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GRDA
Grand River Dam Authority

December 29, 2021

Via E-Filing

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, DC 20426

Subject: Pensacola Hydroelectric Project (FERC Project No. 1494-438); Response to Comments on Initial Study Report, Notice of Technical Meeting, and Request for Privileged Treatment of Cultural Resources Information

Dear Secretary Bose:

The Grand River Dam Authority (GRDA) is relicensing the Pensacola Project (FERC No. 1494) using the Federal Energy Regulatory Commission's (FERC or Commission) Integrated Licensing Process (ILP). Pursuant to the ILP, after completing its first study season, GRDA filed its Initial Study Report (ISR) with the Commission on September 30, 2021. On October 12–14, 2021, GRDA held virtual ISR meetings to discuss the ISR. On October 29, 2021, GRDA filed its ISR Meeting Summary (Meeting Summary) with the Commission. Comments on the ISR and Meeting Summary were filed by Commission staff, federal and state resource agencies, Native American Tribes, and other relicensing participants.

Pursuant to the Commission's regulations at 18 C.F.R. § 5.15(c)(5), and in accordance with the ILP schedule issued by Commission staff, GRDA hereby files its Response to Comments on the Initial Study Report (Response). Based on comments received from Commission staff and relicensing participants, GRDA is proposing several enhancements and other modifications to the study plan for the second study season. These proposed modifications appear in Section 3 of the attached Response.

In particular, based on GRDA's very recently completed efforts to calibrate the Sediment Transport Model, GRDA is proposing significant changes to the

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Commission-approved Sedimentation Study. Because GRDA's calibration efforts were ongoing at the time GRDA completed the ISR, as well as during the ensuing meetings and comment period and only completed this work within the last couple of weeks, GRDA has included an updated *Grand Lake Sedimentation Study* report in Appendix D of the Response. In addition, a detailed proposed modified study plan for the second season of study for the Sedimentation Study is included as Appendix E of the Response. GRDA will be convening a technical meeting with relicensing participants on January 14, 2022, from 9:00 am to 12:00 pm Central Time, to discuss the results of the Sedimentation Study and GRDA's proposed modifications for the second season of studies. The meeting will be held virtually due to COVID-19 concerns. Additional information on accessing the meeting will be sent to relicensing participants via email during the first week of January 2022.

Pursuant to the ILP schedule, GRDA plans to complete its second year of studies by September 2022 and file its Updated Study Report (USR) by September 30, 2022.

Some of the comments filed in response to GRDA's Cultural Resources Study Report, and GRDA's responsive comments, contain sensitive information. All of this information has been placed in Appendix G. Therefore, pursuant to 18 C.F.R. §§ 388.112(b) and 388.113(c)(1), GRDA requests that the information filed in Appendix G be designated and treated in their entirety as privileged and confidential and that it not be released to the public. Appendix G has been labeled "**CONTAINS PRIVILEGED INFORMATION – DO NOT RELEASE (CUI//PRIV).**"

If there are any questions or comments regarding this submittal, please contact me by phone at (918) 981-8472 or by email at Darrell.Townsend@grda.com.

Sincerely,

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Enclosure-Response to Comments on Initial Study Report

cc: Distribution list (see attached)

Stakeholder Distribution List
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GRAND RIVER DAM AUTHORITY

PENSACOLA HYDROELECTRIC PROJECT
FERC No. 1494

RESPONSE TO COMMENTS
ON
INITIAL STUDY REPORT

December 29, 2021

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List of Abbreviations and Terms

ABB	American Burying Beetle
APE	Area of Potential Effect
Commission	Federal Energy Regulatory Commission
CRWG	Cultural Resources Work Group
DLA	Draft License Application
DHM	Downstream Hydraulic Model
ESA	Endangered Species Act
FERC	Federal Energy Regulatory Commission
Grand Lake	Grand Lake O' the Cherokees
GRDA	Grand River Dam Authority
H&H Study	Hydrologic and Hydraulic Modeling Study
HEC	Hydrologic Engineering Center
HPMP	Historic Properties Management Plan
ILP	Integrated Licensing Process
Interior	U.S. Department of the Interior
ISR	Initial Study Report
Kerr Dam	Robert S. Kerr Dam (Markham Ferry Hydroelectric Project)
Licensee	Grand River Dam Authority
MISR	Model Input Status Report
NDAA	National Defense Authorization Act for Fiscal Year 2020
NOI	Notice of Intent
NRHP	National Register of Historic Places
ODWC	Oklahoma Department of Wildlife Conservation
PAD	Pre-Application Document
PD	Pensacola Datum
Project	Pensacola Hydroelectric Project
PSP	Proposed Study Plan
Qals	Quarternary landforms
RAS	River Analysis System
RM	River Mile
RSP	Revised Study Plan
SHPO	State Historic Preservation Officer
SPD	Study Plan Determination
STM	Sediment Transport Model
TCP	Traditional Cultural Properties
THPO	Tribal Historic Preservation Officer
UHM	Upstream Hydrologic Model
USACE	United States Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey

USR .... Updated Study Report
WSEL .... Water Surface Elevation

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1.0 Overview

This Response to Comments on the Initial Study Report (Response) for the Pensacola Hydroelectric Project (Project), Federal Energy Regulatory Commission (FERC or Commission) Project No. 1494, presents the Grand River Dam Authority's (GRDA) response to proposed study modifications, new study requests, and comments received following the Initial Study Report (ISR), the ISR meetings, and GRDA's submission of the ISR meeting summaries, as required by 18 CFR § 5.15(c)(5). The September 30, 2021 ISR describes GRDA's overall progress in implementing its FERC-approved relicensing study plan and schedule, provides an explanation of variances encountered in implementing the FERC-approved study plan to date, and proposes modifications from the study plans and schedules outlined in the Revised Study Plan (RSP), which was filed by GRDA in September 2018[1] and approved by FERC in its November 8, 2018 Study Plan Determination (SPD),[2] and further clarified in its January 23, 2020 Order on Request for Clarification and Rehearing.[3]

1.1 Project Description

The Pensacola Project is located on the Grand Neosho River (Grand River) in Craig, Delaware, Mayes, and Ottawa counties, Oklahoma (Figure 1.0-1). The Pensacola Dam is located at river mile (RM)[4] 77 on the Grand River and creates Grand Lake O' The Cherokees, also known as Grand Lake. The Project as licensed consists of: (a) a reinforced-concrete dam with a multiple-arch section 4,284 feet long, a spillway 861 feet long containing twenty-one radial gates, a non-overflow gravity section 451 feet long, and two non-overflow abutments, comprising an overall length of 5,950 feet and a maximum height of 147 feet; (b) a reinforced-concrete, gravity-type spillway section 886 feet long containing twenty-one radial gates and located about 1 mile east of the main dam; (c) the Grand Lake reservoir, which has a surface area of approximately 45,200 acres and a storage capacity of 1,680,000 acre-feet at normal maximum water surface elevation of 745 feet Pensacola datum (PD),[5] below which is known as the conservation pool; (d) six, 15-foot-diameter steel penstocks supplying flow to six turbines each rated at 17,446 kilowatts (kW) attached to six generators each rated at 24,000 kilovolt amp (kVA) or 21,600 kW, and one 3-foot-diameter penstock supplying flow to one turbine rated at 500-kW3 attached to an identically rated generator, located in a powerhouse immediately below the dam; (e) a tailrace approximately 300 feet wide and a spillway channel approximately 850 feet wide, both about 1.5 miles long; and (f) appurtenant facilities.[6]

The Project is owned and operated by GRDA, which is a non-appropriated agency of the State of Oklahoma, created by the Oklahoma legislature in 1935 to be a "conservation and reclamation district for the waters of the Grand River." As licensed by FERC, the Project serves multiple purposes, including hydropower generation, water supply, public recreation, and wildlife

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1 Revised Study Plan, Project No. 1494-438 (filed Sep. 24, 2018).

2 Study Plan Determination, Project No. 1494-438 (issued Nov. 8, 2018).

3 *Grand River Dam Auth.*, 170 FERC ¶ 61,027 (2020).

4 River miles in this document are based on a dataset created by U.S. Geological Survey (USGS) November 14, 2016, NHD at 1:24,000 scale, unless otherwise noted.

5 Unless otherwise noted, all elevations referenced are relative to PD. PD elevations can be converted to National Geodetic Vertical Datum of 1929 (NGVD) by adding 1.07 feet and to North American Vertical Datum of 1988 (NAVD) by adding 1.40 feet (for example, elevation 745 feet PD = 746.07 feet NGVD = 746.4 feet NAVD88) (http://ok.water.usgs.gov/projects/webmap/miami/datum.htm).

6 *Grand River Dam Auth.*, 77 FERC ¶ 61,251, at p. 62,007 (1996).

enhancement. As directed by Congress under the Flood Control Act of 1944,[7] and the newly enacted National Defense Authorization Act for Fiscal Year 2020 (NDAA 2020),[8] the U.S. Army Corps of Engineers (USACE or Corps) has exclusive jurisdiction over Grand Lake for flood control purposes.

In addition, GRDA operates and maintains five FERC-approved recreation sites at the Project including: (1) Duck Creek Bridge Public Access Area; (2) Seaplane Base Public Access; (3) Monkey Island Public Boat Ramp; (4) Big Hollow Public Access; and (5) Wolf Creek Public Access. These facilities provide public access to Grand Lake for boating, fishing, and other recreational activities.

The Project Boundary is defined by a combination of a metes and bounds description and generally follows contour elevation 750 feet. It encompasses 53,965 acres, including the 45,200 acres of the Project reservoir (at the upper extent of the conservation pool of 745 feet PD). The Project Boundary encompasses all Project facilities and works, Project recreation areas, and a shoreline buffer around the entire reservoir (generally between 745 and 750 feet PD).

1.2 Relicensing Background and Current Status

The current schedule in this integrated licensing process (ILP) began with GRDA's filing of its Notice of Intent (NOI) to relicense the Project and Pre-Application Document (PAD). These documents were filed with the Commission on February 1, 2017. Since that time, the ILP has been modified twice: first, to hold the ILP in abeyance until the outcome of a then-pending license amendment application; and second, to extend the license term to allow more time for GRDA to complete a bathymetric study requested by the City of Miami, Oklahoma (City of Miami), and required by the Commission in its SPD. The following activities listed in chronological order have dictated the schedule following the filing of the NOI and PAD.

1.2.1 Abeyance Period

On February 15, 2017, Commission staff issued a letter order[9] holding the relicensing process in abeyance until the Commission acted on GRDA's May 6, 2016, request to amend the Project's license.[10] The Commission issued an order amending the Project license on August 15, 2017,[11] and on August 24, 2017, Commission staff issued a letter order (Abeyance Order) that lifted the abeyance and provided an ILP process plan and schedule.[12] As a result, the ILP process restarted on January 12, 2018, and the September 26, 2019, deadline for filing the ISR under 18 CFR § 5.15(c)(1) was established.

[7] 33 U.S.C. § 709.

[8] Pub. L. No. 116-92, § 7612(b)(2).

[9] Letter Order Holding the Pensacola Project's Pre-filing Process in Abeyance, Project No. 1494-438 (issued Feb. 15, 2017).

[10] Application for Non-Capacity Related Amendment of License, Project No. 1494-437 (filed May 6, 2016).

[11] *Grand River Dam Auth.,* 160 FERC ¶ 61,001 (2017).

[12] Letter Order Lifting Abeyance and Providing a Revised ILP Process Plan and Schedule, Project No. 1494-438, (issued Aug. 24, 2017).

1.2.2 Pre-NOI Public and Native American Government-to-Government Meetings

Prior to the formal commencement of the relicensing process in January 2018, FERC held a series of public information sessions regarding the procedure for relicensing the Pensacola Project. Meetings were held in Langley (November 14 and 15, 2017), Grove (November 15, 2017), and Miami, Oklahoma (December 13, 2017). The meetings included an overview of the ILP and a discussion of the specific process plan, opportunities for public comment, and how FERC assesses information needs during the study planning process.

In addition, FERC held government-to-government tribal consultation meetings with several Native American Tribes in Miami, Oklahoma, on December 13, 2017,[13] and with the Osage Nation in Pawhuska, Oklahoma, on December 14, 2017.

1.2.3 FERC Scoping

On January 12, 2018, FERC issued notice of the PAD and NOI and commencement of the relicensing pre-filing process. FERC's January 12, 2018 notice also designated GRDA as FERC's non-federal representative for carrying out informal consultation, pursuant to Section 7 of the Endangered Species Act (ESA), and Section 106 of the National Historic Preservation Act (NHPA). In addition, the notice requested that relicensing participants provide comments regarding the PAD and provide study requests. Concurrently, FERC issued Scoping Document 1 (SD1) to outline the subject areas to be addressed in its environmental analysis of the Project pursuant to the National Environmental Policy Act (NEPA).[14]

On February 7, 8, and 9, 2018, FERC held agency and public scoping meetings in Langley, Grove, Miami, and Tulsa, Oklahoma. A site visit to the Project was held on February 8, 2018, which was available to all relicensing participants and the public. Representatives of Oklahoma Department of Agriculture, Food and Forestry, Bureau of Indian Affairs (BIA), and the Miami News participated in the site tour.

In accordance with ILP regulations, comments on the PAD and SD1 and study requests were due to FERC by March 13, 2018, within 60 days of FERC's notice of the PAD and NOI and commencement of the pre-filing process.

FERC issued Scoping Document 2 (SD2) on April 27, 2018. SD2 states that it reflects revisions to SD1 based on the comments received at the scoping meetings, and written comments filed during the scoping process.

1.2.4 Study Plan Development

1.2.4.1 Study Requests Made in Response to NOI and PAD

In accordance with 18 CFR § 5.9(a), a total of 61 comment letters from federal and state resource agencies, Native American Tribes, non-governmental organizations, and other relicensing participants were filed with FERC regarding the relicensing of the Pensacola Project from January

[13] Tribes represented at the meeting included: Cherokee Nation, Eastern Shawnee Tribe, Miami Tribe, Muscogee Creek Nation, Ottawa Tribe, Peoria Tribe, Quapaw Tribe, Seneca-Cayuga Nation, and Wyandotte Nation.

[14] 42 U.S.C. § 4321 *et seq.*

8, 2018 through March 19, 2018. Comments received were a combination of general comments regarding the Project, comments on the PAD and SD1, and study requests. In accordance with ILP regulations, comments on the PAD and SD1 and study requests were due to FERC by March 13, 2018. A total of 27 formal and individual study requests were made by relicensing participants and FERC staff.

1.2.4.2 Proposed Study Plan, Meeting, and Comments

On April 27, 2018, in accordance with the deadline established in the Abeyance Order, and under 18 CFR § 5.11(a), GRDA filed its Proposed Study Plan (PSP) with the Commission.[15] The PSP included five studies addressing hydrologic and hydraulic modeling, sedimentation, recreation facilities and use, cultural resources, and socioeconomics in support of its intent to relicense the Project. GRDA held meetings to discuss the PSP on May 30 and 31, 2018.

Following the PSP meetings, comments on the PSP were filed by Commission staff, U.S. Fish and Wildlife Service (USFWS), Bureau of Indian Affairs (BIA), the Corps, Oklahoma Department of Wildlife Conservation (ODWC), Oklahoma State Historic Preservation Office (Oklahoma SHPO), Oklahoma Archeological Survey (OAS), Cherokee Nation, Delaware Nation, Miami Tribe of Oklahoma, Muscogee (Creek) Nation, Osage Nation, Ottawa Tribe of Oklahoma, Peoria Tribe, Quapaw Nation, Wyandotte Nation, City of Miami, State Representative Ben Loring, and N. Larry Bork representing the plaintiffs in *City of Miami, et al. v. Grand River Dam Authority* (Plaintiffs).

GRDA conducted a formal study plan meeting on May 30 and 31, 2018 in Langley, Oklahoma, in accordance with 18 CFR § 5.11. The meeting provided an opportunity to clarify the PSP and identify any outstanding issues or information needed with respect to the proposed studies. GRDA also held a meeting of the Cultural Resources Working Group (CRWG) following the study plan meeting on May 31, 2018 to provide an opportunity to discuss the Cultural Resources Study plan in detail. On August 14, 2018, GRDA had a relicensing consultation meeting with the Advisory Council on Historic Preservation (ACHP) in Washington D.C., and on August 22, 2018, GRDA had a relicensing consultation meeting with the Oklahoma SHPO and OAS. In addition, on August 21, 2018, FERC held a tribal consultation meeting in Catoosa, Oklahoma, to discuss the PSP.

On August 21, 2018, the Commission hosted a Tribal consultation meeting at the request of the Osage Nation to discuss the proposed cultural resources study plan. Representatives of the Cherokee Nation, Delaware Nation, Muscogee (Creek) Nation, Osage Nation, Peoria Nation, Quapaw Nation, Wyandotte Nation, BIA, and U.S. Department of the Interior (Interior) Solicitor's Office participated in the meeting.

1.2.4.3 Revised Study Plan

GRDA filed its Revised Study Plan (RSP) on September 24, 2018, pursuant to 18 CFR § 5.13(a).[16] The RSP included significant revisions to the PSP, including three new studies addressing aquatic species, terrestrial species, and wetlands and riparian habitat.

Comments on the RSP were filed by BIA, Corps, USFWS, Oklahoma DWC, Cherokee Nation, Miami Nation of Oklahoma, Muscogee (Creek) Nation, Osage Nation, Quapaw Nation, City of

[15] Proposed Study Plan, Project No. 1494-438, (filed Apr. 27, 2018).

[16] Revised Study Plan, Project No. 1494-438, (filed Sep. 24, 2018).

Miami, Local Environmental Action Demanded Agency represented by Grand Riverkeeper and Tar Creekkeeper, and Plaintiffs.

1.2.4.4 Study Plan Determination

As required under 18 CFR § 5.13(c), on November 8, 2018, the Commission issued its SPD approving the RSP with Commission staff recommended modifications.[17] In particular, Commission staff's SPD recommended the following:

- *Hydrologic and Hydraulic Modeling Study (H&H Modeling Study):* Commission staff approved this study with modifications from GRDA's RSP. Specifically:
    - Staff recommended "an iterative approach to establish a range of low and high frequency flood events. If the flood frequency analysis shows that the selected historical inflow events do not exceed a 100-year recurrence interval, inflow events up to and including the 100-year recurrence interval would be evaluated in the [comprehensive hydraulic model]. We recommend that GRDA include in the 6-month Model Input Status Report its proposal for the flood flows to be analyzed in the H&H study based on the flood frequency analysis."[18]
    - Staff recommended "that GRDA's model accommodate a preliminary minimum starting elevation of 734 feet PD, and a preliminary maximum starting elevation of 760 feet PD."[19]
    - Staff recommended "that GRDA provide maps that clearly depict the boundary between lotic and lentic conditions under any proposed operating scenario with the results of the H&H study."[20]
    - Staff recommended that GRDA conduct "a new bathymetric survey of Grand Lake as part of the sedimentation study," for purposes of "accurately reflect[ing] the existing distribution and volume of sediment in the reservoir and update[ing] stage-storage volume curves for the H&H model."[21]
    - Staff recommended that GRDA include in its 6-month progress report "its proposed definition of a 'material difference' in flood elevation based upon the results of the modeling conducted to that point."[22]
    - Staff recommended that GRDA "demonstrate in the ISR that it has validated its model results against [the Corps'] RiverWare [model] output."[23]
    - Staff recommended "that all final output and reports be presented in PD because stakeholders are familiar with this system."[24]
    - Staff recommended "that GRDA make the [comprehensive hydraulic] model, inputs, and outputs available to download on a protected cloud-based server and provide access to relicensing participants upon request."[25]

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17 Study Plan Determination, Project No. 1494-438, (issued Nov. 8, 2018) [hereinafter, SPD].

18 *Id.* at B-2.

19 *Id.* at B-3.

20 *Id.* at B-4.

21 *Id.*

22 *Id.* at B-5.

23 *Id.*

24 *Id.* at B-6.

25 *Id.*

- *Sedimentation Study:* Commission staff approved this study with modifications from GRDA's RSP. Specifically:
  - Staff recommended "that GRDA adopt the City of Miami's proposed methodology for conducting its sedimentation study, specifically the use of HEC-RAS for the sediment transport model."[26]

- *Aquatic Species of Concern Study:* Commission staff approved this study with modifications from GRDA's RSP. Specifically:
  - Staff recommended "that GRDA conduct the proposed paddlefish sub-study, with the modification that it include estimating the proportion of paddlefish spawning habitat affected by increasing the reservoir elevation, relative to available spawning habitat in the project vicinity."[27]
  - Staff recommended "that GRDA modify item 1 of the rare aquatic species sub-study to include a review of existing density estimates in the project vicinity for each species, and item 2 to include surveys designed to estimate each species' density."[28]
  - Staff recommended "including the rabbitsfoot mussel in the rare aquatic species sub-study."[29]
  - Staff recommended "including the winged mapleleaf mussel in the rare aquatic species sub-study."[30]
  - Staff recommended "that item 1 of the sub-study include a review of existing information on Neosho smallmouth bass spawning habitat availability in the project vicinity."[31]
  - Staff recommended "that GRDA modify item 3 of the rare aquatic species sub-study methodology to include comparison of the information collected in items 1 and 2 with the maps of the lentic and lotic boundary produced as part of the paddlefish substudy to identify the proportion of Neosho smallmouth bass spawning habitat affected by raising the reservoir elevation, relative to all Neosho smallmouth bass spawning habitat in the project vicinity."[32]

- *Terrestrial Species of Concern Study:* Commission staff approved this study as provided in the RSP, with no modifications.

- *Wetlands and Riparian Habitat Study:* Commission staff approved this study as provided in the RSP, with no modifications.

- *Recreation Facilities Inventory and Use Study:* Commission staff approved this study with modifications from GRDA's RSP. Specifically:
  - Staff recommended "modifying the recreation facilities inventory and use survey to include three additional study sites to increase the geographic coverage of the

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26 *Id.* at B-9.

27 *Id.* at B-12.

28 *Id.* at B-15.

29 *Id.* at B-16.

30 *Id.*

31 *Id.* at B-18.

32 *Id.*

survey: the Spring River and Council Cove access areas in the lake's upper section, and Willow Park, in Ketchum."[33]
  - Staff recommended several modifications to the summer survey questionnaires for both GRDA and non-GRDA recreation sites.[34]

- *Cultural Resources Study:* Commission staff approved this study with modifications from GRDA's RSP. Specifically:
  - Staff directed that "GRDA must also consult with and request concurrence from the Oklahoma SHPO and Tribal Historic Preservation Officers (THPOs) for tribes with lands within the project boundary on the final [Area of Potential Effect (APE)]. All correspondence with the Oklahoma SHPO and THPOs should be filed with the Commission. The final APE should clearly identify: (1) the project boundary; (2) lands outside the project boundary that are included in the final APE, and (3) the specific locations of any tribal trust lands that GRDA and BIA determine are within the project boundary."[35]
  - Staff recommended "that GRDA, to the best of its ability, (a) prepare a summary of [Traditional Cultural Property (TCP) inventory] results to date to be filed with the [Updated Study Report (USR)], (b) file individual TCP reports for each tribe upon their completion because some studies may take longer than others, and (c) file a final comprehensive TCP report that contains the TCP results for all tribes with the final license application."[36]
  - Staff recommended further consultation to determine the appropriate reconnaissance survey and archaeological testing methods that would apply on federal, non-federal and lands held in trust on behalf of Indian Tribes.[37]
  - Staff recommended "that GRDA include a discussion of any project-related effects to identified TCPs, including but not limited to effects associated with recreational use . . ., in its cultural resources study report."[38]
  - Staff recommended that GRDA adopt certain measures for confidentiality as recommended by BIA.[39]

- *Socioeconomics Study:* Commission staff approved this study with modifications from GRDA's RSP. Specifically:
  - Staff recommended that GRDA modify task 4 of the study "to include an appendix containing electronic copies of documents submitted by stakeholders and links to publicly accessible web sites containing such documents."[40]
  - For purposes of facilitating Commission staff's Environmental Justice analysis, staff recommended "that GRDA modify the socioeconomic study plan to include in task 4, *Prepare Socioeconomics Study Report*, not only a summary of the socioeconomic conditions in the four-county study area, but also tabular data on

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33 *Id.* at B-20.

34 *Id.* at B-21 to B-22.

35 *Id.* at B-24.

36 *Id.* at B-26.

37 *Id.* at B-27.

38 *Id.* at B-29.

39 *Id.* at B-30.

40 *Id.* at B-32.

these conditions reported at the county and census tract level, where such data exist."[41]

- *Infrastructure Study:* Commission staff recommended this new study, which was not included in GRDA's RSP. The staff-required methods and strategies for the Infrastructure Study are included in the SPD.[42]

- *Federal Lands and Project Boundary Study:* Commission staff did not require this study, which was proposed by several relicensing participants. Instead, staff confirmed that information regarding to federal land ownership will be included in GRDA's relicensing application.[43]

- *Contaminated Sediment Study:* Commission staff did not require this study, which was proposed by several relicensing participants. Staff concluded that requestors of this study did not demonstrate a nexus between Project operations and the effects of contaminated sediment transport.[44] Staff concluded that "additional information may be required to describe the effect of such flooding on soil chemistry and potential effects on plants and wildlife" if "based on the results of the H&H modeling and sedimentation studies, it becomes evident that overbank flooding is influenced by project operation."[45]

1.3 Modification of Relicensing Plan and Schedule

On May 20, 2019, GRDA requested a modification of the relicensing plan and schedule, on the basis that unanticipated delays due to the abeyance process, the time required to complete the staff-recommended bathymetry study, and the need to integrate the new bathymetric data into the H&H Modeling Study. On September 9, 2019, the Commission issued an order extending the license term and modifying the relicensing plan and schedule (Extension Order).[46] The Extension Order extended the license term to May 31, 2025,[47] waived the one-year requirement under 18 CFR § 5.14(c)(1), and established the deadline for submitting the ISR as September 30, 2021.[48]

[41] *Id.* at B-33.

[42] *Id.* at B-34 to B-35.

[43] *Id.* at B-36.

[44] *Id.* at B-38.

[45] *Id.*

[46] *Grand River Dam Auth.*, 168 FERC ¶ 62,145 (2019).

[47] Before FERC's Extension Order, the license term was set to expire on March 31, 2022. Thus, the Extension Order extended the license term by two years and two months.

[48] *Grand River Dam Auth.*, 168 FERC ¶ 62,145, at Appendix A (2019).

1.4 National Defense Authorization Act for Fiscal Year 2020

On December 20, 2019, Congress enacted the National Defense Authorization Act for Fiscal Year 2020 (NDAA 2020).[49] Importantly, NDAA 2020 includes special legislation applicable only to the Pensacola Project, and it significantly changes the scope of the ongoing relicensing for this Project.

First, NDAA 2020 resolves a long-standing dispute between GRDA and the City of Miami regarding Project lands and lands over which GRDA has a responsibility to obtain title pursuant to Article 5 of its license.[50] In response to the City of Miami's assertion that GRDA has a license obligation to obtain title to "approximately 13,000 acres of land, including much of the City of Miami" due to periodic flooding,[51] Congress in NDAA 2020 forbids any such requirement in at least three ways:

- NDAA 2020 provides that "[t]he licensing jurisdiction of the Commission for the project shall not extend to any land or water outside the project boundary."[52] Thus, NDAA statutorily prohibits the Commission from imposing any license obligation outside of the Project boundary as it existed as of Congress' enactment of NDAA 2020—including any obligation to purchase lands outside the Project boundary.

- Next, NDAA 2020 provides that "[a]ny land, water, or physical infrastructure or other improvement outside the project boundary shall not be considered to be part of the project."[53] This language also confirms that GRDA cannot be required under its license to obtain title to the approximately 13,000 acres identified by the City of Miami.[54]

- Finally, NDAA 2020 allows FERC to amend the Project boundary "only with the expressed written agreement of" GRDA.[55] If GRDA does not consent to a Project boundary amendment, NDAA 2020 provides that the Commission's responsibilities under the Federal Power Act (FPA) are met without any change to the Project boundary.[56]

Second, NDAA 2020 confirms—consistent with the Corps' long-standing jurisdiction under section 7 of the Flood Control Act of 1944[57]—that the Corps has "exclusive jurisdiction and responsibility for management of the flood pool for flood control operations at Grand Lake O' the

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[49] Pub. L. No. 116-92 (2019).

[50] *See*, *e.g.*, Formal Complaint of the City of Miami, Oklahoma, Project No. 1494-445 (filed Dec. 26, 2018).

[51] *Id.* at 2, 37; *see also id.* at 24–30.

[52] Pub. L. No. 116-92, § 7612(b)(3)(A).

[53] *Id.* § 7612(b)(3)(B).

[54] *See* 16 U.S.C. § 796(11) (defining the "project" to include "lands, or interest in lands the use and occupancy of which are necessary or appropriate in the maintenance and operation of" the unit of development); *compare* Standard Article 5, Form L-3, 54 F.P.C. 1817, 1818–19 (requiring GRDA to acquire lands "necessary or appropriate for the construction, maintenance, and operation of the project").

[55] Pub. L. No. 116-92, § 7612(b)(3)(C).

[56] *Id.*

[57] 33 U.S.C. § 709.

Cherokees."[58] In addition to confirming the Corps' exclusive jurisdiction for flood control, Congress in NDAA 2020 prohibits the Commission or any other federal or state agency from imposing any license condition related to surface water elevations. NDAA 2020 provides:

> Except as may be required by the Secretary [of the Army] to carry out responsibilities under section 7 of the Flood Control Act of 1944 (33 U.S.C. 709), the Commission or any other Federal or State agency shall not include in any license for the project any condition or other requirement relating to—
>
> > (i) surface elevations of the conservation pool; or
> >
> > (ii) the flood pool (except to the extent it references flood control requirements prescribed by the Secretary).[59]

The only exception to this broad prohibition is a requirement for the Project to "remain subject to the Commission's rules and regulations for project safety and protection of human health."[60]

1.5 Model Input Status Report

As outlined in the RSP, confirmed in the SPD, and clarified in the Commission's Order on Request for Clarification and Rehearing dated January 23, 2020,[61] a Model Input Status Report (MISR) was developed and provided to the relicensing participants on March 30, 2021. GRDA held a Technical Conference on April 21, 2021, to summarize the MISR and answer questions.

On June 23, 2021, the City of Miami filed comments on the MISR with the Commission.[62] GRDA addressed these comments as part of the ISR.[63]

1.6 Current and Anticipated Future Project Operations

1.6.1 Current Project Operations

As currently licensed, the Project serves multiple purposes, including hydropower generation, water supply, public recreation, and wildlife enhancement. In order to balance the multiple uses of the reservoir, GRDA currently operates the Project's conservation pool to target reservoir surface elevations. This operational scheme, referred to as the Project's rule curve, is required by Article 401 of the license. Over the years, the rule curve has been adjusted several times. In the prior license term, for example, GRDA operated the Project for power generation down to pool elevation 734 feet PD, with conservation pool levels dropping to 730 feet PD during drought years. In addition, GRDA operated for hydropower up to the top of the conservation pool, at 745 feet PD.

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58 Pub. L. No. 116-92, § 7612(c).

59 *Id.* § 7612(b)(2)(A).

60 *Id.* § 7612(b)(2)(B).

61 *Grand River Dam Auth.*, 170 FERC ¶ 61,027 (2020).

62 Comments of Tetra Tech on Behalf of the City of Miami, Oklahoma (Corrected) on Mead & Hunt's H&H Modeling Upstream Hydraulic Model Input Status Report on behalf of GRDA, June 23, 2021.

63 *See* Initial Study Report, Upstream Hydraulic Model Report, at Appendix A, Project No. 1494-438 (Sep. 30, 2021).

Even during the existing license term, the Article 401 rule curve requirements have been amended several times.[64] Currently, the rule curve establishes a designated target elevation throughout the year, with the target elevation changing for seasonal purposes to balance the different uses of the reservoir. The rule curve currently requires the following target reservoir elevations:

Period	Target Reservoir Elevation (feet)
May 1 through May 31	Raise elevation from 742 to 744
June 1 through July 31	Maintain elevation at 744
August 1 through August 15	Lower elevation from 744 to 743
August 16 through September 15	Maintain elevation at 743
September 16 through September 30	Lower elevation from 743 to 742
October 1 through April 30	Maintain elevation at 742

In addition, the Project is part of a vital navigation and flood control system in the Arkansas River basin. Under the exclusive flood control jurisdiction of the Corps, the Project is part of an elaborate system of eleven large reservoirs and 14 other flood control facilities that the Corps manages for both navigation purposes[65] and flood control—from communities as far upstream as Emporia, Kansas, and downstream to Muskogee, Oklahoma. In fact, within the Arkansas River basin, the Corps manages and balances for flood control even further downstream to Fort Smith, Russellville, Van Buren, and even Little Rock, Arkansas.

The Corps manages all flood control operations at Grand Lake pursuant to its Water Control Manual (1992). The flood control pool associated with Grand Lake consists of the storage volume available between the target pool elevation, which varies seasonally between 742 and 744 feet, and the upper elevation of 755 feet. When Grand Lake elevations are either within the flood control pool (i.e., above elevation 745 feet) or projected to rise into the flood control pool, the Corps directs the water releases from Pensacola Dam under NDAA 2020 and Section 7 of the Flood Control Act of 1944,[66] as defined in the guiding protocol of the 1992 Letter of Understanding and Water Control Agreement between the Corps and GRDA.

When directed to make lake releases by the Corps, GRDA first discharges as much water as possible through the Project's hydropower units. Once the Project has reached the powerhouse's maximum hydraulic capacity, the Corps may direct GRDA to open one or more spillway gates if the conservation pool is still rising, but typically not unless the water surface elevation exceeds, or is projected to exceed 745 feet. The Corps will then determine if additional gates need to be opened. The target discharge rate at any time is based on the current Grand Lake water surface elevation, the current estimated Grand Lake inflow rate, and the amount of projected flooding downstream in the Grand or Arkansas River basins. After a significant inflow event, the Water Control Manual provides that the Corp may direct a gradual release of water to enhance hydropower operations at downstream federal hydropower facilities.[67]

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[64] *See Grand River Dam Auth.*, 160 FERC ¶ 61,001 (2017); *Grand River Dam Auth.*, 77 FERC ¶ 61,251 (1996); *Grand River Dam Auth.*, 59 FERC ¶ 62,073 (1992).

[65] The 445-mile McClellan-Kerr Arkansas River Navigation System provides a vital and strategic shipping channel from the confluence of the Mississippi and White Rivers in Arkansas, upstream to Catoosa, Oklahoma (near Tulsa).

[66] 33 U.S.C. § 709.

[67] "The regulation plan for the Arkansas River basin described in the Master Manual enhances power production at all the hydropower plants in the basin by providing a tapered recession of flood control storage evacuation. This

1.6.2 Anticipated Future Project Operations

In its PAD for the relicensing of the Project, GRDA indicated its intent to "investigate Project operations within the conservation pool and determine whether any changes to the Project's seasonal rule curve, equipment replacements or modernization activities in support of extending the life of the Project, and/or general operational or facility efficiency improvements are warranted."[68] In furtherance of this intent, GRDA's FERC-approved study plan was developed expressly to investigate the feasibility and effects of any potential changes to Project operations that GRDA may propose in its relicensing application.[69]

Following FERC's November 2018 SPD, Congress enacted NDAA 2020, as described above.[70] In NDAA 2020, Congress granted GRDA autonomy in managing Grand Lake surface elevations in the Project's conservation pool.

Since Congress' enactment of NDAA 2020, and informed by the first season of relicensing studies, GRDA has been evaluating different operational scenarios to optimize the hydropower capabilities of the Project, while continuing to protect environmental, recreational and other socioeconomic resources of the Project. While GRDA is still in the process of evaluating this issue, it has determined that the following operational parameters will apply during the new license term:

1. GRDA will no longer utilize a rule curve with seasonal target elevations.

2. GRDA will maintain the conservation pool between elevations 742 and 745 feet PD for purposes of normal hydropower operations. While hydropower operations may occur when water surface elevations are outside this range (e.g., maintenance drawdowns and high-flow events), GRDA expects to generally maintain water surface elevations between 742 and 745 feet PD during normal Project operations.

3. Instead of managing the Project to target a specified seasonal elevation, GRDA's new operations may fluctuate reservoir levels within the elevational range of 742 and 745 feet PD, for purposes of responding to grid demands, market conditions, and the public interest, such as environmental and recreational considerations.

4. GRDA will continue to adhere to the Corps' direction on flood control operations in accordance with the Water Control Manual, with no changes to existing operations.

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provides more days of generation time before the flood control storage is depleted. The hydropower operation provides flows for the downstream run-of-river hydropower projects Markham Ferry, Fort Gibson, Webbers Falls, Robert S. Kerr, Ozark and Dardanelle." Water Control Manual ¶ 8-07, at p. 8-2 (1992).

[68] PAD § 4.5.1, Project No. 1494-438 (filed Feb. 1, 2017).

[69] *E.g.*, RSP § 3.1.1, Project No. 1494-438 (filed Sep. 24, 2018) (describing a goal of the Hydrologic and Hydraulic Modeling Study as "determin[ing] the feasibility of implementing alternative operation scenarios that may be proposed as part of the relicensing effort"); *id.*, Appendix A, Hydrologic and Hydraulic Modeling Study §§ 2.1, 2.6.9 (same); *id.*, Appendix A, Sedimentation Study § 2.1 (same); *id.*, Appendix B (response to Comments 42, 56, 61).

[70] *See supra* § 1.4.

2.0 Initial Study Report and Comments Received

2.1. Initial Study Report

On September 30, 2021, GRDA filed the ISR for the relicensing of the Project. Appendices 2 through 11 of the ISR contain the individual reports for each of the ten studies required by the Commission-approved RSP, as indicated in Table 2.1-1.

Table 2.1-1. Organization of ISR

Appendix No.	Study Report
2	Downstream Hydraulic Model Upstream Hydraulic Model Operations Model
3	Bathymetric Map, Surface Area, and Capacity of Grand Lake O' the Cherokees, Northeastern Oklahoma, 2019
4	Grand Lake Sedimentation Study (interim)
5	Aquatic Species of Concern
6	Terrestrial Species of Concern
7	Wetlands and Riparian Habitat
8	Recreation Facilities Inventory and Use
9	Archaeological Investigations within the Grand River Dam Authority Pensacola Project Area of Potential Effect, Craig, Delaware, Mayes, Ottawa Counties, Oklahoma (Volume I: 2019-2020) Volume II Archaeological Investigations within the Grand River Dam Authority Pensacola Project Area of Potential Effect, Craig, Delaware, Mayes, Ottawa Counties, Oklahoma 2020-2021 Field Season Cultural Historic Investigations Within the Grand River Dam Authority Pensacola Project Area of Potential Effect, Craig, Delaware, Mayes, Ottawa Counties, Oklahoma Status Report of Ethnographic Work-to-date Leading to the Development of a Traditional Cultural Property Inventory Related to the Pensacola Dam Relicensing Process for the Grand River Dam Authority, Oklahoma
10	Socioeconomics
11	Infrastructure

2.2 ISR Meetings and Comments Received

Following GRDA's submission of the ISR, it held a series of meetings from October 12–14, 2021, with federal and state agencies, Native American tribes, local governmental entities, and other relicensing participants, to discuss results of the first season of studies and plans for the second study season, as required under 18 CFR § 5.15(c)(2). Due to Covid-19, these ISR meetings were conducted virtually; however, GRDA estimates that approximately 60 individuals participated over the course of these three days of ISR meetings. On October 29, 2021, GRDA, in accordance with 18 CFR § 5.15(c)(3), filed the summary of the ISR meetings.

As required by 18 CFR § 5.15(c)(4), the following entities filed comments in response to GRDA's ISR:

- Federal Energy Regulatory Commission Staff
- U.S. Department of Energy, Southwestern Power Administration
- U.S. Fish and Wildlife Service
- Bureau of Indian Affairs (comments on ISR reports)
- Bureau of Indian Affairs (concurrence with definition of Area of Potential Effect)
- Osage Nation Historic Preservation Office
- Cherokee Nation
- Oklahoma Department of Wildlife Conservation
- Oklahoma Archeological Survey
- Oklahoma Historical Society, State Historic Preservation Office
- City of Miami, Oklahoma

Most, but not all, of these comments were filed with the Commission and appear in FERC's eLibrary system. For completeness, all publicly available comments received appear in Appendix A of this Response. All comments and responses containing privileged or confidential information appear in Appendix G of this Response, which has been labeled "**CONTAINS PRIVILEGED INFORMATION – DO NOT RELEASE (CUI//PRIV).**"

3.0 Second Study Season Plans

The ISR details GRDA's second season plans for each study in the Commission-approved SPD.[71] Based on comments received from agencies and other relicensing participants, GRDA has modified its second season study plans as provided in the subsections that follow.

3.1 H&H Modeling Study

As stated in the ISR,[72] GRDA proposed the following activities during the second study season for the H&H Modeling Study:

- Update Operations Model without RiverWare constraints and based upon comments.
- Update Upstream Model based upon comments.
- Update Downstream Model based upon comments.
- Run anticipated future operations for upstream and downstream model.

[71] *See* ISR § 5.0.

[72] *Id.* § 5.1.

- Provide Lentic and Lotic Maps for current and anticipated future operations, as needed, in the Aquatic Species of Concern, the Terrestrial Species of Concern, and the Wetland and Riparian Study.

Based on comments received from resource agencies and other relicensing participants, GRDA proposes the following additional activities for the H&H Modeling Study during the second study season:

- In response to comments from Commission staff, as noted in Section 4.5.1 below (Comments 4 and 5), the title of Table 1 of the Upstream Hydraulic Modeling Report will be updated to: “Summary of historical event boundary conditions used in Upstream Hydrologic Model (UHM) UHM calibration.” The revised table title will more accurately describe the information included in the table. In addition, GRDA will include the following tables in the appendices of the USR:
    - Tables of maximum water surface elevation (feet, PD) for each simulation.
    - Tables of maximum extent of inundation (feet) for each simulation.
    - Tables of duration of inundation (hours) for each simulation.
- In response to comments from the City of Miami, as noted in Sections 4.3.1.6, 4.3.1.7, and 4.5.1 (Comment 19) below, now that the Operations Model has been validated against RiverWare output, the Operations Model will be updated to include the 2019 elevation-storage data. If Operations Model simulations are updated as part of the USR development, the updated simulation results will be used to review the Comprehensive Hydraulic Model (CHM) results and the CHM simulations will be re-run if needed. If the CHM updates change the conclusions from those included in the ISR, studies that depend upon the conclusions of the CHM will be updated.
- In response to comments from the City of Miami, as noted in Sections 4.3.1.9 and 4.5.1 (Comment 21) below, GRDA simulated the inflow hydrographs from the Federal Emergency Management Agency’s (FEMA) 2019 study (including the Neosho River hydrograph with a peak flow of 165,000 cfs at the Commerce gage) despite the methodological flaws in the 2019 FEMA study hydrology. GRDA simulated starting reservoir elevations as low as 734 feet PD and as high as 757 feet PD. Water surface elevation profiles for this set of simulations are included as Appendix B to this Response. Despite the methodological flaws in the 2019 FEMA study, the results are very similar to the 100-year event simulation results in the ISR. A starting reservoir elevation difference of 23 feet resulted in no appreciable difference in maximum water surface elevation at the City of Miami. Inflow hydrographs from the 2019 FEMA study and the hydraulic results displayed in Appendix B should not be misconstrued as a replacement of the 100-year event results included in GRDA’s UHM Report. GRDA completed this exercise as a courtesy to the City of Miami, following the ISR. The purpose of the work was to show relicensing participants how the modification to the 100-year inflow hydrographs would not change the conclusions of the H&H Study. GRDA is not proposing to conduct further analysis of the 2019 FEMA hydrographs in the second study season.
- In response to comments from the City of Miami, as noted in Sections 4.3.1.10 and 4.5.1 (Comment 23) below, GRDA performed a sensitivity analysis to determine the impact of the abandoned railway bridge high chord on upstream water surface elevations. Of all the historical inflow events used in the simulation scenarios (see Section 7 of the UHM Report), only the July 2007 event exceeded the high chord of the bridge in the Neosho river channel. Two geometries were tested in the sensitivity analysis: (1) the original geometry used in the ISR, and (2) a flat deck with the bridge trusses completely removed from the high chord. Water surface elevation profiles from the sensitivity analysis are

included as Appendix C of this Response. The results show that removing the trusses from the high chord of the bridge resulted in no appreciable difference in maximum water surface elevation upstream of the bridge. The results of the sensitivity analysis displayed in Appendix C should not be misconstrued as a replacement of the results included in GRDA's UHM Report. GRDA completed this exercise as a courtesy to the City of Miami, after receiving the City of Miami's comments on the ISR. The purpose of the work was to show relicensing participants how the simulation results were insensitive to the bridge high chord. GRDA is not proposing to change the bridge high cord as set forth in the UHM during the second study season modeling.

3.2 Sedimentation Study

As stated in the ISR,[73] GRDA proposed the following activities during the second study season for the H&H Sedimentation Study:

- Update Sediment Transport Model based upon comments;
- Run Sediment Transport Model for current operation;
- Run Sediment Transport Model for anticipated future operations; and
- Describe observed or predicted effects of sedimentation on the power pool.

In addition, the ISR included an interim study report for the sedimentation modeling work conducted at the time of the ISR, noting GRDA's expectation that a full report will be completed by December 31, 2021, once calibration of the model was complete.[74] GRDA has now completed this work and a full *Grand Lake Sedimentation Study* report appears in Appendix D of this Response. Based on GRDA's very recently completed calibration effort, GRDA is proposing significant changes to the Commission-approved Sedimentation Study. Because GRDA's calibration efforts were ongoing at the time GRDA completed the ISR, as well as during the ensuing meetings and comment period and only completed this work within the last couple of weeks, GRDA is now proposing a second-season modification for the Sedimentation Study, which appears at Appendix E of the Response.

A revision to the FERC-approved study plan for the Sedimentation Study is warranted for several reasons:

- The information provided by the City of Miami during the PSP and RSP stages of study plan development, alleging that the bed of the river/reservoir system consisted primarily of sand and that cohesive sediment need not be considered, proved to be erroneous. Field data proved that the sediment being transported down the rivers and into the reservoir consists primarily and predominantly of silt and clay which are cohesive in nature. This required collection of core samples and laboratory testing of cohesive sediment using SEDflume.
- SEDflume analysis demonstrated that the cohesive sediment characteristics including density, critical shear stress and erosion rate vary widely with depth below the sediment surface (485%, 3000%, and 10,000%, respectively). These characteristics also tend to vary over time as cohesive sediment tends to consolidate and gain strength as time goes on.

[73] *Id.* § 5.2.

[74] *Id.* §§ 1.0 (Table 1), 3.1.

- While HEC-RAS in the sediment transport mode allows sediment density to change over time, it only allows one set of parameters for cohesive erosion characteristics which does not vary with depth below the sediment surface and does not change over time. As a result, any selected set of parameters can significantly misrepresent the complexity of cohesive sediment modeling.
- Testing of the Sediment Transport Model (STM) demonstrated significant inconsistencies with reality which indicate it cannot reasonably be expected to simulate the complexities of cohesive and non-cohesive sediment found in this river and reservoir system with any acceptable degree of confidence.
- Sediment transport (whether cohesive or non-cohesive) is driven by the hydraulic shear stresses exerted by flowing water over the bed of a river or reservoir. Analysis of the distribution of hydraulic shear stresses as they vary over the longitudinal extent of the river/reservoir system can be related to the pattern of sedimentation that occurred over the time period from 2009 to 2019 when cross-section and bathymetry data are available.

Further, the City of Miami cited the "widely-accepted ASCE Manual" in their comments on GRDA's RSP, stating "where full calibration is not possible, 'model tests are devised so that engineering judgment can be used to assess the credibility of the calculated results.'"[75] As detailed in the Sedimentation Study Report, tests were performed, and the results were erroneous, leading to the conclusion that the model is unreliable as a predictive tool for sedimentation.

As noted in the ISR,[76] GRDA plans to convene a technical meeting to present the results of the sedimentation model calibration. Now that GRDA has concluded that the STM recommended by Commission staff in its SPD will not simulate the complexities of cohesive and non-cohesive sediment found in this river and reservoir system with any acceptable degree of confidence, this technical meeting will also present an opportunity for relicensing participants to discuss GRDA's proposed modification to the Sediment Study plan, which appears in Appendix E.

This technical meeting will be held on January 14, 2022, from 9:00 am to 12:00 pm Central Time. In light of continuing travel restrictions due to covid-19, this will be a virtual meeting. GRDA will be sending relicensing participants instructions on how to participate in this technical meeting.

Finally, based on comments received from resource agencies and other relicensing participants, GRDA proposes the following additional activities for the Sedimentation Study during the second study season:

- In response to comments from Commission staff, as noted in Section 4.5.2 below (Comment 1), Section 5.1.2.1 "Changes Since October ISR Conference" of the *Grand Lake Sedimentation Study* appearing in Appendix D details flow roughness factors that were changed to calibrate the model and provides explanations for those changes.

75 City of Miami's Comments on RSP at 20, Project No. 1494-438 (filed Oct. 24, 2018).

76 ISR § 3.1.

3.3 Aquatic Species of Concern Study

3.3.1 Neosho Mucket

As stated in the ISR,[77] GRDA proposed the following activities during the second study season for the Neosho mucket:

- The study area will consist of the Elk River from the Oklahoma/Missouri State line to the confluence of Buffalo Creek.
- Use a phased sampling design incorporating both Qualitative and Quantitative methods.
- Qualitative surveys will characterize the substrate, identify potential mussel beds, and potential presence of live mussels within the study area.
- A minimum search time of five person-hours (divided into five one person-hour searches) will be conducted within the delineated search area.
- If no live mussels are encountered after the first three one-person hour searches, surveys within this location will cease and it will be assumed no live mussels are present.
- At the end of each search period, collected mussels will be identified and enumerated.
- If no new species of mussels are collected during the fifth search period, the survey is complete.
- If at least one new mussel species is collected in the fifth search period, additional one person-hour search periods are required until no new species are collected.
- Visual, combined with tactile searching (hand-grubbing into the top 1-4 inches of substrate to increase detection of more-deeply buried mussels) will be used.
- Searchers will select a shoreline and begin searching from downstream to upstream moving back and forth across the stream, ensuring that all the delineated search area is sufficiently covered.
- If listed mussels are detected, initial surveys will immediately cease, and quantitative methods will commence.
- Quantitative surveys will involve sampling on mussel beds identified during qualitative surveys to quantify the mussel populations.
- Quantitative point sampling will be conducted on mussel beds by randomly selecting 0.25 m^2 quadrats plots within each bed.
- Systematic sampling will incorporate three random starts with 2 additional quadrats selected at 1-m intervals (9 quadrats per sample/site).
- Additional, randomly selected quadrat points will be available to replace locations that do not provide mussel habitat (e.g., too close to shore, water depth, poor substrate).
- Quantitative surveys will be performed by visual and tactile searches of randomly placed 0.25 m^2 quadrats placed at random locations as outlined above.
- Substrate within the quadrats will be excavated to a depth of 20 cm and sieved, as this increases the likelihood of detecting juvenile mussels.
- All live individuals will be identified, enumerated, and returned to the approximate location of collection.
- Shell material will also be collected and quantified during sampling from the stream and classified as fresh dead (FD; intact periostracum and lustrous nacre), weathered dead (WD; intact periostracum, weathered and chalky nacre), or subfossil (SF; shell chalky, no periostracum).

[77] *Id.* § 5.3.

- The surveys will be conducted under the supervision of qualified personnel with appropriate licenses and knowledge of mussel survey methods and procedures for handling endangered mussel species.

Both Commission staff and USFWS submitted clarifying comments and questions related to GRDA's proposed study of the Neosho mucket during the second study season. GRDA's response to these questions, including additional details on the survey methods proposed during the second study season, appear in Section 4.5.3 below (Comments 1, 2, 6 & 7).

3.3.2 Rabbitsfoot

As explained in the ISR,[78] GRDA has completed all requirements of the FERC-approved study plan relative to the rabbitsfoot mussel. Because records received by GRDA indicate that neither the rabbitsfoot nor its host species have been present at sampling events in the Neosho, Spring, and Elk Rivers over the past 18 years, any additional study on this species is unwarranted.

In their comments on the ISR, no relicensing participant recommended any proposal to modify this study during the second study season, nor did any relicensing participant disagree with GRDA's conclusion that no further study on the rabbitsfoot is needed. Accordingly, GRDA maintains its view that any additional study of the rabbitsfoot is unwarranted. However, GRDA will report any occurrences of rabbitsfoot in the survey for the Neosho mucket, as described in Section 3.3.1 above.

3.3.3 Winged Mapleleaf

As explained in the ISR,[79] GRDA has completed all requirements of the FERC-approved study plan relative to the winged mapleleaf mussel. A 5-year review of the species completed in 2015 indicates this species is considered extirpated from the Neosho River and Spring River in Kansas and no known populations occur within the larger Grand Lake watershed or the Neosho River Basin. For that reason, GRDA concluded that any additional study on this species is unwarranted.

In their comments on the ISR, no relicensing participant recommended any proposal to modify this study during the second study season, nor did any relicensing participant disagree with GRDA's conclusion that no further study on the winged mapleleaf is needed. Accordingly, GRDA maintains its view that any additional study of the winged mapleleaf is unwarranted. However, GRDA will report any occurrences of winged mapleleaf in the survey for the Neosho mucket, as described in Section 3.3.1 above.

3.3.4 Neosho Madtom

As stated in the ISR,[80] GRDA proposed the following activities during the second study season for the Neosho madtom:

- A 20-mile stretch of the river from HWY60 to the county border be assessed in locations that contain riffles and moderate to low-velocity gravel bar habitats. Fish sampling will be conducted between late summer and early fall at selected sites where riffles and gravel

[78] *Id.* § 4.3.2.

[79] *Id.* § 4.3.3.

[80] *Id.* § 6.1.1.1.

bars are identified via review of aerial imagery that are readily accessible public roads, bridges, or access points.

- Fish sampling will be conducted by kick-seining (4.6 m x 1.8 m seine with 3.2 mm mesh) by one or two individuals thoroughly disturbing the substrate beginning four meters upstream from a stationary seine and then kicking in a downstream direction to the seine's lead line.
- Kick-seining will start at the downstream end of a habitat and proceeded laterally and then upstream with multiple kick-seine efforts until all habitat less than one meter deep at a site had been sampled.
- All fishes captured will be identified to species, measured for total length (TL) to the nearest millimeter, counted, and then returned to the stream.

Both Commission staff and USFWS submitted clarifying comments and questions related to GRDA's proposed study of the Neosho madtom during the second study season. GRDA's response to these questions, including additional details on the survey methods proposed during the second study season, appear in Section 4.5.3 below (Comments 3, 4, and 8). Based on these comments received, GRDA proposes the following changes for the Neosho madtom component of the Aquatic Species of Concern study:

- On the Neosho River, instead of surveying downstream to the HWY60 bridge, GRDA plans to limit the study area to the Interstate 44 bridge. This decision is based on further consideration of the habitat requirements of the Neosho madtom, current information, and knowledge of existent habitat conditions downstream of this point as indicated by other studies in the ISR. The upstream range of these studies will extend to the "Neosho 2" site as depicted on the map appearing in Appendix F. Neosho 2 is located near the originally proposed Craig and Ottawa county border.
- Based on of comments received on the ISR, GRDA intends to expand surveys to include the Spring River. On the Spring River, GRDA plans to survey between the Interstate 44 bridge to the HWY 10 Bridge (i.e., the "Spring 24" appearing in Appendix G map). Methods used for assessment on the Spring River will be identical to the Neosho River.

3.3.5 Neosho Smallmouth Bass

As stated in the ISR,[81] GRDA proposed a modification to FERC's SPD to eliminate any future work on the Neosho smallmouth bass. GRDA explained that records show that a smallmouth bass population is present within the drainages surrounding the Project, but that there was no determination that the Neosho subspecies was identified. Because the Neosho smallmouth bass has no state or federal listing, and the cost of the additional work is expected to be approximately $100,000, GRDA does not believe that the results of any study would justify the cost.

Based on comments received from Commission staff and the ODWC, and based on further consultation with ODWC following the ISR meetings as noted in Section 4.5.3 below (Comments 5 and 9), GRDA maintains its view that any additional study of the Neosho smallmouth bass is unwarranted.

[81] *Id.* § 5.3.

3.3.6 Paddlefish

As stated in the ISR,[82] GRDA proposed a modification to FERC's SPD to eliminate any surveys or additional work on paddlefish spawning habitat during the second study season. GRDA explained that the background research completed in the initial study period shows the availability of continuous high flows during spawning has a significant effect upon paddlefish spawning success. The H&H Modeling Study has demonstrated Project operation has an immaterial impact on upstream water surface elevations and consequently the hydraulic conditions which paddlefish seek at upstream spawning sites during high inflow conditions. Because inflow events—regardless of any future operations of the Project—will continue to dominate hydraulic conditions at upstream spawning sites, and because there is an abundance of paddlefish spawning habitat, additional studies are unwarranted.

In comments filed on the ISR, no relicensing participant recommended any proposal to modify this study during the second study season, nor did any relicensing participant disagree with GRDA's conclusion that no further study on the paddlefish is needed. Accordingly, GRDA maintains its view that any additional study of the paddlefish is unwarranted.

3.4 Terrestrial Species of Concern Study

3.4.1 American Burying Beetle

As stated in the ISR,[83] GRDA proposed to discontinue the second season survey for American burying beetle (ABB). GRDA explained that the results of the H&H Modeling Study demonstrate that future operational changes that may be implemented by GRDA within the conservation pool of Grand Lake will not appreciably influence water levels beyond the current Project boundary. Moreover, GRDA explained that because ABB will only use areas with a soil and/or leaf litter substrate and vegetated cover (as opposed to bare rocky or sandy shorelines), suitable habitat within the Project boundary is limited.

In their comments on the ISR, no relicensing participant recommended any proposal to modify this study during the second study season, nor did any relicensing participant disagree with GRDA's conclusion that no further study on the ABB is needed. Accordingly, GRDA maintains its view that any additional study of the ABB is unwarranted.

3.4.2 Gray Bat

As stated in the ISR,[84] GRDA proposed to continue with the gray bat surveys, as provided in the FERC-approved study plan, with no modifications.

In their comments on the ISR, no relicensing participant recommended any proposal to modify this study during the second study season. Accordingly, GRDA maintains its view that the gray bat surveys should continue during the second study season in accordance with the FERC-approved study plan, with no modifications.

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[82] *Id.* § § 6.1.1.2.

[83] *Id.* § 6.1.2.

[84] *Id.* § 5.4.

3.5 Wetland and Riparian Habitat Study

As stated in the ISR,[85] GRDA proposed the following activities during the second study season for the Neosho mucket:

- Once the lentic and lotic maps are produced by the H&H Study, changes in wetland inundation and riparian habitat due to anticipated future operations will be analyzed.
- If it is determined anticipated future operations are impacting wetlands, the accuracy of the base maps will be verified, as necessary, through ground-truthing.

Based on comments received from resource agencies and other relicensing participants, GRDA proposes the following additional activities for the Wetland and Riparian Habitat Study during the second study season:

- In response to a comment from Commission staff, as noted in Section 4.5.5 below (Comment 1), GRDA will file the Geographic Information Systems (GIS) data layers for the survey as part of the USR.

3.6 Recreation Facilities Inventory and Use Study

As explained in the ISR,[86] GRDA has completed all requirements of the FERC-approved study plan relative to the Recreation Facilities Inventory and Use Study. Therefore, GRDA proposed no further activities for this study during the second study season.[87]

In their comments on the ISR, no relicensing participant recommended any proposal to modify this study during the second study season, nor did any relicensing participant disagree with GRDA's conclusion that the Recreation Facilities Inventory and Use Study is complete. Accordingly, GRDA maintains its view that any additional study of recreation resources is unwarranted.

3.7 Cultural Resources Study

As explained in the ISR,[88] GRDA has made substantial progress in meeting the requirements of the Commission-approved studies for cultural resources. Working closely with the CRWG, GRDA has completed a cultural historic investigation, archaeological investigations in 2019, 2020, and 2021, and has initiated efforts to complete a Traditional Cultural Properties (TCP) inventory within the Project's APE.

As noted in the ISR,[89] additional work is planned during the second study season:

- Report results of the archaeological reconnaissance on five sites not included in the ISR;
- Determine National Register of Historic Places (NRHP) eligibility on recommended sites in consultation with CRWG;

85 *Id.* § 5.5.

86 *Id.* § 4.6.

87 *Id.* § 5.6.

88 *Id.* § 4.7.

89 *Id.* § 5.7.

- Report the results of the surveys on the remaining bluff areas not included in the ISR;
- Complete surveys and report the results of the remaining three (3) areas in the USR;
- Continue with TCP inventory; and
- Continue to adjust the testing interval density for quaternary landforms (Qals) based upon in-field conditions as necessary during remaining surveys using the adjusted survey methods for buried archaeological deposits.

In addition, on December 13, 2021, GRDA held its quarterly meeting with the CRWG, in which it presented its proposed fieldwork plan for 2022. CRWG participants are in the process of reviewing GRDA's plans, and GRDA will implement the 2022 fieldwork based on feedback from the CRWG.

Also, based on written comments received from CRWG in response to the ISR, GRDA proposes several activities for the Cultural Resources Study during the 2022 field season. Because GRDA's proposal includes sensitive information, it appears in Appendix G and is privileged and confidential.

Most comments on GRDA's Cultural Resources Study from CRWG members highlighted the desire for ongoing fieldwork. GRDA appreciates these comments and commits to completing the work outlined above and as noted in Section 4.5.7. GRDA notes that while CRWG members' requests are consistent with GRDA's overall Cultural Resources Study Plan, some of the fieldwork will not be possible in 2022, as GRDA will need to shift its efforts to preparing the Historic Properties Management Plan (HPMP). As set forth in Section 4.5.7 and as discussed with the CRWG, work that is not completed in 2022 will be completed pursuant to the requirements of the HPMP.

3.8 Socioeconomics Study

As explained in the ISR,[90] GRDA has completed all requirements of the FERC-approved study plan relative to the Socioeconomics Study. Therefore, GRDA proposed no further activities for this study during the second study season.[91]

GRDA received a number of proposed modifications to the Socioeconomics Study—all from the City of Miami. As detailed in Section 4.3.8 below, GRDA does not propose to adopt any of these proposed modifications. Rather, GRDA maintains its view that the Socioeconomics Study is now complete and that any additional study of socioeconomic resources is unwarranted.

As noted in Section 4.3.8.10, however, GRDA recognizes that, should conclusions of the H&H Modeling Study change during the second study season, GRDA will update the other studies, including the Socioeconomic Study, as needed. Any such changes will appear in the USR.

[90] *Id.* § 4.8.

[91] *Id.* § 5.8.

3.9 Infrastructure Study

As explained in the ISR,[92] GRDA has completed all requirements of the FERC-approved study plan relative to the Infrastructure Study. Therefore, GRDA proposed no further activities for this study during the second study season.[93]

GRDA received two proposed modifications to the Infrastructure Study—both from the City of Miami. As detailed in Section 4.3.9 below, GRDA does not propose to adopt either of these proposed modifications. Rather, GRDA maintains its view that the Infrastructure Study is now complete and that any additional study of infrastructure is unwarranted.

As noted in Section 4.3.9.1, however, GRDA recognizes that should conclusions of the H&H Modeling Study change during the second study season, GRDA will update the other studies, including the Infrastructure Study, as needed. Any such changes will appear in the USR.

4.0 Response to Requests for New and Modified Studies

4.1 Regulatory Framework

Pursuant to the Commission's regulations implementing the ILP, Commission staff issues the SPD following: (1) an opportunity for relicensing participants to file proposed studies;[94] (2) the applicant's preparation of a PSP;[95] (3) public meetings to review the applicant's PSP;[96] (4) a 90-day period for relicensing participants to comment on the PSP;[97] (5) the applicant's preparation of the RSP;[98] and (6) an opportunity for relicensing participants to comment on the RSP.[99]

Because of the time-consuming, iterative, and exhaustive process required by the ILP for developing the Commission-approved study plan—a process that takes nearly a year to complete—the ILP regulations intentionally provide only a limited opportunity at the ISR stage for justifying modifications to existing studies or new studies. At this advanced stage of the ILP, changes to the Commission-approved study plan are appropriate only in very limited circumstances.

For requested modifications for existing studies, section 5.15(d) of the Commission's regulations provides that any proposal to modify a required study must be accompanied by a showing of good cause *and* must include a demonstration that: (1) the approved study was not conducted as provided for in the Commission's SPD; or (2) the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way.[100] For

[92] *Id.* § 4.9.

[93] *Id.* § 5.9.

[94] 18 C.F.R. § 5.9.

[95] *Id.* § 5.11(a).

[96] *Id.* § 5.11(e).

[97] *Id.* § 5.12.

[98] *Id.* § 5.13(a).

[99] *Id.* § 5.13(b).

[100] 18 C.F.R. § 5.15(d). In this regard, the City of Miami misapprehends the regulatory burden it carries to justify a study modification. Not only must the City of Miami make a showing of good cause, *see* City of Miami Initial

a requested new study, section 5.15(e) of the ILP regulations impose an even heavier burden, requiring the requestor to not only demonstrate "good cause," but also to explain: (1) any material change in law or regulations applicable to the information request; (2) why the goals and objectives of the approved study could not be met with the approved study methodology; (3) why the request was not made earlier; (4) significant changes in the proposal or that significant new information material to the study objectives has become available; and (5) why the new study request satisfies the study criteria in Section 5.9(b) of the regulations.[101]

The preamble to the Commission's ILP regulations clearly explains that the opportunity for justifying modified or new studies at the ISR stage is intentionally limited, explaining that "the study plan determination is the *culmination* of the study plan development process in which potential applicants, study requesters, and the Commission staff consult intensively on what information gathering and studies are needed, study requests and responses thereto are accompanied by discussion of the study criteria, and the study plan determination must explain its decision on each disputed study with reference to the study criteria and any applicable Commission policies and practices."[102]

As a result of the extensive consultation required by the ILP, as detailed in Sections 1 and 2 above, it is now long past the point for relicensing participants to request significant modifications to existing studies or new studies. The Commission has stated that "[t]he purpose of an approved study plan is to bring, to the extent possible, pre-filing finality to the issue of what information gathering and studies will be required by the Commission to provide a sound evidentiary basis on which the Commission and other participants in the process can make recommendations and provide terms and conditions."[103]

4.2 Response to Thematic Comments Received from Relicensing Participants

Several overarching themes emerge from relicensing participants' comments on the ISR. This section responds to these repeated comments universally, for purposes of efficiency, with individual responses to relicensing participants' requests for new and modified studies, as well as their general comments, below.[104]

4.2.1 The Commission Is Prohibited from Regulating Project Reservoir Levels

Under current, normal Project operations, reservoir levels fluctuate seasonally between elevations 742 and 744 feet PD, in accordance with the elevational targets established by the Project's Article 401 rule curve—and well below (i.e., six vertical feet below) the Project

Comments, Request for Supplemental Comment Period, Requests for Study Modifications and Request for Additional Study at 2, Project No. 1494-438 (filed Nov. 29, 2021) [hereinafter, City of Miami Comments], but it also must demonstrate the presence of one of the other two factors identified in the ILP regulations. *See* 18 C.F.R. § 5.15(d). In other words, an applicant cannot justify a proposed study modification simply by stating it has "good cause," or by pointing out an applicant's departure from the Commission-approved SPD. Both factors must be present for the City of Miami or other relicensing participant to justify a study modification.

[101] 18 C.F.R. § 5.15(e).

[102] Hydroelectric Licensing under the Federal Power Act, Order No. 2002, FERC Stats. & Regs (Regs. Preambles) ¶ 31,150, at P 140 (2003) (emphasis added).

[103] *Id.* at P 78.

[104] *See infra* §§ 4.3, 4.4 & 4.5.

boundary.[105] During significant storm events, however, reservoir elevations can arise into the "flood pool," which is designated by the Corps as the reservoir levels between 745 and 755 feet. When Grand Lake reservoir levels approach and rise into the flood pool, the Corps' Tulsa District directs water releases from Pensacola Dam, pursuant to its Water Control Manual and the accompanying Letter of Understanding and Water Control Agreement with Licensee.[106]

Thus, the Commission has historically shared responsibility with the Corps in managing water surface elevations at the Project. Pursuant to this shared management, the Commission has administered its public interest responsibilities under the FPA in the "conservation pool" below elevation 750 feet, while the Corps has managed flows during storm events involving the "flood pool" between elevations 745 and 755 feet, in accordance with its responsibilities under section 7 of the Flood Control Act of 1944.[107]

Congress has consistently made clear that the Corps has sole authority over flood control at the Project. For example, the Flood Control Act of 1944 clearly demonstrated the Corps' authority, providing that:

> it shall be the duty of the Secretary of the Army to prescribe regulations for the *use of storage allocated for flood control* or navigation *at all reservoirs constructed wholly or in part with Federal funds* provided on the basis of such purposes, and the operation of *any such project* shall be in accordance with such regulations ….[108]

The Flood Control Act of 1944 Act is unambiguous, providing that Corps regulations will apply to *any such project* at reservoirs constructed wholly or partially with federal funds. And while the Flood Control Act of 1944 is general legislation that applies to all reservoirs for which federal funds were provided, Congress has repeatedly enacted special legislation pertaining *only* to the Pensacola Project that prohibits the Commission from regulating for flood control—and, more recently, from imposing *any* license requirement related to water surface elevations.

To begin with, when the United States returned the Project to GRDA after World War II, Congress in 1946 authorized Interior to retain "all lands or interests. . . of the United States above elevation seven hundred and fifty feet mean sea level necessary or desirable for operation of the Grand River dam project at a pool elevation of seven hundred and fifty-five feet."[109] This 1946 law not only required Interior to return to GRDA all lands within the conservation pool (i.e., those below elevation 750 feet), it expressly required GRDA to convey to Interior all its "flowage rights on all lands or interests therein" *above* 750 feet.[110] In imposing land conveyance obligations upon both Interior and GRDA, and establishing elevation 750 feet as the upper limit of GRDA's landholding requirements, Congress could hardly have been more clear in limiting the Commission's role in regulating flood control at the Project.

105 *Grand River Dam Auth.*, 160 FERC ¶ 61,001, at P 4 (2017).

106 *Id.* P 3.

107 33 U.S.C. § 709.

108 Pub. L. No. 78–534, 58 Stat. 890 (1944) (codified at 33 U.S.C. § 709) (emphasis added).

109 An Act to authorize the return of the Grand River Dam project to the Grand River Dam Authority and the adjustment and settlement of accounts between the authority and the United States, and for other purposes, Pub. L. No. 79-573 § 3, 60 Stat. 743, 79 Cong. Ch. 710 (July 31, 1946).

110 *Id.*

In response to more recent controversy between GRDA and the City of Miami related to GRDA's alleged obligations to obtain title to approximately 13,000 acres of lands that are periodically subjected to flooding, Congress again stepped in and established a very clear limit on the Commission's authority to regulate the Project for flood control. As detailed above,[111] Congress in NDAA 2020 expressly removed the Commission's jurisdiction over flood control and eliminated authority for the Commission to regulate water surface elevations of the Project. In particular, Congress in NDAA 2020:

- Confirms that the Corps has "exclusive jurisdiction and responsibility for management of the flood pool for flood control operations at Grand Lake O' the Cherokees."[112]
- Prohibits the Commission or any other federal or state agency from imposing any license condition "relating to—(i) surface elevations of the conservation pool; or (ii) the flood pool (except to the extent it references flood control requirements prescribed by the Secretary)."[113]

Relatedly, Congress in NDAA 2020 removed FERC's jurisdiction over lands that are outside of the current Project boundary, providing: (1) ""The licensing jurisdiction of the Commission for the project shall not extend to any land or water outside the project boundary";[114] and (2) " Any land, water, or physical infrastructure or other improvement outside the project boundary shall not be considered to be part of the project."[115] To ensure that the Commission's jurisdiction is confined to the current Project, NDAA 2020 forbids FERC from making any change to the Project boundary without the written consent of GRDA.[116]

Because Congress has expressly removed the Commission's authority to address flood control responsibilities or to otherwise impose any license condition or other requirement "related to" surface elevations within the conservation pool, relicensing participants cannot sustain any study modification or new study request on these bases. The Commission lacks any jurisdiction or authority to address them in this proceeding, and any new or modified study would not "inform the development of license requirements."[117]

This limitation applies not only to the presence or absence of flooding, but also to the duration, frequency, timing, or amplitude of flooding. Under NDAA 2020, these issues cannot be addressed by the Commission in this relicensing process. And in fact, these issues have already been settled by the Corps in its Water Control Manual, expressly requiring "a tapered recession of flood control storage evacuation" to enhance hydropower operations at downstream federal hydropower facilities.[118] This point is amplified by the U.S. Department of Energy's Southwestern Power Administration's comments in this relicensing proceeding:

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111 *See supra* § 1.4.

112 Pub. L. No. 116-92, § 7612(c).

113 *Id.* § 7612(b)(2)(A).

114 *Id.* § 7612(b)(3)(A).

115 *Id.* § 7612(b)(3)(B).

116 *Id.* § 7612(b)(3)(C).

117 18 C.F.R. § 5.9(b)(5).

118 Water Control Manual ¶ 8-07, at p. 8-2 (1992).

> Southwestern's primary concern with the Pensacola relicensing is the operation and timing of Pensacola releases. Any proposed change in operational releases as a result of relicensing should be fully vetted with Southwestern and the other downstream Federal, State, and local agencies which may be impacted. Significant increases or decreases in releases as a result of changed operations could have negative impacts on hydropower and the other Congressionally authorized purposes at Fort Gibson and the four downstream Arkansas River Federal hydroelectric projects. . . . Any changes to the operation and timing of Pensacola releases should not create undue difficulty for Southwestern or the Corps in meeting the needs of the Congressionally authorized purposes of the downstream projects and their responsibilities under the MOU [between Southwestern and the Corps].[119]

Finally, the purpose of this relicensing proceeding is for GRDA to apply for, and the Commission to issue, a new license for the Project. The purpose of this proceeding is *not* the forum in which relicensing participants can litigate potential property damage caused by the Project—or buttress existing litigation claims against GRDA in ongoing litigation.[120] Rather, section 10(c) of the FPA provides that licensees are liable under state law for any damages that may be caused by project operation.[121] At this very Project, the Commission has concluded that while Congress certainly intended for the Commission to ensure that hydroelectric projects are operated and maintained in a safe manner, it specifically enacted section 10(c) of the FPA to preserve existing state laws governing the damage liability of licensees.[122]

4.2.2 Only Reasonable Project Alternatives Should Be Studied in the Relicensing Effort

The Commission's regulations implementing the ILP provide that "the purpose of an approved study plan is to develop a record that allows for the adequate evaluation of *reasonable alternatives* to mitigate ongoing impacts to resources from project operations."[123] This approach is consistent with the Council on Environmental Quality's (CEQ) regulations implementing the NEPA. Under NEPA, the range of alternatives that must be analyzed and discussed "is a matter within the Commission's discretion."[124] In response to stakeholder comments in licensing proceedings, the Commission has repeatedly found that NEPA—consistent with the Commission's own regulations—only requires the consideration of "reasonable alternatives."[125] Importantly, the Commission has also consistently found that its regulations do not require an applicant to propose

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[119] Letter from Ashley Corker, Southwestern Power Administration, to Kimberly D. Bose, Federal Energy Regulatory Commission at 1, Project No. 1494-438 (filed Nov. 30, 2021).

[120] The City of Miami affirmatively states its intentions to commandeer this relicensing process to advance its position in live, pending state court litigation. *See* City's ISR Comments at 3 ("This analysis is particularly important in this case, as unlike almost every other hydroelectric project the Commission regulates, GRDA has already been found liable in state court for upstream flooding regularly caused or exacerbated by the Pensacola Dam."). The Commission should reject the City of Miami's attempt to abuse the ILP in this manner.

[121] *See* 16 U.S.C. § 803(c).

[122] *See Grand River Dam Auth.*, 160 FERC ¶ 61,001, at P 57 (2017) (citing *Pac. Gas & Elec. Co.*, 115 FERC ¶ 61,320 (2006) and *S.C. Pub. Serv. Auth. v. FERC*, 850 F.2d 788 (1988)).

[123] Hydroelectric Licensing under the Federal Power Act, Order No. 2002, FERC Stats. & Regs (Regs. Preambles) ¶ 31,150, at P 78 (2003).

[124] *See, e.g., Vermont Yankee Nuclear Power Corp. v. NRDC*, 435 U.S. 519, 551–52 (1976).

[125] *See, e.g., Swan Lake North Hydro LLC*, 167 FERC ¶ 62,077, at P 137 (2019).

measures for resolving every adverse project effect.[126]

For these reasons, the Commission should not require addition or modified studies to address effects associated with Project water surface elevations that are well beyond GRDA's operational plans under the new license, as explained in Section 1.6.2 above. As explained above, the Commission has no authority to impose license conditions related to surface elevations of Grand Lake.[127] In light of this limitation, GRDA's plans for operating water surface elevations—and not a theoretical operating regime that may be proposed by a relicensing participant or Commission staff—establish the reasonable alternatives in this proceeding. And as discussed above, GRDA plans for a normal operating range of the Project to be maintained between 742 and 745 feet PD.[128]

4.2.3 All Studies Must Have an Established Nexus to the Licensed Project and Inform License Conditions

The preamble to the Commission's regulations promulgating the ILP discusses the seven criteria that staff is to consider when reviewing study requests during relicensing, including the goals and objectives of the study and information to be obtained, the relevant resource management goals of the resource agencies or tribes with jurisdiction over the resource to be studied, and any relevant public interest considerations.[129] The Commission has noted, however, that it places particular emphasis on the criteria requiring that any party requesting a study "explain any nexus between project operations and effects … on the resource to be studied."[130] The Commission provided that such a nexus with project operations and effects "is a threshold requirement that must be demonstrated in every case… [o]therwise, the door would be open to study requests having nothing to do with project impacts."[131]

However, a nexus between project operations and resource impacts alone is not sufficient for the Commission to require a proposed study. Rather, in discussing the seven criteria, the Commission provided that "the criteria are to be considered as a whole, in light of the circumstances of the individual proceeding."[132]

The Commission has found that, in its determination as to appropriate relicensing studies, the "substantial evidence/arbitrary and capricious" standard applies, such that "the findings of the Commission as to the facts, if supported by substantial evidence, shall be conclusive."[133] The Commission has found that, while relicensing participants are free to suggest other studies or methodologies they view as "better" than that relied on by the Commission, "the proper inquiry is whether the methodology relied on was valid and whether the decision was supported by

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126 *See, e.g.,* Study Plan Determination for Turners Falls Project and Northfield Mountain Pumped Storage Project, FERC Nos. 1889-085 and 2485-071 at Appendix C, p. 4 (Jan. 22, 2019).

127 *See supra* §§ 1.4, 4.2.1.

128 *See supra* § 1.6.2.

129 104 FERC ¶ 61,109 at p. 16.

130 *Id.*

131 *Id* at p. 18.

132 *Alabama Power Co.*, 141 FERC ¶ 61,127, at P 99 (2012).

133 *See Upper Peninsula Power Co.*, 83 FERC ¶ 61,071, at p. 61,365-66 (1998).

substantial evidence."[134] The Commission applies the same "substantial evidence" standard in its decisions on whether to require license applicants to perform *additional* studies prior to Commission action on a license application. For example, in *Department of Interior v. FERC*, which involved multiple license applications to install hydropower facilities in the Upper Ohio River Basin, resource agencies requested additional fish entrainment studies prior to issuing their recommendations under section 10(j) of the FPA.[135] In that case, the Commission rejected the study requests, finding that the existing record provided sufficient information for the resource agencies to proceed, stating that:

> The state agencies contend that FERC violated the statute… in refusing to conduct studies that the agencies thought vital to the Section 10(j) recommendation process. Nothing in the statute requires FERC to [require its applicants] to conduct the studies that the fish and wildlife agencies deem necessary to the Section 10(j) process.[136]

Moreover, the D.C. Circuit has found that mere speculation of a problem is not enough to require a study.[137] Thus, the Commission is free to reject any proposed studies that lack a nexus to project effects or that are not supported by substantial evidence.

Here, these principles bear on several proposals by relicensing participants to modify the H&H Modeling Study. These requests should be rejected. Not only do these proposed modifications lack any nexus to the Project, as the Commission lacks jurisdiction and authority to address flood control, but GRDA's studies have demonstrated that flooding is attributable to natural causes—and not GRDA's reservoir operations.

4.2.4 All Studies Should Adhere to the Commission's Well-Established Environmental Baseline Policy

It is well-established that, in relicensing proceedings, the Commission uses existing environmental conditions—continued Project operation under existing license conditions—as a baseline against which to evaluate the environmental impacts of GRDA's proposal.[138] In other relicensing proceedings, the Commission has determined that it is not required "either to pretend that current projects do not exist, or to require applicants to gather information to recreate a 50-year-old environmental base upon which to make present day development decisions."[139] Rather, it has stated that "[w]e do not agree that, in order to assess whether relicensing is in the public interest, we must first examine what environmental conditions existed before a hydroelectric project was built."[140]

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[134] *Id.*

[135] *Dep't. of the Interior v. FERC*, 952 F.2d 538, 544 (D.C. Cir. 1992).

[136] *Id.*

[137] *See City of Centralia v. FERC*, 213 F.3d 742, 749 (D.C. Cir. 2000) ("That fish *could* be attracted to the flow is not evidence of a problem that warrants a study. Indeed, FERC's only evidence that fish are harmed is that someone saw a single jumping fish that hit a concrete barrier and may have been hurt…This is not *evidence* enough to support the disputed conclusion in this case.").

[138] *See, e.g., Eugene Water & Elec. Bd.*, 81 FERC ¶ 61,270, at p. 62,326–27 (1997).

[139] *City of Tacoma,* 71 FERC ¶ 61,381, at p. 62,491 (1995).

[140] *Id.*

The Commission has explicitly rejected the argument that it must consider pre-project environmental conditions to fulfill its statutory obligations under the FPA. In response to this argument in other relicensing proceedings, the Commission found that the FPA does not require that "all past damage to fish and wildlife caused by a project must be 'mitigated' in a relicense proceeding."[141] The Commission went on to state that, in considering mitigation measures put forth by resource agencies, it would consider "whether enhancement of fish and wildlife resources, which may constitute a reduction of the negative impacts attributable to a project since its construction, would be appropriate."[142] Importantly, the Commission has found that use of existing conditions as an environmental baseline does not prohibit it from considering information on resources that may be affected by a project, where appropriate.[143]

The U.S. Courts of Appeal have agreed with this approach, finding that the "no action" alternative in a FERC relicensing context is the existing dam operations, as opposed to conditions that existed prior to the dam.[144] The 9th Circuit, in *American Rivers v. FERC*, found that the use of existing environmental conditions as a baseline is consistent with "the substantive and procedural requirements of both the FPA and NEPA."[145] The D.C. Circuit affirmed the use of existing environmental conditions, and held that use of an existing condition baseline was a reasonable construction of the FPA's requirements for protection of fish and wildlife.[146]

In this proceeding, several relicensing participants have attempted to justify their proposed study modifications by arguing that the Commission should consider pre-project conditions. The Commission should deny these requests based on its long-standing policy and judicial precedent.

4.2.5 All Studies Should Adhere to the Commission's Well-Established Policies on Addressing Climate Change

FERC precedent uniformly maintains that climate change studies are not needed in hydropower licensing proceedings. FERC has acknowledged that climate change is a complex issue, but under NEPA and CEQ regulations, it is afforded discretion based on its expertise and experience, to determine the scope of an environmental analysis based on available information.[147]

FERC has explained that climate change models would not allow it "to predict matters such as water supply or flow within a given basin during the 30 to 50-year term of a typical hydropower license in such a manner to assist the Commission in analyzing alternatives and determining appropriate mitigation for environmental impacts."[148] In addition, FERC in *Alaska Energy Authority* determined that climate change studies are not likely to yield reliable data that can be used to

141 *Id.* at p. 62,492.

142 *Id.*

143 *Id.*

144 *Conservation Law Found. v. FERC,* 216 F.3d 41 (D.C. Cir. 2000); *Am. Rivers v. FERC*, 201 F.3d 1186 (9th Cir. 2000).

145 201 F.3d 1186, 1195-96.

146 *Conservation Law Found.*, 216 F.3d at 46-47.

147 *See Eagle Crest Energy Co.*, 153 FERC ¶ 61,058, at P 39 (2015).

148 *See Id.*, *see also Ala. Power Co.*, 155 FERC ¶ 61,080, P 29 (2016) ("attempting to predict future flow scenarios that may occur due to climate change or other conditions would be too speculative given the state of the science at this time").

develop license requirements.[149] FERC has found that conventional hydrological studies, monitoring techniques and predictive models can be used to effectively study and evaluate the effects of projects on environmental resources.[150]

FERC has long articulated that the Commission is unaware of any study that would be able to capture with enough granularity the effects of climate change on a particular hydropower project. Given the limitations on study, it would simply not be reasonable for GRDA to undertake potentially costly studies that would not be reliable, and thus not useful in informing the public of the potential impacts of the Project and assisting FERC in fulfilling its mandate under NEPA.

While this issue of climate change studies was raised earlier in this relicensing process,[151] relicensing participants continue to raise it in their requests for study plan modifications at this ISR stage. Such requests overlook that the Commission's approach to climate change investigations has remained unchanged since its November 2018 SPD—rejecting a climate study proposed by a federal resource agency as recently as last month.[152]

In another recent relicensing proceeding, the Commission explained:

> [T]he baseline for our analysis is current environmental conditions, not a projected or modeled future condition. Therefore, the requested climate change study to predict uncertain, future climate and associated hydrologic conditions would not inform the development of license requirements [18 C.F.R. § 5.9(b)(5)] and staff does not recommend that [the license applicant] be required to conduct the requested climate change study.[153]

These same principles apply in this case. Although several relicensing participants have requested modified studies for purposes of addressing climate change, Commission policy and precedent maintain that all such requests should be denied. Because climate studies would not "assist the Commission in analyzing alternatives and determining appropriate mitigation for environmental impacts,"[154] FERC should reject these requests for modification.

4.2.6 Appropriate Protection, Mitigation, and Enhancement Measures Will Be Proposed in GRDA's License Application

Several relicensing participants submitted requests in their ISR comments related to proposed protection, mitigation and enhancement (PM&E) measures for the Project. Per the ILP, assessing the need for and adequacy of any such measures now is premature. As such, GRDA is not

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149 *See Alaska Energy Authority*, 144 FERC ¶ 61,040, at P 8 (2013).

150 *Id.* P 9.

151 *See*, *e.g.*, Comments of the City of Miami, Oklahoma on GRDA's Proposed Study Plan at 9-10, Project No. 1494-438 (filed July 26, 2018); City of Miami's Request for Socioeconomic Information at 9, Project No. 1494-438 (filed Aug. 28, 2020).

152 *See*, *e.g.*, Response to Additional Study Request at A-3 to A-5, Project Nos. 2179-043 *et al.* (issued Nov. 3, 2021) (denying a requested study to assess the potential effects of climate change on project operation and anadromous fish habitat in projected-affected waters).

153 Determination on Requests for Study Modifications and New Studies for the Cutler Hydroelectric Project, P-2420-054 at B-6 (June 11, 2021) (denying a study request because "Our environmental effects analysis will address how the proposed relicensing action could affect, among other things, water resources.).

154 *Eagle Crest Energy Co.*, 153 FERC ¶ 61,058, at P 81 (2015).

proposing to incorporate into its ongoing studies or otherwise address PM&E measures at this point in the relicensing process.

Together, the ISR and USR will develop information sufficient for identifying, as part of the Environmental Exhibit (Exhibit E) in the Draft License Application/Final License Application, the existing environment and evaluating any potential impacts of continued Project operations. Once the studies are complete and GRDA conducts the environmental effects analysis, GRDA's license application will propose appropriate PM&E measures, as appropriate. Relicensing participants will have opportunities in the process to propose PM&E measures as well.

4.2.7 The Commission Is Not Required to Conduct Studies to Analyze Cumulative Effects

As currently proposed by CEQ,[155] "cumulative effects" are "effects on the environment that result from the incremental effects of the action when added to the effects of other past, present, and reasonably foreseeable actions . . . ."[156] The U.S. Supreme Court has determined that the "determination of the extent and effect of [cumulative impacts], and particularly identification of the geographic area within which they may occur, is a task assigned to the special competency of the appropriate agencies."[157] CEQ, in turn, has found that "it is not practical to analyze the cumulative effects of an action on the universe; the list of environmental effects must focus on those that are truly meaningful,"[158] and that an agency's analysis of cumulative impacts must only include "such information as appears to be reasonably necessary under the circumstances for evaluation of the project rather than to be so all-encompassing in scope that the task of preparing it would become either fruitless or well-nigh impossible."[159]

Inherent in both NEPA and CEQ's implementing regulations is a rule of reason that agencies should be afforded appropriate discretion, based on their experience and expertise, to determine whether and to what extent to consider environmental impacts of a proposed project based on the availability of information, the usefulness of that information to the decision-making process, and the extent of the anticipated environmental consequences.[160] And in this regard, FERC's long-standing practice is to not require applicants to conduct studies on issues that are limited to cumulative effects.[161] Because several relicensing participants seek to support their requests for modified studies on the basis of "cumulative effects," the Commission should deny these modifications.

4.2.8 The Commission is Not Required to Quantify Socioeconomic Impacts Specific to the City of Miami

In its comments on the ISR, the City of Miami repeatedly asserted that the Commission should direct GRDA to study and quantify socioeconomic effects—not just within the four-county study

[155] *See* National Environmental Policy Act Implementing Regulations Revisions, 86 Fed. Reg. 192, 55757 (Oct. 7, 2021).

[156] *Id.* at 55,769 (CEQ's proposed revision to 40 C.F.R. § 1508.1(g)(3)).

[157] *Kleppe v. Sierra Club*, 476 U.S. 390, 414 (1976).

[158] *See* CEQ, *Considering Cumulative Effects Under the National Environmental Policy Act*, at 8 (Jan. 1997).

[159] *Nat. Resources Def. Council, Inc. v. Callaway*, 524 F.2d 79, 88 (2d Cir. 1975).

[160] *See, e.g., Eagle Crest Energy Co.*, 153 FERC ¶ 61,058, at P 81 (2015).

[161] *See, e.g., Pub. Serv. Co. of N.H.*, 68 FERC ¶ 61,177, at p. 61,865 (1994).

area approved by the Commission in its SPD—but with specific focus on the City of Miami. The City of Miami, for example, requested that GRDA be required to collect information on "a range of socioeconomic values, including direct economic impacts of the Project; Project effects on local government finances; and social and societal impacts of the Project."[162]

The Commission's regulations require that applicants provide a description of the affected environment and an analysis of the project proposal on socioeconomic resources.[163] Specifically, section 5.6(d)(3)(xi) of the regulations requires applicants to provide a general description of socioeconomic conditions in the vicinity of the Project, including general land use patterns, population patterns, and sources of employment in the Project vicinity.[164] The regulations also require that the final license application contain an analysis of how the Project proposal would affect these conditions.[165] The Commission does not, however, typically quantify non-power benefits such as recreation and aesthetics in economic terms.[166] In other study plan determinations, Commission staff has rejected requested studies on, for example, "future land acquisition on the county's tax base and services,"[167] as well as "the economic value of environmental, recreation, or cultural resources."[168] Rather, the Commission has provided that its regulations *already* require license applicants "to provide an economic analysis of the cost of constructing, operating, and maintaining the project and an estimate of the cost of each proposed or recommended protection, mitigation, and enhancement measure. . . ."[169]

For these reasons, the Commission should not accept the proposed study modifications related to the Socioeconomic Study. In fact, the Commission rejected these proposals earlier in this ILP at the study plan development phase. In response to requests for studies that quantify socioeconomic effects to the level of detail requested by the City of Miami, FERC found that "the range of economic and social indicators that could be influenced by the project's presence and continued operation is too diverse to be reliably captured in a quantitative model."[170] Moreover, "collecting new data to study these factors in a meaningful way would not be cost-effective when existing descriptive data for many indicators exists. Therefore, GRDA's proposal to use existing information to conduct a broad, qualitative assessment of socioeconomic resources affected by the project is appropriate."[171]

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[162] City of Miami's Comments at 14.

[163] 18 C.F.R. § 5.18(b)(5)(ii).

[164] *Id.* § 5.6(d)(3)(xi).

[165] *Id.* § 5.18(b)(5)(ii)(B).

[166] *See* Study Plan Determination for Rio, Mongaup Falls, and Swinging Bridge Hydroelectric Projects at B-56, Project Nos. 9690 *et al.* (issued Feb. 9, 2018).

[167] *See* Study Plan Determination for Skagit River Hydroelectric Project at B-81, Project No. 553 (issued Jul. 16, 2021).

[168] *See* Study Plan Determination for Potter Valley Project at B-43, Project No. 77 (issued Mar. 16, 2021).

[169] *See* Study Plan Determination for County Line Road Project at B-45, Project No. 14513 (issued Mar. 2, 2016) (citing 18 C.F.R. § 5.18(b)(5)(ii)(E)).

[170] SPD at B-30–31.

[171] *Id.* at B-31.

4.3 Response to Requests for Modifications to Existing Studies

4.3.1 H&H Modeling Study

4.3.1.1 Analysis of RiverWare Data

The City of Miami requests that GRDA "analyze the RiverWare data and provide a comparison to actual gage flow data, where available."[172]

GRDA does not support this proposed modification to the study plan. In its comments, the City of Miami did not demonstrate that the FERC-approved H&H Modeling Study was not conducted as provided for in the Commission's SPD or that the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way.[173]

In addition, GRDA validated its model results against the RiverWare model output in accordance with the FERC-approved study plan. In its original PSP, GRDA did not propose to include the RiverWare model, but in its comments on the PSP, the City requested that the RiverWare model be incorporated into the H&H Modeling Study. In its SPD, Commission staff recommended validation against the RiverWare output.[174] Thus, GRDA has accomplished what both FERC and the City of Miami have requested with respect to the RiverWare model.

Additional information regarding the City of Miami's request appears in Section 4.5.1 below (Comments 17-19).

4.3.1.2 Use of Actual Gage Flow Data

The City of Miami requests that "[w]here actual gage flow data are available, GRDA should be required to use that data, rather than or in addition to RiverWare modeling outputs, as its basis for validating the Operations Model results."[175]

GRDA does not support this proposed modification to the study plan. In its comments, the City of Miami did not demonstrate that the FERC-approved H&H Modeling Study was not conducted as provided for in the Commission's SPD or that the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way.[176]

As explained in section 4.3.1.1 above, GRDA validated its model results against the RiverWare model output in accordance with the FERC-approved study plan.

4.3.1.3 Operational Outputs

The City of Miami requests that "GRDA should be required to describe how and why the operational outputs from the Operations Model differ from actual operations, particularly with

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[172] City of Miami's Comments at 10.

[173] *See supra* section 4.1; *see also* 18 C.F.R. § 5.15(d).

[174] *See* SPD at B-5.

[175] City of Miami's Comments at 10.

