Acute	8.0
	3	*H. azteca*	Chronic	22.7
	3	*C. tentans*	Acute	64.3 *
	2	*C. tentans*	Chronic	97.0 *

Notes:

1. Data source: Solutia 2002 (Sauget Area 1 Dead Creek Final Remedy and EE/FS).
2. Sediments were collected as part of the Sauget Area 1 Support Sampling Plan, beginning in September 1999 and ending in April 2000.
3. Test organisms are *Hyalella azteca* and *Chironomus tentans*.
4. Acute toxicity test results reflect a 10-day exposure. Chronic toxicity tests reflect a 42-day exposure.
5. An asterisk denotes a statistically-significant reduction in survival.

3.4 INJURY DUE TO REMEDY

In addition to the lines of evidence of surface water injuries explored above, the Trustees evaluate injuries stemming from the collateral effects of remedial activities. Consistent with the DOI NRDA regulations, resource injuries stemming from remedial response activities are compensable:

> *Damages as determined in accordance with this part and calculated based on injuries occurring from the onset of the release through the recovery period, less any mitigation of those injuries by response actions taken or anticipated,* ***plus any increase in injuries that are reasonably unavoidable as a result of response actions taken or anticipated*** (43 C.F.R. Section §11.15(a)(1); emphasis added).

Remedial actions, such as removing sediments and capping portions of the aquatic habitat in Dead Creek, Borrow Pit Lake, and Site M, have caused compensable injury to surface water resources by rendering some locations devoid of aquatic habitat. The resulting surface water injuries commenced in 1990 and 2002, respectively, and exist currently in CS-A and Site M (Exhibit 25).

Additionally, soils at Site Q South were excavated and removed as part of a remedial action initiated in 1999. These physical alterations, which resulted in injury to surface water and sediment resources, are summarized in Exhibit 25. In some cases, as with sediment dredging in parts of Dead Creek and Borrow Pit Lake, the physical injuries may be temporary in nature. In other cases, as with the sediment dredging and placement of an HDPE cap at CS-A, injuries to surface water resources may be considered permanent.

EXHIBIT 25 SUMMARY OF PHYSICAL DISTURBANCES RESULTING IN INJURY

SITE	YEARS ALTERED	DESCRIPTION	SOURCES
CS-A	1990	Dredged, then capped with HDPE vapor barrier and gravel.	Solutia 2002; Solutia/GSI 2012
CS-B through CS-F	2001-2002 and 2005-2006	Dredged.	Menzie-Cura et al. 2002; Solutia 2002; Solutia/GSI 2012
Borrow Pit Lake	2006	Dredged.	Solutia/GSI 2012
Site M	2001	Dredged, then filled in to grade with soil.	Menzie-Cura et al. 2002; Solutia/GSI 2012
Site Q South	1999-2000	Excavation and removal of contaminated soils.	USEPA 2013b; URS 2008

Additional remedial actions are currently planned for sites within Sauget Areas 1 and 2. Of particular interest to the Trustees are anticipated remedial actions for wetland Sites P and Q. The following remedial actions for Site P are described in the Sauget Area 2 Operable Unit 1 Record of Decision (ROD) and are currently being implemented. These actions are meant to minimize current exposure pathways to groundwater and biological resources and minimize transport of uncovered wastes outside site boundaries (USEPA 2013b):

- Collect, treat, and dispose of the non-aqueous phase liquids (NAPLs)[8] that is located near a leachate well;
- Install an asphalt cap over the mobile source area;
- Install a solid waste landfill cap over remaining waste areas;
- Conduct vapor intrusion mitigation; and
- Implement institutional access controls.

As outlined in the ROD, the following remedial actions are anticipated at Site Q South and the Site Q Ponds (USEPA 2013b):

- Removal of intact drums,
- Installation of a RCRA Subtitle C-compliant cap over waste areas, and
- Institutional and access controls.

To the extent planned actions result in natural resource injuries, such injuries will be compensable.

[8] NAPLs are liquid solutions that do not dissolve in or easily mix with water, such as oil, gasoline, and chlorinated solvents.