[176] *See supra* section 4.1; *see also* 18 C.F.R. § 5.15(d).

respect to modeled minimum versus actual discharges."[177]

GRDA does not support this proposed modification to the study plan. In its comments, the City of Miami did not demonstrate that the FERC-approved H&H Modeling Study was not conducted as provided for in the Commission's SPD or that the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way.[178]

Additionally, operational outputs differ from real-world operations because real-world operations during flooding are at the Corps' discretion. The Corps explains its discretion for release decisions as follows:

> Under Section 7 of the Flood Control Act of 1944 (CFR, 1944), the USACE has the responsibility to prescribe releases from Pensacola Dam and Kerr Dam under active or anticipated flood conditions (CFR, 1945). The USACE may exercise direct control over the facilities or provide instructions to GRDA to manage releases for the purpose of basin-wide flood mitigation.[179]

Additionally, as discussed in Sections 1.4 and 4.2.1 above, Congress has spoken definitively on this matter by directing in NDAA 2020 that operations during flood conditions are the exclusive responsibility of the Corps. Therefore, the study modification sought by the City of Miami bears no nexus to the Project and would not inform the development of license conditions.[180]

4.3.1.4 Operational Decisions During Flood Events

The City of Miami requests that "GRDA should be required to explain how and why it and/or the Corps make operational decisions during the course of flood events."[181]

GRDA does not support this proposed modification to the study plan. In its comments, the City of Miami did not demonstrate that the FERC-approved H&H Modeling Study was not conducted as provided for in the Commission's SPD or that the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way.[182]

Additionally, as discussed in Sections 1.4 and 4.2.1 above, Congress has spoken definitively on this matter by directing in NDAA 2020 that operations during flood conditions are the exclusive responsibility of the Corps. Therefore, the study modification sought by the City of Miami bears no nexus to the Project and would not inform the development of license conditions.[183]

4.3.1.5 Development of Operational Scenarios

The City of Miami requests that "GRDA should be required to explain how and why it developed the operational scenarios it selected, including the computation of boundary conditions and

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[177] *Id*.

[178] *Id*.

[179] *See* Operations Model Report at § 2.

[180] *See* 18 C.F.R. § 5.9(b)(5).

[181] City of Miami's Comments at 11.

[182] *See supra* section 4.1; *see also* 18 C.F.R. § 5.15(d).

[183] *See* 18 C.F.R. § 5.9(b)(5).

results, and provide detailed results of the developed scenarios including the water-surface elevations, gate openings during floods, dam outflows, and comparisons with the rule curves."[184]

GRDA does not support this proposed modification to the study plan. In its comments, the City of Miami did not demonstrate that the FERC-approved H&H Modeling Study was not conducted as provided for in the Commission's SPD or that the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way.[185]

As explained in Section 1.6.2 above, GRDA plans to operate the Project within the range of elevations 742 and 745 feet PD. GRDA selected and developed the operational scenarios based on combinations of different historical inflow events and different initial reservoir elevations within this anticipated operating range, as well as outside of the proposed operating range, in accordance with the approved FERC study plan and as explained in the ISR and presented at the ISR meeting.

FERC required GRDA to validate its model results against the RiverWare model output. Therefore, model elements such as boundary conditions, computed outflows, and rule curves were modeled for consistency with the existing period-of-record RiverWare model. Elements such as gate openings are not specifically included in the RiverWare model. Data provided by the Corps documenting the RiverWare model setup, inputs, and results did not include gate openings, number of gates, or individual gate capacities, but rather treat the total spillway discharge capacity and operating restrictions as total, combined rating curves. Therefore, modeling of specific gate openings by GRDA was not necessary or possible.

4.3.1.6 Sensitivity Analysis

The City of Miami requests that "GRDA should be required to perform a sensitivity analysis of the Operations Model by updating it with the 2019 stage-storage curves and evaluating the impacts on reservoir elevation and lake storage. If the updated stage-storage information causes more than a negligible difference in reservoir surface, GRDA should be required to re-run all modeling scenarios with outputs from the updated Operations Model as inputs to the CHM runs."[186]

The H&H Modeling Study currently uses the elevation-storage ratings from the RiverWare model because the City of Miami requested that the RiverWare model be incorporated into the H&H Modeling Study and Commission staff accepted the City of Miami's request by requiring GRDA to validate the model against the RiverWare output.[187] To facilitate the validation step, which was part of the ISR, GRDA needed to use as much of the same input data as possible from the RiverWare model. Now that model validation has been demonstrated, some of the model inputs for which more recent data is available, including the elevation-storage data, can be updated to improve the model for the USR.

Therefore, as noted in Section 3.1 above, GRDA plans to include the 2019 elevation-storage data in the next version of the model used to prepare the USR. If Operations Model simulations are updated as part of the USR development, the updated simulation results will be used to review

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[184] City of Miami's Comments at 11.

[185] *See supra* section 4.1; *see also* 18 C.F.R. § 5.15(d).

[186] City of Miami's Comments at 11.

[187] *See* SPD at B-5.

the CHM results and the CHM simulations will be re-run if needed.

4.3.1.7 Upstream Hydraulic Model Results

The City of Miami requests that "[t]o the extent that the UHM results depend on Operations Model outputs assuming outdated stage-storage curves, those results should be updated. Any studies that depend on UHM results, including the sedimentation and infrastructure studies and the requested Contaminated Sediment Transport Study, should also be revised as needed in light of updated UHM model results."[188]

As noted in Sections 3.1 and 4.3.1.6 above, GRDA will update the other studies as needed. To be clear, GRDA will update other studies only if changes to the H&H Modeling Study result in the conclusions of the H&H Modeling Study that GRDA relied upon in other studies.

4.3.1.8 Analysis of Existing and Historical Data

The City of Miami requests that "GRDA should be required to analyze all existing information and historical data to identify statistical trends (including, but not limited to, those due to climate change) that may indicate that future conditions will diverge from historical norms. GRDA should then refine the H&H study to account for any such trends."[189]

GRDA does not support this proposed modification to the study plan. In its comments, the City of Miami did not demonstrate that the FERC-approved H&H Modeling Study was not conducted as provided for in the Commission's SPD or that the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way.[190]

In addition, the City of Miami's request to require GRDA to analyze "historical data" seems to run afoul of the Commission's environmental baseline policy, as discussed in Section 4.2.4 above. Its request to require an analysis on "statistical trends" including due to climate change is inconsistent with well-established Commission precedent, as explained in Section 4.2.5 above.

4.3.1.9 Development of Flood Hydrographs

The City of Miami requests that GRDA "be required to develop realistic flood hydrographs as inputs for the 100-year inflow simulation."[191] Specifically, it requested that GRDA:

> a. Perform flood-frequency analysis at each of the Neosho (Commerce) Gage, Spring and Elk Rivers, and Tar Creek gages; and
>
> b. Perform hydrologic modeling using the HEC-HMS software to develop flood hydrographs at each of the inflow locations that have physically based rationale for predicting the peak flow and volume.[192]

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[188] City of Miami's Comments at 11.

[189] *Id.*

[190] *See supra* section 4.1; *see also* 18 C.F.R. § 5.15(d).

[191] City of Miami's Comments at 11.

[192] *Id.*

GRDA does not support this proposed modification to the study plan. In its comments, the City of Miami did not demonstrate that the FERC-approved H&H Modeling Study was not conducted as provided for in the Commission's SPD or that the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way.[193] Neither a gage-specific flood frequency analysis nor a HEC-HMS model were required in FERC's SPD.

In further support for the Commission's rejection of this proposed study modification, after receipt of the City of Miami's ISR comments GRDA simulated the inflow hydrographs from the FEMA 2019 study, as noted in Sections 3.1 above and 4.5.1 (Comment 21) below. The results of this analysis appear in Appendix B. Despite the methodological flaws in the 2019 FEMA study, the results are very similar to the 100-year event simulation results in the ISR: a starting reservoir elevation difference of 23 feet resulted in no appreciable difference in maximum water surface elevation at the City of Miami.

4.3.1.10 Updated CHM to Reflect Geometry of Railway Bridge

The City of Miami requests that "GRDA should be required to update the CHM to reflect the actual geometry of the abandoned railway bridge at river mile 134.599."[194]

GRDA does not support this proposed modification to the study plan. In its comments, the City of Miami did not demonstrate that the FERC-approved H&H Modeling Study was not conducted as provided for in the Commission's SPD or that the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way.[195]

The high chord of the bridge was modeled according to best practices; it was defined at the elevation where flow is partially or fully blocked by the bridge structure. During a flood event, the gaps between trusses would likely become clogged with debris.

In further support for the Commission's rejection of this proposed study modification, after receipt of the City of Miami's ISR comments GRDA performed a sensitivity analysis to determine the impact of the abandoned railway bridge high chord on upstream water surface elevations, as noted in Sections 3.1 above and 4.5.1 (Comment 23) below. The results of this sensitivity analysis appear in Appendix C. This analysis demonstrates that of all the historical inflow events used in the simulation scenarios (see Section 7 of the UHM Report), only the July 2007 event exceeded the high chord of the bridge in the Neosho river channel. The results show that removing the trusses from the high chord of the bridge resulted in no appreciable difference in maximum water surface elevation upstream of the bridge.

4.3.1.11 Consistent River Mile Numbering

The City of Miami requests that "GRDA should be required to use consistent river mile numbering across studies."[196]

GRDA does not support this proposed modification to the study plan. In its comments, the City of

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[193] *See supra* section 4.1; *see also* 18 C.F.R. § 5.15(d).

[194] City of Miami's Comments at 11.

[195] *See supra* section 4.1; *see also* 18 C.F.R. § 5.15(d).

[196] City of Miami's Comments at 11.

Miami did not demonstrate that the FERC-approved H&H Modeling Study was not conducted as provided for in the Commission's SPD or that the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way.[197]

FERC's approved study plan does not specify any specific convention for using consistent river miles across studies. Regardless, GRDA used consistent river mile numbering across its studies. The H&H Modeling Study, Infrastructure Study, and Sedimentation Study all use U.S. Geological Survey (USGS) river miles.

4.3.1.12 Project's Impacts on Flooding

The City of Miami requests that FERC should require GRDA "to provide an analysis of the Project's impacts on the frequency, timing, amplitude, and duration of flooding."[198]

GRDA does not support this proposed modification to the study plan. In its comments, the City of Miami did not demonstrate that the FERC-approved H&H Modeling Study was not conducted as provided for in the Commission's SPD or that the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way.[199]

In fact, in accordance with section 2.6.9 of the Hydrologic and Hydraulic Modeling Study Revised Study Plan and the section titled *Model Validation and Information Sharing of the Study Plan Determination*, GRDA has made the CHM model available to relicensing participants. The City of Miami obtained the CHM from GRDA months ago. Further information regarding the magnitude, duration, and frequency inundation is included in the model output files and is available to relicensing participants.

Moreover, as discussed in Sections 1.4 and 4.2.1 above, Congress has spoken definitively on this matter by directing in NDAA 2020 that operations during flood conditions are the exclusive responsibility of the Corps. Issues related to frequency, timing, amplitude, and duration of flooding are all within the exclusive direction of the Corps. In fact, the City's reference to an "'unofficial Corps policy' to allow GRDA under some flood conditions to stop spilling water and 'generate down' the reservoir level" is misplaced.[200] Contrary to the City of Miami's allegations, this operating direction is codified expressly in the Corps' Water Control Manual,[201] as noted in Sections 1.6.1 and 4.2.1 above. For these reasons, the study modification sought by the City of Miami bears no nexus to the Project and would not inform the development of license conditions.[202]

Finally, GRDA simulated events with estimated return periods ranging from 1 year to 100 years, in accordance with FERC's SPD. With respect to timing and duration of flooding, FERC has requested that GRDA report the duration of inundation. GRDA will include additional tables that report duration of inundation in the USR. With respect to amplitude (the maximum water surface

[197] *See supra* section 4.1; *see also* 18 C.F.R. § 5.15(d).

[198] City of Miami's Comments at 11.

[199] *See supra* section 4.1; *see also* 18 C.F.R. § 5.15(d).

[200] City of Miami's Comments at 5.

[201] *See* Water Control Manual ¶ 8-07, at p. 8-2 (1992).

[202] *See* 18 C.F.R. § 5.9(b)(5).

elevation), GRDA reported this result in the ISR.[203]

4.3.1.13 Assumptions Regarding Trends in Flooding Due to Climate Change

The City of Miami requests that FERC require GRDA "to state its assumptions regarding trends in flood frequency and severity, including those trends due to climate change, and provide evidence and analysis supporting these assumptions."[204]

GRDA does not support this proposed modification to the study plan. In its comments, the City of Miami did not demonstrate that the FERC-approved H&H Modeling Study was not conducted as provided for in the Commission's SPD or that the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way.[205] Moreover, its request to require an analysis of trends due to climate change is inconsistent with well-established Commission precedent, as explained in Section 4.2.5 above.

4.3.1.14 Quantification of Flooding Area

The City of Miami requests that "GRDA should be required to quantify the land area in which flooding exceeds Project-related property rights for each modeled scenario and, in order to inform the cumulative impacts analysis (including cumulative sedimentation in tributaries caused by the Project and its operations), demonstrate the extent to which that area exceeds the area that would have flooded had the dam not been built."[206]

GRDA does not support this proposed modification to the study plan. In its comments, the City of Miami did not demonstrate that the FERC-approved H&H Modeling Study was not conducted as provided for in the Commission's SPD or that the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way.[207]

Moreover, the City of Miami's proposed modification bears no nexus to the Project and would not inform the development of license conditions.[208] Most importantly, NDAA 2020 forbids the Commission from exercising jurisdiction or authority over any lands that are currently beyond the Project boundary, as explained in Sections 1.4 and 4.2.1 above. Moreover, well-established Commission policy sets existing conditions—not pre-project conditions—as the environmental baseline, as noted in Section 4.2.4 above. Next, as explained in Section 4.2.7 above, FERC does not require applicants to conduct studies to investigate cumulative impacts, as the City of Miami's proposed modification seeks to require. And finally, as a factual matter, the H&H Modeling Study demonstrates that flooding beyond the Project boundary is attributable to variations in the natural topography in the upstream watershed that are completely independent of GRDA's Project operations. And in this regard, the City of Miami is correct that GRDA bears no responsibility for natural flooding.[209] Accordingly, GRDA should not be required to undertake the modification

[203] *See* ISR at Appendix 2.

[204] City of Miami's Comments at 12.

[205] *See supra* section 4.1; *see also* 18 C.F.R. § 5.15(d).

[206] City of Miami's Comments at 12.

[207] *See supra* section 4.1; *see also* 18 C.F.R. § 5.15(d).

[208] *See* 18 C.F.R. § 5.9(b)(5).

[209] City of Miami's Comments at 9.

proposed by the City of Miami.

4.3.1.15 Revision of Studies Dependent on H&H Modeling Study

The City of Miami requests that "[t]o the extent that the infrastructure, socioeconomic, and sedimentation studies depend on the H&H Study conclusions or model outputs, GRDA should be required to revise those studies once it has rectified the shortcomings of the H&H Study identified above. Further, rather than stating unsubstantiated conclusions without reference to any of the other studies that rely on the H&H Study, GRDA should provide the model results in a format that can productively inform analyses of Project effects on infrastructure, socioeconomics, and sedimentation."[210]

GRDA does not support this proposed modification to the study plan. In its comments, the City of Miami did not demonstrate that the FERC-approved H&H Modeling Study was not conducted as provided for in the Commission's SPD or that the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way.[211]

Moreover, GRDA does not agree with the City of Miami's assertion that the conclusions of the H&H Modeling Study are "unsubstantiated."[212] Although the City of Miami may not agree with the conclusions of the H&H Modeling Study that flooding in the vicinity of Miami is caused by natural events and not Project operations, it cannot legitimately claim that these conclusions lack substantiation. The H&H Modeling Study has been conducted using industry-standard methods, is built on the work of the City of Miami's own consultants, Tetra Tech, and the City of Miami's own ISR comments raise no serious flaws in the H&H Modeling Study results at all.

Regardless, as noted in Sections 3.1, 4.3.1.6 and 4.3.1.7 above, should conclusions of the H&H Modeling Study change during the second study season, GRDA will update the other studies as needed.

4.3.2 Sedimentation Study

4.3.2.1 Cumulative Impacts of Sedimentation Resulting from Project Operations on Flooding

The City of Miami requests that "GRDA should be required to fully analyze the cumulative impacts of sedimentation resulting from Project operations on upstream flooding."[213]

GRDA does not support this proposed modification to the study plan. In its comments, the City of Miami did not demonstrate that the FERC-approved Sedimentation Study was not conducted as provided for in the Commission's SPD or that the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way.[214]

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[210] City of Miami's Comments at 13.

[211] *See supra* section 4.1; *see also* 18 C.F.R. § 5.15(d).

[212] City of Miami's Comments at 13.

[213] *Id.*

[214] *See supra* section 4.1; *see also* 18 C.F.R. § 5.15(d).

Additionally, and as discussed above in section 4.2.7, FERC's long-standing practice is to not require applicants to conduct studies on issues that are limited to cumulative effects.

4.3.2.2 Starting Reservoir Elevations

The City of Miami requests that "GRDA should be required to examine the sedimentation impacts and resultant flooding impacts associated with a wider range of starting reservoir elevations."[215]

GRDA does not support this proposed modification to the study plan. In its comments, the City of Miami did not demonstrate that the FERC-approved Sedimentation Study was not conducted as provided for in the Commission's SPD or that the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way.[216]

FERC's SPD did not require GRDA to examine sedimentation impacts associated with a wider range of starting elevations other than the Project's current operation and alternative operating scenarios proposed during this relicensing process. As discussed in section 1.6.2 above, GRDA anticipates an operating range of the Project between 742 feet PD and 745 feet PD.

Regarding initial reservoir stages below 742 feet PD and above 745 feet PD, FERC's SPD was issued prior to NDAA 2020, as discussed in detail in Sections 1.4 and 4.2.1 above. As GRDA explained in section 1.6.2, its anticipated operating range of the Project reservoir is 742 feet PD to 745 feet PD. Because neither the Commission nor any other federal or state resource agency may require a different set of requirements for reservoir operating levels, as explained in Sections 1.4 and 4.2.1 above, exploring the theoretical effects of other operating regimes would not be reasonable, as explained in Section 4.2.2 above. For these reasons, GRDA will continue to focus on simulated starting reservoir elevations between 742 feet PD and 745 feet PD.

4.3.2.3 Future Trends in Hydrology

The City of Miami requests that FERC require GRDA "to consider future trends in hydrology in order to effectively evaluate overall trends and impacts of sedimentation."[217]

GRDA does not support this proposed modification to the study plan. In its comments, the City of Miami did not demonstrate that the FERC-approved Sedimentation Study was not conducted as provided for in the Commission's SPD or that the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way.[218]

FERC's Study Plan Determination did not require GRDA to examine trends in future hydrology including the effects of climate change over time. As discussed in section 4.2.5 above, FERC has long articulated that any such study would be unable to capture with enough granularity the effects of climate change on a particular hydropower project. Given the limitations on study, it would simply not be reasonable for GRDA to undertake potentially costly studies that would not be reliable, and thus not useful in informing the public of the potential impacts of the Project and assisting FERC in fulfilling its mandate under NEPA.

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[215] City of Miami's Comments at 13.

[216] *See supra* section 4.1; *see also* 18 C.F.R. § 5.15(d).

[217] City of Miami's Comments at 13.

[218] *See supra* section 4.1; *see also* 18 C.F.R. § 5.15(d).

4.3.2.4 Calibration of Sediment Transport Model

The City of Miami requests that "GRDA should be required to improve calibration of the Sedimentation Transport Model as informed by the H&H Study, including calibrating over a full range of flows."[219]

GRDA does not support this proposed modification to the study plan. In its comments, the City of Miami did not demonstrate that the FERC-approved Sedimentation Study was not conducted as provided for in the Commission's SPD or that the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way.[220]

Moreover, the calibration flows for the Sedimentation Study were selected based on those used for the H&H Modeling Study. Each of the following six events that were used to calibrate the UHM were also used to calibrate the STM: July 2007, October 2009, December 2015, January 2017, April 2017, and May 2019. The City of Miami makes no showing that these events are not adequately representative or otherwise insufficient in any way.

4.3.2.5 Revise Sedimentation Study to Reflect Results of Revised H&H Study

The City of Miami requested that, "[o]nce the H&H Study has been modified as described above, GRDA should be required to revise the Sedimentation Study to reflect the results of the revised H&H Study."[221]

As noted in Sections 3.1, 4.3.1.6, 4.3.1.7, and 4.3.1.15 above, should conclusions of the H&H Modeling Study change during the second study season, GRDA will update the other studies as needed.

4.3.3 Aquatic Species of Concern Study

4.3.3.1 Effects of Flooding on Aquatic Species Habitat

USFWS requests "information on the potential frequency and duration of flooding events in order to determine effects on habitat for the . . . Neosho madtom (Noturus placidus) [and] federally-listed mussels. . . . Current information is focused on peak flood events and does not include information for effects of potential lake level changes on the frequency and duration of lesser flooding events. The frequency and duration of storing water in the flood pool could affect the suitability of riverine habitat . . . . Shoreline habitat within the reservoir may also be affected."[222]

GRDA does not support this proposed modification to the study plan. In its comments, USFWS did not demonstrate that the FERC-approved Aquatics Species of Concern Study was not conducted as provided for in the Commission's SPD or that the study was conducted under

[219] City of Miami's Comments at 14.

[220] *See supra* section 4.1; *see also* 18 C.F.R. § 5.15(d).

[221] City of Miami's Comments at 14.

[222] USFWS Comments at p. 1–2.

anomalous environmental conditions or that environmental conditions have changed in a material way.[223]

Moreover, as discussed in Sections 1.4 and 4.2.1 above, Congress has consistently made clear that the Corps has sole authority over flood control at the Pensacola Project, which includes issues of frequency and duration of flooding events referenced by USFWS. Most recently, in NDAA 2020, Congress expressly removed the Commission's jurisdiction over flood control and eliminated any authority for the Commission, USFWS, or any other federal or state agency from regulating water surface elevations of the Project.

Thus, to the extent the USFWS requested modifications to the FERC-approved study plan to consider the impacts of flooding on these species, that consideration is beyond the scope of both FERC's and USFWS's authority to address in this relicensing proceeding.

4.3.4 Terrestrial Species of Concern Study

4.3.4.1 Effects of Flooding on Aquatic Species Habitat

USFWS "requests information on the potential frequency and duration of flooding events in order to determine effects on habitat for the American burying beetle (*Nicrophorus americanus)*…and bat cave habitat affected by the flood pool storage. Current information is focused on peak flood events and does not include information for effects of potential lake level changes on the frequency and duration of lesser flooding events."[224]

GRDA does not support this proposed modification to the study plan. In its comments, USFWS did not demonstrate that the FERC-approved Terrestrial Species of Concern Study was not conducted as provided for in the Commission's SPD or that the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way.[225]

Moreover, as discussed in Sections 1.4 and 4.2.1 above, Congress has consistently made clear that the Corps has sole authority over flood control at the Pensacola Project, which includes issues of frequency and duration of flooding events referenced by USFWS. Most recently, in NDAA 2020, Congress expressly removed the Commission's jurisdiction over flood control and eliminated any authority for the Commission, USFWS, or any other federal or state agency from regulating water surface elevations of the Project.

Thus, to the extent the USFWS requested modifications to the FERC-approved study plan to consider the impacts of flooding on these species, that consideration is beyond the scope of both FERC's and USFWS's authority to address in this relicensing proceeding.

4.3.5 Wetlands and Riparian Habitat Study

No relicensing participant requested any modification to the Wetlands and Riparian Habitat Study.

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[223] *See supra* section 4.1; *see also* 18 C.F.R. § 5.15(d).

[224] USFWS Comments at p. 1-2.

[225] *See supra* section 4.1; *see also* 18 C.F.R. § 5.15(d).

4.3.6 Recreation Facilities Inventory and Use Study

No relicensing participant requested any modification to the Recreation Facilities Inventory and Use Study.

4.3.7 Cultural Resources Study

No relicensing participant requested any modification to the Cultural Resources Study.

4.3.8 Socioeconomics Study

4.3.8.1 Baseline Analysis

The City of Miami requests that "GRDA should be required to ensure that the baseline conditions underlying its Socioeconomics Study reflect a comprehensive review of all available information. To do so—and to satisfy the commitments made in GRDA's prior responses to stakeholder comments—GRDA should augment its baseline analysis to fully consider direct economic impacts of the Project; Project effects on local government finances; and social and societal impacts of the Project."[226]

GRDA does not support this proposed modification to the study plan. In its comments, the City of Miami did not demonstrate that the FERC-approved Socioeconomics Study was not conducted as provided for in the Commission's SPD or that the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way.[227]

Section 2.6.1 of the FERC-approved RSP for the Socioeconomics Study defines the baseline information to be included in GRDA's socioeconomic study as "the general land use patterns within the study area, an assessment of population trends (historical, current, and projected), economic activity and labor force, age distribution, median household and per capita income, and poverty levels". GRDA precisely followed the FERC-approved study plan and included all required information. As noted in Section 1 of GRDA's Socioeconomic Study, general land use patterns are described in Section 1.1, population trends and demography assessments are provided in Section 1.2, economic activity is described in Section 1.4, labor force is described in Section 1.5, age distribution is provided in Section 1.2, and median household and per capita income, and poverty levels are described in Section 1.6.

Additionally, GRDA followed FERC's recommendation to collect information using stakeholder outreach. GRDA updated a list of stakeholders and sent out letters to obtain additional socioeconomic information. This information is included in Attachment B of the ISR, which contains PDF copies of documents received from stakeholders. All documents submitted by stakeholders were included in GRDA's ISR filing and are available for download on eLibrary, as well as on GRDA's relicensing website.

Finally, as explained in Section 4.2.8 above, Commission policy and precedent have rejected the argument—similar to the City of Miami's assertions here—that FERC must complete a granular, quantification of socioeconomics, such as the City of Miami's request for an analysis of "effects on local government finances" and "social and societal impacts of the Project."

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[226] City of Miami's Comments at 17.

[227] *See supra* section 4.1; *see also* 18 C.F.R. § 5.15(d).

4.3.8.2 Additional Economic Information

The City of Miami requests that "GRDA should be required to reinitiate its outreach to relicensing participants and county, regional, and state entities—including Tribes—using a method better calculated to ensure an adequate response."[228]

GRDA does not support this proposed modification to the study plan. In its comments, the City of Miami did not demonstrate that the FERC-approved Socioeconomics Study was not conducted as provided for in the Commission's SPD or that the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way.[229]

GRDA followed the FERC-approved process in the Socioeconomics Study plan, which contemplated a robust public outreach to solicit information from 190 stakeholders. Despite the ongoing pandemic, GRDA received responses from the City of Miami and others. While the City of Miami expresses concerns with the response rate, it is GRDA's experience that this is the typical rate of response that occurs with these information requests. Moreover, the City of Miami has not identified any information that was omitted from these responses and GRDA's independent research that would further inform the Socioeconomics Study.

4.3.8.3 Demonstration of Information Gathered

The City of Miami requests that "GRDA should be required to illustrate that it has gathered and analyzed the categories of information it committed to provide in the RSP, including all economic impacts of the Project; Project effects on local government finances; and social and societal impacts of the Project."[230]

GRDA does not support this proposed modification to the study plan. In its comments, the City of Miami did not demonstrate that the FERC-approved Socioeconomics Study was not conducted as provided for in the Commission's SPD or that the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way.[231]

As set forth in Section 4.3.8.1 above, the FERC-approved Revised Study Plan for the Socioeconomics Study, Section 2.6.1 defines the baseline information to be included in GRDA's socioeconomic study as "the general land use patterns within the study area, an assessment of population trends (historical, current, and projected), economic activity and labor force, age distribution, median household and per capita income, and poverty levels". GRDA precisely followed the FERC-approved study plan and included all required information.

Additionally, as noted in Section 4.3.8.2 above, GRDA followed the FERC-approved methodology to collect information through a robust stakeholder outreach effort. This information is included in Attachment B of the ISR. All documents submitted by stakeholders were included in GRDA's ISR filing and are available for download on eLibrary, as well as on GRDA's relicensing website.

[228] City of Miami's Comments at 17.

[229] *See supra* section 4.1; *see also* 18 C.F.R. § 5.15(d).

[230] City of Miami's Comments at 17.

[231] *See supra* section 4.1; *see also* 18 C.F.R. § 5.15(d).

Finally, GRDA notes that FERC has already rejected this request from the City of Miami. In its SPD, FERC states:

> The City of Miami asserts that, in the RSP, GRDA fails to account for social and societal costs and benefits of the project. The City of Miami states that GRDA rejected requests to collect information on population and demographics, regional employment and income, revenues and expenditures, government finances, public services, and social conditions. In the RSP, however, GRDA's socioeconomic study plan specifically includes a proposal for collecting information on population trends, economic activity and the labor force, age distribution, median household and per capita income, and poverty levels. GRDA also proposes outreach to collect additional information relating to state and regional industry trends; local, tribal, and regional trends in land and resource values; as well as other information that may be potentially relevant to the study from relicensing participants. To make the best use of GRDA's socioeconomic data information request, we recommend that GRDA modify task 4, Prepare Socioeconomic Study Report, to include an appendix containing electronic copies of documents submitted by stakeholders and links to publicly accessible web sites containing such documents. Providing access to all sources available to GRDA for its analysis will aid the analysis of socioeconomic resources.[232]

GRDA completed the Socioeconomics Study as directed by FERC's SPD. While the City of Miami may be displeased with the study results, that is no legitimate basis to question the results of the study or require a study plan modification.

4.3.8.4 FEMA Flood Insurance Study

The City of Miami requests that "GRDA should review the most recent FEMA Flood Insurance Study and update its Socioeconomics Study to reflect analysis of this and other publicly-available resources reflecting the impacts of flooding on the availability and affordability of housing in the study area."[233]

GRDA does not support this proposed modification to the study plan. In its comments, the City of Miami did not demonstrate that the FERC-approved Socioeconomics Study was not conducted as provided for in the Commission's SPD or that the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way.[234]

Additionally, GRDA's comments regarding the FEMA flood insurance study were given in response to the City of Miami's comments on direct analysis of social and societal impacts, which GRDA maintains is inappropriate for this study. While GRDA did commit to looking at the FEMA flood insurance study, it did not commit to do so in the context of the Socioeconomic Study. To the extent the FEMA flood insurance study would inform a cumulative impact assessment, that will be included in Exhibit E of the license application.

[232] SPD at B-32.

[233] City of Miami's Comments at 17.

[234] *See supra* section 4.1; *see also* 18 C.F.R. § 5.15(d).

4.3.8.5 Assessment of Cumulative Socioeconomic Impacts

The City of Miami requests that “GRDA should be required to revise its overly broad assessment of cumulative socioeconomics impacts to disclose and assess the negative economic impacts of the Project.”[235]

GRDA does not support this proposed modification to the study plan. In its comments, the City of Miami did not demonstrate that the FERC-approved Socioeconomics Study was not conducted as provided for in the Commission’s SPD or that the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way.[236]

Moreover, the FERC-approved study plan did not require GRDA to identify any specific “negative” or “positive” socioeconomic impacts, as alleged by the City of Miami. Rather, the FERC-approved plan required GRDA to describe the baseline socioeconomics of the four-county study area. This approach is exactly consistent with governing FERC policy and precedent, as explained in Section 4.2.8 above. The results of this study demonstrate that the Project has an overwhelmingly positive socioeconomic impact within the four-county study area—a conclusion that the City of Miami does not dispute with any evidentiary support. The City of Miami’s request for FERC to direct GRDA to search for any specific negative effects within the study area is inconsistent with governing FERC policy and precedent, as explained in Section 4.2.8.

4.3.8.6 Temporal Scope of Cumulative Impacts Assessment

The City of Miami requests that “GRDA should be required to augment the limited temporal scope of cumulative impacts assessed thus far to identify all past, present, and reasonably foreseeable cumulative socioeconomic impacts of the project.”[237]

GRDA does not support this proposed modification to the study plan. In its comments, the City of Miami did not demonstrate that the FERC-approved Socioeconomics Study was not conducted as provided for in the Commission’s SPD or that the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way.[238]

As set forth in Section 4.3.8.1 above, the FERC-approved RSP for the Socioeconomics Study, Section 2.6.1 defines the baseline information to be included in GRDA’s socioeconomic study as “the general land use patterns within the study area, an assessment of population trends (historical, current, and projected), economic activity and labor force, age distribution, median household and per capita income, and poverty levels”. GRDA precisely followed the FERC-approved study plan and included all required information.

In addition, section 2.6.3 of the FERC-approved RSP defines the assessment of cumulative impacts as follows: “After describing the baseline socioeconomic conditions within the study area and reviewing the information compiled in Task 2, GRDA will assess and verify the information gathered in Task 2 in order to identify the socioeconomic metrics necessary to provide a broad assessment of the cumulative socioeconomic impacts of the Project. Using available information gathered in Task 2, this qualitative assessment will identify the past, present, and reasonably

[235] City of Miami’s Comments at 17.

[236] *See supra* section 4.1; *see also* 18 C.F.R. § 5.15(d).

[237] City of Miami’s Comments at 17.

[238] *See supra* section 4.1; *see also* 18 C.F.R. § 5.15(d).

foreseeable cumulative socioeconomic impacts due to the continued operation and maintenance of the Project under a new license." GRDA's Socioeconomic Study provides this cumulative evaluation in section 3.0 of the study report.

4.3.8.7 Preparation of the Socioeconomic Study Report

The City of Miami requests that "GRDA should be required to provide an appendix containing electronic copies of documents submitted by stakeholders and links to publicly-accessible web sites containing such documents."[239]

The stakeholder outreach information was provided in Attachment B of the Socioeconomic Study Report e-filed with the Commission on September 30, 2021. It was also posted on GRDA's publicly accessible relicensing webpage, https://www.grda.com/pensacola-hydroelectric-project-relicensing/.

4.3.8.8 Identification of Data Sources

The City of Miami comments that "GRDA should be required to update the Socioeconomics Study Report to clearly state which data source was used to produce the tabular data on socioeconomic conditions reported at the county and census tract level and augment this data where current sources are insufficient."[240]

The U.S. Census Bureau data requested by the FERC-approved study plan was provided in Attachment A of GRDA's Socioeconomic Study.

4.3.8.9 Environmental Justice

The City of Miami requests that "GRDA should provide an adequate level of detail to enable Commission Staff to analyze environmental justice impacts as part of its environmental review."[241]

GRDA does not support this proposed modification to the study plan. In its comments, the City of Miami did not demonstrate that the FERC-approved Socioeconomics Study was not conducted as provided for in the Commission's SPD or that the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way.[242]

GRDA completed the Socioeconomic Study as required by FERC when issuing its SPD. The Socioeconomic Study included the information that the Commission deemed necessary to meet its Environmental Justice requirements. FERC will conduct an environmental justice assessment as part of its environmental review, which will be supported by the results of the Socioeconomic Study, as well as any other information from other studies and available information deemed appropriate by the Commission.

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[239] City of Miami's Comments at 17.

[240] *Id.*

[241] *Id.*

[242] *See supra* section 4.1; *see also* 18 C.F.R. § 5.15(d).

4.3.8.10 Revisions to Reflect H&H Modeling Study Results

The City of Miami request that "GRDA should be required to revise the Socioeconomic Study to reflect the results of the revised H&H Study."[243]

GRDA does not support this proposed modification to the study plan. In its comments, the City of Miami did not demonstrate that the FERC-approved Socioeconomics Study was not conducted as provided for in the Commission's SPD or that the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way.[244]

Moreover, as provided in the H&H Modeling Study reports in the ISR, flooding in and around Miami is a natural event not influenced by Project operations. Nature is causing the effect, not the operation of the Project. Thus, there is no basis for the City of Miami's request to revise the Socioeconomics Study.

Regardless, as provided in Sections 3.1, 4.3.1.6, 4.3.1.7, and 4.3.1.15 above, should conclusions of the H&H Modeling Study change during the second study season, GRDA will update the other studies as needed. Any such changes will appear in the USR.

4.3.9 Infrastructure Study

4.3.9.1 GRDA's Request to Discontinue Analysis

The City of Miami requests that "[t]he Commission should reject GRDA's request not to continue any analysis of infrastructure impacts, given the deep and wide-ranging flaws in the H&H Study that underpins it. Instead, GRDA should be required to update the Infrastructure Study based on the results of the H&H Study once it has been modified as described above."[245]

GRDA does not support this proposed modification to the study plan. In its comments, the City of Miami did not demonstrate that the FERC-approved Infrastructure Study was not conducted as provided for in the Commission's SPD or that the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way.[246]

Moreover, there are no "deep and wide-ranging flaws in the H&H Study" as alleged by the City of Miami. The City of Miami may well be displeased with the results of the H&H Modeling Study, but as explained in Section 4.3.1 above and Section 4.5.1 below, the City of Miami raises no technical objections to the H&H Modeling Study that are not easily addressed. GRDA also reminds the City of Miami that as discussed in Section 2 of the *Hydrologic and Hydraulic Modeling: Upstream Hydraulic Model* report filed with the ISR, GRDA built the H&H Modeling Study upon the work of the City of Miami's own consultant, Tetra Tech. The City of Miami has consistently relied upon Tetra Tech for hydrologic and hydraulic analysis of the area upstream of the Project and has referred to its Tetra Tech consultants as "world class hydrologists"[247] and a "world-class team of

243 City of Miami's Comments at 18.

244 *See supra* section 4.1; *see also* 18 C.F.R. § 5.15(d).

245 City of Miami's Comments at 12.

246 *See supra* section 4.1; *see also* 18 C.F.R. § 5.15(d).

247 Motion of City of Miami, Oklahoma for Leave to Intervene and Protest and Comments at 3, Project No. 1494-437 (filed Oct. 24, 2016).

engineers."[248] The City of Miami cannot disavow the work of both its own consulting team and GRDA's supplemental work simply because it dislikes the results.

In any event, GRDA's H&H work is iterative. Although there is no basis for revising the Infrastructure Study methods at this time, as provided in Sections 3.1, 4.3.1.6, 4.3.1.7, and 4.3.1.15 above, should conclusions of the H&H Modeling Study change during the second study season, GRDA will update the other studies as needed. Any such changes will appear in the USR.

4.3.9.2 Flooding Parameters

The City of Miami requests that "GRDA should be required to analyze Project impacts on infrastructure based on all flooding parameters, not merely the binary determination of whether or not a flood peak ever reaches a particular piece of infrastructure."[249]

GRDA does not support this proposed modification to the study plan. In its comments, the City of Miami did not demonstrate that the FERC-approved Infrastructure Study was not conducted as provided for in the Commission's SPD or that the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way.[250]

The H&H Modeling Study and Infrastructure Study concluded that GRDA's Project operations do not impact any infrastructure. The FERC Infrastructure Study Plan did not require GRDA to assess "all flooding parameters" at infrastructure locations. The City of Miami has not demonstrated adequate justification for requesting a study plan modification, as explained in section 4.1.

Moreover, there is no reason for FERC to require a study plan modification related to an expanded set of flooding parameters because flooding parameters are an element of flood control over which FERC has no jurisdiction. Rather, the Corps has exclusive jurisdictional control over flood control as discussed in Sections 1.4 and 4.2.1. These same Sections explain how Congress, in NDAA 2020, removed any authority for the Commission to regulate water surface elevations of Grand Lake, except as may be needed to comply with project and public safety regulations. Thus, the City of Miami's requested modification bears no nexus to the Project and would not inform the development of license conditions, as required by regulation.[251]. With regard to the City of Miami's concerns about the duration of inundation, the Corps' Water Control Manual already addresses this issue.[252]

In sum, duration of inundation is a function of post-inflow event drawdown, the Corps has exclusive jurisdictional control over flood pool drawdown, and under NDAA 2020 the Commission lacks authority to address this issue. For these reasons, the Commission should reject the City of Miami's proposed study modification.

[248] Comments of City of Miami, Oklahoma at 3, Project No. 1494-437 (filed Feb. 6, 2017).

[249] City of Miami's Comments at 13.

[250] *See supra* section 4.1; *see also* 18 C.F.R. § 5.15(d).

[251] *See* 18 C.F.R. § 5.9(b)(5).

[252] Water Control Manual ¶ 8-07, at p. 8-2 (1992).

4.4 Response to Requests for New Studies

4.4.1 Contaminated Sediment Transport

In its comments on the ISR, the City of Miami reiterated its prior request that "the Commission approve the City's requested Contaminated Sediment Transport Study to examine how Project operations alter the way contaminated sediment is transported and deposited on lands occupied by the City and its residents."[253]

The Commission's November 2018 SPD specifically addressed the City of Miami's request for a contaminated sediment transport study. There, staff declined to recommend a contaminated sediment transport study. However, as discussed above, it recommended H&H and sedimentation studies, and noted that the results of those studies would be used to evaluate the extent to which Pensacola Project operations contribute to sediment deposition in the overbank areas of the Grand Lake tributaries.[254] Such a finding, staff concluded, "would demonstrate a possible nexus between project operation and effects of contaminated sediment transport," and "could also indicate the possibility that a contaminated sediment transport study could inform a license requirement."[255] The Commission concluded that, "until that connection is made, it is premature to require such a study." Rather, the SPD provided that "[i]f this nexus to project operations is established, it would be appropriate to reevaluate the need for a contaminated sediment study during review of the ISR."[256]

For these reasons, the City's request is unwarranted. As detailed in the ISR, the "nexus" referred to by the Commission in its SPD has not been established.

Additionally, the City of Miami's request fails to satisfy the regulatory criteria that a relicensing participant must meet in requesting a new study at the ISR stage of the ILP. As discussed above, section 5.15(e) of the Commission's regulations provides that requests for new information or studies include a statement explaining: (1) any material change in law or regulations applicable to the information request; (2) why the goals and objectives of the approved study could not be met with the approved study methodology; (3) why the request was not made earlier; (4) significant changes in the proposal or that significant new information material to the study objectives has become available; and (5) why the new study request satisfies the study criteria in Section 5.9(b) of the regulations.[257]

While the City of Miami notes that its proposed study was submitted during the study plan development phase of the ISR, its renewed request fails to satisfy—or even address—these other criteria required by the Commission's ILP regulations. Instead, the City of Miami alleges only that "[g]ood cause exists to require this additional study, as the City anticipates that the full Sedimentation Study, including the Sediment Transport Model, when finally produced by GRDA will provide significant new information material to and supportive of the objectives of the proposed Contaminated Sediment Transport Study."[258]

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253 City of Miami's Comments at 18.

254 SPD at B-38.

255 SPD at B-38.

256 SPD. at B-39.

257 18 C.F.R. § 5.15(e).

258 City of Miami's Comments at 18.

Because the City of Miami has failed to demonstrate that "significant new information material to the study *has become available*," as required by section 5.15(e), it has failed to satisfy the regulatory criteria for requesting a new study. In addition, although the City of Miami "anticipates" that new information will support the need for its proposed study, its anticipation is not supported by the record in this ILP. As fully detailed in the ISR, the H&H Modeling Study demonstrates that flooding in the vicinity of the City of Miami is caused by natural events—and not GRDA's Project operations.

For these reasons, the Commission should deny the City of Miami's proposed Contaminated Sediment Transport Study.

4.5 Response to General Comments from Relicensing Participants

4.5.1 H&H Modeling Study

#	Entity	Comment	GRDA Response
1	FERC Staff, 11/24/2021	Section 8 of the Upstream Hydraulic Model Report (UHM Report) states that the tabulated results of the maximum water surface elevations (WSELs) and maximum inundation extents for starting reservoir elevations between 742 feet and 745 feet NGVD 29 are included in Appendix D. However, the approved study plan filed on September 24, 2018, recommends that GRDA use starting reservoir elevations between 734 feet and 760 feet. Please explain why the study and study results were limited to starting reservoir elevations between 742 feet and 745 feet rather than between 734 feet and 760 feet, as required by the approved study plan.	GRDA simulated starting reservoir elevations as low as 734 feet PD, as recommended in the SPD. GRDA simulated starting reservoir elevations as high as 757 feet PD, which is 3 feet below the maximum starting elevation of 760 feet PD listed in the SPD. Regarding the maximum starting elevation, 760 feet PD is the approximate maximum elevation of the existing flowage easement. GRDA deviated from the SPD because the crest of Pensacola Dam is 757 feet PD. This variance (starting reservoir elevation of 757 feet PD instead of 760 feet PD) is documented in the ISR. To meet the requirements of the SPD, GRDA simulated starting reservoir elevations between 734 feet PD and 757 feet PD. The results of these simulations show impacts, if any, of extreme starting reservoir elevations well outside the existing or proposed operating range of the Project reservoir. Therefore, GRDA selected the most extreme inflow event, the 100-year inflow at Pensacola Dam, for these extreme starting reservoir elevations. As discussed in Section 1.6.2 above, GRDA anticipates operating the Project reservoir within the range of 742 feet PD to 745 feet PD. Therefore, GRDA focused on simulated starting reservoir elevations between 742 feet PD and 745 feet PD. Six different inflow events with estimated return periods at Pensacola Dam ranging from 1 year to 100 years were simulated with five different starting reservoir elevations (historical elevation, 742 feet PD, 743 feet PD, 744 feet PD, and 745 feet PD). These simulations represent a matrix of operational conditions and inflow conditions.
2	FERC Staff, 11/24/2021	Section 3 of the UHM Report states that United States Geological Survey (USGS) gage data were used for the upstream inflow boundaries, and WSELs at Pensacola Dam were used for the downstream stage boundary. If the starting WSEL at the dam is varied, this would create extra storage, which in turn would affect the stage hydrograph at the lake (for at least some period of the event duration). Therefore, please explain how the elevations for these stage hydrographs were obtained, and how the variations in the starting lake elevations are reflected in the model output.	Section 3 of the UHM report discusses model calibration. The goal of model calibration was to create a single geometry file that could be used for a variety of synthetic/hypothetical simulations. For model calibration, historical data from USGS gages were used at upstream inflow boundaries and historical reservoir elevation hydrographs (a.k.a. stage hydrographs) were used for the downstream stage boundary. During calibration, the starting reservoir elevation (stage) at the dam was never modified from the historical value. Furthermore, no ordinate of the reservoir elevation hydrograph (stage hydrograph) was modified from the historical value during model calibration. For simulations discussed in Section 7 of the UHM report, the methodology is different. The goal is different. The simulations in Section 7 are designed to determine the impact, if any, that dam operations have on upstream water surface elevations. For simulations in Section 7, the starting reservoir elevation is purposefully modified from the historical value. For example, the simulation for the July 2007 event begins at 12:00 AM midnight on 6/28/2007. At that time, the reservoir elevation was 745.69 feet PD. That value is a historical measurement. Other simulations for the July 2007 event use an artificial, non-historical value for the initial reservoir elevation. Other initial elevations used are: 742 feet PD, 743 feet PD, 744 feet PD, and 745 feet PD. Again, the purpose of these simulations is to determine the impact, if any, that dam operations have on the upstream water surface elevations. As set forth in Section 1.6.2 above, GRDA anticipates an operating range of the Project reservoir between 742 and 745 feet PD. After the initial reservoir elevation, the remaining ordinates of the stage hydrograph are calculated by the Operations Model. The Operations Model simulates flood routing, hydropower scheduling, and other constraints on an hourly time step. The user-defined starting reservoir elevation is used in the Operations Model to calculate storage in the reservoir. As the Operations Model progresses through the hourly time steps, the storage in the reservoir changes based on inflows and outflows. The output of these calculations is a stage hydrograph at Pensacola Dam. The output stage hydrograph at Pensacola Dam, calculated by the Operations Model, is used for each of the HEC-RAS simulations discussed in Section 7 of the UHM Report.
3	FERC Staff, 11/24/2021	Figure 13 of the UHM Report shows the over/under prediction of simulated water surface elevations at the four USGS gages. According to the USGS Neosho River gage at the city of Commerce, Oklahoma, the maximum water surface elevation of the July 2007 historical inflow event was 776.62 feet. However, there is no blue bar comparing the simulated and observed values, as there is for the other gages. Therefore, please revise Figure 13 to include the data point for the July 2007 event, or clarify why it was not included.	At the time of model calibration (March 2021), GRDA did not possess USGS data for the July 2007 event for the Neosho River gage at the City of Commerce, Oklahoma. On USGS's website, stage data were only available in hourly increments from October 2007 onward. Following the Model Input Status Report (filed with FERC on March 30, 2021), the City of Miami filed comments on the Model Input Status Report with FERC (filed on June 23, 2021). The City of Miami stated that hourly gage data that pre-dated October 2007 for the Neosho River gage at Commerce was available upon request from USGS. GRDA contacted USGS and requested data for the July 2007 event. USGS delivered the July 2007 stage data to GRDA with a disclaimer that the possibility exists that the data provided "*was not processed in accordance with current USGS standards and could contain errors.*" Because of this disclaimer, GRDA searched for other USGS data. Two additional data sources exist: 1. Peak streamflow, which is the maximum flow that occurred during the USGS water year. Stage associated with the peak streamflow is reported by USGS.

#	Entity	Comment	GRDA Response
			2. Streamflow measurements, which are USGS field measurements and are independent of gage-recorded values. USGS reports flow and gage height for streamflow measurements. GRDA compared the USGS data to the HEC-RAS model results at the Commerce gage. The magnitude of the differences between HEC-RAS results was similar to the magnitude between the various USGS measurements. When considering whether to update Figure 13 in the UHM Report with data received from USGS, GRDA considered the following: 1. USGS included a disclaimer on the data, noting that the data may not have been processed in accordance with current USGS standards and could contain errors. 2. Differences between various USGS measurements were similar to the differences between HEC-RAS results and USGS measurements. 3. USACE cautions HEC-RAS users that a ±5% flow measurement, which may be "optimistic," can translate to a stage error of ±1 foot. Considering the differences between various USGS measurements, there may be errors for the July 2007 event flow measurement that result in stage errors of 1.0 feet or more. 4. The City of Miami expressed a lack of comfort regarding the July 2007 USGS data in their comments on the *H&H Modeling: Upstream Hydraulic Model – Model Input Status Report*. The City of Miami's comments were filed with FERC on June 23, 2021. Based on these considerations, GRDA determined that updating Figure 13 to include a blue bar representing over/under prediction of simulated water surface elevations at the Commerce gage could mislead the reader to assume a disagreement between simulated and measured data where there is no such disagreement.
4	FERC Staff. 11/24/2021	Table 1 of the UHM Report provides a summary of the peak inflow at each of the stream flow gages during historical inflow events. However, the table does not include any peak inflow data for the September 1993 inflow event. Therefore, please revise Table 1 to include the peak inflow information for the September 1993 event at each gage or clarify why it was not included.	Table 1 of the UHM Report provides a summary of peak inflow at each stream flow gage for a series of historical inflow events. Table 1 does *not* include data for the September 1993 inflow event. However, the purpose of the table is to summarize the peak inflows of historical events *used during model calibration*. The current table title in the ISR is: "Summary of historical event boundary conditions." In the USR, the tile of the table will be updated to: "Summary of historical event boundary conditions used in UHM calibration." The revised table title will more accurately describe the information included in the table. The September 1993 inflow event was not used during model calibration and thus the peak inflows for the September 1993 event are not included in Table 1. The September 1993 event was one of the events used to analyze the range of operating conditions at Pensacola Dam. Table 15 of the UHM Report includes a summary of peak inflows for the September 1993 event, along with the other events used to analyze the range of operating conditions at Pensacola Dam.
5	FERC Staff, 11/24/2021	The approved study plan requires that the Hydrologic & Hydraulic Modeling Study (H&H Study) quantify the influence of project operation on water levels upstream and downstream of the dam to improve an understanding of the magnitude, duration, and frequency of inundation upstream. However, section 10 of the UHM Report states that the initial stage at Pensacola Dam has an "immaterial impact" on upstream WSEL and inundation frequencies, and that only different inflows cause an "appreciable difference" in maximum WSEL and maximum inundation extent. Further, the report states that the difference in WSEL and inundation extent due to the size of the inflow event are an order of magnitude greater than the differences in WSEL and inundation extent due to the initial stage. Although the ISR indicates that the tabular data listing the maximum water depths for each of the six modeling scenarios is available in Appendix F, the appendix only includes maps of inundation scenarios. In order to understand the results of the H&H Study and quantify the impact of project operation on upstream WSELs and flooding, please: a. define "immaterial impact" and "appreciable difference" as a unit of measure (feet); and b. revise Appendix F to include a list or table that compares the upstream WSELs (feet), extent of inundation (feet), and duration of inundation (hours) at each initial stage (in 0.5-foot intervals) above (in the range of 745 feet to 757 feet) and below (in the range of 734 feet to 745 feet) the flood pool WSEL during the modeled flood events (i.e., compare stage to stage operation).	The ISR reports and appendices quantify the influence of Project operation on water levels upstream and downstream of the dam. Appendix D of the UHM Report and Appendix C of the DHM Report include tabulated water surface elevations for every simulation performed for the ISR. In accordance with Section 2.6.9 of the *Hydrologic and Hydraulic Modeling Study Revised Study Plan* and the section titled *Model Validation and Information Sharing* of the *Study Plan Determination*, GRDA has provided the model to relicensing participants. Further information regarding the magnitude, duration, and frequency inundation is included in the model output files and is available to relicensing participants. Regarding staff's specific comment that "the ISR indicates that the tabular data listing the maximum water depths for each of the six modeling scenarios is available in Appendix F," GRDA could find no instance in the UHM Report where GRDA states that tabular data is included in Appendix F. In the UHM Report, all tabular data is included in Appendix D. Regarding staff's request to define "immaterial impact" and "appreciable difference," these phrases are not intended to be quantitative measurements. Rather, these phrases as used in the UHM Report are intended to describe the simulation results, which show that the difference in water surface elevation and inundation extent due to the size of the inflow event are an order of magnitude greater than the differences in water surface elevation and inundation extent due to the initial stage. The order of magnitude difference is derived from the numerical simulation results, which are inherently quantifiable. The phrases "immaterial impact" and "appreciable difference" are overall characterizations of the difference between the effect that dam operations have on the upstream water surface elevations/inundation extents compared to the effect that inflow events have on upstream water surface elevations/inundation extents. The phrases describe how different the dam operation impact is from the inflow event impact. Consider the maximum water surface elevation difference in the City of Miami. The maximum water surface elevation difference due to a different starting pool elevation was 0.3 feet, while the difference due to the inflow event was 20.9 feet. *The inflow*

#	Entity	Comment	GRDA Response
			event's impact is 70 times greater than the impact of the starting pool elevation. GRDA used the phrases like "immaterial impact" and "appreciable difference" to articulate the tremendous difference in impact resulting from natural inflow events versus the impact resulting from dam operations. Regarding staff's request to revise Appendix F, GRDA's understanding is that the following tables should be included in the appendices of the USR: • Tables of maximum water surface elevation (feet, PD) for each simulation. • Tables of maximum extent of inundation (feet) for each simulation. • Tables of duration of inundation (hours) for each simulation. GRDA requests verification that this is what Commission staff needs to complete its analysis of Project-related effects. Regarding staff's requested initial stages, as stated in Section 1.6.2 above, GRDA anticipates an operational range between 742 feet and 745 feet PD, and under NDAA 2020, neither the Commission nor any other regulator is empowered to impose any operating requirement related to water surface elevations of the Project's conservation pool, as explained in Sections 1.4 and 4.2.1, above. For these reasons, GRDA will simulate initial reservoir stages from 742 feet PD to 745 feet PD in 0.5-foot increments as requested by FERC. Results of these simulations will be included in the USR. In contrast, GRDA does *not* propose to simulate initial reservoir stages in 0.5-foot increments from 734 to 742 feet PD or from 745 feet to 757 feet PD. Because GRDA does not anticipate normal Project operations to be within these ranges during the new license term (see Section 1.6.2, above), these scenarios are not reasonable alternatives, as discussed in Section 4.2.2 above. Simulating a single initial reservoir stage is a costly, multi-step process that includes the following: 1. Update and run the Flood Routing Model with the new initial stage. 2. Create a new suite of Operations Model simulations with the new initial stage, both for Pensacola Dam and Kerr Dam. 3. Run the new suite of Operations Model simulations. 4. Perform quality control on Operations Model outputs. 5. Create a new suite of HEC-RAS simulations in the UHM. 6. Create a new suite of HEC-RAS simulations in the DHM. 7. Perform preliminary simulations of the UHM and DHM. 8. Troubleshoot computational issues in the UHM and DHM. 9. Finalize simulations of the UHM and DHM. 10. Export 2D raster results from the UHM. 11. Export 1D results from the UHM and DHM. 12. Extract WSEL data from 2D raster results in ArcGIS. 13. Import compiled WSEL data from UHM and DHM into spreadsheets. 14. Update plots of WSEL results for the UHM and DHM, adjusting vertical scaling and range. 15. Update tables of WSEL results for the UHM and DHM. 16. Perform quality control on spreadsheets. 17. Export plots and tables of WSEL results from Excel. 18. Import plots and tables of WSEL results into Word and format. 19. Post-process inundation extent shapefiles from UHM and DHM. 20. Update sets of inundation maps in ArcGIS for UHM and DHM. 21. Perform quality control on sets of maps. 22. Compress and compile maps. Adding a single initial reservoir stage scenario is estimated to cost $18,752. Simulating reservoir stages in 0.5-foot increments from 734 to 742 feet PD and from 745 to 757 feet PD (outside the normal operations range) would require an additional 40 initial reservoir stage scenarios to be analyzed and is estimated to cost $750,080. Furthermore, such a large number of initial reservoir stages creates new issues of understandability and comprehension. Focusing on the normal Project operational range of 742 feet to 745 feet PD will facilitate clear communication to the relicensing participants and FERC staff and will enhance understandability.
6	OAS, 11/29/2021	Did the H&H study incorporate consideration of rates of erosion and measurable changes in shoreline (for example), or just water surface elevations?	The H&H Modeling Study did not consider rates of erosion and changes in shoreline, as such analyses were not required by FERC's SPD.
7	OAS, 11/29/2021	The H&H study appears to have used overbank flooding data and high water marks. Did the H&H study take into account other measures of fluvial and alluvial activity-such as soils data in the areas adjacent to the waterways?	The H&H Modeling Study did not consider fluvial and alluvial activity, as such factors were not required by FERC's SPD.

<table>
<tr><th>#</th><th>Entity</th><th>Comment</th><th>GRDA Response</th></tr>
<tr><td>8</td><td>OAS, 11/29/2021</td><td>How are "sensitive resources" defined and how were impacts to those resources measured?</td><td>FERC required GRDA to study the following sensitive resources:
Aquatic species,
Terrestrial species,
Wetlands and riparian habitat, and
Cultural resources.
Each study plan has an individual methodology for measuring the impacts to sensitive resources.</td></tr>
<tr><td>9</td><td>OAS, 11/29/2021</td><td>The Executive Summary and Conclusion reference a finding: "The results of the UHM demonstrate that the initial stage at Pensacola Dam has an immaterial impact on upstream WSELs and inundation" (emphasis added). In Section 106, we have very specific understandings of what constitutes an Adverse Effect. Can you provide a definitions for the following terms/phrases and how they are measured and applied to understand impacts to cultural resources (or lack thereof):
Immaterial impact
Appreciable difference
No material difference</td><td>Regarding the definitions of “immaterial impact” and “appreciable difference,” please see GRDA’s response to Comment #5, above.

Regarding the definition of “no material difference,” Section 6 of the UHM Report is devoted to the discussion of material difference. The Revised Study Plan stated that:

The H&H study area will encompass the channel and overbank areas of the Grand/Neosho River watershed that have a material difference in water surface elevation due to Project operation during the measured inflow events of the H&H Study. A material difference in water surface elevation due to Project operations will be based on professional judgment.

In the SPD, FERC recommended that GRDA define “material difference.” GRDA defined “material difference” in Section 6 of the UHM Report. The simulation results confirmed that the model did not need to be extended further upstream.

For the purposes of identifying Project effects under Section 106, GRDA’s analysis determined that Project operations are not causing flooding. Rather, flooding is a natural event not influenced by Project operations. Nature is causing the effect, not the operation of the Project. For the purposes of compliance with the requirements of Section 106, any changes in water surface elevations due to the operation of the Project are contained within the approximate elevation of 750 feet (Project boundary) and within the current APE for the Cultural Resources Study. Therefore, no adverse effects to cultural resources from Project operations occur outside of the current Project boundary or the current APE for the cultural resources study.</td></tr>
<tr><td>10</td><td>OAS, 11/29/2021</td><td>What do you believe accounts for the lack of "material difference"?</td><td>Naturally occurring flooding events are so extensive that the Project operation’s influence on the extent of inundation and the maximum inundation depth is immaterial.</td></tr>
<tr><td>11</td><td>OAS, 11/29/2021</td><td>Do I understand correctly that the initial stage as it pertains to the H&H model is the current operation levels? In other words, it does not incorporate pre-dam conditions to assess cumulative/historic impacts of operations?</td><td>Initial stage refers to the water surface elevation at Pensacola Dam at the beginning of the HEC-RAS hydraulic simulation. GRDA simulated a variety of initial stages in the model (see Section 7 of the UHM Report). Several initial water surface elevations simulated are not within operational ranges: 734 feet PD, 740 feet PD, and 757 feet PD. Other initial water surface elevations simulated are within operational ranges: 742 feet PD, 743 feet PD, 744 feet PD, and 745 feet PD.

Regarding pre-dam conditions and cumulative/historic impacts of operations:
The Commission’s Study Plan Determination did not require an analysis of pre-dam conditions (see Section 4.1, above).
As discussed in Section 4.2.4, FERC’s well-established policy requires a review of existing environmental conditions, rather than pre-dam conditions.
As discussed in Section 4.2.7, FERC’s long-standing practice is to not require applicants to conduct studies on issues that are limited to cumulative effects.</td></tr>
<tr><td>12</td><td>OAS, 11/29/2021</td><td>For the downstream model: do you feel your model allows for the ability to differentiate between impacts of flooding due to emergency operations vs. day-to-day releases and operations for hydroelectric power generation? If so, please provide that information. If not, can that be incorporated into the Second Period of this study?</td><td>Day-to-day releases and operations for hydroelectric power generation do not cause downstream flooding. Downstream flooding occurs when USACE is in control of Pensacola Dam operations. Flood control is an exclusive jurisdictional control of USACE, as discussed in Section 4.2.1 above.

Both (1) flooding and (2) day-to-day hydraulic conditions are included in the suite of simulations that use a range of initial reservoir elevations and a range of inflow events.</td></tr>
<tr><td>13</td><td>OAS, 11/29/2021</td><td>Given these outstanding questions, I do not believe the H&H Modeling Study as currently presented is adequate to support the determination that Project operations only impact archaeological resources within the current Project boundaries.</td><td>GRDA respectfully disagrees for the following reasons:
The Project boundary encompasses areas up to approximate elevation 750 feet.
Flooding impacts upstream of the Project are due to nature (inflow events) and not Project operations.
GRDA stands by the H&H analysis, which was performed using well-established and accepted scientific practice and methodologies.</td></tr>
<tr><td>14</td><td>OAS, 11/29/2021</td><td>In light of these concerns, I continue to be in agreement with the FERC-approved definition of the APE as issued on November 8, 2018, which acknowledges the potential for Project-related effects to be identified outside the current Project boundary.</td><td>GRDA agrees that the current definition of the APE is appropriate. However, results of the H&H Modeling Study concluded that any potential effects on cultural resources occurring outside the Project boundary are not due to Project operations, but nature. Cultural</td></tr>
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#	Entity	Comment	GRDA Response
			resources that may be impacted due to nature (or other activities not attributable to the Project) do not require study or analysis by the Commission to meet its obligations under Section 106.
15	City of Miami, 11/29/2021	GRDA has wholly failed to examine the flooding impacts of the Project over time, instead focusing entirely on the marginal effects of a narrow slice of present-day Project operations. Although current conditions provide the baseline for analysis, the Commission will still consider pre-project conditions and cumulative impacts of project operations when appropriate.	As stated in Section 1.6.2 above, GRDA anticipates operating the Project between 742 and 745 feet PD. As explained in Sections 1.4 and 4.2.1 above, the Commission and other regulators are not empowered to regulate water surface elevations within the conservation pool, and the Corps has exclusive jurisdiction over flood control. Accordingly, there is no basis to investigate a wider range of hypothetical reservoir elevations, as explained in Section 4.2.2 above. Moreover: • FERC's SPD did not require GRDA to examine flooding impacts over time, and the City of Miami makes no showing that the FERC-approved H&H Modeling Study was not conducted as provided for in the Commission's SPD or that the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way, as explained in Section 4.1 above. • Examining flooding impacts over time is inappropriate, as explained in Section 4.2.4 above. • Regarding cumulative impacts, FERC's long-standing practice is to not require applicants to conduct studies on issues that are limited to cumulative effects, as discussed in Section 4.2.7 above.
16	City of Miami, 11/29/2021	The SPD required the model runs undertaken in the H&H Study to "accommodate a preliminary minimum starting elevation of 734 feet Pensacola Datum ("PD"), and preliminary maximum starting elevation of 760 feet PD," a 26-foot range of starting elevations. GRDA's H&H Study, however, models flooding over just a 3-foot range of starting elevations, with one flawed exception. Contrary to the requirements of the SPD, GRDA also fails to analyze flood effects other than peak depth and extent of inundation. The H&H Study is thus patently deficient, as is every study informed by the results thereof.	In the H&H Study, GRDA ran simulations with starting reservoir elevations as low as 734 feet PD and as high as 757 feet PD. Regarding a starting elevation of 760 feet PD, see the GRDA response to Comment #1. As discussed in GRDA's response to Comment #1, GRDA selected the most extreme inflow event, the 100-year inflow at Pensacola Dam, for the extreme starting reservoir elevations of 734 feet PD and 757 feet PD. The City of Miami incorrectly states that GRDA did not meet the requirements of the SPD. In accordance with the SPD, GRDA developed a model that analyzes the Project's operational effect on frequency, timing, amplitude, and duration of the inundation. The SPD required GRDA to develop a tool to analyze these values. The H&H Modeling Study is not flawed or deficient because the ISR did not explicitly report a value of concern. In accordance with Section 2.6.9 of the *Hydrologic and Hydraulic Modeling Study Revised Study Plan* and the section titled *Model Validation and Information Sharing* of the *Study Plan Determination*, GRDA provided the model to relicensing participants. Further information regarding additional values is included in the model output files and is available to all relicensing participants. FERC has requested additional reporting of hydraulic values. Per GRDA's response to Comment #5, GRDA will include additional tables in the USR.
17	City of Miami, 11/29/2021	The Operations Model Report indicates that the Operations Model is calibrated to the Corps' RiverWare model. However, in the one instance where GRDA compared the Operations Model output against actual data, the Operations Model showed a return to normal reservoir levels weeks sooner than what actually occurred during the same flood. Therefore, it appears that the Operations Model vastly underestimates flooding duration. The City requests that GRDA validate its model against actual flow data, and report on the appropriateness of the RiverWare model as a basis for validation of the Operations Model.	As explained in Section 4.3.1.1 above, GRDA validated its model results against the RiverWare model output in accordance with the FERC-approved study plan. With regard to flooding duration, this is not an issue that the Commission can address in this relicensing proceeding. As explained in Sections 1.4 and 4.2.1, flood control issues are under the exclusive jurisdiction of the Corps, and the Corps' Water Control Manual expressly provides for the gradual release of flood waters to allow for electric generation at downstream federal hydropower facilities.
18	City of Miami, 11/29/2021	Additionally, neither the Operations Model Report nor the H&H Study Report explain how release decisions are made (i.e., who has discretion as between GRDA and the Corps). A 1995 report by the Grand/Neosho River Committee reports on an "unofficial Corps policy" to allow GRDA under some flood conditions to stop spilling water and "generate down" the reservoir level, maximizing power production but increasing flood risk. This crucial operational choice is not mentioned in the Operations Model Report. However, it could explain why, for example, the actual reservoir level during the 2007 flood stayed some five feet higher than predicted by GRDA's models for about two weeks. The actual operational data from that flood, shown below, indicates that GRDA in fact completely stopped all non-generation releases roughly a month before the reservoir returned to its target level: [Figure 1] A detailed explanation of the criteria used for operational decision-making is crucial to evaluating whether the CHM inputs from the Operations Model are realistic. Therefore, in addition to validating the modeled operations against actual data, GRDA should be required to explain the actual decision-making process for each historical event in which modeled operations diverge from GRDA's actual operation of the Project at that time. Additionally, the Operations Model Report does not explain how or why GRDA selected the modeling scenarios it did. GRDA should be required to provide this information.	As explained in Section 4.2.1.3 above, the Operations Model Report references USACE's discretion for release decisions: *Under Section 7 of the Flood Control Act of 1944 (CFR, 1944), the USACE has the responsibility to prescribe releases from Pensacola Dam and Kerr Dam under active or anticipated flood conditions (CFR, 1945). The USACE may exercise direct control over the facilities or provide instructions to GRDA to manage releases for the purpose of basin-wide flood mitigation.* Moreover, as explained in Sections 1.4 and 4.2.1 above, the Corps' directives for the gradual release of water to enhance generation at downstream federal hydropower facilities is not merely "an unofficial Corps policy," as averred by the City of Miami. To the contrary, the Corps' Water Control Manual expressly provides for these operations. Under NDAA 2020, the Flood Control Act of 1944, and the Corps' Water Control Manual, GRDA manages water surface elevations at the Project in accordance with Article 401 of the license until the Corps provides operational direction based on its flood control authority. GRDA resumes its management of water surface elevations once water surface elevations return to 745 feet PD. Questions about how the Corps interprets "active or anticipated flood conditions" in real time as pertains to specific values of reservoir elevation, inflow forecasts, or the total system state are not within GRDA's purview, nor are they subject to the Commission's oversight in this relicensing process.

#	Entity	Comment	GRDA Response
			For these reasons, these additional analyses and information requests by the City of Miami are inappropriate. Not only were they not required by the Commission's SPD, see Section 4.1 above, but obtaining this information would not inform licensing conditions in this relicensing process, as required by 18 CFR § 59(b)(5). Regarding the selection of modeling scenarios, Section 2.6.5 of GRDA's RSP states that six inflow hydrographs, including the 2007 inflow event hydrograph, will be simulated. FERC's SPD required that the 100-year recurrence interval inflow event be simulated. GRDA selected inflow events that ranged from an estimated 1-year return period to a 100-year return period. The wide range of inflow events was selected to determine the impact, if any, that Project operations have on upstream water surface elevations.
19	City of Miami, 11/29/2021	Finally, the Operations Model Report indicates that the Operations Model relies on elevation-reservoir storage ratings from the Corps' RiverWare model. GRDA should, at a minimum, be required to perform a sensitivity analysis by updating the Operations Model to include the 2019 storage curves, re-running the model, and comparing the predicted lake water-surface elevations and volumes for the modeled floods. Using outdated storage volumes could result in simulated Project operations that assume more available reservoir storage than actually exists and could provide inaccurate data for calibrating the Operations Model. The Commission should also require GRDA to analyze and report on the sensitivity of reservoir surface elevation to updated stage-storage information. If the updated stage-storage information causes more than a negligible difference in reservoir surface elevation, GRDA should be required to re-run all modeling scenarios with outputs from the updated Operations Model as inputs to the CHM runs.	Please see Section 4.3.1.6 above.
20	City of Miami, 11/29/2021	*Failure to analyze the full cumulative impact of the Project's existence and operations.* Fundamentally, GRDA fails to simulate the full effect of the dam's presence and historical operations as required to study cumulative impacts, the potential for mitigating harms inherent in the current baseline, and the scope of GRDA's legal liability for flooding under state law.	The FERC-approved study plan did not require GRDA to "simulate the full effect of the dam's presence and historical operations," as averred by the City of Miami, and the City of Miami does not contend that the FERC-approved H&H Modeling Study was not conducted as provided for in the Commission's SPD or that the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way. Moreover, the City of Miami's comment is not supported by well-established Commission policy and precedent with regard to cumulative impacts (Section 4.2.7 above), environmental baseline (Section 4.2.4 above), or issues of liability under state law (Section 4.2.1 above).
21	City of Miami, 11/29/2021	*"100-year" hydrograph dramatically overestimates Neosho River flows.* As indicated in Tetra Tech's June 23, 2021 comments on GRDA's earlier H&H Model Input Status Report, the method for developing the 100-year inflow to Grand Lake is flawed, makes no physical sense, and artificially minimizes the impacts of Project operations on flooding. GRDA determined that the 100-year inflow (from all rivers and creeks) to Grand Lake is approximately 299,000 cubic feet of water per second ("cfs"). It then developed an inflow hydrograph by simply scaling up the 2007 flood hydrographs, resulting in a peak flow in the Neosho River alone (at Commerce gage) of about 308,200 cfs. A flood-frequency analysis of historical Commerce gage flows conducted by Tetra Tech indicates that 308,000 cfs is greater than the 1,000-year flood at that location. By contrast, the Federal Emergency Management Agency's ("FEMA") 2019 Flood Insurance Study applied a 100-year hydrograph with a peak flow of 165,000 cfs at the Commerce gage—just 54% of what GRDA modeled. GRDA's simplistic approach of scaling up the 2007 flood means that its "100-year" scenario actually models a greater-than-1,000-year event on the Neosho River. This is physically unrealistic and hides the impact of Project operations. It is misleading to apply the greater than 1,000-year flood at the Commerce gage for a range of starting water-surface elevations, then use this as the basis to claim that the dam has only an "immaterial impact" on flooding in the City. Instead, the City requests that the Commission require GRDA to develop realistic flood hydrographs as inputs for the 100-year inflow simulation. Specifically, the City requests that the Commission require GRDA to perform flood-frequency analysis at each of the Neosho (Commerce) gage, Spring and Elk Rivers, and Tar Creek gage and perform hydrologic modeling using the HEC-HMS software to develop flood hydrographs at each of the inflow locations that have physically-based rationales for predicting peak flow and volume. Realistically representing the portion of the 100-year inflow that would pass through the Neosho River rather than other tributaries is crucial for accurate modeling of the impacts of Project operations. Moreover, a 100-year reservoir inflow hydrograph that includes 100-year river floods	Contrary to the City of Miami's comment, GRDA did not "simply" scale up the July 2007 inflow event hydrographs. Rather, as explained extensively in Section 5 of the UHM Report, GRDA used a statistical analysis of historical inflow volumes and peak flows to adjust the inflow hydrograph for the July 2007 event. GRDA used established statistical methodology to develop the 100-year inflow event hydrographs. The City of Miami's comment confuses the 100-year return period event *at the Neosho River Commerce gage* with the 100-year return period event *at Pensacola Dam*. Additionally, the City of Miami's comment relies on FEMA's 2019 Flood Insurance Study, a study which used flawed methodology for an unregulated system to create the 100-year hydrograph. The 2019 FEMA study used a single sub-basin to represent the 5,927 square miles that drain to the Commerce gage and the model did not include John Redmond Reservoir. FEMA's model calibration was performed using the 2007 event and model validation was performed using a flood frequency curve computed using statistical methods in USGS's PeakFQ software. FEMA's approach includes the following deficiencies: 1. Not including John Redmond Reservoir (thus treating a regulated system like an unregulated system) and then calibrating to historic data from the regulated system will result in inaccurate model parameters, which will decrease the predictive capability of the model. 2. Statistical methods should not be used to estimate flood frequency for regulated basins. Using statistical methods within PeakFQ to validate the HEC-HMS model does not follow best practices (USGS Bulletin 17C). Regardless, after receipt of the City of Miami's ISR comments GRDA simulated the inflow hydrographs from the FEMA 2019 study, as noted in Sections 3.1 and 4.3.1.9 above. The results of this analysis appear in Appendix B. Despite the methodological flaws in the 2019 FEMA study, the results are very similar to the 100-year event simulation results in the ISR: a starting reservoir elevation difference of 23 feet resulted in no appreciable difference in maximum water surface elevation at the City of Miami. With regard to the City of Miami's request that FERC require GRDA to build HEC-HMS models, please see Section 4.3.1.9 above.

#	Entity	Comment	GRDA Response
		at Miami and other locations on the Neosho River (rather than 1000-year or greater) is far more consistent with the Commission's requirements in the SPD.	
22	City of Miami, 11/29/2021	*Failure to model the full range of Commission-prescribed starting reservoir elevations.* GRDA has failed to model the range of starting elevations for the floods where the availability of Project storage could meaningfully mitigate flooding impacts. Instead of modeling a full range of reservoir starting elevations for all floods—including those that damage the City on a regular basis—GRDA ran only one scenario, the hypothetical 100-year flood event, with anything close to the full range of starting reservoir elevations. For all other events, it modeled only a three-foot range, with starting elevations from 742 to 745 feet PD. That approach artificially minimizes the Project's operational impacts on upstream flooding. This minimization is exaggerated further by the physically unrealistic nature of the hypothetical 100-year hydrograph, as described above. Thus, GRDA's conclusory statements that Project operations have little impact on flood damage are unsupported by any probative analysis. This narrow range also ignores the fact that when the reservoir elevation rises above 755 feet PD, operational control reverts entirely back to GRDA. In stark contrast, previous analysis by Tetra Tech, as well as studies by expert referee Prof. Forrest Holly, show that the Project causes the greatest additional harm to the City during intermediate-sized floods. Similarly, the 2021 analysis by the Corps' Silver Jackets program using different methods concluded that in individual floods, most of the economic damage within Miami accrues at magnitudes between the 10-year flood (estimated damages of $258,000) and 25-year flood (estimated damages of $27 million). In order to sufficiently model the damaging impact of intermediate-sized floods, GRDA should be required to comply with the SPD and analyze starting reservoir elevations between 734 feet and 757 feet.	In the H&H Study, GRDA ran simulations with starting reservoir elevations as low as 734 feet PD and as high as 757 feet PD. As discussed in GRDA's response to Comment #1, GRDA selected the most extreme inflow event, the 100-year inflow at Pensacola Dam, for the extreme starting reservoir elevations of 734 feet PD and 757 feet PD. As discussed in Section 1.6.2 above, GRDA anticipates operating the Project reservoir within the range of 742 feet PD to 745 feet PD. Therefore, GRDA focused on simulated starting reservoir elevations between 742 feet PD and 745 feet PD. Six different inflow events with estimated return periods at Pensacola Dam ranging from 1 year to 100 years were simulated with five different starting reservoir elevations (historical elevation, 742 feet PD, 743 feet PD, 744 feet PD, and 745 feet PD). These simulations represent a matrix of operational conditions and inflow conditions. Given the limitations in this relicensing proceeding regarding the ability for the Commission or other agencies to regulate water surface elevations of Grand Lake (as explained in Sections 1.4 and 4.2.1 above), requiring any analysis beyond this three-foot operating range would be unreasonable as discussed in Section 4.2.2. The City of Miami's concerns regarding the lack of intermediate-sized floods ignore the fact that GRDA simulated events with the following estimated return periods: • 1 year • 3 years • 4 years • 15 years • 21 years • 100 years Finally, the City of Miami is mistaken in its comment that flood control reverts to GRDA when reservoir levels rise above 755 feet PD. As explained in Sections 1.4 and 4.2.1 above, the Corps has exclusive jurisdiction over flood control at the Project. Neither NDAA 2020 nor the Flood Control Act of 1944 specify an upper elevational limit to the Corps' exclusive flood control jurisdiction.
23	City of Miami, 11/29/2021	*Erroneous railway bridge geometry.* The geometry of the abandoned railway bridge at river mile 134.599 is not representative of the actual conditions. The bridge has wide openings between the upper and lower truss, which are about ten feet apart. GRDA's HEC-RAS model represents the area between the lower and upper spans as completely blocked, thus preventing flow between the trusses. This error effectively models the bridge as a solid barrier, rather than a permeable fixture, and likely results in the CHM masking the full flood impact of the Project upstream of the bridge by overpredicting the water-surface elevation due to factors other than the presence and operation of the dam.	Please see Sections 3.1 and 4.3.1.10 above and Appendix C.
24	City of Miami, 11/29/2021	*Confusing new river mile numbering system.* GRDA's studies use a new river mile numbering system. This introduces needless confusion and difficulty because it differs by about eight miles from that of all previous studies—since construction of the dam—of which the City is aware. The City raised this concern in response to the H&H Model Input Status Report. GRDA's only explanation is that it "used [United States Geological Survey ("USGS")] river miles because it is a publicly available dataset." This disregards the need for consistency across studies. In the SPD, the Commission—noting the importance of consistency—required GRDA to use PD instead of NGVD for vertical measurements. Requiring GRDA to use the same system as past studies will similarly avoid needless confusion.	Please see Section 4.3.1.11 above. GRDA followed USGS conventions to define river mile numbering in the model. GRDA consistently used this convention across all studies—the H&H Modeling Study, Infrastructure Study, and Sedimentation Study all use USGS river miles.
25	City of Miami, 11/29/2021	*No analysis of Project impacts on flooding duration, frequency, timing, or amplitude.* The SPD stated that the CHM was intended to, "calculate inundation and flood routing specifics, such as frequency, timing, amplitude and duration[.]" However, the CHM as described in the ISR addressed only the maximum lateral extent and depth of inundation, ignoring all other parameters. During the ISR meeting, GRDA indicated it did not present these factors—even though required by the SPD—in order to "simplify" the results. GRDA's failure to comply with its own study protocols is unacceptable. Moreover, failure to analyze these parameters substantially erodes the accuracy and reliability of the studies that depend on H&H Study results. The Commission should therefore require GRDA to add analysis of the Project's impacts on the frequency, timing, amplitude, and duration of flooding.	Please see Section 4.3.1.12 above.

#	Entity	Comment	GRDA Response
26	City of Miami, 11/29/2021	*No analysis of trends in flood frequency.* The ILP requires study methods "consistent with generally accepted practice in the scientific community," but nothing in the ISR explains the basis for GRDA's methods in performing the flood frequency analysis. At the ISR Meeting, GRDA was clear that it made no attempt to identify trends in the factors that contribute to stream flows and flooding near the Project (notably climate change, but also land use change and sedimentation in upstream flood control reservoirs). This evaluation is important to understanding how environmental trends will affect flooding and sedimentation over the duration of the license period. By turning a blind eye toward possible trends, GRDA assumes without discussion or justification that the magnitude and probability of floods in 2050 or 2070 will be the same as it was a century earlier. That assumption carries forward into every study that relies on the H&H Study results. The Commission should require GRDA to state and provide support for its assumptions about trends in flood frequency, including those due to climate change.	Please see Section 4.3.1.8. With regard to the City of Miami's assertion that GRDA should have included methods in the flood frequency analysis that address climate change, please see Section 4.2.5.
27	City of Miami, 11/29/2021	*No discussion of the extent of flooding beyond Project property rights.* GRDA is liable for any flooding (or increase in natural flooding) it causes beyond the property rights held by GRDA. Nothing in the H&H Study analyzes the extent of that flooding, although previous studies have estimated that it covers 13,000 acres. Even the UHM Study shows that just a three-foot change in starting reservoir elevation makes a difference of hundreds of additional acres flooded. The flood inundation maps in the UHM Report appendices depict the boundaries of Project easements, with flooding that often extends far beyond them. The Commission should require GRDA to quantify the area for which flooding exceeds Project-related property rights for each modeled scenario. In order to inform the Commission's cumulative impacts analysis, GRDA should also be required to demonstrate the extent by which the flooded area under each scenario exceeds the area that would have flooded under natural conditions (i.e., prior to existence of the dam).	Please see Section 4.3.1.14 above. In addition: • The City of Miami misapprehends the whole purpose of the relicensing process. As explained in Section 4.2.1 above, the Commission has no jurisdiction or role to determine whether GRDA is liable for flooding. Such issues are for state courts and are irrelevant in this relicensing proceeding. • The City of Miami ignores limitations on the Commission's jurisdiction and authority with respect to lands outside the Project boundary, as explained in Sections 1.4 and 4.2.1 above. • The City of Miami's allegations related to cumulative impacts and pre-project conditions are inconsistent with well-established Commission policy and precedent, as explained in Sections 4.2.4 and 4.2.7 above.
28	City of Miami, 11/29/2021	*Unsupported conclusions in the H&H Study fail to adequately inform the other studies that depend on it.* One of the stated objectives of the UHM report is to "provide the model results in a format that can inform other analyses (to be completed separately) of Project effects, if any, in several resource areas." The report fails to do that. Instead, the executive summary and conclusions offer nothing but conclusory statements, with no link to supporting model analysis. For example, the report claims that "[t]he results of the UHM demonstrate that the initial stage at Pensacola Dam has an immaterial impact on upstream [water surface elevations] and maximum inundation extent" and that Project operations do not cause "an appreciable difference in maximum water surface elevation ("WSEL") and maximum inundation extent." GRDA entirely omits any explanation of what degree of Project-caused flooding is "immaterial" or what increase in WSEL (let alone other flooding parameters) is "appreciable." At the ISR meeting, GRDA was unable to provide any numerical criterion or citation to a source for these conclusions. Yet many of GRDA's other studies—and requests to reduce future work or terminate them early—cite exactly those conclusions from the H&H Study. The Commission should require that the H&H Study, rather than stating unsubstantiated conclusions, instead do what it said it would and "provide the model results in a format that can inform other analyses (to be completed separately) of Project effects… in several resource areas."	Please see GRDA's response to *FERC Staff Comment #5.* In addition, GRDA does not agree with the City of Miami's assertion that the H&H Modeling Study is supported only by "conclusory statements." To the contrary, GRDA has exerted considerable resources—building on the work first developed by the City of Miami's own consultant Tetra Tech—in investigating whether and the extent to which flooding in the vicinity of Miami are attributable to Project operations. After years of studying this issue, GRDA has concluded—in a study report that spans over 1,000 pages of analysis—that Project operations are not the cause of flooding in Miami. The phrases "immaterial impact" and "appreciable difference" in the H&H Modeling Study are simply an attempt to succinctly capture the immense difference between the effect that dam operations have on the upstream water surface elevations/inundation extents compared to the effect that inflow events have on upstream water surface elevations/inundation extents. The statements that Project-caused flooding is "immaterial" and the increase in water surface elevation is not "appreciable" come from quantifications such as nature's 70-fold greater impact compared to the Project operation's impact, as demonstrated in the H&H Modeling Study.
29	USFWS, 11/30/2021	The studies provided N and roughness values to estimate current flooding risks, but this may not represent flooding risks for the license period of 30 or more years. The levels of woody encroachment within the flood plain are likely to continue over time and this will increase roughness values and inundation risks. Changes in roughness, upstream flood control reservoirs filling with sediment and reduced storage, and climate effects over a 30 year or more period may combine to increase inundation levels and durations during the license period.	This matter has already been discussed as resolved by the Commission in its SPD. FERC did not require GRDA to speculate what changes in roughness and land cover, sedimentation of upstream reservoirs, or climate change, that could occur in the future. In addition, please see Section 4.2.5 above.
30	Southwest Power Administration, 11/30/2021	Southwestern's primary concern with the Pensacola relicensing is the operation and timing of Pensacola releases. Any proposed change in operational releases as a result of relicensing should be fully vetted with Southwestern and the other downstream Federal, State, and local agencies which may be impacted. Significant increases or decreases in releases as a result of changed operations could have negative impacts on hydropower and the other Congressionally authorized purposes at Fort Gibson and the four downstream Arkansas River Federal hydroelectric projects. Southwestern and the Corps have a Memorandum of Understanding (MOU) that states the responsibilities of both parties relating to the operation of the hydropower projects. Any changes to the operation and timing of Pensacola releases	As discussed in Section 1.6.2, GRDA does not anticipate any changes to the Corps' flood control operations at the Project, including the requirements in Section 8-07 of the Water Control Manual, which states: *The regulation plan for the Arkansas River basin described in the Master Manual enhances power production at all the hydropower plants in the basin by providing a tapered recession of flood control storage evacuation. This provides more days of generation time before the flood control storage is depleted. The hydropower operation provides flows for the downstream run-of-river hydropower projects Markham Ferry, Fort Gibson, Webbers Falls, Robert S. Kerr, Ozark and Dardanelle.*

#	Entity	Comment	GRDA Response
		should not create undue difficulty for Southwestern or the Corps in meeting the needs of the Congressionally authorized purposes of the downstream projects and their responsibilities under the MOU.	
31	Southwest Power Administration, 11/30/2021	Additionally, as the relicensing effort continues to assess proposed operational changes for Pensacola Dam, the reliability of the electric grid should be a primary criterion. Dispatchable hydropower has become an even more vital component of grid reliability as additional nondispatchable renewable resources have been added to the generation mix. The relicensing should preserve or increase the flexibility of GRDA operations to respond to grid emergencies.	GRDA agrees with the need for flexibility of Project operations. As discussed in Section 1.6.2, GRDA anticipates adopting an operating range between 742 feet PD and 745 feet PD. This operating range would give GRDA the ability to help increase electric grid reliability and operate the Project in a way that responds to grid needs.
32	Southwest Power Administration, 11/30/2021	Finally, there was discussion pertaining to the flood releases and flood control operations at Pensacola during the ISR meetings. Southwestern would like to remind those involved in the relicensing that the National Defense Authorization Act for Fiscal Year 2020 states that the Secretary of the Army, acting through the Corps, has “exclusive jurisdiction and responsibility for management of the flood pool for flood control operations at Grand Lake O’ the Cherokees”. Any action involving management of the flood pool or flood control operations will be the responsibility of the Corps.	As explained in Sections 1.4 and 4.2.1 above, GRDA agrees with this comment from the Southwest Power Administration.
33	BIA, 11/19/2021	Executive Summary, last paragraph, and Conclusion. “The results of the UHM demonstrate that the initial stage at Pensacola Dam has an immaterial impact on upstream WSELs and inundation. Only a different inflow event caused an appreciable difference in maximum WSEL and maximum inundation extent. The differences in WSEL and inundation extent due to the size of the inflow event were an order of magnitude greater than the differences in WSEL and inundation extent due to the initial stage at Pensacola Dam.” A further explanation of what an immaterial impact is and what specifically it is regarding is needed.	See GRDA’s response to Comment # 5.

4.5.2 Sedimentation Study

#	Entity	Comment	GRDA Response
1	FERC Staff, 11/24/2021	The Sedimentation Study Report states that the hydraulic calibration of the Sediment Transport Model is on-going, and the report will be updated by the end of the year. When filing the updated report, please clearly detail which, if any, roughness coefficients and/or flow roughness factors were changed to calibrate the model, and please provide an explanation for those changes.	GRDA has provided that information in Section 5.1.2.1 “Changes Since October ISR Conference” of the Sedimentation Study report (Appendix D), as requested.
2	City of Miami, 11/29/2021	GRDA’s full Sedimentation Study is now more than two months overdue. In the ISR, GRDA states that it has not yet finished calibrating the sediment transport model, much less produced any model results for review. GRDA characterizes this near-total lack of reported results as having “completed [the study] in accordance with the RSP, as modified by the Commission staff in the SPD, except for one variance in schedule.” GRDA “plans”—with no commitment—“to provide the full report and access to a calibrated model to all stakeholders” by the end of this year, followed by “a virtual meeting with interested relicensing participants to present the calibration in January 2022.” Adding insult to injury, it is the City’s understanding that GRDA does not propose to request that the Commission allow stakeholders to provide comments on its untimely submittal. GRDA’s failure to comply with the Commission’s established deadline for the Sedimentation Study also has an adverse effect on the Commission’s ability to reevaluate the need for the Contaminated Sediment Transport Study as requested by the City. In light of the insufficient sedimentation information provided thus far, the City respectfully requests that the Commission permit the filing of supplemental comments within thirty days after the City’s receipt of the later of the Operations Model and the full Sedimentation Study Report and model, and adjust the deadlines set forth in the Commission’s regulations—including the Director’s resolution of disputed modification requests—accordingly. As part of those comments, the City should be allowed to request further modifications to the H&H, infrastructure, sedimentation, and socioeconomic studies, to the extent that the request could not reasonably have been made without having reviewed the Operations Model and full Sedimentation Study Report and model.	The original Sedimentation Study schedule was set with the understanding that the sediment present in the system was largely non-cohesive sand. During collection of grab samples for grain size analysis, GRDA found a significant portion of the sediment to be cohesive silts and clays. This change in grain size analysis was contrary to the City of Miami’s July 26, 2018 characterization of sediment: *Although some gravel is present in the bed, the Neosho and Spring River channels are primarily sand in the critical part of the study; thus, this material is most likely mobile over essentially the entire range of flows that can occur in the relevant reaches.* The cohesive sediment requires more detailed information to produce a sediment transportation study. This includes determination of critical shear stress and erosion rate throughout the sediment column using SEDflume testing as referenced in the ISR. It also requires an assessment of sediment density as a function of depth within the bed. While some samples in riverine sections consist of non-cohesive materials (primarily gravel, with some sand and cobbles), other samples consist of silt and clay. In a number of locations in close proximity, one sample was primarily non-cohesive and a nearby sample was cohesive. The wide variations in sediment sizes covering approximately 5 orders of magnitude in range indicate a wide array of sediment behavior with respect to erosion. For example, SEDflume sample analysis shows the following: sediment bulk density covers a range of 485%, critical shear stress covers a range of 3,000%, erosion rates cover a range of 10,000%. Cohesive sediment modeling requires inclusion of all these parameters, in addition to parameters associated with non-cohesive sediment which both exist along these rivers and reservoir. These factors combine to significantly increase the complexity of sediment transport modeling of this river and reservoir system. As a result of GRDA’s work—which, again, contradicts the previous representations that the City of Miami made to FERC staff, and which FERC staff adopted in its SPD—GRDA is proposing a significant change to the Sedimentation

#	Entity	Comment	GRDA Response
			Study during the second study season. A modified study plan appears in Appendix E of this Response, and GRDA will be convening a technical meeting to review the Sedimentation Study results and its proposed modified study plan on January 14, 2022, as provided in Section 3.2 above.
3	City of Miami, 11/29/2021	In the SPD, the Commission required GRDA to adopt the City's proposed methodology for conducting its Sedimentation Study. As such, the City is uniquely suited to review the Sedimentation Study as described in the ISR. As noted above, GRDA has not yet submitted its full Sedimentation Study. Instead, GRDA provided only limited detail regarding data collection and model development. In anticipation of eventual receipt of the full Sedimentation Study, the City offers the following initial comments and proposed modifications in response to the Sedimentation Report provided in the ISR. The Sedimentation Report does not analyze cumulative impacts such as loss of reservoir storage due to sedimentation, which is a cumulative impact going back to completion of the dam. Similarly, the Sedimentation Study as described does not appear to consider the cumulative effect of sediment that has settled out and accumulated over decades in tributary channels and/or the head of the reservoir, further compounding the backwater effect upstream. Additionally, the Sedimentation Study, as informed by the H&H Study, fails to consider whether lower elevations at the start of a flood could transport sediment deeper into the reservoir, where the reservoir's presence has historically caused accumulation of dozens of feet of sediment that contribute to upstream backwater flooding . More broadly, the Sedimentation Study should also be expanded to consider trends in future hydrology, including the effects of climate change over the term of the new license.	GRDA disputes the City of Miami's claim that GRDA has provided only "limited detail regarding data collection and model development." All data from data collection have been provided in the ISR. The ISR also provided a discussion on the model development including how the model would be calibrated with specific time periods and corresponding bathymetric data over which model computations are being compared to actual data. The City of Miami contends that there have been "dozens of feet" of sediment deposition on the bed of the river and lake bed. This statement requires acceptance of data that is demonstrably unreliable. As shown during the ISR and associated presentation, the 1998 REAS datasets suggest that the riverbed is above water surface elevations recorded by the USGS at their monitoring site on the Elk River. This physically impossible scenario demonstrates the unreliability of the 1998 REAS bathymetry. The 1998 REAS data also includes an implausibly smooth thalweg profile at multiple locations in the Neosho River in contrast to the variable thalweg profile present in surveyed bathymetric data of natural channels. Comparisons to subsequent surveys by OWRB (2009) and USGS (2019) indicate that in some reaches of the Neosho, 20-30 feet of sediment were purportedly deposited between 1998 and 2009, while only 2-3 ft were deposited between 2009 and 2019. An analysis of sediment transport during these time periods using the sediment transport rating curves applied to historic daily flows showed sediment transport from 1998 to 2009 is similar in magnitude to 2009 to 2019. There is no known physical phenomenon that would explain this massive shift in deposition patterns given the similar incoming sediment loads over these two periods of time. These unrealistic features and evaluation of the 1998 dataset suggest that it is unreliable and should not be used as a basis to argue that there are "dozens of feet" of sediment deposition within the study area. Regarding the City of Miami's comments on cumulative impacts, please see Section 4.2.7 above. It should be noted, too, that the City of Miami's comment advocates for extra analyses which are not required as part of the FERC's SPD. The City of Miami has not demonstrated justification for requesting a study plan modification at this time, as explained in Section 4.1 FERC's SPD did not require GRDA to examine trends in future hydrology including the effects of climate change over time, and, as discussed in Section 4.2.5 above, such an analysis would be inconsistent with governing FERC policy and precedent.

4.5.3 Aquatic Species of Concern Study

#	Entity	Comment	GRDA Response
1	FERC Staff, 11/24/2021	The approved study plan requires that GRDA review information on the habitat preferences and spatial and temporal patterns for the federally endangered Neosho mucket which occurs in the project vicinity, and if existing information is inadequate, conduct targeted field surveys during the second study season to estimate Neosho mucket distribution. Section 3.1.3 of the Aquatic Species of Concern Study Report presents a review of existing information on Neosho mucket, and indicates that live Neosho mucket may occur in the Elk River portion of the project boundary, but not in the Spring or Neosho river portions of the project boundary. Therefore, the ISR only proposes to conduct targeted freshwater mussel surveys in the Elk River. However, table 3 in section 3.1 of the Aquatic Species of Concern Study Report indicates that EcoAnalysts (2018) reported live Neosho mucket in the Oklahoma portion of the Spring River. Please clarify where, along the Oklahoma portion of the Spring River, the live Neosho mucket were found relative to the project boundary. In addition, please explain whether or not the proposed freshwater mussel survey will be expanded to include the Spring River, and if so, please file updated methods. If the proposed survey will not be expanded to include the Spring River, please explain why not.	Table 3 in section 3.1 references a study completed by Eco Analysts Inc. in 2018 for USFWS as part of continued Natural Resource Damage Assessment and Superfund Site litigation within the Tri-State Mining District. When preparing the ISR, GRDA unsuccessfully attempted to obtain a copy from the company as well as the Colombia Missouri USFWS office it was prepared for, as GRDA was informed that the report was subject to a non-disclosure agreement. Subsequent to the ISR, and in response to Commission staff's comment, GRDA has been able to review and report on this document. GRDA greatly appreciates USFWS's assistance in helping GRDA obtain access to this report. On the Spring River in Oklahoma, Eco Analysts performed a reconnaissance assessment at 13 sites in August of 2016. At each site they noted the area of habitat, habitat characteristics, qualitative unionid community and sediment metals concentrations. From the qualitative surveys, "Spring 19" contained 5 Neosho mucket (Lampsilis rafinesqueana) in 2016. Subsequent quantitative assessments in 2017 at this location were unable to locate any Neosho muckets for a density calculation; suggesting that at this mussel bed the Neosho mucket occurs in low densities. A summary of the EcoAnalysts findings on the Spring River can be found in Appendix F, Table 1 of this Response. The location of Spring 19 and Spring 20 mussel bed complex is about 1.5 miles upstream of the Project boundary adjacent to the Peoria Tribe Fish Hatchery. The Peoria Tribe has been an active participant in the conservation of this species, having released mussels raised in their fish hatchery in both the Spring and Neosho Rivers. Whether these individuals found represent the Peoria Tribe's efforts to conserve the species, a natural occurrence, or a combination of both is unknown. The

#	Entity	Comment	GRDA Response
			Neosho mucket was also observed at “Spring 14 and Spring 15,” which are approximately 6.25 miles upstream of the Project boundary at Bicentennial State Park during qualitative analyses. No quantitative analyses were performed as these locations were not indicative of a significant unionid community per their assessment. Given the extensive and timely work performed by various entities regarding freshwater mussels on the Spring River reach in question, GRDA has concluded that additional surveys are unwarranted and does not propose further study on this river. The habitat requirements for the Neosho mucket as well as other listed mussel species of concern become increasingly incompatible with water conditions in further downstream reaches of the river, including within the Project boundary. The Neosho mucket is typically associated with shallow riffles and runs comprised of gravel substrate with moderate to swift currents. Previous research has suggested the species evolved in the Spring River and Ozark highland streams as its foot is adept at clinging to gravel in swift moving water. The unionid mussel beds that EcoAnalysts 2018 located had moderately swift runs and with stable gravel and cobble. Of the 3 sites the EcoAnalysts 2018 study visited within the Project boundary, the two most downstream sites, Spring 23 and 24, did not have suitable unionid habitat. The Spring 22 site, which is located near the very edge of the Project boundary, had 650 m^2 of suitable habitat but a very low Catch Per Unit Effort rate at 0.3 live unionids/10 minutes; no Neosho muckets were found. The species found at Spring 22 included the Plain Pocketbook (L. Cardium), Blufer (P. purpuratus), and threehorn wartyback (O. reflexa). These are widespread species tolerant of impoundment or reduced river flows. Angelo et al. (2007) surveyed a site (Spring 9) between the EcoAnalysts Spring 23 and 24 sites and found the same previously mentioned species as well as fragile paper shell (L. Fragilis), giant floater (P. grandis), and Fragile heelsplitter (P. ohiensis). All these species are tolerant of impoundment conditions and within the species pool for the larger reach of river. Surveying farther downstream from the Project boundary (i.e. warren branch) is unlikely to find any species of concern as the environment changes markedly as the river transitions into lacustrine conditions. Furthermore, both Angelo et al. 2007 and EcoAnalysts 2018 found metal concentrations in the Spring River to be problematic for freshwater mussel richness and diversity. Given the habitat preferences of the Neosho mucket, as well as possible pollution concerns from the Tri-State Mining District, GRDA has concluded that the species is unlikely to occur within Project boundary. Furthermore, if species of concern do occur, the EcoAnalysts study demonstrates that quantitative assessment would likely be impossible due to their low density. Therefore, GRDA intends to focus on the largest data gap identified with respect to the Neosho mucket which occurs on the Elk River. To GRDA’s knowledge, no surveys have been completed on the Oklahoma side of the Elk River (within Project boundary), and the habitat condition seems favorable for the species to persist. Moreover, the Elk River does not have the same water pollution considerations (i.e., metal concentrations) as demonstrated on the Spring River.
2	FERC Staff, 11/24/2021	As discussed above, the ISR proposes to only conduct a freshwater mussel survey in the Elk River during the second study season. Section 3.1.3 of the Aquatic Species of Concern Study Report includes methods for conducting the freshwater mussel survey and indicates that a minimum search time of five person-hours (divided into five one-person hour long searches) will be conducted within the delineated search area. However, the subsequent sentence indicates that if no mussels are encountered after the first three one-person hour searches, surveys will cease, and it will be assumed that no live mussels are present. The latter sentence suggests that the minimum search time will be three person-hours and not five person-hours. Please clarify the minimum search time that will be conducted in the search area, provide an estimate of the total area (or river length) of the Elk River to be surveyed, and an estimate of how great an area (or river length can be surveyed per person hour. In addition, the proposed study does not include methods for determining the location of each one-person hour search. To evaluate the proposed study, we need to fully understand the methods. Therefore, please explain the methods that will be used to determine the location of each one-person hour search.	The five person-hour effort was originally proposed as a very conservative approach based on previous studies within the region. Oklahoma does not have an approved mussel survey protocol or specific guidelines from the USFWS or ODWC. However, the minimum effort required according to the Kansas Department of Wildlife and Park’s (KDWP) guidelines is 1 person-hour with no mussels detected. Based on these guidelines, as well as recent coordination with a regional malacologist, GRDA has concluded that a minimum of 3 person-hours with no mussels detected is a conservative approach and should be more than sufficient to assess mussel presence. The survey area proposed for mussels within the Elk River, as identified in the Study Plan, will cover approximately 1 mile of Elk River from the confluence with Buffalo Creek upstream to the Missouri state line. Qualitative: An initial survey will be conducted moving from downstream (the mouth of Buffalo Creek) to upstream (the Missouri state line) to identify the presence of suitable unionid habitat focusing on preferred habitat for the Neosho mucket (riffles and runs with moderate to swift currents and stable gravel substrate). The Neosho mucket tends to prefer sites with larger gravel as such sites could be more stable and less compacted than sites with overall smaller gravel, and with a large variation in gravel size as these areas could provide good water flow through the streambed (ODWC 1997). Wherever suitable habitat is identified, the location will be delineated, and surveys will be limited to those areas. Surveys will continue moving upstream until all suitable mussel habitat within the 1-mile study area is delineated. A minimum search time of three one-person-hour effort will be conducted within each of the identified suitable habitat areas delineated during the initial survey. At the end of each search period (3-person-hour), collected mussels will be identified, enumerated and held in mesh bags until the end of the survey at which time all mussels and shell material will be returned to the survey area where they were collected. If no live mussels are encountered during the third person-hour of effort, surveys within that search area will cease and it will be assumed no live mussels are present.

#	Entity	Comment	GRDA Response
			Quantitative: If during initial survey any listed live mussels are encountered, quantitative surveys will be performed by visual and tactile searches of randomly placed 0.25 m^2 quadrat plots within mussel beds identified. Substrate within the quadrats will be excavated to a depth of 20 cm and sieved, as this increases the likelihood of detecting juvenile mussels (Smith et al. 2000). All live individuals collected will be identified, enumerated, and returned to the approximate location of collection. Shell material will also be collected and quantified during sampling from the stream and classified as fresh dead (FD; intact periostracum and lustrous nacre), weathered dead (WD; intact periostracum, weathered and chalky nacre), or subfossil (SF; shell chalky, no periostracum). The number and species of mussels collected as well as the density of the mussel bed will be recorded/calculated. At the end of each search period, collected mussels will be identified, enumerated, and returned to the survey area where they were collected. Searchers will start at the downstream extent of the search area (suitable mussel habitat) and begin searching from downstream to upstream ensuring that all of the suitable mussel habitat within the search area is sufficiently surveyed to determine if mussels are present. The area of each mussel bed identified will be delineated and included as part of the study. The exact length covered per person-hour of survey is difficult to determine as it can vary dependent upon multiple site conditions (substrate type/size, water depth, water clarity, flow, number of mussels present, etc). However, based on GRDA's understanding of the site conditions present within this section of the Elk River, it is reasonable to expect that each person-hour of searching will cover a maximum of 1000 feet of river.
3	FERC Staff, 11/24/2021	The approved study plan requires that GRDA review existing information on the habitat preferences and spatial and temporal patterns of the federally threatened Neosho madtom which occurs in the project vicinity, and if existing information is inadequate, conduct targeted field surveys during the second study season to estimate Neosho madtom distribution. Section 3.4.1 and 3.4.3 of the Aquatic Species of Concern Study Report presents existing information on the occurrence of Neosho madtom, which indicates that Neosho madtom populations are located in the Neosho River and have been found in Neosho River drainages of the study area as recently as 2007. However, during the most recent surveys conducted in 2016, no Neosho madtom were observed. Because the most recent surveys were conducted 5 years ago, the report proposes to conduct a targeted Neosho madtom field survey in a portion of the Neosho River and assess habitat quality upstream of the area of the targeted madtom field survey. Section 3.4.3 of the Aquatic Species of Concern Study Report includes proposed methods for the targeted madtom field survey, but does not include any methods regarding how and where habitat quality will be assessed upstream of the targeted madtom field survey. So that we can evaluate the proposal to search for additional Neosho madtom habitat upstream of the targeted madtom field survey, please provide as much detail as possible regarding the methods for determining madtom habitat quality upstream of the targeted Neosho madtom field survey area, including where and how habitat quality will be assessed.	The Neosho madtom has similar habitat preferences to many native mussel species. EcoAnalysts (2018) provided an assessment of the substrate in both the Spring and Neosho rivers, to assess presence and habitat quality for freshwater mussels. GRDA anticipates conducting surveys at the locations identified by EcoAnalysts (2018) within both the rivers as well as suitable habitat within other areas where madtoms may occur beyond what has been visited in past research, extending from approximately 3 miles upstream of the Project boundary into the upper end of the Project boundary. This will include EcoAnalyst sites 21-24 on the Spring River and sites 2-6 on the Neosho River. This will be completed on the Spring River by floating from the I-44 bridge south to site 24 and on the Neosho River from approximately site 2 continuing south to site 6 immediately downstream of the I-44 bridge. Surveys will be limited to areas of suitable habitat quality. The Neosho madtom inhabits riffles composed of unconsolidated sand and pebbles with moderate flow and depth. Moss (1981) reported that Neosho madtoms were only abundant on riffles containing abundant 8−16 mm diameter gravel that is not compacted. Therefore, to assess habitat quality at each riffle not previously identified by EcoAnalysts in 2018, a substrate sample will be collected from near the center of each riffle. Water depth and velocity will be measured at each riffle with a current meter and wading staff. The substrate sample will be sieved on site using a series of sieves (ex. 38 mm, 19 mm, 9.5 mm, and 2 mm) to determine the particle size distribution. If the substrate is not compacted and over 50% by volume of the of the riffles contains gravel 8-16 mm in diameter, the riffle will be considered suitable habitat. The suitable habitat area (m^2) will be delineated at each survey site. Following habitat assessment, each site will be sampled via kick seining. Kick seining is a common method for the assessment of benthic species in swift moving water. This technique is particularly well suited for madtoms which inhabit the interstitial spaces of gravel.
4	FERC Staff, 11/24/2021	Based on the review of existing information on the habitat preferences and spatial and temporal patterns of the federally threatened Neosho madtom required in the approved study plan as discussed above, the Aquatic Species of Concern Study Report concludes that Neosho madtom populations are restricted to the Neosho River. Therefore, GRDA proposes to conduct a Neosho madtom survey in the Neosho River portion of the study area. However, during the ISR Meeting, ODWC stated that Neosho madtom were collected in the Spring River in 2021. Based on the information provided by Oklahoma DWC, the study may need to include the Spring River in the Neosho madtom survey so that accurate species distribution information is available for our NEPA analysis. Therefore, please consult with Oklahoma DWC on the occurrence of Neosho madtom in the study area and surrounding drainages. In addition, if Neosho madtom do occur in the Spring River, please explain whether or not the proposed survey will be expanded to include the Spring River, and if so, please file updated methods. If the proposed survey will not be expanded to include the Spring River, please explain why not.	At the ISR meeting both USFWS and ODWC indicated that there were instances of occurrence of Neosho madtom within the Spring River that were overlooked. After further research from this discussion, GRDA was able to locate a record in an online Field Notes Entry dated October 1, 2007 indicating the discovery of one Neosho madtom at Bicentennial State Park (6.5 miles upstream of the project boundary) on October 10, 2007. (Note: The dates do not align on the Field Notes Entry in the database.) This USFWS survey was based on the results of 2006 survey by the Peoria Tribe of Indians, which also found a single occurrence of the species at this same location. At the time, USFWS believed this was the first time the species had been documented in the lower Spring River. GRDA reached out to ODWC after the ISR meeting and was able to obtain a recent sighting record that also occurred on 8/12/2021 again at Bicentennial State Park (36.96167, -94.72163). ODWC was able to collect 12 individuals in their effort from this location. ODWC has no other records of the species' presence or absence downstream of this point.

#	Entity	Comment	GRDA Response
			Based on continued consultation and feedback from the ISR meeting, surveys will be expanded to include portions of the Spring River immediately upstream and within the upper reach of the study area. The study area and methods for this additional study work appear in GRDA's response to Comment #3, above.
5	FERC Staff, 11/24/2021	The approved study plan requires that GRDA review existing information on the habitat preferences and spatial and temporal patterns of the Neosho smallmouth bass that occur in the project vicinity, and if existing information is inadequate, conduct targeted field surveys during the second study season to estimate Neosho smallmouth bass distribution. Section 3.5.3 of the Aquatic Species of Concern Study Report indicates that there are no data indicating that Neosho smallmouth bass occur within the study area. Therefore, the ISR does not propose to conduct targeted field surveys during the second study season to estimate Neosho smallmouth bass distribution. However, during the ISR Meeting, Oklahoma DWC staff indicated that Neosho smallmouth do occur within the study area. Based on the information provided by Oklahoma DWC, there may be a need for targeted field surveys within the study area, so that accurate species distribution information is available for our NEPA analysis. Therefore, please consult with Oklahoma DWC on the known locations of Neosho smallmouth bass in the study area and file those locations. In addition, please explain whether or not the second study season will include the targeted field surveys discussed above, and if so, please file the proposed survey methods. If targeted field studies are not proposed for the second season, please explain why not.	Neosho smallmouth bass (*Micropterus dolomieu velox; NSB)* is a subspecies of smallmouth bass (*Micropterus dolomieu)* native to the Ozark Highlands. Because of the ability to cross breed within the species, the Neosho smallmouth bass must be determined genetically. Prior to the advent of widespread genetics research and the now known importance of conservation genetics, many lakes and rivers in the four-state region were stocked with various strains of smallmouth bass native to larger river systems in the hope that it would create more angling opportunities for fisherman. Grand Lake was never stocked with non-native strains by ODWC. Within the Project area, Honey Creek and Buffalo Creek were found to have genetically pure populations of NSB. In general, rivers and streams that flow off the Ozark Highlands (east side of the lake) within the Grand Lake Watershed contain predominantly pure NSB, NSB backcrosses, or F_2 crosses, demonstrating that the unidirectional movement toward NSB from other strains and the dominant presence of NSB. Hence the concern for the conservation of this unique subspecies genetics particular to the tributaries of Grand Lake. Streams within the watershed tested with pure or near pure NSB genetics include Elk River, Buffalo Creek, Indian Creek (Missouri), Big Sugar Creek (Missouri), Honey Creek, and Sycamore Creek (Taylor et al. 2018). Furthermore, the genetic diversity of NSB populations is higher in larger river systems (e.g. Elk River and its tributaries) than smaller systems (Honey Creek, Sycamore Creek) that drain directly into Grand Lake. Through continued consultation, as recommended by Commission staff, GRDA and ODWC have rectified the miscommunications in earlier consultations regarding the NSB topic. Although ODWC's prior comments indicated that NSB did not occur within the reservoir, the ISR was incorrect in stating the NSB does not occur in surrounding drainages (tributaries). However, per the ODWC comment (See Response to Comment #11) on the ISR, no further study on this species is required or requested in the second season. Since there is no request for additional study on the sub-species by ODWC, GRDA does not propose additional study.
6	USFWS, 11/30/2021	Additional surveying of mussels in the Neosho and Spring rivers could be beneficial; however, such surveying should be designed in consideration of survey work that has been completed recently as well as survey work planned in the area that is fairly certain to occur. The Tri-State Mining District mussel assessment (EcoAnalysts Inc. 2018) is the primary recent work that should be considered. In addition, the Tar Creek Trustee Council (TCTC) is planning mussel surveys of some Spring River tributaries that might include sampling of river sites at the mouth s of those tributaries. Details of the planned surveys are currently not available but should become available from the TCTC soon.	GRDA appreciates the USFWS comment.
7	USFWS, 11/30/2021	In conserving federally listed mussels, the Service looks at locations and timing of studies performed by different parties and encourages separation of those studies so as not to facilitate conflicts between studies or subject any given sites to sampling that is excessive, in terms of stressing the mussels present. Although the EcoAnalysts assessment was quite robust, we recommend obtaining information about the mussel communities of the Neosho and Spring rivers, especially the former, if the information is derived from locations other than those surveyed by EcoAnalysts or in the upcoming TCTC studies. For example, we recommend mussel surveys of the Neosho River downstream of Miami, OK, and of the Spring River downstream of Warren Branch to add new information for mussels near the Pensacola Project and assist with relicensing issues. Other areas of the Neosho River upstream also remain under-surveyed and are indicated by consideration of the coverage by EcoAnalysts. We recommend that the Grand River Dam Authority coordinate with EcoAnalysts, Inc., the TCTC, and this office, in the specific design of any mussel surveys it seeks to perform.	The Neosho and Spring rivers have a long history of mussel surveys spanning the entire period of the current project license. The Elk River is the only site which has a known and sustained threatened and endangered mussel population near the project boundary. The Elk River is considered critical habitat and has a substantial data gap. The most recent study performed by EcoAnalysts Inc (2018) included 6 locations along the Neosho River, 4 of which occurred in Project boundary. At these locations, no Neosho muckets or other federally listed mussel species were found in their surveys. Mussels found by the surveys indicate generalist mussel species with a tolerance for deeper water and both lentic and lotic conditions. Additional surveys downstream are unlikely to locate the threatened and endangered species in the Neosho and Spring River. For more information, please see GRDA's response to FERC's Comments 1-2, above. There are a couple of contextual things GRDA is considering as well with these previous studies. First, it's been reported the Grand River (and by interference the Spring River) in 1925 prior to the construction of the Pensacola Dam, lacked mussels during the early 20th century (Angelo et al., 2007). Whether this was due to historical mining activities, overharvest for the pearl button industry or a combination of both is unclear. However, both rivers seem to have increased mussel density regardless of the operation of the Project in the upstream sections. Second, it's been documented in the 5-year status review that USFWS, academia, and the Peoria Tribe of Indians released 200,000 Neosho mucket juveniles into the Spring River in 2008 in areas under Peoria Tribal Jurisdiction, and 516,400 juveniles at Stepps Ford Bridge on the Neosho River. At Stepps Ford Bridge only one live Neosho mucket was found in a survey in 2014 (USFWS 2018). The EcoAnalysts surveyed the site in 2017 and was unable to locate the Neosho mucket despite having a high CPUE rate of 35.3 live unionids/10 minutes. The 3500 m^2 Stepps Ford Bridge site is located at the edge of the Project boundary and contains gravel substrate and bedrock, with swift current velocities and is ideal habitat. Coincidentally, these are the same habitat characteristics required for Neosho madtom. This area and upstream are where most of the madtom sightings are concentrated. Finally, the problem of moving downstream for more mussel surveys on the Neosho River encounters the same problem as that of the Spring River as discussed in GRDA's response to FERC's Comment 1 above: as the river runs downstream into the Project area, it slows and deepens, and the habitat is not conducive to the federally listed species of concern.
8	USFWS, 11/30/2021	The Service recommends Neosho madtom surveys on the Spring River, in addition to those proposed on the Neosho River. While we agree that habitat in the lower Spring River is impacted by metals related to mining wastes, we believe	Please see GRDA's response to Commission staff Comments 3 and 4, above.

#	Entity	Comment	GRDA Response
		that habitat conditions could improve during the license period and we do not agree that extant populations in Oklahoma are limited to the Neosho River. We request that the Grand River Dam Authority consult with our office for locations and methods of surveys for Neosho madtoms.	
9	ODWC, 11/16/2021	Section 4.3.5 of the ISR states that Neosho Smallmouth Bass does not occur within the study area or surrounding drainages. This statement is false, as Taylor et al. (2018) genetically identified Neosho Smallmouth Bass within multiple tributaries of Grand Lake O' the Cherokees, as well as in surrounding drainages. Although Neosho Smallmouth Bass may not require further sampling efforts for the scope of the ISR, removing them from the list of species that may be impacted by the project is inadvisable and ultimately irresponsible.	The work performed by Taylor et. al. (2018) demonstrated that the subspecies occurs within the tributaries surrounding the project area. Please see GRDA's Response to Commission staff's Comment #5.

4.5.4 Terrestrial Species of Concern Study

#	Entity	Comment	GRDA Response
1	USFWS, 11/30/2021	The FERC and U.S. Army Corps of Engineers do not have any incidental take coverage for Indiana and northern long-eared bats at the Pensacola Project under existing biological opinions. The Service recommends that both agencies initiate section 7 consultation in compliance with the Endangered Species Act.	GRDA expects FERC to complete its obligations under section 7 of the Endangered Species Act as part of the ongoing relicensing of the Project. Although GRDA is unaware of any federal action that would trigger the Corps' need to initiate section 7 consultation with the USFWS, that issue is beyond the scope of this FERC relicensing process.

4.5.5 Wetlands and Riparian Habitat Study

#	Entity	Comment	GRDA Response
1	FERC Staff, 11/24/2021	The Wetlands and Riparian Habitat Study Report states that baseline mapping is complete, and wetlands have been identified and classified within the area that may be impacted by project operation, in accordance with the H&H Study. It also states that the Updated Study Report will address changes in wetland inundation and wetland habitat due to anticipated future operations. If it is determined that project operation is impacting wetlands, the accuracy of the base maps will be verified through ground-truthing, as necessary. In order for us to analyze the impact of project operation on wetlands resources within the affected area, please file the Geographic Information Systems (GIS) data layers for the survey.	The data layers for the study will be eFiled with the Commission as part of the USR.

4.5.6 Recreation Facilities Inventory and Use Study

#	Entity	Comment	GRDA Response
1	ODWC, 11/22/2021	A recreation inventory and use survey was conducted as part of the ISR, and the study failed to identify the need for additional access sites to be established as part of the relicensing process (section 4.6). While I agree that Grand Lake offers a multitude of access sites, I believe that the study and survey methods were flawed. Surveys require users to be present; and other than the FERC-approved Wolf Creek site, I understand that users were not encountered at the FERC- approved sites. This is not surprising, as four of the five FERC-approved access sites are entirely unwelcoming to boaters. One of these sites, Big Hollow, has no available parking, and none of the four sites have a courtesy or mooring dock. With the rocky substrate present at the sites, launching a boat with no available mooring dock will result in boat damage. Other access sites are available, but they are State Park or privately owned, and are costly to users. Most private access sites require ten dollars per use, and State Park sites require eight dollars. I recommend that the Big Hollow site be moved to an area with available parking, and the other three sites, Duck Creek, Seaplane base, and Monkey Island have mooring docks installed to accommodate users.	The characterization of the protocol used for the recreation study is incorrect. According to the approved study plan, any visitor interviewed at any of the recreation sites were asked their opinion about all recreation sites included in the study. Many recreationists were interviewed at sites other than the FERC-approved sites but used their knowledge of the sites from prior visits to the FERC-approved sites to rate the sites and provide comments. These results are enclosed in Table 5.5.4-2 of the Recreation Facilities Inventory Use Study. In addition, as outlined in Table 5.5.5-1, interviewees did not provide negative comments about the Big Hollow, Duck Creek, Monkey Island, and Sea Plane Base recreation sites. Therefore, the recreation study protocol was appropriate and accomplished the objectives outlined in the approved study plan. Moreover, it is premature at the study phase of the ILP to raise suggestions for protection, mitigation, and enhancement measures as explained in Section 4.2.6 above.

4.5.7 Cultural Resources Study

Because it contains privileged and confidential information, GRDA's comment/response table on Cultural Resources appears in Appendix G and has been removed from the public version of this Response.

4.5.8 Socioeconomics Study

#	Entity, Description	Comment	GRDA Response
1	BIA, 11/19/2021	The Socioeconomic Study indicates that responses to their outreach efforts (Part 2.0, page 12) will be found in Attachment B, which is blank. The responses in Attachment B should be provided.	The stakeholder outreach information was provided in Attachment B of the Socioeconomic Study Report e-filed with the Commission on September 30, 2021. It was also posted on GRDA's Relicensing webpage at the same time. GRDA e-mailed the BIA an additional copy of Attachment B on December 9, 2021.
2	City of Miami, 11/29/2021	The City requested in its comments on the PSP that GRDA collect information on a range of socioeconomic values, including direct economic impacts of the Project; Project effects on local government finances; and social and societal impacts of the Project. In response, During the ISR meeting, GRDA took the position that it is not obligated to undertake any task not expressly called out in the RSP or SPD, even if its prior responses to stakeholder comments committed it to doing so. To that end, it is unclear if Enercon—the consultant that produced GRDA's Socioeconomics Study Report—ever received the list of information requested in the City's comments. If so, nothing in the record suggests any attempt to determine whether the requested information was available. GRDA should be required to demonstrate a concerted effort to provide the requested information, where available.	GRDA followed FERC's SPD to collect information using stakeholder outreach. GRDA updated a list of stakeholders and sent out letters to obtain additional socioeconomic information, as it committed to do in its RSP. And contrary to the City of Miami's comment that it is "unclear" whether GRDA received the information it provided in response to GRDA's request, Attachment B of the Socioeconomics Study ISR includes PDF copies of all responses received from stakeholders—including the City of Miami. This document was e-filed with FERC and placed on GRDA's relicensing website for review by the City and all other relicensing participants. Contrary to the City of Miami's allegation that "nothing in the record suggests any attempt [by GRDA] to determine whether the requested information was available," the FERC-approved Socioeconomics Study, Section 2.6.1 defines the baseline information to be included in GRDA's socioeconomic study as "the general land use patterns within the study area, an assessment of population trends (historical, current, and projected), economic activity and labor force, age distribution, median household and per capita income, and poverty levels". GRDA precisely followed the FERC-approved study plan and included all required information. As noted in Section 1 of GRDA's Socioeconomic Study, general land use patterns are described in Section 1.1, population trends and demography assessments are provided in Section 1.2, economic activity is described in Section 1.4, labor force is described in Section 1.5, age distribution is provided in Section 1.2, and median household and per capita income, and poverty levels are described in Section 1.6.
3	City of Miami, 11/29/2021	Additionally, it is difficult to discern the source of some of the information GRDA did gather. For example, Figure 4 of the Socioeconomics Study Report purports to illustrate areas where the percentage of people living below the poverty level exceed 20 percentage points above the State of Oklahoma's poverty level. However, GRDA does not provide a source for the information provided in this map, making it impossible to confirm its accuracy.	The source references for Figure 4, as cited in Section 4.0 are: USCB. 2020b. American Community Survey – Oklahoma and Craig, Delaware, Mayes and Ottawa County, OK (poverty – individual and family). Retrieved from <https://www.census.gov/acs/www/data/data-tables-and-tools/data-profiles/> (accessed May 29, 2020). USCB. 2020d. TIGERLine Shapefiles – 2019. Retrieved from <https://www.census.gov/geographies/mapping-files/time-series/geo/tiger-line-file.2019.html> (accessed May 29, 2020).
4	City of Miami, 11/29/2021	In addition to querying "participants to the relicensing, as well as local organizations and business, for available, relevant data related to the [Pensacola] Project study area," GRDA committed to identifying "other publications and statistics" in order to gather sufficient economic information to inform its analysis. However, in the Socioeconomics Study Report, GRDA fails to cite to any document it consulted for this purpose that was older than 2008. Notably, none of the documents older than 2015 are attributed to any source other than GRDA.	Contrary to the City's allegation, GRDA did gather sufficient economic information to inform its analysis. The FERC-approved Revised Study Plan for the Socioeconomics Study, Section 2.6.1 defines the baseline information to be included in GRDA's socioeconomic study as "the general land use patterns within the study area, an assessment of population trends (historical, current, and projected), economic activity and labor force, age distribution, median household and per capita income, and poverty levels." GRDA precisely followed the FERC-approved study plan and included all required information. As noted in Section 1 of GRDA's Socioeconomic Study, general land use patterns are described in Section 1.1, population trends and demography assessments are provided in Section 1.2, economic activity is described in Section 1.4, labor force is described in Section 1.5, age distribution is provided in Section 1.2, and median household and per capita income, and poverty levels are described in Section 1.6. GRDA used recent and reputable sources for the socioeconomic analysis. With regard to the City of Miami's concern that GRDA did not consult any document that was older than 2008, FERC's SPD did not include a requirement for GRDA to obtain sources that were produced prior to 2008, nor does the City of Miami articulate any basis for the Commission to modify the approved Socioeconomics Study to require this information, as explained in Section 4.1 above.
5	City of Miami, 11/29/2021	The Socioeconomics Study Report notes that only eight responses were received from the roughly 190 stakeholders who were contacted. At the ISR meeting, GRDA was unable to answer whether that response rate was indicative of a flaw in its information gathering process and/or whether additional outreach might be necessary in order to increase the number of responses. Notably, GRDA sent out its information-gathering mailings in July of 2020, when many stakeholders—particularly Tribes—were preoccupied with coordinating their pandemic response. As such, this outreach was neither effective nor equitable.	Please see Section 4.3.8.2 above.
6	City of Miami, 11/29/2021	Additionally, although GRDA committed to reviewing "the most recent FEMA Flood Insurance Study to summarize available information on the cumulative impacts of flooding in the area[,]" the Socioeconomics Study Report does not include any reference to this resource. At the ISR meeting, GRDA was unable to confirm whether its analysis of available housing stock included publicly-available information from FEMA, HUD, or the City regarding the impacts of flooding—and any exacerbated impacts due to climate change—on the availability and affordability of housing in the	Please see Section 4.3.8.4 above.

#	Entity, Description	Comment	GRDA Response
		study area.	
7	City of Miami, 11/29/2021	The Socioeconomics Study Report notes that the median housing values in Ottawa County are the lowest in the four-county area, and Table 3 shows that while the housing values for Craig, Delaware, and Mayes counties increased by upwards of 25% between 2010 to 2019, housing values in Ottawa County rose by only 9%. However, the Socioeconomics Study Report neglects to discuss the impacts of flooding on home values or the related socioeconomic impact of rising flood insurance premiums. Instead, GRDA asserts that "any reasonably foreseeable effects on housing that has a reasonably close causal relationship to the hydroelectric project is not expected in the [region of project influence]." This conclusion is flatly contradicted by the results of litigation to which GRDA was a party.	GRDA does not believe that any factual findings on insurance premiums from litigation proceedings occurring over 20 years are at all relevant in this relicensing proceeding—particularly since GRDA's H&H Modeling Study has concluded that flooding in and around Miami is attributable to natural events, and not Project operations. Moreover, any flooding in Miami occurs only when the Corps controls Project operations pursuant to its exclusive jurisdiction pursuant to NDAA 2020 and the Flood Control Act of 1944.
8	City of Miami, 11/29/2021	The SPD anticipated that GRDA would utilize the baseline socioeconomic information it gathered to "identify the past, present, and reasonably foreseeable cumulative socioeconomic impacts due to the continued operation and maintenance of the [Pensacola] Project under a new license." However, the information provided in the Socioeconomics Study Report is not sufficient to address the scope of review that GRDA committed to undertake, particularly with regard to past, present, and future negative economic impacts as a result of Project operations.	Please see Section 4.3.8.5 above.
9	City of Miami, 11/29/2021	The Socioeconomics Study Report points to the Oklahoma Department of Commerce's March 2015 economic impact study, which summarized "the economic benefits associated with operating, constructing, and positive externalities from GRDA." However, at the ISR meeting, GRDA was unable to confirm that it made any attempt to identify negative socioeconomic impacts. Additionally, GRDA was unable to provide any information as to how the various benefits and burdens of the Project were distributed, rather than merely aggregating them in a broad assessment of the Project vicinity. In short, there is no evidence that GRDA to study the negative externalities that are unfairly borne by upstream communities made any effort to the benefit of others in the Project area.	Please see GRDA's response to the City of Miami's Comment #3, above. GRDA notes that the City of Miami's assertion that GRDA should have studied the negative effects of one particular community is flatly inconsistent with Commission precedent, as explained in Section 4.2.8 above.
10	City of Miami, 11/29/2021	Page 3 of the ISR cover report lists the Socioeconomics Study as complete, but the Socioeconomics Study Report itself states that, "[t]he proposed operations model and hydraulic model will provide information to evaluate any reasonably foreseeable effect that has a reasonably close causal relationship to hydroelectric project operations or USACE flood control operations." At the ISR meeting, GRDA was unable to provide a firm answer as to how and when the Socioeconomics Study will be updated to reflect the H&H Study results. Additionally, the SPD required GRDA to include an appendix containing electronic copies of documents submitted by stakeholders and links to publicly-accessible web sites containing such documents. It does not appear that the Socioeconomics Study Report includes this appendix.	The City of Miami is quoting the Socioeconomic Study out of context and has misunderstood the meaning of the text it has quoted. GRDA presents the full text in context below from the Socioeconomic Study report and clarified text from the ISR to correct the City of Miami's misunderstanding. The Socioeconomic Study Report contained as Appendix 10 of the ISR states on Page 20 the following in its entirety: *As discussed previously, the presence of the Pensacola Project provides significant economic benefit to the economy in the ROI. Existing and ongoing studies provide extensive information for use in evaluation of Project operations. In addition, the City of Miami, tribes, and other interested parties have raised the issue of flooding in the area and potential economic impacts on the community. The proposed operations model and hydraulic model will provide information to evaluate any reasonably foreseeable effect that has a reasonably close causal relationship to hydroelectric project operations or USACE flood control operations. Initially the dam was developed to provide power to the region. Currently, in addition to power, the dam provides flood control for the region and allows for tourism around Grand Lake (GRDA 2017a).* However, as provided in the H&H Modeling Study reports in the ISR, flooding in and around Miami is a natural event not influenced by Project operations. Nature is causing the effect, not the operation of the Project. Thus, at this time, any change to the now-completed Socioeconomics Study is unwarranted. As provided in Sections 3.1, 4.3.1.6, 4.3.1.7, and 4.3.1.15 above, should conclusions of the H&H Modeling Study change during the second study season, GRDA will update the other studies as needed. Any such changes will appear in the USR. With regard to the City of Miami's concerns about accessing information provided by stakeholders, all of this information appeared in Attachment B of the Socioeconomic Study Report, which was efiled with the Commission and uploaded to GRDA's publicly available relicensing website.
11	City of Miami, 11/29/2021	In order to provide the level of detail needed for Commission Staff to adequately analyze environmental justice impacts as part of its eventual environmental review, the SPD also recommended that GRDA modify the socioeconomics study plan to include not only a summary of the socioeconomic conditions in the four-county study area, but also tabular data on these conditions reported at the county and census tract level, where such data exist. The SPD also noted that GRDA should clearly state in the Socioeconomics Study Report which data source was used for each level of aggregation documents. More broadly, at the ISR meeting, GRDA was unable to offer a response regarding: 1. whether the Socioeconomics Study as conducted aligns with the Commission's recently announced focus on environmental justice, as consistent with Executive Order 14008; and 2. whether it considered including statistics specific to environmental justice when compiling other relevant	Please see Section 4.3.8.9 above.

#	Entity, Description	Comment	GRDA Response
		socioeconomic and demographic data.	

4.5.9 Infrastructure Study

#	Entity	Comment	GRDA Response
1	BIA, 11/19/2021	The Infrastructure Report, as required by FERC in the Study Plan determination document, indicates that GRDA is supposed to provide info on structures that are flooded under both the normal operations of the dam and under the flood control operations of the dam. However, the modeling addressed in the study only goes over how impacted the infrastructure is when the dam is at 742 ft and 745 ft. Was the impact on infrastructure under the flood control operation of the dam not included in this study?	Under normal circumstances, when the reservoir is within the operational range of 742 feet PD to 745 feet PD and there is no inflow event, which is an act of nature, no flooding of identified infrastructure locations occurs. There is no impact on infrastructure during normal operation of the dam. As discussed in the ISR, the Project reservoir elevation *at the start* of the simulation is 742 feet PD or 745 feet PD. As the inflow event—an act of nature—moves through the hydraulic model, operations at the Project switch from normal operations to flood control operations. Flood control is an exclusive jurisdictional control of the Corps, as discussed in Sections 1.4 and 4.2.1 above.
2	BIA, 11/19/2021	In the last paragraph of page 7, it specifically states "function of inflow event arrival time". An explanation of the meaning of this phrase is needed.	When GRDA states that "*the time of maximum inundation depth was solely a function of inflow event arrival time and not reservoir elevation,*" GRDA is explaining that the time of maximum depth is completely independent of the Project reservoir elevation. The flood is moving down the river and then arrives at the infrastructure location. The flood water does not move backward upstream from the Project reservoir. Inflow events, which are an act of nature, move through the river system from upstream to downstream. These acts of nature inundate some infrastructure locations upstream of the Project reservoir. This inundation occurs before the natural event arrives at the Project reservoir. When the natural event arrives at the Project reservoir, the reservoir elevation increases to 745 feet PD, where the Corps has exclusive jurisdictional control as discussed in Sections 1.4 and 4.2.1 above.

5.0 Next Steps

Following GRDA's filing of this Response to Comments on the ISR, GRDA will convene a technical meeting with relicensing participants on January 14, 2022, from 9:00 am to 12:00 pm Central Time, to discuss the results of the Sedimentation Study and GRDA's proposed modifications to the Sedimentation Study plan for the second season of studies, as explained in Section 3.2 above and in Appendix E.

Following the technical meeting, FERC is expected to issue its next Study Plan Determination, pursuant to 18 CFR § 5.15(c)(6). Under the Commission's process plan and schedule, this next Study Plan Determination will be issued by January 28, 2022.[259]

Following the Commission's January 2022 Study Plan Determination, the second study season will commence, and GRDA will file its USR with the Commission by September 30, 2022.

Following submittal of the USR and consistent with requirements under 18 CFR § 5.15(c)(2), GRDA will, within 15 days following the filing of the USR, hold a meeting with relicensing participants and Commission staff to discuss the 2022 study results reported in the USR.

Under 18 CFR § 5.15(c)(3), within 15 days following this meeting or by October 30, 2022, GRDA will file a meeting summary. Under 18 CFR § 5.15(c)(4), FERC staff or any agency and other interested party may file a disagreement concerning GRDA's meeting summary within 30 days of its issuance or by November 29, 2022. This filing must set forth the basis of any disagreement with the material content of GRDA's meeting summary and propose any desired alternative modifications to ongoing studies or new studies. Under 18 CFR § 5.15(c)(5), GRDA will then have 30 days to respond to any disagreements by December 29, 2022. Within 30 days of GRDA's response or by January 28, 2023, under 18 CFR § 5.15(c)(6), any remaining disagreements will be resolved by the Commission, and the study plan will be amended as appropriate.

GRDA's Proposed License Proposal or Draft License Application will be filed by January 1, 2023, and the Final License Application will be filed by May 31, 2023, two years before the license expires on May 31, 2025.

The proposed timeline for study reporting, i.e., the filing of the USR, as modified by the Extension Order is presented in Table 5.0-1.

Table 5.0-1. Reporting and review opportunities associated with the USR

Activity or Information Sharing	Commission Deadline
GRDA Technical Meeting for Sedimentation Study	January 14, 2022
Commission Resolution of Disagreements	January 28, 2022
File USR	September 30, 2022
Hold USR meeting (meeting on study results and any proposals to modify study plan)	October 15, 2022
File USR Meeting Summary	October 30, 2022

[259] *Grand River Dam Auth.*, 168 FERC ¶ 62,145 (2019) (Appendix A).

Activity or Information Sharing	**Commission Deadline**
File Meeting Summary Disagreements	November 29, 2022
File Responses to Disagreements	December 29, 2022
Commission Resolution of Disagreements	January 28, 2023

Appendix A

Comments Received in Response to Initial Study Report

FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON, D.C. 20426
November 24, 2021

OFFICE OF ENERGY PROJECTS

Project No. 1494-438–Oklahoma
Pensacola Hydroelectric Project
Grand River Dam Authority

Darrell Townsend II
Vice President
Grand River Dam Authority
P.O. Box 70
Langley, OK 74350-0070

Subject: Comments on the Initial Study Report and Initial Study Report Meeting Summary for the Pensacola Hydroelectric Project

Dear Mr. Townsend:

We have reviewed Grand River Dam Authority's (GRDA) Initial Study Report (ISR) for the Pensacola Hydroelectric Project (Pensacola Project) filed on September 30, 2021, and reviewed the ISR Meeting Summary filed on October 29, 2021. Based on our review, we are providing comments, pursuant to 18 C.F.R. section 5.15(c)(4).

Our comments are provided in Attachment A. Unless otherwise noted, please address the comments by December 29, 2021.

If you have questions please contact Navreet Deo at (202) 502-6304, or at navreet.deo@ferc.gov.

Sincerely,

Stephen Bowler, Chief
South Branch
Division of Hydropower Licensing

Enclosures: Attachment A

Attachment A

Staff comments on the Initial Study Report (ISR) and Initial Study Report Meeting Summary[1]

Hydrologic and Hydraulic Modeling Study

1. Section 8 of the Upstream Hydraulic Model Report (UHM Report) states that the tabulated results of the maximum water surface elevations (WSELs) and maximum inundation extents for starting reservoir elevations between 742 feet and 745 feet NGVD 29[2] are included in Appendix D. However, the approved study plan filed on September 24, 2018, recommends that GRDA use starting reservoir elevations between 734 feet and 760 feet.[3] Please explain why the study and study results were limited to starting reservoir elevations between 742 feet and 745 feet rather than between 734 feet and 760 feet, as required by the approved study plan.

2. Section 3 of the UHM Report states that United States Geological Survey (USGS) gage data were used for the upstream inflow boundaries, and WSELs at Pensacola Dam were used for the downstream stage boundary. If the starting WSEL at the dam is varied, this would create extra storage, which in turn would affect the stage hydrograph at the lake (for at least some period of the event duration). Therefore, please explain how the elevations for these stage hydrographs were obtained, and how the variations in the starting lake elevations are reflected in the model output.

3. Figure 13 of the UHM Report shows the over/under prediction of simulated water surface elevations at the four USGS gages.[4] According to the USGS Neosho River gage at the city of Commerce, Oklahoma, the maximum water surface elevation of the

[1] Comments pursuant to the Commission's obligations under the Federal Power Act (FPA), National Environmental Policy Act (NEPA), section 7 of the Endangered Species Act (ESA), and section 106 of the National Historic Preservation Act (NHPA).

[2] National Geodetic Vertical Datum of 1929 (NGVD 29). Unless otherwise noted, all elevations referenced are in the NGVD 29 datum.

[3] The UHM Report clarified that the height of the dam is only 757 feet. Therefore, analyses of starting reservoir elevations above 757 feet are not necessary.

[4] The model was calibrated using measured data from USGS stream gages at the city of Commerce, city of Miami, Elk River near Tiff City, and Spring River near Quapaw, Oklahoma.

July 2007 historical inflow event[5] was 776.62 feet. However, there is no blue bar comparing the simulated and observed values, as there is for the other gages. Therefore, please revise Figure 13 to include the data point for the July 2007 event, or clarify why it was not included.

4. Table 1 of the UHM Report provides a summary of the peak inflow at each of the stream flow gages during historical inflow events. However, the table does not include any peak inflow data for the September 1993 inflow event. Therefore, please revise Table 1 to include the peak inflow information for the September 1993 event at each gage or clarify why it was not included.

5. The approved study plan requires that the Hydrologic & Hydraulic Modeling Study (H&H Study) quantify the influence of project operation on water levels upstream and downstream of the dam to improve an understanding of the magnitude, duration, and frequency of inundation upstream. However, section 10 of the UHM Report states that the initial stage at Pensacola Dam has an "immaterial impact" on upstream WSEL and inundation frequencies, and that only different inflows cause an "appreciable difference" in maximum WSEL and maximum inundation extent. Further, the report states that the difference in WSEL and inundation extent due to the size of the inflow event are an order of magnitude greater than the differences in WSEL and inundation extent due to the initial stage. Although the ISR indicates that the tabular data listing the maximum water depths for each of the six modeling scenarios is available in Appendix F, the appendix only includes maps of inundation scenarios. In order to understand the results of the H&H Study and quantify the impact of project operation on upstream WSELs and flooding, please:

a. define "immaterial impact" and "appreciable difference" as a unit of measure (feet); and

b. revise Appendix F to include a list or table that compares the upstream WSELs (feet), extent of inundation (feet), and duration of inundation (hours) at each initial stage (in 0.5-foot intervals) above (in the range of 745 feet to 757 feet) and below (in the range of 734 feet to 745 feet) the flood pool WSEL during the modeled flood events (*i.e.*, compare stage to stage operation).

Sedimentation Study

6. The Sedimentation Study Report states that the hydraulic calibration of the Sediment Transport Model is on-going, and the report will be updated by the end of the

[5] GRDA utilized flow data from six historical inflow events to develop and calibrate the UHM.

year. When filing the updated report, please clearly detail which, if any, roughness coefficients and/or flow roughness factors were changed to calibrate the model, and please provide an explanation for those changes.

Aquatic Species of Concern Study

7. The approved study plan requires that GRDA review information on the habitat preferences and spatial and temporal patterns for the federally endangered Neosho mucket which occurs in the project vicinity, and if existing information is inadequate, conduct targeted field surveys during the second study season to estimate Neosho mucket distribution.[6] Section 3.1.3 of the Aquatic Species of Concern Study Report presents a review of existing information on Neosho mucket, and indicates that live Neosho mucket may occur in the Elk River[7] portion of the project boundary, but not in the Spring or Neosho river portions of the project boundary. Therefore, the ISR only proposes to conduct targeted freshwater mussel surveys in the Elk River.[8] However, table 3 in section 3.1 of the Aquatic Species of Concern Study Report indicates that EcoAnalysts (2018) reported live Neosho mucket in the Oklahoma portion of the Spring River. Please clarify where, along the Oklahoma portion of the Spring River, the live Neosho mucket were found relative to the project boundary. In addition, please explain whether or not the proposed freshwater mussel survey will be expanded to include the Spring River, and if so, please file updated methods. If the proposed survey will not be expanded to include the Spring River, please explain why not.

8. As discussed above, the ISR proposes to only conduct a freshwater mussel survey in the Elk River during the second study season. Section 3.1.3 of the Aquatic Species of Concern Study Report includes methods for conducting the freshwater mussel survey and indicates that a minimum search time of five person-hours (divided into five one-person hour long searches) will be conducted within the delineated search area. However, the subsequent sentence indicates that if no mussels are encountered after the first three one-person hour searches, surveys will cease, and it will be assumed that no live mussels are present. The latter sentence suggests that the minimum search time will be three person-hours and not five person-hours. Please clarify the minimum search time that will be conducted in the search area, provide an estimate of the total area (or river length) of

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[6] In the Commission's Study Plan Determination issued November 8, 2018, staff recommended GRDA's proposal.

[7] The Elk, Spring, and Neosho Rivers and Tar Creek are tributaries to Grand Lake. The current project boundary extends upstream into these tributaries.

[8] GRDA specifies that the targeted surveys will occur in an approximately 1-mile stretch of critical habitat that occurs within the project boundary on the Elk River.

the Elk River to be surveyed, and an estimate of how great an area (or river length can be surveyed per person hour.

In addition, the proposed study does not include methods for determining the location of each one-person hour search. To evaluate the proposed study, we need to fully understand the methods. Therefore, please explain the methods that will be used to determine the location of each one-person hour search.

9. The approved study plan requires that GRDA review existing information on the habitat preferences and spatial and temporal patterns of the federally threatened Neosho madtom which occurs in the project vicinity, and if existing information is inadequate, conduct targeted field surveys during the second study season to estimate Neosho madtom distribution.[9] Section 3.4.1 and 3.4.3 of the Aquatic Species of Concern Study Report presents existing information on the occurrence of Neosho madtom, which indicates that Neosho madtom populations are located in the Neosho River and have been found in Neosho River drainages of the study area[10] as recently as 2007. However, during the most recent surveys conducted in 2016, no Neosho madtom were observed. Because the most recent surveys were conducted 5 years ago, the report proposes to conduct a targeted Neosho madtom field survey in a portion of the Neosho River, and assess habitat quality upstream of the area of the targeted madtom field survey.[11] Section 3.4.3 of the Aquatic Species of Concern Study Report includes proposed methods for the targeted madtom field survey, but does not include any methods regarding how and where habitat quality will be assessed upstream of the targeted madtom field survey. So that we can evaluate the proposal to search for additional Neosho madtom habitat upstream of the targeted madtom field survey, please provide as much detail as possible regarding the methods for determining madtom habitat quality upstream of the targeted Neosho madtom field survey area, including where and how habitat quality will be assessed.

10. Based on the review of existing information on the habitat preferences and spatial and temporal patterns of the federally threatened Neosho madtom required in the approved study plan as discussed above, the Aquatic Species of Concern Study Report concludes that Neosho madtom populations are restricted to the Neosho River.

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[9] In the Commission's Study Plan Determination issued November 8, 2018, staff recommended GRDA's proposal.

[10] The study area was described in section 1.3 of the Aquatic Species of Concern Study Report.

[11] GRDA states that sampling habitat quality upstream of the study area will allow for appropriate mitigation if management practices limit suitable habitat within the study area.

Therefore, GRDA proposes to conduct a Neosho madtom survey in the Neosho River portion of the study area. However, during the ISR Meeting, Oklahoma Department of Wildlife Conservation (Oklahoma DWC) stated that Neosho madtom were collected in the Spring River in 2021. Based on the information provided by Oklahoma DWC, the study may need to include the Spring River in the Neosho madtom survey so that accurate species distribution information is available for our NEPA analysis. Therefore, please consult with Oklahoma DWC on the occurrence of Neosho madtom in the study area and surrounding drainages. In addition, if Neosho madtom do occur in the Spring River, please explain whether or not the proposed survey will be expanded to include the Spring River, and if so, please file updated methods. If the proposed survey will not be expanded to include the Spring River, please explain why not.

11. The approved study plan requires that GRDA review existing information on the habitat preferences and spatial and temporal patterns of the Neosho smallmouth bass that occur in the project vicinity, and if existing information is inadequate, conduct targeted field surveys during the second study season to estimate Neosho smallmouth bass distribution.[12] Section 3.5.3 of the Aquatic Species of Concern Study Report indicates that there are no data indicating that Neosho smallmouth bass occur within the study area. Therefore, the ISR does not propose to conduct targeted field surveys during the second study season to estimate Neosho smallmouth bass distribution. However, during the ISR Meeting, Oklahoma DWC staff indicated that Neosho smallmouth do occur within the study area.[13] Based on the information provided by Oklahoma DWC, there may be a need for targeted field surveys within the study area, so that accurate species distribution information is available for our NEPA analysis. Therefore, please consult with Oklahoma DWC on the known locations of Neosho smallmouth bass in the study area, and file those locations. In addition, please explain whether or not the second study season will include the targeted field surveys discussed above, and if so, please file the proposed survey methods. If targeted field studies are not proposed for the second season, please explain why not.

Wetlands and Riparian Habitat Study

12. The Wetlands and Riparian Habitat Study Report states that baseline mapping is complete, and wetlands have been identified and classified within the area that may be impacted by project operation, in accordance with the H&H Study. It also states that the Updated Study Report will address changes in wetland inundation and wetland habitat

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[12] In the Commission's Study Plan Determination issued November 8, 2018, staff recommended GRDA's proposal and recommended surveys to assess the availability of Neosho smallmouth bass spawning habitat during the spawning season under existing conditions.

[13] *See supra* note 10.

due to anticipated future operations. If it is determined that project operation is impacting wetlands, the accuracy of the base maps will be verified through ground-truthing, as necessary. In order for us to analyze the impact of project operation on wetlands resources within the affected area, please file the Geographic Information Systems (GIS) data layers for the survey.

Cultural Resources Study

13. During the ISR Cultural Resources Working Group meeting, a representative from the Oklahoma Archaeological Survey inquired about the potential downstream effects of project operation during power generation (when the reservoir WSEL is below 745 feet) in comparison to effects from the U.S. Army Corps of Engineers' (Corps) flood control (when the reservoir WSEL is 745 feet) operation. In a verbal response during the meeting, GRDA stated that they distinguish between natural releases and power generation releases by using "different channels." To evaluate whether, and how, cultural resources within the Area of Potential Effect (APE) are affected by the project, please:

a. clarify whether the H&H study compared the potential downstream effects of project operation with the effects of the Corps' operation;

b. describe the "different channels" used to distinguish different flow releases; and

c. clarify if, and how, downstream project flows vary in magnitude from the flows released by the Corps.

14. To offset the potential effects of the management of Grand Lake on Beaver Dam Cave (DL-2,[14] a gray bat maternity colony), Article 405 of the current license requires GRDA to: (1) construct, maintain, repair, and replace, when necessary, cave gates, fences, fence gates, signs, and vehicle barriers at one of the following areas: Jail Cave (DL-38, the preferred site), Shiflet Cave (OT-4), or Boy Scout Cave (OT-13); (2) provide assistance to the Nature Conservancy for maintaining, repairing, and replacing, when necessary, the gates, fences, fence gates, signs, alarm system, and vehicle barriers at Twin Cave (DL-91); (3) improve cave security at the aforementioned locations through intermittent checks by GRDA Lake Patrol; (4) evaluate and report on the effectiveness of cave management features; and (5) implement a public education program on gray bats and cave conservation. During the Cultural Resources Working Group meeting, a representative from the Osage Nation asked if GRDA is responsible for the enlargement of the openings to the bat caves, and whether the caves are located within the APE. The

[14] This code system is used by the Oklahoma Department of Wildlife Conservation and others to identify caves surveyed for endangered bats and aquatic species.

representative stated that the caves may have traditional significance and may also have served as sites of human habitation. To determine the effects of project operation on cultural resources, we need to understand the resources that are located within the APE. Therefore, please provide:

a. the location of the bat caves that GRDA helps manage relative to the current APE;[15] and

b. a summary of GRDA's activities in implementing Article 405 under the current license.

15. The Cultural Resources Study Report states that GRDA will continue to consult with, and request the concurrence of, the Oklahoma State Historic Preservation Officer (SHPO) and Tribal Historic Preservation Officers (THPOs) for tribes with lands within the proposed APE. Please file the proposed APE maps with the Updated Study Report. The maps should clearly identify the proposed project APE, as well as the project boundary, highlight land outside the project boundary where project-related activities have the potential to affect historic properties, and identify the locations of any tribal trust lands within the project boundary that overlap with the proposed APE.

[15] Because some of the sites could be of cultural importance, please file this location information with the Commission as Privileged (non-public).

Department of Energy
Southwestern Power Administration
One West Third Street
Tulsa, Oklahoma 74103-3502

November 30, 2021

Ms. Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, D.C. 20426

RE: Initial Study Report for the Pensacola Hydroelectric Project (P-1494-483)

Dear Ms. Bose,

Southwestern Power Administration (Southwestern) appreciates the opportunity to comment on the Initial Study Report (ISR) filed by Grand River Dam Authority (GRDA) for the Pensacola Hydroelectric Project (Pensacola) relicensing.

Southwestern is an agency within the U.S. Department of Energy that markets hydroelectric power from 24 multi-purpose Federal water resources projects constructed and operated by the U.S. Army Corps of Engineers (Corps), in the states of Arkansas, Missouri, Oklahoma, and Texas. Those projects include Fort Gibson, which is located immediately downstream of the GRDA Pensacola (at Grand Lake O' the Cherokees) and Markham Ferry (at Lake Hudson) hydroelectric projects, and four additional lock and dam run-of-river projects on the Arkansas River downstream of the Grand River confluence. By statute, Federal hydropower serves not-for-profit customers, largely rural electric cooperatives and municipalities, in the four previously mentioned states as well as Kansas and Louisiana. Additionally, Southwestern is obligated to repay the Federal investment, with interest, and all expenses allocated to the hydropower purpose in the water resource projects with revenues received from the sale of power. Therefore, Southwestern has a clear and direct interest in any activities which may impact the operation of these projects, which directly influence Southwestern's ability to fulfill Federal contractual obligations and repayment to the Federal Treasury. Southwestern's specific comments on the ISR are detailed below.

Southwestern's primary concern with the Pensacola relicensing is the operation and timing of Pensacola releases. Any proposed change in operational releases as a result of relicensing should be fully vetted with Southwestern and the other downstream Federal, State, and local agencies which may be impacted. Significant increases or decreases in releases as a result of changed operations could have negative impacts on hydropower and the other Congressionally authorized purposes at Fort Gibson and the four downstream Arkansas River Federal hydroelectric projects. Southwestern and the Corps have a Memorandum of Understanding (MOU) that states the responsibilities of both parties relating to the operation of the hydropower projects. Any changes to the operation and timing of Pensacola releases should not create undue difficulty for Southwestern or the Corps in meeting the needs of the Congressionally authorized purposes of the downstream projects and their responsibilities under the MOU.

Additionally, as the relicensing effort continues to assess proposed operational changes for Pensacola Dam, the reliability of the electric grid should be a primary criterion. Dispatchable hydropower has become an even more vital component of grid reliability as additional non-dispatchable renewable resources have been added to the generation mix. The relicensing should preserve or increase the flexibility of GRDA operations to respond to grid emergencies.

Finally, there was discussion pertaining to the flood releases and flood control operations at Pensacola during the ISR meetings. Southwestern would like to remind those involved in the relicensing that the National Defense Authorization Act for Fiscal Year 2020 states that the Secretary of the Army, acting through the Corps, has "exclusive jurisdiction and responsibility for management of the flood pool for flood control operations at Grand Lake O' the Cherokees". Any action involving management of the flood pool or flood control operations will be the responsibility of the Corps.

Please contact Tyler Gipson at 918-595-6685 or Tyler.Gipson@swpa.gov if you have any questions regarding our comments. Thank you again for the opportunity to comment on the Pensacola ISR.

Sincerely,

Ashley Corker
Director
Division of Resources and Rates

United States Department of the Interior
FISH AND WILDLIFE SERVICE
Division of Ecological Services
9014 East 21st Street
Tulsa, Oklahoma 74129
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In Reply Refer To:
FWS/R2/OKES/
02EKOK00-2022-I-
0397

November 30, 2021

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First St., NE
Washington, DC 20426

COMMENTS ON THE GRAND RIVER DAM AUTHORITY INITIAL STUDY REPORTS FOR RELICENSING, THE FEDERAL ENERGY REGULATORY COMMISSION LICENSE FOR THE PENSACOLA PROJECT NO. P-1494-438.

Secretary Bose:

We are pleased to provide comments on the Initial Study Reports for relicensing the Federal Energy Regulatory Commission (FERC) Pensacola Project No. P-1494-438, (Grand Lake) in northeast Oklahoma. The U.S. Fish and Wildlife Service (Service) provided verbal comments during the virtual presentation of Initial Study Reports on October 12-13, 2021. The comments provided in this letter support the comments made during the virtual presentation and include some additional information and recommendations. We also support comments provided by the Oklahoma Department of Wildlife Conservation (ODWC).

Specific Comments

Flooding and Inundation Evaluations

The studies provided N and roughness values to estimate current flooding risks, but this may not represent flooding risks for the license period of 30 or more years. The levels of woody encroachment within the flood plain are likely to continue over time and this will increase roughness values and inundation risks. Changes in roughness, upstream flood control reservoirs filling with sediment and reduced storage, and climate effects over a 30 year or more period may combine to increase inundation levels and durations during the license period.

Threatened and Endangered Species

The Service requests information on the potential frequency and duration of flooding events in order to determine effects on habitat for the American burying beetle (*Nicrophorus americanus*), Neosho madtom *(Noturus placidus)*, federally-listed mussels and bat cave habitat affected by the flood pool storage. Current information is focused on peak flood events and does not include information for effects of potential lake level changes on the frequency and duration of lesser flooding events. The frequency and duration of storing water in the flood pool could affect the suitability of riverine habitat in the lower reaches of rivers as they approach the reservoir and habitat for bats. Shoreline habitat within the reservoir may also be affected. For example, would changing the lake target elevation to 745 feet Pensacola Datum (PD) affect how often and how long the entrance to cave DL-2 (Beaver Dam Cave) is affected by lake elevations of 751-752 feet PD or greater? The excavation and enlargement of a high passage at the cave may allow bats to escape, but flooding the entrance increases the risk of take and the effects of forced evacuation to alternative caves is unknown. However, flooding the entrance increases the risk of take and the effects of forced evacuation to alternative caves could be detrimental, especially when gray bat pups are non-volant (unable to fly). The initial study reports also presented some added risk of inundated habitat near the upstream reaches of the reservoir and more substantial increased inundation downstream of the reservoir with potential increases in initial lake surface elevations. Several hundred acres of additional habitat were projected to be inundated under several flood events with higher initial lake elevations. Flooding additional areas of trees could increase the risk of take for federally-listed bats like Indiana bats (*Myotis sodalis*) and northern long-eared bats (*M. septentrionalis*) that roost in trees, especially during the pup season, which coincides with flood prone time periods in late spring to early summer. These listed species were not addressed in the reports and all potential effects should be evaluated. The FERC and U.S. Army Corps of Engineers do not have any incidental take coverage for Indiana and northern long-eared bats at the Pensacola Project under existing biological opinions. The Service recommends that both agencies initiate section 7 consultation in compliance with the Endangered Species Act.

Additional surveying of mussels in the Neosho and Spring rivers could be beneficial; however, such surveying should be designed in consideration of survey work that has been completed recently as well as survey work planned in the area that is fairly certain to occur. The Tri-State Mining District mussel assessment (EcoAnalysts Inc. 2018) is the primary recent work that should be considered. In addition, the Tar Creek Trustee Council (TCTC) is planning mussel surveys of some Spring River tributaries that might include sampling of river sites at the mouths of those tributaries. Details of the planned surveys currently are not available, but should become available from the TCTC soon.

In conserving federally-listed mussels, the Service looks at locations and timing of studies performed by different parties and encourages separation of those studies so as not to facilitate conflicts between studies or subject any given sites to sampling that is excessive, in terms of stressing the mussels present. Although the EcoAnalysts assessment was quite robust, we recommend obtaining information about the mussel communities of the Neosho and Spring rivers, especially the former, if the information is derived from locations other than those surveyed by EcoAnalysts or in the upcoming TCTC studies. For example, we recommend mussel surveys of the Neosho River downstream of Miami, OK, and of the Spring River downstream of Warren Branch to add new information for mussels near the Pensacola Project and assist with relicensing issues. Other areas of the Neosho River upstream also remain undersurveyed and are indicated by consideration of the coverage by EcoAnalysts. We recommend that the Grand River Dam Authority coordinate with EcoAnalysts, Inc., the TCTC, and this office, in the specific design of any mussel surveys it seeks to perform.

The Service recommends Neosho madtom surveys on the Spring River, in addition to those proposed on the Neosho River. While we agree that habitat in the lower Spring River is impacted by metals related to mining wastes, we believe that habitat conditions could improve during the license period and we do not agree that extant populations in Oklahoma are limited to the Neosho River. We request that the Grand River Dam Authority consult with our office for locations and methods of surveys for Neosho madtoms.

Thank you for considering our comments and we look forward to working with the ODWC, the Grand River Dam Authority, FERC and other partners in developing license conditions for this project. If you have questions or want more information, please contact Kevin Stubbs at 918-695-6769 or Kevin_Stubbs@fws.gov.

Sincerely,

ELIZABETH GARDINER Digitally signed by ELIZABETH GARDINER Date: 2021.11.30 08:41:14 -06'00'

Dawn Gardiner
Acting Field Supervisor

Cc: Director, Oklahoma Department of Wildlife Conservation
Valery Giebel, DOI Solicitors office
Richard Stark, Ozark Plateau NWR

References Cited:

EcoAnalysts,Inc. 2018. Final report: Tri-State Mining District unionid assessment, Missouri, Kansas, and Oklahoma, 2016-2018. EA Project no. 16-001 & 18-006. Report prepared for U.S. Fish and Wildlife Service, Columbia, MO, September 2018. 106 p.

OKLAHOMA

J. KEVIN STITT, GOVERNOR
J.D. STRONG, DIRECTOR

DEPARTMENT OF WILDLIFE CONSERVATION
P.O. Box 53465 Oklahoma City, OK 73152 PH. (405) 521-3851

ORIGINAL

November 16, 2021

Ms. Kimberly Bose, Secretary
Federal Energy Regulatory Commission
888 First Street N.E.
Washington, DC 20426

RE: Pensacola Hydroelectric Project (FERC Project No. 1494-438)
Initial Study Report

Dear Secretary Bose:

After reviewing the Pensacola Hydroelectric Project (FERC Project No. 1494-438) Initial Study Report (ISR), I would like to submit a couple of comments for the record.

Section 4.3.5 of the ISR states that Neosho Smallmouth Bass does not occur within the study area or surrounding drainages. This statement is false, as Taylor et al. (2018) genetically identified Neosho Smallmouth Bass within multiple tributaries of Grand Lake O' the Cherokees, as well as in surrounding drainages. Although Neosho Smallmouth Bass may not require further sampling efforts for the scope of the ISR, removing them from the list of species that may be impacted by the project is inadvisable and ultimately irresponsible.

A recreation inventory and use survey was conducted as part of the ISR, and the study failed to identify the need for additional access sites to be established as part of the relicensing process (section 4.6). While I agree that Grand Lake offers a multitude of access sites, I believe that the study and survey methods were flawed. Surveys require users to be present, and other than the FERC-approved Wolf Creek site, I understand that users were not encountered at the FERC-approved sites. This is not surprising, as four of the five FERC-approved access sites are entirely unwelcoming to boaters. One of these sites, Big Hollow, has no available parking, and none of the four sites have a courtesy or mooring dock. With the rocky substrate present at the sites, launching a boat with no available mooring dock will result in boat damage. Other access sites are available, but they are State Park or privately owned, and are costly to users. Most private access sites require ten dollars per use, and State Park sites require eight dollars. I recommend that the Big Hollow site be moved to an area with available parking, and the other three sites, Duck Creek, Seaplane base, and Monkey Island have mooring docks installed to accommodate users.

I appreciate your time in reviewing these comments and recommendations.

Sincerely,

Josh Johnston
Northeast Region Supervisor of Fisheries
Oklahoma Department of Wildlife Conservation

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November 29, 2021

The Honorable Kimberly Bose
Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

Re: Pensacola Hydroelectric Project, FERC Project No. 1494-438; Initial Comments, Request for Supplemental Comment Period, Requests for Study Modifications, and Request for Additional Study

Dear Secretary Bose:

Attached please find the City of Miami's (the "City") initial comments on the Grand River Dam Authority's ("GRDA") relicensing studies, as reported to date in the Initial Study Report ("ISR") for the Pensacola Hydroelectric Project No. 1494 (the "Project") filed by GRDA on September 30, 2021 and summarized in the ISR meeting summary filed on October 29, 2021. In accordance with the regulations of the Federal Energy Regulatory Commission (the "Commission") at 18 C.F.R. § 5.15 (2020), the City: (1) proposes modifications to four of the studies contained in GRDA's ISR, specifically those on hydrology and hydraulics ("H&H"), infrastructure, sedimentation, and socioeconomics; and (2) renews its prior request, on which the Commission deferred decision, for a study of how contaminated sediment is transported and deposited on lands occupied by the City and its residents as a result of Project operations.

There are two important aspects of GRDA's studies that neither the Commission nor the City have had the opportunity to review: The Operations Model and the full Sedimentation Study Report and model. On November 19, 2021, GRDA filed a proposed Protective Order intended to facilitate GRDA's sharing of the Project's Operations Model and its accompanying datasets with the City. The Operations Model provides the model inputs to the Comprehensive Hydraulic Model to simulate hypothetical events and alternative operating scenarios, that are used, in part, to evaluate Project-caused flooding and to evaluate mitigation alternatives. The Operations Model is therefore essential to the City's ability to fully comment on the H&H Study, as well as the City's ability to fully comment on the infrastructure, sedimentation, and socioeconomic studies, which are each premised on the H&H Study results. GRDA has also indicated that it will not be submitting its full Sedimentation Study Report until the end of the year, some three months after the ISR deadline and a month after the deadline for comments on the ISR. The City and other stakeholders cannot provide comprehensive comments on the Sedimentation Study until after GRDA submits the full report.

In order for the City to offer comprehensive comments on the H&H, infrastructure, sedimentation, and socioeconomic studies, the City respectfully requests that the Commission permit the filing of supplemental comments within thirty days after the City's receipt of both the Operations Model and the full Sedimentation Study Report and model, and adjust the deadlines set forth in the Commission's regulations—including the Director's resolution of disputed modification requests—accordingly.[1] Providing the same opportunity for comment as would have been available had GRDA filed all studies by the Commission's established deadline is a matter of fundamental fairness and will help ensure a robust record in this proceeding.[2] As part of those comments, the City should be allowed to request further modifications to any of the four aforementioned studies, to the extent that the request could not reasonably have been made without having reviewed the Operations Model and full Sedimentation Study Report and model.

Sincerely,

/s/ Craig Gannett
Craig Gannett
Davis Wright Tremaine LLP

Counsel for the City of Miami, Oklahoma

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[1] *See* 18 C.F.R. §§ 5.15(c)(4)-(7).

[2] *See Grand River Dam Authority*, 168 FERC ¶ 62,145, app. A, at 2 (2019) (setting a deadline of September 30, 2021 for GRDA to file its ISR).

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I. INTRODUCTION

The existing license for the Pensacola Hydroelectric Project No. 1494 (the "Project") will expire on May 31, 2025.[3] On February 1, 2017, the Grand River Dam Authority ("GRDA") filed a Notice of Intent to relicense the Project using the Federal Energy Regulatory Commission's (the "Commission") Integrated Licensing Process ("ILP").

As required by the Commission's regulations governing the ILP,[4] GRDA has begun implementing its relicensing study plan, as outlined in the Revised Study Plan ("RSP") filed by GRDA on September 24, 2018 and approved with Commission staff-recommended modifications in a November 8, 2018 Study Plan Determination ("SPD"). GRDA filed its Initial Study Report ("ISR") —describing its overall progress in implementing its RSP—on September 30, 2021 and held a meeting to discuss the ISR on October 12-14, 2021. On October 29, 2021, GRDA filed a cursory summary of the ISR meeting, with no mention of the many serious concerns raised by stakeholders at the meeting.

The City of Miami, Oklahoma (the "City") has suffered from repeated flooding due to the Project and its operations since the dam's completion in 1940. As such, the City has a compelling interest in the integrity of the studies that will lay the factual foundation for the flooding-related conditions to be included in the new license.

In accordance with the Commission's regulations,[5] the City requests modifications to the relicensing studies as described in GRDA's ISR and proposes an additional study to examine how contaminated sediment is transported and deposited on lands occupied by the City and its residents as a result of Project operations.

II. REQUEST FOR SUPPLEMENTAL COMMENT PERIOD

GRDA has declined to provide the Operations Model for its H&H Study until the confidential information contained in the model is protected to its satisfaction.[6] Following prolonged negotiations between GRDA and the City as to the most appropriate means for providing that protection, GRDA and the City agreed to support the proposed Protective Order filed by GRDA on November 19, 2021.

While awaiting Commission approval of the Protective Order (and thus, access to the Operations Model), the City is submitting these comments on the ISR consistent with the Commission's November 29, 2021 deadline. However, the Operations Model is essential to the City's ability to fully comment on not only the H&H Study, but also GRDA's infrastructure, sedimentation, and socioeconomics studies, which are all premised on the results of the H&H Study. Understanding the full extent of flooding (as would be shown by a properly conducted

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[3] *See Grand River Dam Authority*, 168 FERC ¶ 62,145, at P 35 (2019).

[4] *See* 18 C.F.R. § 5.15 (2020).

[5] *Id*.

[6] The Operations Model is intended to simulate operations of the Project over a range of flow events. Importantly, the Operations Model is used to predict the measured and hypothetical water-surface elevations at the reservoir for a series of floods that are input to the CHM to evaluate the resultant flooding. Operations Model ISR at iii, 19.

H&H Study) is also critical for understanding the necessity for the Contaminated Sediment Transport Study, a matter deferred for consideration by the Commission.[7]

Moreover, GRDA's full Sedimentation Study is now more than two months overdue. In the ISR, GRDA states that it has not yet finished calibrating the sediment transport model, much less produced any model results for review.[8] GRDA characterizes this near-total lack of reported results as having "completed [the study] in accordance with the RSP, as modified by the Commission staff in the SPD, *except for one variance in schedule*."[9] GRDA "plans"—with no commitment—"to provide the full report and access to a calibrated model to all stakeholders" by the end of this year, followed by "a virtual meeting with interested relicensing participants to present the calibration in January 2022."[10] Adding insult to injury, it is the City's understanding that GRDA does not propose to request that the Commission allow stakeholders to provide comments on its untimely submittal.

GRDA's failure to comply with the Commission's established deadline for the Sedimentation Study also has an adverse effect on the Commission's ability to reevaluate the need for the Contaminated Sediment Transport Study as requested by the City.[11] In light of the insufficient sedimentation information provided thus far, the City respectfully requests that the Commission permit the filing of supplemental comments within thirty days after the City's receipt of the later of the Operations Model and the full Sedimentation Study Report and model, and adjust the deadlines set forth in the Commission's regulations—including the Director's resolution of disputed modification requests—accordingly.[12]

As part of those comments, the City should be allowed to request further modifications to the H&H, infrastructure, sedimentation, and socioeconomic studies, to the extent that the request could not reasonably have been made without having reviewed the Operations Model and full Sedimentation Study Report and model.

III. REQUESTS FOR STUDY MODIFICATIONS

The Commission's regulations contemplate that stakeholders, such as the City, should bring to its attention reasons why study modifications are required.[13] Here, GRDA has failed to comply with the study requirements spelled out in its own study plans and the Commission's SPD. The City requests modifications to four of GRDA's studies to ensure that each study encompasses the required scope. Each requested modification is preceded by a "showing of good cause why the proposal should be approved," as required by the ILP regulations.[14]

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[7] The Commission previously deferred ruling on the need for the Contaminated Sediment Transport Study until receiving the ISR results from the Sedimentation Study. SPD at B-39.

[8] *See* Sedimentation ISR at 2.

[9] ISR Summary at 9 (emphasis added).

[10] *Id.* at 10.

[11] SPD at B-39.

[12] *See* 18 C.F.R. §§ 5.15(c)(4)-(7).

[13] *See* 18 C.F.R. § 5.15(d).

[14] *Id.* These explanations also include, "as appropriate to the facts of the case," demonstrations that GRDA has not conducted studies as provided in its approved study plan. *Id.*

Most fundamentally, GRDA has wholly failed to examine the flooding impacts of the Project over time, instead focusing entirely on the marginal effects of a narrow slice of present-day Project operations.[15] Although current conditions provide the baseline for analysis, the Commission will still consider pre-project conditions and cumulative impacts of project operations when appropriate.[16]

The need to examine pre-project conditions and historical impacts is contemplated in the Commission's regulations,[17] the scoping document for the Project relicensing,[18] and GRDA's RSP.[19] Analysis of past conditions allows the Commission to evaluate measures to improve from the present baseline and mitigate historic impacts.[20] This analysis is particularly important in this case, as unlike almost every other hydroelectric project the Commission regulates, GRDA has already been found liable in state court for upstream flooding regularly caused or exacerbated by the Pensacola Dam.[21]

For these reasons, the Commission should require study modifications that facilitate analysis of all past, present, and reasonably foreseeable future impacts. Beyond addressing that central failure of GRDA's studies, the Commission should require other specific modifications for the reasons below.

A. Hydrology and Hydraulics Study

The H&H Study is deficient in many respects, including its failure to consider the required range of starting elevations for its model runs. GRDA's RSP specified that the H&H Study would model the Grand/Neosho River, both upstream and downstream of Pensacola Dam, in order to produce a tool for analyzing the effects of GRDA's operation of the Project under the new license, as well as indirect and cumulative impacts associated with flood control

[15] Under the Federal Power Act ("FPA", the "project" is "the complete unit of improvement or development" including "all dams . . . which are a part of said unit, and all storage, diverting, or forebay reservoirs directly connected therewith . . . ." 16 U.S.C. § 796(11). As such, all operations of Pensacola Dam, Grand Lake, and related infrastructure are "Project operations."

[16] *City of Tacoma*, 71 FERC ¶ 61,381, at 62,492 (1995).

[17] 18 C.F.R. § 2.23; 18 C.F.R. § 5.18(b)(2).

[18] *See* FERC, Scoping Document 2, Pensacola Hydroelectric Project No. 1494-438 at 23 (Apr. 27, 2018) ("The temporal scope of our cumulative effects analysis in the NEPA document will include a discussion of past, present, and reasonably foreseeable future actions and their effects on each resource that could be cumulatively affected.").

[19] RSP, Socioeconomics Study Plan, Attachment B, Response to Comment 16 ("[F]or purposes of NEPA … past actions are to be considered as part of the cumulative impacts component of the analysis."). *See also Am. Rivers v. Fed. Energy Regulatory Comm'n*, 895 F.3d 32, 55 (D.C. Cir. 2018) (finding that the Commission's NEPA cumulative-effects analysis had to account for all past impacts of the dams' construction and operation, including the enduring or ongoing effects of past actions).

[20] *See City of Tacoma*, 71 FERC ¶ at 62,492 n. 42 ("At the time of relicensing, we can consider appropriate conditions to curtail *or even reverse* the decline of a resource of concern…") (emphasis added). *Hydroelectric Licensing under the Federal Power Act*, 102 FERC ¶ 61,185, P 66 n. 85 (2003) (citing *City of Tacoma*, 67 FERC ¶ 61,152 (1994)) ("[R]eliable information on pre-project conditions may help to inform our decisions about what environmental enhancement measure may be appropriate for a new license.").

[21] *Perry v. Grand River Dam Auth.*, 344 P.3d 1, 5, 7 (Ok. Civ. App. 2013) (upholding trial court finding of constitutional taking requiring compensation to owners of land outside Project-related easements).

operations.[22] The SPD made clear that the scope of the H&H Study needs to "support an analysis of project-related flooding," including Staff's evaluation of the Project's operation for all purposes, "regardless of the regulatory bases for the [U.S. Army Corps of Engineers, or "Corps"] jurisdiction to direct operation" under most flood conditions.[23]

The SPD required the model runs undertaken in the H&H Study to "accommodate a preliminary minimum starting elevation of 734 feet Pensacola Datum ("PD"), and preliminary maximum starting elevation of 760 feet PD,"[24] a 26-foot range of starting elevations. GRDA's H&H Study, however, models flooding over just a 3-foot range of starting elevations, with one flawed exception.[25] Contrary to the requirements of the SPD, GRDA also fails to analyze flood effects other than peak depth and extent of inundation. The H&H Study is thus patently deficient, as is every study informed by the results thereof.

The Commission should require GRDA to address the deficiencies identified above. In addition, the City requests the following modifications to the key components of the H&H Study. Good cause exists to grant these requests because GRDA has failed to conduct the H&H Study as provided in the RSP.

1. Operations Model Report

As noted above, the City has not yet received the Operations Model, and therefore cannot check its assumptions or validate its performance. More importantly, because Operations Model outputs are key CHM inputs, the City also cannot model alternative flow scenarios to evaluate Project impacts and potential mitigation alternatives. Therefore, the following comments on the Operations Model Report provided in the ISR should be considered preliminary only.

The Operations Model Report indicates that the Operations Model is calibrated to the Corps' RiverWare model.[26] However, in the one instance where GRDA compared the Operations Model output against actual data, the Operations Model showed a return to normal reservoir levels *weeks* sooner than what actually occurred during the same flood.[27] Therefore, it

[22] RSP, H&H Study Plan at 3.

[23] SPD at B-2 and n.2. Additionally, the Commission has previously stated that arguments regarding ongoing and unauthorized Project-related flooding would appropriately be addressed in the relicensing proceeding for the Project. *Grand River Dam Authority*, 160 FERC ¶ 61,001, at PP 49, 56 (2017).

[24] SPD at B-3. With respect to Pensacola Datum, it appears that Staff's comments on the ISR may have inadvertently labeled Project-related elevations as National Geodetic Vertical Datum ("NGVD") when the same numbers rendered in PD, not NGVD, are the elevations generally relevant to Project operations. *See* FERC Staff November 24, 2021 ISR Comments, Attachment A at 1 and n. 2. *See also* UHM ISR at 3 for an explanation of the relationship between PD and NGVD.

[25] The only exception is GRDA's hypothetical "100-year" flood construct. For that hydrograph, GRDA modeled a wider 23-foot range of starting elevations, but the hydrograph itself is deeply flawed. That scenario assumes Neosho River flows well beyond the 1,000-year event for that river as its contributions to the hypothetical "100-year" inflow to Grand Lake as a whole (based on a flood-frequency analysis at the Commerce gage). Modeling such an immense and unlikely event on the Neosho results in misleading conclusions regarding Project impacts. Further, the 100-year inflow is by far the largest modeled flood, so it is also the one in which the Project's reservoir capacity is least useful for evaluating dam impacts and mitigation alternatives.

[26] Operations Model ISR at iii, 12-19.

[27] *See id.* at 15, Figure 6.

appears that the Operations Model vastly underestimates flooding duration. The City requests that GRDA validate its model against actual flow data, and report on the appropriateness of the RiverWare model as a basis for validation of the Operations Model.

Additionally, neither the Operations Model Report nor the H&H Study Report explain how release decisions are made (i.e., who has discretion as between GRDA and the Corps). A 1995 report by the Grand/Neosho River Committee reports on an "unofficial Corps policy" to allow GRDA under some flood conditions to stop spilling water and "generate down" the reservoir level, maximizing power production but increasing flood risk.[28] This crucial operational choice is not mentioned in the Operations Model Report. However, it could explain why, for example, the actual reservoir level during the 2007 flood stayed some five feet higher than predicted by GRDA's models for about two weeks. The actual operational data from that flood, shown below, indicates that GRDA in fact completely stopped all non-generation releases roughly a month before the reservoir returned to its target level:

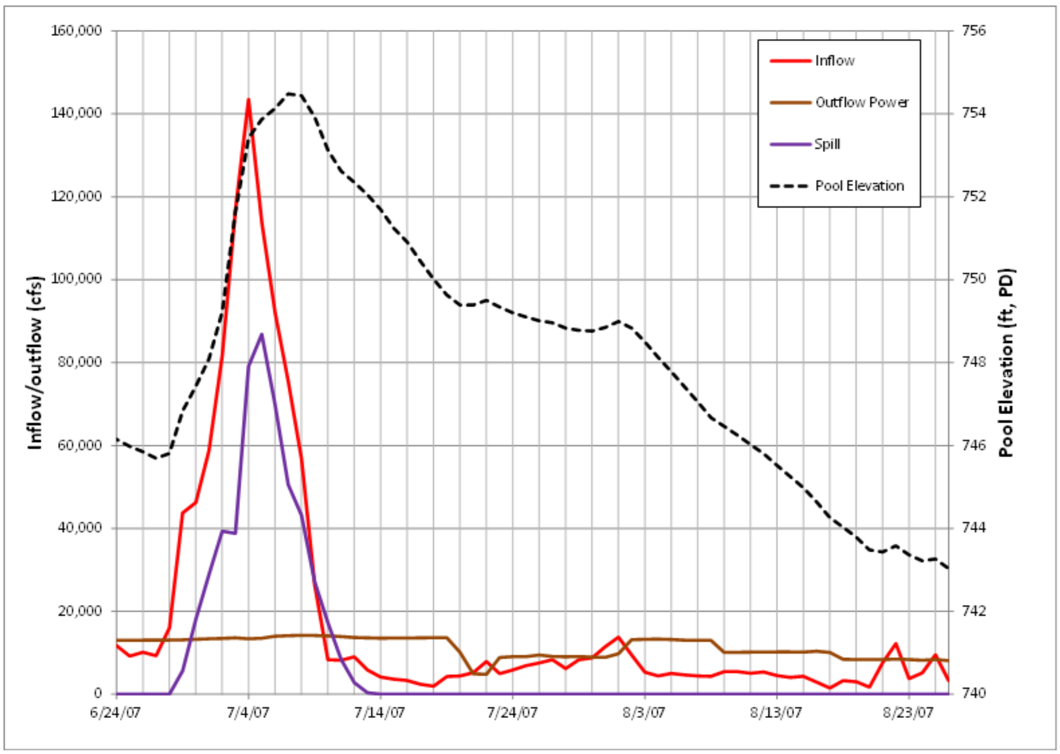

Figure 1: Actual Grand Lake surface elevations and inflows and Pensacola Dam releases during the 2007 flood. Note the complete elimination of spill from July 13 onward, while the reservoir surface remained some 5 feet above the target of 744 feet PD.

A detailed explanation of the criteria used for operational decision-making is crucial to evaluating whether the CHM inputs from the Operations Model are realistic. Therefore, in addition to validating the modeled operations against actual data, GRDA should be required to explain the actual decision-making process for each historical event in which modeled operations

[28] *Final Report and Recommendations of the Grand/Neosho River Committee*, Flood Control (Above Pensacola) Subcommittee Report (dated Aug. 1, 1995).

diverge from GRDA's actual operation of the Project at that time. Additionally, the Operations Model Report does not explain how or why GRDA selected the modeling scenarios it did.[29] GRDA should be required to provide this information.

Finally, the Operations Model Report indicates that the Operations Model relies on elevation-reservoir storage ratings from the Corps' RiverWare model.[30] GRDA should, at a minimum, be required to perform a sensitivity analysis by updating the Operations Model to include the 2019 storage curves, re-running the model, and comparing the predicted lake water-surface elevations and volumes for the modeled floods. Using outdated storage volumes could result in simulated Project operations that assume more available reservoir storage than actually exists and could provide inaccurate data for calibrating the Operations Model. The Commission should also require GRDA to analyze and report on the sensitivity of reservoir surface elevation to updated stage-storage information. If the updated stage-storage information causes more than a negligible difference in reservoir surface elevation, GRDA should be required to re-run all modeling scenarios with outputs from the updated Operations Model as inputs to the CHM runs.

2. Comprehensive Hydraulic Model

The CHM and the scenarios GRDA chose to model suffer from a number of deficiencies, as detailed below.[31]

Failure to analyze the full cumulative impact of the Project's existence and operations. Fundamentally, GRDA fails to simulate the full effect of the dam's presence and historical operations as required to study cumulative impacts, the potential for mitigating harms inherent in the current baseline, and the scope of GRDA's legal liability for flooding under state law.

"100-year" hydrograph dramatically overestimates Neosho River flows. As indicated in Tetra Tech's June 23, 2021 comments on GRDA's earlier H&H Model Input Status Report, the method for developing the 100-year inflow to Grand Lake is flawed, makes no physical sense, and artificially minimizes the impacts of Project operations on flooding.[32] GRDA determined that the 100-year inflow (from all rivers and creeks) to Grand Lake is approximately 299,000 cubic feet of water per second ("cfs").[33] It then developed an inflow hydrograph by simply scaling up the 2007 flood hydrographs, resulting in a peak flow in the Neosho River alone (at Commerce gage) of about 308,200 cfs.[34] A flood-frequency analysis of historical Commerce gage flows conducted by Tetra Tech indicates that 308,000 cfs is greater than the 1,000-year

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[29] The Operations Model Report simply states that the Operations Model was used to develop reservoir hydrographs for five floods that range in starting water-surface elevation from 742 to 745 feet. Operations Model ISR at 20. In addition, boundary conditions were developed for GRDA's hypothetical "100-year" flood for starting water-surface elevations of from 734 to 757 feet. *Id.*

[30] *Id.* at 8.

[31] The H&H Study presents separate CHM results from modeling downstream of the Project (the "Downstream Hydraulic Model" or "DHM") and upstream of the Project (the "Upstream Hydraulic Model" or "UHM"). Damaging flooding occurs more frequently upstream, where the City and several other stakeholders are located, so the City's comments on the CHM focus on the UHM and related report unless noted otherwise.

[32] *See* Tetra Tech, June 23, 2021 Comments on Behalf of the City of Miami, Oklahoma.

[33] UHM ISR at 29.

[34] *Id.* at 35.

flood at that location. By contrast, the Federal Emergency Management Agency's ("FEMA") 2019 Flood Insurance Study applied a 100-year hydrograph with a peak flow of 165,000 cfs at the Commerce gage [35]—just 54% of what GRDA modeled.

GRDA's simplistic approach of scaling up the 2007 flood means that its "100-year" scenario actually models a greater-than-1,000-year event on the Neosho River.[36] This is physically unrealistic and hides the impact of Project operations. It is misleading to apply the greater than 1,000-year flood at the Commerce gage for a range of starting water-surface elevations, then use this as the basis to claim that the dam has only an "immaterial impact" on flooding in the City.

Instead, the City requests that the Commission require GRDA to develop realistic flood hydrographs as inputs for the 100-year inflow simulation. Specifically, the City requests that the Commission require GRDA to perform flood-frequency analysis at each of the Neosho (Commerce) gage, Spring and Elk Rivers, and Tar Creek gage and perform hydrologic modeling using the HEC-HMS software to develop flood hydrographs at each of the inflow locations that have physically-based rationales for predicting peak flow and volume. Realistically representing the portion of the 100-year inflow that would pass through the Neosho River rather than other tributaries is crucial for accurate modeling of the impacts of Project operations. Moreover, a 100-year reservoir inflow hydrograph that includes 100-year river floods at Miami and other locations on the Neosho River (rather than 1000-year or greater) is far more consistent with the Commission's requirements in the SPD.[37]

Failure to model the full range of Commission-prescribed starting reservoir elevations. GRDA has failed to model the range of starting elevations for the floods where the availability of Project storage could meaningfully mitigate flooding impacts. Instead of modeling a full range of reservoir starting elevations for all floods—including those that damage the City on a regular basis—GRDA ran only one scenario, the hypothetical 100-year flood event, with anything close to the full range of starting reservoir elevations. For all other events, it modeled only a three-foot range, with starting elevations from 742 to 745 feet PD. That approach artificially minimizes the Project's operational impacts on upstream flooding. This minimization is exaggerated further by the physically unrealistic nature of the hypothetical 100-year hydrograph, as described above. Thus, GRDA's conclusory statements that Project operations have little impact on flood damage are unsupported by any probative analysis. This narrow range also ignores the fact that when the reservoir elevation rises *above* 755 feet PD, operational control reverts entirely back to GRDA.[38]

In stark contrast, previous analysis by Tetra Tech, as well as studies by expert referee Prof. Forrest Holly, show that the Project causes the greatest additional harm to the City *during*

[35] FEMA, *Flood Insurance Study for Ottawa County, Oklahoma and Incorporated Areas*, FIS Study No. 40115CV000B (2019).

[36] Although the total inflow of about 300,000 cfs into Grand Lake may be calculated correctly, it is virtually impossible that the entirety of that flow would come down the Neosho. This has the effect of exaggerating the impacts of natural flooding on the Neosho, which flows through Miami, and minimizing any possible relief that could be achieved through Project operations.

[37] *See* SPD at B-3.

[38] Corps, *Pensacola Reservoir, Grand (Neosho) River, Oklahoma Water Control Manual*, Letter of Understanding – Pensacola Dam and Reservoir (previously filed in Docket No. P-1494-438, under Accession No. 20180306-3047).

intermediate-sized floods.[39] Similarly, the 2021 analysis by the Corps' Silver Jackets program using different methods concluded that in individual floods, most of the economic damage within Miami accrues at magnitudes between the 10-year flood (estimated damages of $258,000) and 25-year flood (estimated damages of $27 million).[40] In order to sufficiently model the damaging impact of intermediate-sized floods, GRDA should be required to comply with the SPD and analyze starting reservoir elevations between 734 feet and 757 feet.[41]

Erroneous railway bridge geometry. The geometry of the abandoned railway bridge at river mile 134.599 is not representative of the actual conditions. The bridge has wide openings between the upper and lower truss, which are about ten feet apart. GRDA's HEC-RAS model represents the area between the lower and upper spans as completely blocked, thus preventing flow between the trusses. This error effectively models the bridge as a solid barrier, rather than a permeable fixture, and likely results in the CHM masking the full flood impact of the Project upstream of the bridge by overpredicting the water-surface elevation due to factors other than the presence and operation of the dam.

Confusing new river mile numbering system. GRDA's studies use a new river mile numbering system. This introduces needless confusion and difficulty because it differs by about eight miles from that of all previous studies—since construction of the dam—of which the City is aware. The City raised this concern in response to the H&H Model Input Status Report.[42] GRDA's only explanation is that it "used [United States Geological Survey ("USGS")] river miles because it is a publicly available dataset."[43] This disregards the need for consistency across studies. In the SPD, the Commission—noting the importance of consistency—required GRDA to use PD instead of NGVD for vertical measurements.[44] Requiring GRDA to use the same system as past studies will similarly avoid needless confusion.

3. Improperly Truncated Analysis of Model Results and Project Flooding Impacts

As described below, there are additional deficiencies in GRDA's analysis and application of its H&H Study results.

No analysis of Project impacts on flooding duration, frequency, timing, or amplitude. The SPD stated that the CHM was intended to, "calculate inundation and flood routing specifics,

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[39] *See, e.g.*, Tetra Tech, *Hydraulic Analysis of the Effects of Pensacola Dam on Neosho River Flooding in the Vicinity of Miami, Oklahoma*, at viii (Dec. 9, 2015); *see also* Forrest M. Holly Jr., Ph.D., P.E., "Flood Level and Duration Determination Neosho River below Commerce Gage," referee report in *Dalrymple et al. vs. Grand River Dam Authority*¸ Case No. CJ 94-444, District Court of Ottawa County (April 2001) (previously filed in Docket No. P-1494-437, at Ex. A under Accession No. 20161031-0146).

[40] Army Corps, Southwestern Division, Tulsa District, *Silver Jackets Nonstructural Interagency Project: Miami Flood Resilience and Risk Reduction Benefit Analysis – Economic Analysis* at 4, Table 2 (July 2021).

[41] *See also* FERC Staff November 24, 2021 ISR Comments, Attachment A at 1 (querying GRDA's failure to comply with the requirements of the SPD, but noting that because the height of the dam is only 757 feet, analyses of starting reservoir elevations above 757 feet are not necessary).