CHAPTER 4 | CONCLUSIONS

The information presented in this report demonstrates that surface water has been and continues to be injured by hazardous substance releases at the SIC Sites (Exhibit 26; 43 C.F.R. §11.62(b)). Hazardous substances in surface waters exceed, or have previously exceeded, criteria set by the USEPA and Illinois Pollution Control Board for the protection of aquatic life. Hazardous substances in sediment resources also exceed, or have previously exceeded, consensus-based sediment thresholds for a suite of hazardous substances measured in sediments. Data collected as recently as 2018 indicate that site- wide injury is persistent, based on hazardous substances concentrations in sediment (IEc 2020). In addition to the hazardous substances that form the focus of this analysis, other contaminants may be present and cause additional toxicity that is not captured here. Toxicity tests reveal that sediment-dwelling test organisms exposed to sediment from Borrow Pit Lake, Dead Creek, and Site M have experienced statistically significant decreased survival compared to controls, indicating injury to biological and therefore sediment resources. Notably, species exposed to contaminated sediment may transfer hazardous substances to predators through ingestion, implying the potential for other site- wide injuries to biological resources. Lastly, remedial actions have caused a permanent alteration of habitat at CS-A, which is considered a permanent injury to surface water resources at that site.

In Dead Creek, hazardous substances in surface waters and sediments exceed, or have previously exceeded, promulgated and/or literature-based benchmarks. Dead Creek and its surface water resources represent a pathway of contamination from initial point of release to the creek downstream to Borrow Pit Lake and the Mississippi River, and to floodplain soils (Lewis and Arthur 2016). Sediments collected from Dead Creek CS-B, CS-C, CS-D, CS-E, and CS-F led to significantly decreased survival of sediment- dwelling organisms in acute and chronic toxicity tests.

In Borrow Pit Lake, samples from surface waters and sediments exceed, or previously exceeded, promulgated and/or literature-based benchmarks for a number of hazardous substances. Sediments collected from Borrow Pit Lake led to decreased survival of sediment-dwelling organisms in acute toxicity tests using the test organism *C. tentans*.

At Site M, surface waters exceeded promulgated water quality criteria for iron and lead. Sediments collected from Site M, prior to remedial actions, were heavily contaminated and exceeded literature-based benchmarks for PCBs and several metals. Exposure to Site M sediments led to statistically significant decreased survival for sediment-dwelling organisms in acute toxicity tests using the test organism *H. azteca*. Due to extensive remedial actions, aquatic habitat was significantly altered at Site M when it was dredged to remove sediments, then filled to grade with soil.

At Site P, soils collected from areas within Site P that are delineated as wetlands exceeded literature-based benchmarks for a number of hazardous substances, though recent sampling in 2018 did not identify wetland habitat to confirm current concentrations of hazardous substances. Remedial actions are ongoing for Site P and may have additional and permanent adverse impacts on natural resources.

At Site Q South and the Site Q Ponds, sampling indicates that surface waters and sediments exceed, or have previously exceeded, promulgated and/or literature-based benchmarks for a number of hazardous substances. Recent sampling documented extremely high concentrations of PCBs (13,800 ppb), orders of magnitude above the PEC (676 ppb) for sediment dwelling organisms (IEc 2020). Remedial actions are also planned for Site Q and may have additional adverse impacts on natural resources.

Recent sediment sampling in 2018 documented concentrations of hazardous substances that exceed the TEC and PEC in areas that exist outside the boundaries of the specific SIC Sites (Exhibit 23). For example, a sample collected in wetlands adjacent to Dead Creek CS-F (SED02) had some of the highest measured concentrations of Total PCBs and Total PAHs measured as part of that sampling event (IEc 2020). This determination of injury in wetlands outside the lettered SIC Sites is an important finding, given that no cleanup is currently planned for floodplain soils. This finding will inform the NRDA injury quantification and restoration approaches for the SIC.

In light of the documented injuries to surface water resources at these sites, the Trustees will proceed with additional steps in the NRDA, including but not limited to quantification of the scope and magnitude of surface water resource injuries that will require compensation from the parties responsible for the releases of hazardous substances leading to these injuries.

EXHIBIT 26 SUMMARY OF SURFACE WATER AND SEDIMENT INJURIES BY SIC LOCATION

SIC LOCATION	EXCEED WATER QUALITY CRITERIA? *	EXCEED SEDIMENT QUALITY CRITERIA? *	STATISTICALLY SIGNIFICANT DECREASED SURVIVAL OF SEDIMENT-DWELLING ORGANISMS?	INJURY DUE TO REMEDIAL ACTIONS
CS-A	NA[1]	NA[1]	NA[1]	Yes
CS-B	Yes (7)	Yes (12)	Yes	Yes
CS-C	No	Yes (13)	Yes	Yes
CS-D	Yes (11)	Yes (13)	Yes	Yes
CS-E	Yes (1)	Yes (14)	Yes	Yes
CS-F	Yes (3)	Yes (14)	Yes	Yes
Borrow Pit Lake	Yes (4)	Yes (13)	Yes	Yes
Site M	Yes (2)	Yes (13)	Yes	Yes
Site Q	Yes (5)	Yes (11)	NA	Yes
Site P	NA	Yes (11)	NA	NA
Other Locations (not within lettered SIC Sites)	NA	Yes (12)	NA	NA

Notes.

***** The number of contaminants elevated above the injury criteria reported in this document is noted in parentheses.

[NA] indicates data are not available.

1. Creek Segment A was the site of extensive remedial actions at the time of sampling and aquatic habitat was entirely removed as a result of those actions.

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APPENDIX 1

HAZARDOUS SUBSTANCES [9]

The focus of this report is on hazardous substances, as defined in CERCLA, to which natural resources have been exposed as a result of releases from SIC sites. Hazardous substances at the SIC are numerous, given the diversity of waste disposal and other land use practices over the course of decades, as well as discharges, emissions, and other direct or indirect contaminant releases.[10] However, consistent with the Preassessment Screen (PAS) (Trustees 2009) and Assessment Plan (Trustees 2013), the Trustees focus on substances for which ecotoxicity information (i.e., information about the adverse effects caused by ecological exposures to such hazardous substances) is readily available and for which promulgated water quality criteria and/or literature-based sediment benchmarks exist.

This appendix describes the classes of contaminants that have been documented at SIC sites (including polychlorinated biphenyls (PCBs), VOCs, SVOCs and metals) upon which this report focuses. Many of these contaminants experience minimal degradation and persist in the environment for years and even decades. Others, such as metals, are elements and do not degrade at all.

POLYCHLORINATED BIPHENYLS (PCBS)

PCBs are a class of synthetic chlorinated hydrocarbon chemicals. PCBs are resistant to breakdown by heat and are chemically stable. These characteristics resulted in their use in a variety of industrial and commercial applications, including, for example, as insulation in electrical equipment. PCBs were originally manufactured (and subsequently released) as mixtures known as Aroclors, which were composed of varying specifications of individual PCB congeners. Individual PCB congeners are differentiated by the number and physical arrangement of chlorine atoms in the PCB molecule. Due to their chemical structure and properties, PCBs persist in the environment and accumulate in wildlife tissues, concentrating in upper trophic level consumers such as piscivorous fish (i.e., fish that eat other fish), birds, and mammals (Eisler 2000). In 1979, manufacture and use of PCBs was phased out due to their known toxicity, in particular their propensity to cause birth defects and cancer (EPA 1979).

From the 1930s until the 1970s, PCBs were manufactured by the Monsanto Company at the W.G. Krummrich Plant in Sauget, Illinois within the SIC.

[9] The information presented in this appendix is an edited version of the text on hazardous substances presented in the Sauget Industrial Corridor Sites Pathway Report (Lewis and Arthur 2016).

[10] For more details on the manufacture and release of hazardous substances in the SIC, please see Trustees 2009, Trustees 2013, Lewis and Arthur 2016, and Abt Associates 2018.