[42] Tetra Tech, June 23, 2021 Comments on Behalf of the City of Miami, Oklahoma, Attachment at 4.

[43] UHM ISR, app. A, Response to Comment No. 3.

[44] SPD at B-6.

such as frequency, timing, amplitude and duration[.]"[45] However, the CHM as described in the ISR addressed only the maximum lateral extent and depth of inundation, ignoring all other parameters. During the ISR meeting, GRDA indicated it did not present these factors—even though required by the SPD—in order to "simplify" the results. GRDA's failure to comply with its own study protocols is unacceptable. Moreover, failure to analyze these parameters substantially erodes the accuracy and reliability of the studies that depend on H&H Study results. The Commission should therefore require GRDA to add analysis of the Project's impacts on the frequency, timing, amplitude, and duration of flooding.

No analysis of trends in flood frequency. The ILP requires study methods "consistent with generally accepted practice in the scientific community,"[46] but nothing in the ISR explains the basis for GRDA's methods in performing the flood frequency analysis. At the ISR Meeting, GRDA was clear that it made no attempt to identify trends in the factors that contribute to stream flows and flooding near the Project (notably climate change, but also land use change and sedimentation in upstream flood control reservoirs).[47] This evaluation is important to understanding how environmental trends will affect flooding and sedimentation over the duration of the license period.[48] By turning a blind eye toward possible trends, GRDA assumes without discussion or justification that the magnitude and probability of floods in 2050 or 2070 will be the same as it was a century earlier. That assumption carries forward into every study that relies on the H&H Study results. The Commission should require GRDA to state and provide support for its assumptions about trends in flood frequency, including those due to climate change.

No discussion of the extent of flooding beyond Project property rights. GRDA is liable for any flooding (or increase in natural flooding) it causes beyond the property rights held by GRDA. Nothing in the H&H Study analyzes the extent of that flooding, although previous studies have estimated that it covers 13,000 acres. Even the UHM Study shows that just a three-foot change in starting reservoir elevation makes a difference of hundreds of additional acres flooded.[49] The flood inundation maps in the UHM Report appendices depict the boundaries of Project easements, with flooding that often extends far beyond them.[50] The Commission should require GRDA to quantify the area for which flooding exceeds Project-related property rights for each modeled scenario. In order to inform the Commission's cumulative impacts analysis, GRDA should also be required to demonstrate the extent by which the flooded area under each

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[45] *Id.* at B-1.

[46] 18 C.F.R. § 5.9(b)(6).

[47] By contrast, USGS' guidelines caution that "special effort should be made to identify those records that are not homogenous." USGS, *Guidelines for Determining Flood Flow Frequency* 23 (May 2019), https://pubs.usgs.gov/tm/04/b05/tm4b5.pdf.

[48] There is readily available data specific to Oklahoma to evaluate climate change and other trends and complete a full assessment of the potential inflow events and resulting floods. *See, e.g.*, AMEC Earth & Environmental, "Oklahoma Comprehensive Water Plan: Climate Impacts to Streamflow" (2011), https://www.owrb.ok.gov/supply/ocwp/pdf_ocwp/WaterPlanUpdate/OCWP_ClimateChangeHydrologyReport.pdf. That study is part of a comprehensive plan applicable to this proceeding under Section 10(a)(2) of the FPA, 16 U.S.C. § 803(a)(2)(A). FERC, Scoping Document 2, Pensacola Hydroelectric Project No. 1494-438 at 30-31.

[49] UHM ISR at 39, Table 18.

[50] *See, e.g.*, *id.*, app. F.3, Map B4 (showing extensive flooding beyond flowage easements in 2007 flood).

scenario exceeds the area that would have flooded under natural conditions (i.e., prior to existence of the dam).

Unsupported conclusions in the H&H Study fail to adequately inform the other studies that depend on it. One of the stated objectives of the UHM report is to "provide the model results in a format that can inform other analyses (to be completed separately) of Project effects, if any, in several resource areas."[51] The report fails to do that. Instead, the executive summary and conclusions offer nothing but conclusory statements, with no link to supporting model analysis. For example, the report claims that "[t]he results of the UHM demonstrate that the initial stage at Pensacola Dam has an immaterial impact on upstream [water surface elevations] and maximum inundation extent" and that Project operations do not cause "an appreciable difference in maximum water surface elevation ("WSEL") and maximum inundation extent."[52]

GRDA entirely omits any explanation of what degree of Project-caused flooding is "immaterial" or what increase in WSEL (let alone other flooding parameters) is "appreciable." At the ISR meeting, GRDA was unable to provide any numerical criterion or citation to a source for these conclusions. Yet many of GRDA's other studies—and requests to reduce future work or terminate them early—cite exactly those conclusions from the H&H Study. The Commission should require that the H&H Study, rather than stating unsubstantiated conclusions, instead do what it said it would and "provide the model results in a format that can inform other analyses (to be completed separately) of Project effects… in several resource areas."[53]

4. Requested Modifications

Based on the foregoing, the City requests the following modifications to the H&H Study with respect to the Operations Model Report, the CHM, and the analysis of the related modeling results. The City reserves the right to supplement these comments following receipt of the Operations Model.

Operations Model Report

1. GRDA should analyze the RiverWare data and provide a comparison to actual gage flow data, where available.

2. Where actual gage flow data are available, GRDA should be required to use that data, rather than or in addition to RiverWare modeling outputs, as its basis for validating the Operations Model results.

3. GRDA should be required to describe how and why the operational outputs from the Operations Model differ from actual operations, particularly with respect to modeled minimum versus actual discharges.

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[51] UHM ISR at 1 (citing RSP, H&H Study Plan at 4).

[52] *Id.* at v, 50. *See also* FERC Staff November 24, 2021 ISR Comments, Attachment A at 2 (requesting clarification of GRDA's quantification of the influence of Project operations on water levels upstream and downstream of the dam).

[53] RSP, H&H Study Plan at 4.

4. GRDA should be required to explain how and why it and/or the Corps make operational decisions during the course of flood events.

5. GRDA should be required to explain how and why it developed the operational scenarios it selected, including the computation of boundary conditions and results, and provide detailed results of the developed scenarios including the water-surface elevations, gate openings during floods, dam outflows, and comparisons with the rule curves.

6. GRDA should be required to perform a sensitivity analysis of the Operations Model by updating it with the 2019 stage-storage curves and evaluating the impacts on reservoir elevation and lake storage. If the updated stage-storage information causes more than a negligible difference in reservoir surface, GRDA should be required to re-run all modeling scenarios with outputs from the updated Operations Model as inputs to the CHM runs.

7. To the extent that the UHM results depend on Operations Model outputs assuming outdated stage-storage curves, those results should be updated. Any studies that depend on UHM results, including the sedimentation and infrastructure studies and the requested Contaminated Sediment Transport Study, should be also be revised as needed in light of updated UHM model results.

Comprehensive Hydraulic Model

8. GRDA should be required to analyze all existing information and historical data to identify statistical trends (including, but not limited to, those due to climate change) that may indicate that future conditions will diverge from historical norms. GRDA should then refine the H&H Study to account for any such trends.

9. GRDA should be required to develop realistic flood hydrographs as inputs for the 100-year inflow simulation. Specifically, GRDA should:

    a. Perform flood-frequency analysis at each of the Neosho (Commerce) Gage, Spring and Elk Rivers, and Tar Creek gages; and

    b. Perform hydrologic modeling using the HEC-HMS software to develop flood hydrographs at each of the inflow locations that have physically based rationale for predicting the peak flow and volume.

10. GRDA should be required to update the CHM to reflect the actual geometry of the abandoned railway bridge at river mile 134.599.

11. GRDA should be required to use consistent river mile numbering across studies.

Analysis of Model Results and Project Flooding Impacts

12. GRDA should be required to provide an analysis of the Project's impacts on the frequency, timing, amplitude, and duration of flooding.

13. GRDA should be required to state its assumptions regarding trends in flood frequency and severity, including those trends due to climate change, and provide evidence and analysis supporting those assumptions.

14. GRDA should be required to quantify the land area in which flooding exceeds Project-related property rights for each modeled scenario and, in order to inform the cumulative impacts analysis (including cumulative sedimentation in tributaries caused by the Project and its operations), demonstrate the extent to which that area exceeds the area that would have flooded had the dam not been built.

15. To the extent that the infrastructure, socioeconomic, and sedimentation studies depend on H&H Study conclusions or model outputs, GRDA should be required to revise those studies once it has rectified the shortcomings of the H&H Study identified above. Further, rather than stating unsubstantiated conclusions without reference to any of the other studies that rely on the H&H Study, GRDA should provide the model results in a format that can productively inform analyses of Project effects on infrastructure, socioeconomics, and sedimentation.

B. Infrastructure Study

The Commission's SPD required GRDA to conduct an infrastructure impacts study to characterize existing infrastructure that could be affected under flood conditions and help Commission Staff analyze the broad effect of Project operations on various land uses, including uses related to infrastructure or municipal recreation areas.[54] The Infrastructure Study depends on the accuracy and reliability of the H&H Study. However, as noted above, the H&H Study does not consider a realistic range of flood events and starting reservoir elevations. Nor does it include any analysis of flooding parameters other than maximum depth and extent.

As a result, the Infrastructure Study fails to consider how depth, amplitude, and duration of inundation impacts infrastructure. At the ISR meeting, GRDA explained that under this study, if a particular piece of infrastructure is flooded under two different H&H Study model scenarios, GRDA assumes that there is no additional loss of infrastructure use at the location. In other words, GRDA essentially pretends that all flood impacts are identical, regardless of depth, duration, or amplitude.

<u>Requested modifications:</u> Noting these concerns, the City requests the following modifications to the Infrastructure Study:

1. The Commission should reject GRDA's request not to continue any analysis of infrastructure impacts, given the deep and wide-ranging flaws in the H&H Study that underpin it. Instead, GRDA should be required to update the Infrastructure Study based on the results of the H&H Study once it has been modified as described above.

[54] SPD at B-34.

2. GRDA should be required to analyze Project impacts on infrastructure based on all flooding parameters, not merely the binary determination of whether or not a flood peak ever reaches a particular piece of infrastructure.

C. Sedimentation Study

In the SPD, the Commission required GRDA to adopt the City's proposed methodology for conducting its Sedimentation Study.[55] As such, the City is uniquely suited to review the Sedimentation Study as described in the ISR. As noted above, GRDA has not yet submitted its full Sedimentation Study. Instead, GRDA provided only limited detail regarding data collection and model development. In anticipation of eventual receipt of the full Sedimentation Study, the City offers the following initial comments and proposed modifications in response to the Sedimentation Report provided in the ISR.

The Sedimentation Report does not analyze cumulative impacts such as loss of reservoir storage due to sedimentation, which is a cumulative impact going back to completion of the dam. Similarly, the Sedimentation Study as described does not appear to consider the cumulative effect of sediment that has settled out and accumulated over decades in tributary channels and/or the head of the reservoir, further compounding the backwater effect upstream. Additionally, the Sedimentation Study, as informed by the H&H Study, fails to consider whether lower elevations at the start of a flood could transport sediment deeper into the reservoir, where the reservoir's presence has historically caused accumulation of dozens of feet of sediment that contribute to upstream backwater flooding .[56] More broadly, the Sedimentation Study should also be expanded to consider trends in future hydrology, including the effects of climate change over the term of the new license.

<u>Requested modifications:</u> The City requests the following modifications to the Sedimentation Study, while reserving the right to provide supplemental comments following GRDA's submission of its full Sedimentation Study, including the Sedimentation Transport Model:

1. GRDA should be required to fully analyze the cumulative impacts of sedimentation resulting from Project operations on upstream flooding.

2. As noted in reference to the H&H Study, GRDA should be required to examine the sedimentation impacts and resultant flooding impacts associated with a wider range of starting reservoir elevations.

3. GRDA should be required to consider future trends in hydrology in order to effectively evaluate overall trends and impacts of sedimentation.[57]

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[55] SPD at B-9.

[56] *See* UHM ISR, app. A, Comment No. 5. Figure B to that comment shows greater than twenty feet of sediment accumulation downstream of Twin Bridges compared to the Corps' 1941 survey, which is caused by the presence of the dam and is one of the reasons to consider pre-project conditions in the analysis of cumulative impacts.

[57] *See* Sedimentation ISR at 3 (noting that the Sedimentation Transport Model will provide this sort of evaluation).

4. GRDA should be required to improve calibration of the Sedimentation Transport Model as informed by the H&H Study, including calibrating over a full range of flows.

5. Once the H&H Study has been modified as described above, GRDA should be required to revise the Sedimentation Study to reflect the results of the revised H&H Study.

D. Socioeconomics Study

GRDA's RSP specified that the Socioeconomics Study, as informed by the H&H Study and detailed in the eventual Socioeconomics Study Report, would describe baseline socioeconomic information; gather and analyze additional economic information; and assess the cumulative socioeconomic impacts of continued operation and maintenance of the Project under a new license. Noting that the Socioeconomics Study stands on the deficient foundation laid by the H&H Study, the City requests the following modifications of the Socioeconomics Study.

Deficient description of baseline socioeconomic information. In its RSP, GRDA committed to compiling "published and other objective information that will be used to describe a demographic, housing, and economic profile for the four-county study area."[58] To augment this approximation of a baseline, the City requested in its comments on the PSP that GRDA collect information on a range of socioeconomic values, including direct economic impacts of the Project; Project effects on local government finances; and social and societal impacts of the Project.[59] In response, GRDA said it would "query all relicensing participants, as well as other county, regional and state entities for relevant information as part of the study" and "provide the information identified in the comment to the extent it is available."[60]

During the ISR meeting, GRDA took the position that it is not obligated to undertake any task not expressly called out in the RSP or SPD, even if its prior responses to stakeholder comments committed it to doing so. To that end, it is unclear if Enercon—the consultant that produced GRDA's Socioeconomics Study Report—ever received the list of information requested in the City's comments. If so, nothing in the record suggests any attempt to determine whether the requested information was available. GRDA should be required to demonstrate a concerted effort to provide the requested information, where available.

Additionally, it is difficult to discern the source of some of the information GRDA did gather. For example, Figure 4 of the Socioeconomics Study Report purports to illustrate areas where the percentage of people living below the poverty level exceed 20 percentage points above the State of Oklahoma's poverty level.[61] However, GRDA does not provide a source for the information provided in this map, making it impossible to confirm its accuracy.

[58] RSP, Socioeconomics Study Plan at 5.

[59] City of Miami, August 28, 2020 Comments Regarding GRDA Request for Socioeconomic Information at 17-19.

[60] RSP, Socioeconomics Study Plan, Attachment B, Response to Comment 259.

[61] *See* Socioeconomics ISR at 27.

Insufficient gathering and analysis of additional economic information. In addition to querying "participants to the relicensing, as well as local organizations and businesses, for available, relevant data related to the [Pensacola] Project study area," GRDA committed to identifying "other publications and statistics" in order to gather sufficient economic information to inform its analysis.[62] However, in the Socioeconomics Study Report, GRDA fails to cite to any document it consulted for this purpose that was older than 2008. Notably, none of the documents older than 2015 are attributable to any source other than GRDA.

The Socioeconomics Study Report notes that only eight responses were received from the roughly 190 stakeholders who were contacted.[63] At the ISR meeting, GRDA was unable to answer whether that response rate was indicative of a flaw in its information gathering process and/or whether additional outreach might be necessary in order to increase the number of responses. Notably, GRDA sent out its information-gathering mailings in July of 2020, when many stakeholders—particularly Tribes—were preoccupied with coordinating their pandemic response. As such, this outreach was neither effective nor equitable.

Additionally, although GRDA committed to reviewing "the most recent FEMA Flood Insurance Study to summarize available information on the cumulative impacts of flooding in the area[,]" the Socioeconomics Study Report does not include any reference to this resource.[64] At the ISR meeting, GRDA was unable to confirm whether its analysis of available housing stock included publicly-available information from FEMA, HUD, or the City regarding the impacts of flooding—and any exacerbated impacts due to climate change—on the availability and affordability of housing in the study area.

The Socioeconomics Study Report notes that the median housing values in Ottawa County are the lowest in the four-county area, and Table 3 shows that while the housing values for Craig, Delaware, and Mayes counties increased by upwards of 25% between 2010 to 2019, housing values in Ottawa County rose by only 9%. However, the Socioeconomics Study Report neglects to discuss the impacts of flooding on home values or the related socioeconomic impact of rising flood insurance premiums. Instead, GRDA asserts that "any reasonably foreseeable effects on housing that has a reasonably close causal relationship to the hydroelectric project is not expected in the [region of project influence]."[65] This conclusion is flatly contradicted by the results of litigation to which GRDA was a party.[66]

Failure to identify negative socioeconomic impacts. The SPD anticipated that GRDA would utilize the baseline socioeconomic information it gathered to "identify the past, present, and reasonably foreseeable cumulative socioeconomic impacts due to the continued operation and maintenance of the [Pensacola] Project under a new license."[67] However, the information

[62] RSP, Socioeconomics Study Plan at 5.

[63] Socioeconomics ISR at 12.

[64] *See* RSP, Socioeconomics Study Plan, Attachment B, Response to Comment 259.

[65] Socioeconomics ISR at 21.

[66] *See e.g., McCool vs. Grand River Dam Authority*¸ Case No. CJ 94-444-A, District Court of Ottawa County (October 2001) (finding that flooding due to Project operations resulted in $75,000 of damage to a home, $21,731 of which was a reduction in the fair market value of the home even after it was repaired).

[67] *See* SPD at B-31.

provided in the Socioeconomics Study Report is not sufficient to address the scope of review that GRDA committed to undertake, particularly with regard to past, present, and future *negative* economic impacts as a result of Project operations.

The Socioeconomics Study Report points to the Oklahoma Department of Commerce's March 2015 economic impact study, which summarized "the economic benefits associated with operating, constructing, and positive externalities from GRDA."[68] However, at the ISR meeting, GRDA was unable to confirm that it made any attempt to identify negative socioeconomic impacts. Additionally, GRDA was unable to provide any information as to how the various benefits and burdens of the Project were distributed, rather than merely aggregating them in a broad assessment of the Project vicinity. In short, there is no evidence that GRDA made any effort to study the negative externalities that are unfairly borne by upstream communities to the benefit of others in the Project area.

Failure to explain how Socioeconomics Study Report will be updated in light of H&H Study results. Page 3 of the ISR cover report lists the Socioeconomics Study as complete, but the Socioeconomics Study Report itself states that, "[t]he proposed operations model and hydraulic model will provide information to evaluate any reasonably foreseeable effect that has a reasonably close causal relationship to hydroelectric project operations or USACE flood control operations."[69] At the ISR meeting, GRDA was unable to provide a firm answer as to how and when the Socioeconomics Study will be updated to reflect the H&H Study results. Additionally, the SPD required GRDA to include an appendix containing electronic copies of documents submitted by stakeholders and links to publicly-accessible web sites containing such documents. It does not appear that the Socioeconomics Study Report includes this appendix.

Failure to analyze environmental justice impacts. In order to provide the level of detail needed for Commission Staff to adequately analyze environmental justice impacts as part of its eventual environmental review, the SPD also recommended that GRDA modify the socioeconomics study plan to include not only a summary of the socioeconomic conditions in the four-county study area, but also tabular data on these conditions reported at the county and census tract level, where such data exist. The SPD also noted that GRDA should clearly state in the Socioeconomics Study Report which data source was used for each level of aggregation documents.

More broadly, at the ISR meeting, GRDA was unable to offer a response regarding (1) whether the Socioeconomics Study as conducted aligns with the Commission's recently announced focus on environmental justice, as consistent with Executive Order 14008; and (2) whether it considered including statistics specific to environmental justice when compiling other relevant socioeconomic and demographic data.

<u>Requested modifications:</u> In light of the deficiencies outlined above, the City requests the following modifications to the Socioeconomics Study:

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[68] Socioeconomics ISR at 8 (citing Oklahoma Department of Commerce, *Economic Impact of the Grand River Dam Authority* (Apr. 27, 2015) https://www.okcommerce.gov/grand-river-dam-authority-part-of-oklahomas-economic-engine/).

[69] *Id.* at 20.

Description of Baseline Socioeconomic Information

1. GRDA should be required to ensure that the baseline conditions underlying its Socioeconomics Study reflect a comprehensive review of all available information. To do so—and to satisfy the commitments made in GRDA's prior responses to stakeholder comments—GRDA should augment its baseline analysis to fully consider direct economic impacts of the Project; Project effects on local government finances; and social and societal impacts of the Project.

Gathering and Analysis of Additional Economic Information

2. GRDA should be required to reinitiate its outreach to relicensing participants and county, regional and state entities—including Tribes—using a method better calculated to ensure an adequate response.

3. Additionally, GRDA should be required to illustrate that it has gathered and analyzed the categories of information it committed to provide in its RSP, including all economic impacts of the Project; Project effects on local government finances; and social and societal impacts of the Project.

4. GRDA should review the most recent FEMA Flood Insurance Study and update its Socioeconomics Study to reflect analysis of this and other publicly-available resources reflecting the impacts on flooding on the availability and affordability of housing in the study area.

Assessment of Cumulative Socioeconomic Impacts

5. GRDA should be required to revise its overly broad assessment of cumulative socioeconomics impacts to disclose and assess the negative economic impacts of the Project.

6. Additionally, GRDA should be required to augment the limited temporal scope of cumulative impacts assessed thus far to identify all past, present, and reasonably foreseeable cumulative socioeconomic impacts of the project.

Preparation of the Socioeconomics Study Report

7. As noted in the SPD, GRDA should be required to provide an appendix containing electronic copies of documents submitted by stakeholders and links to publicly-accessible web sites containing such documents.

8. GRDA should be required to update the Socioeconomics Study Report to clearly state which data source was used to produce the tabular data on socioeconomic conditions reported at the county and census tract level and augment this data where current sources are insufficient.

9. GRDA should provide an adequate level of detail to enable Commission Staff to analyze environmental justice impacts as part of its environmental review.

10. Once the H&H Study has been modified as described above, GRDA should be required to revise the Socioeconomic Study to reflect the results of the revised H&H Study.

IV. REQUEST FOR NEW STUDY: CONTAMINATED SEDIMENT TRANSPORT

In its comments on GRDA's Proposed Study Plan, the City requested a Contaminated Sediment Transport Study to determine how Project operations affect the transport and deposition of potentially contaminated sediments from the massive Tri-State Mining District, including the Tar Creek Superfund site and other contaminated areas a few miles upstream of the City.[70] That study remains relevant and necessary for the reasons given in the City's study plan request and in its subsequent comments on GRDA's RSP.[71]

As noted above, GRDA has not yet submitted its full Sedimentation Study or any sediment transport modeling results. GRDA should not be able to frustrate the development of a complete record by delay. Therefore, and in anticipation of eventual receipt of the full Sedimentation Study and review of the information contained therein, the City requests that the Commission approve the City's requested Contaminated Sediment Transport Study to examine how Project operations alter the way contaminated sediment is transported and deposited on lands occupied by the City and its residents. Good cause exists to require this additional study, as the City anticipates that the full Sedimentation Study, including the Sedimentation Transport Model, when finally produced by GRDA will provide significant new information material to and supportive of the objectives of the proposed Contaminated Sediment Transport Study.

The City appreciates the opportunity to provide these initial comments on the ISR for the Pensacola Project. Please feel free to contact me at (206) 605-3638 or via email at craiggannett@dwt.com if you have any questions regarding these comments.

Sincerely,

/s/ Craig Gannett
Craig Gannett
Walker Stanovsky
Shannon O'Neil
Davis Wright Tremaine LLP

Counsel for the City of Miami, Oklahoma

---

[70] City of Miami, July 26, 2018 PSP Comments, Attachment 3 – Study Plan Request for Contaminated Sediment Transport Study.

[71] City of Miami, October 24, 2018 RSP Comments at 21-28. In the SPD, the Commission deferred ruling on the need for the Contaminated Sediment Transport Study until receiving the ISR results from the Sedimentation Study. SPD at B-39.

Appendix B

Water Surface Elevation Profiles for the FEMA 2019 Flood Insurance Study Inflow Event

APPENDIX B:
WATER SURFACE ELEVATION PROFILES FOR THE FEMA 2019 FLOOD INSURANCE STUDY INFLOW EVENT

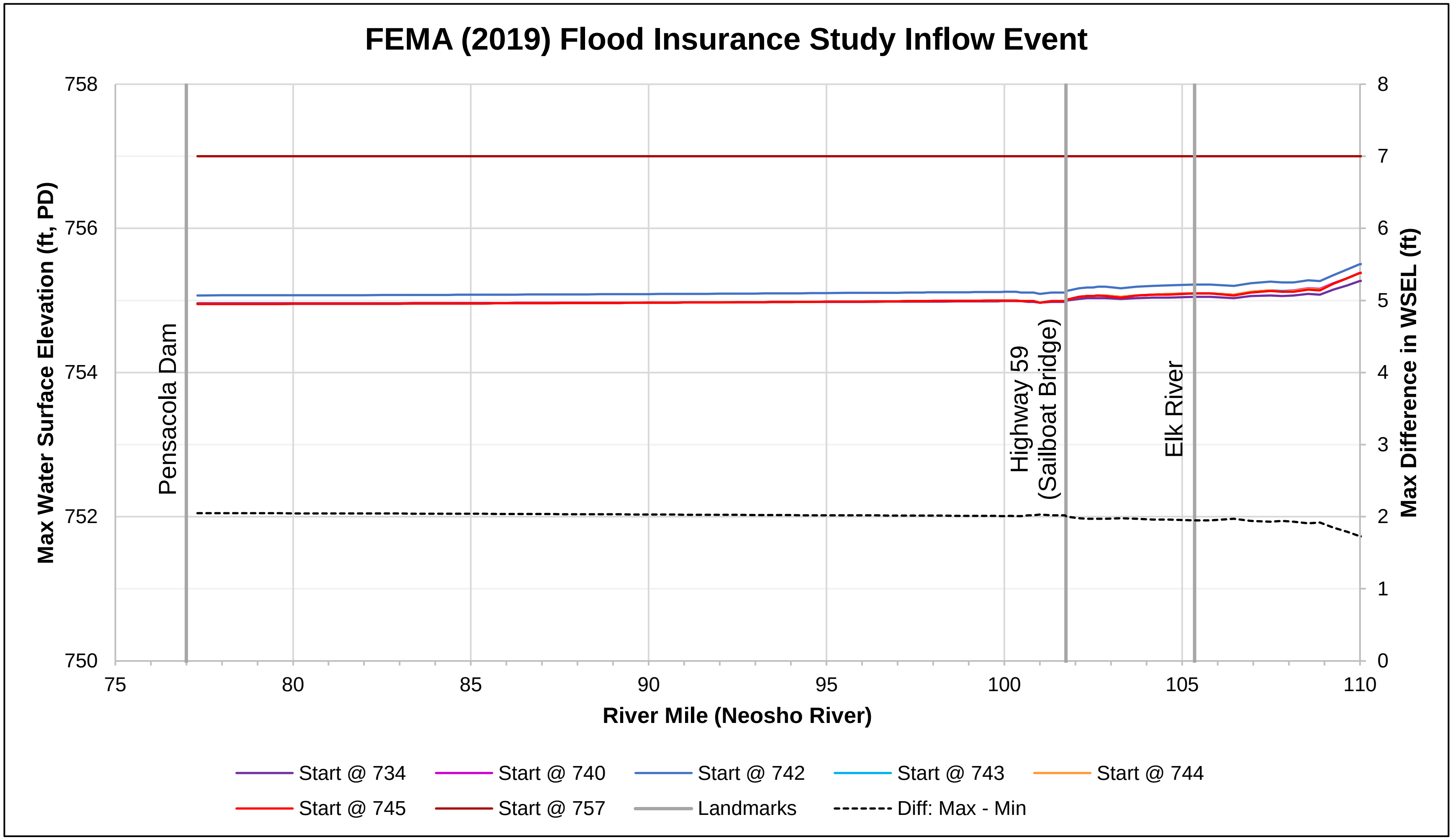

Exhibit 1 Figure 1. Water surface elevations for the FEMA (2019) Flood Insurance Study event upstream of Pensacola Dam along the Neosho River profile (1 of 5).

Notes:

1. *In the legend, the first set of series names refers to pool elevation at Pensacola Dam at the start of the simulation. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.*
2. *The dashed line is plotted against the right y-axis and represents the difference between the highest and lowest max WSEL displayed on the figure.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles displayed.*
4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profile for the other starting elevations is nearly identical.*

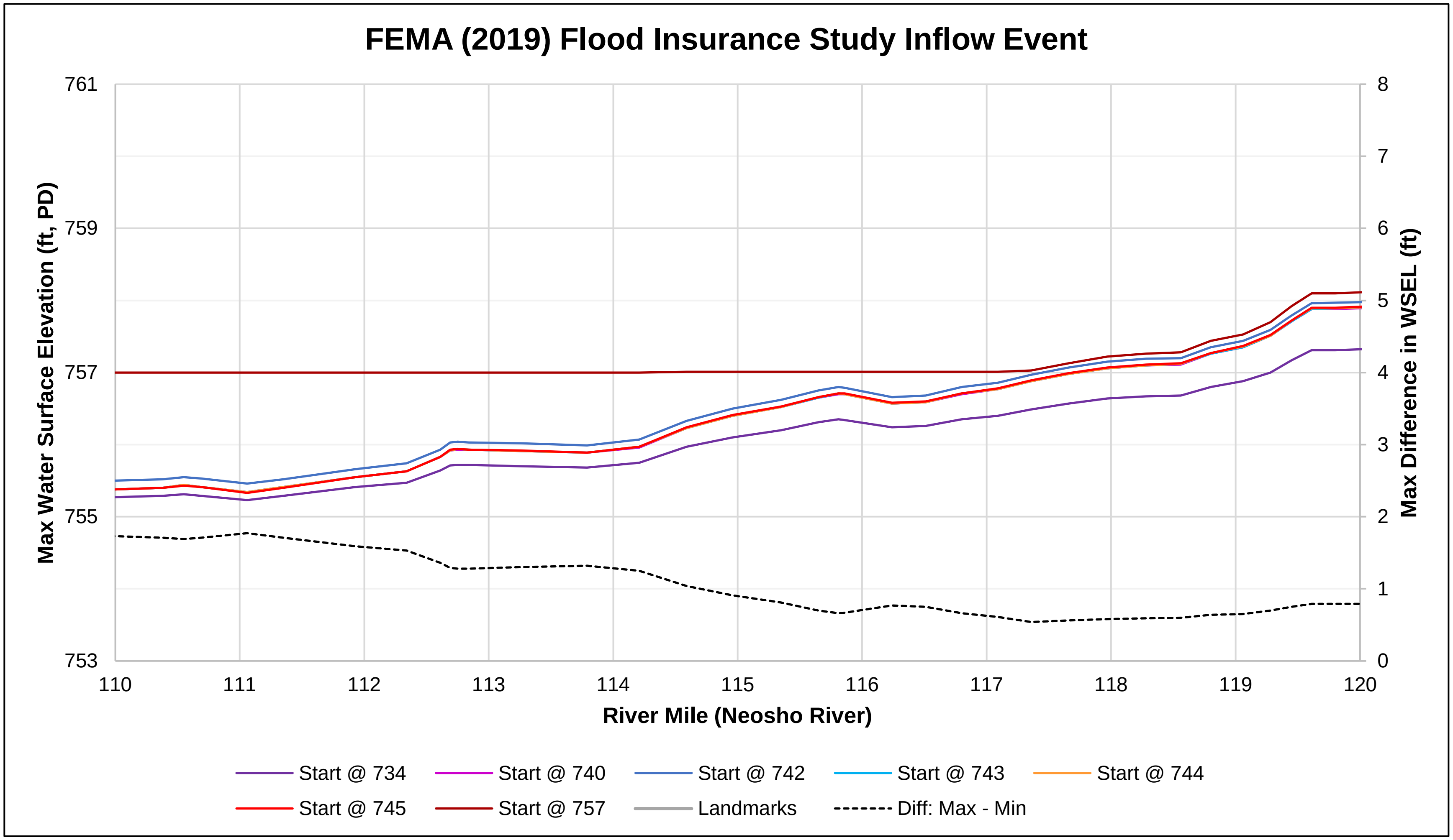

Exhibit 1 Figure 2. Water surface elevations for the FEMA (2019) Flood Insurance Study event upstream of Pensacola Dam along the Neosho River profile (2 of 5).

Notes:

1. In the legend, the first set of series names refers to pool elevation at Pensacola Dam at the start of the simulation. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The dashed line is plotted against the right y-axis and represents the difference between the highest and lowest max WSEL displayed on the figure.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profile for the other starting elevations is nearly identical.

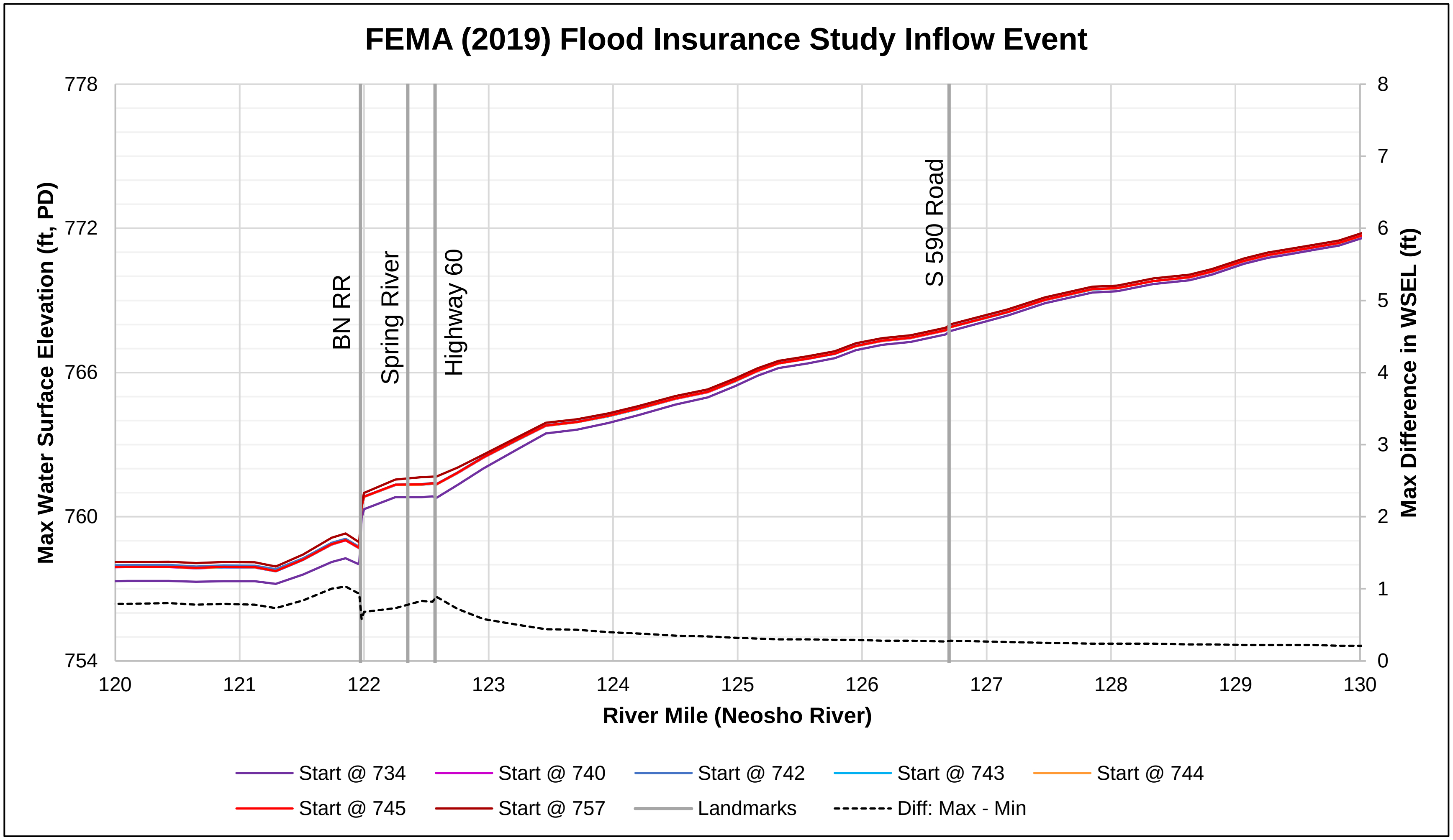

Exhibit 1 Figure 3. Water surface elevations for the FEMA (2019) Flood Insurance Study event upstream of Pensacola Dam along the Neosho River profile (3 of 5).

Notes:

1. In the legend, the first set of series names refers to pool elevation at Pensacola Dam at the start of the simulation. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The dashed line is plotted against the right y-axis and represents the difference between the highest and lowest max WSEL displayed on the figure.

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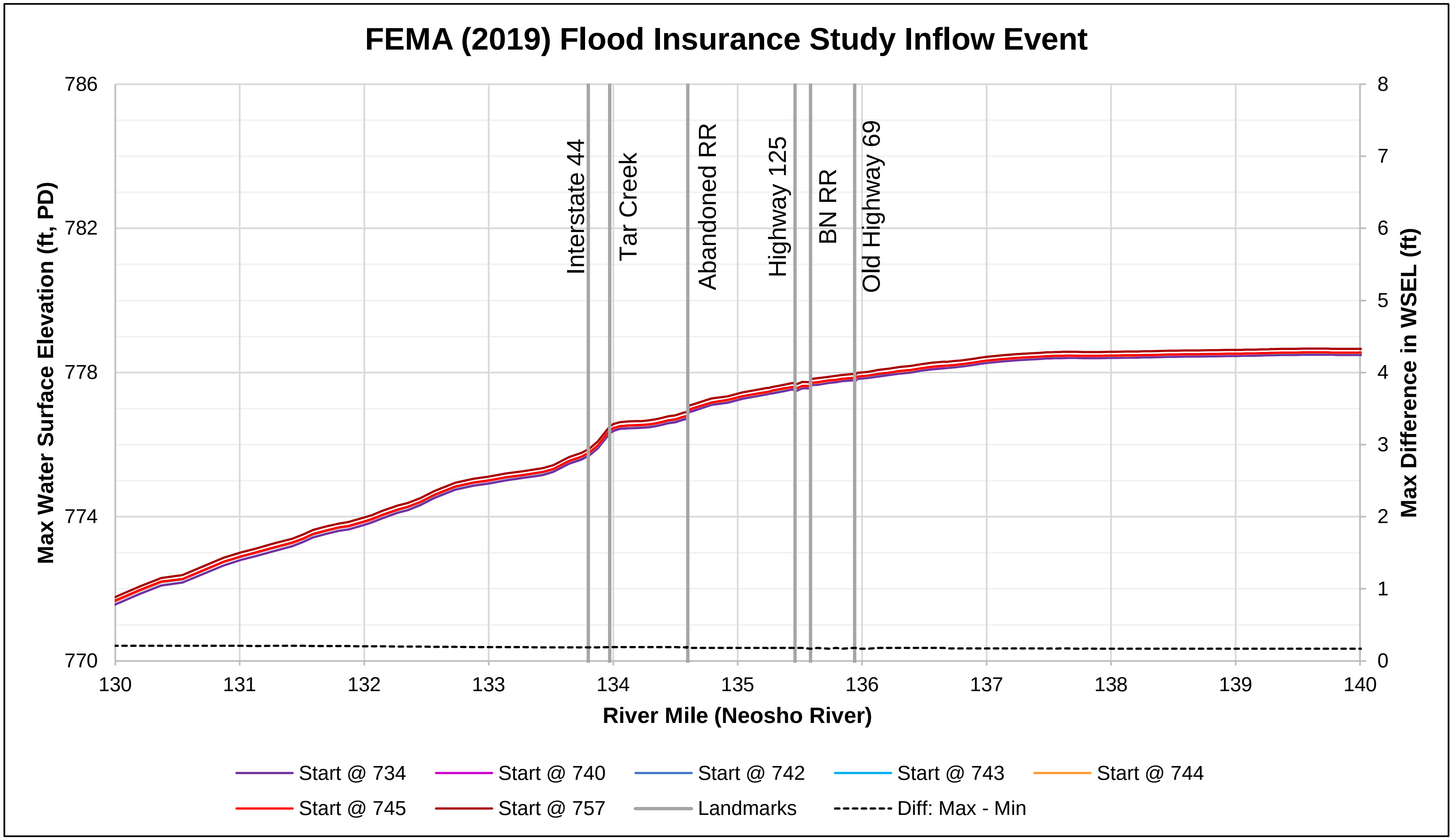

Exhibit 1 Figure 4. Water surface elevations for the FEMA (2019) Flood Insurance Study event upstream of Pensacola Dam along the Neosho River profile (4 of 5).

Notes:

1. In the legend, the first set of series names refers to pool elevation at Pensacola Dam at the start of the simulation. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The dashed line is plotted against the right y-axis and represents the difference between the highest and lowest max WSEL displayed on the figure.

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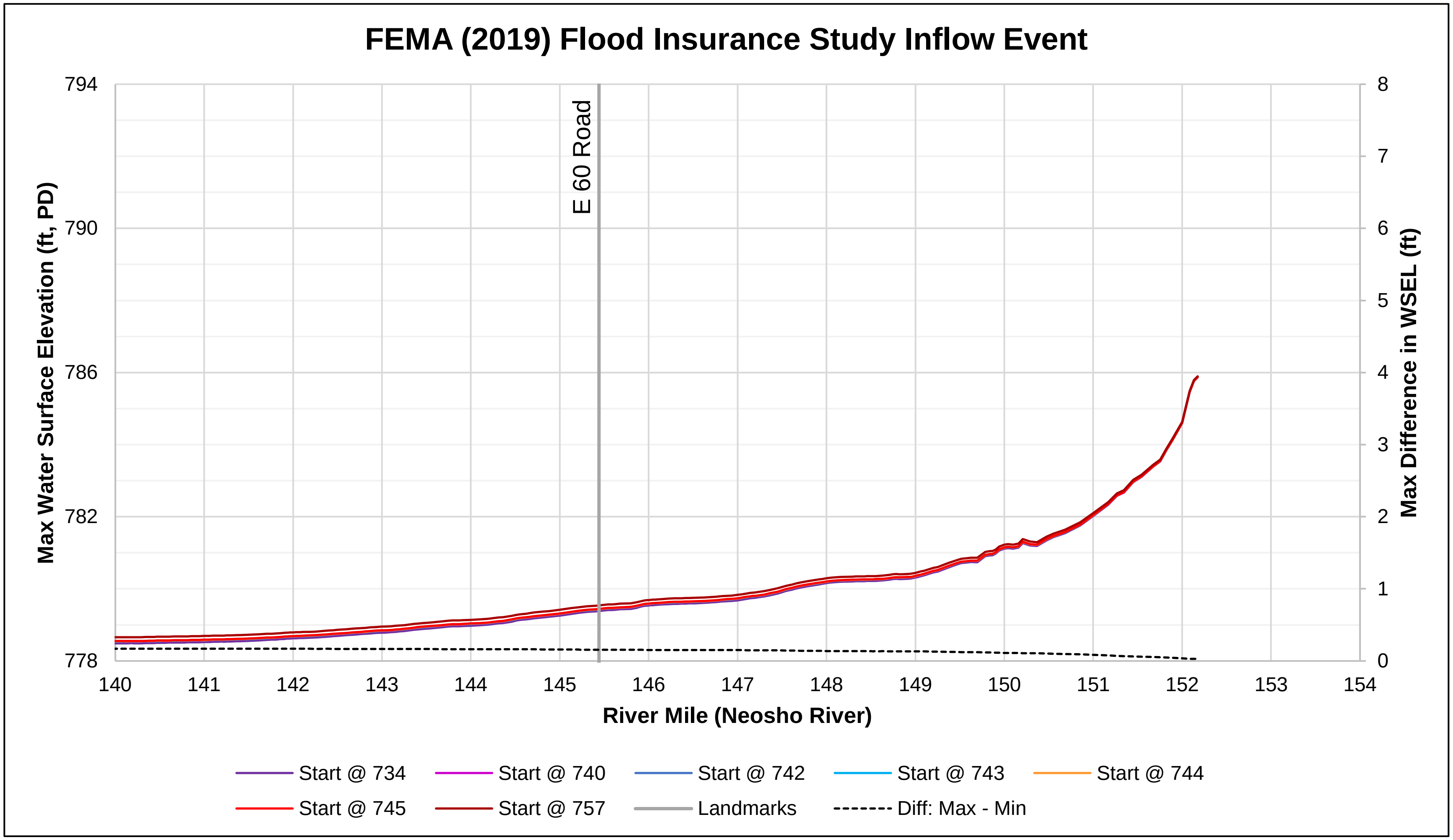

Exhibit 1 Figure 5. Water surface elevations for the FEMA (2019) Flood Insurance Study event upstream of Pensacola Dam along the Neosho River profile (5 of 5).

Notes:

1. In the legend, the first set of series names refers to pool elevation at Pensacola Dam at the start of the simulation. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The dashed line is plotted against the right y-axis and represents the difference between the highest and lowest max WSEL displayed on the figure.

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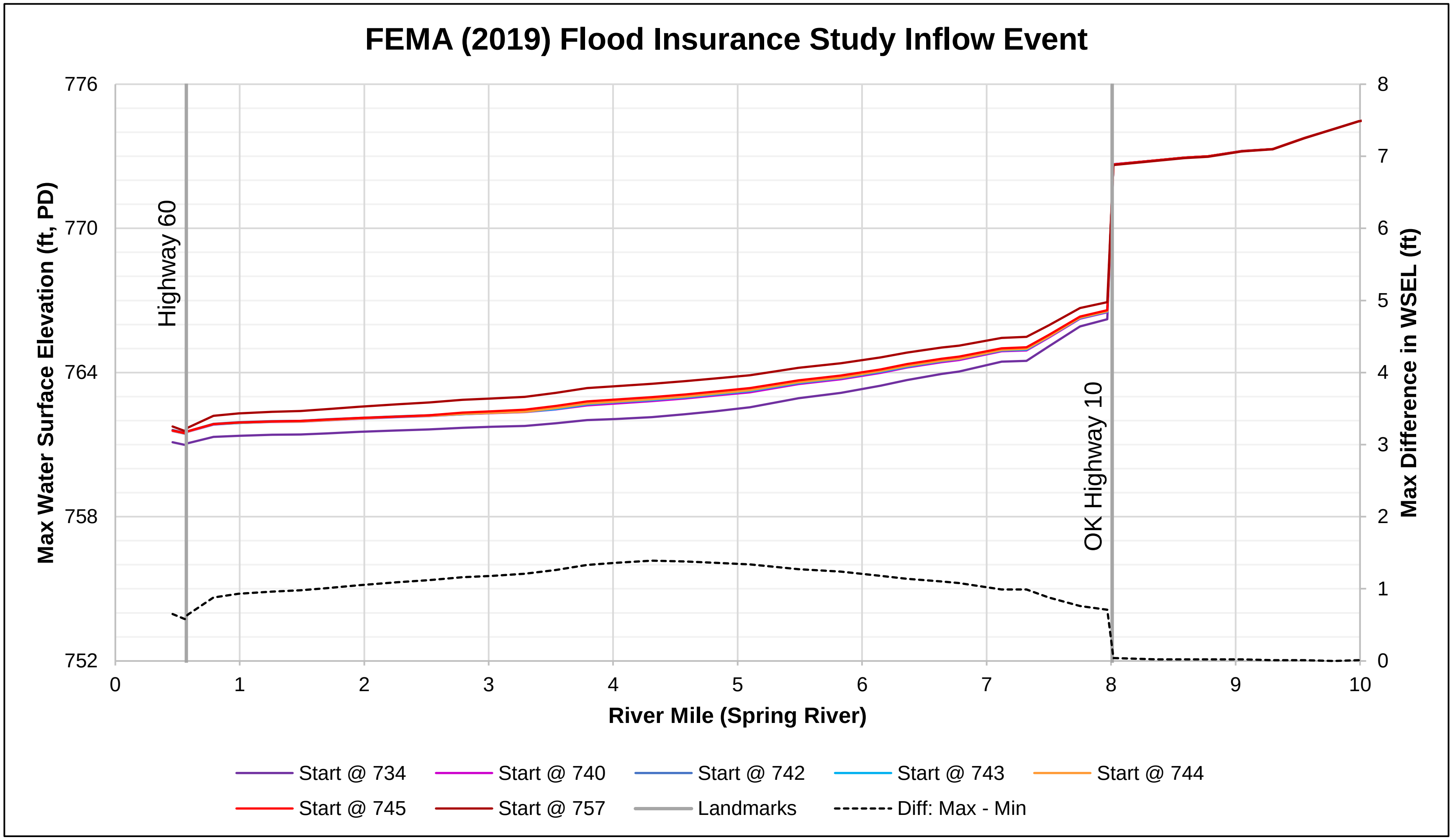

Exhibit 1 Figure 6. Water surface elevations for the FEMA (2019) Flood Insurance Study event upstream of Pensacola Dam along the Spring River profile (1 of 2).

Notes: 1. In the legend, the first set of series names refers to pool elevation at Pensacola Dam at the start of the simulation. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The dashed line is plotted against the right y-axis and represents the difference between the highest and lowest max WSEL displayed on the figure.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profile for the other starting elevations is nearly identical.

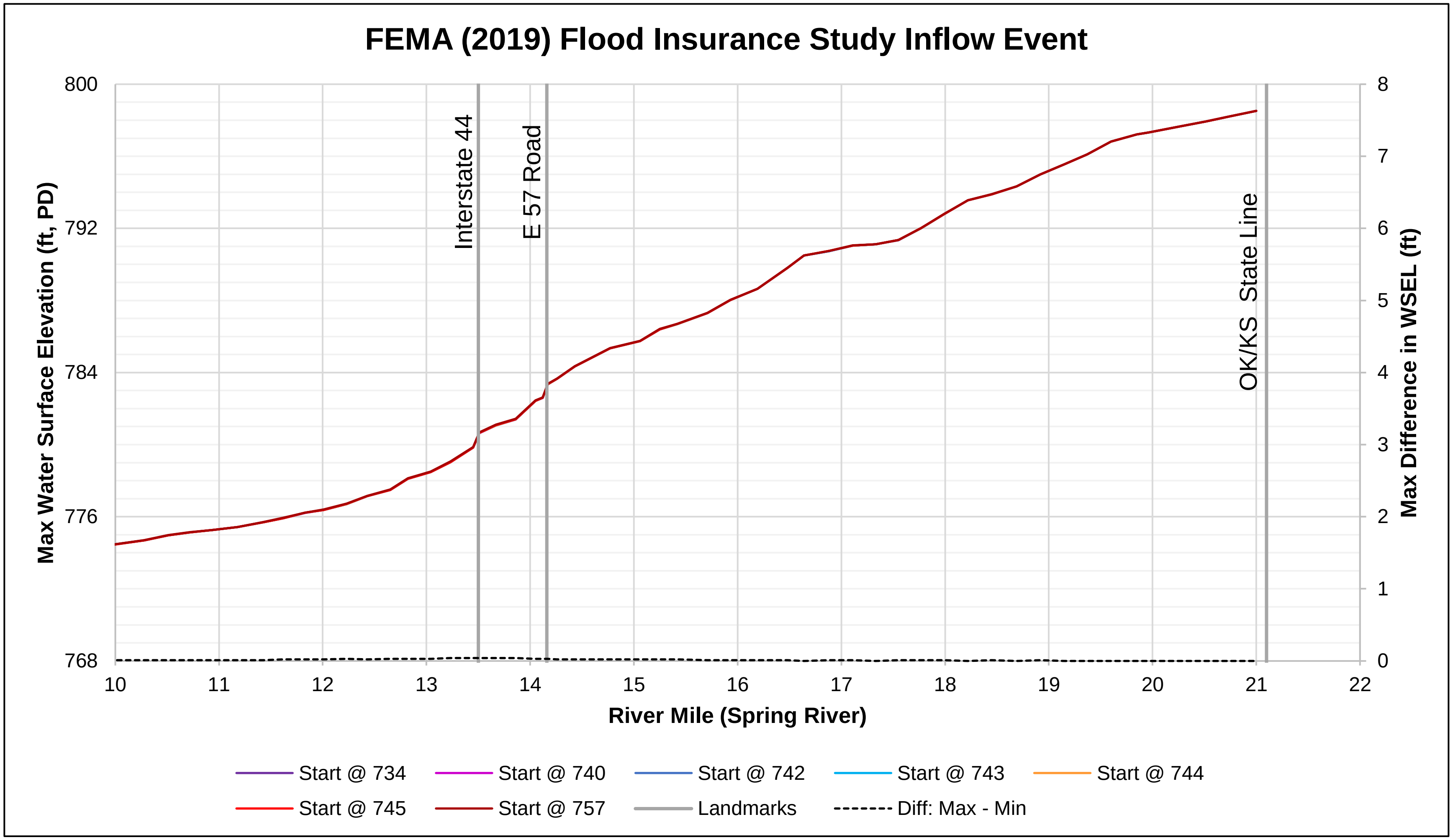

Exhibit 1 Figure 7. Water surface elevations for the FEMA (2019) Flood Insurance Study event upstream of Pensacola Dam along the Spring River profile (2 of 2).

Notes:

1. In the legend, the first set of series names refers to pool elevation at Pensacola Dam at the start of the simulation. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The dashed line is plotted against the right y-axis and represents the difference between the highest and lowest max WSEL displayed on the figure.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profile for the other starting elevations is nearly identical.

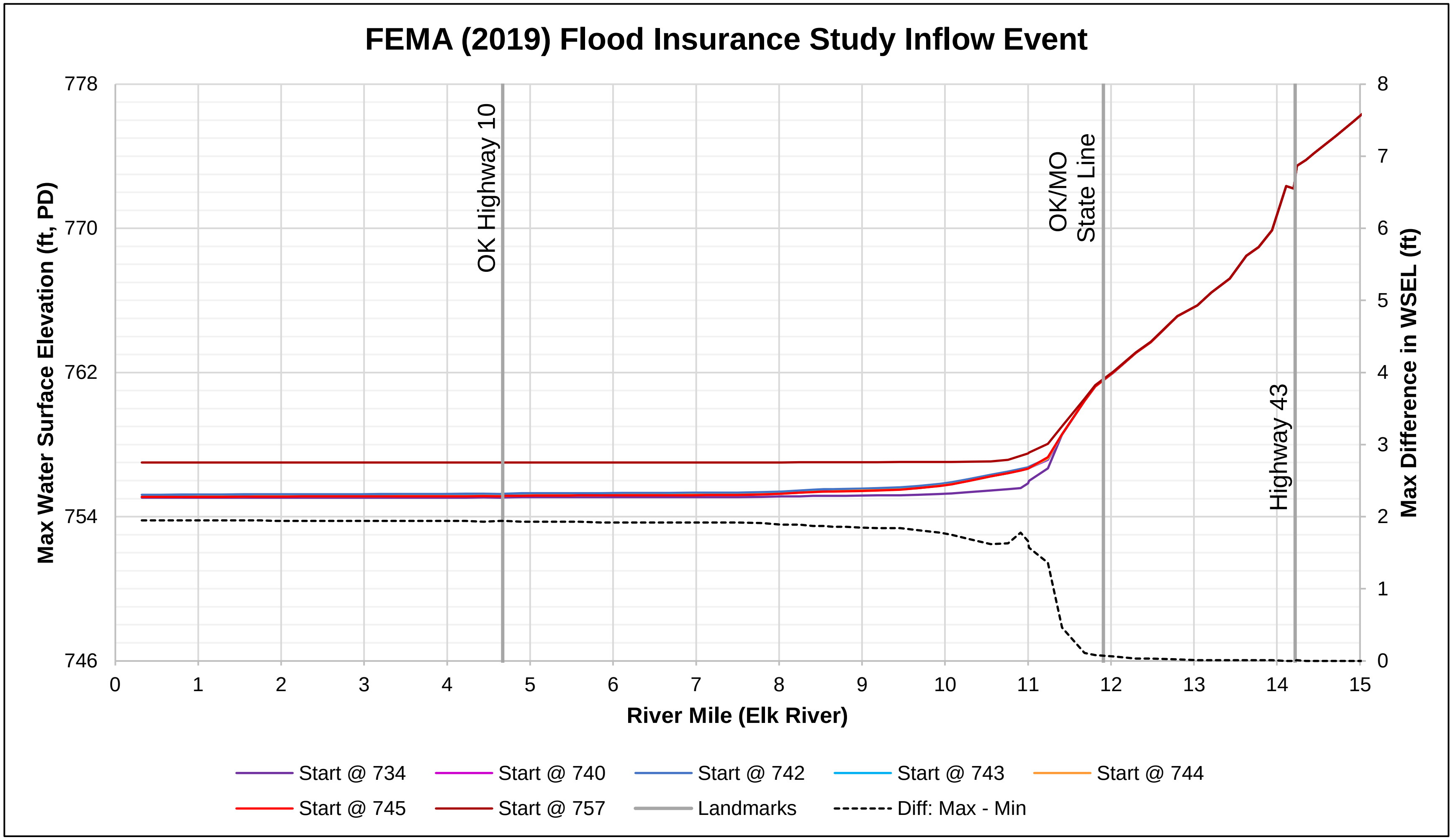

Exhibit 1 Figure 8. Water surface elevations for the FEMA (2019) Flood Insurance Study event upstream of Pensacola Dam along the Elk River profile (1 of 2).

Notes:

1. In the legend, the first set of series names refers to pool elevation at Pensacola Dam at the start of the simulation. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The dashed line is plotted against the right y-axis and represents the difference between the highest and lowest max WSEL displayed on the figure.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profile for the other starting elevations is nearly identical.

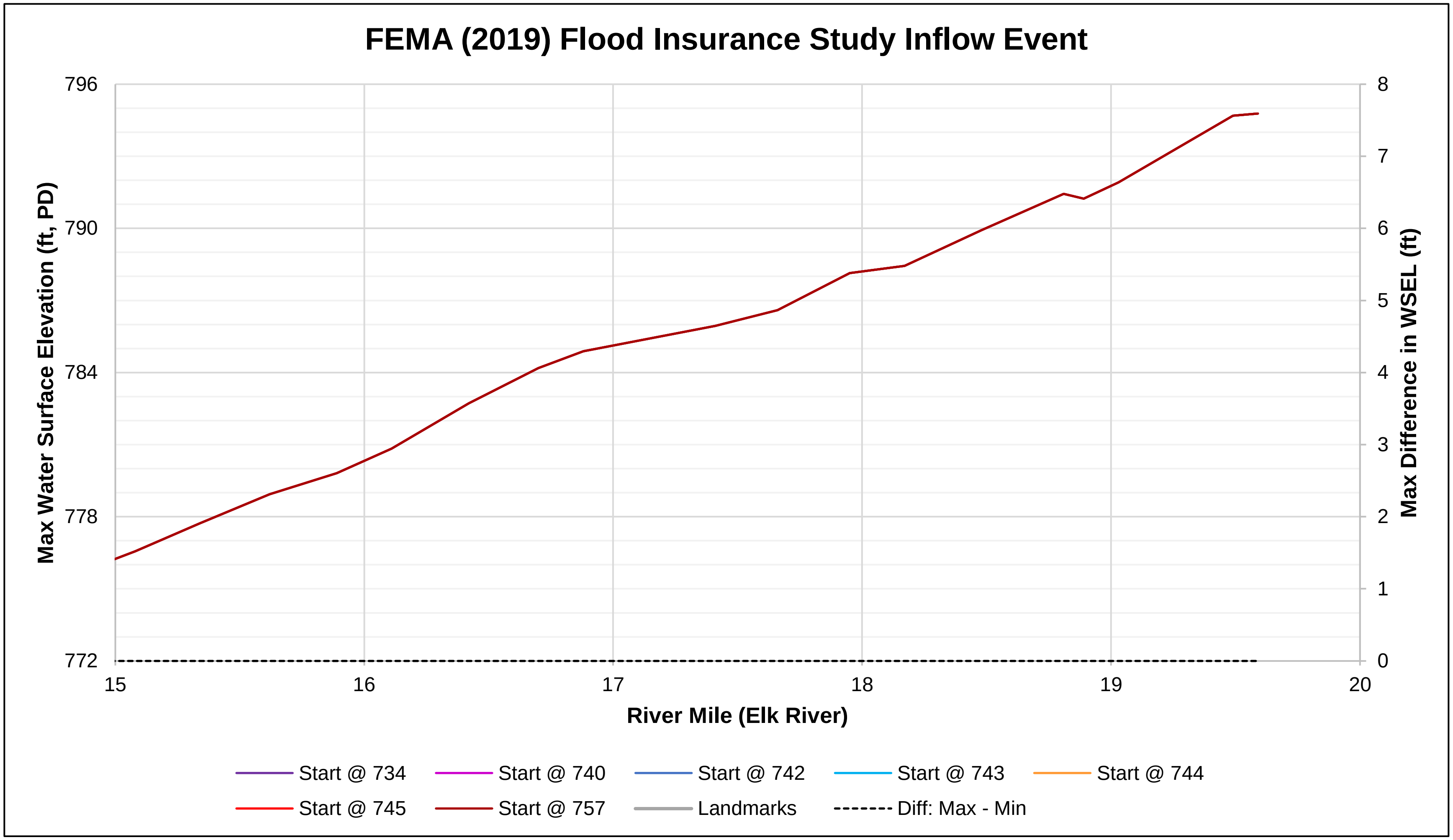

Exhibit 1 Figure 9. Water surface elevations for the FEMA (2019) Flood Insurance Study event upstream of Pensacola Dam along the Elk River profile (2 of 2).

Notes:

1. *In the legend, the first set of series names refers to pool elevation at Pensacola Dam at the start of the simulation. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.*
2. *The dashed line is plotted against the right y-axis and represents the difference between the highest and lowest max WSEL displayed on the figure.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles displayed.*
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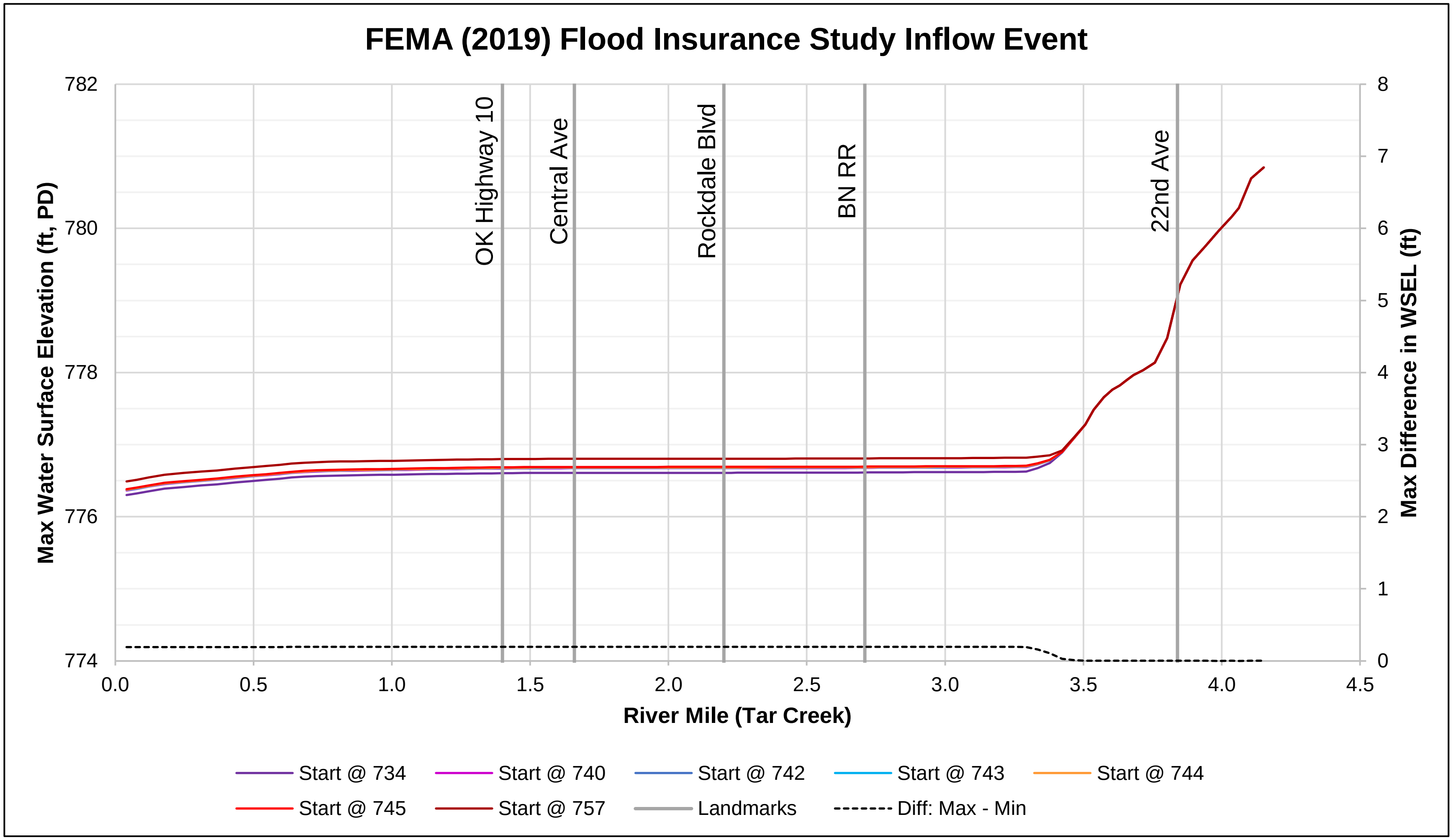

Exhibit 1 Figure 10. Water surface elevations for the FEMA (2019) Flood Insurance Study event upstream of Pensacola Dam along the Tar Creek profile (1 of 1).

Notes:

1. *In the legend, the first set of series names refers to pool elevation at Pensacola Dam at the start of the simulation. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.*
2. *The dashed line is plotted against the right y-axis and represents the difference between the highest and lowest max WSEL displayed on the figure.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles displayed.*
4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profile for the other starting elevations is nearly identical.*

Appendix C

Water Surface Elevations Profiles for the Abandoned Railroad Bridge Sensitivity Analysis

APPENDIX C:
WATER SURFACE ELEVATION PROFILES FOR THE ABANDONED RAILROAD BRIDGE SENSITIVITY ANALYSIS

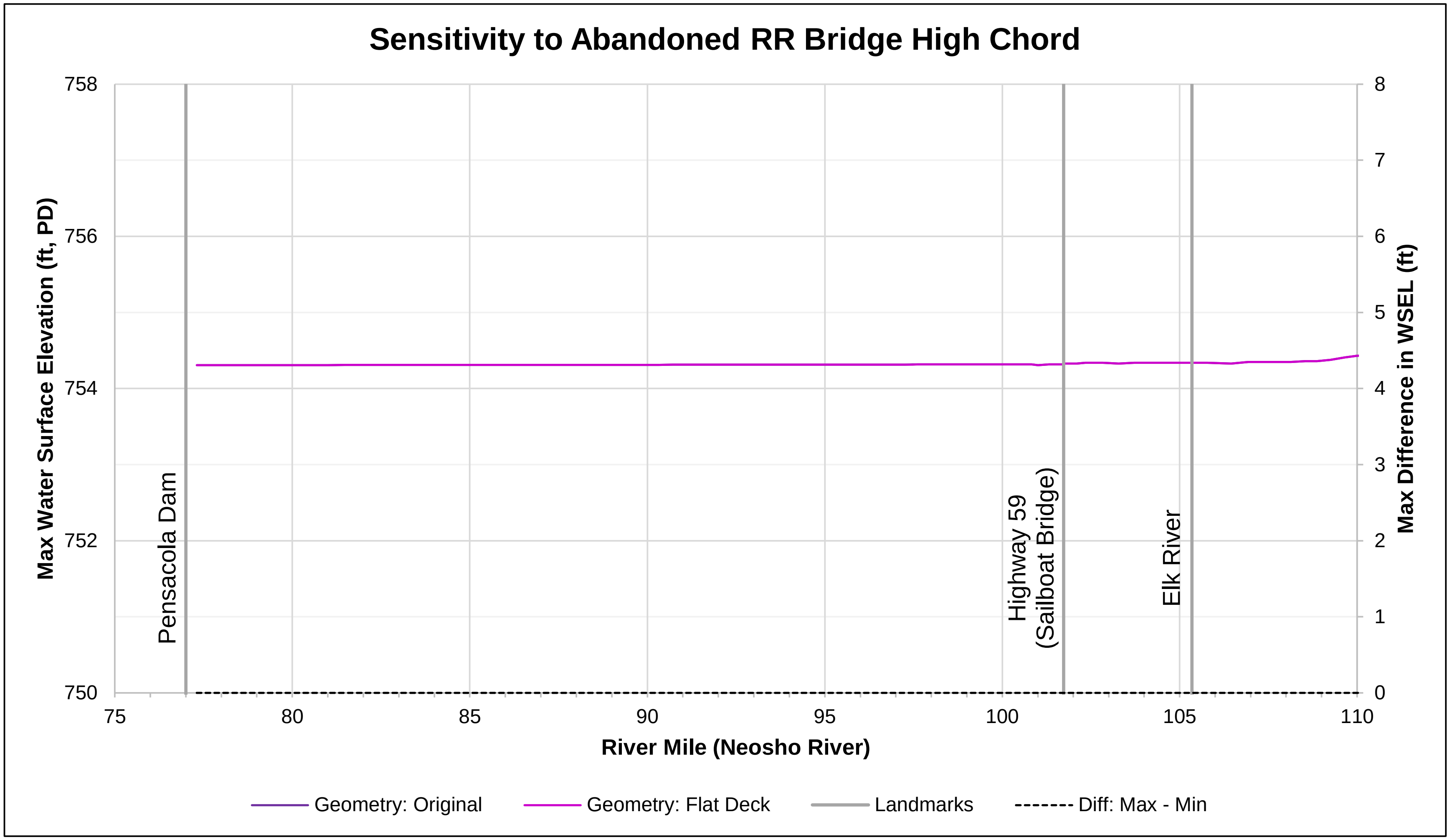

Exhibit 2 Figure 11. Water surface elevations for the Abandoned RR bridge sensitivity analysis upstream of Pensacola Dam along the Neosho River profile (1 of 5).

Notes:

1. The July 2007 event was used to analyze water surface elevation sensitivity to the Abandoned RR bridge high chord definition.
2. The dashed line is plotted against the right y-axis and represents the difference between the highest and lowest max WSEL displayed on the figure.
3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles displayed.
4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other simulations are nearly identical.

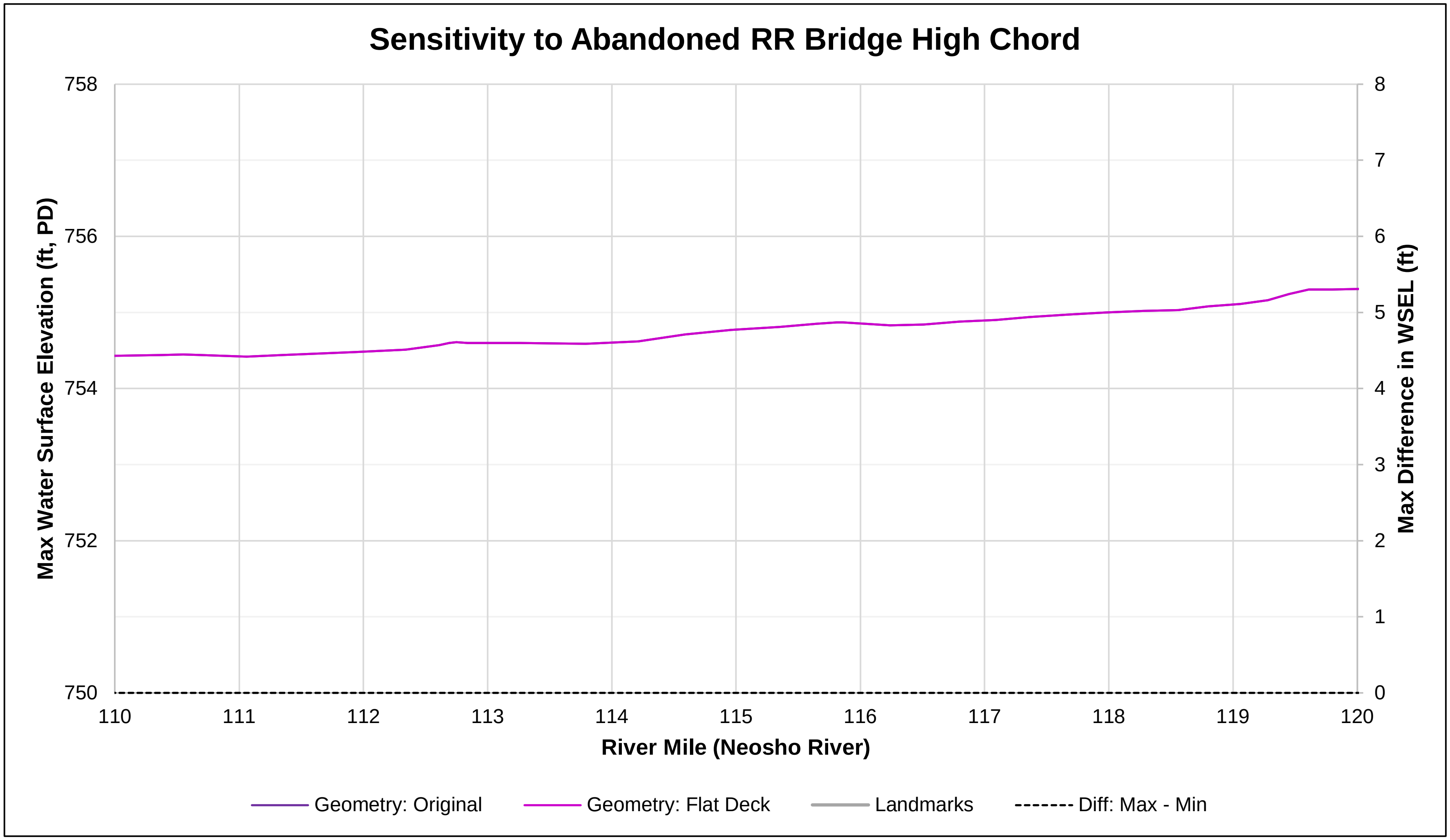

Exhibit 2 Figure 12. Water surface elevations for the Abandoned RR bridge sensitivity analysis upstream of Pensacola Dam along the Neosho River profile (2 of 5).

Notes:

1. *The July 2007 event was used to analyze water surface elevation sensitivity to the Abandoned RR bridge high chord definition.*
2. *The dashed line is plotted against the right y-axis and represents the difference between the highest and lowest max WSEL displayed on the figure.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles displayed.*
4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other simulations are nearly identical.*

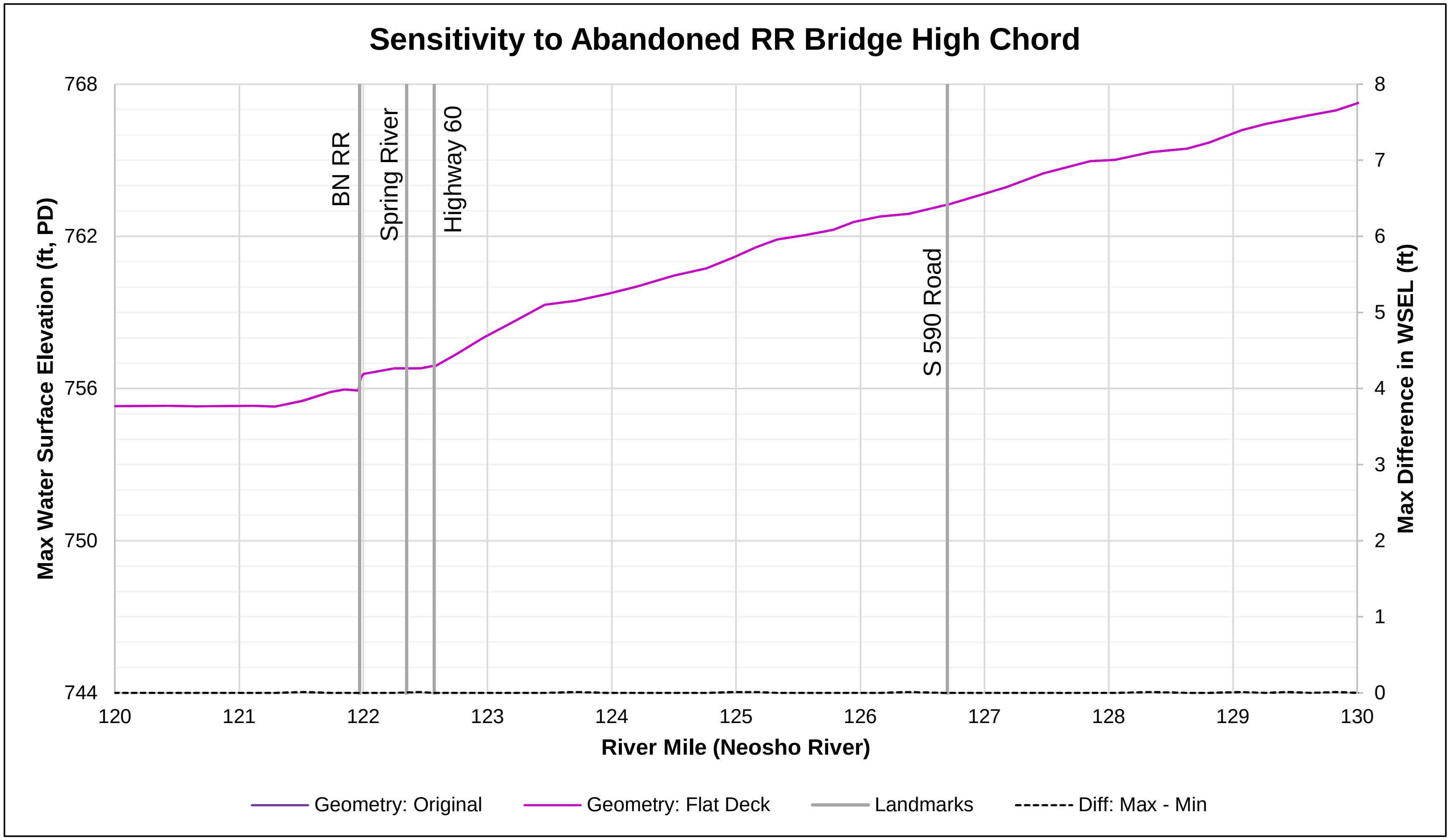

Exhibit 2 Figure 13. Water surface elevations for the Abandoned RR bridge sensitivity analysis upstream of Pensacola Dam along the Neosho River profile (3 of 5).

Notes:

1. The July 2007 event was used to analyze water surface elevation sensitivity to the Abandoned RR bridge high chord definition.
2. The dashed line is plotted against the right y-axis and represents the difference between the highest and lowest max WSEL displayed on the figure.
3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles displayed.
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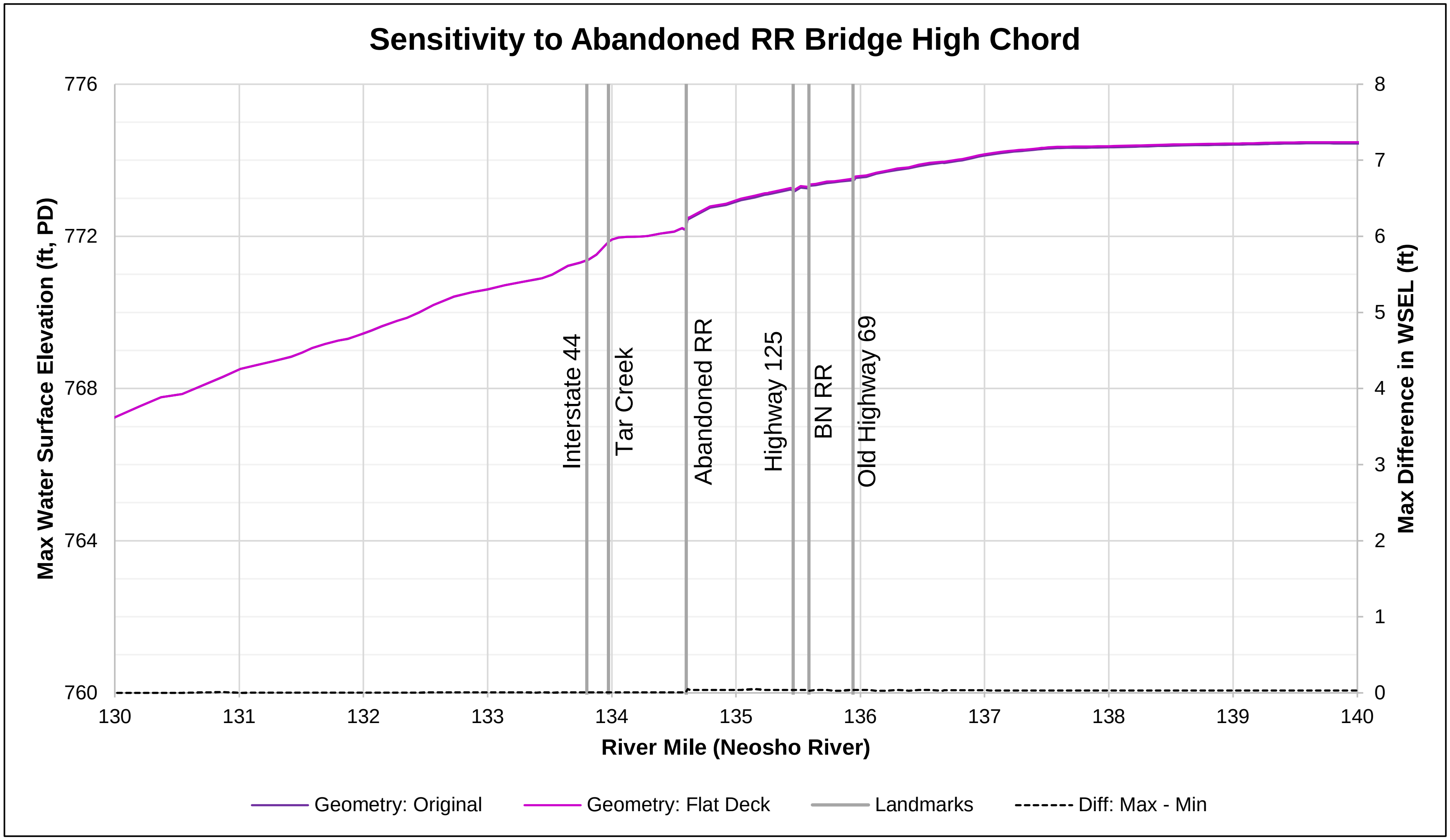

Exhibit 2 Figure 14. Water surface elevations for the Abandoned RR bridge sensitivity analysis upstream of Pensacola Dam along the Neosho River profile (4 of 5).

Notes:
1. *The July 2007 event was used to analyze water surface elevation sensitivity to the Abandoned RR bridge high chord definition.*
2. *The dashed line is plotted against the right y-axis and represents the difference between the highest and lowest max WSEL displayed on the figure.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles displayed.*
4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other simulations are nearly identical.*

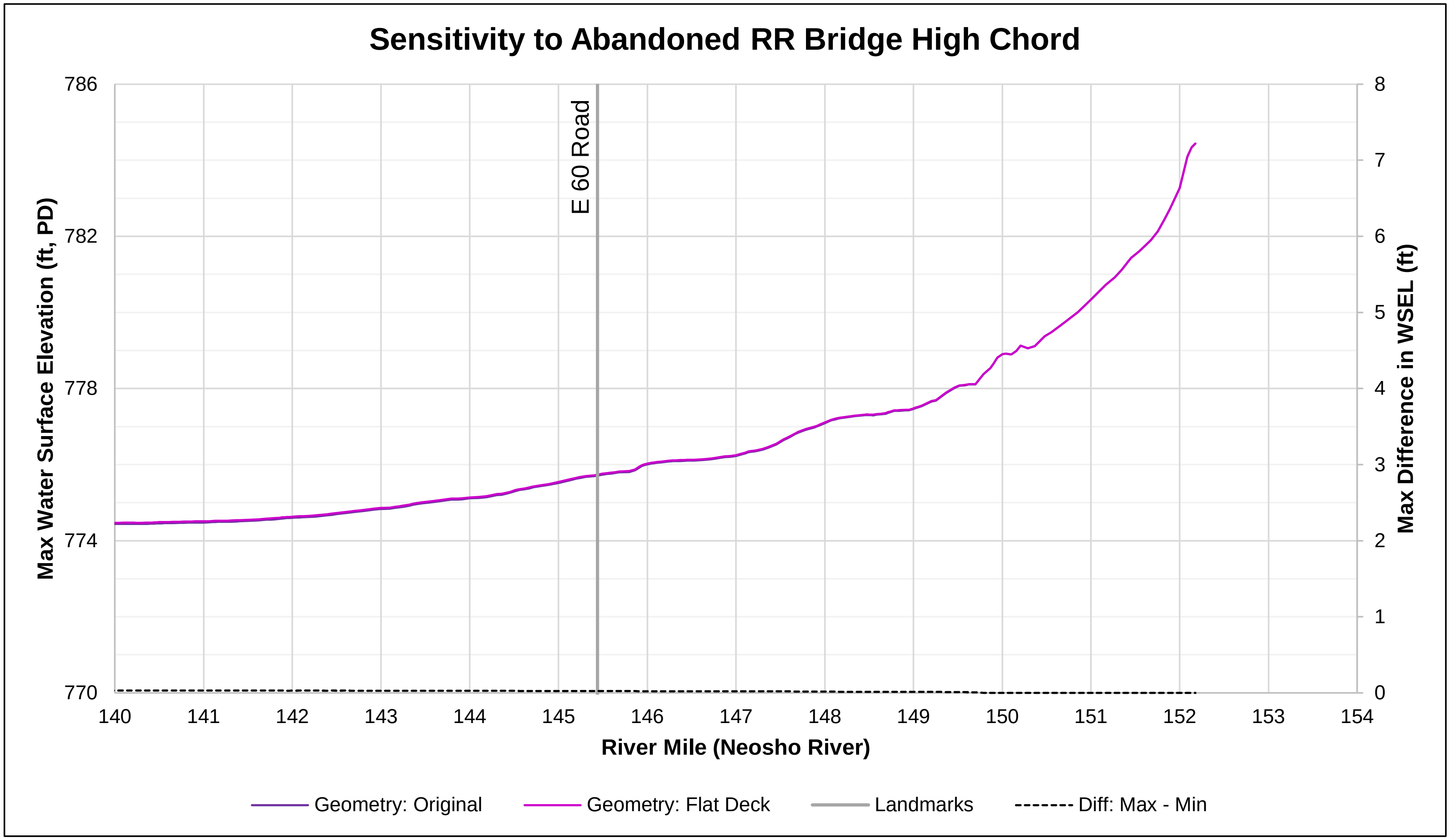

Exhibit 2 Figure 15. Water surface elevations for the Abandoned RR bridge sensitivity analysis upstream of Pensacola Dam along the Neosho River profile (5 of 5).

Notes:

1. *The July 2007 event was used to analyze water surface elevation sensitivity to the Abandoned RR bridge high chord definition.*
2. *The dashed line is plotted against the right y-axis and represents the difference between the highest and lowest max WSEL displayed on the figure.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles displayed.*

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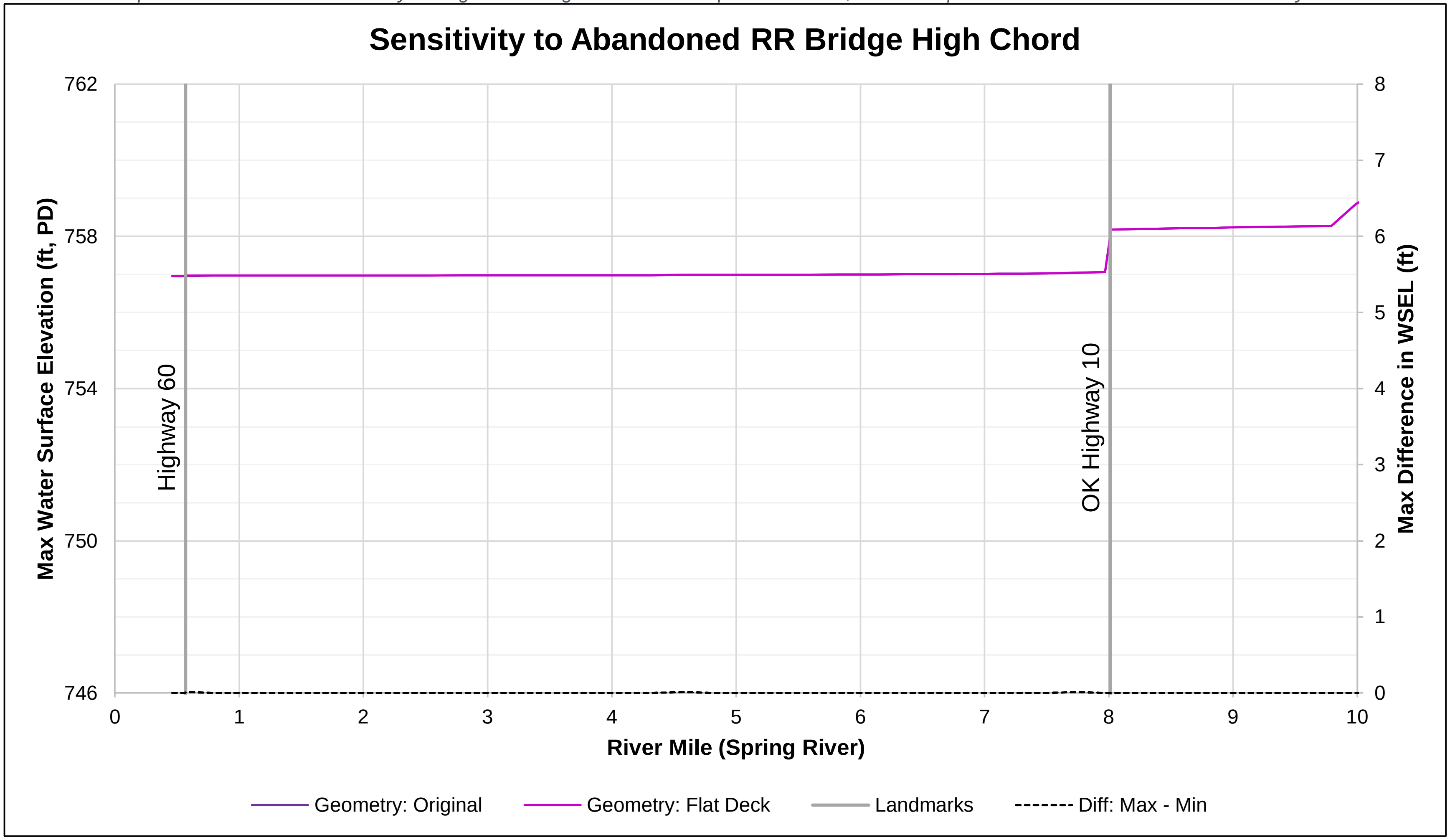

Exhibit 2 Figure 16. Water surface elevations for the Abandoned RR bridge sensitivity analysis upstream of Pensacola Dam along the Spring River profile (1 of 2).

Notes:

1. The July 2007 event was used to analyze water surface elevation sensitivity to the Abandoned RR bridge high chord definition.
2. The dashed line is plotted against the right y-axis and represents the difference between the highest and lowest max WSEL displayed on the figure.
3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other simulations are nearly identical.

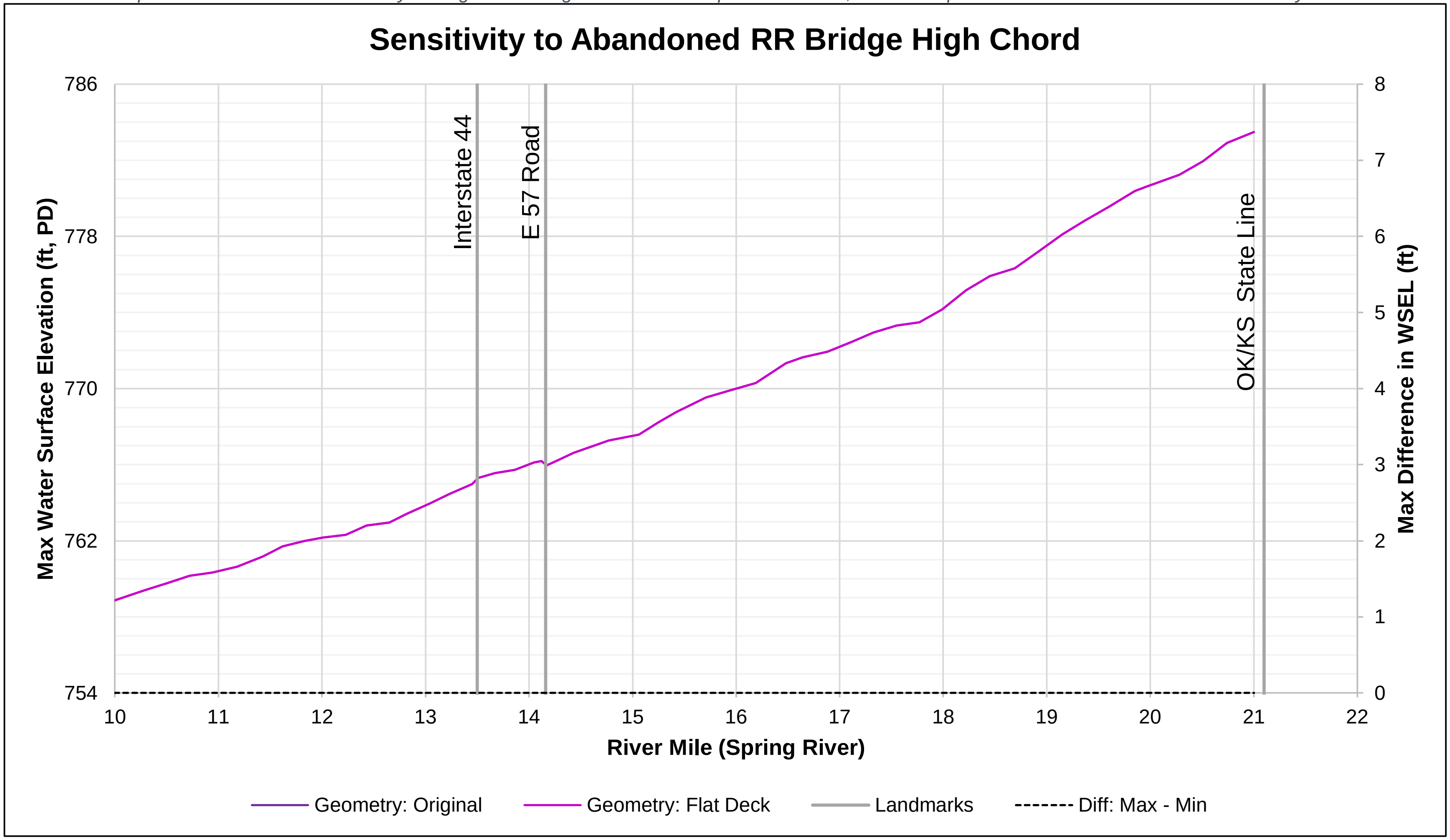

Exhibit 2 Figure 17. Water surface elevations for the Abandoned RR bridge sensitivity analysis upstream of Pensacola Dam along the Spring River profile (2 of 2).

Notes: *1. The July 2007 event was used to analyze water surface elevation sensitivity to the Abandoned RR bridge high chord definition.*
2. The dashed line is plotted against the right y-axis and represents the difference between the highest and lowest max WSEL displayed on the figure.
3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other simulations are nearly identical.