Approximately 99 percent of the PCBs used for industrial purposes in the United States were produced by Monsanto in Sauget in the SIC (ATSDR 2000). For perspective, from 1929 to 1977, more than 571,000 metric tons of PCB mixtures were produced and/or used in the United States (ATSDR 2000 and sources therein). Thus, enormous quantities of PCBs were manufactured within the assessment area. PCBs were released within the assessment area in various ways over the course of production, including to air due to volatilization of PCBs from soil and water and incineration of PCB-contaminated equipment; to water through waste water discharge to municipal sewers; and to soils through direct dumping in landfills (ATSDR 2000 and sources therein).

VOLATILE ORGANIC COMPOUNDS (VOCS)

Volatile organic compounds (VOCs) are a class of organic chemicals (i.e., chemicals that contain carbon) that have a high vapor pressure at standard temperature, and thus volatilize (i.e., evaporate) readily into the air at common ambient temperatures. Many of these chemicals are used in household products, such as paint, solvents, and cleaning products; and many can be toxic to humans and wildlife. VOCs have been released within and are widely distributed throughout the assessment area (Solutia/GSI 2012; URS 2008).

Examples of VOCs documented in natural resources at SIC sites include benzene, chlorobenzene, styrene, toluene, and xylene. These compounds were either manufactured and/or used at facilities located within or adjacent to the assessment area or were disposed of within the SIC Sites. For example, the Clayton Chemical Company's facility recovered waste oil and a wide range of solvents and is a documented source of VOC groundwater contamination within the assessment area (Solutia/GSI 2012). Similarly, the W.G. Krummrich plant manufactured feedstock chemicals, such as benzene and its derivatives including several SVOCs, which are documented in natural resources within the SIC (Solutia 2000).

SEMI-VOLATILE ORGANIC COMPOUNDS (SVOCS)

SVOCs have a higher boiling point than water and volatilize at temperatures somewhat higher than common ambient temperatures. These chemicals have a wide range of applications and are used in, for example, pesticides, cleaning products, and as additives to furniture, cookware, food packaging, and electronics. This class of compounds includes phthalates, used to soften plastic; polycyclic aromatic hydrocarbons (PAHs), a class of chemicals found in petroleum and formed during the combustion of organic materials; phenols, used as a disinfectant and as a chemical precursor for synthesizing other organic chemicals; and halogenated compounds, such as chlorinated benzenes. As with other classes of compounds that are the focus of this report, many of SVOCs are recalcitrant and do not readily break down in the environment.

A wide variety of SVOCs are known to have been released within the assessment area (Solutia/GSI 2012; URS 2008). Examples of SVOCs found in natural resources at SIC Sites include 4-chloroaniline, bis(2-ethylhexyl) phthalate, phenol, pentachlorophenol, phenanthrene, and naphthalene. Plastics manufacturing, as was conducted at the Monsanto Company's facility, is known to use and result in the release of SVOCs.

Pesticides such as 2,4,-dichlorophenoxyacetic acid (2,4-D; a component of Agent Orange manufactured at the W.G. Krummrich Plant for many years), endosulfan, dieldrin, and 4,4'-dichlorodiphenyltrichloroenane (4,4'-DDT), which are considered SVOCs, have been found within environmental media within the assessment area (Solutia 2000).

METALS

Metals are elements found in the earth's crust, have been mined and used for thousands of years, and have a variety of industrial uses. As elements, they do not degrade, though the extent to which they react with the environment can change over time. For example, metals can form inorganic complexes with other elements such as oxygen and sulfur (e.g., iron can react with oxygen to form rust), or form chemical complexes with organic compounds, which can alter their chemical properties and bioavailability. Metals can also be toxic to sediment-dwelling and aquatic organisms.

Numerous metals have been released within the assessment area (Solutia/GSI 2012; URS 2008). Aluminum, arsenic, cadmium, copper, lead, mercury, nickel, zinc, and a number of additional metals have been documented as contaminants in natural resources at SIC sites (Solutia/GSI 2012; URS 2008). Metals were released within the assessment area due to a variety of industrial practices, including direct disposal within landfills, borrow pits, and/or via direct dumping into Dead Creek. In particular, the Cerro Copper facility in Sauget, IL produced a wide range of metal materials, including industrial copper tubing, plumbing systems, and refrigeration systems, and generated metal waste which was disposed of at Site O and the Clayton Chemical facility (EPA 2005).