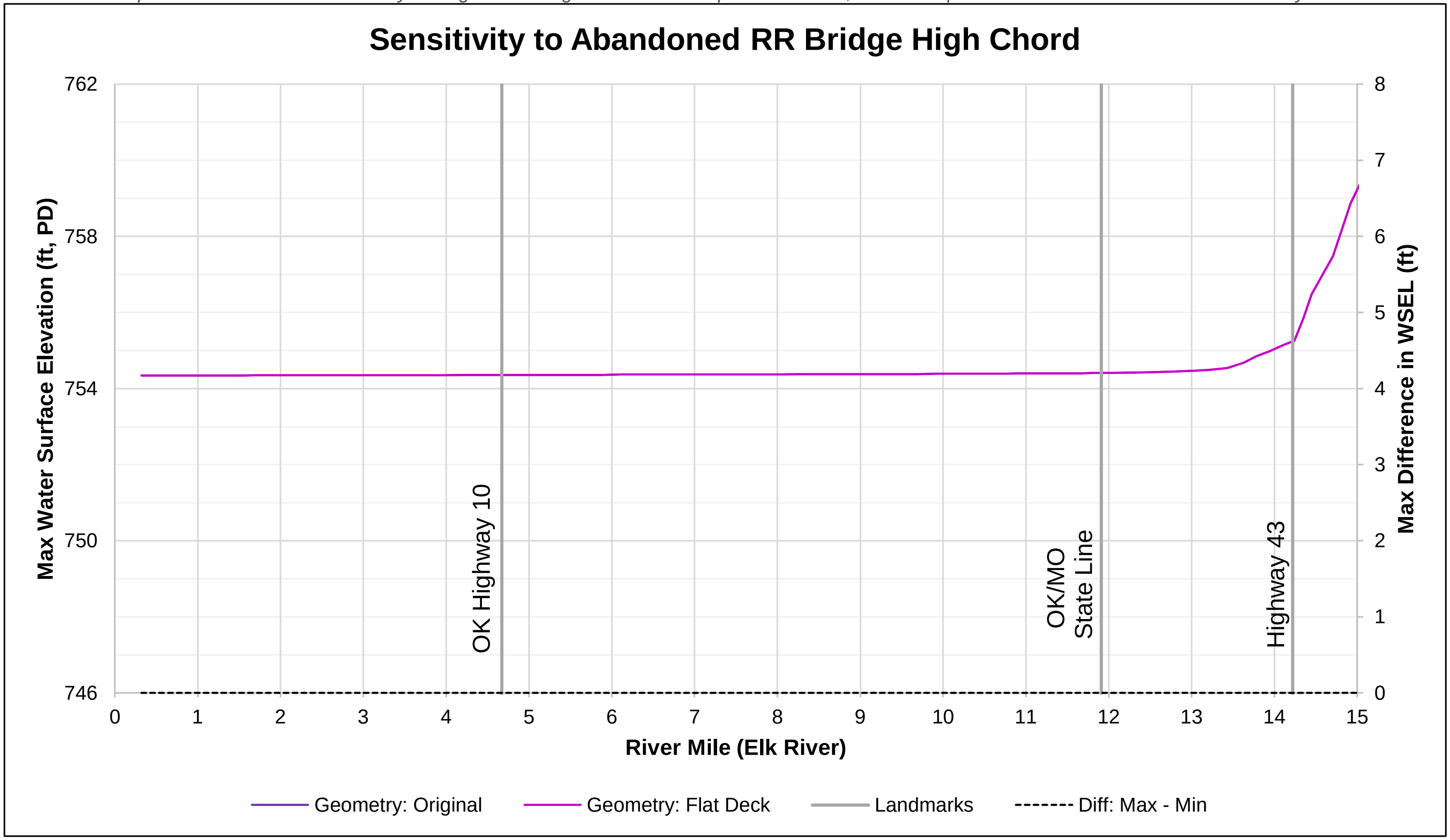

Exhibit 2 Figure 18. Water surface elevations for the Abandoned RR bridge sensitivity analysis upstream of Pensacola Dam along the Elk River profile (1 of 2).

Notes:
1. *The July 2007 event was used to analyze water surface elevation sensitivity to the Abandoned RR bridge high chord definition.*
2. *The dashed line is plotted against the right y-axis and represents the difference between the highest and lowest max WSEL displayed on the figure.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles displayed.*
4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other simulations are nearly identical.*

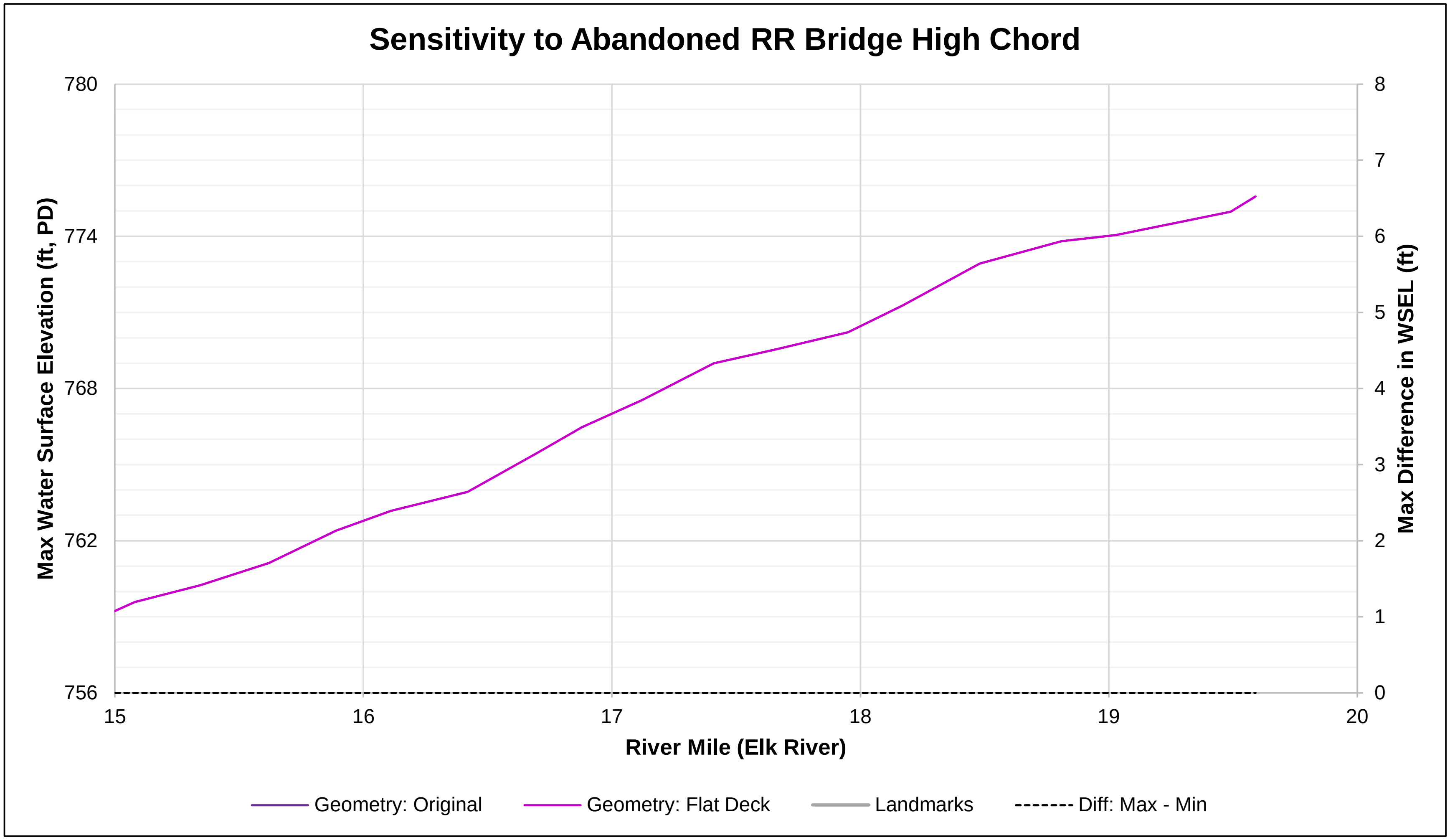

Exhibit 2 Figure 19. Water surface elevations for the Abandoned RR bridge sensitivity analysis upstream of Pensacola Dam along the Elk River profile (2 of 2).

Notes:
1. *The July 2007 event was used to analyze water surface elevation sensitivity to the Abandoned RR bridge high chord definition.*
2. *The dashed line is plotted against the right y-axis and represents the difference between the highest and lowest max WSEL displayed on the figure.*
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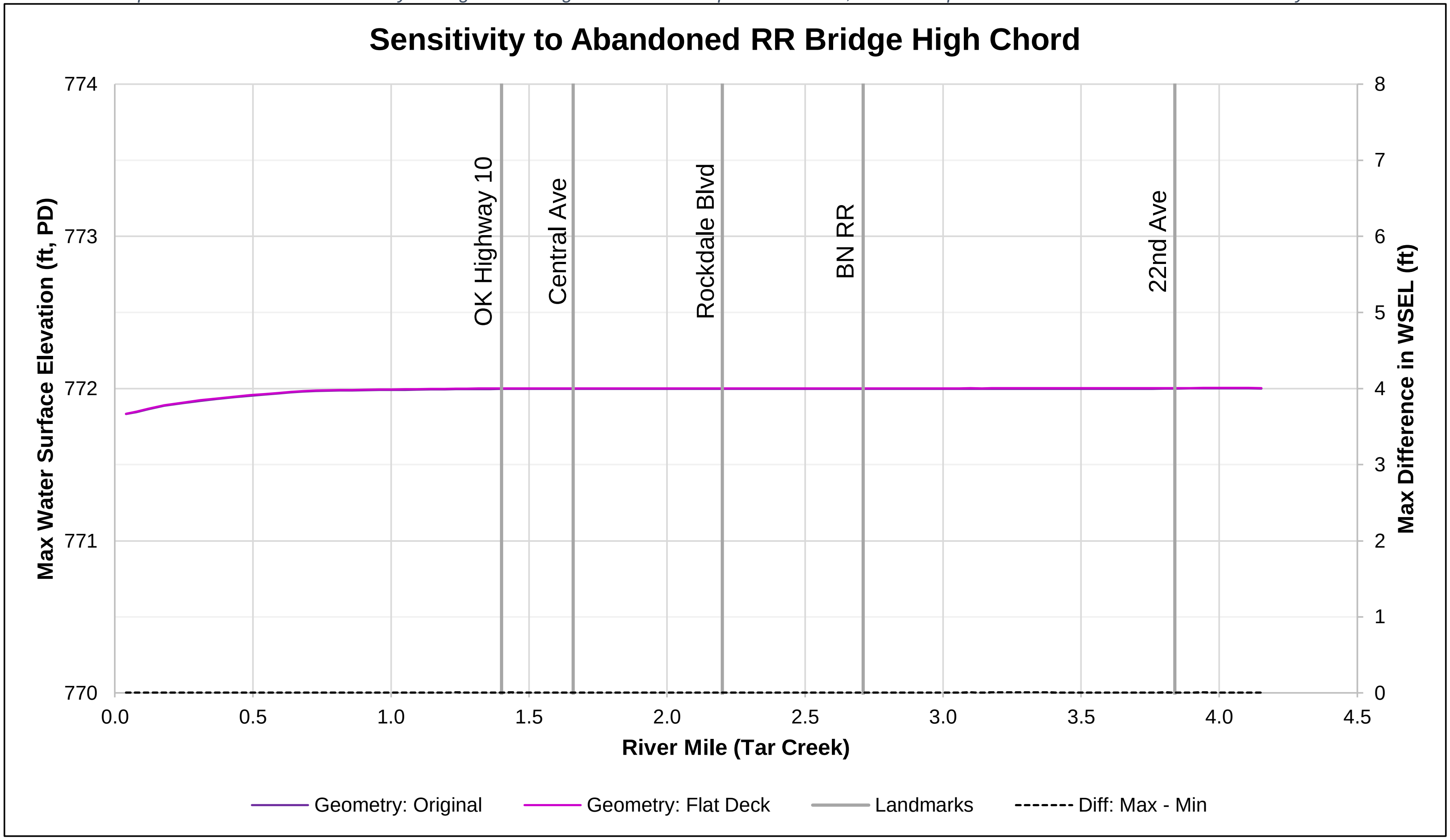

Exhibit 2 Figure 20. Water surface elevations for the Abandoned RR bridge sensitivity analysis upstream of Pensacola Dam along the Tar Creek profile (1 of 1).

Notes:

1. The July 2007 event was used to analyze water surface elevation sensitivity to the Abandoned RR bridge high chord definition.
2. The dashed line is plotted against the right y-axis and represents the difference between the highest and lowest max WSEL displayed on the figure.
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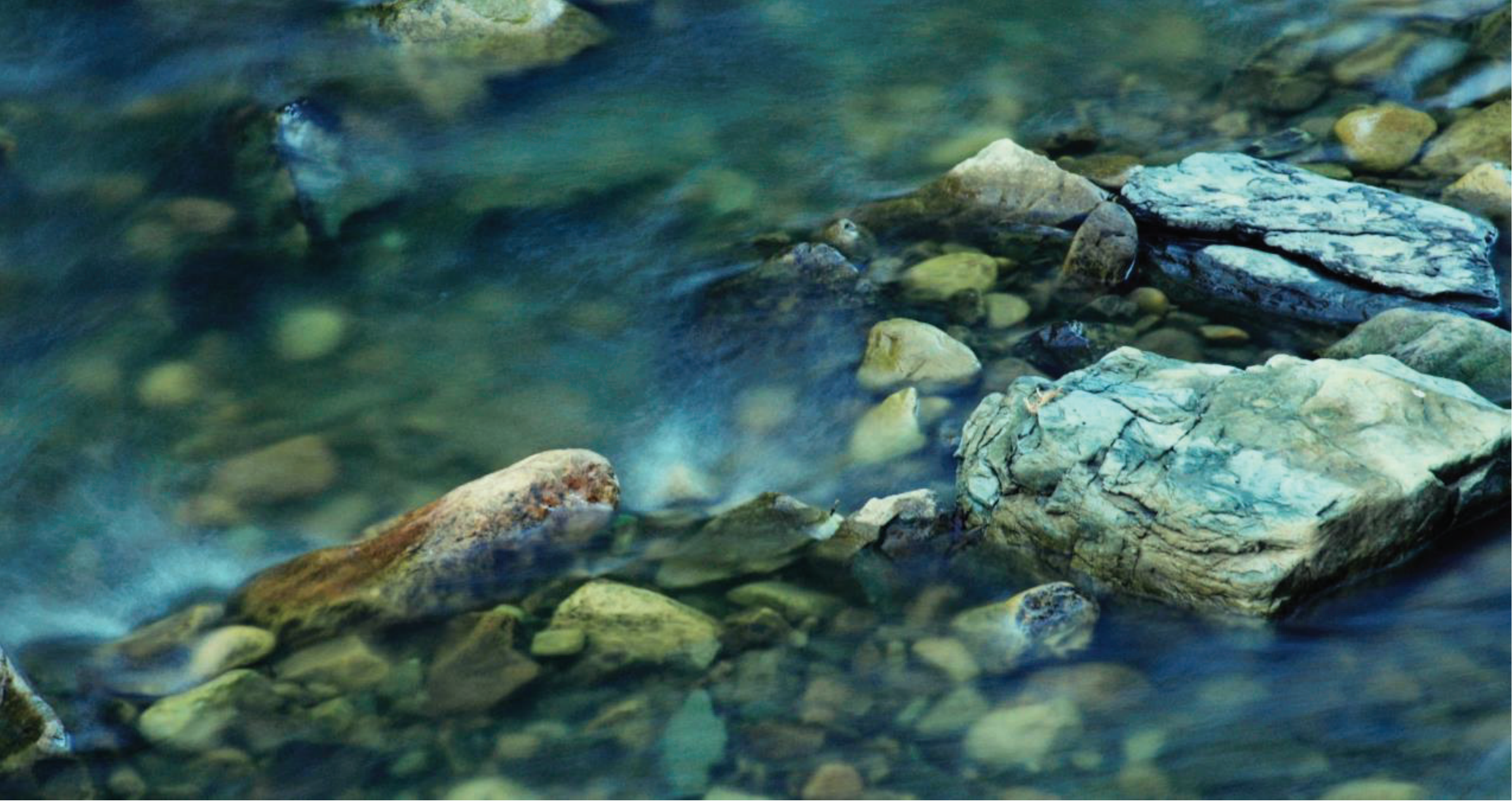
4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other simulations are nearly identical

Appendix D

Grand Lake Sedimentation Study Report



December 2021
Grand Lake Sedimentation Study

Simons & associates
ANCHOR QEA

Initial Study Report

Prepared for

GRDA
Grand River Dam Authority

December 2021
Grand Lake Sedimentation Study

Initial Study Report

Prepared for
Grand River Dam Authority
P.O. Box 409
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ABBREVIATIONS

1D	one-dimensional
2D	two-dimensional
ADCP	acoustic Doppler current profiler
BC	boundary condition
cfs	cubic feet per second
cm	centimeter
cm/s	centimeters per second
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
ft/ft	vertical feet per horizontal foot
g/cm^3	gram per cubic centimeter
Grand Lake	Grand Lake o' the Cherokees
GRDA	Grand River Dam Authority
HEC-RAS	Hydrologic Engineering Center's River Analysis System
LiDAR	Light Detection and Ranging
mm	millimeter
NED	National Elevation Dataset
OWRB	Oklahoma Water Resources Board
Pa	pascal
pcf	pound per cubic foot
PD	Pensacola Datum
REAS	Real Estate Adequacy Study
RM	river mile
RSP	revised study plan
SSC	suspended sediment concentration
STM	sediment transport model
UHM	upstream hydraulic model
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
UWSFL	University of Wisconsin Soil and Forage Laboratory
WSE	water surface elevation
WSLH	Wisconsin State Laboratory of Hygiene
µm	micrometer

1. Executive Summary

Anchor QEA, LLC (formerly FreshWater Engineering) and Simons & Associates were retained to support the Grand River Dam Authority (GRDA) as subconsultants to Mead & Hunt with Federal Energy Regulatory Commission (FERC) relicensing of the Pensacola Dam. Anchor QEA's and Simons & Associates' role, with Mead & Hunt's support, is to perform a sedimentation study to determine the rates and locations of sedimentation throughout the Grand Lake o' the Cherokees (Grand Lake) watershed and associated tributaries.

This task will culminate in the development of a sediment transport model (STM) using the Hydrologic Engineering Center's River Analysis System (HEC-RAS) fluvial modeling software. Data needed for model development ranges from topographic information to stream discharge volumes, water surface elevations, and sediment parameters both in the lake and streambeds and moving into the system through major tributaries. Anchor QEA evaluated publicly available data sources to compile parameters necessary for model development and to determine where additional field work was required to fill data gaps.

Topographic and bathymetric data are available from a range of sources. Grand Lake itself was surveyed as part of the 1998 Real Estate Adequacy Study (REAS), then again by the Oklahoma Water Resources Board (OWRB) in 2009, and once more by the U.S. Geological Survey (USGS) in 2019. Upstream surveys of the Neosho River, Spring River, and Elk River were performed as part of the 1998 REAS, and USGS surveyed those reaches again in 2017. Topographic information was available from surveys performed in support of the 1998 REAS and Light Detection and Ranging (LiDAR) flights conducted in 2011. Other topographic information was obtained from the USGS National Elevation Dataset (NED) one-third arc-second datasets where LiDAR information was unavailable. Additionally, stage-storage curves were available from 1940 U.S. Army Corps of Engineers (USACE) as-built drawings as well as the more recent Grand Lake bathymetry surveys.

Other data are available from USGS gaging stations located throughout the Grand Lake watershed. Water surface elevation (WSE) data and stream discharge information are available along the Neosho, Spring, and Elk rivers, as well as on Tar Creek. These stations also provide sediment transport data in the form of suspended sediment concentration (SSC) measurements taken throughout the period of record at each gage.

Data gaps exist within the period of record for the USGS gaging stations within the Grand Lake watershed and the gaging network lacks in spatial density. As a result, the study team developed a field monitoring system to track WSE throughout the study area and fill data gaps. A set of 16 monitoring locations were selected, and HOBO pressure loggers were installed at each site in December 2016. Over the last 4.5 years, pressure and temperature have been recorded at 30-minute intervals. The record provides a detailed dataset of water levels that can be used for model development and calibration.

Other data gaps identified were related to sediment properties. Sediment conditions within the basin were evaluated using grab samples to evaluate grain size distributions. In general, the streambeds consist of gravel with limited sand; the lake is primarily silt and clay. Due to the presence of cohesive material (silt and clay) in the lake, Anchor QEA also collected core samples for SEDflume erosion analysis. The erosion analysis was used to determine parameters for sediment movement as part of model development.

Sediment transport rates were the final missing parameters. The aforementioned SSC measurements occur only occasionally, and samples taken during large flow events are limited. Researchers were also unable to find bedload sediment transport measurements at any location in the watershed. Anchor QEA field work included trips to gather additional SSC measurements to help close data gaps in the record. Technicians also sampled bedload sediment transport and found that even under large flows, the bulk of sediment transport occurs in suspension rather than along the bed.

Hydraulic calibration of the model consisted of tuning roughness parameters to match measured peak WSEs for a range of flow events. Events that occurred between July 2007 and April 2017 were used for hydraulic calibration. Model tuning relied on adjusting hydraulic roughness coefficients and flow roughness factors. Calibration datasets included the USGS gages throughout the model domain, high water marks, and the Anchor QEA monitoring stations. Model results showed good agreement with the gaged locations.

HEC-RAS has only limited capabilities to accurately model cohesive sediment. As discussed in this report, developing and calibrating a sediment model using cohesive sediments requires the flexibility to adjust a wide range of sediment parameters both spatially and temporally as sediment settles on the bed. HEC-RAS is only able to adjust density over time, while the critical shear stress values and erosion rate parameters are set globally and do not change over time. As a result, the over-simplified parameters available for use in HEC-RAS will not produce a reliable predictive sediment transport model.

These limitations are especially apparent because of the type of sediment present in the system. The original argument requiring use of HEC-RAS for development of an STM relied on the assumption that bed materials were primarily non-cohesive sand and gravel. This was repeatedly argued by the City in comments on GRDA’s RSP (City of Miami 2018), saying “the median bed material size at and upstream from Miami ranged from 3 mm to 12 mm,” and asserting that, “sand load is the most critical to this study.” Based on field measurements, including grab samples, sediment core samples, SSC collections, and bedload sediment transport measurements, the primary type of sediment moving through the system is cohesive silts and clays. This change to the assumptions has led to the finding that HEC-RAS is incapable of accurately modeling sediment transport through the system, and an alternative plan is necessary to ensure any predictive ability of the model.

A Proposed Modified Study Plan (PMSP) will be submitted to the Commission. The PMSP is largely similar to the approach initially offered by GRDA with the assumption that cohesive sediment present in the study area would make HEC-RAS an unsuitable tool for sediment transport modeling. Therefore, the hydraulically-calibrated STM will be used to simulate shear stress at various locations. Those shear stress values will be compared to the critical shear stress of sediments present and used in an analysis of sedimentation patterns which will then analyze effects on flooding.

The sedimentation model inputs and outputs will be made available to relicensing participants for download upon request.

2. Introduction

2.1 Study Goals and Objectives

The primary goal of the Sedimentation Study is to determine the potential effect of Project operations on sediment transport, erosion, and deposition in the lower reaches of tributaries to Grand Lake upstream of Pensacola Dam. Additionally, the Sedimentation Study is designed to provide an understanding of the sediment transport processes and patterns upstream of Grand Lake on the Neosho, Spring, and Elk rivers, as well as on Tar Creek. An STM will provide estimates of overall sedimentation trends and impacts of sedimentation in the project Boundary.

2.2 Study Area

The Pensacola Dam is located near Langley, Oklahoma. It impounds the Neosho River, forming the Grand Lake reservoir (often referred to as Grand Lake o' the Cherokees). The Grand Lake reservoir is split between four counties, including Craig, Ottawa, Delaware, and Mayes in northeastern Oklahoma. The main tributaries that flow into the reservoir are the Neosho, Spring, and Elk rivers. Honey, Drowning, Duck, and Horse Creeks also flow into the lake. Additional minor tributaries include Sycamore and Tar creeks.

3. Study Methods

The sedimentation study has been divided into three main stages—Data Collection, Model Development, and Sedimentation Predictions. During the initial stage, the study team collected data that was publicly available, analyzed data gaps, and created and executed plans to gather additional information. Model Development used the field data to develop and calibrate the STM. Sedimentation Predictions will use the calibrated model to estimate the future deposition and erosion patterns within the study area to help evaluate future flood risks in the basin.

3.1 Data Collection

3.1.1 Existing Data

A significant amount of the necessary data was available to the study team at the beginning of the project. Sources included USACE, the USGS, past studies in Grand Lake, and surveys performed by the OWRB.

3.1.1.1 Terrain Information

Terrain data had been collected by several sources throughout the history of Pensacola Dam. For the purposes of this report, "terrain" refers to the combination of bathymetric and topographic data that are used for model development. Surveys to develop terrain files included reservoir storage volume studies (bathymetric survey of Grand Lake), bathymetric surveys on the tributaries, and topographic measures of the surrounding topography.

The more recent surveys provided geometry information that was used for model development. Namely, the 1998 REAS; (USACE 1998), 2009 OWRB, and 2019 USGS (Hunter et al. 2020) surveys provided Grand Lake bathymetric information for the three primary terrain datasets used in development of the STM. The terrain files are referred to by the years associated with the Grand Lake surveys—1998, 2009, and 2019, respectively.

3.1.1.1.1 Upstream Bathymetry Surveys

Upstream of the reservoir, the tributaries were surveyed at different times. The upper reaches of the Neosho, Spring, and Elk rivers, as well as Tar Creek were mapped during the 1998 REAS efforts.

The REAS project included detailed investigation of upstream areas, but the other Grand Lake surveys ended considerably lower in the watershed. The 2009 OWRB survey ended at Connors Bridge (South 590 Road) over the Neosho River, approximately 4.5 miles upstream of Twin Bridges. The survey of the Spring River ended approximately 3.5 miles upstream of Twin Bridges near East 130 Road. Along the Elk River, the survey reached 5 miles upstream of the Highway 10 bridge. The upstream extents of the 2019 USGS Grand Lake survey were Twin Bridges on the Neosho and Spring rivers and Cayuga, 2 miles upstream of Highway 10, on the Elk River.

In 2017, USGS performed a bathymetric survey of the upper tributaries (Smith et al. 2017). This survey reached the Oklahoma and Kansas border on the Neosho River and stopped approximately at the border on the Spring River. The Elk River survey reached across the Oklahoma and Missouri border to river mile (RM) 16.4, approximately 2.5 miles upstream of the Highway 43 bridge.

The 2017 survey did not include Tar Creek bathymetry. To represent Tar Creek, Federal Emergency Management Agency (FEMA) cross-section data was used (FEMA 2019).

3.1.1.1.2 Topographic Surveys

Two primary data sources exist for overbank analyses. The first is topographic survey information gathered during the 1998 REAS (USACE 1998). The extents of this survey reach the Oklahoma and Kansas border along both the Neosho and Spring River and approximately 5 miles upstream of the Highway 43 bridge on the Elk River. The second major overbank data source is LiDAR data from a mission flown in 2011 (Dewberry 2011). Where additional data was needed for overbank areas, it was obtained from the USGS NED one-third arc-second dataset (USGS 2017). These combined datasets covered the entire overbank portion of the study area.

3.1.1.1.3 Terrain Datasets

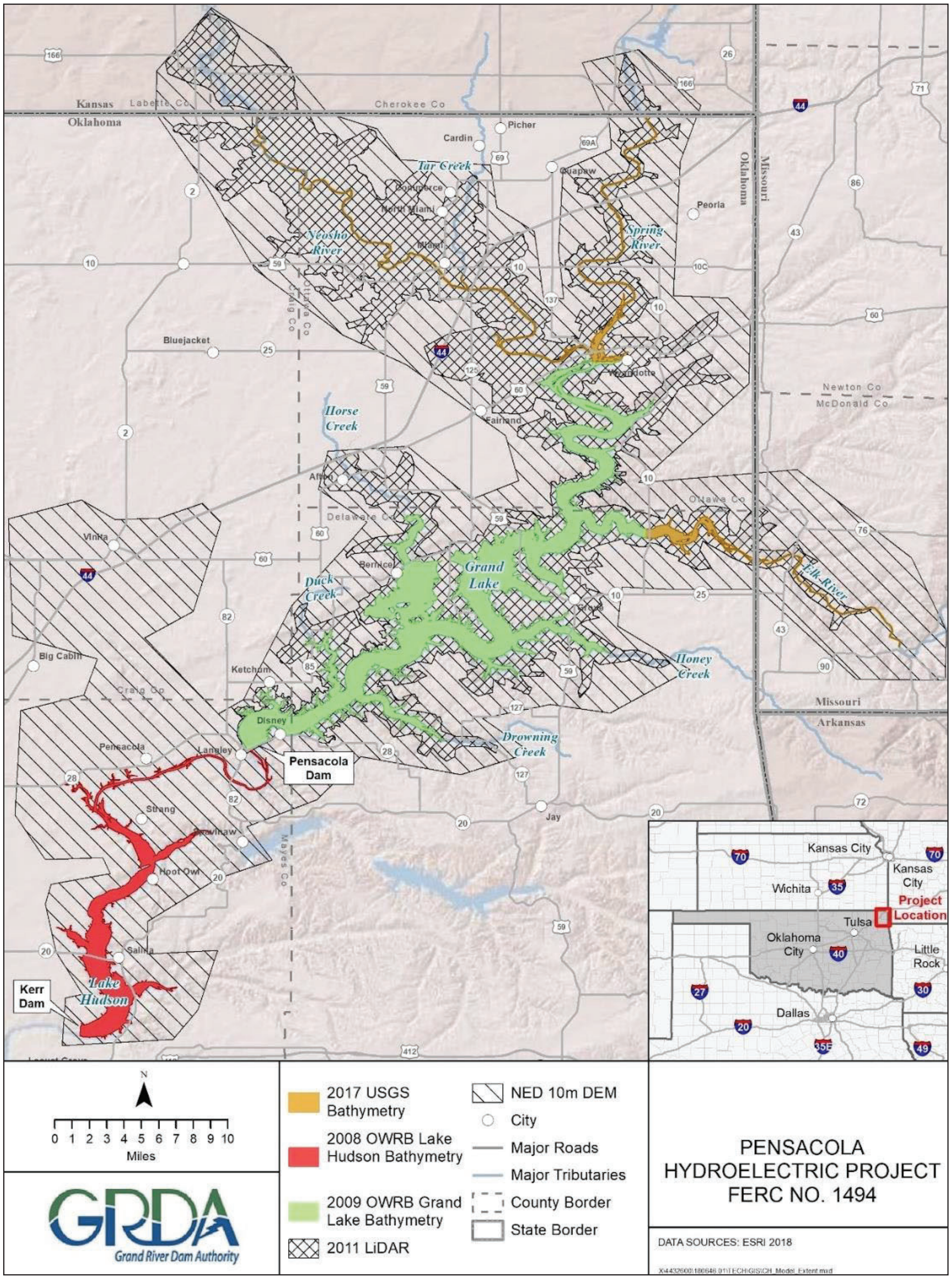
The information gathered from the above sources was compiled to make three terrain datasets. The datasets served as the basis for all STM geometry development. While data for each was created from a patchwork of sources measured at different times, for simplicity of naming them, they will be referred to in this report by the year of the relevant Grand Lake survey. Terrain files contain both bathymetric and topographic information. Table 1 details the terrain names and relevant source materials.

Table 1
Summary of Datasets Used to Create the Three Primary Terrain Files Used in the Sediment Study

Terrain Name	Grand Lake Survey	Upstream Survey	Overbank Survey
1998 Terrain	1998 REAS	1998 REAS	1998 REAS/2011 LiDAR/2017 NED
2009 Terrain	2009 OWRB	2017 USGS	2011 LiDAR/2017 NED
2019 Terrain	2019 USGS	2017 USGS	2011 LiDAR/2017 NED

Figure 1 shows the survey areas for each of the above-referenced surveys, with the exception of the 2019 USGS bathymetric survey of Grand Lake. The extents of the 2019 Grand Lake survey are approximately the same as those of the 2009 OWRB survey.

Figure 1
Survey Extents of Various Data Sources for Sediment Transport Model Development



3.1.1.1.4 Stage-Storage Curves

Grand Lake stage-storage curves were available dating back to 1940. USACE created a capacity curve from as-built dimensions and surveys at that time. The 1998 REAS produced an additional Grand Lake dataset. An OWRB survey of Grand Lake completed in 2009 and a USGS survey of the lake in 2019 provide additional data points. These were used to estimate the annual volume of sediment deposition within the Grand Lake reservoir as a ground truthing measure.

3.1.1.2 Water Surface Elevation, Discharge, and Flow Velocity

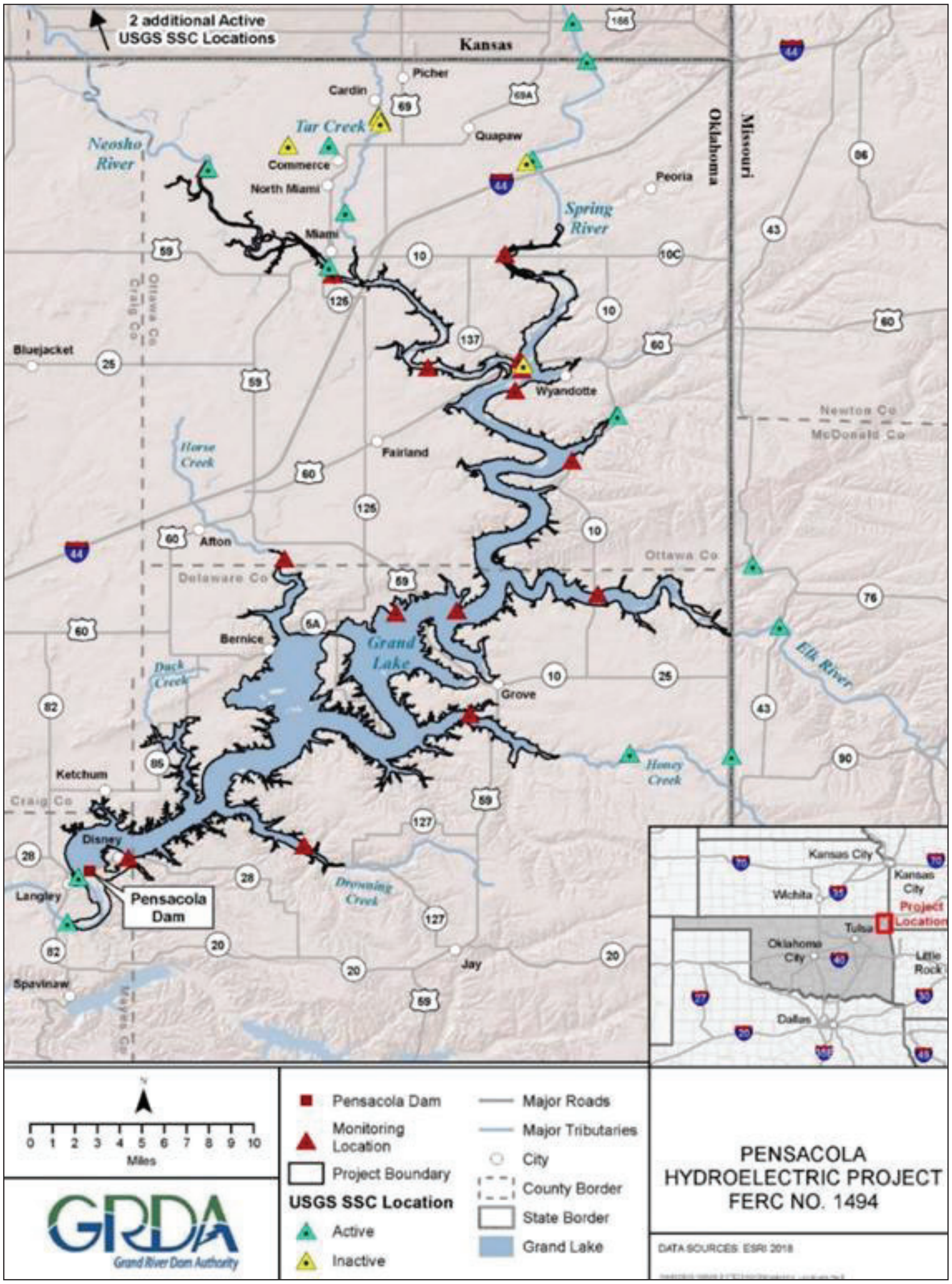
USGS provides monitoring gages in several locations within the study watershed. These locations are shown in Figure 2, and station information is provided in Table 2. Each station provides WSE information at regular intervals; most also list discharge volumes. These gage readings are available to the public through USGS websites (USGS 2021a, 2021b, 2021c, 2021d, 2021e, 2021f).

Table 2
USGS Gages Present in the Grand Lake Watershed and Periods of Record for Parameters Relevant to the Study

USGS Station ID	Site Name	Period of Record		
		Discharge (Continuous Record)	WSE (Continuous Record)	SSC (Intermittent Record)
07185000	Neosho River near Commerce, Oklahoma	1990–Present	2007–Present	1944–2016
07185080	Neosho River at Miami, Oklahoma	N/A	2007–Present	N/A
07185090	Tar Creek near Commerce, Oklahoma	2007–Present	2007–Present	2004–2016
07185095	Tar Creek at 22nd Street Bridge at Miami, Oklahoma	1989–Present	2007–Present	1988–2006
07188000	Spring River near Quapaw, Oklahoma	1989–Present	2007–Present	1944–Present
07189000	Elk River near Tiff City, Missouri	1990–Present	2007–Present	1993–2009
07190000	Lake O' the Cherokees at Langley, Oklahoma	N/A	2007–Present	N/A

Note:
N/A indicates that the specific data type was not recorded at these locations.

Figure 2
Map of the Study Area Showing Locations of USGS Gaging Stations and Water Surface Elevation Monitoring Sites



USGS also performs periodic discharge profile measurements at the gage stations. These typically use an acoustic Doppler current profiler (ADCP), and data are available upon request. Table 3 provides a summary of the available ADCP data.

Table 3
Acoustic Doppler Current Profiler Data Available from USGS Measurements

USGS Station ID	Site Name	Period of Record	Range of Flows (cfs)
07185000	Neosho River near Commerce, Oklahoma	2006–Present	931–129,000
07185080	Neosho River at Miami, Oklahoma	2013–2017	172–57,100
07185090	Tar Creek near Commerce, Oklahoma	2008–2017	402–4,930
07185095	Tar Creek at 22nd Street Bridge at Miami, Oklahoma	2012–2016	398–2,400
07188000	Spring River near Quapaw, Oklahoma	2004–Present	639–62,600
07189000	Elk River near Tiff City, Missouri	2008–2017	2,340–24,800

3.1.1.3 Sediment Information

There are two primary components of sediment information needed for this study. The first is analysis of the bed sediments in the rivers and lake; the second is evaluation of sediment volumes moving into the study area from upstream sources.

3.1.1.3.1 Bed Sediments

Understanding and analysis of sediment transport through the rivers flowing into Grand Lake requires knowledge of the sediment forming the bed of these streams. Only limited information was available regarding bed material of these streams. Several studies investigated sediment in the channel and upland areas within Grand Lake (e.g., Pope 2005; Andrews et al. 2009; Ingersoll et al. 2009; Juracek and Becker 2009; Smith 2016). While the studies have produced a great deal of sediment analysis, they do not contain information that can be used to determine properties necessary for the proposed study such as critical shear stress or detailed grain size distributions.

Mussetter, in a 1998 report entitled *Evaluation of the Roughness Characteristics of the Neosho River in the Vicinity of Miami, Oklahoma*, photographically documented characteristics of the bed material forming the Neosho River and describing the sediment as sand and gravel.

Mussetter (1998) observed the following regarding the bed material of the Neosho River:

> Based on field observations and sediment samples taken from bank-attached bars and from the bed of the river, the bed material in the reach upstream from approximately the I-44 Bridge (RM 142) is composed primarily of gravel and sand. Downstream from I-44, the surface bed material at the time of the sampling in late 1996, which was performed when the discharge in the river was relatively low, was primarily silt and clay (Mussetter 1997). There are no obvious factors other than reduced flow velocities caused by backwater from Pensacola Dam that would cause the observed change in character of the river bed in the reach downstream from Miami. Prior to construction of the dam, the bed of the river downstream from Miami was most likely gravel and sand, similar to that found upstream. (Figure 3)

Figure 3
Typical Sand and Gravel Material on a Point Bar Along the Left (North) Side of the Neosho River at Approximately River Mile 147

Note: Mussetter 1998

In the conclusions of his report, Mussetter continues his observations and speculation regarding the bed of the Neosho River:

> The bed of the Neosho River through and upstream from Miami consists of a mixture of sand and gravel. In contrast, the bed is composed of finer-grained material in the reaches downstream from Miami due to the effects of backwater from Grand Lake. Samples taken from the bed surface at low flow in late 1996 consisted primarily of silt- and clay-sized material. Based on the characteristics of the upstream bed material, it is probable that the silt and clay is entrained and carried farther downstream into the reservoir during higher flows, and that the bed is composed primarily of sand. (Mussetter 1998)

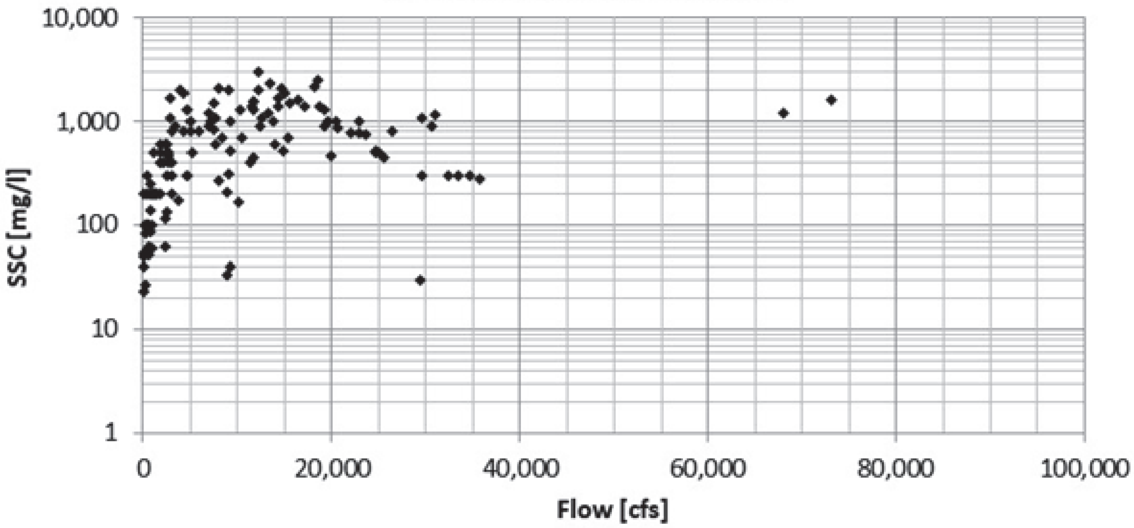
The concept that the bed consists primarily of sand was apparently reinforced by the analysis of resistance to flow. In discussing the Manning's *n* values, which quantify resistance to flow in hydraulic modeling, Mussetter states the following:

> These values are consistent with observed values in other sand bed streams having dune bedforms. This result indicates that dunes, and therefore relatively high Manning's n values, must be present in the reach downstream from Miami during high flows under with-reservoir conditions. (Mussetter 1998)

3.1.1.3.2 Sediment Transport

The second sediment analysis required is measurement of sediment volumes flowing into the system. Approximate sediment transport rates can be determined from USGS measurements of SSCs (Figure 4). SSC provides a measurement of sediment loading, typically in milligrams per liter, of streamflow. That information can then be multiplied by discharge volumes to determine transport rates within the water column. Table 2 provides a summary of the available period of record for SSC information. However, the datasets are small with samples collected on rare occasions; they do not represent continuous records like the discharge and WSE measurements.

Figure 4
Suspended Sediment Concentration Samples and Stream Discharges During Sampling on the Neosho River Near Commerce (USGS Gage 07185000)



Note: Only two samples were collected at discharges above 40,000 cfs.

SSC measurements focus only on fine materials suspended in the water column. This typically includes silts and clays, with limited sand possible depending on turbulence at the sampling site. It does not, however, measure transport rates along the streambed. Bedload transport is generally dominated by sands, gravels, and cobbles. This information is critical to understand the full sediment transport regimes of a watershed. Recorded sediment transport rates are limited to SSC calculations as bedload transport has not been reported within the Grand Lake watershed.

3.1.1.3.3 Contaminated Sediment

City of Miami, Miami Tribe, Eastern Shawnee Tribe, Ottawa Tribe, Seneca Cayuga Nation, Wyandotte Nation, and N. Larry Bork (counsel for the City of Miami citizens) provided a list of existing information to be used in their requested contaminated sediment transport study. The toxicity of the sediments is not within the scope of this study. However, existing data and information available from studies conducted of the Superfund site within the Tar Creek watershed were reviewed and incorporated in the study as appropriate.

3.1.2 Field Data Collection

Due to information gaps relevant to the study, field data collection was deemed necessary. This consisted primarily of WSE monitoring and sediment and water sampling to provide calibration information for eventual model development.

3.1.2.1 Water Surface Elevation Monitoring

Anchor QEA collected WSE data throughout the project site (Figure 2). Sixteen monitoring locations were selected, and HOBO pressure loggers (Figure 5) were installed at each site in December 2016. The loggers record raw pressures and water temperatures at 30-minute intervals to provide a continuous WSE record throughout the basin. Data are stored in onboard memory; with 30-minute recording intervals, the memory capacity is approximately 1.2 years.

Figure 5
Photograph of HOBO Pressure Loggers and Mounting Chamber

Loggers were placed in a mounting chamber and attached to rebar driven into the bed at each location shown in Figure 2. The mounting chamber was constructed of PVC with threaded caps painted black to limit visibility and deter theft or vandalism. Rebar was driven into the bed to a sufficient depth to prevent the loggers from washing away during high flow events.

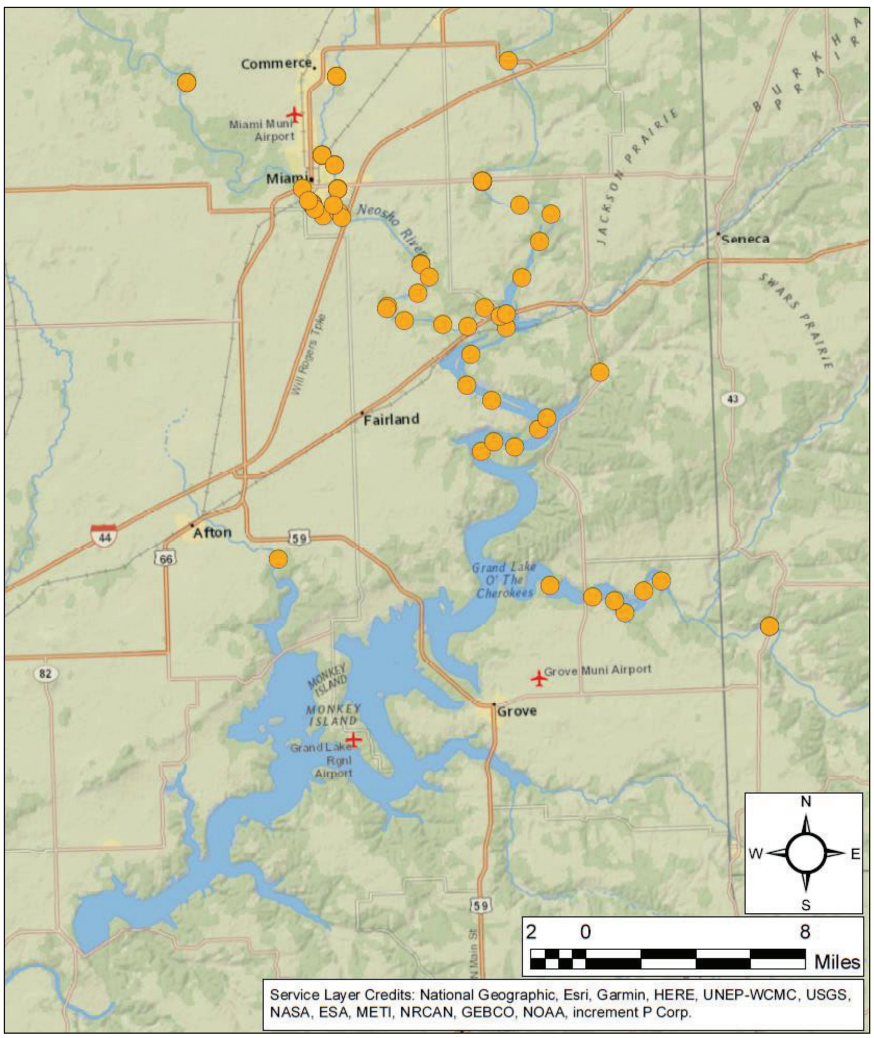
3.1.2.2 Sediment Grab Samples

The study team first collected surface samples of stream sediment throughout the watershed. A total of 62 samples were collected during a visit in December 2019 (Table 4). Figure 6 shows the locations of the sediment samples.

Table 4
Surface Sediment Grab Sampling Locations by River and Reach

Stream	Samples Collected
Neosho River North of Spring River	20
Neosho River South of Spring River	9
Tar Creek	13
Spring River	10
Elk River	8
Sycamore Creek	1
Horse Creek	1

Figure 6
Location of Sediment Grab Sampling Efforts within the Grand Lake Watershed



Samples were collected both in the overbank and in-channel areas. Overbank samples were gathered with shovels while in-channel samples were taken with either a PVC push-core sampler, a shovel, or an Ekman dredge (Figure 7). Once collected, the samples were placed into containers for analysis at the University of Wisconsin Soil and Forage Laboratory (UWSFL) in Marshfield, Wisconsin.

Figure 7
Ekman Dredge Used for In-Channel Sediment Sampling

3.1.2.3 SEDflume Core Sampling

Cohesive sediment cores were collected during the study for erosion testing using SEDflume. Despite initial reports indicating the Grand Lake watershed sediment was dominated by sands (Tetra Tech 2018), field information showed that cohesive sediments were prevalent throughout the basin. As a result, plans were adapted to account for the presence of silts and clays, which are not eroded or transported in the same way as non-cohesive sediments such as sand and gravel.

Sediment transport is generally dictated by bed shear stress. Bed shear is a function of bed slope and water depth. It is essentially a measure of frictional drag on the streambed. At low shear stress, sediment is held in place by gravitational forces. At the point of incipient motion, shear and gravitational forces are essentially balanced; the shear stress in this condition is known as the critical shear stress. Above critical shear, the bed sediment becomes mobile and can be transported. Below critical shear, sediment does not move and may settle out of the water column. Depending on sediment properties, critical shear stress can vary widely, with boulders having high critical shear values and fine sand exhibiting low critical shear stresses.

Non-cohesive sediments such as sand, gravel, and cobbles (Figure 8, top) tend to have easily predictable critical shear stress. It is typically proportional to sediment density and grain size and is relatively constant through the entire sediment layer. Generally, grains move relatively independently of each other. As a result, these sediments are comparatively simple to evaluate and model.

Figure 8
Visual Comparison of Different Sediment Types

Note: Top—non-cohesive sand, gravel, and cobbles; bottom—cohesive silt and clay.

Modeling cohesive sediments is far more complex. Critical shear stress is determined primarily by the cohesive forces between silt and clay particles rather than individual grain sizes. This is complicated by the process of consolidation; as sediment is deposited in an area, it applies force to the underlying layers, compressing them and increasing the cohesion, making them less susceptible to erosion. The amount of time spent on the bed also affects consolidation and critical shear stress. Furthermore, erosion typically occurs as clumps break free of the surrounding sediment. Due to the changing resistance to erosion based on depth and the nature of cohesive sediment transport, it is considerably more difficult to accurately model and requires additional information.

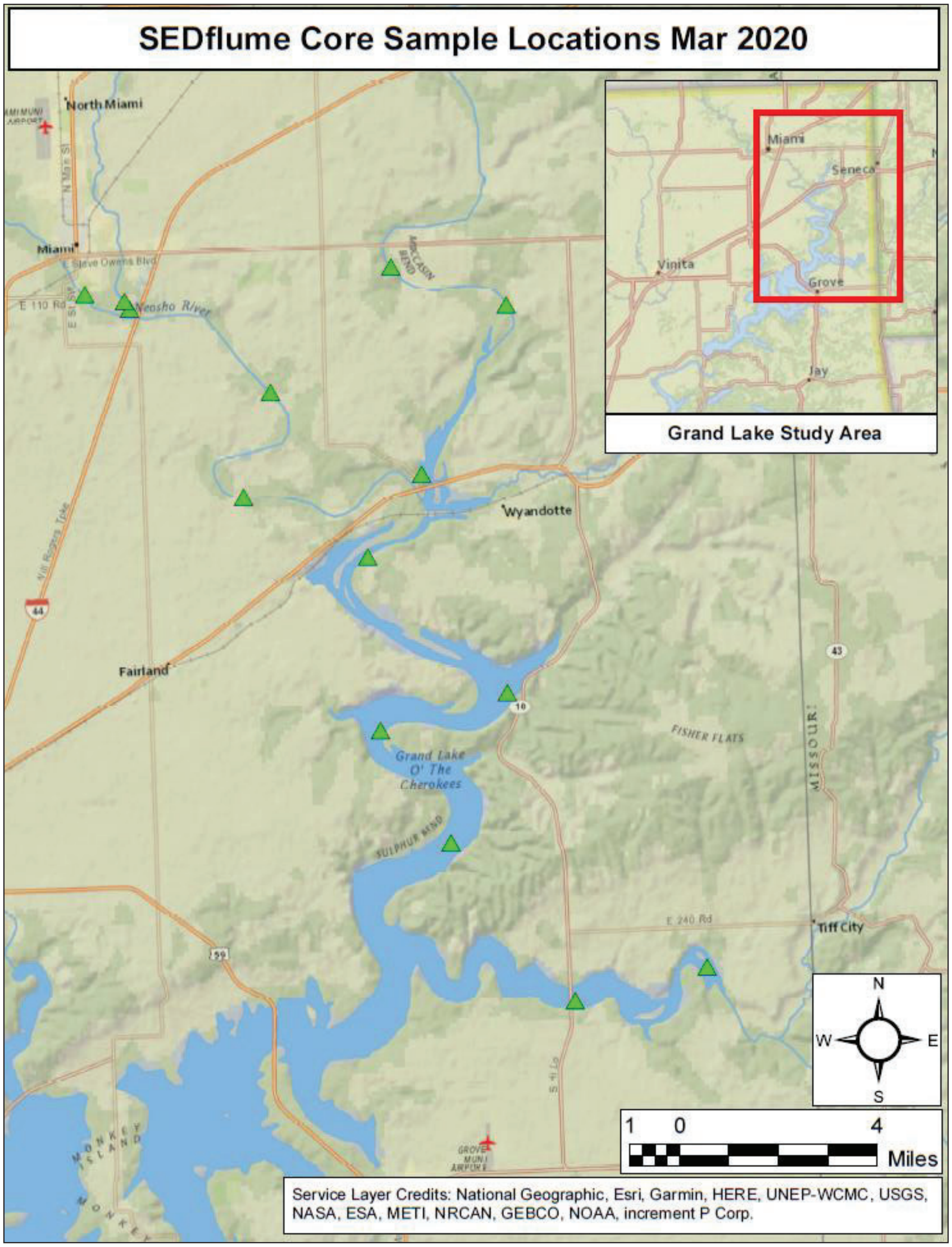
Accurate collection of sediment information can be accomplished through erosion testing on SEDflume (Borrowman et al. 2006; McNeil et al. 1996). The SEDflume testing facility consists of an enclosed flume with a hole in the bed. An undisturbed sediment core sample is placed under the hole, and the surface of the core is raised to be flush with the flume bed. Water is pumped across the sample surface at a known shear stress; as the core erodes, a jack lifts it to keep the surface flush with the flume bed. The rate of erosion is the distance the jack moved per unit time of the test. Bed shear stress can then be increased to evaluate rates at a range of shear values. This test provides information about critical shear stress throughout the sediment core, allowing engineers to evaluate critical shear as a function of depth.

The study team collected core samples for SEDflume analysis in March 2020 (Figure 9). A total of 14 core samples were collected using a box push-core system (Figure 10). The box core was a clear plastic sleeve, which was pressed into the sediment bed. A pressure relief valve at the top of the core allowed air and water to escape as the core sank into the streambed. The resulting suction pressure kept the sample inside the sleeve as it was raised back to the water surface. The sample was then measured, sealed, and transported to the test laboratory for analysis.

Figure 9
SEDflume Core Sampling

Note: Left—technician pulling box core rig out of the bed; center—box core showing sediment fill and measuring depth of sample; right—several collected samples before shipment to the test facility.

Figure 10
Locations of SEDflume Core Samples Collected During the Sediment Investigation



SEDflume analysis also provided particle size analysis. During testing, Integral Consulting used a Beckman Coulter LS particle size analyzer over a range of depths below the surface of the core for each sample.

3.1.2.4 Sediment Transport Measurements

Sediment transport measurements were also included in the sediment study. These consisted primarily of two forms of data: SSC and bedload transport quantification. Bedload samples were collected immediately following SSC sampling at each site. Dates of sampling efforts and discharges are provided in Table 5.

Table 5
Sampling Dates and Discharge Measurements, per USGS Gaging Station Records

Date	Discharge (cfs)			
	USGS 07185000 Neosho River at E 60 Rd	**USGS 07185090 Tar Creek at Hwy 69**	**USGS 07188000 Spring River at E 57 Rd**	**USGS 07189000 Elk River at Hwy 43**
August 2019	15,500	10.0	1,240	537
May 2020	37,500	*	8,040	4,940
July 2020	2,930	5.29	3,480	*
April 2021	2,330	*	2,250	*
May 2021	18,900	750	16,500 23,400**	*
July 2021	41,600	500	14,700	*

Notes:
*Samples not taken at this location
**Spring River was sampled twice during the May 2021 site visit

3.1.2.4.1 Suspended Sediment Concentration

A D-74 depth-integrating water sampler was used to collect SSC samples (Figure 11). This sampler features a finned body with a nozzle pointing upstream and a vent pointing downstream. As it is lowered into the water, flow is allowed through the nozzle and into a sampling bottle. The sampler is lowered into the stream until it reaches the bed, then is raised; this is all done at a constant speed. Based on flow conditions at the site, researchers have an array of nozzle sizes and travel speeds to choose to ensure valid data (USGS 2006).

Figure 11
Sampling Equipment Used During SSC Sampling Efforts

Notes: The D-74 Water Sampler is attached to the crane, and the SonTek M9 ADCP used to measure stream flows is in the lower right. Samples are placed in the carrier at left after collection.

Anchor QEA followed standard USGS protocols for equal width interval water sampling (USGS 2006). The field technicians used a SonTek M9 ADCP to measure current profiles at each site before sampling began. Based on flow velocities and patterns, they selected appropriate nozzle sizes and descent and ascent velocities for the D-74 sampler following USGS standard procedures (USGS 2006). Following nozzle installation, a calibrated winch lowered the sampler to the stream and raised it at the specified rates. Samples were then capped and sent to the Wisconsin State Laboratory of Hygiene (WSLH) for SSC analysis.

3.1.2.4.2 Bedload Transport

Anchor QEA used a Helley-Smith bedload sampler (Figure 12) to collect bedload transportation measurements. Sampling sites were the same as those used for SSC measurements to ensure capture of all sediment (SSC and bedload) moving through the system under given flow conditions. The Helley-Smith sampler sits on the streambed with a rectangular opening pointed upstream. Saltating, sliding, and rolling sediment is transported at the bed surface into the opening and trapped in a mesh bag. USGS documentation provides guidelines for the use of this equipment; Anchor QEA followed USGS procedures (Edwards and Glysson 1999) to collect bedload sediment during site visits (Table 5).

Figure 12
Bedload Transport Measurements Collected Using the Helley-Smith Sampler

3.1.3 Field Results

3.1.3.1 Water Surface Records

Anchor QEA has visited the site several times to collect and redeploy pressure loggers. Trips to collect WSE monitoring data were performed according to Table 6.

Table 6
WSE Monitoring Site Visit Dates and Logger Retrieval Rates

Date	Loggers Recovered
December 2016	16 Deployed
August 2017	13 of 16
March 2018	2 of 16
April 2019	12 of 16
December 2020	13 of 16

Anchor QEA retrieved the loggers on an approximately annual basis. Upon arrival at each monitoring station, Anchor QEA staff collected Real-Time Kinematic Global Positioning System measurements of the WSE and surveyed any nearby benchmarks. The loggers were collected, and data were read from them using an optic USB interface. They were then relaunched and placed back in the field; staff measured depth to the loggers and depth to bed before leaving the site. After all loggers were retrieved, the data was processed to produce WSE readings from the pressure data.

The loggers recorded raw pressure measurements that had to be converted to water depths and then WSE. Because pressure readings include both water pressure and atmospheric pressure, it was first necessary to subtract ambient air pressure from the measurements. Records from the Grove Municipal Airport provided atmospheric pressure readings for processing. Computer scripts were used to subtract the raw readings to water pressure measurements; water density was then used to estimate the depth of the sensors according to the following equation:

Equation 1

$$h = \frac{P}{\rho g}$$

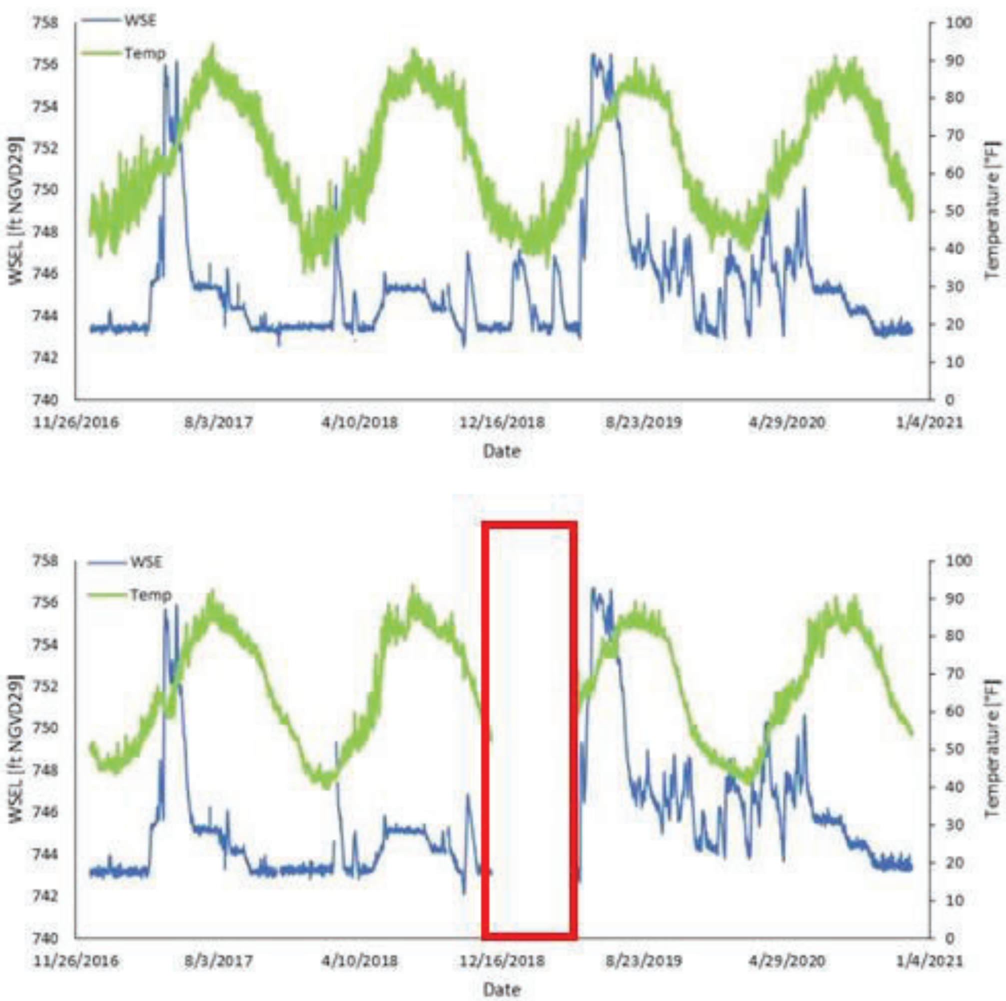
where:

h	=	water depth
P	=	pressure
ρ	=	water density
g	=	acceleration due to gravity

Once water depths were established at the time of retrieval, logger elevation was set based on the measured WSE and recorded depth; data throughout the period of record were thus converted from the raw pressure recordings to WSE measurements (Figure 13).

Several loggers had data gaps in the record. At various sites, the loggers were washed away or vandalized, which prevented recovery. One additional data gap was due to an unforeseen high water event that prevented recovery until after internal storage had been filled. Full datasets are available in Appendix A.

Figure 13
Sample Series



Note: Top: complete dataset; bottom: gap in record.

3.1.3.2 Sediment Grain Size Analysis

Following the December 2019 sediment grab sample collection, Anchor QEA sent 62 sediment samples to the UWSFL for grain size analysis. The results of the analysis indicated a bi-modal size distribution, with a majority of streambed sediments consisting of gravels and coarse sediments and a majority of lakebed sediments composed of silt and clay. The results showed limited volumes of sand in either stream or lake sediments with most of the lakebed being finer than sand and most of the riverbed being coarser than sand (Figure 14).

Figure 14
Particle Size Distributions within the Grand Lake Study Area

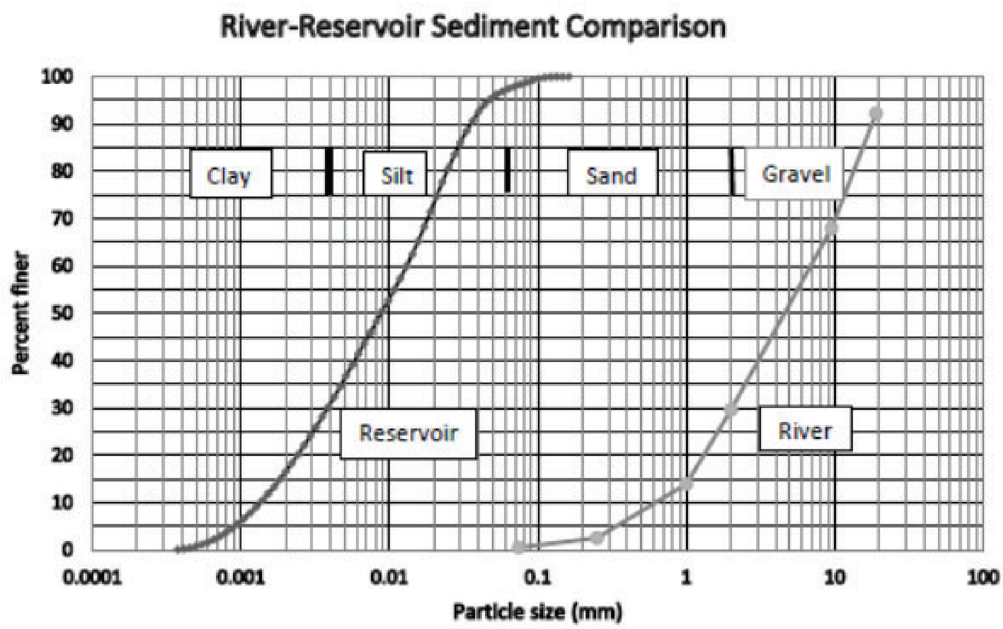


Figure 15
Sample Photographs Showing the Sediment in the Spring River, Tar Creek, Elk River, and Neosho River

Note: Clockwise from top left, the Spring River, Tar Creek, Elk River, and Neosho River.

As shown in Figure 15, the beds of these streams consist primarily of gravel, with some sand. The surface of the streambeds appears to be armored by gravel and (in the case of areas of Tar Creek), larger particles. Hydraulic and sediment transport analyses, based on particle size distributions, will determine the extent to which these particles may be transported downstream into the reservoir.

Farther downstream, as the tributaries transition into lacustrine conditions, the character of the bed material changes dramatically. Samples collected from the reservoir bed appear to consist primarily of silt and clay (Figure 16).

Figure 16
Sediment Grab Samples Collected from the Reservoir Bed in Grand Lake

Full results for each sample are presented in Appendix B. These results show the significant variability in particle size distributions from reach to reach within streams and even significant differences between samples taken in close proximity.

3.1.3.3 SEDflume Test Results

SEDflume samples were tested by Integral Consulting at their Santa Cruz, California laboratory. Testing was performed according to the procedures described by McNeil et al. (1996) and Borrowman et al. (2006). The laboratory analysis of the samples included evaluation of erosion parameters, grain size distributions, and bulk density of the samples.

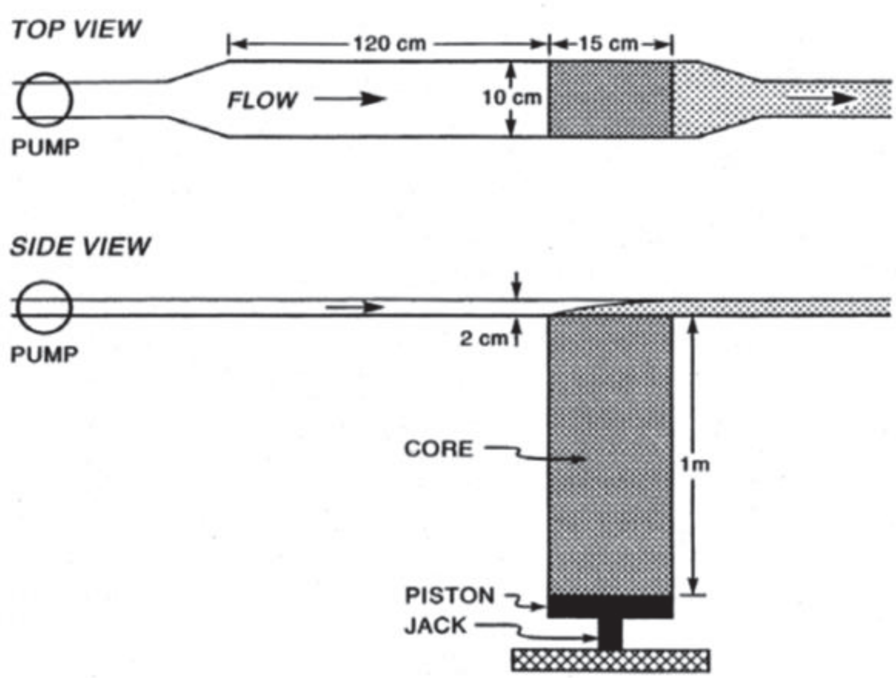
3.1.3.3.1 Erosion Parameter Analysis

Erosion of cohesive sediment is quantified by two key parameters: critical shear stress at which erosion begins, and the rate of erosion as a function of increasing shear stress greater than critical shear. A standard technology, SEDflume, has been developed to measure these parameters. The SEDflume is described as follows:

> A SEDflume is essentially a straight flume with an open bottom section through which a rectangular, cross-sectional core barrel containing sediment can be inserted (Figure [Figure 17]). The main components of the flume are the water tank, pump, inlet flow converter (which establishes uniform, fully developed, turbulent flow), the main duct, test section, hydraulic jack, and the core barrel containing sediment (Figure [Figure 18]). The core barrel, test section, flow inlet section, and flow exit section are made of transparent

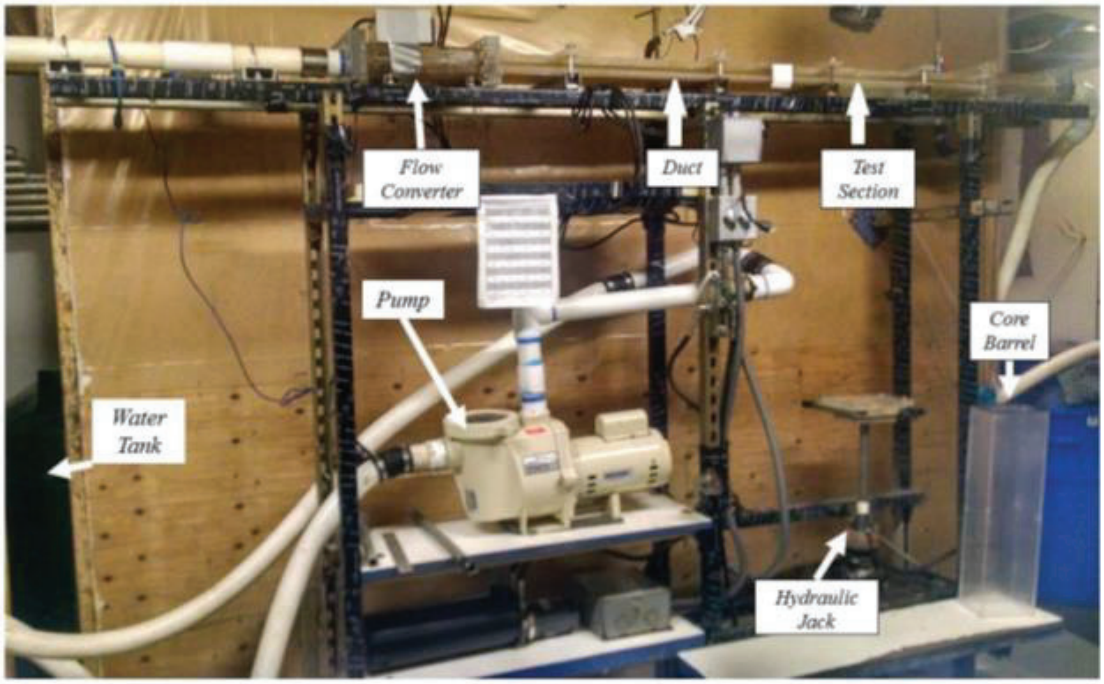
acrylic so that the sediment–water interactions can be observed visually. The core barrel has a rectangular cross section, 10 by 15 cm, and a length of 60 cm. (Integral Consulting 2020)

Figure 17
SEDflume Schematic Showing Top and Side Views



Source: Integral Consulting 2020

Figure 18
Photograph of SEDflume Test System



Source: Integral Consulting 2020

In their report, Integral Consulting describes the process of conducting the laboratory testing with SEDflume.

> At the start of each test, a core barrel and the sediment it contains are inserted into the bottom of the test section. The sediment surface is aligned with the bottom of the SEDflume channel. When fully enclosed, water is forced through the duct and test section over the surface of the sediment. The shear stress produced by the flow and imparted on the particles causes sediment erosion. As the sediment on the surface of the core erodes, the remaining sediment in the core barrel is slowly moved upward so that the sediment–water interface remains level with the bottom of the flume. (Integral Consulting 2020)

They then describe the process of taking measurements to develop critical shear and erosion rate data.

> At the start of each core analysis, an initial reference measurement is made of the starting core length. The flume is then operated at a specific flow rate corresponding to a particular shear stress, and sediment is eroded (McNeil et

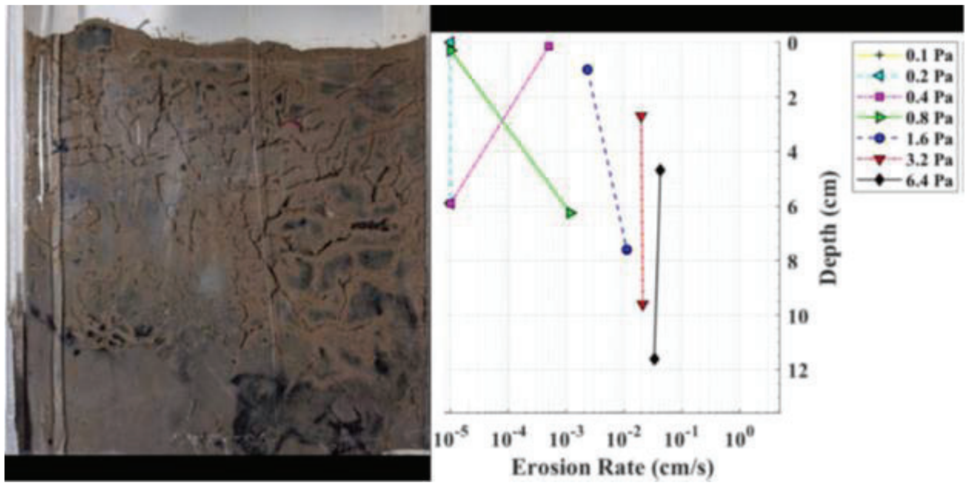
al. 1996; Jepsen et al. 1997). As erosion proceeds, the core is raised if needed to keep the core's surface level with the bottom of the flume. This process is continued until either 10 minutes has elapsed or the core has been raised roughly 2 cm. (Integral Consulting 2020)

As the flow rate is increased through the flume and as sediment begins to erode from the surface of the core, this determines the critical shear value above which erosion occurs and below which no erosion occurs. Once the critical shear value is determined for that layer of sediment, the flow rate through the flume is increased and erosion measured over a range of flow or shear stresses. This process is repeated at different levels of the core sample below the surface to develop the critical shear and erosion rates through the depth of the sample. Tabulated results for each of the streams showing the critical shear erosion parameters determined using SEDflume can be seen in Table 7 through Table 10, whereas Figure 19 through Figure 22 show the erosion rates at the various applied shear stresses over the depth of the core sample for the associated streams.

Table 7
Physical Properties and Derived Critical Shear Stresses of SEDflume Sample NR-130 (Neosho River)

Sample Depth (cm)	Median Grain Size (µm)	Wet Bulk Density (g/cm^3)	Dry Bulk Density (g/cm^3)	Loss on Ignition (%)	τ_{no} (Pa)	τ_1 (Pa)	τ_c Linear (Pa)	τ_c Power (Pa)	Final Critical Shear (Pa)
0.0	8.34	1.49	0.84	3.7	0.2	0.4	0.84	0.33	0.33
5.9	5.20	1.56	1.01	6.8	0.4	0.8	0.44	0.29	0.40
8.6	7.01	1.64	1.10	5.0	---	---	---	---	---
Mean	6.85	1.56	0.98	5.2	0.3	0.6	0.64	0.31	0.37

Figure 19
Photograph of Core NR-130 (Neosho River) Aligned with Applied Shear Stresses and Associated Erosion Rates

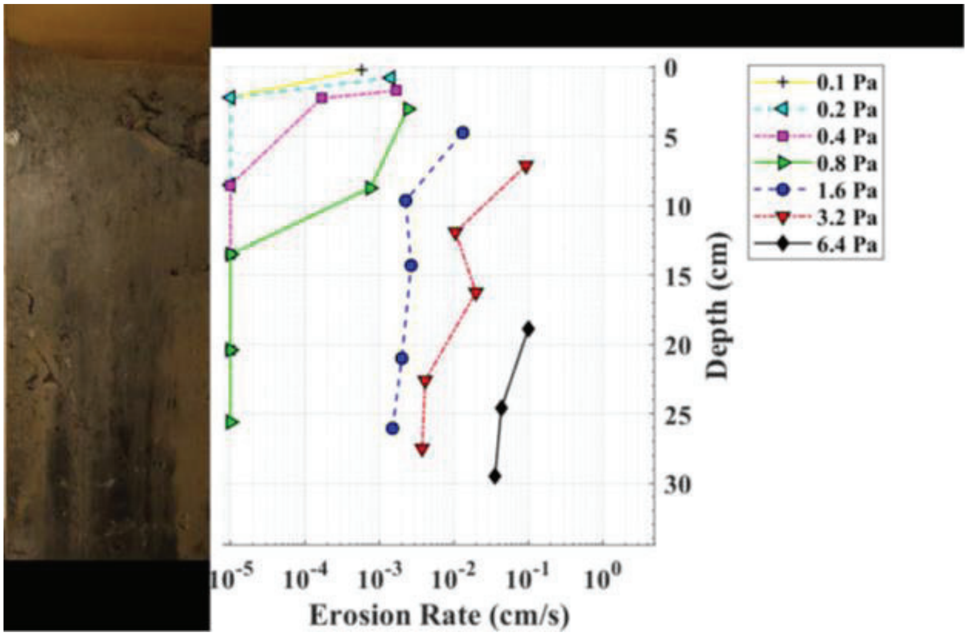


Source: Integral Consulting 2020

Table 8
Physical Properties and Derived Critical Shear Stresses of SEDflume Sample TC-DS (Tar Creek)

Sample Depth (cm)	Median Grain Size (µm)	Wet Bulk Density (g/cm^3)	Dry Bulk Density (g/cm^3)	Loss on Ignition (%)	τ_{no} (Pa)	τ_1 (Pa)	τ_c Linear (Pa)	τ_c Power (Pa)	Final Critical Shear (Pa)
0.0	7.99	1.15	0.34	8.0	0.05	0.1	0.06	0.04	0.05
2.2	9.76	1.27	0.53	7.7	0.2	0.4	0.32	0.32	0.32
8.5	8.72	1.20	0.43	8.7	0.4	0.8	0.46	0.40	0.40
13.5	10.64	1.40	0.72	5.8	0.8	1.6	0.83	0.71	0.80
20.4	9.37	1.41	0.74	5.8	0.8	1.6	0.84	0.73	0.80
25.6	7.91	1.47	0.84	5.3	0.8	1.6	0.86	0.76	0.80
Mean	9.07	1.32	0.60	6.9	0.5	1.0	0.56	0.49	0.53

Figure 20
Photograph of Core TC-DS (Tar Creek) Aligned with Applied Shear Stresses and Associated Erosion Rates

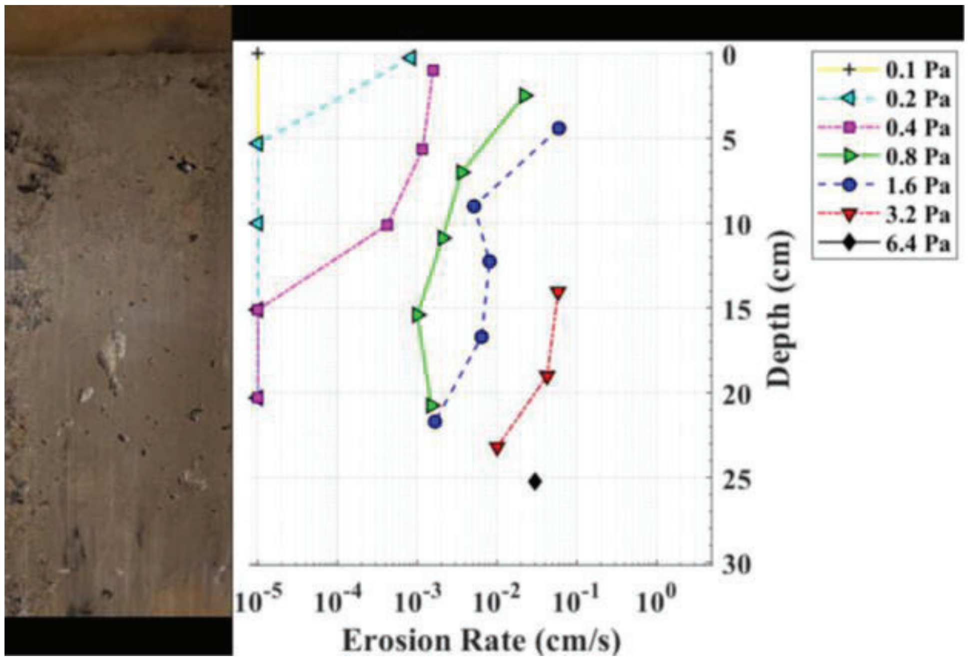


Source: Integral Consulting 2020

Table 9
Physical Properties and Derived Critical Shear Stresses of SEDflume Sample SR-100 (Spring River)

Sample Depth (cm)	Median Grain Size (µm)	Wet Bulk Density (g/cm³)	Dry Bulk Density (g/cm³)	Loss on Ignition (%)	τ_{no} (Pa)	τ_1 (Pa)	τ_c Linear (Pa)	τ_c Power (Pa)	Final Critical Shear (Pa)
0.0	13.20	1.13	0.34	11.6	0.1	0.2	0.12	0.11	0.11
5.3	112.80	1.26	0.57	12.1	0.2	0.4	0.22	0.16	0.20
10	6.22	1.38	0.70	6.8	0.2	0.4	0.25	0.24	0.24
15.1	13.00	1.34	0.65	8.1	0.4	0.8	0.45	0.41	0.41
20.3	9.37	1.35	0.68	8.2	0.4	0.8	0.43	0.32	0.40
Mean	30.92	1.29	0.59	9.4	0.3	0.5	0.29	0.25	0.27

Figure 21
Photograph of Core SR-100 (Spring River) Aligned with Applied Shear Stresses and Associated Erosion Rates

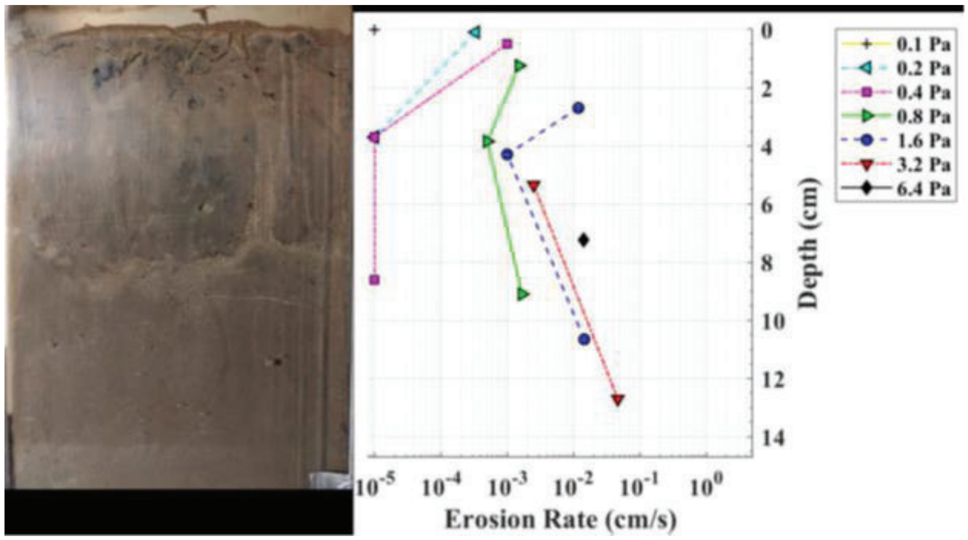


Source: Integral Consulting 2020

Table 10
Physical Properties and Derived Critical Shear Stresses of SEDflume Sample ER-680 (Elk River)

Sample Depth (cm)	Median Grain Size (µm)	Wet Bulk Density (g/cm^3)	Dry Bulk Density (g/cm^3)	Loss on Ignition (%)	τ_{no} (Pa)	τ_1 (Pa)	τ_c Linear (Pa)	τ_c Power (Pa)	Final Critical Shear (Pa)
0.0	18.95	1.39	0.68	3.4	0.1	0.2	0.13	0.12	0.12
3.7	32.96	1.70	1.16	2.9	0.4	0.8	0.48	0.42	0.42
8.6	16.32	1.66	1.11	3.0	0.4	0.8	0.43	0.37	0.40
13.7	23.18	1.54	0.94	4.2	---	---	---	---	---
Mean	22.85	1.57	0.97	3.4	0.3	0.6	0.35	0.30	0.31

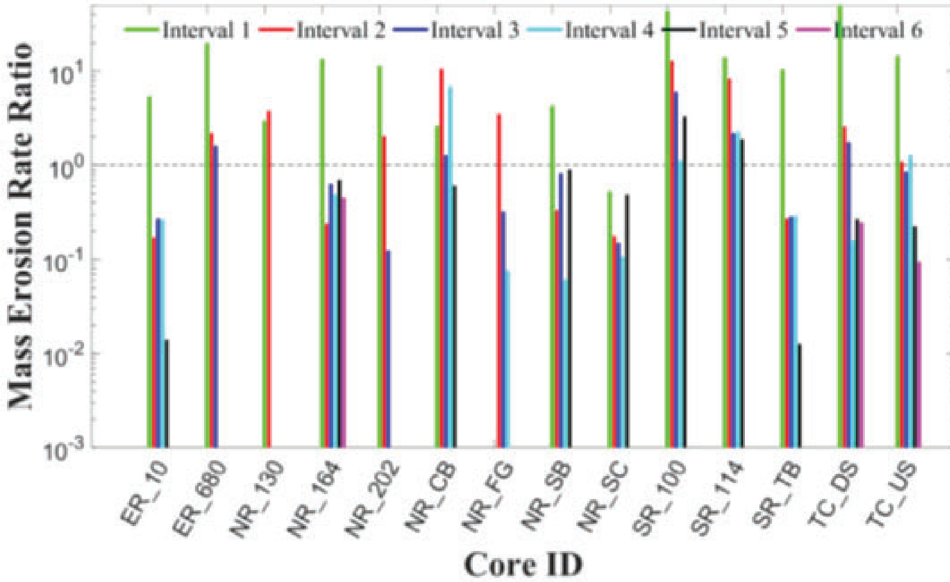
Figure 22
Photograph of Core ER-680 (Elk River) Aligned with Applied Shear Stresses and Associated Erosion Rates



Source: Integral Consulting 2020

A summary of erosion rates ratios developed by Integral Consulting (Figure 23) shows that erosion rates generally are significantly lower at deeper locations in the sediment columns than at the surface. Interval 1 refers to the top layer of the sediment cores, with each subsequent interval representing a deeper layer of material. Exact interval thicknesses vary, though most are 5 centimeters (cm) or less.

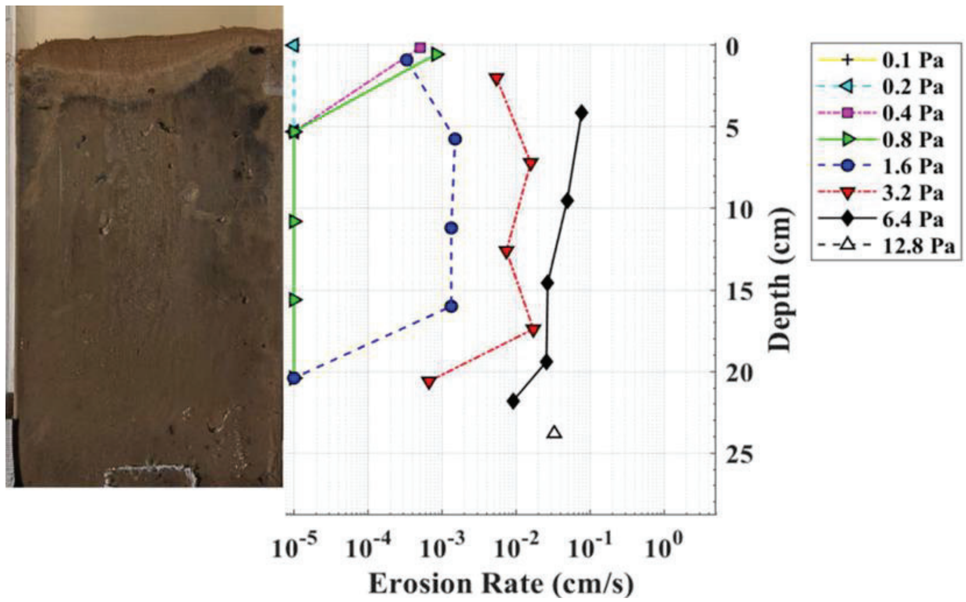
Figure 23
Intracore Erosion Rate by Interval for Each SEDflume Core Sample



The results of the tests showed expected critical shear patterns. Sediment near the top of the column is more recently deposited and therefore has had less time to consolidate; in general, it is more easily eroded. Lower in the sediment column, the particles have consolidated over time and under higher pressures due to the overlying material; critical shear stress is generally higher as one moves deeper into the core sample.

It is important to understand the high degree of variability of erosion rates as a function of depth below the sediment surface by looking at an example. A sample of the data are shown in Figure 24. The photograph on the left allows visual inspection of the core sample before erosion; the chart on the right provides erosion rate as a function of depth and applied shear stress. It indicates more resistance to erosion at deeper levels of the soil column. For example, at 0.4 pascal (Pa) of shear stress, the surface material eroded at a rate of approximately 4×10^{-3} centimeters per second (cm/s), but at 5 cm of depth, erosion was significantly lower (approximately 10^{-5} cm/s) for the same shear stress.

Figure 24
Example SEDflume Analysis Results



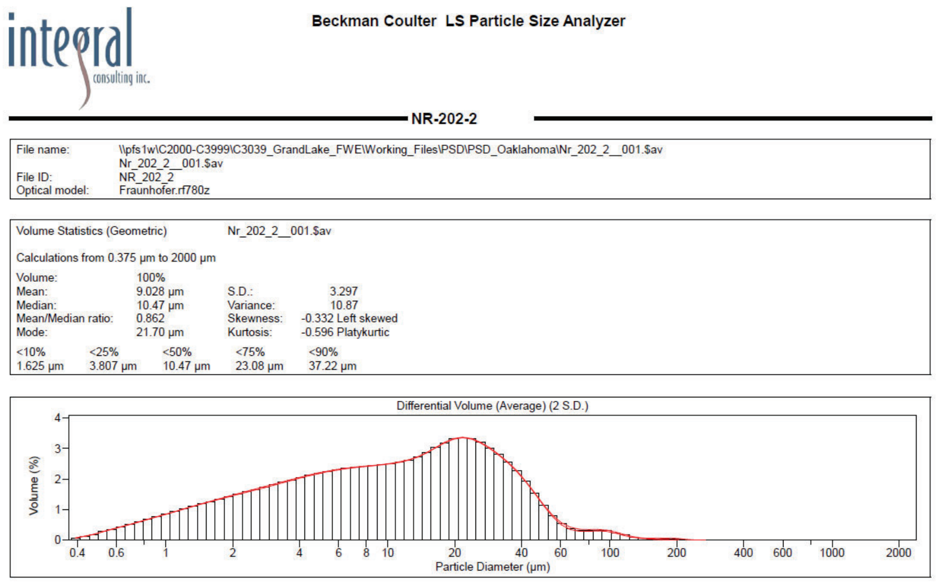
Note: Left: image of sediment core before erosion testing; right: graphical dataset showing erosion rates as a function of bed shear stress and depth in sediment column.
Source: Integral Consulting 2020

This example and the previous summary of intracore erosion rates show a variation of several orders of magnitude over the depth of samples. This extreme variability affects the development of reasonable erosion parameters to be used in the STM.

3.1.3.3.2 Sediment Particle Size Analysis

During erosion of the samples, the testing facility used a Beckman Coulter LS particle size analysis system to collect sediment grain size information (Integral Consulting 2020). An example of the output is provided in Figure 25.

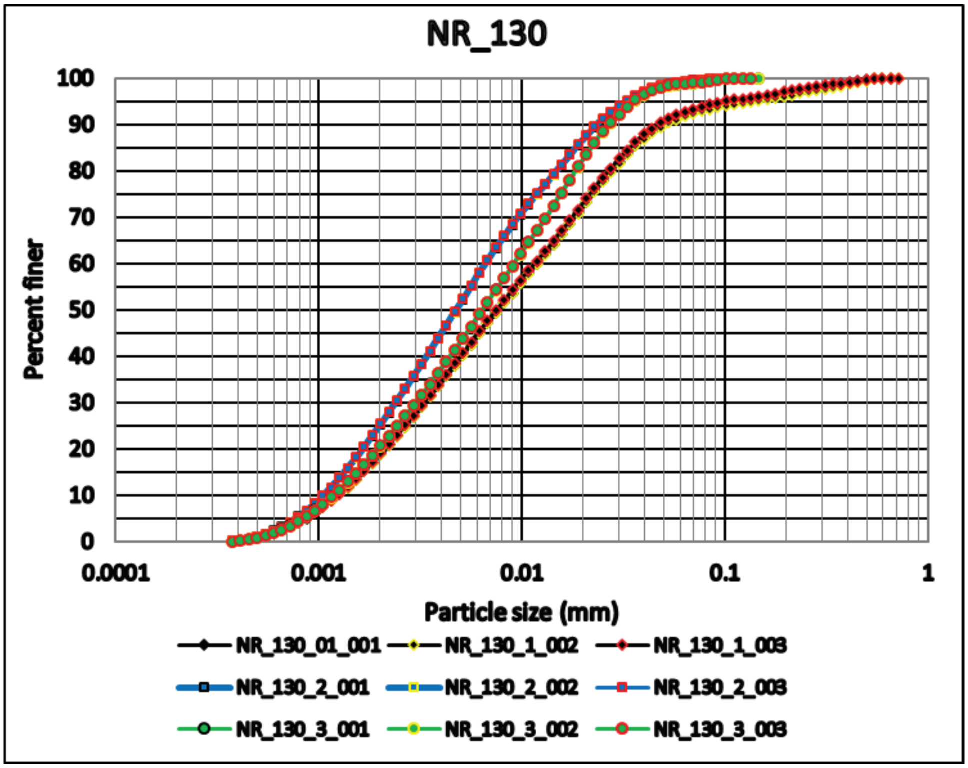
Figure 25
Sample Particle Size Analysis Output from SEDflume Analysis



Source: Integral Consulting 2020

The particle count analysis shows that most of these samples consist of silt- and clay-sized particles. These data were developed into particle size distribution curves relating sediment size to the percentage of the sample finer than the individual sizes to cover the entire range of sediment sizes in the sample. Figure 26 presents an example of this type of graph. A complete set of particle size distribution graphs for the samples is found in Appendix C.

Figure 26
Sample Particle Size Analysis Output from SEDflume Analysis Showing Cumulative Percent Finer Values for Core NR-130 (Neosho River)



3.1.3.3.3 Sediment Deposit Bulk Density Analysis

A key factor in understanding silt and clay deposits is the density of sediment and how it varies vertically in the sediment column. Density, along with erodibility and the particle size distribution, are critical parameters for evaluating fluvial transport of this type of sediment.

While density of sand and gravel deposits fits into a relatively narrow band and does not vary significantly over time, sediment deposits of silt and clay generally settle out of the water column at a low density and then gradually increase in density over time as water is compressed out of the sediment column. As more sediment deposits over the original layers, density of lower layers increases; the consolidation process continues over time until a maximum value is reached. In some situations, this can result in the formation of sedimentary rock such as claystone or shale.

As discussed above, this process also affects the strength or erodibility of sediment. The deeper, more consolidated layers tend to exhibit higher critical shear stress values than the more recently deposited layers near the bed surface.

Density is also the link between sediment transport and deposition. Incoming sediment load is quantified in weight (i.e., tons per day as the unit of sediment transport), while sediment deposition as measured by survey is defined in terms of volume. In the case of reservoir sediment deposits, the deposited volume can vary considerably over time and with the depth of the sediment layer.

Sediment density of the upper layer of the sediment deposit was determined in the analysis of sediment cores. Table 11 summarizes the range of sediment density values for the core samples.

Table 11
Density Results from Top Layer Testing of SEDflume Samples

Sediment Core	Min Dry Density		Max Dry Density		Mean Dry Density (pcf)
	pcf	% of Mean	pcf	% of Mean	
SED-ER-10	28.7	66.7	48.7	113.0	43.1
SED-ER-680	42.5	70.1	72.4	119.6	60.6
SED-NR-130	52.4	85.7	68.7	112.2	61.2
SED-NR-164	76.2	81.9	103.0	110.7	93.0
SED-NR-202	27.5	63.8	53.1	123.2	43.1
SED-NR-CB	37.5	74.1	64.9	128.4	50.6
SED-NR-FG	73.0	90.0	85.5	105.4	81.2
SED-NR-SB	30.6	62.8	62.4	128.2	48.7
SED-NR-SC	48.7	88.6	61.2	111.4	54.9
SED-SR-100	21.2	57.6	43.7	118.6	36.8
SED-SR-114	32.5	69.3	54.9	117.3	46.8
SED-SR-TB	29.3	73.4	46.2	115.6	40.0
SED-TC-DS	21.2	56.7	52.4	140.0	37.5
SED-TC-US	30.0	75.0	46.2	115.6	40.0
Minimum	21.2	56.7	43.7	105.4	36.8
Mean	39.4	72.6	61.7	118.5	52.7
Maximum	76.2	90.0	103.0	140.0	93.0

The summary table shows a significant degree of variability for the dry density values for the sediment cores. For example, the minimum dry density ranges from 21.2 to 76.2 pounds per cubic foot (pcf), and the maximum dry density ranges from 43.7 to 103 pcf. For reference, the bulk density of water is 62.4 pcf and solid rock at a specific gravity of 2.65 is 165.4 pcf. Laboratory results for each individual sample analysis are found in Appendix C. Preliminary assessment of the data does not reveal any readily apparent spatial trends in sediment density.

Sediment density may be correlated with depth below the surface of the sediment deposit due to the consolidation process as fine sediment deposits generally compress over time. Table 12 through Table 15 display the sediment density from the SEDflume samples in relation to sample depth for each of the streams. Corresponding graphs (Figure 27 through Figure 30) of sediment density with depth below the sediment surface for each stream show this general trend (noting that 1 gram per cubic centimeter [g/cm^3] is equivalent to 62.4 pcf—the density of water). Also shown on the graphs are D_{10}, D_{50}, and D_{90} (the sediment grain diameters that are larger than 10%, 50%, and 90% of the total sample, respectively) to give some perspective on sediment sizes found in the samples.

Table 12
Physical Properties of SEDflume Sample NR-130 (Neosho River)

Sample Depth (cm)	Median Grain Size (µm)	Wet Bulk Density (g/cm^3)	Dry Bulk Density (g/cm^3)	Loss on Ignition (%)
0.0	8.34	1.49	0.84	3.7
5.9	5.20	1.56	1.01	6.8
8.6	7.01	1.64	1.10	5.0
Mean	6.85	1.56	0.98	5.2

Figure 27
Physical Properties of SEDflume Sample NR-130 (Neosho River) with Depth

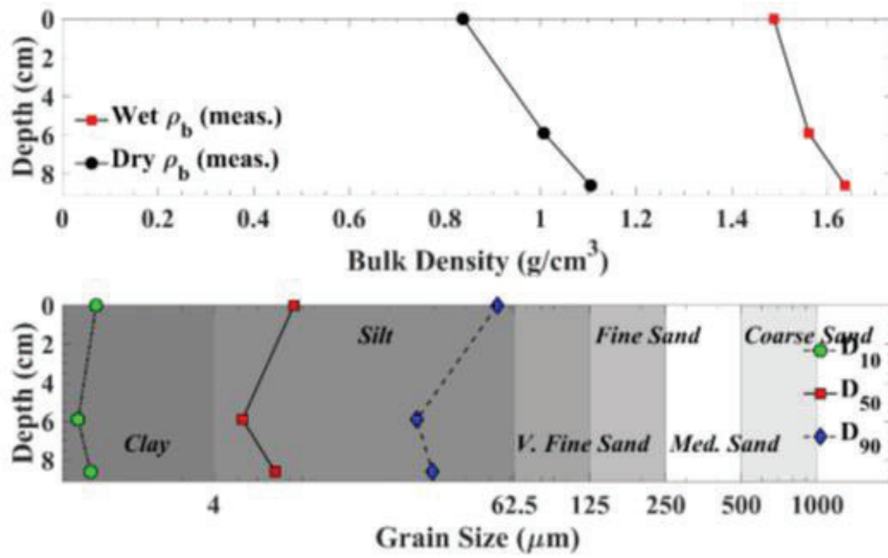


Table 13
Physical Properties of SEDflume Sample SR-100 (Spring River)

Sample Depth (cm)	Median Grain Size (µm)	Wet Bulk Density (g/cm^3)	Dry Bulk Density (g/cm^3)	Loss on Ignition (%)
0.0	13.20	1.13	0.34	11.6
5.3	112.80	1.26	0.57	12.1
10.0	6.22	1.38	0.70	6.8
15.1	13.00	1.34	0.65	8.1

20.3	9.37	1.35	0.68	8.2
Mean	30.92	1.29	0.59	9.4

Figure 28
Physical Properties of SEDflume Sample SR-100 (Spring River) with Depth

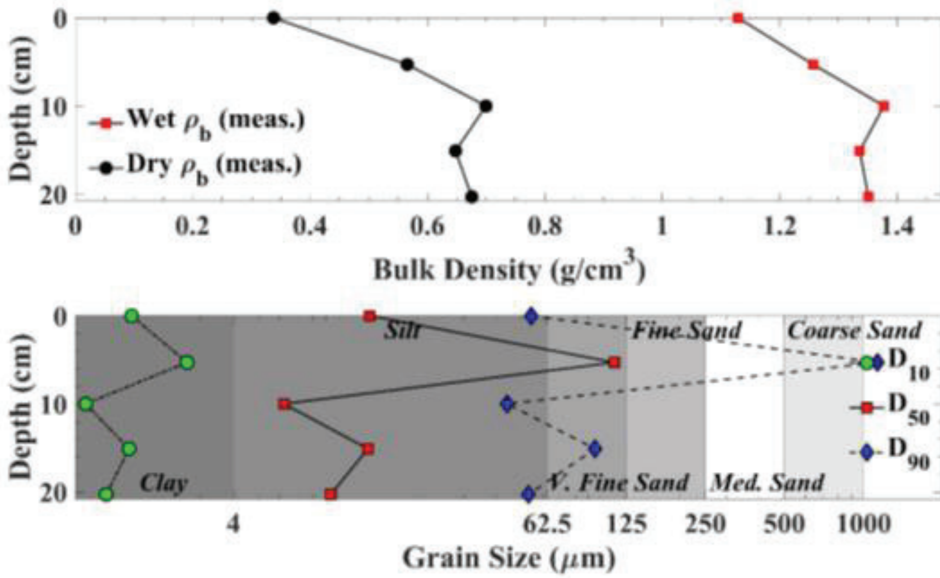


Table 14
Physical Properties of SEDflume Sample TC-DS (Tar Creek)

Sample Depth (cm)	Median Grain Size (µm)	Wet Bulk Density (g/cm^3)	Dry Bulk Density (g/cm^3)	Loss on Ignition (%)
0.0	7.99	1.15	0.34	8.0
2.2	9.76	1.27	0.53	7.7
8.5	8.72	1.20	0.43	8.7
13.5	10.64	1.40	0.72	5.8
20.4	9.37	1.41	0.74	5.8
25.6	7.91	1.47	0.84	5.3
Mean	9.07	1.32	0.60	6.9

Figure 29
Physical Properties of SEDflume Sample TC-DS (Tar Creek) with Depth

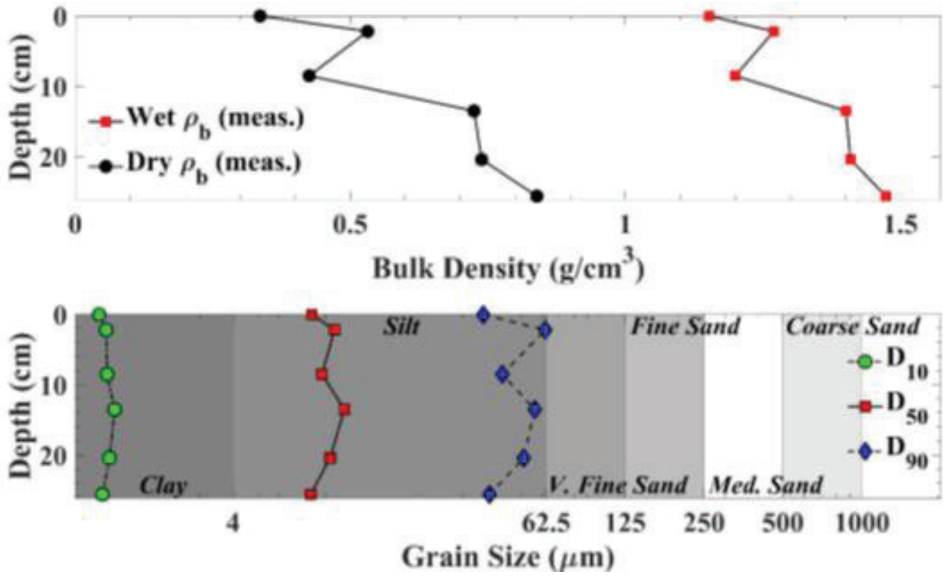
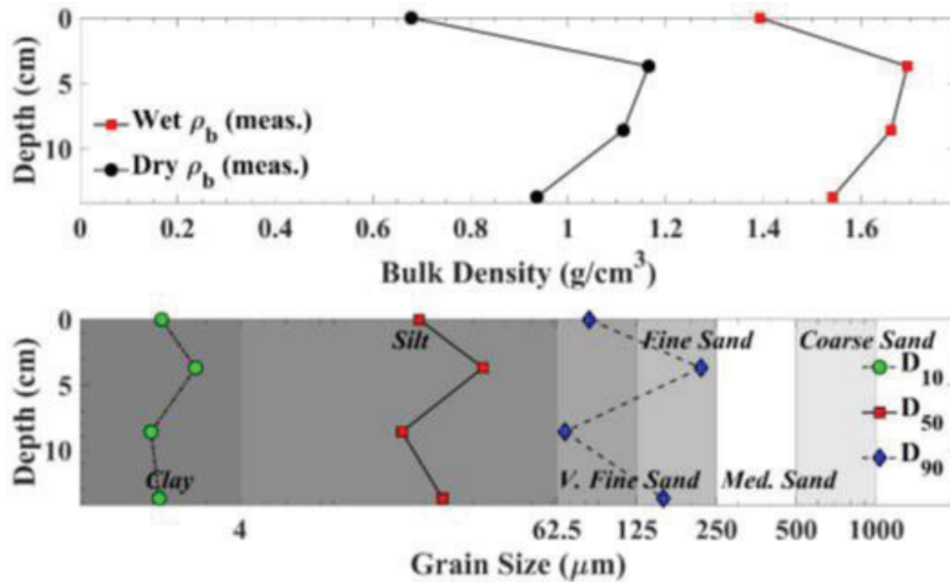


Table 15
Physical Properties of SEDflume Sample ER-680 (Elk River)

Sample Depth (cm)	Median Grain Size (µm)	Wet Bulk Density (g/cm^3)	Dry Bulk Density (g/cm^3)	Loss on Ignition (%)
0.0	18.95	1.39	0.68	3.4
3.7	32.96	1.70	1.16	2.9
8.6	16.32	1.66	1.11	3.0
13.7	23.18	1.54	0.94	4.2
Mean	22.85	1.57	0.97	3.4

Figure 30
Physical Properties of SEDflume Sample ER-680 (Elk River) with Depth



3.1.3.4 Sediment Transport Measurements

Sediment transport samples were collected during several site visits and delivered to appropriate laboratories for analysis.

3.1.3.4.1 Suspended Transport Results

SSC samples were processed by the WSLH. Sample analysis evaluated both total sediment concentration as well as concentration of sediment with grain sizes less than 63 micrometer (µm; upper limit of silt-sized particles) to assess the percentage of cohesive sediments moving through the system in suspension.

Several samples produced erroneous results due to laboratory processing errors, with cohesive sediment concentrations higher than total sediment concentrations. These results were discarded. Across all samples, particles smaller than 63 µm accounted for 82% of all suspended sediment.

Full reports of SSC sample analysis can be found in Appendix D.

3.1.3.4.2 Bedload Transport Results

During each SSC sampling trip, Anchor QEA collected bedload transportation measurements as well. At no point did the Helley-Smith sampler bag collect any sediment particles. Flow rates during sampling efforts are shown in Table 5. Data collected to date indicate that for the vast majority of flow conditions experienced on these rivers, very little bedload transport occurs. Bed material particle size distributions, coupled with shear stress calculations over a wider range of flows and standard STM parameters for non-cohesive sediment sizes will be used in the model to develop a more complete understanding of the relative contribution of bedload transport. Initial indications are that bedload transport does not represent a significant contribution to the overall sediment transport into Grand Lake.

3.1.4 Discussion

The field campaign provided valuable insights for the sediment study. Initial understanding of the reservoir indicated the system was dominated by sand and gravel sediments (Mussetter 1998; Tetra Tech 2018). While that appears to be the case in the riverine components of the overall system, field work results have found cohesive silts and clays play a far more important role than initially anticipated.

The relative dearth of bedload sediment transport and comparatively high concentrations of fines moving in suspension through the watershed have indicated a need to focus extra resources on silt- and clay-sized sediment modeling. Because silt and clay deposits typically exhibit cohesive characteristics along with several other complicating factors, increases the complexity of the overall sediment study and associated modeling tasks. *Modeling Sediment Movement in Reservoirs* prepared by the United States Society on Dams Committee on Hydraulics of Dams, Subcommittee on Reservoir Sedimentation (USSD 2015), presents a discussion of the issues associated with cohesive sediments. Some of the challenges are related to changing density over time through the process of consolidation; others are related to the fact that cohesive sediment particle motion is determined primarily by electrochemical surface forces rather than gravity forces which dominate sand and gravel motion. Further complicating the development of appropriate input data and parameters is the fact that the data show a wide degree of variability from sample to sample and location to location.

To develop the necessary information additional efforts for sediment core sampling were required beyond what was originally planned in the Sediment Study Plan. The study team selected locations for and performed sampling of the reservoir bed. The material was then subjected to erosion testing for model parameterization. SEDflume testing provided multiple valuable data points for sediment within the Grand Lake reservoir.

Critical shear stress is perhaps the most important of the SEDflume outputs. The gradual consolidation of fine, cohesive material and its effect on erosion resistance as a function of depth within the sediment column are crucial for accurately modeling sediment transport and deposition within the basin. Its use in developing the STM will allow HEC-RAS to determine whether sediment will erode from the bed or remain in place during a variety of flow conditions, and particle size and density parameters will allow the model to determine whether deposition will occur.

3.1.4.1 Sediment Transport

3.1.4.1.1 Suspended Sediment Transport

Sediment transport data, in the form of suspended sediment sampling, were collected at various USGS stations on the primary rivers of interest flowing into Grand Lake. In addition to the USGS data, additional suspended sediment samples were collected by Anchor QEA at these same stations. At each station, regression analyses were conducted to develop a numerical relationship between suspended sediment transport (in tons per day) and flow that forms a rating curve between sediment transport and flow. The data used for the development of the suspended sediment transport rating curves include all available data from the USGS through July 8, 2021, and the Anchor QEA data collected through July 1, 2021.

Preliminary assessment of the two sets of data reveal that they both lie within the bounds of variability typically seen in sets of suspended sediment data. The Anchor QEA data, however, generally lies in the mid- to lower end of the range of the available data. It is possible because these data were collected in recent years and the USGS data covers the entire period of record, which dates several decades back in time; there may be a trend towards lower sediment transport from these rivers over time.

Sediment transport data are only collected occasionally so no continuous, or even daily record of sediment transport exists. With a sediment transport rating curve, the regression equation can be applied to the daily flow data to develop an estimate of the long-term historic quantity of sediment flowing past given stations on these rivers and hence sediment transport into the reservoir. Figure 31 through Figure 34 present the available suspended sediment transport data along with the best fit regression curves.

Figure 31
Suspended Sediment Transport Rates and Fluvial Discharge Measured on the Neosho River near Commerce, Oklahoma

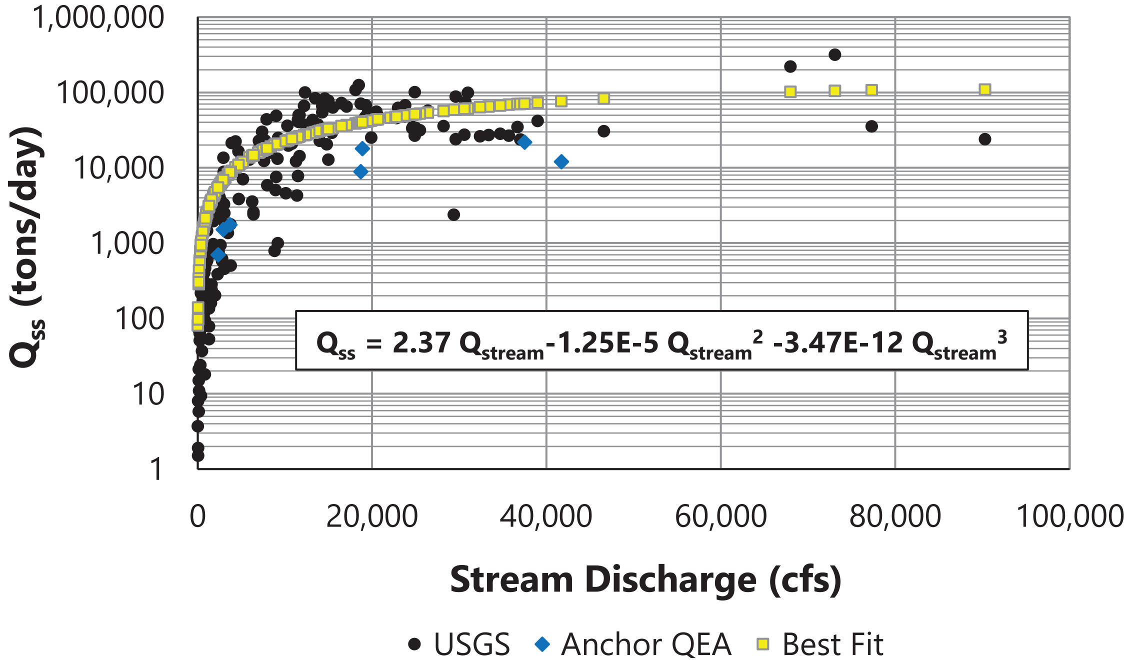


Figure 32
Suspended Sediment Transport Rates and Fluvial Discharge Measured on Tar Creek near Commerce, Oklahoma

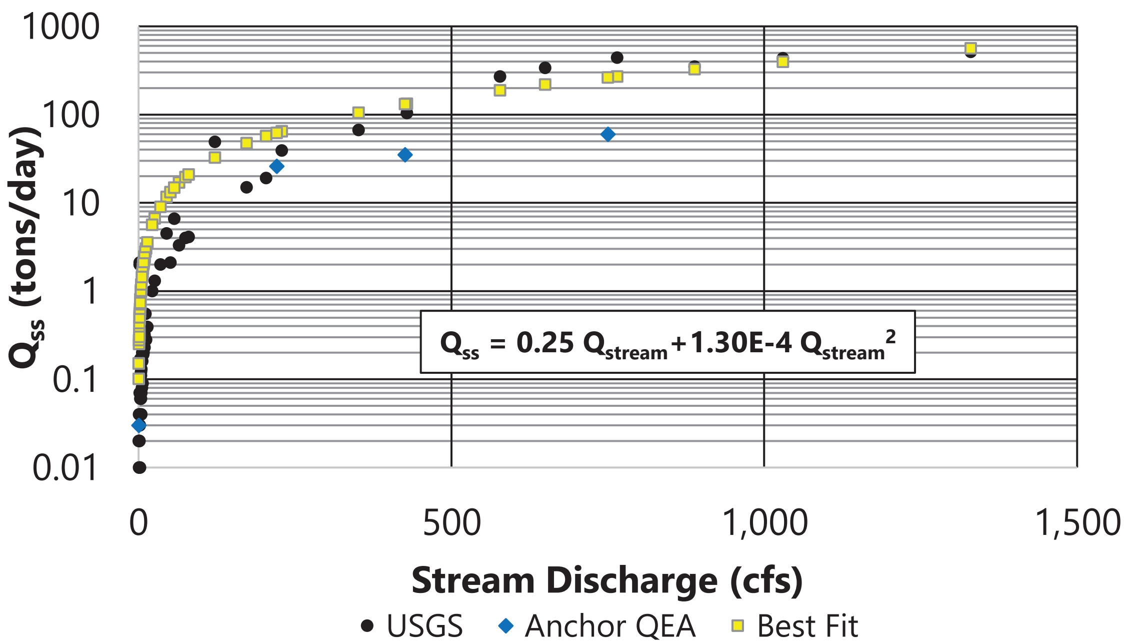


Figure 33
Suspended Sediment Transport Rates and Fluvial Discharge Measured on the Spring River near Quapaw, Oklahoma

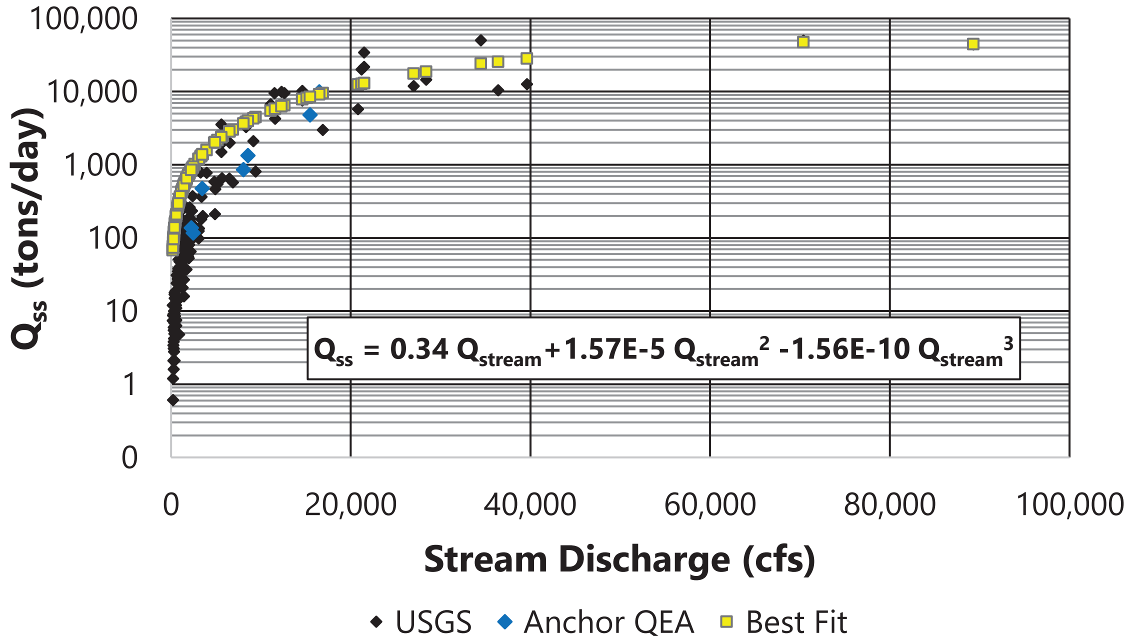


Figure 34
Suspended Sediment Transport Rates and Fluvial Discharge Measured on the Elk River near Tiff City, Missouri

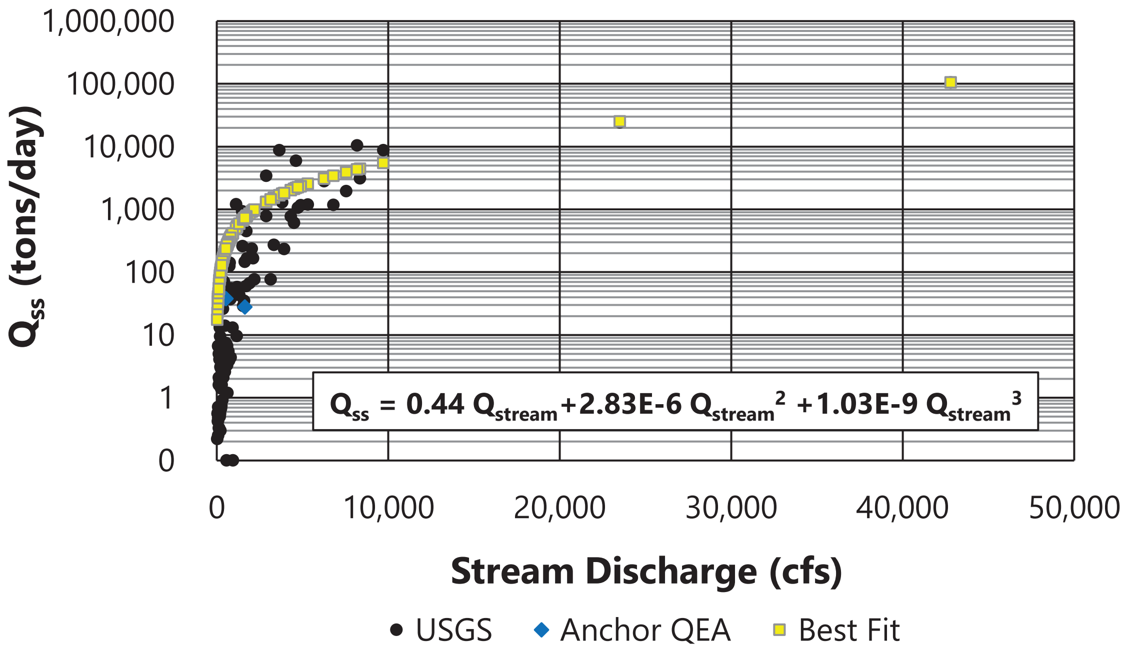


Table 16 presents the coefficients in the regression equations along with the correlation coefficient r for the polynomial equations used to develop the suspended sediment transport rating curves where:

Equation 2

$$\mathrm{Q_{ss}} = a + b\, Q_{stream} + c\, Q_{stream}^2 + d\, Q_{stream}^3$$

where:

$\mathrm{Q_{ss}}$	=	suspended sediment discharge in tons per day
a, b, c, d	=	coefficients
Q_{stream}	=	stream discharge in cubic feet per second (cfs)

Table 16
Regression Coefficients for the Suspended Sediment Transport Rating Curves

Location	a	b	c	d	Correlation Coefficient r
Neosho River near Commerce, Oklahoma	0.00	2.37	-1.25E-05	-3.47E-12	0.654
Tar Creek near Commerce, Oklahoma	0.00	0.25	1.30E-04	0.00	0.932
Spring River near Quapaw, Oklahoma	0.00	0.34	1.57E-05	-1.56E-10	0.884
Elk River near Tiff City, Missouri	0.00	0.44	2.83E-06	1.03E-09	0.993

Analysis of the particle size distribution of the suspended sediment samples collected by Anchor QEA are shown in Figure 35 through Figure 38. These data show that suspended sediment is predominantly finer than 0.0625 millimeters (mm), which is the break point between sand and silt. Consistent with the bed material in the reservoir, most of the suspended sediment consists of silt and clay-sized sediment, which is being transported into the reservoir.

Figure 35
Fine Sediment as Fraction of Total Suspended Sediment Sampled on the Neosho River near Commerce, Oklahoma

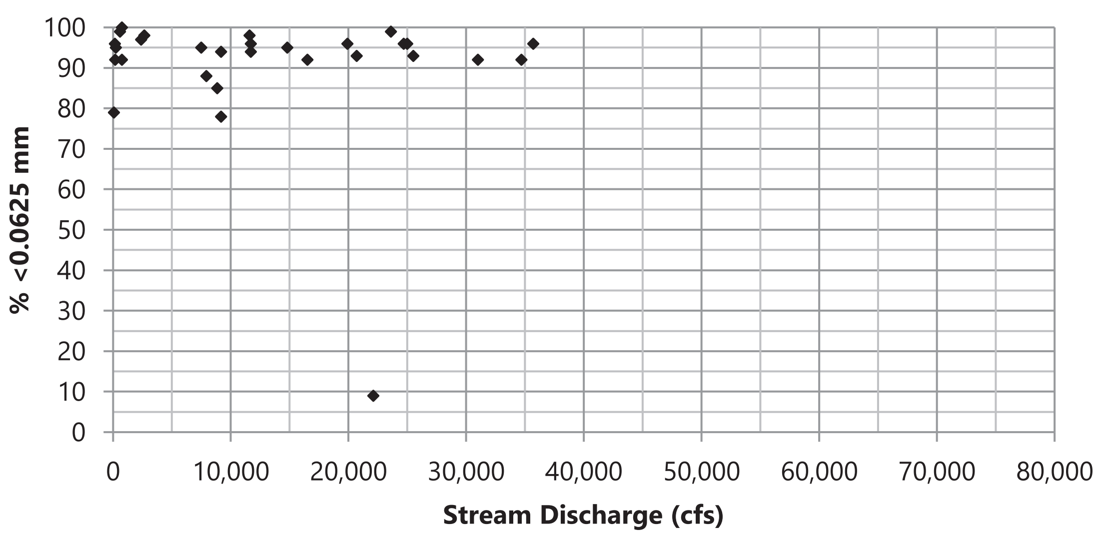


Figure 36
Fine Sediment as Fraction of Total Suspended Sediment Sampled on Tar Creek near Commerce, Oklahoma

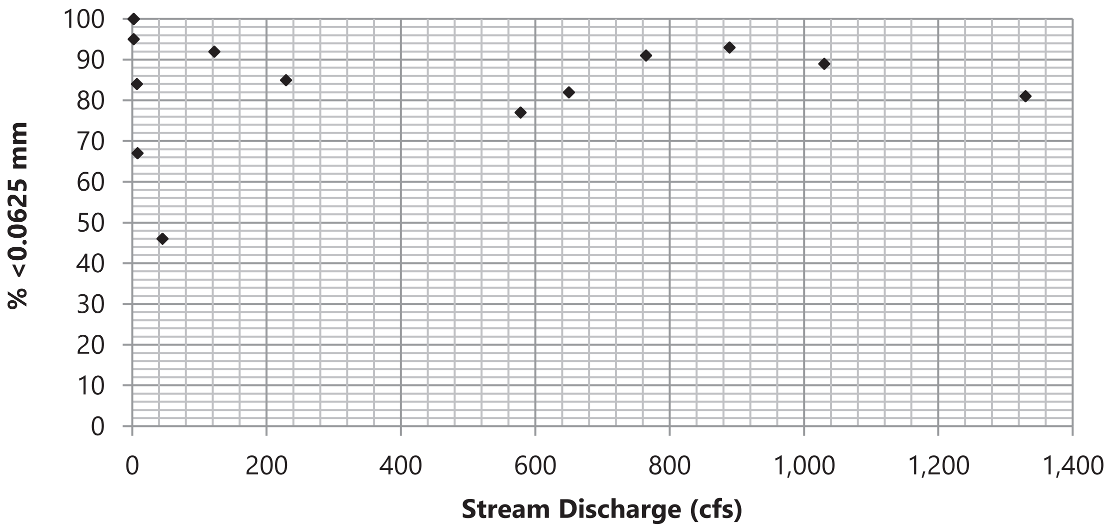


Figure 37
Fine Sediment as Fraction of Total Suspended Sediment Sampled on the Spring River near Quapaw, Oklahoma

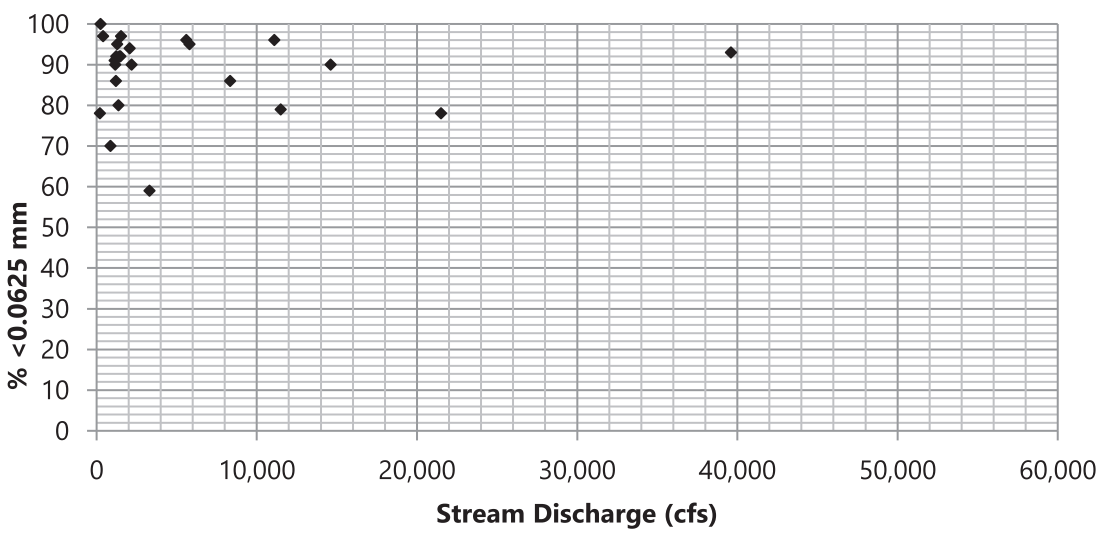
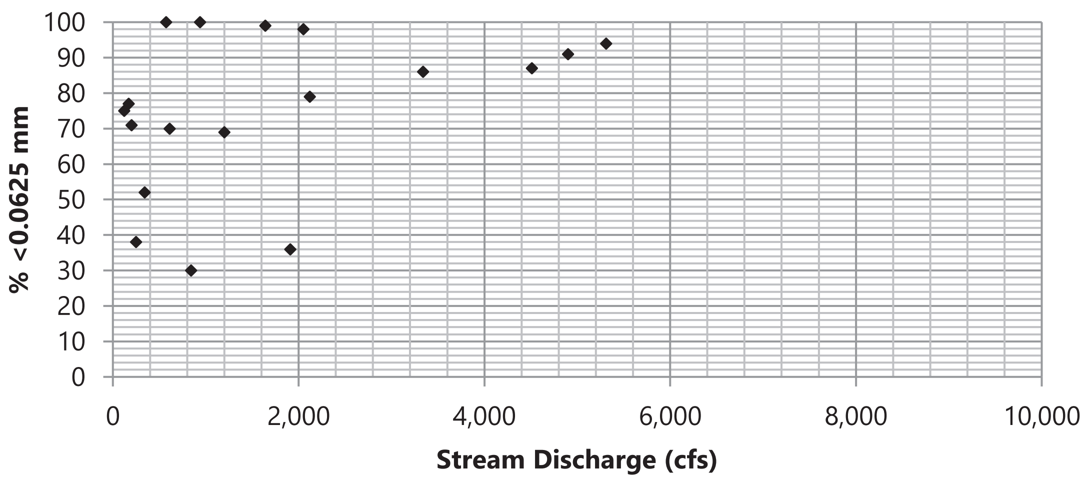


Figure 38
Fine Sediment as Fraction of Total Suspended Sediment Sampled on the Elk River near Tiff City, Missouri



3.1.4.1.2 Bedload Sediment Transport

While bedload sediment transport data have been sampled, these samples indicate virtually no bedload transport. This is likely because shear stresses induced by the velocity of the flowing water has not been sufficient to mobilize, erode, and transport the coarse sediment sizes (primarily gravel) in the upstream river reaches where bedload sampling was conducted. This will be further evaluated in the STM using critical shear criteria for non-cohesive sediments.

4. Sediment Transport Model Development

Following the data-gathering phase of the project, the team developed the STM. Terrain files, USGS gaging station records, sediment transport rates, and sediment sampling information were used as inputs for the model.

The STM was developed using *HEC-RAS v 5.0.7* as available from the USACE. The software is one of the leading fluvial system modeling packages and is frequently used for flood evaluations, hydrologic and hydraulic studies, and sediment transport estimates. It supports both one-dimensional (1D) and two-dimensional (2D) hydraulic evaluations with hydraulic routines to account for bridges along streams. Mead & Hunt developed the hybrid 1D/2D Upstream Hydraulic Model (UHM) using this version of HEC-RAS, taking advantage of these features.

Sediment transport models are more limited than their hydraulic-only counterparts with this version of HEC-RAS. Only 1D models are supported in sediment evaluations, and bridge routines are unavailable for modeling as well. Because it was based on the UHM, the STM required significant modifications to the terrain.

4.1 Terrain Information

Terrain files were developed by Mead & Hunt as part of the UHM. These files were compilations from a range of surveys performed in support of the 1998 REAS, 2009 OWRB survey, and various USGS efforts as discussed in Section 3.1.1.1. All elevations are reported in reference to the Pensacola Datum (PD) unless otherwise noted.

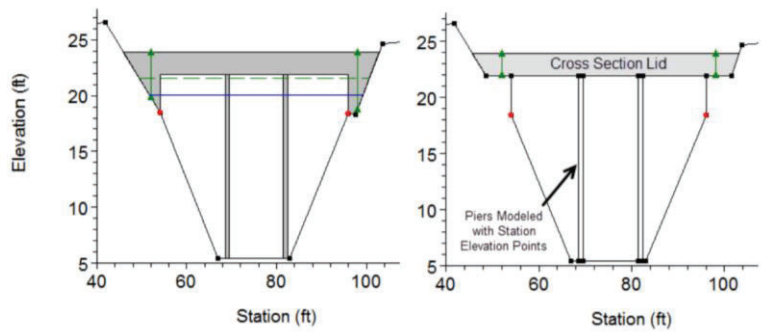
The UHM's 2D flow areas were converted to 1D cross sections. These were cut from the relevant model terrain using built-in features of the HEC-RAS geometry editor. Cross-section stations were then filtered to limit station-elevation points at each cross section to a maximum of 500 individual values in accordance with HEC-RAS modeling requirements. Filtering was also performed using standard HEC-RAS features; data was filtered using the program's "Minimize Area Change" option.

Land-use patterns were used to determine the base Manning's *n* values for the model. Where cross sections were copied from the UHM to the STM, these were left unchanged. Where 2D flow areas had been converted to 1D cross sections, river stations were used to define the Manning's *n* values to match the UHM values at those locations.

Bridge geometry information was gathered from the Oklahoma Department of Transportation, Missouri Department of Transportation, local and county road commissions, and from measurements provided by GRDA. Bridge geometries in HEC-RAS typically are input as separate structures, with bridge deck geometry, support piles, and abutments entered into the program along with widths and cross sections immediately upstream and downstream of the structure.

The bridges in the STM were modified from those present in UHM models following USACE guidelines (Brunner 2016). Recommendations included converting piles from bridge components to terrain data as station-elevation points. The bridge deck was then converted to a lid with the same geometry, and abutments were tied into the bank (Figure 39).

Figure 39
Example Bridge Replacement Using Modified Station-Elevation Terrain Data and a Cross Section Lid



Source: Brunner 2016, Figure 17-24

4.2 Streams

The STM consisted of four streams: the Neosho, Spring, and Elk rivers, as well as Tar Creek.

4.2.1 Neosho River

The Neosho River was modeled from RM 152.25 to RM 77.12 at Pensacola Dam (USGS gage 07190000). It was divided into three reaches with junctions at the confluence with the Spring and Elk rivers (upstream of RM 122.25 and 105.35, respectively). The confluence with Tar Creek was modeled as a lateral structure emptying from Tar Creek into the Neosho at approximately Neosho RM 134.

4.2.2 Spring River

The Spring River was modeled from RM 21 to its confluence with the Neosho River at RM 0.

4.2.3 Elk River

The Elk River was modeled from RM 19.59 to the confluence with the Neosho River and Grand Lake at RM 0.

4.2.4 Tar Creek

Tar Creek was modeled from RM 7.6 to the confluence with the Neosho River. The confluence was modeled as a lateral structure at the downstream extent of the creek rather than a traditional junction to improve WSE accuracy. Geometry of the lateral structure was cut from the terrain and filtered to 500 data points to comply with model requirements. The STM therefore does not contain cross sections below Tar Creek RM 1.6; the rest of the creek was included in the lateral extent of Neosho River cross sections.

4.3 Boundary Conditions

Boundary conditions (BCs) define parameters at the model limits. HEC-RAS offers several options for BC types, including WSE, discharge, and normal depths. WSE and discharge can be set as a specified time series, and normal depths can be calculated based on the friction slope. For the STM, upstream BCs (at the upstream extents of the Neosho, Spring, and Elk rivers, as well as Tar Creek) were defined by USGS discharge measurements stepped at intervals ranging from 15 to 60 minutes. The downstream BC was set as normal depth with a friction slope of 0.0033 vertical feet per horizontal feet [ft/ft] (for Tar Creek) and recorded WSE at Pensacola Dam (Neosho River). WSE measurements taken at Pensacola Dam were used to set the downstream water levels in the model. These data points are provided at one-hour intervals.

4.4 Quasi-Unsteady Modeling

HEC-RAS offers three modes of hydraulic modeling: *Steady*, *Unsteady*, and *Quasi-Unsteady*. In *Steady* mode, static BCs are defined, and constant discharges, WSE, and other outputs are reported. Short-term simulations of specific events are often modeled using *Unsteady* models, which allow engineers to evaluate changing BCs over a known flood event lasting several days or weeks. When evaluating long-term events over the course of years—such as evaluations of sediment transport, deposition, and erosion—*Quasi-Unsteady* models are more commonly used.

The STM is built using *Quasi-Unsteady* model routines. BCs are therefore assumed static between time steps, with no ramping of discharge or WSE over time as one would see in *Unsteady* models. In the STM, upstream BCs are set as discharges; under *Quasi-Unsteady* mode, those discharges are simulated throughout the entire reach of the relevant tributary simultaneously. In typical flow events, a peak flow rate moves downstream over time, with hydrographs peaking later the closer one gets to the reservoir. With *Quasi-Unsteady* model routines, that pulse occurs simultaneously at all points along the stream.

4.5 Sediment Data

Input data for the STM includes the sediment supply for the upstream boundary for each stream, the sediment characterizing the bed of each stream through the various reaches, and the erosion parameters defining the cohesive sediment where it is found in the river or lake beds. Data from field work was adapted to create the inputs. Specific parameters are described in the following sections.

4.5.1 Upstream Sediment Supply

The upstream sediment supply applies the suspended sediment regression curves to develop a sediment rating curve (table of suspended sediment transport rate in tons per day with flow). This table is input into the HEC-RAS model for each stream: Neosho River, Tar Creek, Spring River and Elk River. These tables can be seen as input files for the STM. The model then computes suspended sediment inflow at the upstream boundary of each stream for each time step of the model using the flow data for the calibration time period (2009 through 2019). The upstream sediment supply for these rivers and creek are tabulated versions of the regression equations developed in Section 3.1.4.1.1.

4.5.2 Bed Material

For each cross-section and for each stream, a bed material size distribution is developed as input into the STM. These data are based on the particle size distributions for the bed material and core sampling analysis and can be seen as input tables of the particle size distribution for each cross-section.

As previously shown (see Section 3.1.3.2), the bed of these streams and the reservoir consists of a wide range of sediment sizes resulting in a bi-modal distribution of sediment, one of which is fine, cohesive material (primarily silt and clay), and the other distribution being non-cohesive material (primarily gravel with some sand and finer material as well as cobble sized material). Further complicating the bi-modal distributions, samples of primarily non-cohesive gravel exist near samples of predominantly cohesive silt and clay. In addition, samples do not show any clear longitudinal trend of sediment characteristics where an upstream sample may be fine, cohesive sediment and the next sample farther downstream may be coarse, non-cohesive sediment. This range of longitudinal distributions of sediment in close proximity complicate development of input data that describe the characteristics of the bed of these streams. The following examples demonstrate this complexity.

A profile of the Neosho River showing the bed (2009) and water surface (at 743.07 feet NGVD29), Figure 40; along with Figure 41 and Figure 42 show the wide range of bed material sizes along the Neosho River.

Figure 40
Water Surface and Thalweg Profile of the Neosho River above Tar Creek

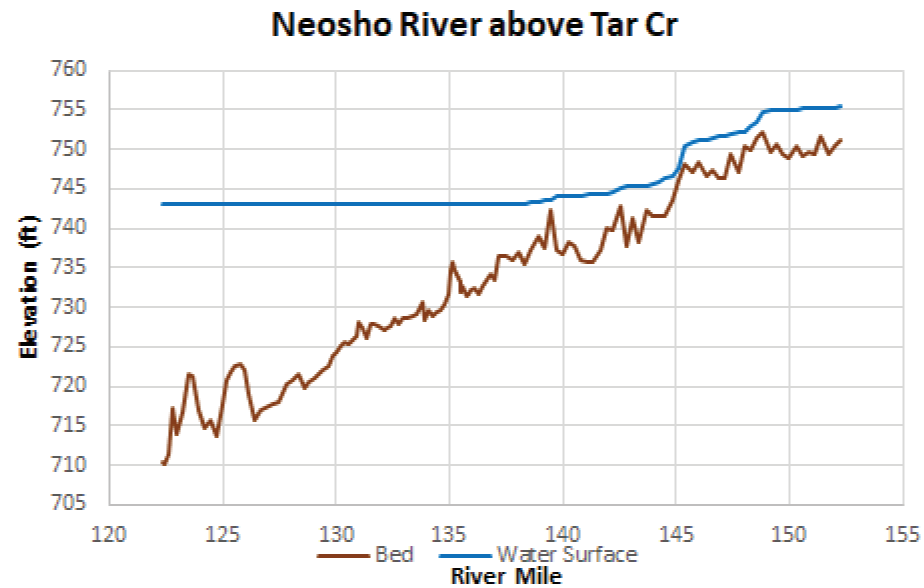


Figure 41
Neosho River Sediment Size Gradation Results Comparison

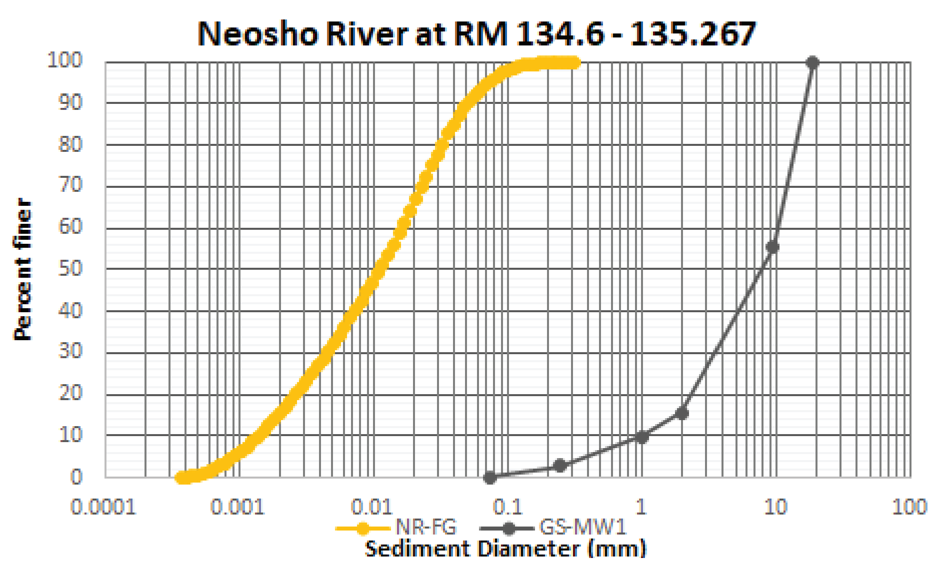
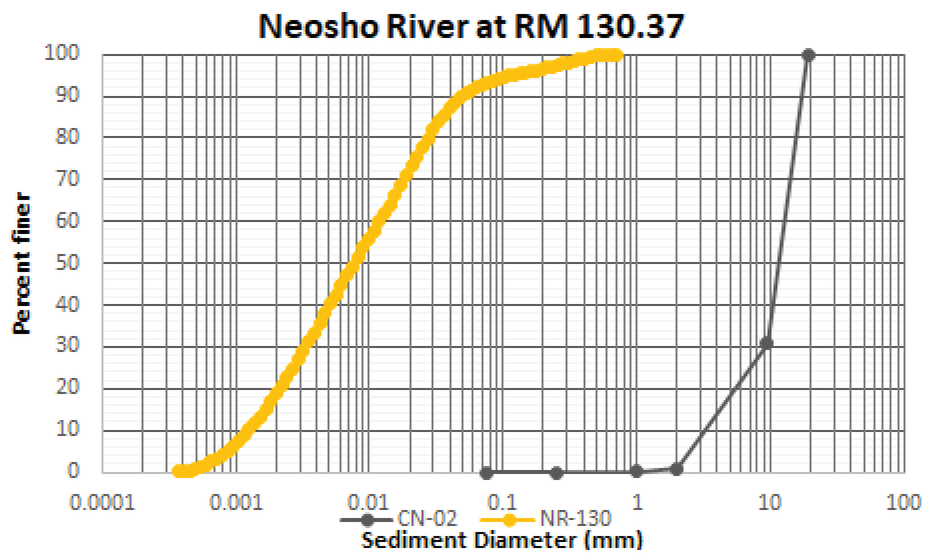


Figure 42
Neosho River Sediment Size Gradation Results Comparison



Farther downstream in the upper reservoir, this same wide range in bed material size distributions continue in close proximity to these separate samples (Figure 43 through Figure 45).

Figure 43
Water Surface and Thalweg Profile of Upper Grand Lake between Twin Bridges and the Elk River Confluence

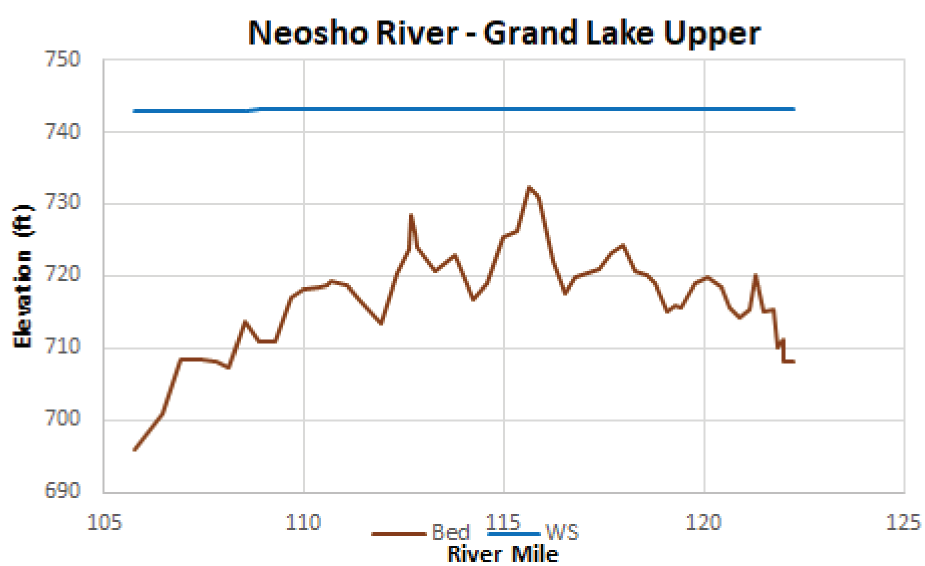


Figure 44
Upper Grand Lake Sediment Size Gradation Results Comparison

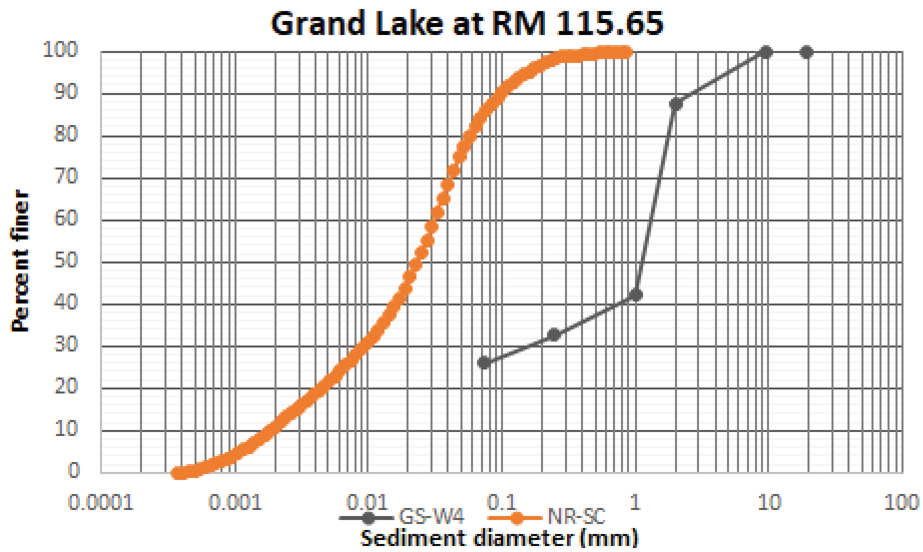
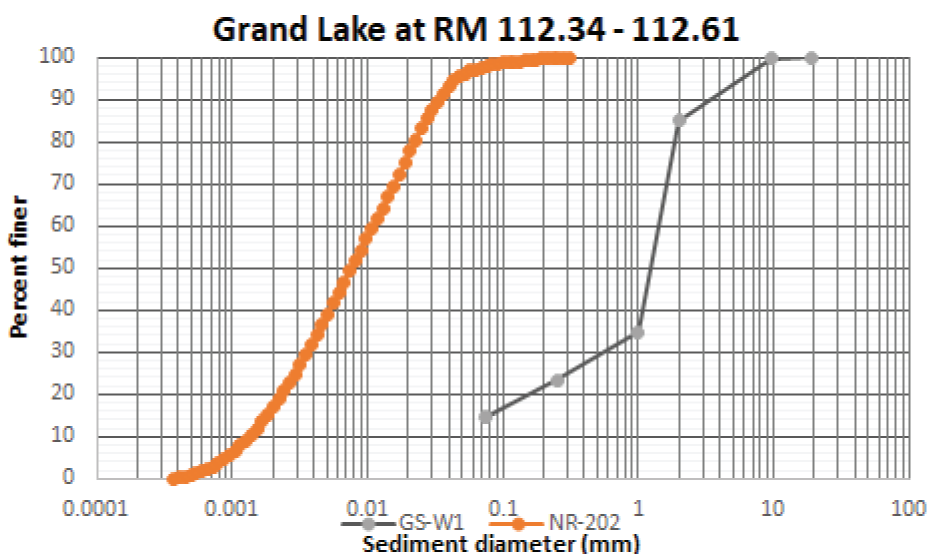


Figure 45
Upper Grand Lake Sediment Size Gradation Results Comparison



This same disparity in adjacent samples continues on the tributaries as well (Figure 46 through Figure 54).

Figure 46
Water Surface and Thalweg Profile of Tar Creek

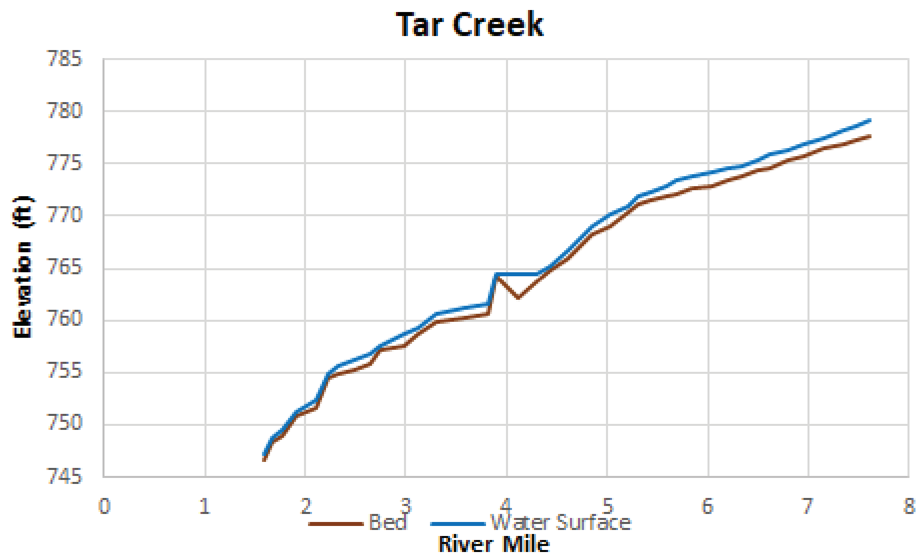


Figure 47
Tar Creek Sediment Size Gradation Results Comparison

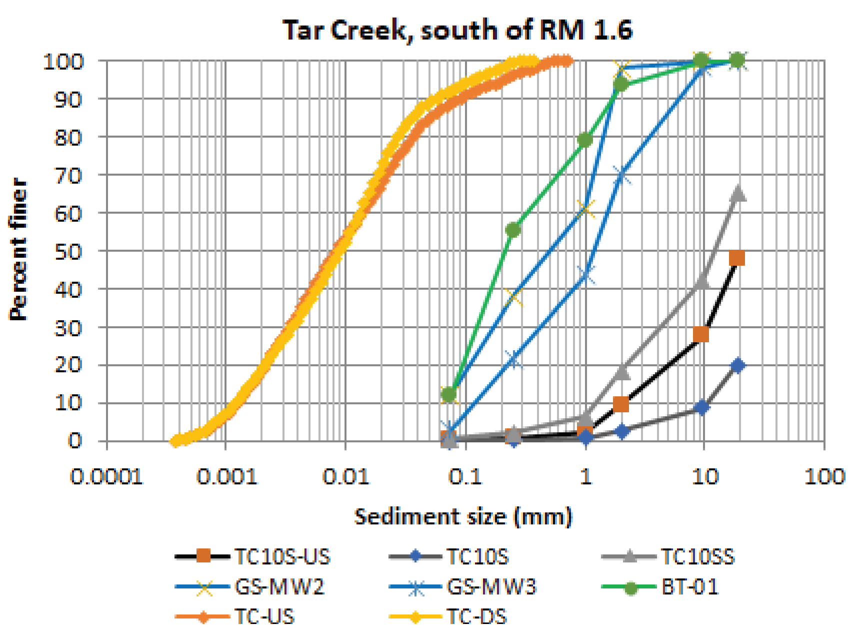


Figure 48
Water Surface and Thalweg Profile of the Spring River

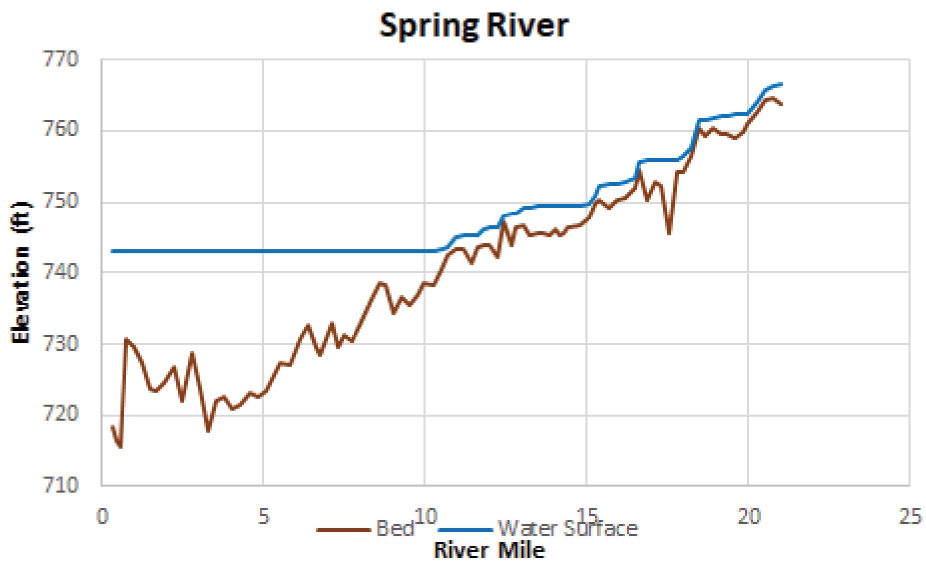


Figure 49
Spring River Sediment Size Gradation Results Comparison

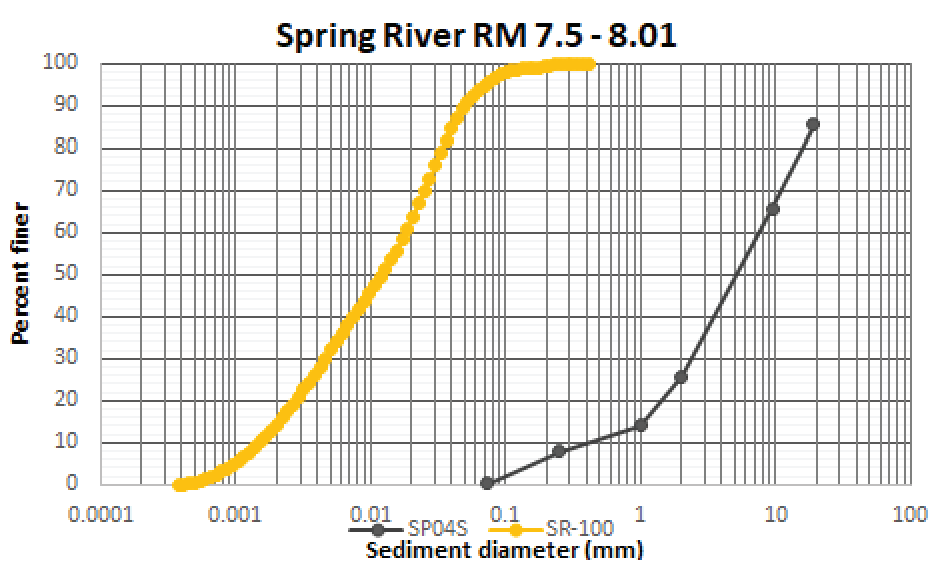


Figure 50
Spring River Sediment Size Gradation Results Comparison

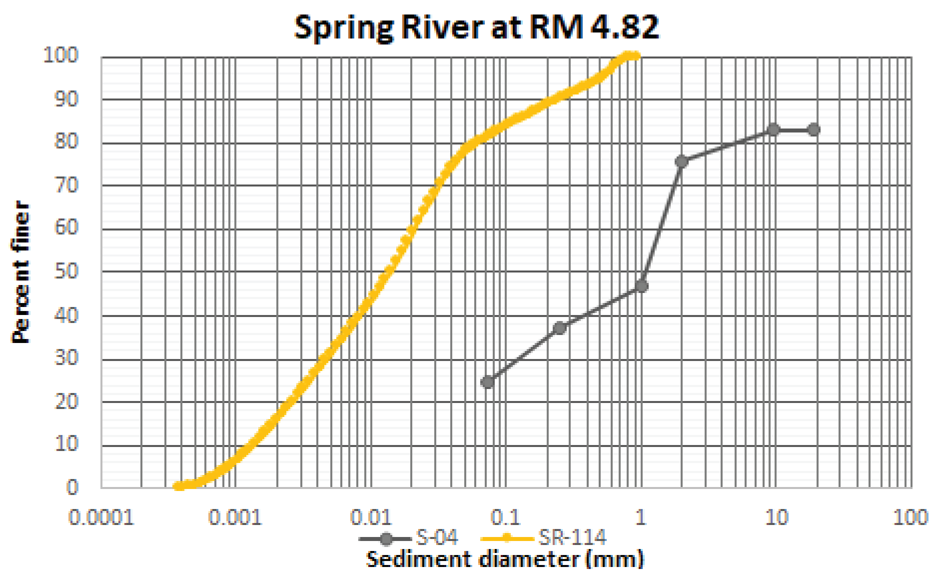


Figure 51
Spring River Sediment Size Gradation Results Comparison

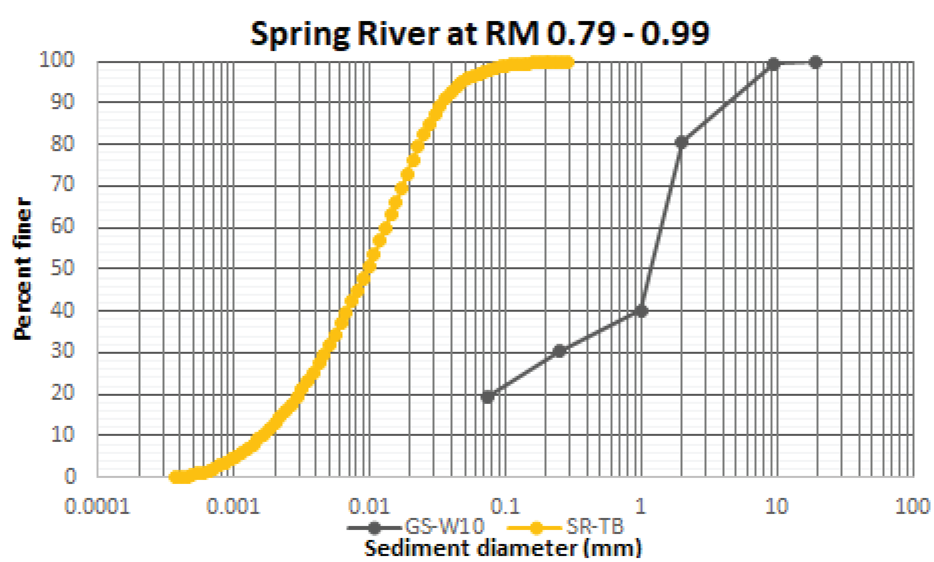


Figure 52
Water Surface and Thalweg Profile of the Elk River

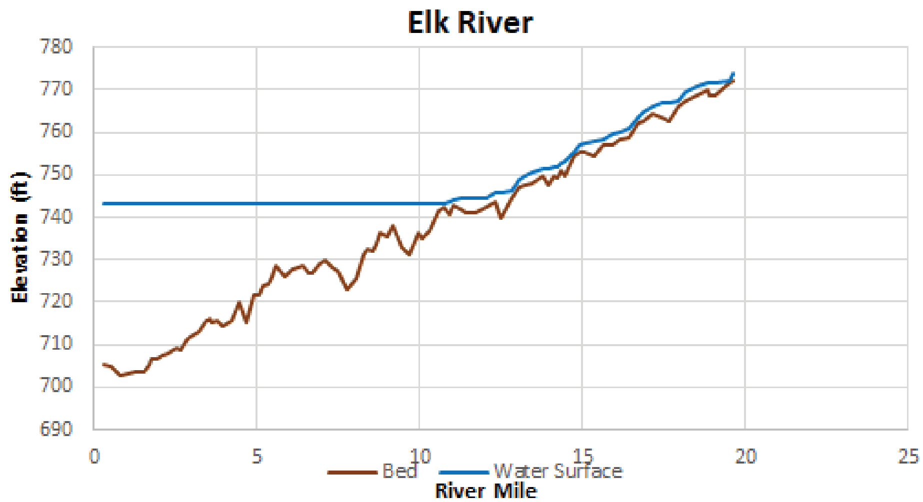


Figure 53
Elk River Sediment Size Gradation Results Comparison

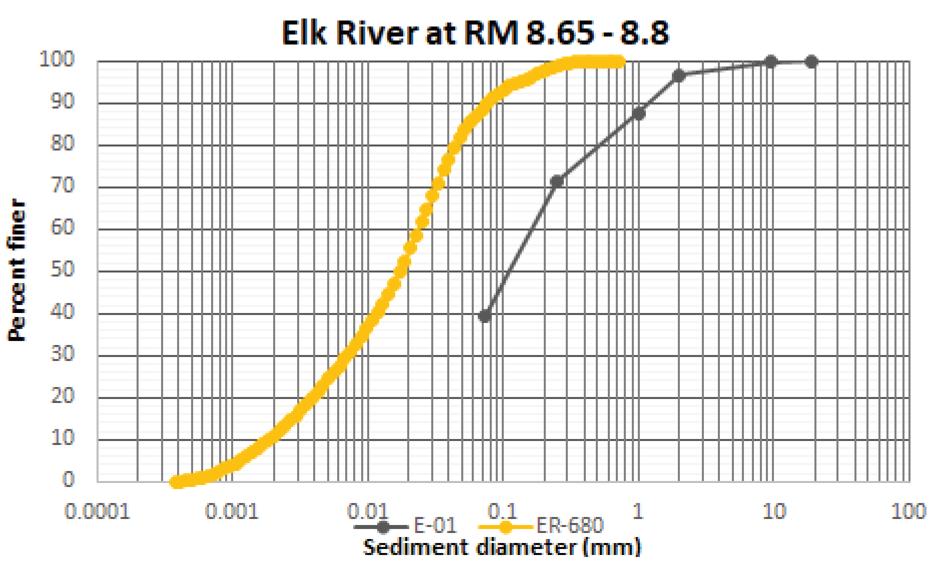
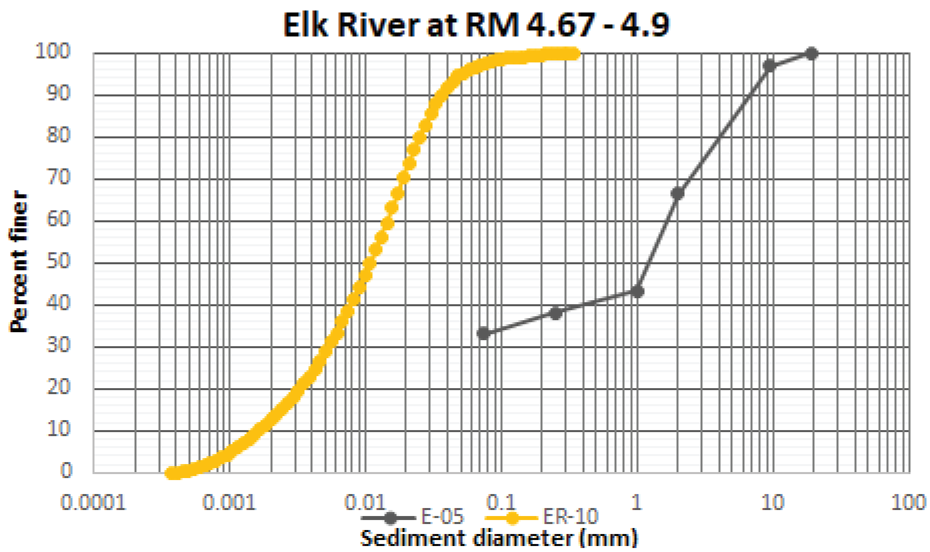


Figure 54
Elk River Sediment Size Gradation Results Comparison



The above plots show that samples taken along the Neosho, Spring, and Elk rivers, as well as Tar Creek include both fine cohesive sediment (primarily silt and clay) near non-cohesive sediment (primarily gravel along with some finer sediment and coarser sediment). These bi-modal distributions cover six log cycles of sediment size in samples collected in relatively close proximity (but different times: December 2019 and March 2020). This wide range of sediment types and sizes may be due to fine sediment being transported down river and deposited in the reservoir during certain events or seasons and then may be flushed farther downstream under other flow and reservoir conditions.

Mussetter, in *Evaluation of the Roughness Characteristics of the Neosho River in the Vicinity of Miami, Oklahoma* (Mussetter 1998), made observations regarding the bed of the river.

> Based on field observations and sediment samples taken from bank-attached bars and from the bed of the river, the bed material in the reach upstream from approximately the I-44 bridge (RM 142) is composed primarily of gravel and sand (Plate 4). Downstream from I-44, the surface bed material at the time of sampling in late 1996, which was performed when the discharge in the river was relatively low, was primarily silt and clay (Mussetter 1997).
>
> In reaches that are affected by backwater, the bed is composed of smaller material because the river does not have sufficient energy to transport the gravel into the reach and at least a portion of the smaller sand- and silt-sized material deposits on the bed.

> At higher discharge, the flow velocities in this reach are probably sufficient to transport the silt farther downstream into the reservoir. The velocities are not, however sufficiently high to transport upstream gravels beyond the upstream end of the backwater effect.

Mussetter suggests that as the finer sediments are transported farther downstream into the reservoir, the bed reverts to something closer to its coarser, non-cohesive nature:

> Prior to construction of the dam, the bed of the river downstream of Miami was most likely gravel and sand, similar to that found upstream. (Mussetter 1998)

These observations and suggestions are consistent with the bed samples collected in 2019 and 2020. Under some conditions, the bed consists of fine sized sediment (silt and clay) and under other conditions, in close proximity to the fine samples, the bed consists primarily of coarser, non-cohesive sediment (gravel and sand). The data and observations indicate that the fine sediment transported down river into the upstream reaches of the reservoir as suspended load tends to deposit temporarily under some hydrologic and hydraulic conditions and then is flushed farther downstream under other hydrologic and hydraulic conditions as suggested previously by Mussetter.

Tetra Tech's discussion from both the 2015 and 2016 reports, *Hydraulic Analysis to Evaluate the Impacts of the Rule Curve Change at Pensacola Dam on Neosho River Flooding in the Vicinity of Miami, Oklahoma* (Tetra Tech 2015, 2016), make comparisons between 1940, 1995/1998, and 2015 survey data and basic hydraulic and sediment transport concepts to conclude that:

> Because the amount of sediment that can be carried by the river is controlled by the local hydraulic energy, and the required amount of energy increases with increasing particle size, the coarser-grained portion of the sediment load (i.e., sands and gravels) will typically deposit on the river bed near the head of the reservoir and the finer grained sediment will be carried progressively farther downstream into the reservoir. (Tetra Tech 2016)

And regarding the quantities of deposition:

> Based on the bank elevations, there has been approximately 15 feet of overbank deposition in the vicinity of Twin Bridges between 1940 and 2015.
>
> Comparison of the thalweg (i.e., minimum bed elevation) profiles from the 2015 bathymetry with thalweg elevations measured in 1940 indicates that the bed has aggraded by an average of about 5 feet, with over 10 feet of

> aggradation in some locations in the 6- to 7-mile reach upstream from Twin Bridges/U.S. Highway 60. (Tetra Tech 2016)

Based on our review of the earlier data sets, such as the 1995/1998 data (discussed in more detail in Section 5.1.3.1), which proved to be unreliable, and about which Tetra Tech states that data at some locations "appears to be anomalously high compared to the adjacent river profile," there is no reasonable accuracy test of the 1940 data that would verify the validity of conclusions based on these comparisons.

While Tetra Tech presents a logical position that the coarser-grained portion of the sediment load (sands and gravels) would tend to deposit in the upper reach of the reservoir, recent collection of bedload transport data showed virtually no transport of those grain sizes in the rivers. The sediment team used equipment specifically designed to capture sands and gravels and found no evidence of coarse material transport even at the highest flows sampled in 2019 and 2020, which represents. It is difficult to conclude significant deposition of these sizes of sediment is occurring on the bed when no movement of such materials has been measured.

Sediment transport sampling shows that virtually all sediment transport consists of fine silts and clays, and that bed samples at a given location alternate between stationary coarse materials and fines. It is therefore likely that the earlier observation of Mussetter and current observations of the transitory nature of fine sediment deposition are valid and that most of the fine sediment load is eventually moved farther down into the reservoir without permanent or ongoing deposition in the more riverine sections of the river. These are the complexities of the sediment transport analysis, which are being addressed through the data collection, analysis, and modeling process. Any previous quantification and conclusions regarding the sediment transport and deposition process must be evaluated considering these complexities, significantly increased data, and further analysis including the modeling process.

Several factors contribute to a complicated analysis and model development effort, as follows:

- Sediment sizes and types are quite different, even when collected near other samples representing entirely different sediments.
- There is a wide range in sediment density from sample to sample and depth below sediment surface.
- Non-cohesive sediments are expected to follow standard transport equations and parameters and are found in certain bed samples but not in the bulk of the incoming sediment load.
- Incoming sediment load consists primarily of fine sediment that may deposit under some conditions and exhibit a wide range of erosion and transport parameters that vary location to location and depth below sediment surface.

Further complicating the physical characteristics of the diversity of sediment types, sizes, and characteristics is the fact that the bulk of data collected to develop the sediment characteristics were collected in 2019 and 2020 whereas the model calibration period starts in 2009. If these types of data were collected in 2009, it was collected before this study began and the findings have not been available to the STM development team. As a result, while channel and reservoir geometry were surveyed in 2009, the river and lakebed sediment characteristics for 2009 are based on data collected a decade later, which may or may not represent conditions at the beginning of the calibration period. STM setup and calibration present a very complicated and challenging task.

4.5.3 Sediment Transport Model Parameters

For non-cohesive sediment transport, a standard equation from the HEC-RAS model will be used to compute critical shear and sediment transport rate. For the cohesive sediment component of sediment transport, critical shear and erosion rate parameters will be based on the laboratory analysis conducted to measure these parameters. Actual values for all parameters can be seen in the model itself. With these values as a starting point, parameters may be adjusted in the calibration process.

5. Sediment Transport Model Calibration

STM calibration was performed in two components. As with any model calibration procedure, it is easiest to start with the simplest format available, ensure accuracy, then increase complexity. For the STM, that meant beginning with hydraulic calibration and neglecting sediment movement, erosion, and deposition. Once the hydraulics were well-calibrated, sediment transport was added to the STM, and the sediment model parameters were finalized.

Initial plans for STM calibration started with the 1998 terrain data. Once hydraulics were calibrated against known WSE measurements, sediment transport calibration would begin. Sediment erosion and deposition from 1998 to 2009 would be used to calibrate the model and running the model from 2009 to 2019 would be used as validation. Due to geometry inconsistencies discussed in Section 5.1.3.1, the approach was modified: the 1998 geometry was not used, and validation was therefore not possible. Instead, the model used the 2009 terrain as a baseline and calibrated to the 2019 geometry.

The overall goal of this step was to create a baseline geometry using the 2009 terrain dataset that could be used to predict future sediment transport, erosion, and deposition patterns.

5.1 Hydraulic Calibration

Hydraulic calibration for this phase focused on matching peak WSE records. WSE information was provided by a collection of USGS gages, WSE monitoring stations placed by the project team, and high water mark information provided by Tetra Tech.

5.1.1 Model Inputs

Model input parameters were developed specifically for the hydraulic calibration components. Sediment modeling was not included in this part of the calibration procedure.

5.1.1.1 Sediment Information

The process started with hydraulic calibration. To remove any sediment influence, an empty sediment dataset was created for the entire model domain. This dataset included an arbitrary bed gradation and set maximum erodible depths to 0 feet throughout the model. The BCs were set to equilibrium load inflows as well.

5.1.1.2 Modeled Events

Hydraulic calibration involved using known parameters from USGS data. BCs were defined as described in Section 4.3 for several flow events. The modeling team selected six events for calibration; these were also used for UHM calibration procedures. The timing of specific events and peak stream discharges used for hydraulic calibration are listed in Table 17.

Table 17
Modeled Flow Events and Stream Discharges

Event Date	Peak Stream Discharge (cfs)			
	Elk River @ Hwy 43	Neosho River @ E 60 Rd	Tar Creek @ E 50 Rd	Spring River @ E 57 Rd
July 2007	4,830	141,000	2,490	105,000
October 2009	39,300	46,100	5,150	66,200
December 2015	107,000	45,400	3,320	151,000
January 2017	1,140	10,200	672	15,900
April 2017	107,000	58,200	2,980	114,000
May 2019	66,500	91,400	6,410	109,000

The downstream WSE at Pensacola Dam was defined by USGS gage records, and the downstream BC for Tar Creek at its confluence with the Neosho River was set at normal depth with a friction slope of 0.0033 ft/ft.

5.1.2 Roughness Parameters

Calibration of hydraulic models in HEC-RAS relies primarily on hydraulic roughness parameters. These are typically reported as Manning's *n* values and are usually defined within a set range by land cover type (Table 18). The STM values were based on UHM roughness parameters throughout the model domain. Generally, higher *n* values produce slower flows and raise WSE whereas lower *n* values decrease WSE.

Table 18
Typical Overland Manning's *n* Values by Land Cover

Land Cover	*n* Value
Field crops	0.040
Pasture	0.080
Urban	0.070
Urban, dense	0.090
Water	0.040
Woody vegetation	0.100
Woody vegetation, dense	0.150

In-channel Manning's *n* values were adjusted iteratively until simulated WSE results showed reasonable agreement with recorded measurements. Table 19 lists in-channel roughness values developed during the calibration process.

Table 19
Base Manning's *n* Roughness Parameters for Streams in the Sediment Transport Model

Reach	*n* Value
Grand Lake (reservoir, up to RM 121.29)	0.020
Neosho River (RM 121.51 up to 122.33)	0.025
Neosho River (RM 122.46 up to 130.87)	0.024
Neosho River (RM 131.01 up to 133.99)	0.035
Neosho River (RM 134.09 up to 135.37)	0.015
Neosho River (RM 135.46 up to RM 152.2)	0.030
Elk River	0.015–0.053
Spring River (full reach)	0.0332
Tar Creek	0.027–0.100

These base roughness values were then modified based on changes in stream discharge values. River bedforms have a significant influence on hydraulic roughness. As stated by Mussetter (1998), the bedforms are affected by flow volumes, generating different bed roughness values as a function of total discharge. In HEC-RAS, "Flow Roughness Factors" were used to tune the model to account for changes in bed roughness at higher or lower flow rates.

5.1.2.1 Changes Since October ISR Conference

Between the October conference and the issue date of this report, the model hydraulic calibration was updated to include the May 2019 flow event. This calibration did not require changes to any roughness parameters shown in Table 18 or Table 19. It did, however, require changes to Flow Roughness Parameters. Lines shown in ***bold italics*** have been updated in Table 20 and Table 21.

Table 20
Flow Roughness Parameters for Elk and Spring Rivers and Tar Creek in the Sediment Transport Model

Elk River		Spring River		Tar Creek	
Discharge (cfs)	Flow Roughness	Discharge (cfs)	Flow Roughness	Discharge (cfs)	Flow Roughness
0	1.30	0	0.90	0	0.80
40,000	1.25	50,000	1.00	4,600	0.95
66,500	***0.85***	110,000	1.00	***4,700***	***0.90***
75,000	0.80	120,000	1.20	4,800	1.00
105,000	0.80	151,000	1.20	***5,500***	***1.00***
110,000	1.00	152,000	1.00	***6,400***	***0.90***
				6,500	***1.00***

The Neosho River roughness parameters were adjusted in two sections of the stream to calibrate the model. Results of the calibration process are shown in Table 21.

Table 21
Flow Roughness Parameters for the Neosho River in the Sediment Transport Model

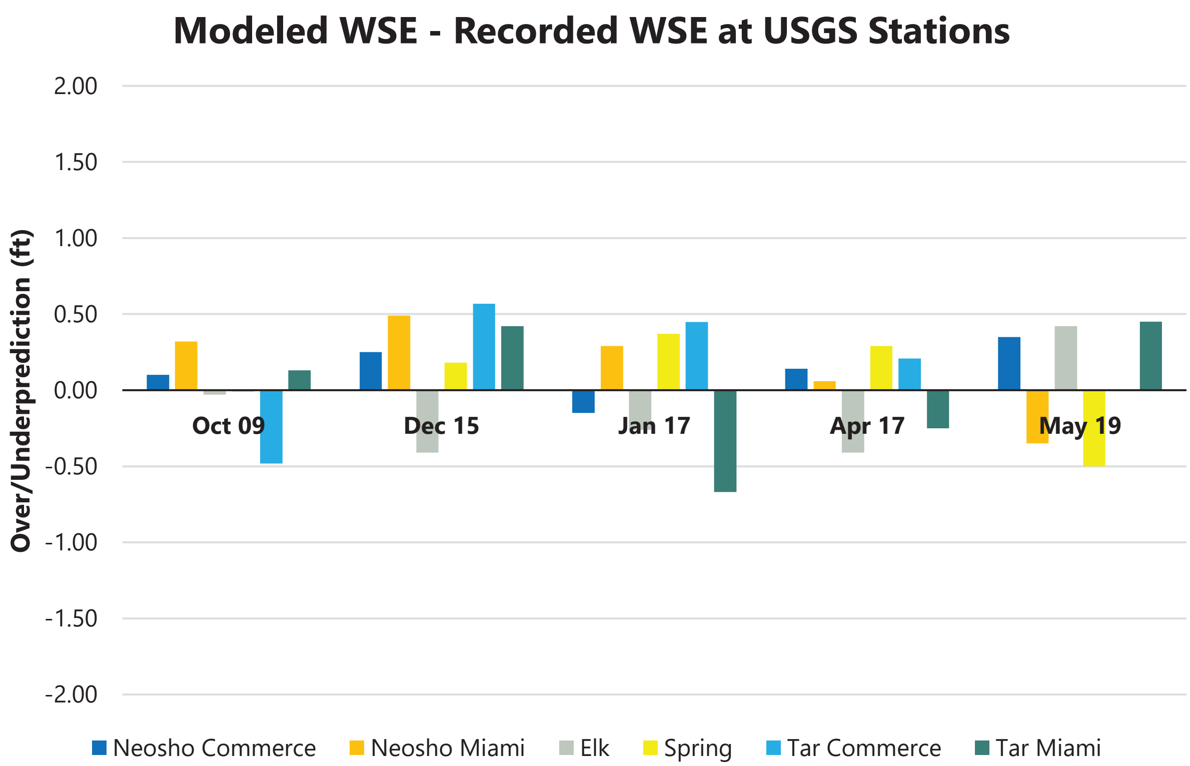
RM 130.54–135.267		RM 135.37–152.25	
Discharge (cfs)	**Flow Roughness**	**Discharge (cfs)**	**Flow Roughness**
0	0.80	0	0.80
45,000	0.80	45,000	1.10
60,000	1.30	60,000	1.20
65,000	1.30	***91,000***	***1.10***
91,000	***1.30***	***92,000***	***1.00***
92,000	***1.00***		

5.1.3 Results

Model calibration results showed good agreement with measured WSEs, as discussed herein.

Model calibration results as compared to USGS gages are shown in Figure 55. The average difference between simulated WSE and measured USGS gage WSEs is 0.07 feet; the model slightly overpredicts WSE at the USGS gages for the calibration events.

Figure 55
Overprediction and Underprediction of Simulated WSE at USGS Gages



STM calibration results were also compared to high water marks as compiled by Tetra Tech (2016). Model results from the July 2007, October 2009, and December 2015 calibration run are shown in Figure 56 through Figure 58. Average model difference is 0.6 feet for July 2007, 0.2 feet for October 2009, and -0.01 feet for December 2015; the model overpredicted WSE during the July 2007 and October 2009 events and underpredicted WSE for the December 2015 event.

Quasi-unsteady modeling presents difficulties when evaluating WSE measurements downstream of tributaries. WSE is heavily influenced by the arrival times of peak flow pulses from contributing streams. Because quasi-unsteady models change the relative arrival times downstream of confluences, it is difficult to accurately model maximum WSE at those locations. For sediment transport modeling, it is impractical to model with fully unsteady flows; for WSE evaluations, the UHM is a more fitting tool.

Figure 56
Comparison of STM WSE Results and Measured High Water Marks during the July 2007 Event

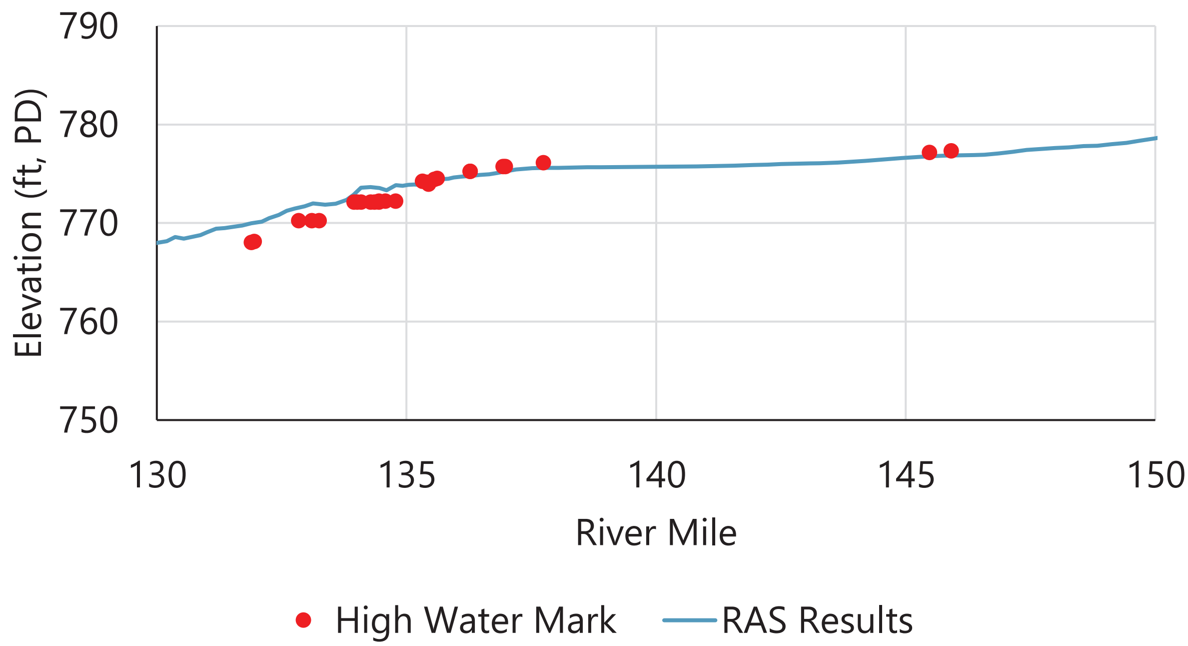


Figure 57
Comparison of STM WSE Results and Measured High Water Marks during the October 2009 Event

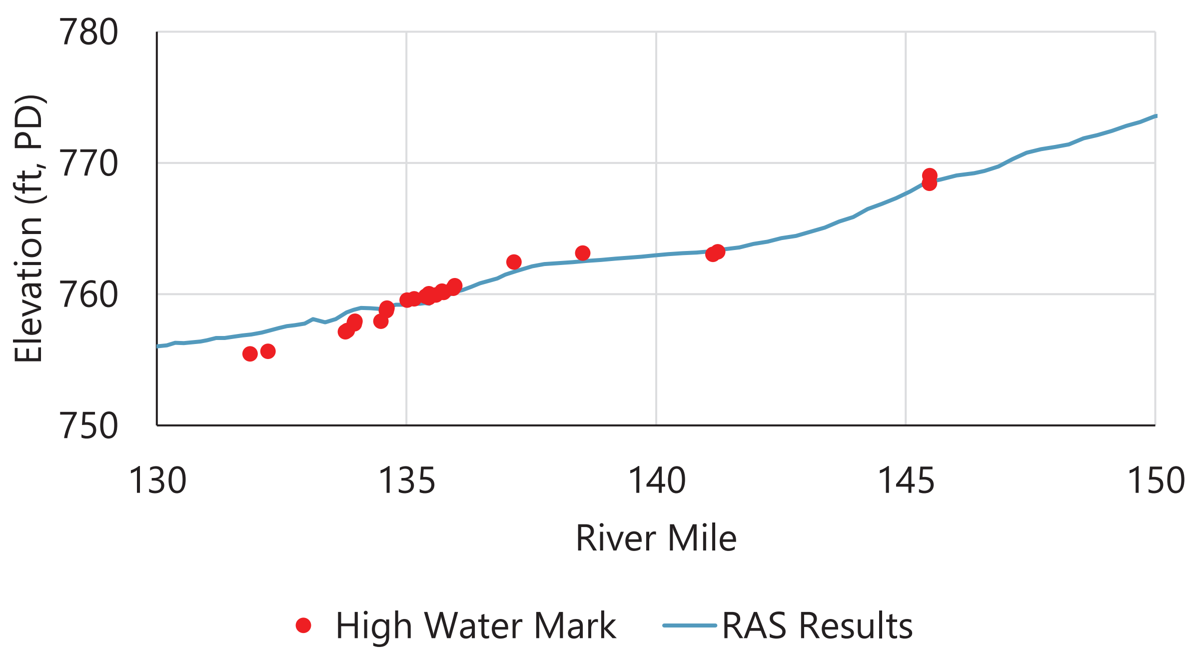
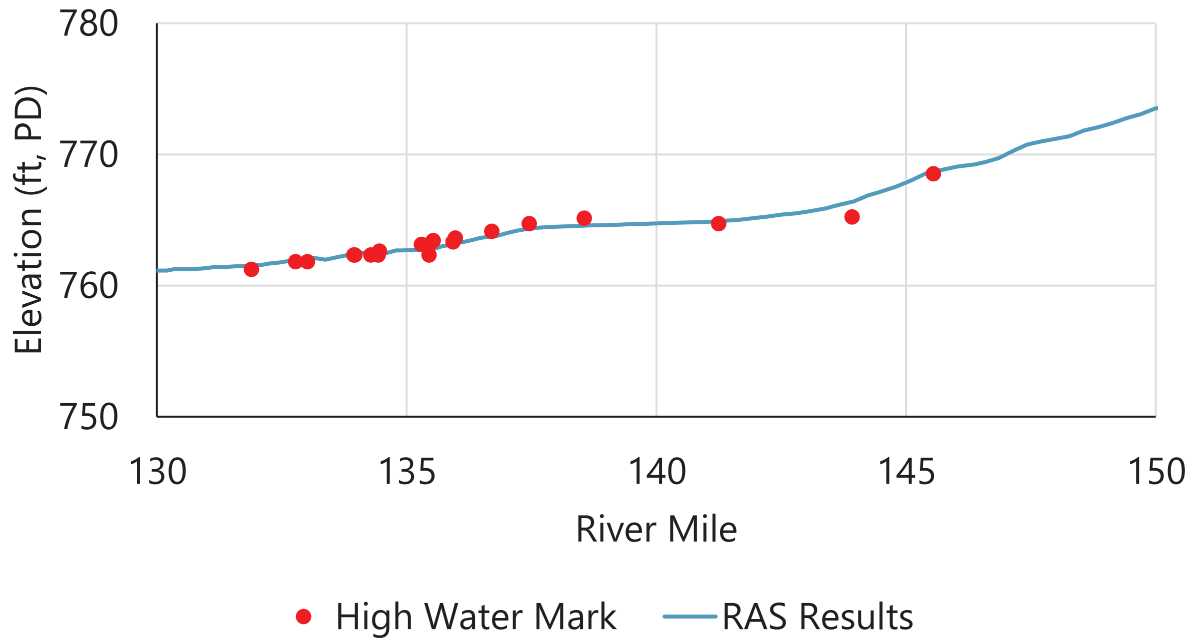
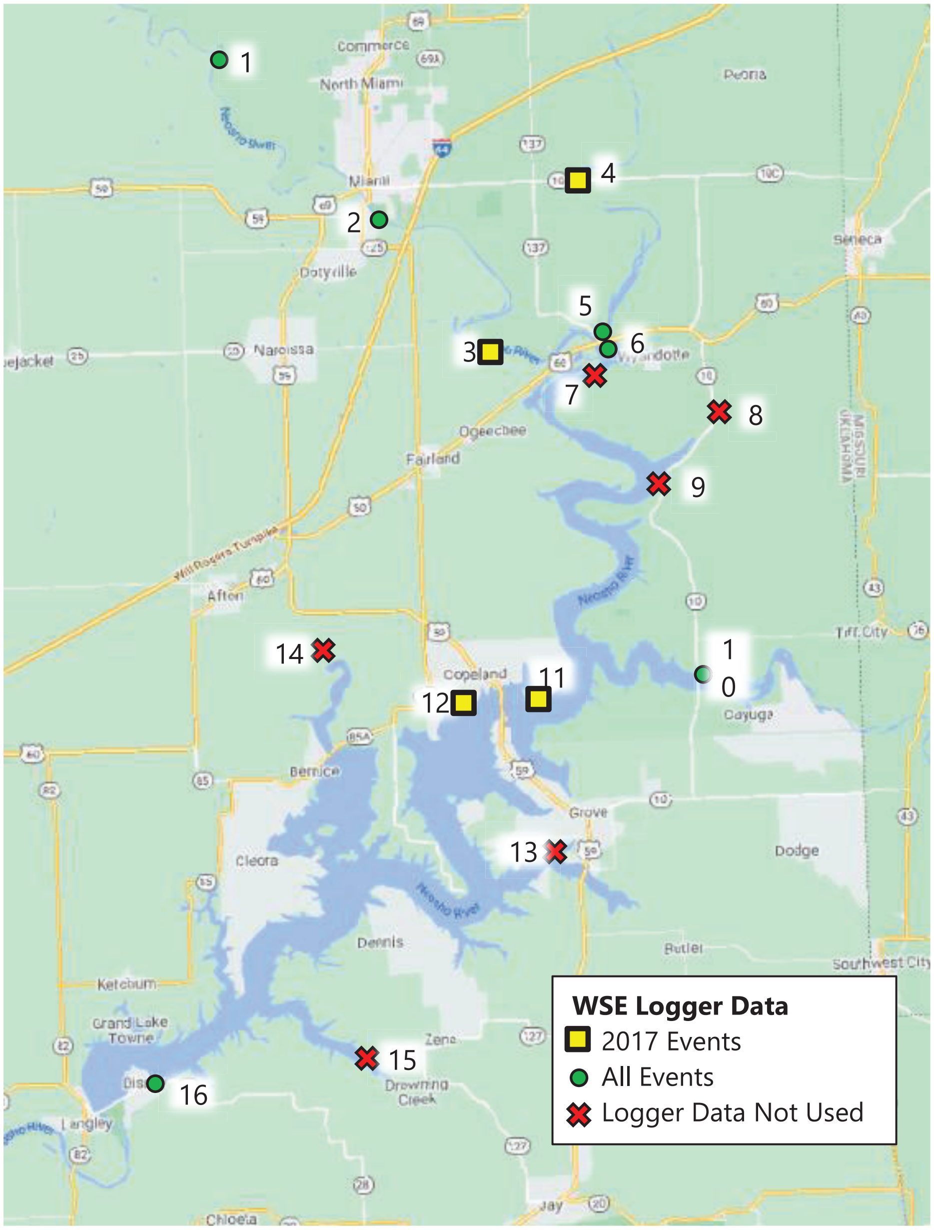


Figure 58
Comparison of STM WSE Results and Measured High Water Marks during the December 2015 Event



A third source of calibration WSEs was the field monitoring data collected during the study. The WSE loggers were in place for two of the calibration events: January and April 2017. Not all logger locations have data for a given event; some were washed away or vandalized when attempts were made to retrieve data. Logger 9 was missing for both events, and data from loggers 7, 8, 13, 14, and 15 were not included in calibration as they were located in areas where incoming, ungaged streams affected WSE reporting. These were initially placed before model parameters had been fully defined. Figure 59 shows the location of loggers used in the calibration process.

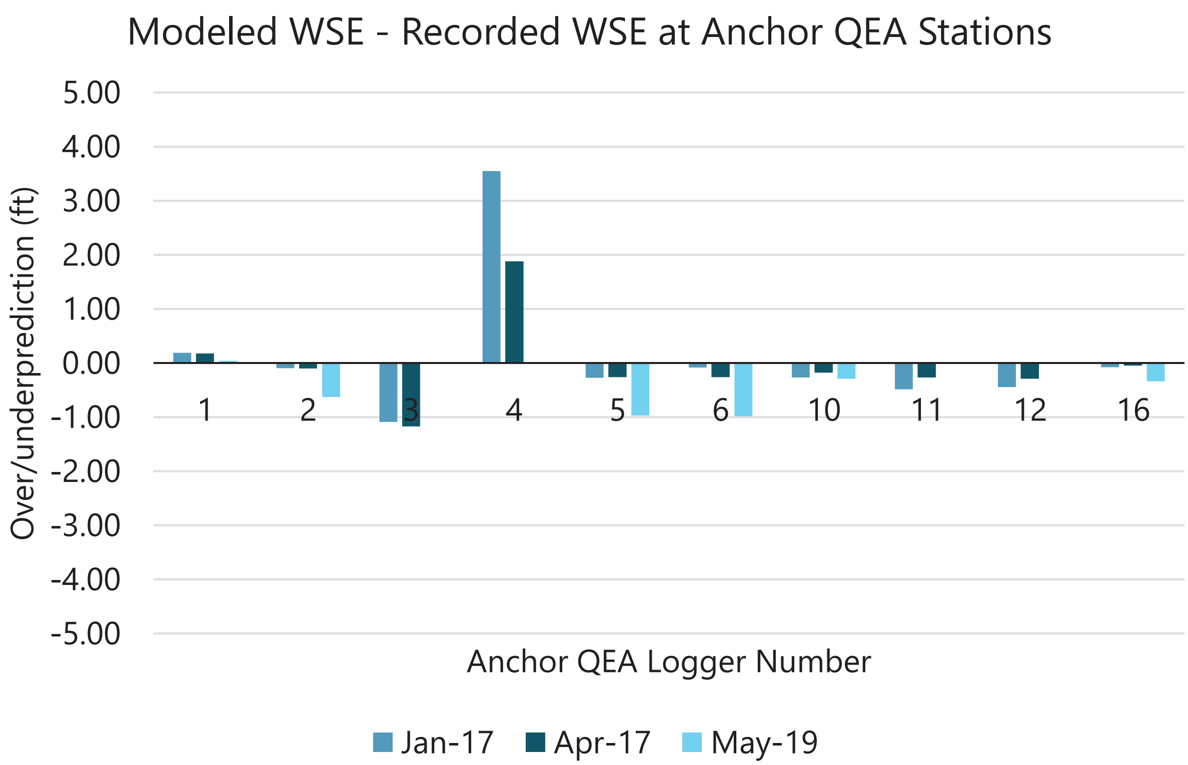
Figure 59
Locations of Anchor QEA Loggers



Note: Data from loggers 7, 8, 9, 13, 14, and 15 were not used in the analysis as discussed above.

Figure 60 shows the over and underprediction of peak WSE at the logger locations for those loggers used as calibration points. During the January 2017 event, the model averaged an overprediction of WSE by 0.09 feet. During the April 2017 event, the model averaged an underprediction of 0.05 feet. For the May 2019 event, the model averaged an underprediction of 0.53 ft.

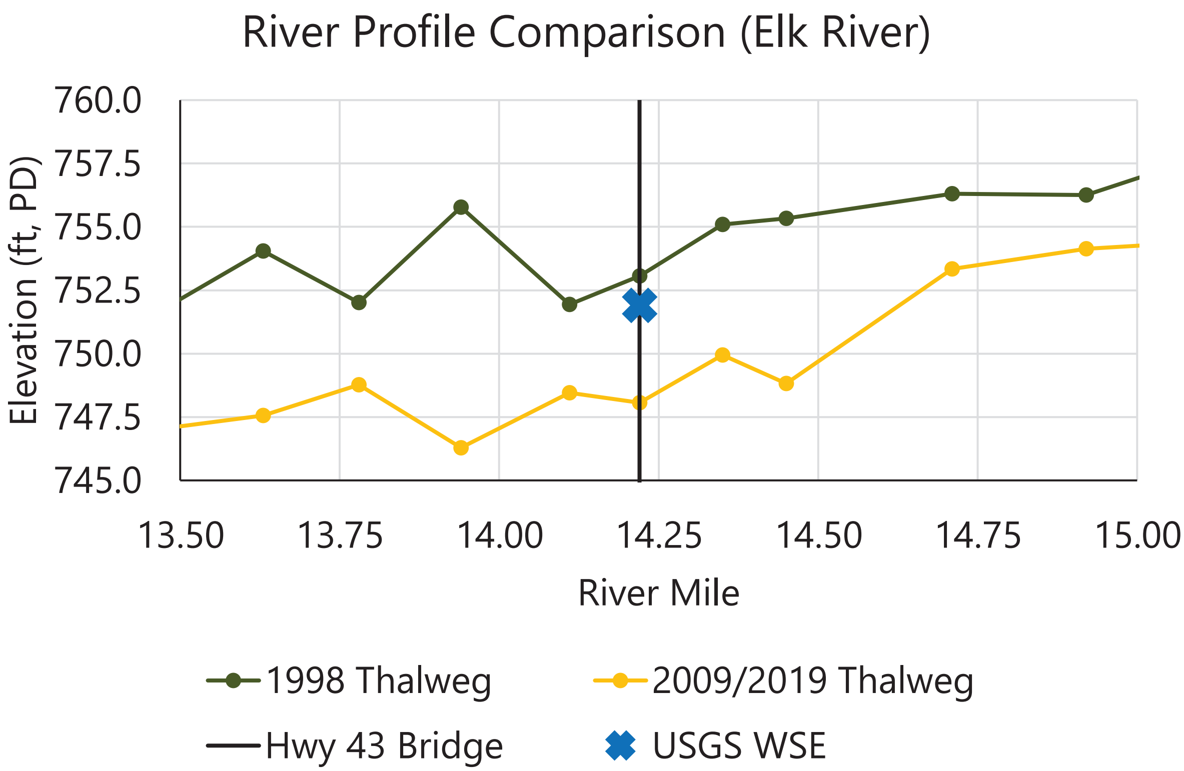
Figure 60
Comparison of STM WSE Results and Measured Values from Anchor QEA Loggers



5.1.3.1 Geometry Inconsistencies

During calibration, issues were noted with the 1998 terrain data. Calibration of high flows was achievable, but model results overpredicted WSE at lower discharges. Evaluation of the terrain file showed that the 1998 bathymetry thalweg was higher than WSE measurements on the Elk River (Figure 61). As a result, the model would never predict a WSE of 752.93 ft at the Elk River gage, despite measured values at or below that level during calibration events. See January 13, 2017, at 00:00, (USGS 2021e) as an example.

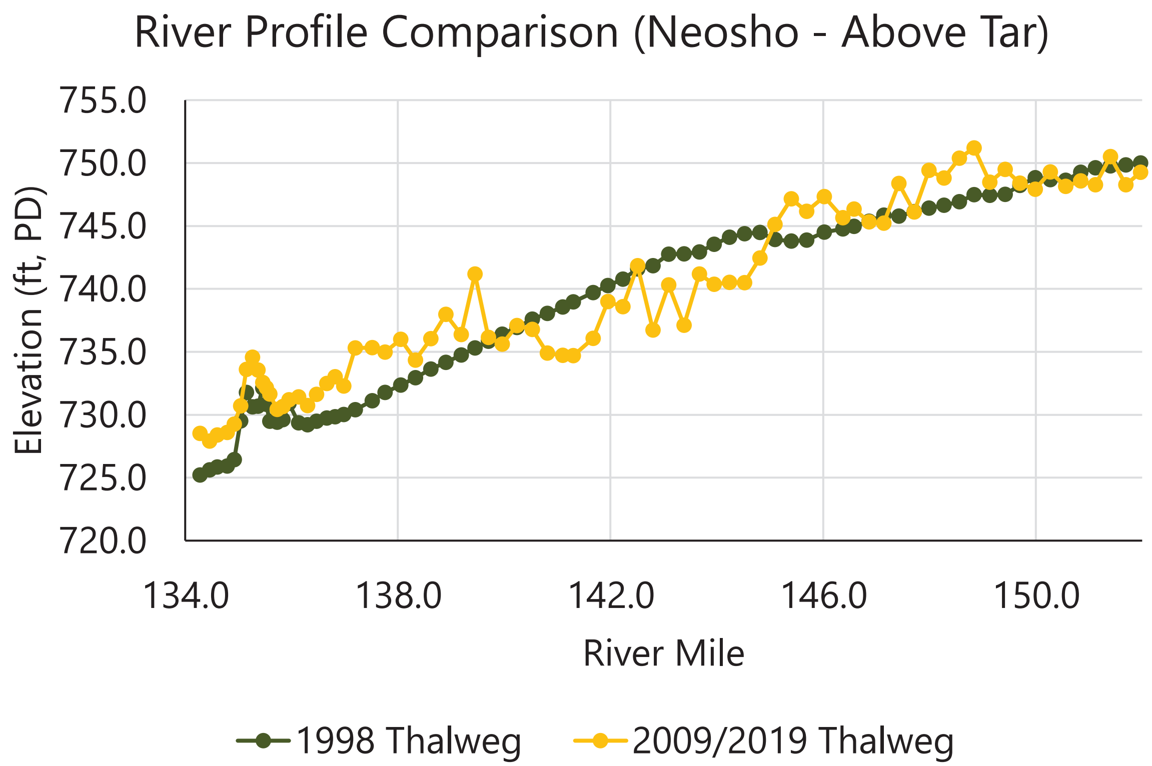
Figure 61
Elk River Thalweg Comparison and WSE Measurement



Note: Elk River geometry information for the 2009 and 2019 datasets are identical at this location; both are from the 2017 USGS bathymetric survey (USGS 2017).

Further evaluation of the 1998 dataset revealed other inconsistencies. Above the confluence with Tar Creek, the Neosho River profile in the 1998 dataset appears artificially smooth (Figure 62). This indicates that relatively few cross sections were directly surveyed, and bathymetric data was instead interpolated across long portions of the river. The data from the 2017 USGS survey (incorporated into both the 2009 and 2019 terrain files) shows the expected undulating stream profile (USGS 2017).

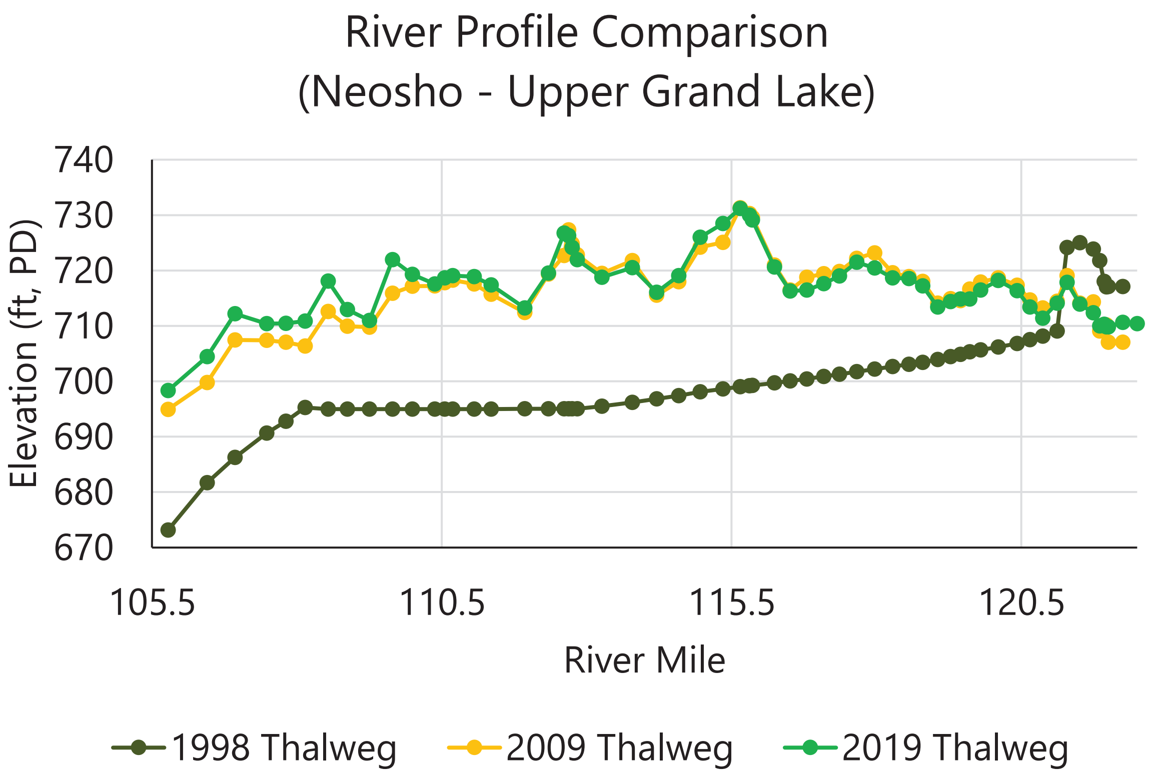
Figure 62
Neosho River Thalweg Comparison



Note: Neosho River geometry information for the 2009 and 2019 datasets are identical at this location; both are from the 2017 USGS bathymetric survey.
This graph covers the Neosho River between the USGS gage near Commerce at RM 152.2 and the confluence with Tar Creek at RM 134.0.

Other locations raised similar concerns. The Neosho River upstream of the Elk River confluence indicated as much as 30 feet of sediment deposition along the thalweg between 1998 and 2009 followed by limited deposition between 2009 and 2019 (Figure 63). This is unlikely to be accurate and cannot be reasonably explained by typical sediment transport phenomena.

Figure 63
Upper Grand Lake Thalweg Comparison



Note: This plot covers the stretch of Grand River between Twin Bridges at RM 122.25 to the confluence with the Elk River at RM 105.78.

To confirm these findings in the STM, the modeling team reviewed thalweg elevations using the original datasets. All elevations in the STM were confirmed, indicating that the original 1998 bathymetric dataset is unreliable for the purposes of this study and was not used in STM development.

The team also evaluated changes in the reservoir and modeled domain to further evaluate the 1998 terrain information in two ways. First, stage-storage curves provided by the USGS, USACE, and OWRB were compared to evaluate the magnitude and rate of changes from 1998 to 2009. This rate was then compared to long-term historical rates to evaluate plausibility. Second, the amount of deposition in the reservoir was compared to the sediment transport supplied by the tributaries by applying the sediment transport rating curves to the historic flow data over the life of the reservoir. If the deposition were as significant from 1998 to 2009, as shown in the above graphics, it would be reasonable to expect noticeable and corresponding variations in sediment supply with a significantly greater sediment supply from 1998 to 2009 yet a smaller amount of sediment transport from 2009 to 2019. Such trends were not found in the sediment transport analysis. The analysis of sediment transport over time compared to sediment deposition in the reservoir further calls into question the 1998 data.

STM calibration was thus limited to the period from 2009 to 2019. Because the 1998 dataset does not provide a useful baseline, it is impossible to calibrate from 1998 to 2009 followed by a validation run from 2009 to 2019. Instead, calibration was limited to comparisons between the 2009 and 2019 datasets. These largely consisted of Grand Lake evaluations because the terrain files were derived from a shared 2017 USGS survey in the upper reaches of each tributary (USGS 2017) with different data sources in the reservoir (the 2009 OWRB and 2019 USGS surveys).

5.2 Sediment Calibration

The initial plans for sediment calibration began with the 2009 geometry (OWRB 2009; USGS 2017) as the starting conditions. Bed material parameters, sediment inflow volumes, stream flows, and WSE information were developed based on field sampling and USGS stream gaging information (USGS 2021a-f) as discussed previously. Calibration would require parameterization of the sediment and simulation of the flows between 2009 and 2019; STM bathymetric change results would then be calibrated to the surveyed 2019 conditions.

As STM development progressed, it became apparent that there were significant challenges to overcome. These included significant differences between reported sediment conditions and what was found in the field, limitations imposed by HEC-RAS cohesive sediment modeling capabilities, temporally-varying sediment conditions, and an unreliable REAS topographic and bathymetric dataset (USACE 1998). Each issue contributed to additional difficulty in development of the STM.

Sediment conditions misreported in previous analysis by others led to increased effort to collect necessary sediment parameters for model development. Contrary to the City of Miami's claim that the sediment being transported in the system was primarily sand, extensive field observations demonstrated that the sediment being transported was not sand but instead cohesive silt and clay. Although the City of Miami maintained that there was no need to collect cohesive sediment data and that the STM could be run using non-cohesive sediment, the sediment being transported in these rivers is almost exclusively silt and clay. This observation is based on suspended sediment sampling and particle size distribution analysis of suspended sediment samples, as well as bedload sampling which yielded virtually no non-cohesive sediment captured in any samples.

Second, limitations in HEC-RAS with regard to cohesive sediment transport modeling curtail the ability of the STM to produce meaningful predictions for deposition and erosion patterns in the future. Given the wide ranges of sediment properties discovered during fieldwork efforts, the STM would need to allow highly variable sediment critical shear stress, erosion rates, and density.

However, HEC-RAS only allows for crude inputs of critical shear stress that do not change over time. These oversimplifications limit the ability of the model to accurately portray the real world.

Changing sediment conditions also pose significant hurdles for STM development. For example, sediment samples were collected and analyzed in 2019 and 2020, but bed geometry for the starting conditions was collected in 2009. Observations indicate that particle size distributions vary by several orders of magnitude even when collected in close proximity to each other, suggesting that properties may change considerably over time. These observations further indicate that – based on sediment inflow, hydrologic, and hydraulic conditions – fine sediment may temporarily deposit over coarser sediment before being transported further downstream under changing flow conditions. It is impossible to know what material was present on the beds of Grand Lake and the associated tributaries during bathymetric surveys collected more than 10 years before sediment sampling began, and the available data suggests that there is a wide range of possible sediment types. Widely-varying sediment parameters combined with over-simplification of the system due to software limitations prevent use of the model as a predictive tool.

Finally, considerable effort was applied to setting up the STM using 1998 data and attempting to calibrate the model hydraulically. During this process inconsistencies between measured water levels and the cross-section data itself became apparent, as did the overall nature of the cross-section data and bed profile (see Section 5.1.3.1). These issues were further confirmed by computing the overall sediment load over time by applying the sediment transport rating curves to the historic hydrologic regime and noting that the alleged deposition between 1998 and 2009 compared to 2009 to 2019 could not be reconciled. As a result, the effort put into the set up and calibration attempts using the 1998 data as a basis had to be abandoned as a lost effort.

As a result of these issues, the STM is unlikely to provide reliable predictions of future sedimentation patterns. These challenges are discussed in more detail in Section 5.2.3, and GRDA's plans for future analysis are presented in Section 5.2.4.

5.2.1 Modeled Shear Stress vs Measured Critical Shear Stress

A key factor in understanding sediment transport is the concept of critical shear stress of the sediment compared to the shear stress applied by flowing water over the sediment. Critical shear stress was determined through SEDflume analysis of the sediment cores by applying a range of flows (and corresponding hydraulic shear stresses) to the sediment surface to determine what shear stress begins to cause erosion of the sediment surface. Knowing the critical shear values for the various samples, these can be compared to the computed hydraulic shear stress from the STM. Hydraulic shear stress is computed for each time step in the model based on the flow and reservoir level as they varied historically from 2009 to 2019. The basic concept is that when the hydraulic shear stress exceeds critical shear sediment can be eroded from the bed and does deposit on the bed.

Conversely, when hydraulic shear stress is less than critical shear, sediment is not eroded from the bed and instead sediment tends to deposit on the bed. A number of comparisons are shown which illustrate this important relationship between critical shear stress of the sediment to hydraulic shear from the STM.

Several test runs have been made with the STM over the calibration period from 2009 through 2019. Some examples of the model output of hydraulic shear stress compared to the critical shear for cohesive sediments are illustrative in understanding transport of these materials into and through the system.

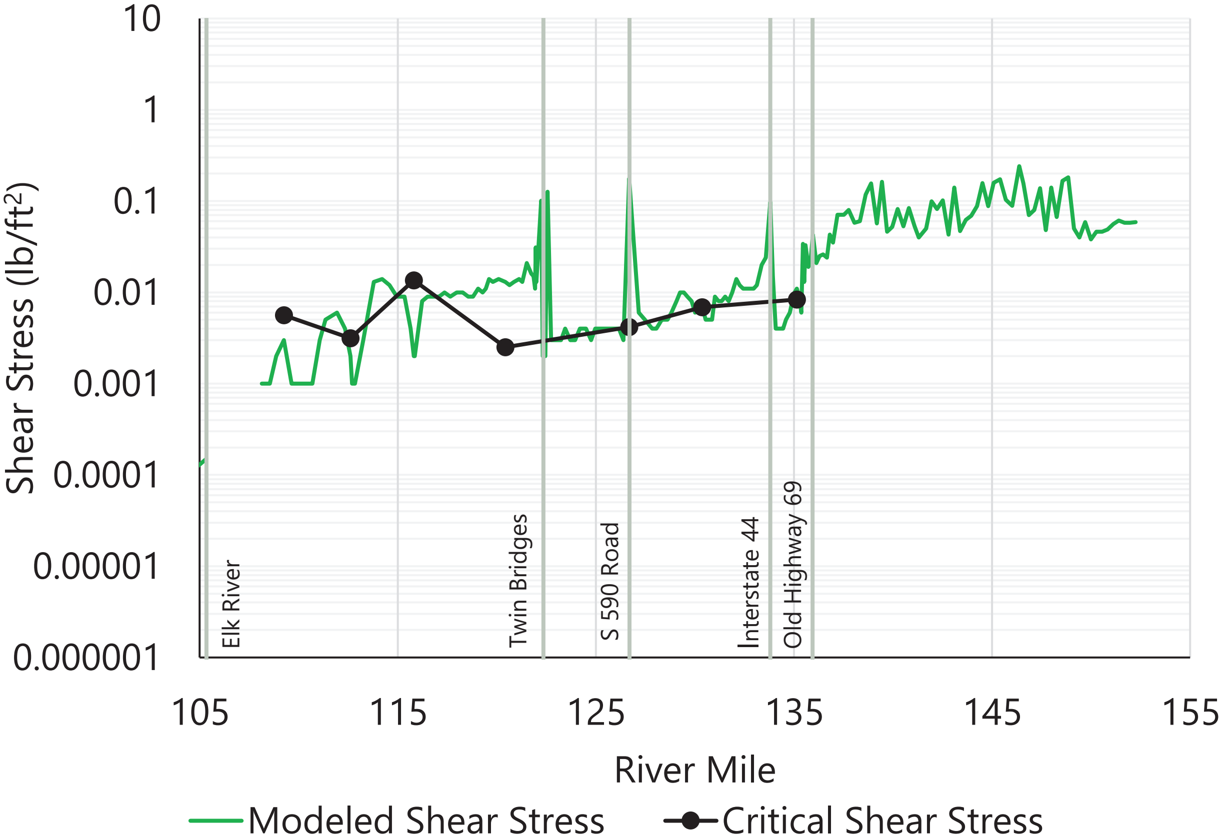
30 JUL 2013

On July 30, 2013, the flow in the Neosho River was 4,320 cfs and the WSE in the reservoir was 744.08 ft. This represents a typical event in the stream (average flow is approximately 4,312 cfs).

For this reach of the river, the hydraulic shear stress was compared to the critical shear stress for the upper layer of cohesive sediment that is potentially most active in terms of erosion or deposition (Figure 64 and Figure 65).

The comparison in the upper reach of the Neosho River, for example, in the vicinity of Miami (upstream of Interstate 44), shows that the hydraulic shear stress (green line) significantly exceeds critical shear stress (black line) which results in no deposition of cohesive sediment. This is consistent with field sampling and observations because cohesive sediment is not found to be deposited in the upper reach.

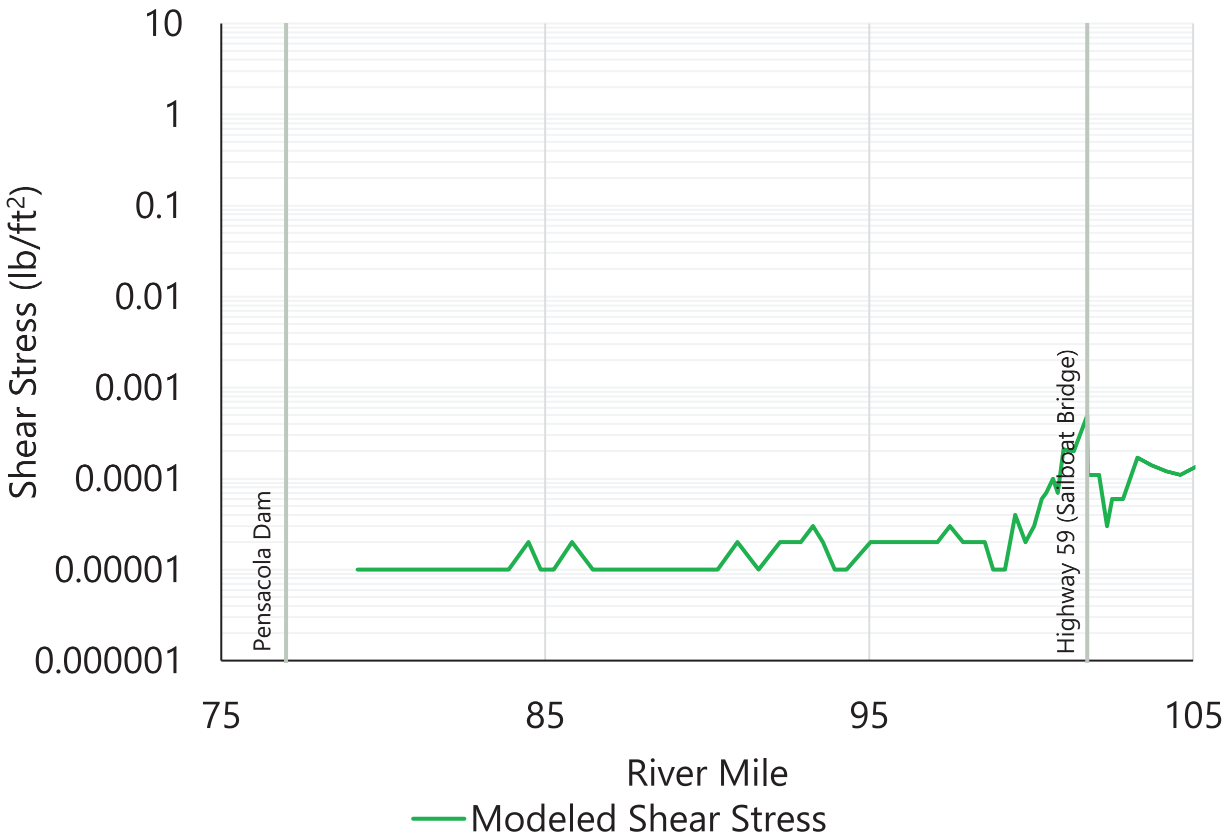
Figure 64
30 JUL 2013 Hydraulic Shear Stress Compared to Critical Shear Stress of the Upper Layer of Sediment on the Neosho River Upstream of the Elk River Confluence



Note: Modeled bed shear stress is shown in green with measured critical shear stresses of sediment samples shown in black.

Farther downstream into the reservoir, the hydraulic shear stresses significantly reduce towards zero such that they are less than critical shear stress which results in deposition of cohesive sediment (Figure 65). This is also consistent with field sampling and observations.

Figure 65
30 JUL 2013 Hydraulic Shear Stress Computed Downstream of the Elk River Confluence in Grand Lake

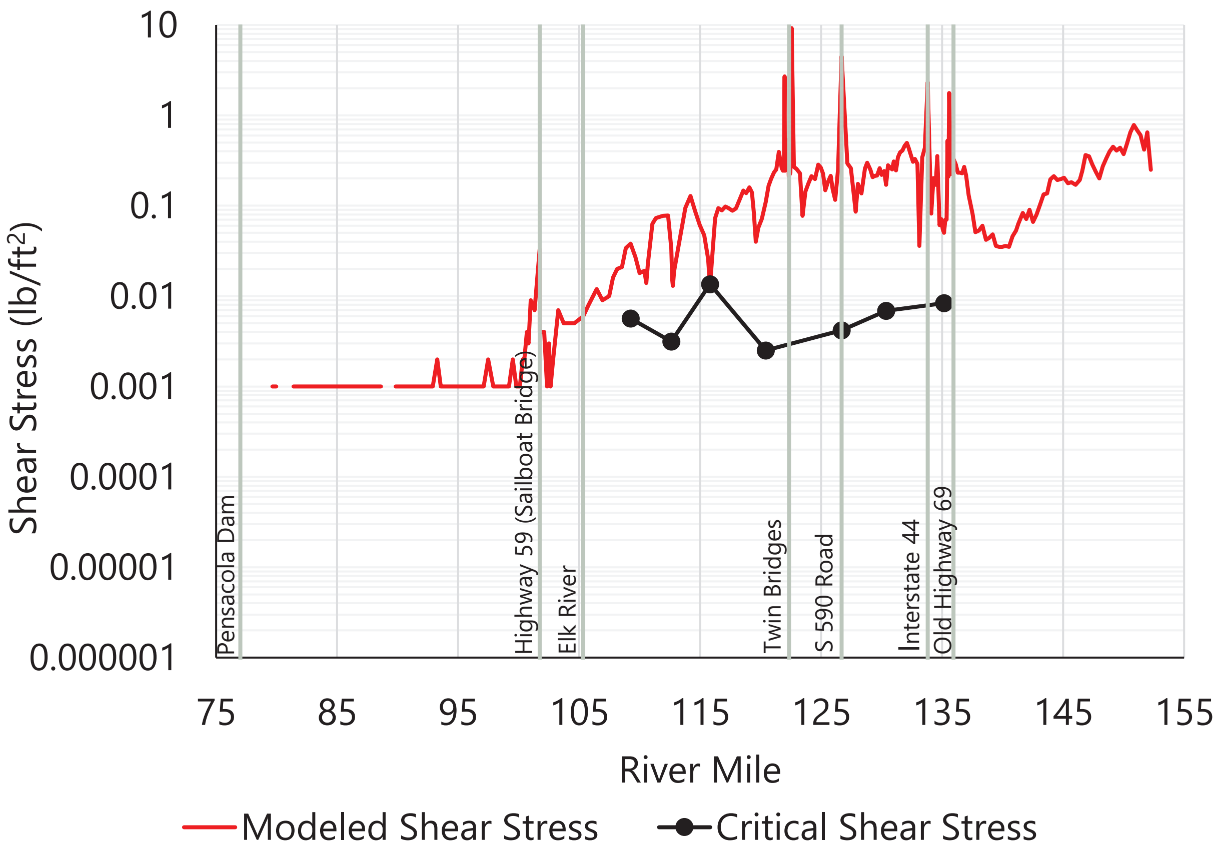


24 MAY 2019

On May 24, 2019, the flow in the Neosho River was 90,100 cfs and the water level in the reservoir was 754.94 ft, representing a condition of high flow and a high water level.

The high flow produces hydraulic shear stresses (red line) that are greater than critical shear stresses (black line) for the deposited surface sediments in the reach where the samples were collected (Figure 66). These hydraulic shear stresses cause cohesive sediment to be transported farther downstream into the reservoir. These same hydraulic shear stresses experienced during this flow event are great enough to erode some of the existing non-cohesive deposits and move them further downstream along with cohesive sediments in suspension.

Figure 66
24 MAY 2019 Hydraulic Shear Stress Compared to Critical Shear Stress of the Upper Layers of Deposited Sediment



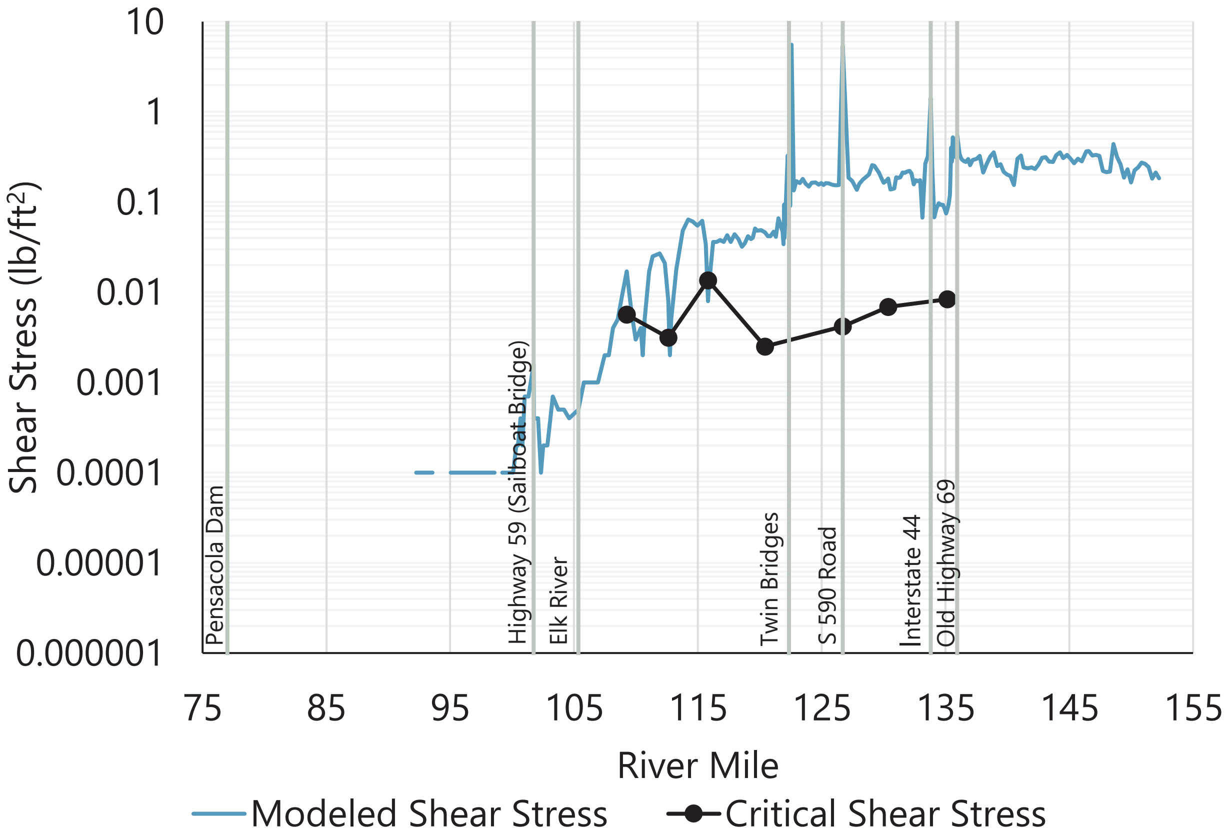
Note: Modeled bed shear stress is shown in red with measured critical shear stresses of sediment samples shown in black.

11 OCT 2018

On October 11, 2018, the flow in the Neosho River was 30,500 cfs and the water level was 742.08 ft, representing a moderate flow and a water level near the low end of the operating regime.

For this moderate flow and low water level, the hydraulic shear stresses experienced upstream of the confluence with Sycamore Creek are greater than the critical shear stresses experienced at the deposited sediment surface (Figure 67). Downstream from Sycamore Creek, hydraulic shear stresses experienced are similar to the critical shear stresses at the deposited sediment surface in the region where samples were collected. Farther downstream in the reservoir the hydraulic shear stresses continue to decrease to zero which would cause cohesive sediment in suspension to deposit.

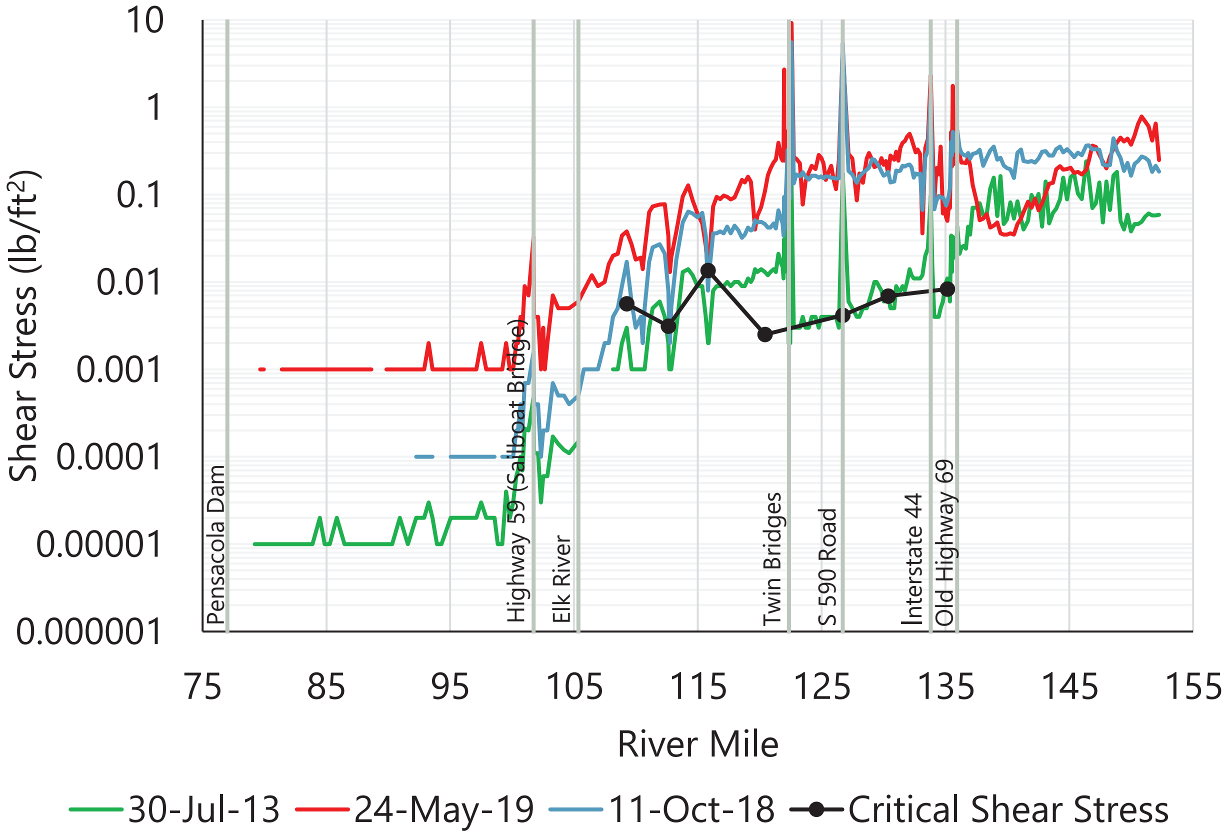
Figure 67
11 OCT 2018 Hydraulic Shear Stress Compared to Critical Shear Stress of Upper Layer of Deposited Sediment



Note: Modeled bed shear stress is shown in blue with measured critical shear stresses of sediment samples shown in black.

All three examples show how the hydraulic shear stress pattern varies with flow and reservoir level (Figure 68).

Figure 68
Hydraulic Shear Stress Compared to Critical Shear Stress of Upper Layer of Deposited Sediment



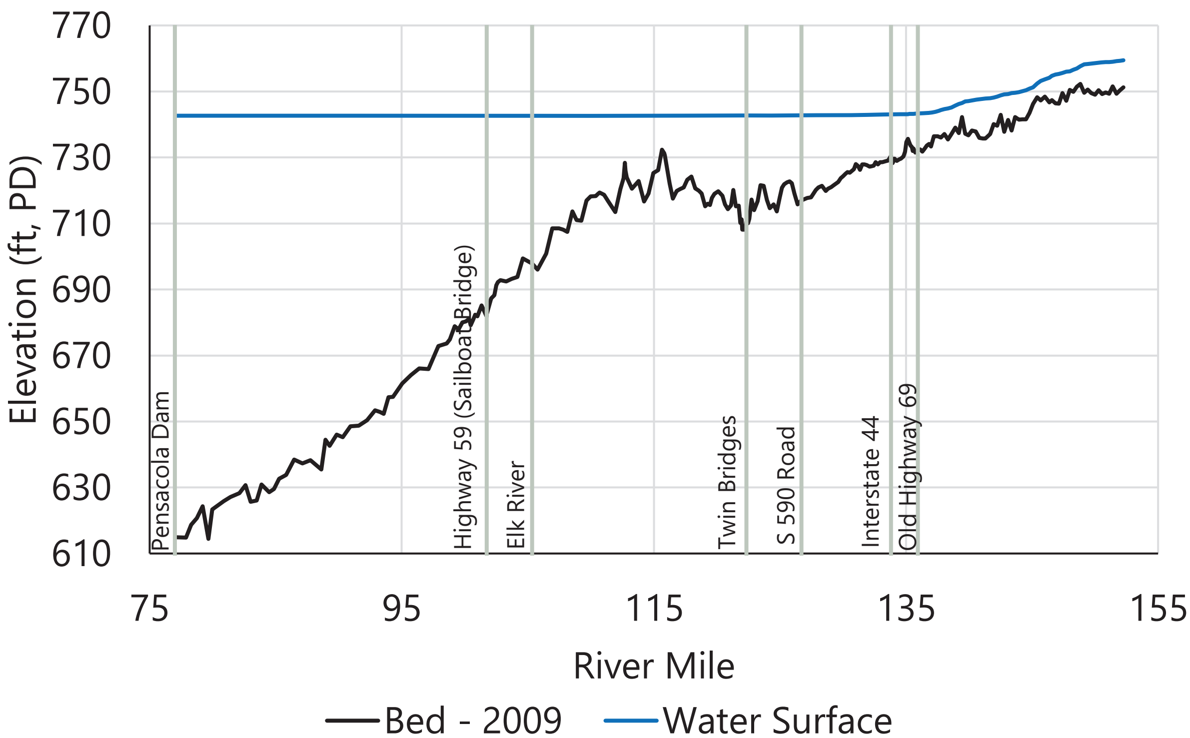
Note: Modeled bed shear stresses are shown in green, red, and blue for the 30 JUL 2013, 24 MAY 2019, and 11 OCT 2018 events, respectively. Measured critical shear stresses of sediment samples shown in black.

The green line represents average flow conditions while the red and blue lines represent higher discharge conditions.

Bed Profile

The profile of the riverbed shows a distinct hump where the primary non-cohesive sediment deposits are located in the reservoir (Figure 69). The pattern of hydraulic shear stress with respect to critical shear stress and settling properties of the cohesive sediment dictate where the suspended sediment deposits.

Figure 69
Neosho River Thalweg and Water Surface Profiles



The first step in evaluating the comparisons between critical shear stress of the sediment deposited on the bed and hydraulic shear stress is to examine the bed material at two locations: (1) where hydraulic shear stress exceeds critical shear stress and causes suspension or transport, and (2) where hydraulic shear stress is less than critical shear stress for the sediment load being suspended or transported in the rivers and down into the reservoir, which causes deposition. As shown by the suspended sediment sampling and bedload transport sampling, the incoming sediment load into the rivers predominantly consists of suspended silt and clay. Bedload sampling found no transport or movement of non-cohesive sediment (gravel and sand) under the wide range of flow conditions over which data was collected. See Figure 70, Figure 71, and Figure 72 for the range of flows where data was collected.

Figure 70
Range of Neosho River Flows During Sediment Transport Data Collection

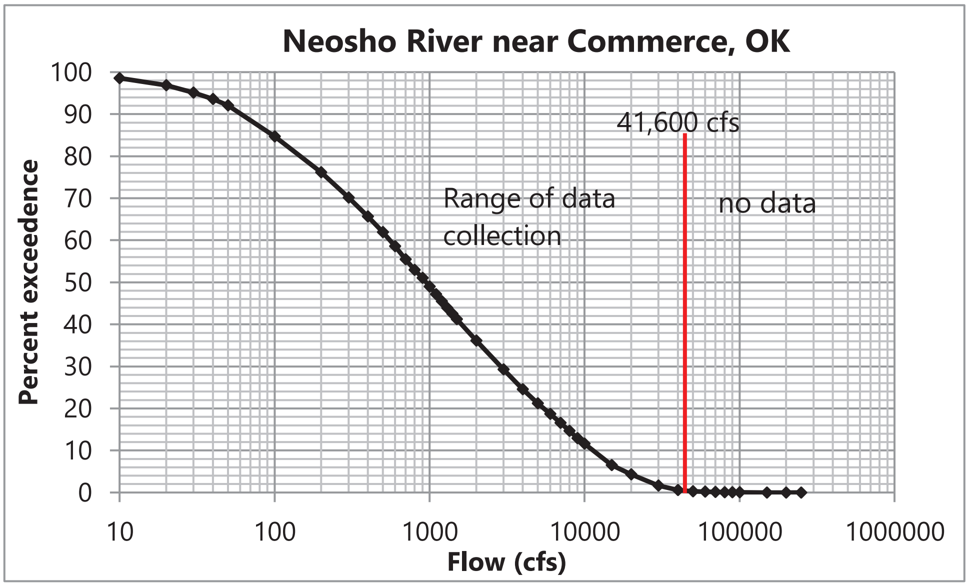


Figure 71
Range of Spring River Flows During Sediment Transport Data Collection

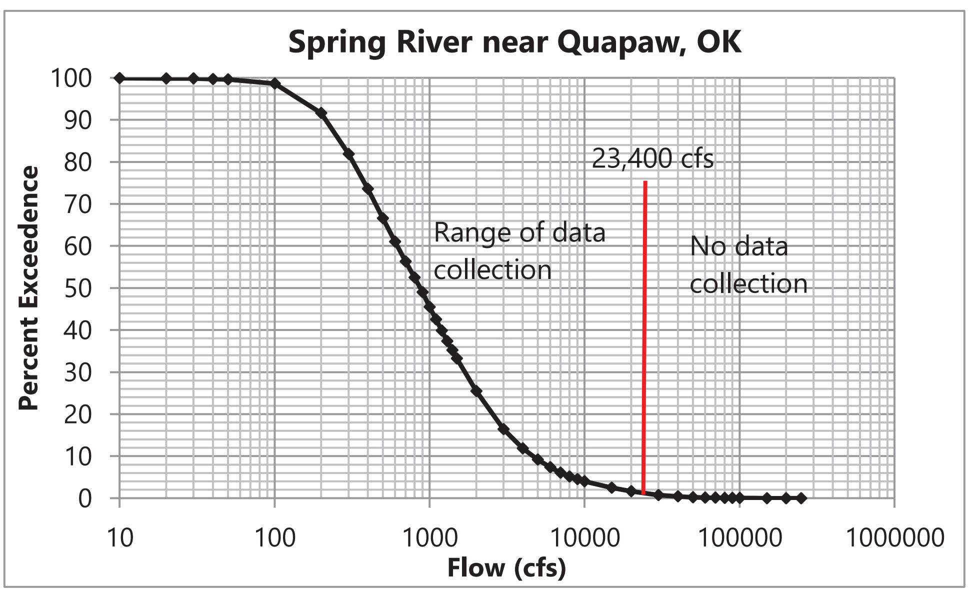
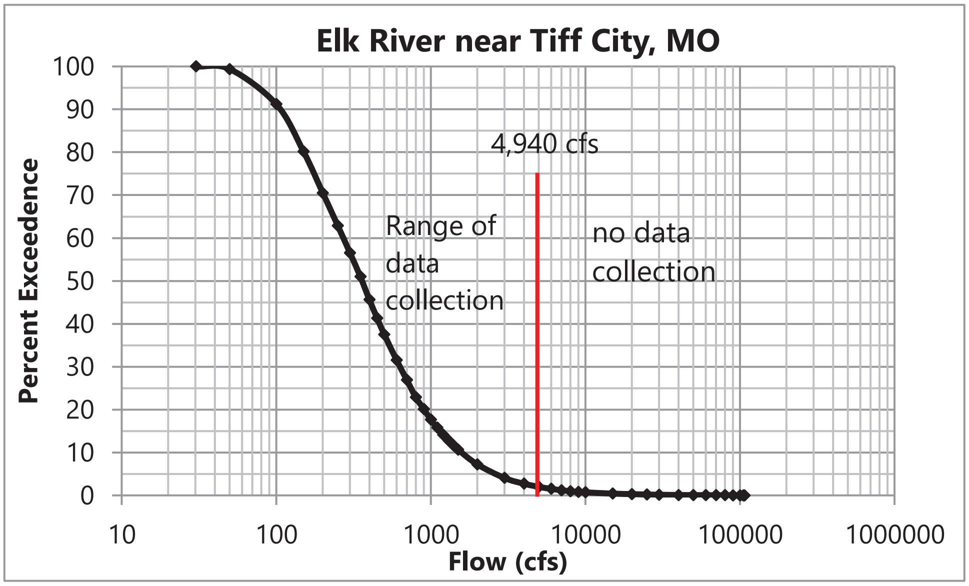


Figure 72
Range of Elk River Flows During Sediment Transport Data Collection



These flow exceedance curves coupled with the highest peak flow for sediment data collection show that transported bedload and suspended sediment data collection covers the vast majority of the flow regime. It provides 99.7, 98.9 and 98.0% coverage, for the Neosho, Spring and Elk Rivers, respectively.

In the reach of river where hydraulic shear stresses exceed critical shear stresses (in the vicinity of Miami and upstream), the bed material of the Neosho River consists primarily of gravel and virtually no silt and clay. This indicates the river in this location is transporting only silt and clay sized materials (Figure 73).

Figure 73
Neosho River Bed Material

Farther downstream in Grand Lake, hydraulic shear stresses are generally less than critical shear stresses required for cohesive sediment suspension or transport. In Grand Lake, the bed material consists of silt and clay. This indicates that cohesive sediment, consisting of silt and clay, is transported by the rivers in suspension downstream into the reservoir. When the hydraulic shear stresses in the reservoir are consistently less than critical shear required to keep cohesive silt and clay in suspension, the silt and clay cohesive sediment load settles out of suspension and deposits on the bed of the reservoir (Figure 74).

Figure 74
Sediment Deposit in Grand Lake

The above analysis compares hydraulic shear stress to critical shear stress, in conjunction with suspended sediment and bedload sampling, as well as bed material sampling. This provides significant insight into the key issue related to the effect of sedimentation on flooding in the City of Miami.

The analysis of STM hydraulic shear stresses compared to critical shear stresses, along with the bed material sampling and suspended and bedload transport data clearly demonstrate the incoming sediment load (silt and clay) is not depositing on the bed of the river in the vicinity of Miami. Silt and clay sediment load is not found deposited on the bed in the City of Miami or immediately downstream. The bed in these areas consists primarily of gravel along with some sand. This conclusion is supported by the City of Miami's consultants when they stated the following:

> The cohesive sediment is carried as wash load well downstream into the reservoir, and deposition and re-entrainment of that material has very little, if any effect, on upstream channel capacity and flooding. (City of Miami 2018)

The STM hydraulic shear stress compared to critical shear stress, the bed material data, and the suspended and bedload transport data all confirm this key observation and conclusion. The City's consultants indicated that the incoming sediment load is not depositing on the bed of the river in the vicinity of Miami, but instead is transported farther downstream into the reservoir.

5.2.2 Discussion of STM calibration

Several parameters or variables affect the calibration of the STM. These include the following:

- Sediment bulk density (and consolidation over time)
- Critical shear stress for cohesive sediment
- Erosion rate for particle and mass erosion
- Sediment transport equation parameters for non-cohesive sediment (critical shear stress parameter, coefficient, and exponent)

The following table summarizes the range of variables and parameters for cohesive sediment as well as similar information for bed material size distributions and Manning's n.

Table 22
Range of Calibration Parameters

Calibration Factor	Hydraulic Model	Cohesive Sediment Model
Resistance to flow	Manning's *n* Range: 0.015 – 0.045 in channel 300%	Manning's *n* Range: 0.015 – 0.045 in channel 300%
Bed material	n/a	Bi-modal distribution covering 5 orders of magnitude (1,000,000%)
Critical Shear Stress	n/a	Range: 3,000%
Erosion rate	n/a	Range: 5 orders of magnitude 1,000,000%
Bulk density	n/a	Range: 485%

HEC-RAS includes each of these variables and parameters to simulate sediment transport for both cohesive and non-cohesive sediment.

5.2.2.1 Sediment Bulk Density

Three values of bulk density are allowed per sample or location in HEC-RAS for each of the following types of sediment: sand/gravel, silt, and clay. As described in the HEC-RAS User's Manual (USACE 2016), "Sediment unit weights or densities are used to convert deposited or eroded masses into volumes that translate into bed elevation changes." The incoming sediment load is computed in terms of weight (tons per day as a function of flow from the sediment transport rating curves). These tonnages must be converted to volume, which in turn can be converted to depth of deposition (or erosion) by using the bulk density. Tonnages must be converted to volume because comparisons between measured and computed bed elevations are needed for calibration.

The HEC-RAS User's Manual (USACE 2016) provides the following modeling note regarding cohesive sediment density:

> Modeling Note – Cohesive unit weight/density: Cohesive unit weight can vary substantially between systems and even within the same reservoir (e.g., deeper consolidated clays are often consolidated and much denser than surficial deposits). HEC-RAS adopted defaults from HEC 6 but are on the low end of the range, representing 'fluffy,' surficial reservoir deposits. When calibrating a depositional cohesive model to volume change computed from repeated cross-sections, cohesive density will be a very sensitive parameter. (USACE 2016, pg 17-44)

The sediment cores show a range of dry bulk density from 21.2 to 103 pounds per cubic foot which is a 485% range in values. This means that if an average value were utilized for bulk density and the actual density were on either extreme of the range the conversion from weight to volume (or depth) of deposition could be off by over 200%. Potential errors in this conversion could be off up to several hundred percent.

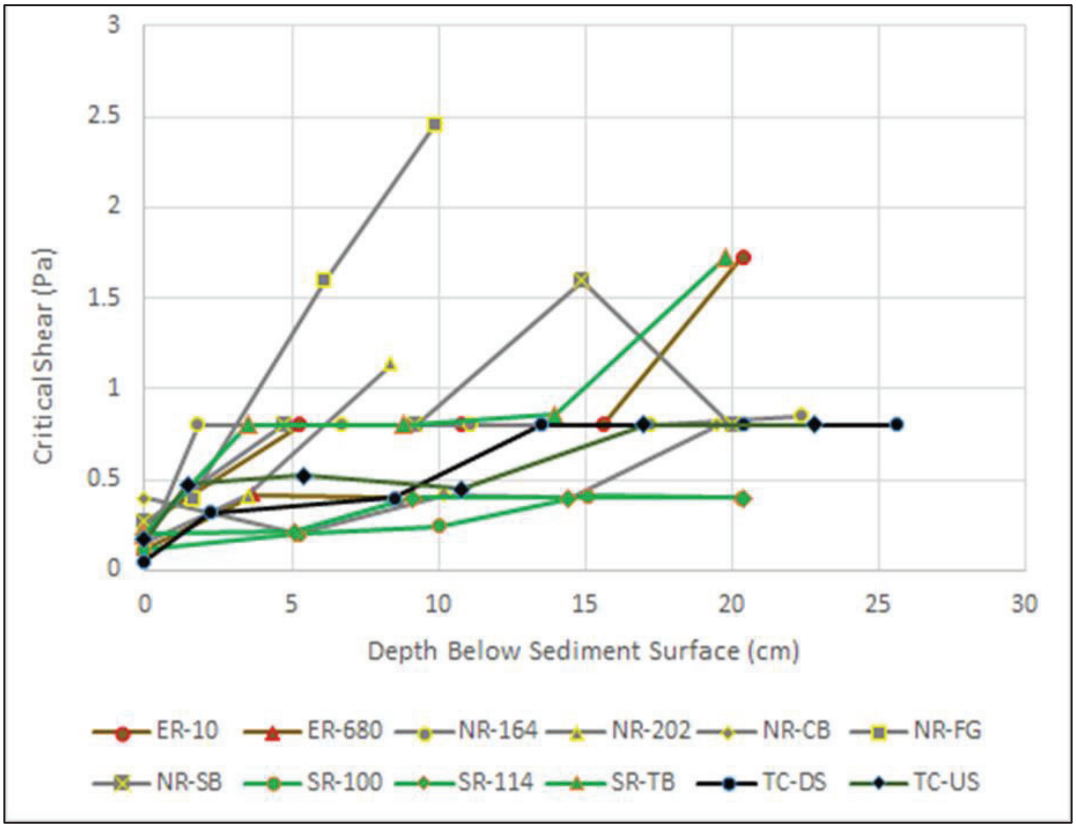
Another complicating factor is that cohesive sediment tends to consolidate over time resulting in higher densities. The HEC-RAS 2D Sediment User Manual (USACE 2020) presents this discussion of the use of a sediment consolidation curve:

> Consolidation curves are developed for a specific bed material. Since HEC-RAS only allows the user to specify one consolidation curve, a representative consolidation curve is used for all of the modeling domain. It is assumed that the consolidation curve was developed for cohesive sediments. Until more than one consolidation curve is added to HEC-RAS a simple correction is computed to account for the presence of non-cohesive sediments which can significantly affect the consolidation curve. (USACE 2020)

5.2.2.2 Critical Shear Stress

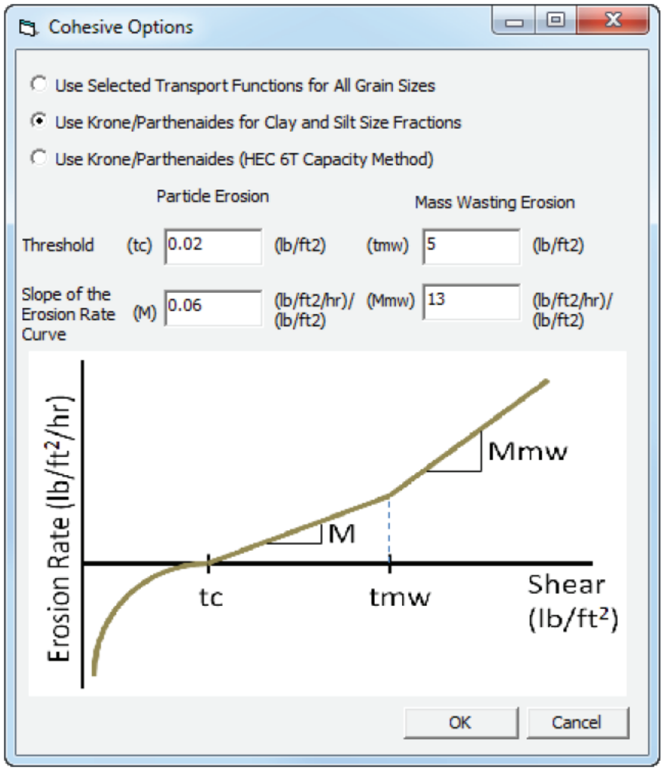
Critical shear stress, as previously described, is the force required per unit area of sediment surface to begin to erode the sediment surface. SEDflume laboratory analysis measured the critical shear stress in the sediment column over a range of depth of up to about 25 cm (9.8 inches). Figure 75 shows the measured critical shear values as a function of depth below the sediment surface. Typically, the data show a general increase in critical shear stress with depth. This is due to the fact that as sediment consolidates and ages, it typically becomes stronger and more resistant to erosion. Measured critical shear stress values cover a range of about 3000% based on the samples collected and analyzed.

Figure 75
Critical Shear vs Depth Below the Sediment Surface



Two values of critical shear stress for each location or sample in HEC-RAS, one representing the critical shear stress when beginning particle erosion and the other as a threshold when mass wasting erosion begins as shown in the following figure from the HEC-RAS User's Manual (USACE 2016).

Figure 76
HEC-RAS Cohesive Erosion Parameters



Source: HEC-RAS User's Manual (USACE 2016, Figure 17-38)

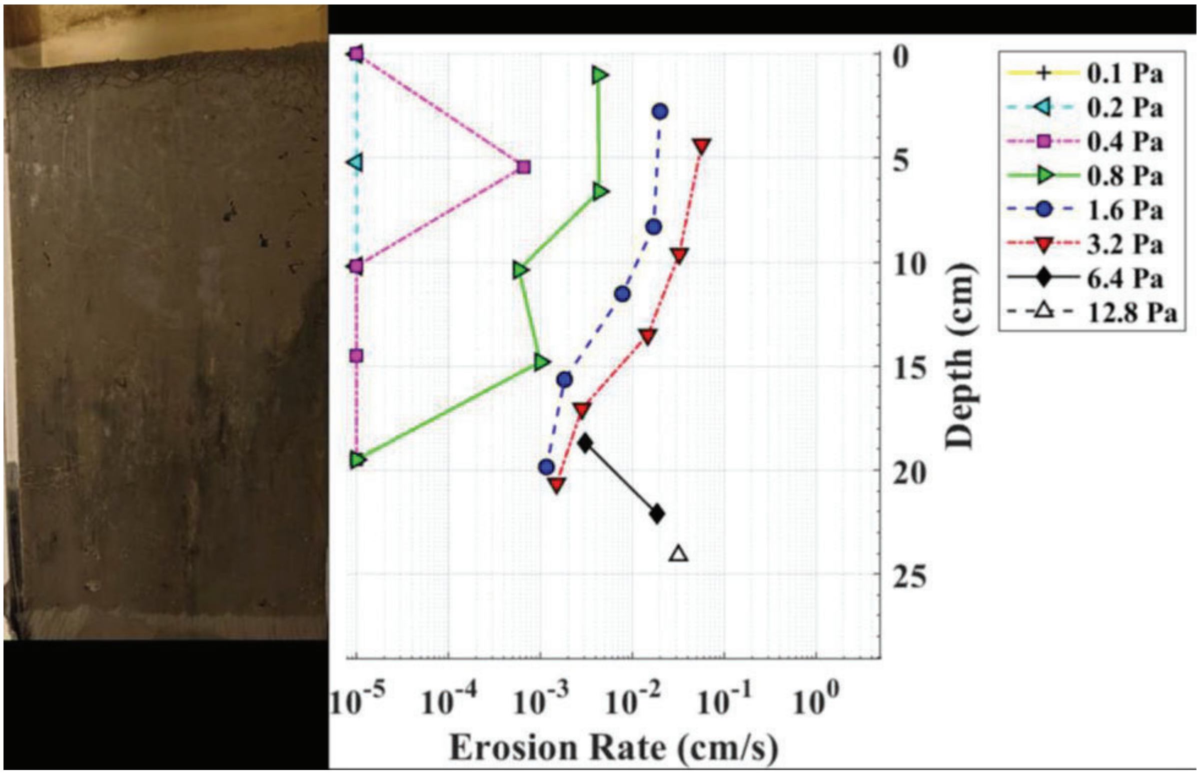
With only these two values of critical shear stress per sample or location, as with bulk density, there is a wide range of values to select from based on the fact that critical shear stress varies as a function of depth below the sediment surface. Selection of critical shear stresses at the surface tends to result in a greater susceptibility to erosion at lower hydraulic shear stresses. Selection of critical shear stresses from deeper depths results in a lower susceptibility to erosion at progressively greater shear stresses. With only one set of critical shear stresses allowed in the model this can significantly affect computed erosion thresholds that do not provide a true representation of actual conditions.

In actual conditions, as the upper layers of sediment are eroded because critical shear stresses are exceeded, the lower layers become exposed and are progressively more resistant to transport. The lower layers require higher critical sheer stresses to erode and mobilize. With critical shear stress values covering a range of 3000%, and only one set of critical shear stress values allowed per sample or location, the computed thresholds of erosion can be significantly different than actual conditions.

5.2.2.3 Erosion rate

Erosion rate data collected from the SEDflume laboratory analysis shows an extremely large range of erosion rates per sample (5 orders of magnitude or 1,000,000%). Similar to density and critical shear stress, erosion rate is a function of depth below the sediment surface. It varies because of sediment consolidation and strengthening with depth. Figure 77 shows an example of one set of results from one of the SEDflume samples.

Figure 77
Erosion Rate Variation with Depth for One SEDflume Sample Analysis



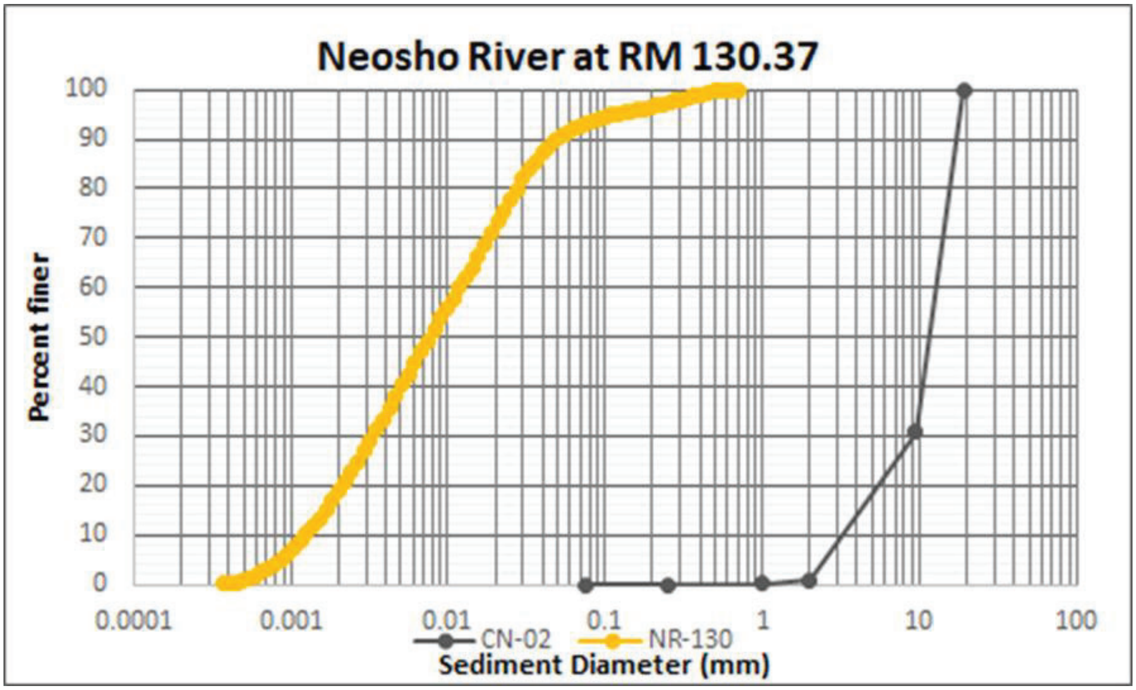
Source: Integral Consulting (2020)

Two parameters are allowed in HEC-RAS. One parameter defines particle erosion, and the other parameter defines mass erosion. With only two parameters allowed in HEC-RAS, the computed erosion rates tend to depart significantly from actual conditions because the erosion rates vary widely over several orders of magnitude.

5.2.2.4 Bed material

Bed material covers a wide range of sizes and includes both cohesive and non-cohesive sediment as seen in Figure 78. The wide range of sediment sizes presents additional difficulties in developing a model that represents actual conditions.

Figure 78
Comparison of Neosho River Bed Material Grain Size Analyses at RM 130.37



5.2.3 Difficulties With Modeling Systems Including Primarily Cohesive Sediment

While HEC-RAS includes the various basic components of cohesive sediment transport modeling, it is limited in terms of representing actual conditions by how it applies the various parameters to simulate actual sediment transport, erosion and deposition processes. Key parameters vary significantly with depth below the sediment surface, and they do not vary by small amounts. They vary by hundreds of percent up to and including 1,000,000% in a relatively small depth (~10 inches) below the sediment surface. If the critical shear stress in the model is set at X but the actual condition is 3,000% of X, or if erosion rate is Y but in reality, it is 1,000,000% of Y, the computed occurrence of erosion and the erosion rate would be drastically incorrect. The model would not represent actual erosion and transport conditions. The predictive results of a cohesive STM can easily become unrealistic.

The diagram shown in Figure 79 represents the trade-off with respect to modeling complexity and realistic representation of whatever is being modeled (Overton and Meadows 1976).

Figure 79
Modeling Complexity Trade-Off

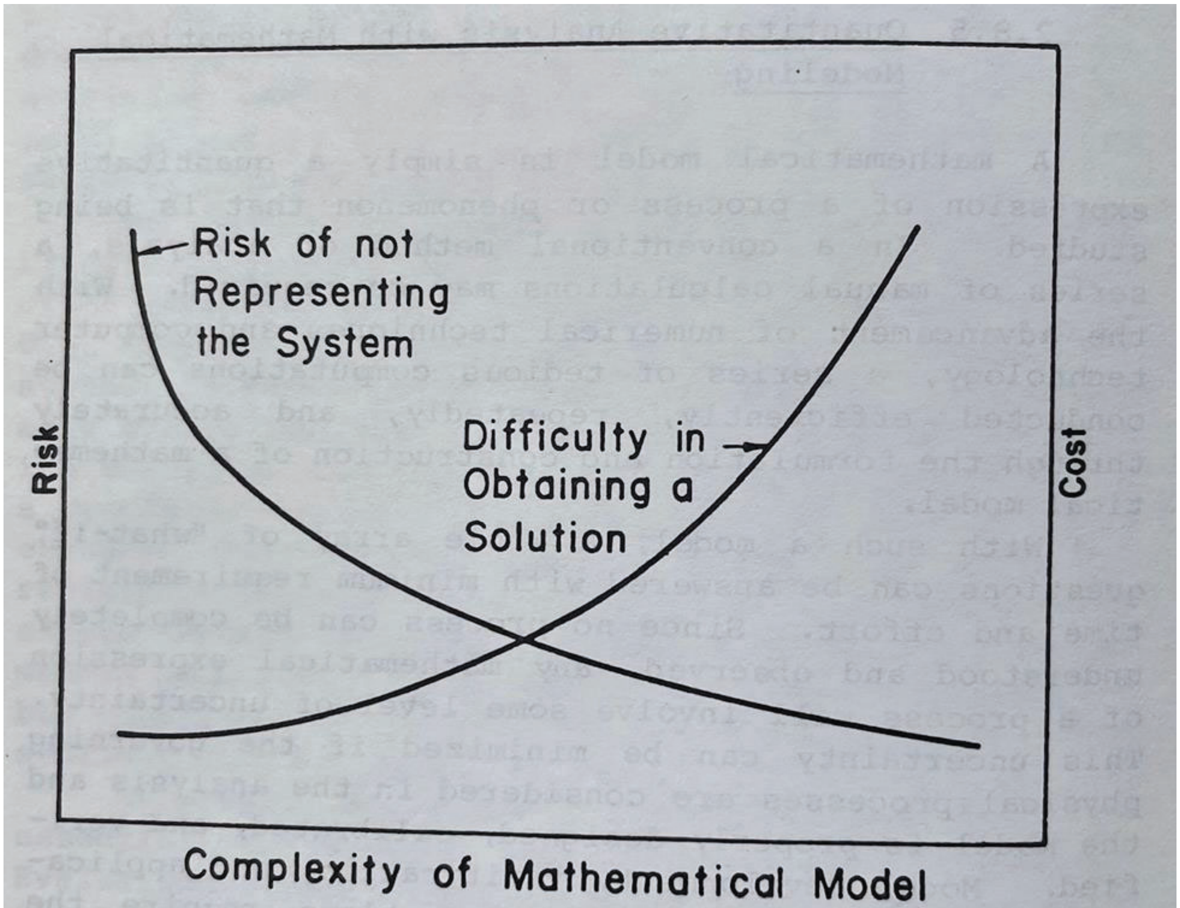


Figure 2.8. The model complexity trade-off diagram (after Overton and Meadows, 1976).

If model complexity is low (on the left side of the diagram), the risk of not representing the system is high. As a model gets progressively more complex, and presumably more realistic, the risk of not representing the actual system decreases, but the difficulty in obtaining a solution and the cost increase. In the case of HEC-RAS modeling of cohesive sediment transport, the risk of not representing the system is relatively high because HEC-RAS does not represent how cohesive sediment behaves. It does not represent the fact that density, critical shear stress, and erosion rate vary significantly with depth below the sediment surface and that it changes over time (HEC-RAS does allow density to change over time but not the other parameters).

While HEC-RAS allows sediment density to change over time, it does not allow critical shear stress or erosion rate to change over time. This would not be important if the model was running on an event-by-event basis, but in this case the model is intended to be calibrated over approximately 10 years and complete model runs that extend 50 years into the future. These factors lead to considerable uncertainty and elevated risk of not representing the actual system and undermining the predictive function of the STM.

In cohesive sediment transport modeling, a particular calibration result of a given bed profile related to the final survey at the end of the calibration period can be achieved in a wide variety of ways. A set of values for cohesive shear stress could be used that represents the surface layer of the sediment with associated low critical shear stresses and high erosion rates. Then the calibration could focus on adjusting sediment density to achieve the desired depth of sediment deposition to reasonably match the surveyed channel bed elevations.

In a similar way, a set of cohesive shear stress and erosion rates could be used that represent something deeper in the sediment column with higher critical shear stresses and lower erosion rates and again adjust the result using sediment density.

Yet another strategy could set sediment densities to reasonable values and the critical shear stresses and erosion rates could be adjusted to obtain some reasonable calibration result.

The parameters vary so widely, there are a number of approaches that could potentially achieve a "reasonable" calibration result. Using sets of parameters that are quite different from alternative approaches and which would likely respond differently when applied to future predictions over significantly longer time periods than the calibration period could still provide a "reasonable" calibration result.

Since the surface layer of sediment is in direct contact with the flowing water, it could make sense to use the sediment characteristics for the surface layer. This approach seems reasonable, especially in a primarily depositional environment. However, in an erosional environment this surface layer could quickly be eroded due to low critical shear stresses and high erosion rates. Using the surface layer characteristics to represent lower layers would overestimate erosion rates.

As described in the three examples above, hydraulic shear stresses vary considerably, and the zone of higher shear stress shifts upstream and downstream depending on flow. Using sediment characteristics from deeper in the sediment deposit would tend to underestimate potential erosion and erosion rates that do not simulate actual conditions at the bed surface. Using average values for critical shear and erosion rates could calculate results that are hundreds to thousands of percent different from actual erosion conditions.

Potential biases could be built into the calibration process by either using higher or lower critical shear stresses and erosion rates. There is a very wide range of parameters that may be adjusted to achieve some potentially "reasonable" calibration from a restricted perspective of bed elevation, yet such “reasonable” calibration parameters could influence future trends over a longer term that either minimize or maximize erosion and do not provide realistic predictions.

There is such latitude in parameters and approaches that it will be easy for anyone to criticize how a solution is obtained with no real proof that one way is more representative than another. The approach could then be considered potentially valid, but a reasonable result could be obtained for the wrong reasons, which do not represent actual conditions and which in turn could then affect how the model responds in running future predictive scenarios. In generally-accepted scientific practice, debates and criticisms abound over how sediment transport models are calibrated and what the implications are for the predictive use of said model where sediments are primarily cohesive.

Based on the recommendation of the City of Miami’s consultants and acceptance by FERC, HEC-RAS is being utilized as the STM for analyzing sediment transport. Initially, and prior to field observations, this seemed to be a reasonable approach despite our original proposals to use alternative approaches to analyze sediment transport. The STM approach was further supported by the use of HEC-RAS in the H&H study and by the fact that HEC-RAS has been used for many years as a sediment transport model, including by Simons & Associates on numerous projects.

Work began by setting up and calibrating the model for use in sediment transport with the 1998 data (which proves itself to be inaccurate and unreliable). Subsequent to those findings, model simulations from 2009 to 2019 were created.

The field observations indicated that cohesive sediment was the dominant type of sediment being transported through the rivers and down into the reservoir. Therefore, it became necessary to collect sediment samples to develop the erosion characteristics of cohesive sediment through the use of SEDflume. Since HEC-RAS includes parameters for cohesive sediment, it was appropriate to continue developing the model with the cohesive parameters. Even though SEDflume results yielded an extremely wide range of parameters for cohesive sediment, testing of the model was conducted to understand how the HEC-RAS STM was behaving.

Upon initial testing, the model indicated erosion of the channel bed in the upper reaches of the rivers was occurring using the standard Meyer-Peter-Muller (MPM) bedload equation. The MPM equation was selected because it is well suited for gravel and sand beds. Simons & Associates had used it on numerous occasions with good success.[1] However, actual bedload data that were collected on the Neosho, Spring and Elk Rivers showed that no bedload transport was occurring (over a wide range of flows covering from 98% to over 99% of the flow regime). This discrepancy between the model and actual field observations indicated that the MPM equation should be

[1] On a recent project where bedload transport data had been collected Simons and Associates tested several of the sediment transport equations in HEC-RAS. They determined that the MPM equation worked best because it more closely matched the measured data as compared to the other equations tested.

calibrated to simulate no bedload transport as indicated by the data. This was accomplished by setting the erosion option to zero in HEC-RAS where non-cohesive sediments existed as a test. It was also tested by adjusting the parameters (as allowed in the calibration option in HEC-RAS) to get zero bedload transport. When the no erosion option in HEC-RAS was set to zero, simulations show that erosion of the bed stopped, but instead of the model generating near zero bed change, it generated up to several feet of deposition. This did not seem reasonable because actual field observation data show no transport of non-cohesive sediment in the upper river reaches and simultaneously show no deposition of cohesive sediment. When the calibration option in HEC-RAS was used to set bedload transport to zero as indicated by actual field observation data, the model generated massive deposition of the incoming cohesive sediment load – resulting in over 20 feet of theoretical deposition of cohesive sediment in the uppermost part of the river where, in reality, no evidence of cohesive sediment is found on the riverbed. This indicates that the non-cohesive sediment transport equation is being utilized by HEC-RAS to compute the transport of cohesive sediment. This is not appropriate or reasonable and indicates a significant issue when attempting to run a model that has both non-cohesive and cohesive sediment.

The other tests involved the wide range of cohesive sediment parameters. For example, one run was made using the generally lower critical shear stress and high erosion rate representative of the surface layer of sediment. These results were then compared to another run using higher critical shear stress, based upon SEDflume data, and a low erosion rate representative of the deeper layer of sediment. As expected, erosion is greater for the surface sample than the sample representing a deeper layer of sediment. The differences in the ultimate result of bed elevation change, which is the variable for calibrating the model, was on the same order of magnitude as the total change in bed elevation between the 2009 and 2019 data. In other words, the model sensitivity to these parameters over a few centimeters of depth below the sediment surface results in several feet of difference in the simulated result. This produced a simulation of a large and unrealistic change in bed elevation over the calibration period. Clearly, modeling the erosion and transport of cohesive sediment requires the use of different parameters over a range of depths below the sediment surface to realistically simulate this phenomenon. The choice of parameters resulted in differences in bed elevation over a short period of time that were as large as what is intended as the measured changes over the 10-year calibration period in the model.

As a result of these significant issues, the use of HEC-RAS for this system which includes both cohesive and non-cohesive sediment cannot be recommended. To realistically simulate this type of situation, it would require inclusion of a sediment transport function for cohesive sediment that is independent from the non-cohesive sediment transport equation in the reaches of river where non-cohesive sediment is found. It would also require the option to include layers of cohesive sediment with different erosion parameters for each layer. Without these modifications to the STM, it cannot realistically simulate cohesive and non-cohesive sediment transport simultaneously and cannot realistically simulate the phenomena of varying cohesive erosion parameters over depth below the sediment surface. These issues reduce the credibility of STM results such that its predictive capability cannot be accurate.

One of the key questions in the analysis of sediment transport and sedimentation is whether or not sediment will deposit sufficiently to cause backwater and flooding upstream into the City of Miami. Accurately modeling this reach where the bed could be transitioning from primarily non-cohesive to cohesive sediment would require an STM that is capable of simulating both non-cohesive and cohesive sediment transport in a realistic way. Although an STM has been produced for the ISR, analysis of this issue using a model that is unable to realistically simulate such a condition is not appropriate.

5.2.4 Modified STM Calibration Approach

To resolve these challenges, GRDA is proposing a modified approach to calibrating the STM. However, discussion of the modified STM calibration approach first requires a review of work conducted to date. Once the decision was made to create the STM, work began to develop it in HEC-RAS, as directed by FERC's study plan determination. The initial approach, as previously discussed, was to start the model using 1998 channel geometry data, run the STM from 1998 to 2009 for calibrating the model, and then continue running the model from 2009 to 2019 to verify or validate the model. Since the STM would be used to predict the effect of project operations on sedimentation, this was believed to provide a good basis for developing confidence in the model results and its predictive capabilities.

It is important to note that the 2009 and 2019 data does not all originate in 2009 and 2019. Specific reaches where cross-section data are available are found in Table 23 and Table 24. In reaches where both the 2009 and 2019 data rely on the same channel geometry source, calibration will not be possible. For example, it is not possible to calibrate the reach of the Neosho River in the vicinity of Miami because the 2009 and 2019 cross-section data both come from the same set of data (USGS 2017 bathymetry). These tables show the data sources for each terrain geometry.

Table 23
Geometry Data Sources for 2009 Terrain

River	Station	Channel Geometry Source	Floodplain Source
Neosho	152.25 - 122	2017 Bathymetry	2011 LiDAR
Neosho	121.93 - 77.12	2009 Bathymetry	2011 LiDAR
Tar Creek	7.6 - 1.6	n/a	2011 LiDAR
Spring	21 - 3.54	2017 Bathymetry	2011 LiDAR
Spring	3.29 - 0.34	2009 & 2017 Bathymetry	2011 LiDAR
Elk	19.59 - 9.94	2017 Bathymetry	2011 LiDAR
Elk	9.68 - 5.59	2009 & 2017 Bathymetry	2011 LiDAR
Elk	5.47 - 0.32	2009 Bathymetry	2011 LiDAR

Table 24
Geometry Data Sources for 2019 Terrain

River	Station	Channel Geometry Source	Floodplain Source
Neosho	152.25 - 122.46	2017 Bathymetry	2011 LiDAR
Neosho	122.33	2019 Bathymetry	2011 LiDAR
Neosho	122.25 - 122	2017 & 2019 Bathymetry	2011 LiDAR
Neosho	121.93 - 77.12	2019 Bathymetry	2011 LiDAR
Tar Creek	7.6 - 1.6	n/a	2011 LiDAR
Spring	21 - 18.45	n/a	2011 LiDAR
Spring	18.22 - 0.46	2017 Bathymetry	2011 LiDAR
Spring	0.34	2017 & 2019 Bathymetry	2011 LiDAR
Elk	19.59 - 16.7	n/a	2011 LiDAR
Elk	16.42 - 6.95	2017 Bathymetry	2011 LiDAR
Elk	6.68 - 5.59	2017 & 2019 Bathymetry	2011 LiDAR
Elk	5.47 - 0.32	2019 Bathymetry	2011 LiDAR

Based on the sources of channel geometry data, calibration of the STM is possible on the Neosho River between RM 77.12 and 121.93, the Spring River at RM 0.34, and the Elk River from RM 0.32 to 6.68.

Lastly, modeling cohesive sediment transport is significantly more complex than either the underlying hydraulic modeling or modeling of non-cohesive sediment as originally proposed by the City of Miami and accepted by FERC in the Study Plan Determination. While HEC-RAS includes the various basic components of cohesive sediment transport modeling, it is limited by how it applies the various parameters to simulate actual sediment transport, erosion, and deposition processes. Many of these parameters vary considerably with depth below the sediment surface, even at a relatively small depth. If critical shear stress in the model is set to a specific value but the actual condition is 3000% of that number, or if erosion rate is set to 1,000,000% of the actual value, the computed erosion and rate of erosion would not represent actual erosion and transport conditions. The predictive results of a cohesive STM can easily become unrealistic. Therefore, an alternative approach previously suggested by GRDA should be used to determine actual transport processes and to predict future trends.

GRDA proposes using the STM to evaluate bed shear stresses and determine sediment transport rates and patterns. This will be similar to the approach suggested by GRDA in the Revised Study Plan (RSP) submitted in 2018. STM results will be used to develop hydraulic shear stress-duration curves at specific locations within the study area; these hydraulic shear stresses will then be compared to the known critical shear stresses of bed sediments as determined through SEDflume analysis and historic sediment loading within the study area. This approach will allow GRDA to determine how incoming sediment was distributed over this time period.

STM outputs can then be used for future scenarios using synthetic hydrographs and associated sediment loading rates. The potential sediment transport patterns can then be developed, model geometry can be updated to reflect those changes, and hydraulic shear stress-duration curves can be created to update potential deposition patterns and determine the effects of sedimentation on hydraulics under future flow regimes. This approach relies on real-world data coupled with easy-to-understand analysis techniques and does not suffer from the extremely wide range of calibration parameters that affect the STM approach proposed by the City of Miami.

Sediment transport is a function of the hydraulic shear stress applied to the bed of a river or reservoir. Given the incoming sediment load and erosion characteristics of the sediment, the distribution of hydraulic shear stress as it varies in the downstream direction as water flows from the rivers into the reservoir dictates how the pattern of sedimentation develops. For example, in the riverine reaches where hydraulic shear stress exceeds critical shear stress, no sediment will be deposited. As the water and sediment reach the reservoir where hydraulic shear stresses progressively decrease in the downstream direction, sediment will deposit. Relationships can be developed between the distribution of hydraulic shear stress and the amount of sediment deposited at various locations along the river and reservoir. These relationships explain the sedimentation pattern that has developed in the reservoir based on changes in bathymetry over time. Using these relationships based on data and hydraulic analysis of shear stress, scenarios representing hydraulic shear stress distributions will be developed for alternative operating scenarios. Based on these scenarios of hydraulic shear stress, new patterns of sedimentation representing future conditions will be developed. The sediment loading from the rivers using the associated hydrology accompanying the scenarios combined with the sediment rating curves will provide the necessary sediment loading information. A more detailed explanation of the approach is discussed in the PMSP.

GRDA will convene a technical meeting to discuss results to date, present the wide range of STM parameter values that define cohesive sediment characteristics, and to discuss specific approaches in moving forward to develop an understanding of sedimentation processes relevant to the relicensing process. Such discussions are necessary given the potential for disagreement regarding potential approaches and solutions in an attempt to focus efforts on what will best serve the varied interests.

The overall objective of the proposed discussion and subsequent analysis will continue to assess the effects of Project operations on sediment erosion, transport and deposition in the lower reaches of the tributaries to Grand Lake and to characterize the impact that sedimentation has on flooding upstream of Pensacola Dam and the conservation pool.

5.2.5 Calibration Discussion

Calibration efforts for sediment transport within the STM have been hampered by several factors. These include misleading claims about sediment properties in the system, widely varying sediment characteristics both spatially and temporally, and limitations of the modeling system that result in considerable errors in predictive simulations.

Information provided by the City of Miami (City of Miami 2018) indicated that the bed consisted primarily of sand and non-cohesive materials. Field data proved that a majority of sediment moving through the study area was in fact cohesive silts and clays. This required additional field and laboratory efforts in the form of core sampling and SEDflume analysis to determine additional sediment parameters.

SEDflume analysis showed that the silts and clays varied widely within the study area. They vary spatially and with depth in the sediment column; density, critical shear stress, and erosion rate have ranges of 485%; 3,000%; and 1,000,000%, respectively. Because these characteristics also vary over time as they consolidate and gain additional strength, simulating such a system requires a powerful, flexible modeling package.

HEC-RAS is not a suitable modeling package for simulating cohesive sediment transport over decades of flow conditions. It allows sediment density to change over time, but critical shear stress and erosion characteristics are static within the model. These parameters also do not vary with depth in the sediment column, and this over-simplification greatly reduces the reliability of HEC-RAS as a predictive tool for the purposes of this study.

The sediment team performed simulations described above to test the potential range of outcomes while making reasonable simplified assumptions about sediment characteristics. The model failed to accurately predict sediment transport and realistically simulate the transport of a mixture of cohesive and non-cohesive sediments, indicating that HEC-RAS is not a viable option for the goals of predicting sediment transport within the Grand Lake study area.

The team is instead moving forward with analysis using the relationship between hydraulic shear stress and sediment transport rates. Using the STM to produce shear stress outputs will provide the required information for this study without relying on a questionable model that over-simplifies reality and has been shown to be incapable of predicting sediment transport. Full details of the plan have been included in the PMSP.

6. Continuing Work

Following presentation of the ISR and calibrated model, the following tasks were specified in the ISR:

- Update STM, as appropriate, based upon comments.
  - Run the STM for current operation over a 50-year period.
  - Run the STM for anticipated future operations over a 50-year period.
  - Describe observed or predicted effects of sedimentation on the power pool.

The findings from the analyses during the initial study period have resulted in the development of a PMSP.

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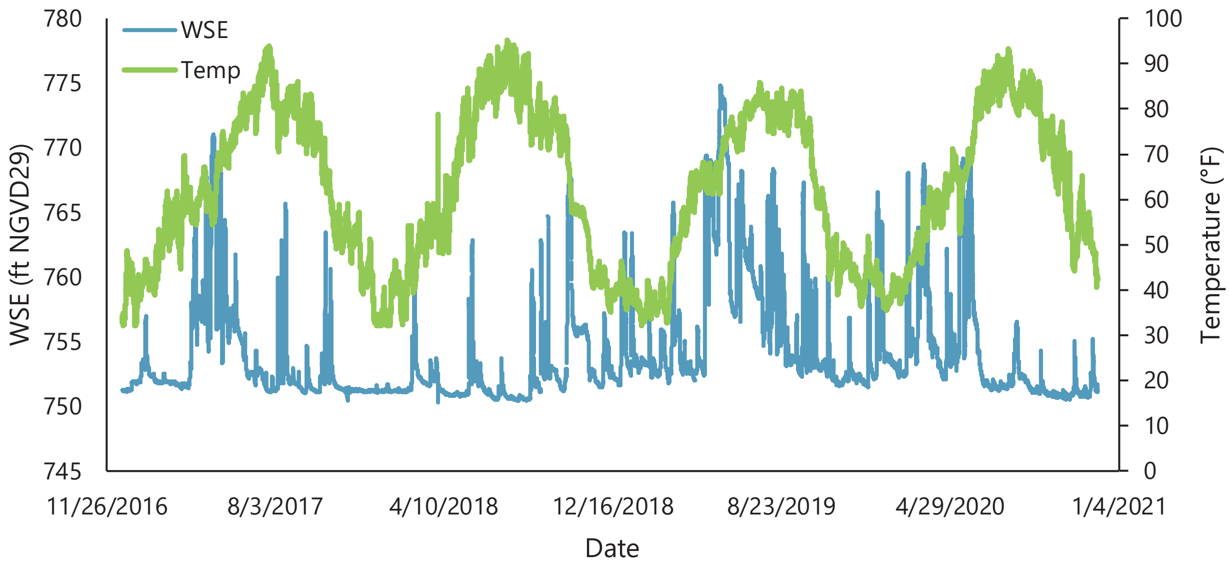
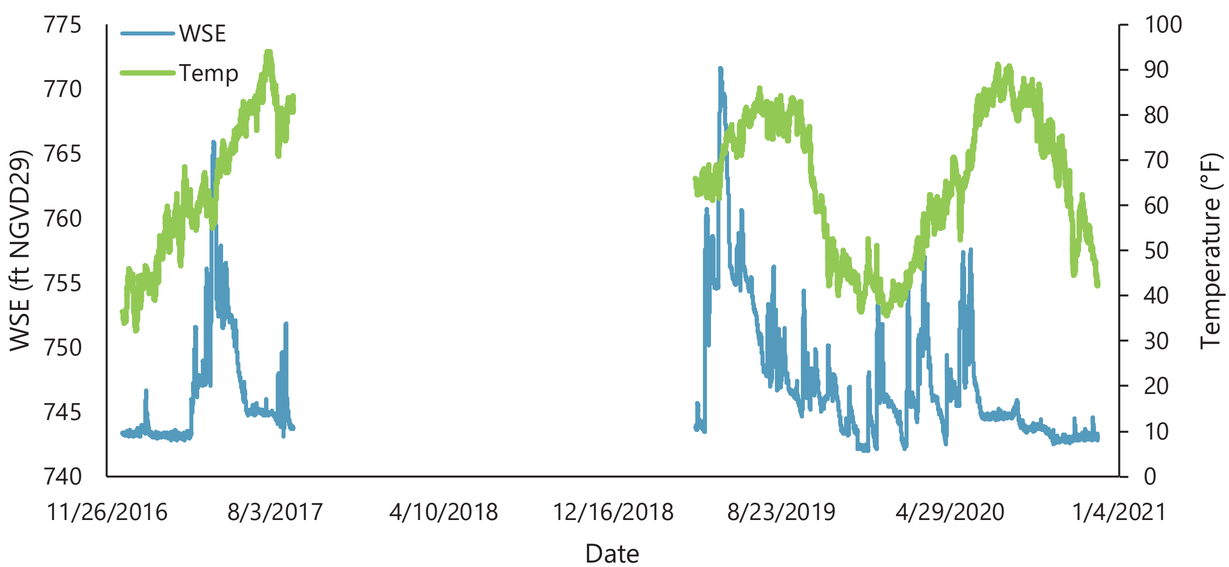
Appendix A
Water Surface Elevation Monitoring

Station 1: Neosho River near Commerce, Oklahoma

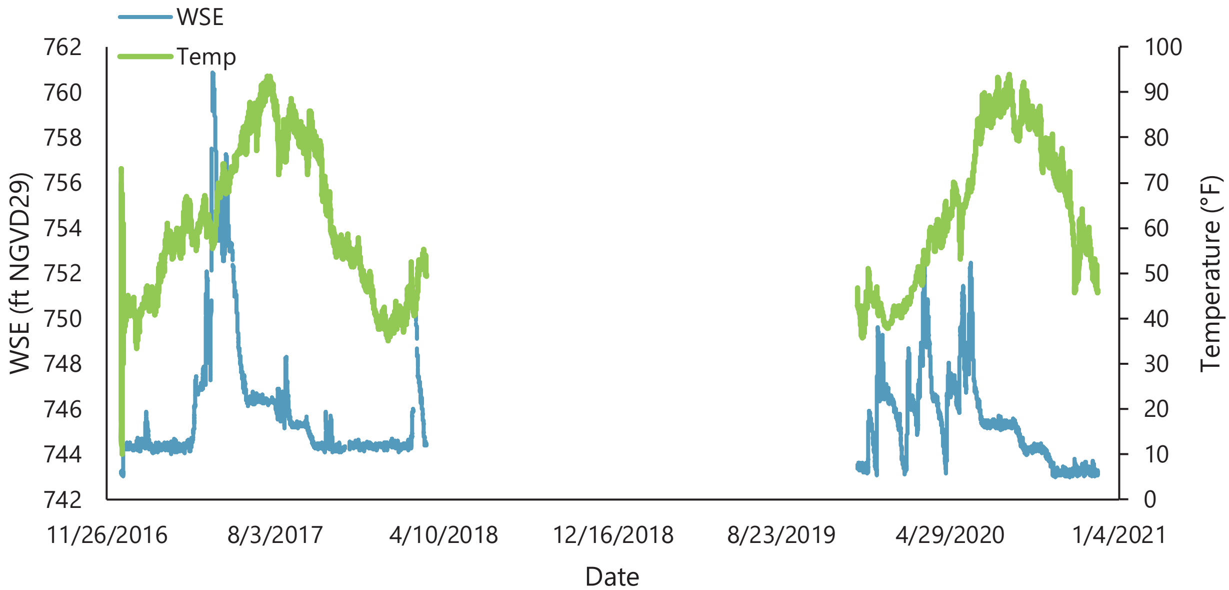


Station 2: Neosho River at Riverview Park in Miami, Oklahoma



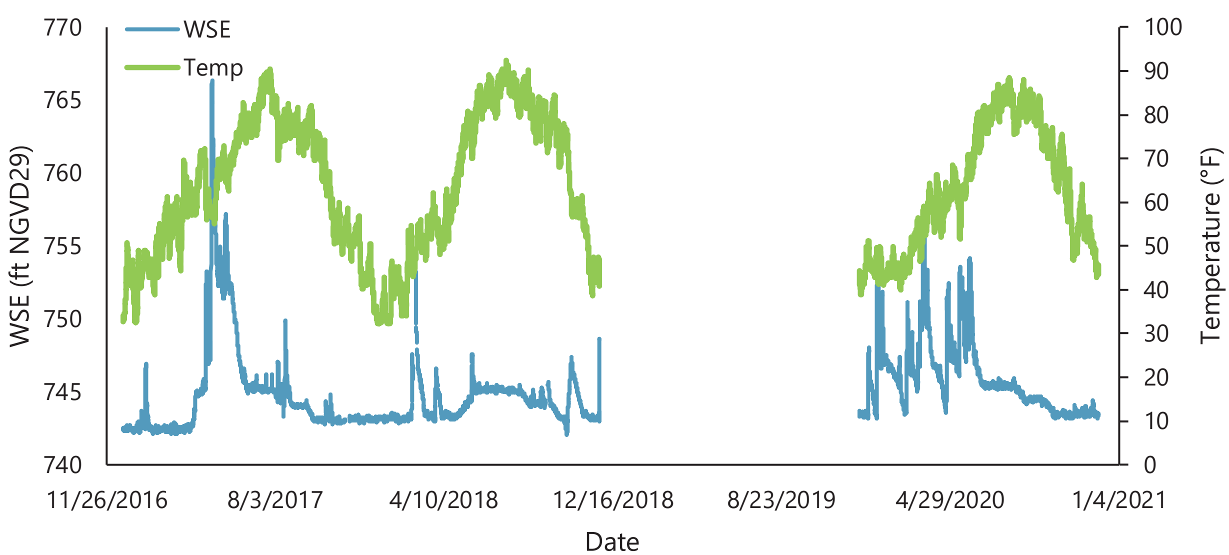
Note: WSE logger not recoverable after August 2017 and had washed away by April 2019. It was replaced and has been recording since April 2019.

Station 3: Neosho River at Connors Bridge at South 590 Road



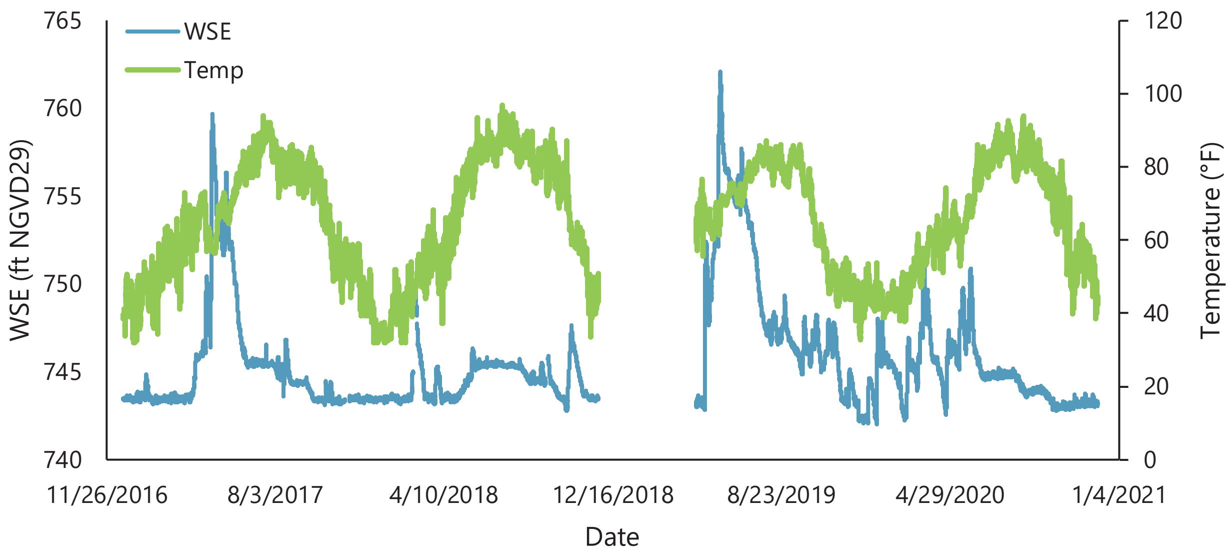
Note: WSE logger not recoverable between August 2017 and April 2019. Internal storage was filled by March 2018. It was re-deployed in April 2019 but washed away between April and December 2019 and was replaced.

Station 4: Spring River Upstream of Highway 10 Bridge



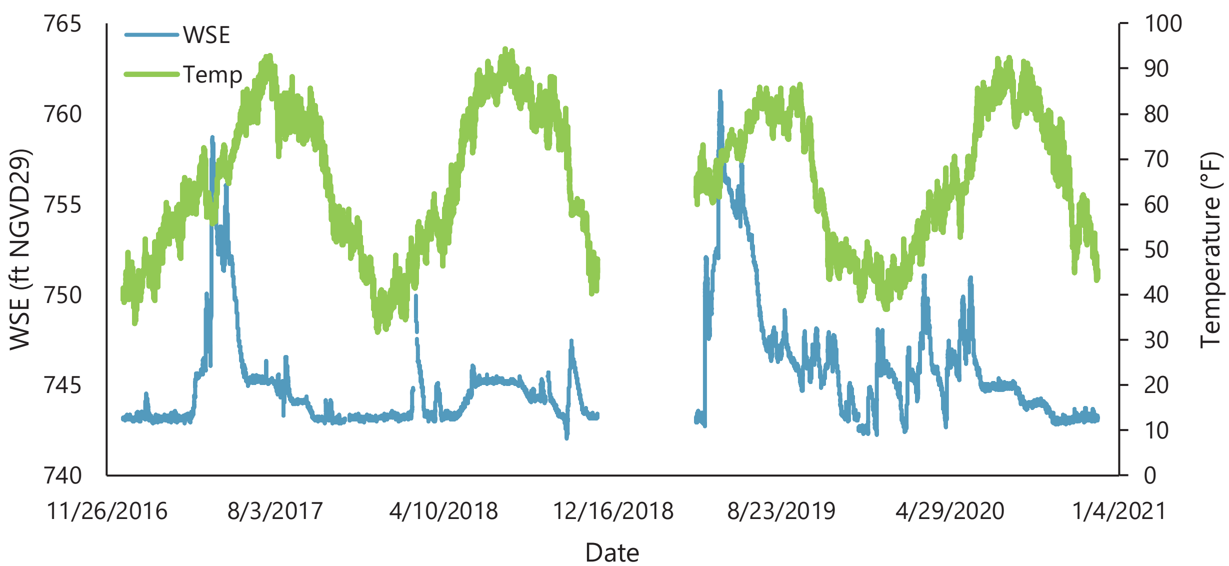
Note: WSE logger not recoverable between August 2017 and April 2019. Logger washed away between April and December 2019 and was replaced.

Station 5: Spring River at Twin Bridges Area at Grand Lake State Park Boat Launch



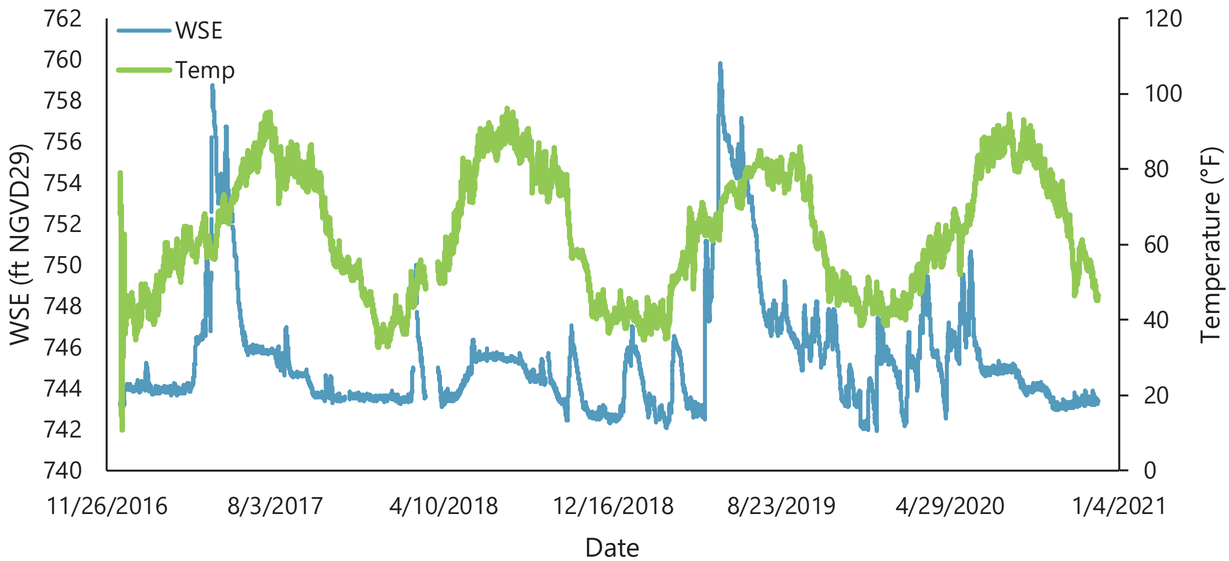
Note: WSE logger not recoverable between August 2017 and April 2019. Data gap due to insufficient internal memory following August 2017 deployment.

Station 6: Confluence of Neosho River and Spring River at Twin Bridges Area at Grand Lake State Park

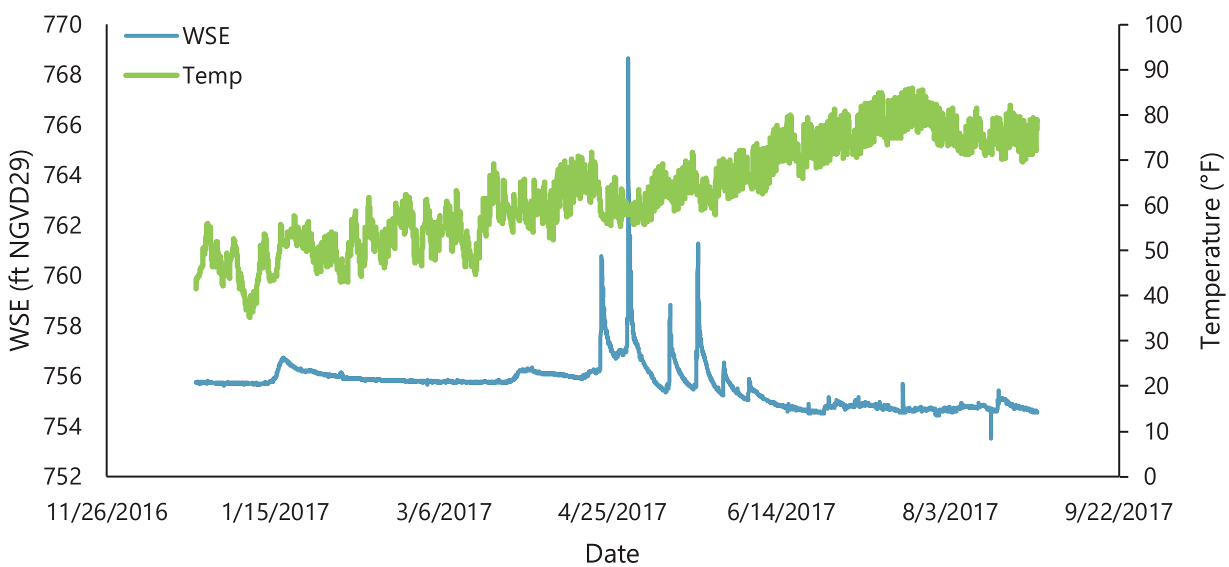


Note: WSE logger not recoverable between August 2017 and April 2019. Data gap due to insufficient internal memory following August 2017 deployment.

Station 7: Neosho River off East 157 Road Downstream of Railroad Bridge



Station 8: Sycamore Creek at Highway 10 Bridge

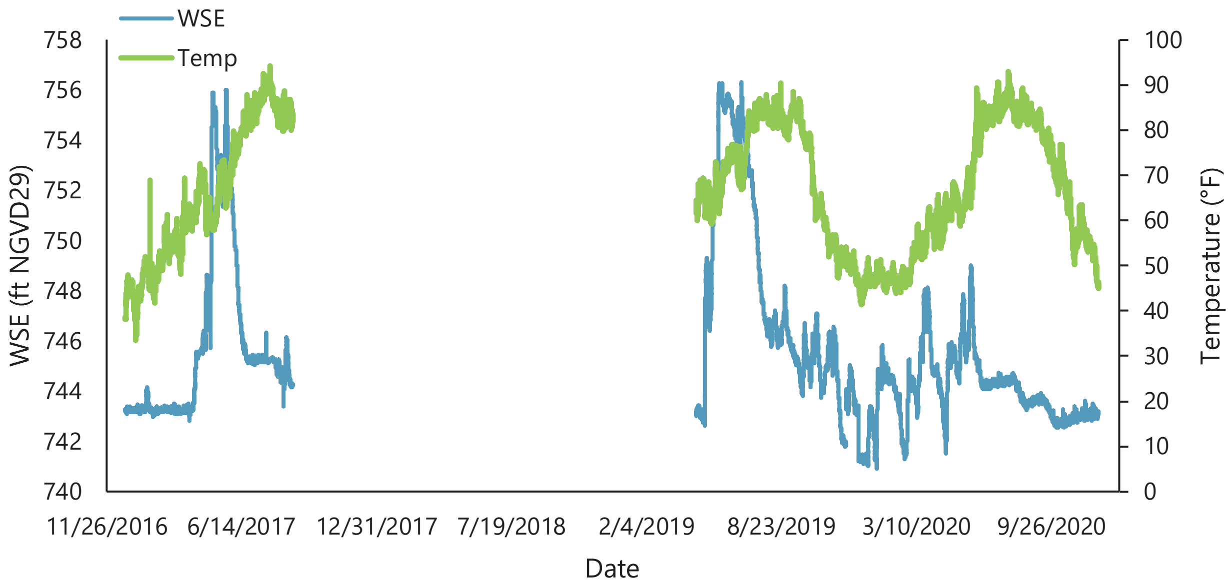


Note: WSE logger not recoverable since August 2017. Logger washed away three times and was replaced in both April and December 2019 as well as December 2020.

Station 9: Neosho River at Roadside Park off Highway 10

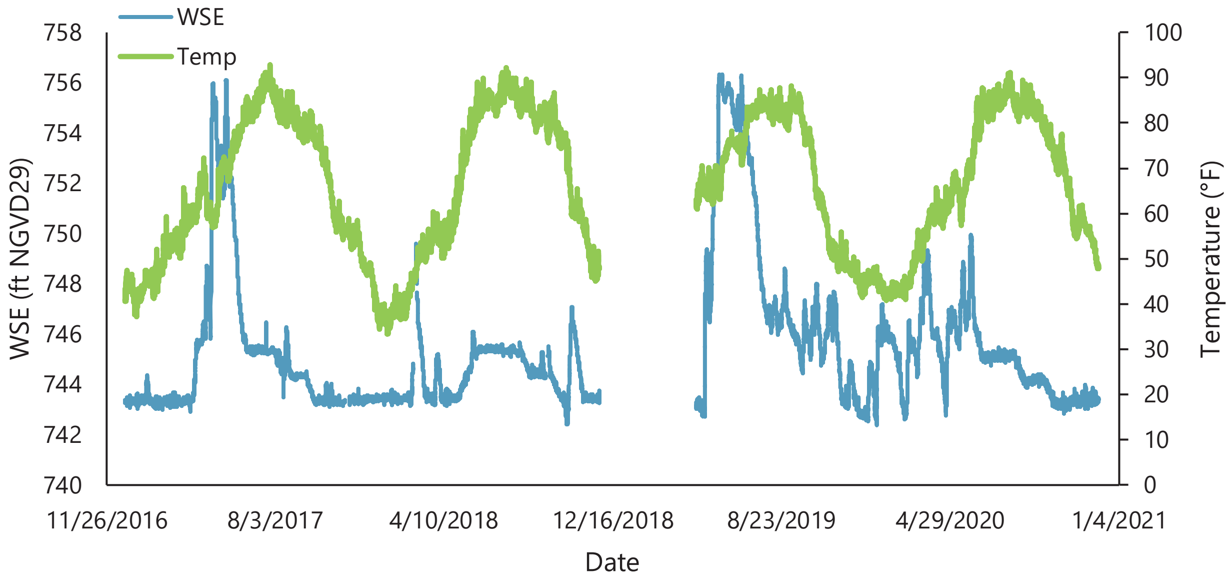
Note: WSE logger not recoverable since August 2017

Station 10: Grand Lake/Elk River Upstream of Highway 10 Bridge North of Grove, Oklahoma



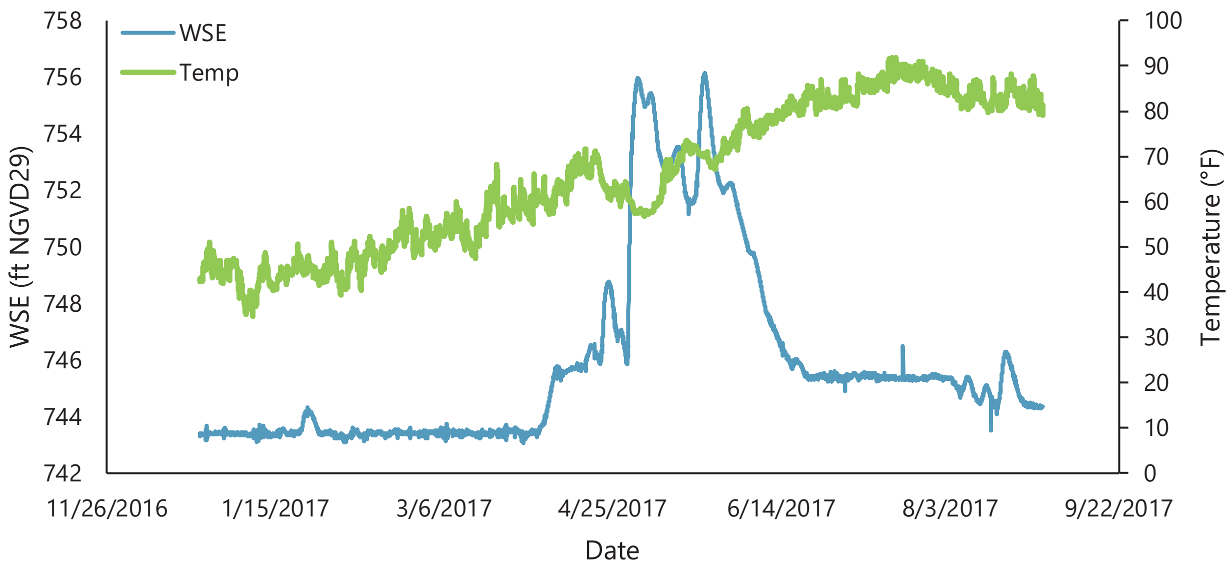
Note: WSE logger not recoverable after August 2017 and had washed away by April 2019. It was replaced and has been recording since April 2019. Data gap due to insufficient internal memory following August 2017 deployment.

Station 11: Grand Lake at Hickory Point, Upstream of Highway 59 Bridge



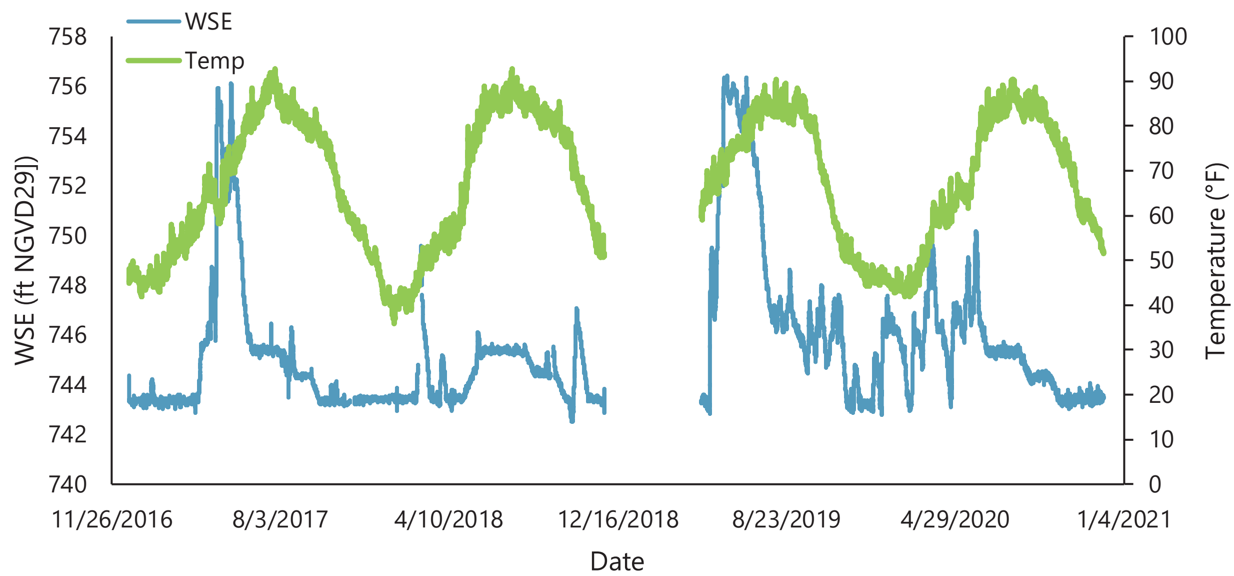
Note: WSE logger not recoverable between August 2017 and April 2019. Data gap due to insufficient internal memory following August 2017 deployment.

Station 12: Grand Lake at Public Access off South 580 Road, Downstream of Highway 59 Bridge



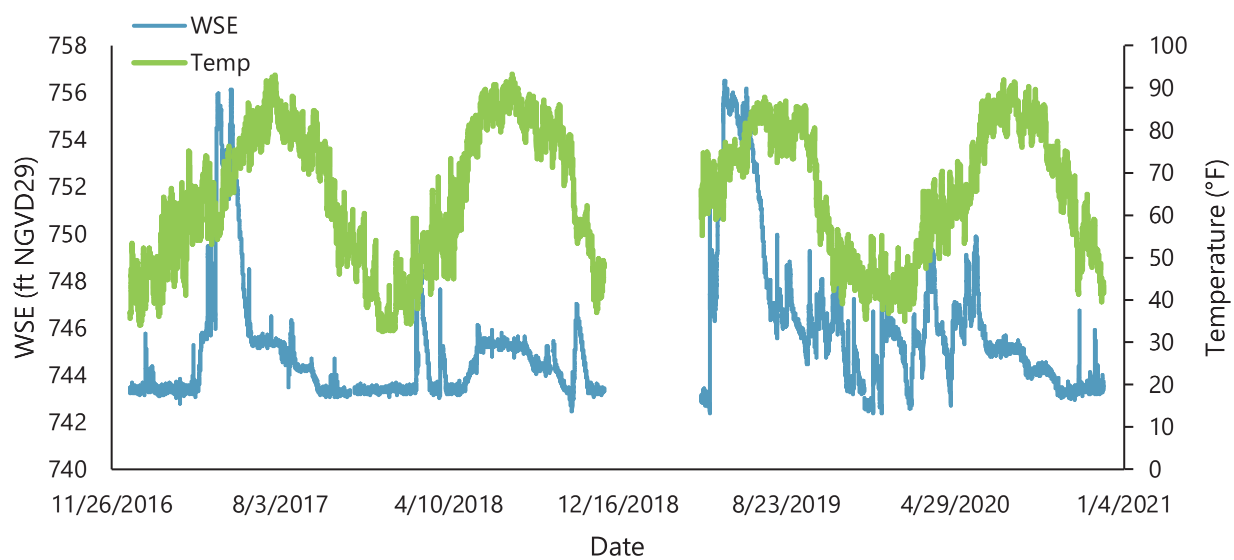
Note: WSE logger not recoverable since August 2017.

Station 13: Grand Lake at Honey Creek State Park



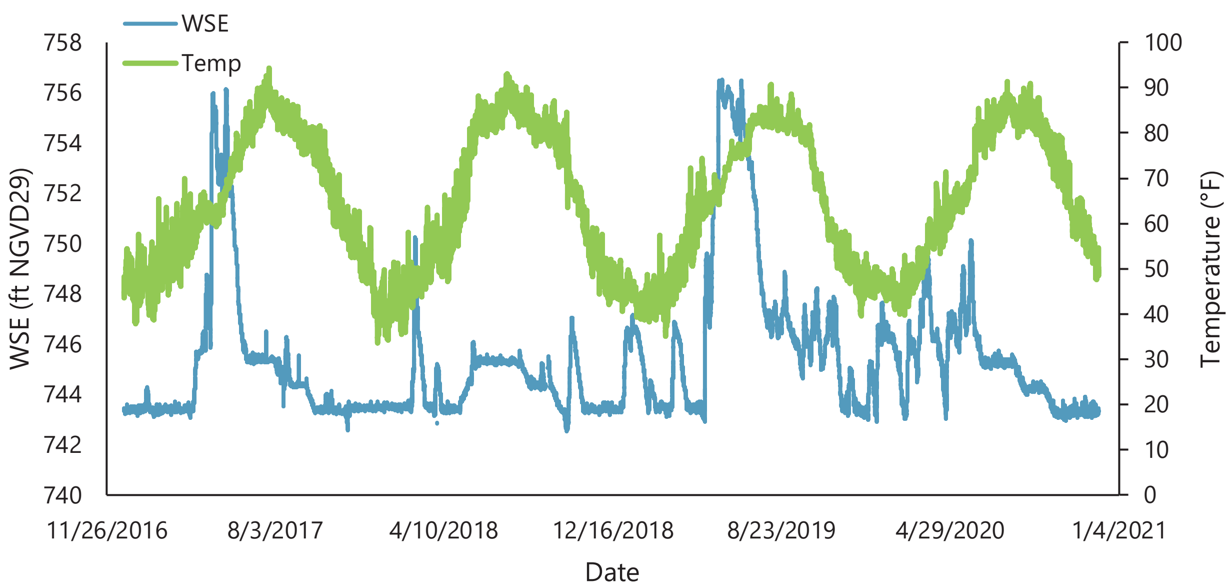
Note: WSE logger not recoverable between August 2017 and April 2019. Data gap due to insufficient internal memory following August 2017 deployment.

Station 14: Horse Creek off East 249 Road

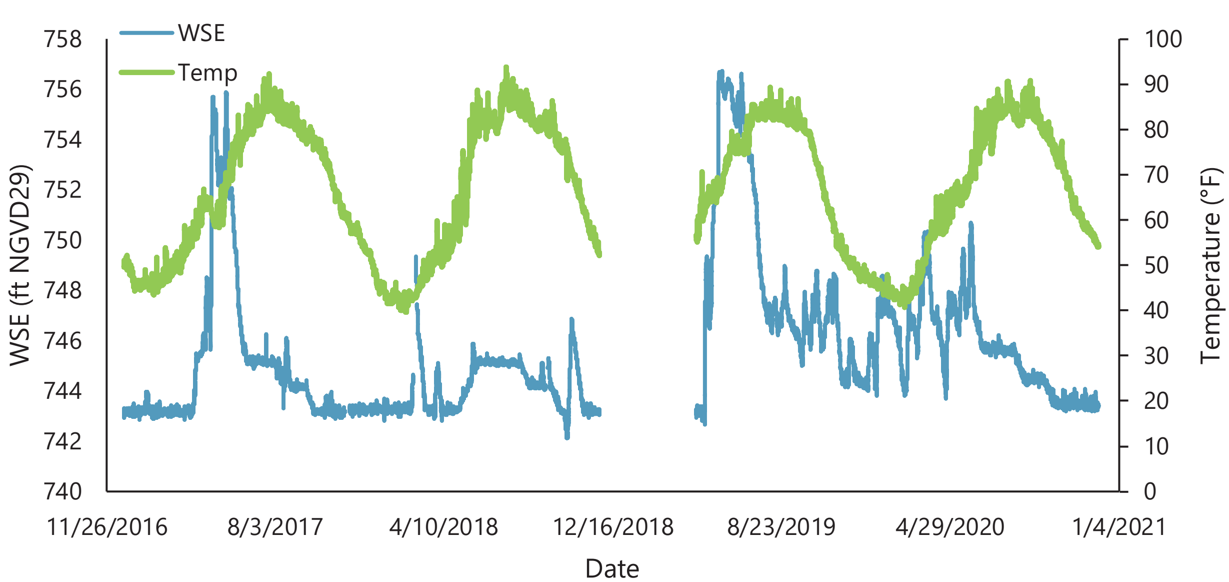


Note: WSE logger not recoverable between August 2017 and April 2019. Data gap due to insufficient internal memory following August 2017 deployment.

Station 15: Grand Lake near Woods Spring Branch off South 560 Road and East 360 Road



Station 16: Grand Lake at Cherokee State Park Boat Ramp in Disney, Oklahoma



Note: WSE logger not recoverable between August 2017 and April 2019. Data gap due to insufficient internal memory following August 2017 deployment.

Table A-19
RTK-GPS Water Surface Elevation Measurements

Site No.	Location Description	Status	Date	Time [U.S. Central]	Northing [ft, OK N]	Easting [ft, OK N]	Elevation [ft NGVD29]
2	Neosho River at Riverview Park; Miami, OK	FIXED	04/17/2019	9:47	691658.298	2882200.694	743.774
3	Neosho River at Connors Bridge at S 590 Rd	FIXED	04/17/2019	16:43	670153.750	2899762.406	743.316
4	Spring River upstream of HWY 10 Bridge	***FLOAT***	04/17/2019	15:38	697539.664	2914724.085	747.985
5	Spring River at Twin Bridges Area at Grand Lake State Park boat launch	FIXED	04/17/2019	19:44	672656.026	2918379.484	743.124
6	Confluence of Neosho and Spring Rivers at Twin Bridges Area at Grand Lake State Park	FIXED	04/17/2019	20:05	670392.455	2918839.044	743.033
7	Neosho River off E 157 Road downstream of railroad bridge	FIXED	04/18/2019	7:52	665496.805	2917824.623	743.052
8	Sycamore Creek at HWY 10 Bridge	FIXED	04/18/2019	9:07	660201.790	2937133.318	754.728
10	Grand Lake/Elk River upstream of HWY 10 Bridge; north of Grove, OK	FIXED	04/18/2019	9:52	617897.988	2935022.412	743.286
11	Grand Lake at Hickory Point, upstream of HWY 59 Bridge	FIXED	04/18/2019	10:53	613027.180	2908379.085	743.223
12	Grand Lake at public access off S 580 Rd, downstream of HWY 59 Bridge	FIXED	04/18/2019	11:31	612194.062	2896453.042	742.883
13	Grand Lake at Honey Creek State Park	FIXED	04/18/2019	16:57	588620.786	2911838.008	743.266
14	Horse Creek off E 249 Rd	FIXED	04/18/2019	13:26	624203.231	2875288.114	742.929
15	Grand Lake near Woods Spring Branch off S 560 Rd & E 360 Rd	FIXED	04/18/2019	15:50	556696.710	2881255.658	743.104
16	Grand Lake at Cherokee State Park Boat Ramp; Disney, OK	FIXED	04/18/2019	14:31	552673.819	2847801.546	743.160
1	Neosho River near Commerce, OK	FIXED	08/14/2019	11:07	715787.060	2857696.142	762.693
2	Neosho River at Riverview Park; Miami, OK	FIXED	08/16/2019	11:10	691694.498	2882172.159	747.276
3	Neosho River at Connors Bridge at S 590 Rd	FIXED	08/16/2019	11:52	670169.134	2899764.755	747.150
4	Spring River upstream of HWY 10 Bridge	FIXED	08/16/2019	14:07	697038.562	2914621.602	**723.284**
5	Spring River at Twin Bridges Area at Grand Lake State Park boat launch	FIXED	08/16/2019	12:44	672645.296	2918394.628	746.758
6	Confluence of Neosho and Spring Rivers at Twin Bridges Area at Grand Lake State Park	FIXED	08/16/2019	12:58	670401.875	2918830.210	746.535
7	Neosho River off E 157 Road downstream of railroad bridge	FIXED	08/17/2019	12:31	665497.806	2917855.086	746.721
8	Sycamore Creek at HWY 10 Bridge	FIXED	08/17/2019	12:12	660158.317	2937196.121	755.483
9	Neosho River at roadside park off HWY 10	FIXED	08/17/2019	12:01	649343.294	2929170.012	746.653
10	Grand Lake/Elk River upstream of HWY 10 Bridge; north of Grove, OK	FIXED	08/17/2019	11:48	617894.238	2935003.439	745.961
13	Grand Lake at Honey Creek State Park	FIXED	08/17/2019	11:09	588622.899	2911844.853	746.420
15	Grand Lake near Woods Spring Branch off S 560 Rd & E 360 Rd	FIXED	08/17/2019	10:27	556783.467	2881176.310	746.769
16	Grand Lake at Cherokee State Park Boat Ramp; Disney, OK	FIXED	08/17/2019	9:46	552689.099	2847945.632	746.253
1	Neosho River near Commerce, OK	FIXED	12/12/2019	11:50	715877.597	2857162.787	751.844
1	Neosho River near Commerce, OK	FIXED	12/13/2019	13:38	715876.418	2857161.820	752.124
2	Neosho River at Riverview Park; Miami, OK	FIXED	12/13/2019	14:18	691693.165	2882187.376	743.394
3	Neosho River at Connors Bridge at S 590 Rd	FIXED	12/13/2019	15:36	670153.753	2899760.180	743.472
4	Spring River upstream of HWY 10 Bridge	FIXED	12/14/2019	8:16	697067.767	2914585.433	743.632
4	Spring River upstream of HWY 10 Bridge	FIXED	12/15/2019	17:15	697733.625	2914844.643	743.520
5	Spring River at Twin Bridges Area at Grand Lake State Park boat launch	FIXED	12/14/2019	9:28	672655.499	2918380.029	743.352
6	Confluence of Neosho and Spring Rivers at Twin Bridges Area at Grand Lake State Park	FIXED	12/14/2019	10:03	670395.980	2918845.765	743.400
7	Neosho River off E 157 Road downstream of railroad bridge	FIXED	12/14/2019	11:01	665496.584	2917821.749	743.447
8	Sycamore Creek at HWY 10 Bridge	FIXED	12/14/2019	12:27	660147.944	2937238.325	755.437

Table A-19
RTK-GPS Water Surface Elevation Measurements

Site No.	Location Description	Status	Date	Time [U.S. Central]	Northing [ft, OK N]	Easting [ft, OK N]	Elevation [ft NGVD29]
8	Sycamore Creek at HWY 10 Bridge	FIXED	12/15/2019	15:43	660151.595	2937222.997	755.485
9	Neosho River at roadside park off HWY 10	FIXED	12/14/2019	12:52	649312.398	2929135.362	743.144
10	Grand Lake/Elk River upstream of HWY 10 Bridge; north of Grove, OK	FIXED	12/14/2019	13:08	617890.491	2935018.927	743.295
11	Grand Lake at Hickory Point, upstream of HWY 59 Bridge	FIXED	12/14/2019	16:05	613059.851	2908384.212	743.288
13	Grand Lake at Honey Creek State Park	FIXED	12/14/2019	14:34	588657.222	2911737.544	743.161
14	Horse Creek off E 249 Rd	FIXED	12/15/2019	13:48	624518.073	2875233.239	743.428
15	Grand Lake near Woods Spring Branch off S 560 Rd & E 360 Rd	FIXED	12/15/2019	11:13	556701.317	2881246.886	743.147
16	Grand Lake at Cherokee State Park Boat Ramp; Disney, OK	FIXED	12/15/2019	10:07	552700.649	2847980.396	744.178
1	Neosho River near Commerce, OK	FIXED	12/03/2020	9:31	715879.316	2857162.495	751.701
2	Neosho River at Riverview Park; Miami, OK	FIXED	12/03/2020	11:49	691664.321	2882203.087	743.194
3	Neosho River at Connors Bridge at S 590 Rd	FIXED	12/03/2020	13:10	670153.687	2899734.638	743.236
4	Spring River upstream of HWY 10 Bridge	FIXED	12/04/2020	7:37	697091.619	2914603.187	743.476
5	Spring River at Twin Bridges Area at Grand Lake State Park boat launch	FIXED	12/03/2020	15:03	672650.395	2918388.949	743.258
6	Confluence of Neosho and Spring Rivers at Twin Bridges Area at Grand Lake State Park	FIXED	12/03/2020	16:10	670402.201	2918854.959	743.226
7	Neosho River off E 157 Road downstream of railroad bridge	FIXED	12/04/2020	11:01	665512.468	2917841.979	743.393
8	Sycamore Creek at HWY 10 Bridge	FIXED	12/04/2020	8:51	660159.476	2937217.898	755.754
9	Neosho River at roadside park off HWY 10	FIXED	12/04/2020	10:41	649350.815	2929145.018	743.320
10	Grand Lake/Elk River upstream of HWY 10 Bridge; north of Grove, OK	FIXED	12/04/2020	11:03	617870.337	2934983.314	743.195
11	Grand Lake at Hickory Point, upstream of HWY 59 Bridge	FIXED	12/04/2020	16:09	613045.080	2908374.723	743.297
12	Grand Lake at public access off S 580 Rd, downstream of HWY 59 Bridge	FIXED	12/05/2020	9:23	612070.218	2896299.887	743.456
13	Grand Lake at Honey Creek State Park	FIXED	12/04/2020	12:53	588671.915	2911713.703	743.437
14	Horse Creek off E 249 Rd	FIXED	12/05/2020	7:56	624543.162	2875241.079	743.404
15	Grand Lake near Woods Spring Branch off S 560 Rd & E 360 Rd	FIXED	12/04/2020	15:06	556774.614	2881150.404	743.208
16	Grand Lake at Cherokee State Park Boat Ramp; Disney, OK	FIXED	12/04/2020	14:04	552706.889	2847914.361	742.976

Notes:

—: data unavailable

ft: feet

NGVD29: National Geodetic Vertical Datum of 1929

Temp: temperature in degrees Fahrenheit

Figures

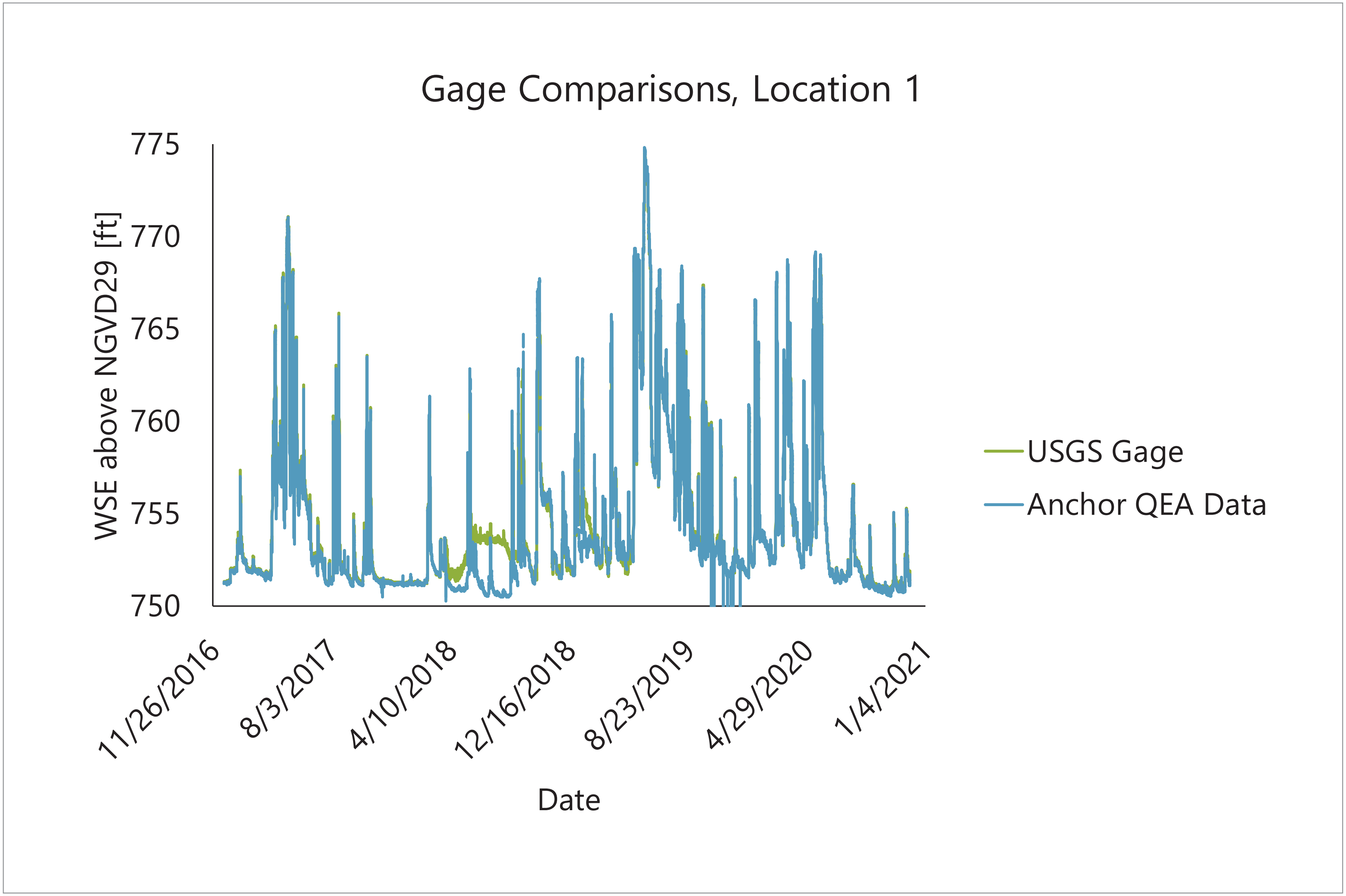
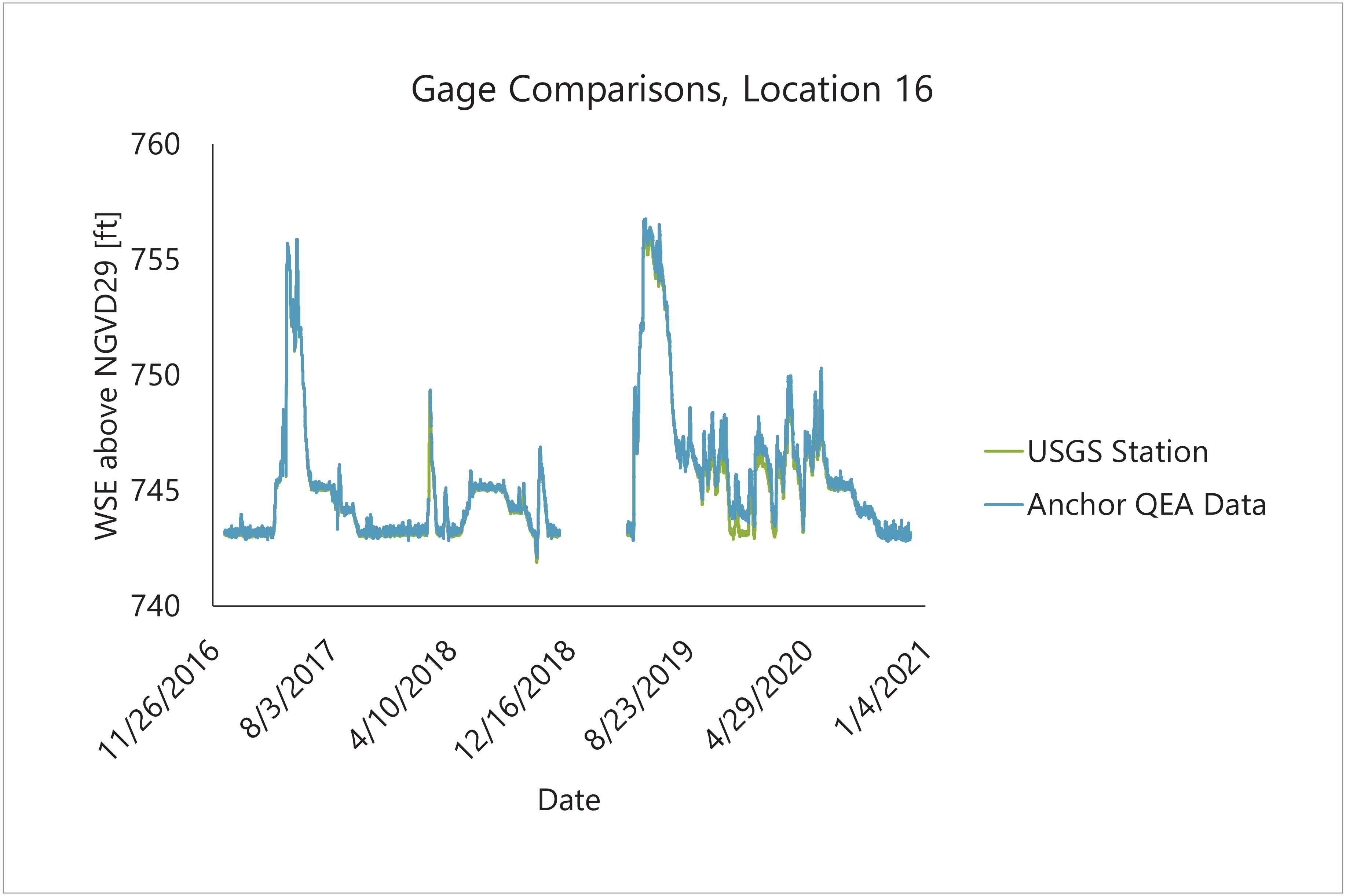
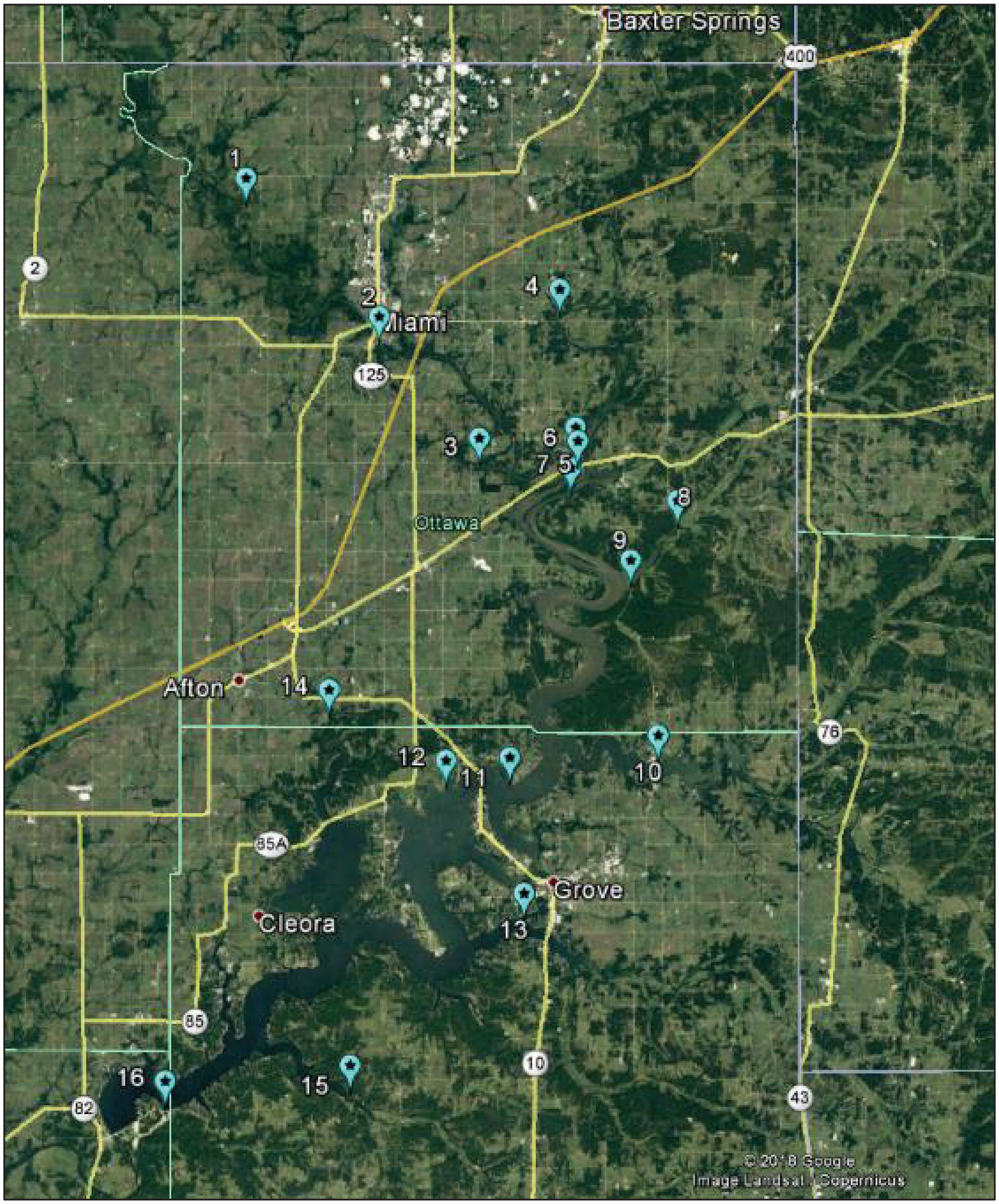


Figure A-1
Gage Comparisons, Location 1
Initial Study Report
Grand Lake Sedimentation Study



ANCHOR QEA

Figure A-2
Gage Comparisons, Location 16
Initial Study Report
Grand Lake Sedimentation Study



ANCHOR QEA

Figure A-3
Location Map
Initial Study Report
Grand Lake Sedimentation Study

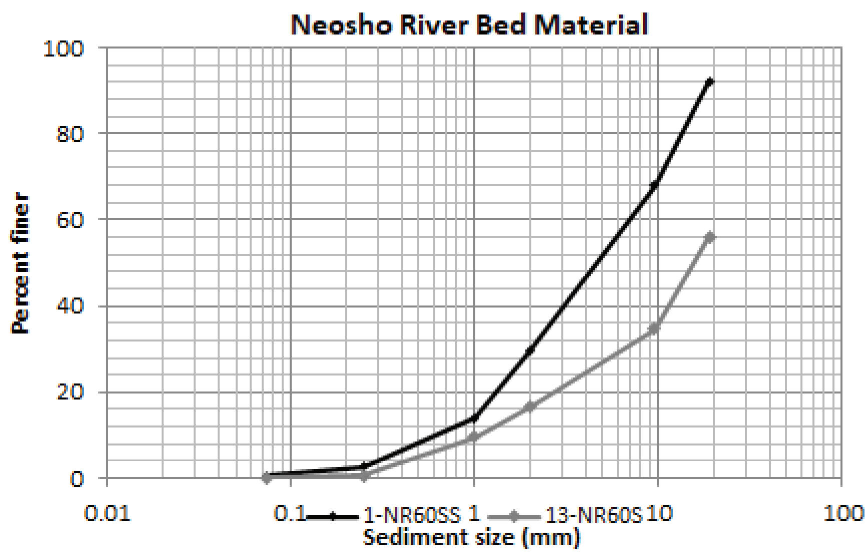
Appendix B
Sediment Grab Sampling

Particle Size Distribution Results

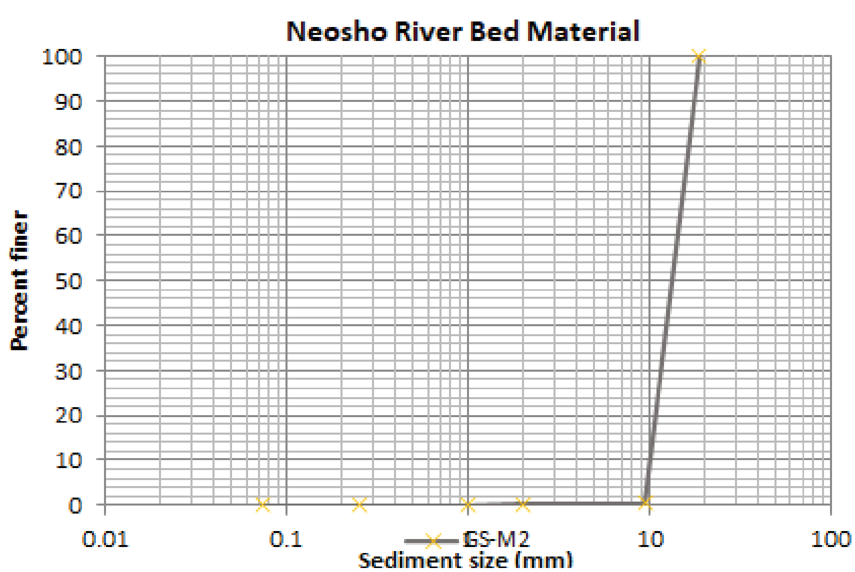
Note: Graphs are provided for each stream in an upstream to downstream direction showing HEC-RAS River Mile for each sample. Core sample particle size distributions are also included with other samples to provide context and completeness. Unless otherwise noted, samples are from the riverbed.

Neosho River above Tar Creek

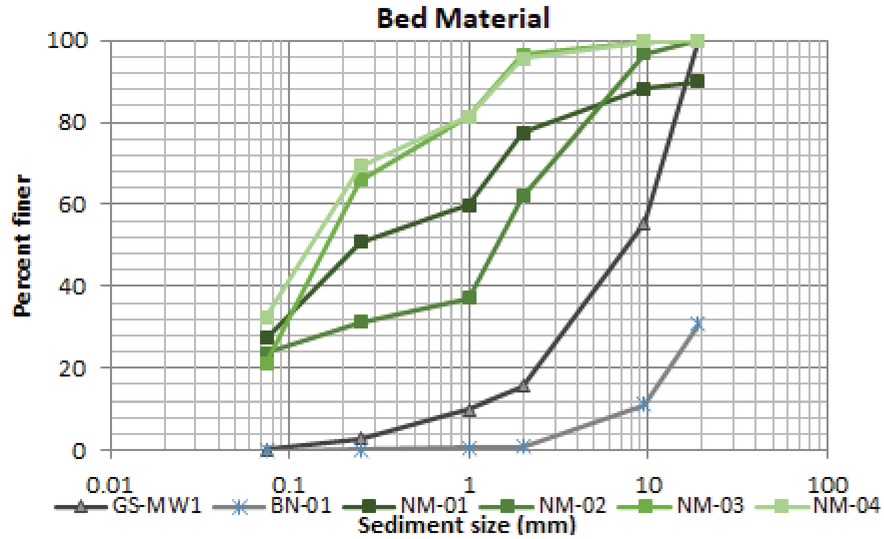
River Mile 145.5



River Mile 135.95

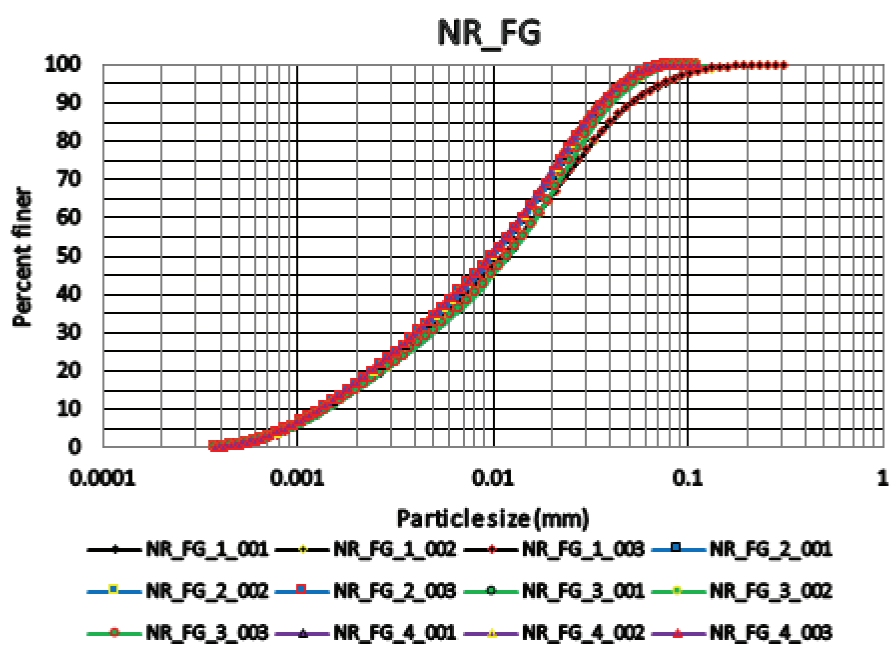


River Mile 134.6–135.46

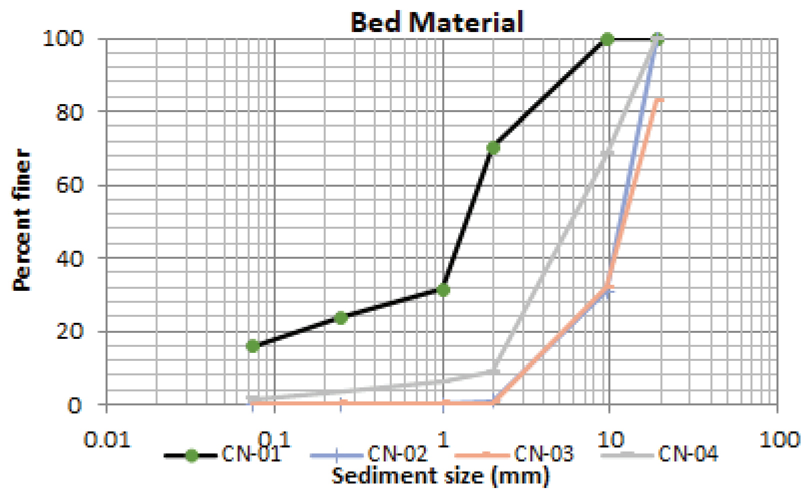


Note: NM-01 – left bank surface, NM-02 – floodplain surface, NM-04 – right bank surface

River Mile 135.04

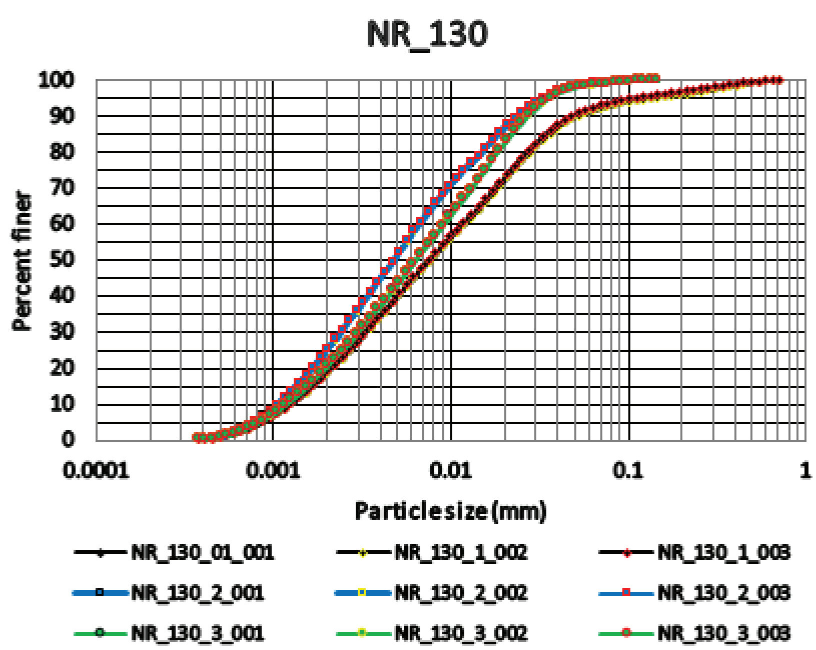


River Mile 128.81–130.37

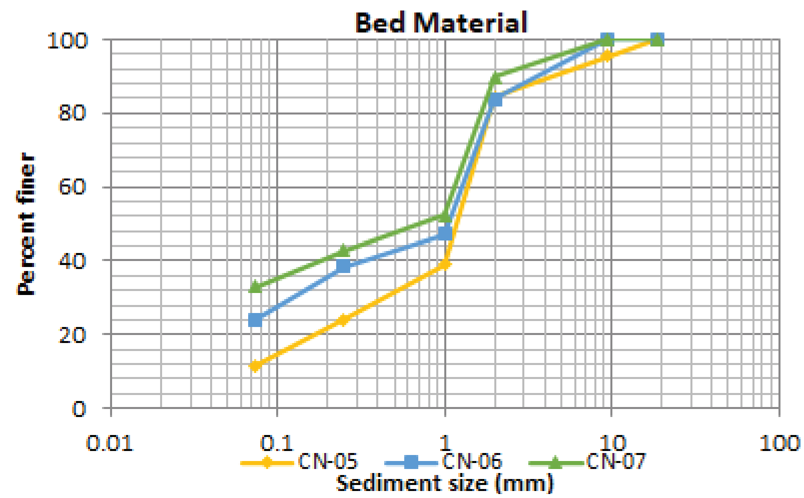


Note: CN-01 – bank

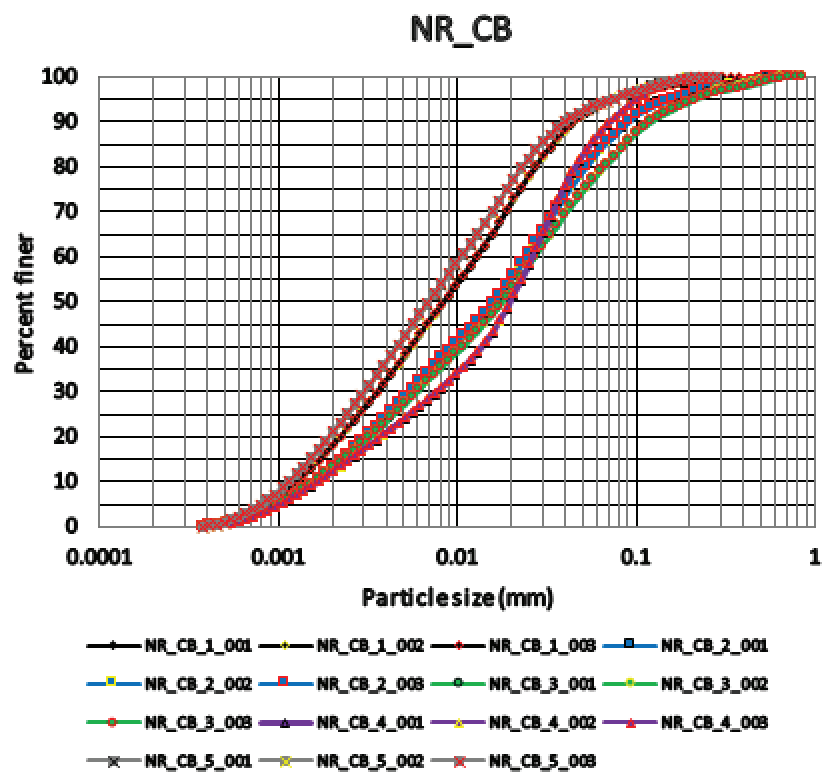
River Mile 130.37



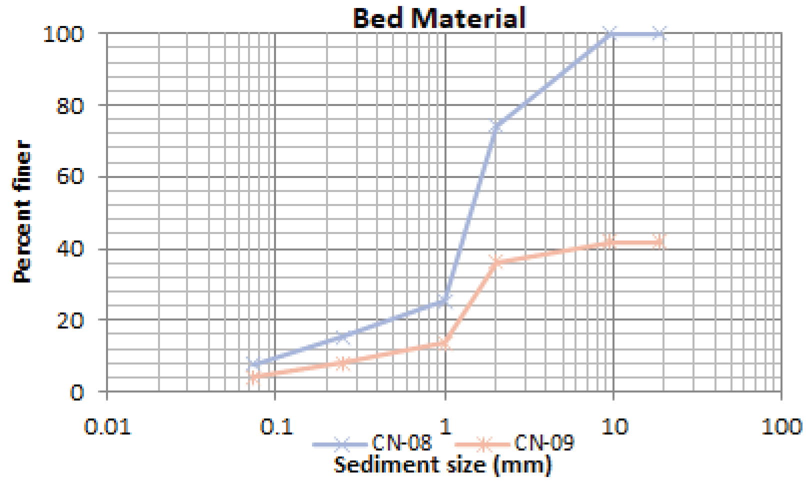
River Mile 126.69–127.85



River Mile 126.69

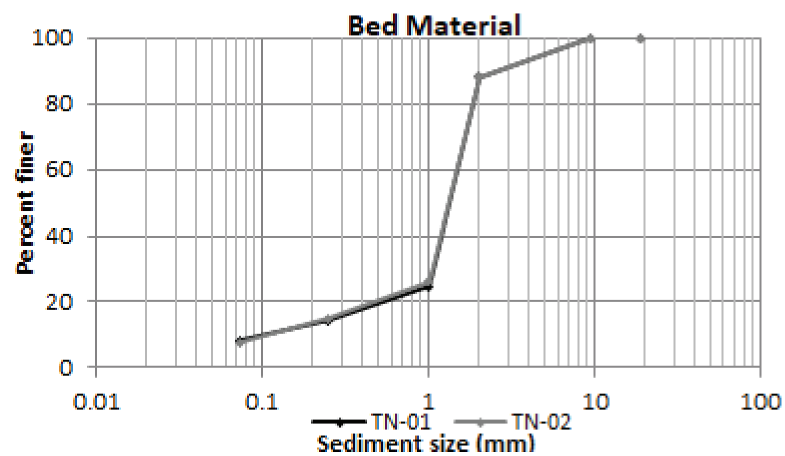


River Mile 124.2–125.33



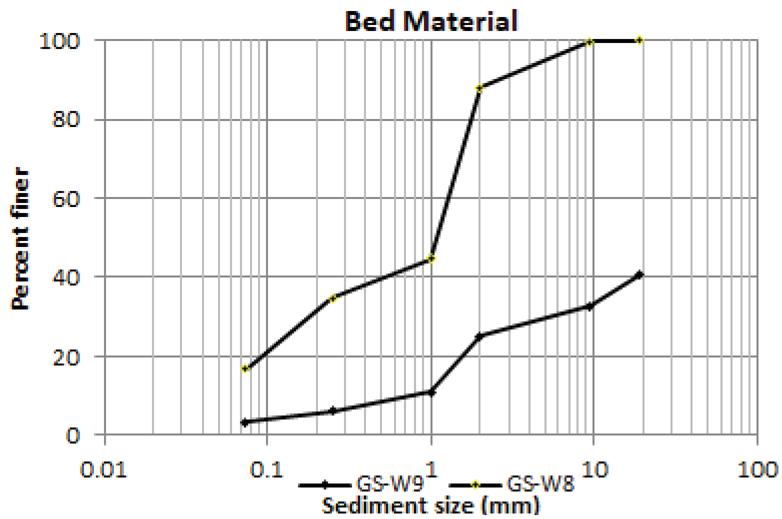
Note: CN-08 – left bank

River Mile 122.57–123.24

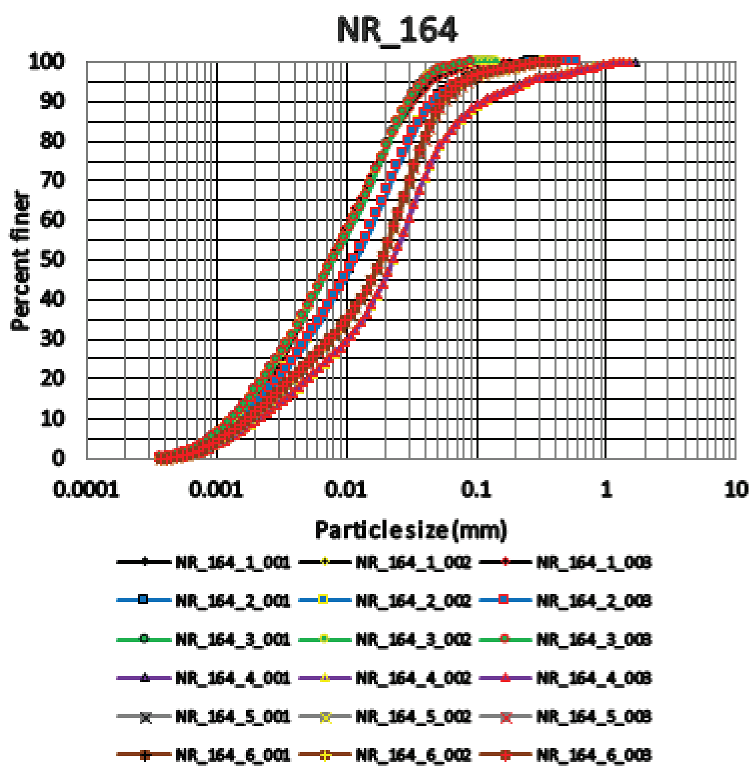


Neosho River – Grand Lake

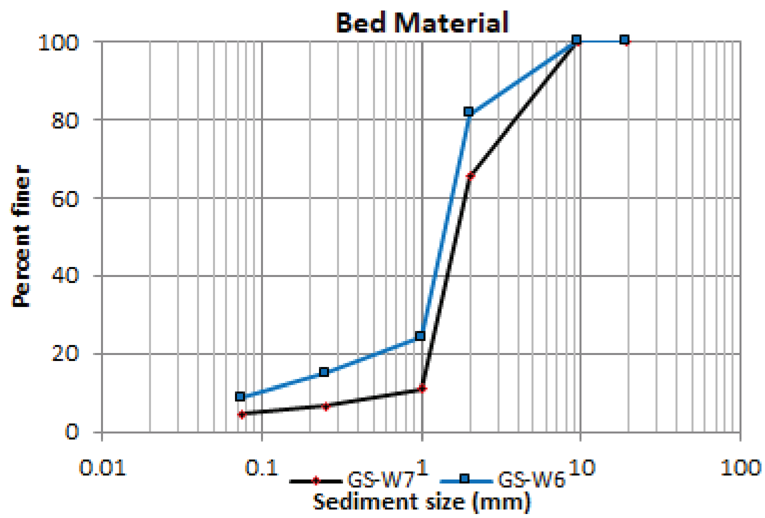
River Mile 120.1–122.25



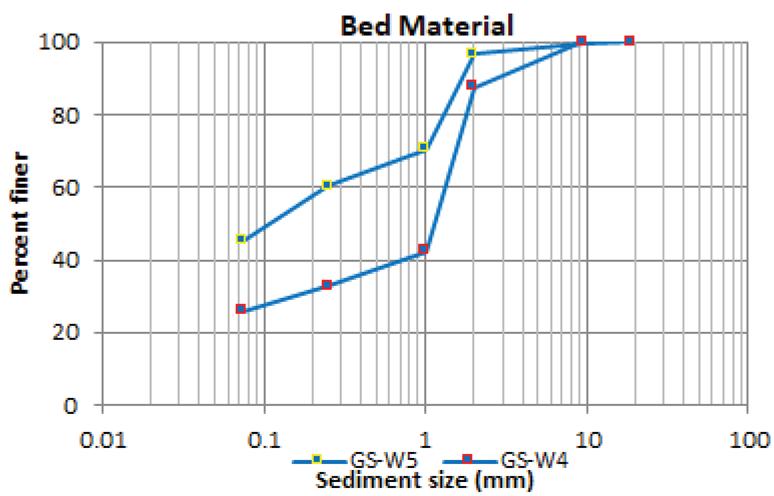
River Mile 120.1–120.43



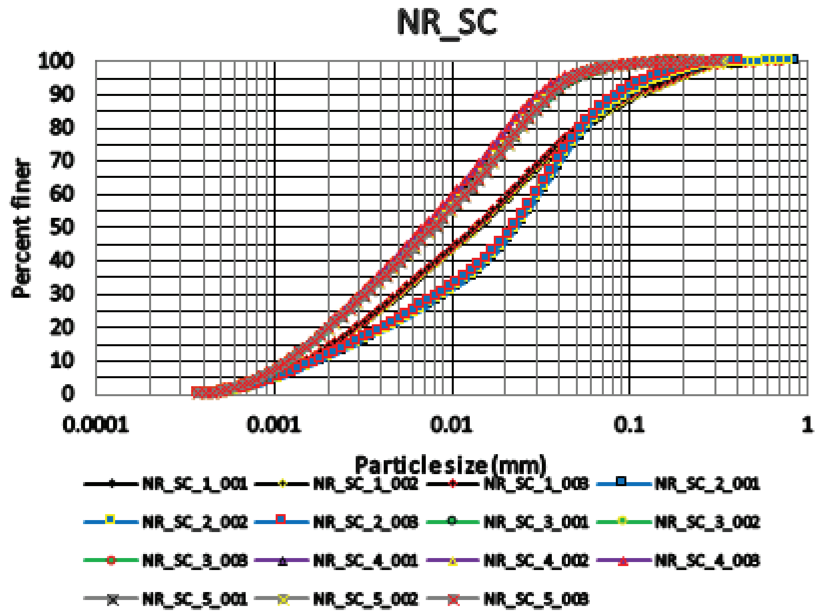
River Mile 117.66–119.06



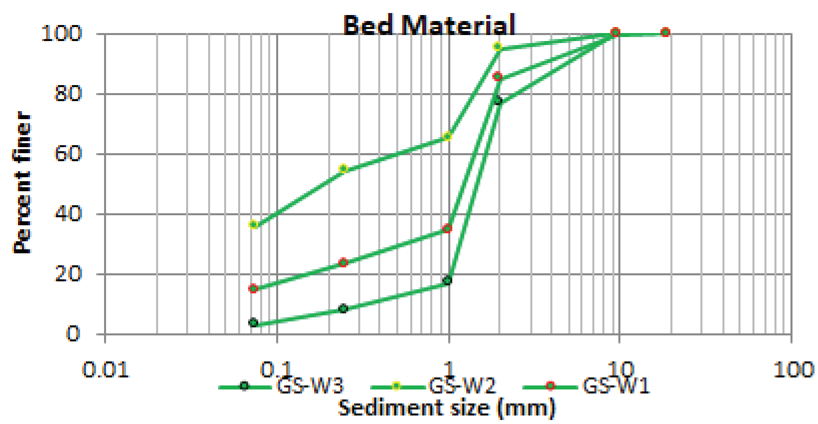
River Station 115.65–115.86



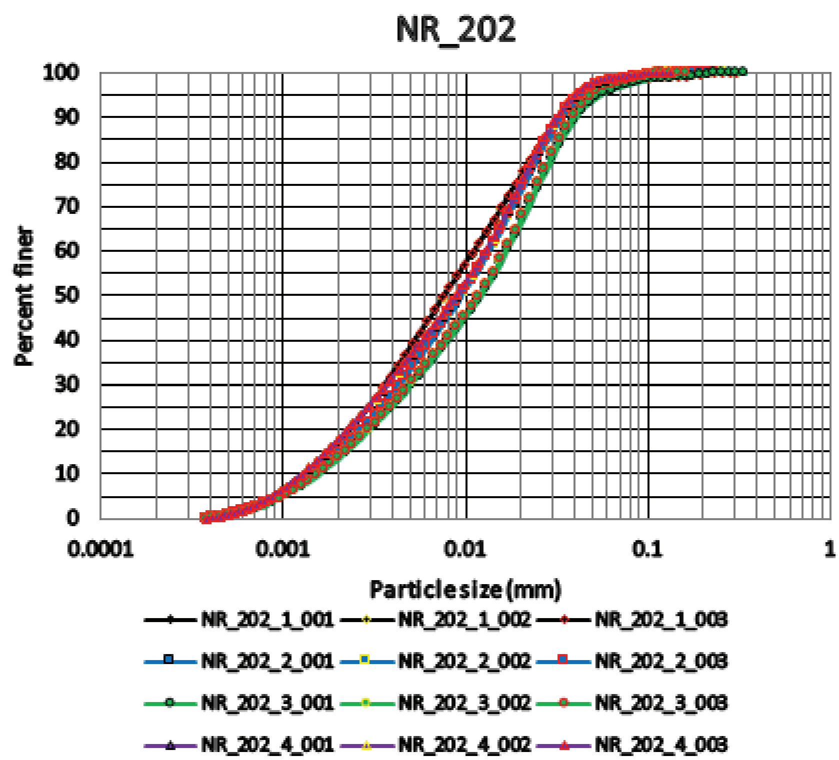
River Station 115.65–115.86



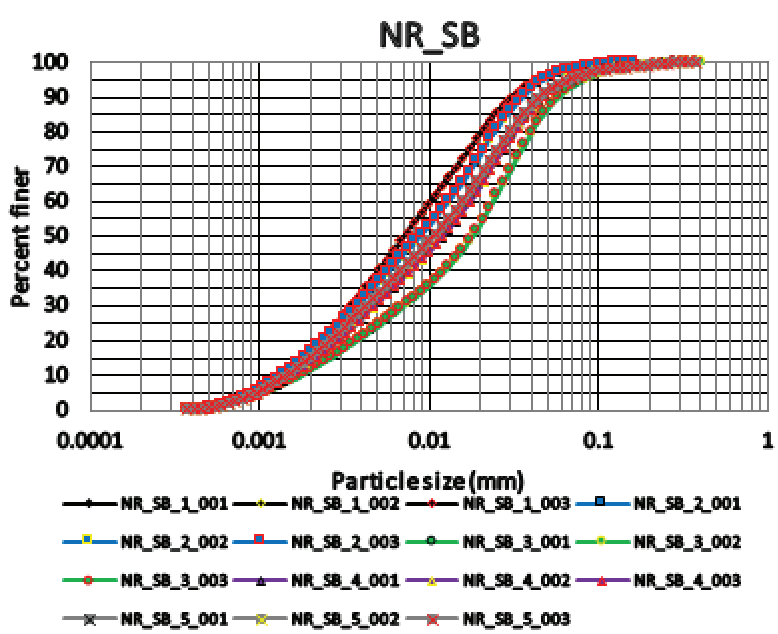
River Mile 112.34–114.21



River Mile 112.34–112.61

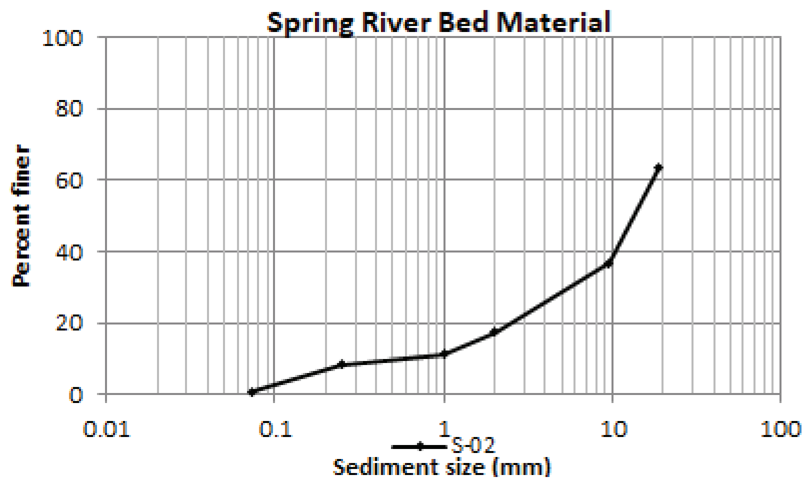


River Mile 108.87–109.25

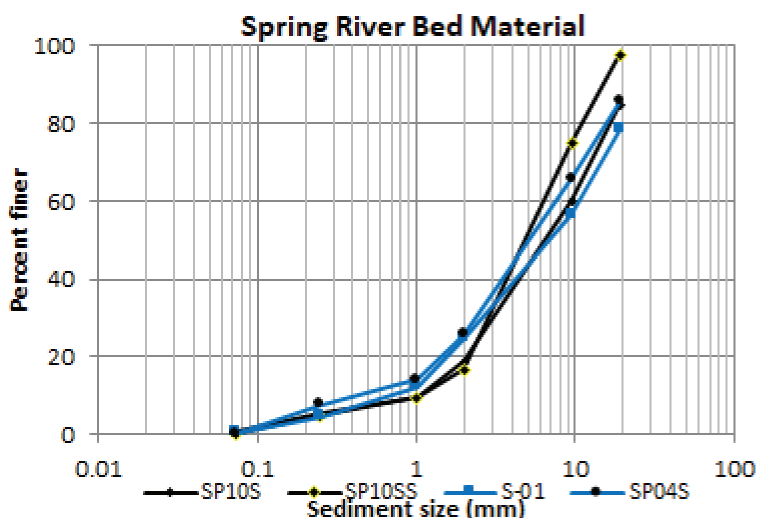


Spring River

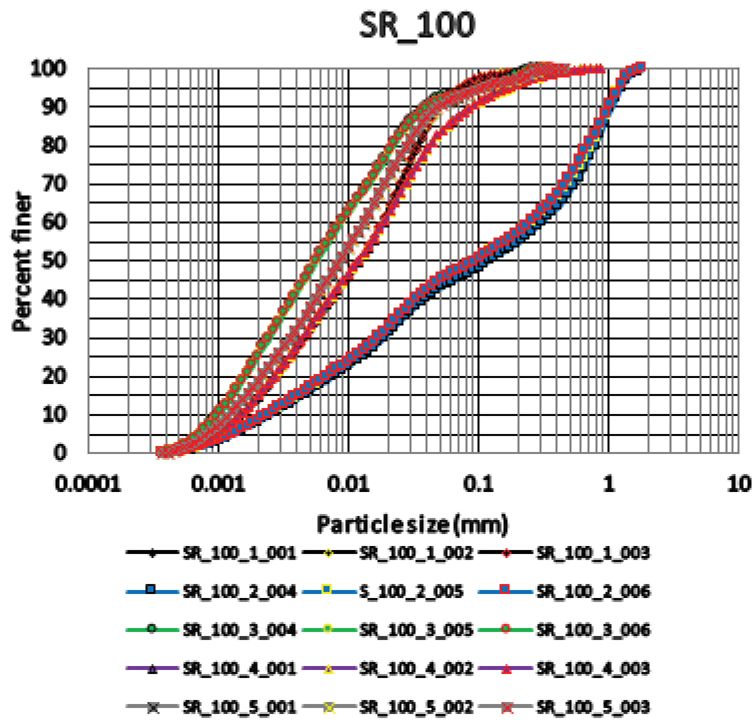
River Mile 14.16



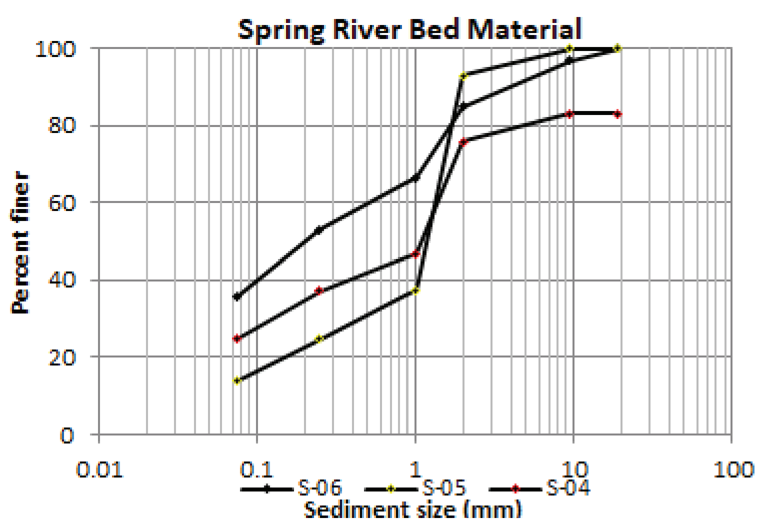
River Mile 8.01



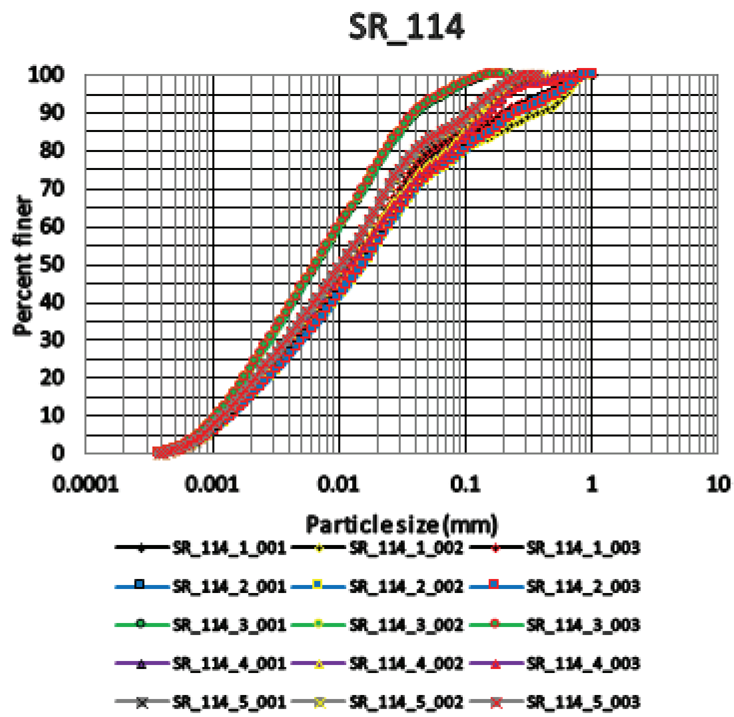
River Mile 7.5



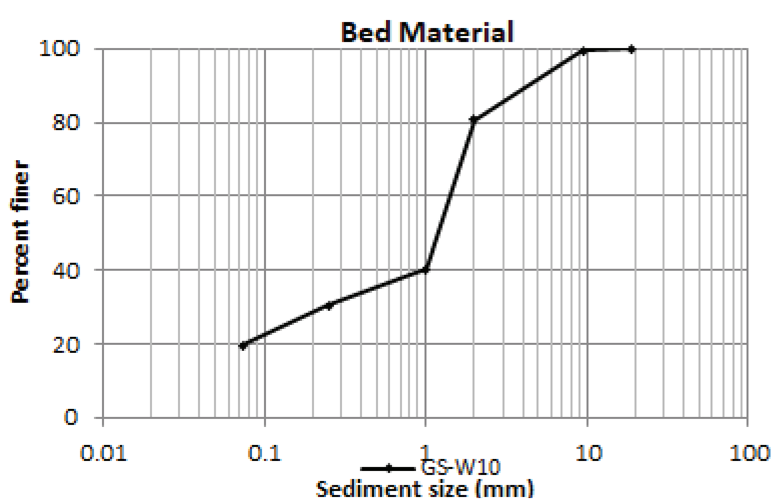
River Mile 2.26–5.1



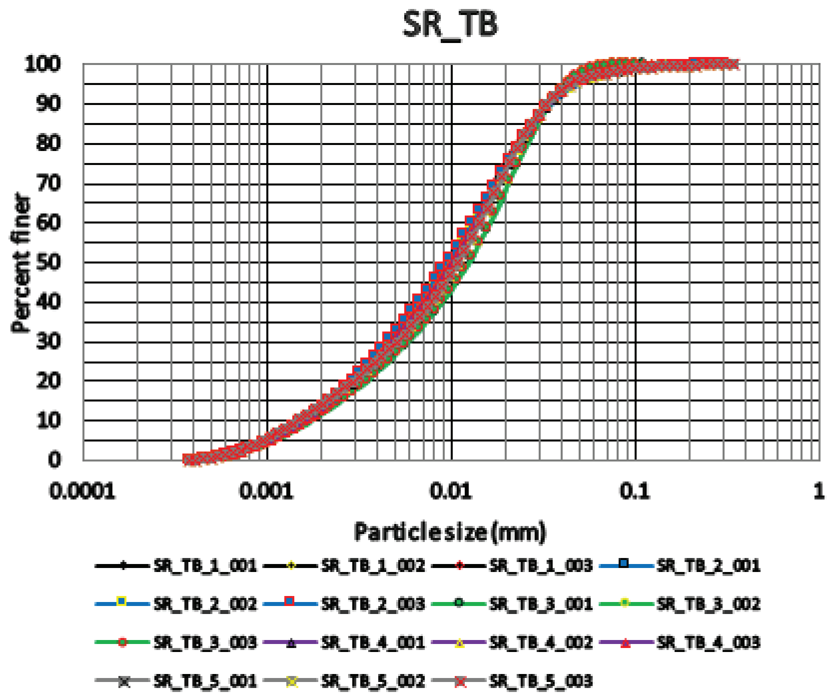
River Mile 4.82



River Mile 0.57–0.69

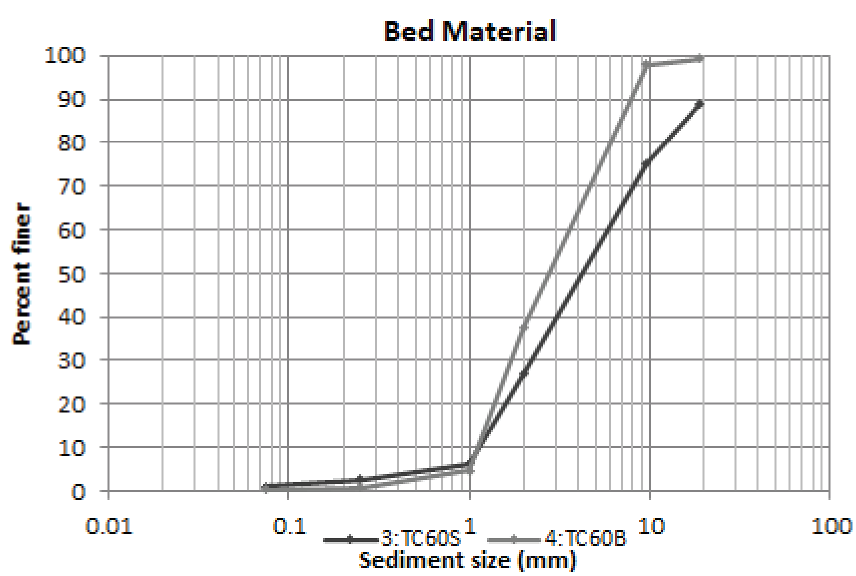


River Mile 0.79–0.99

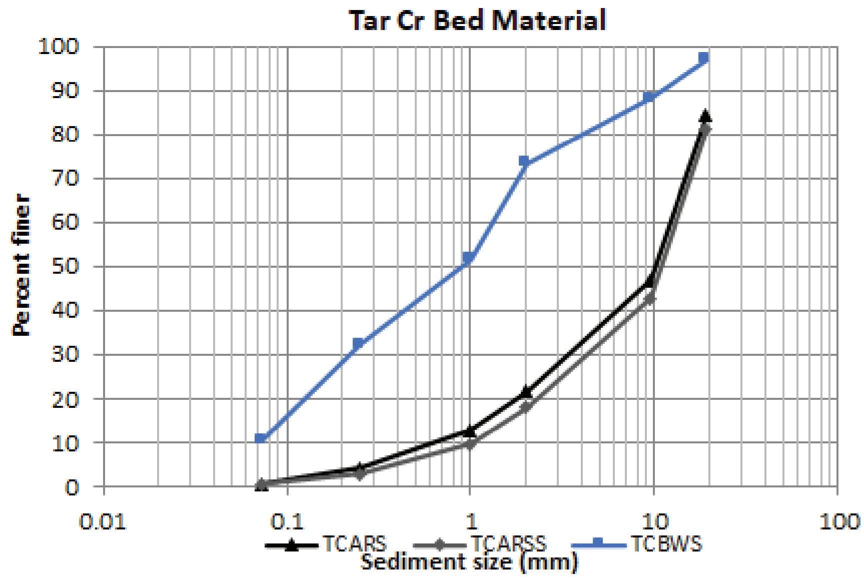


Tar Creek

River Mile 6.33

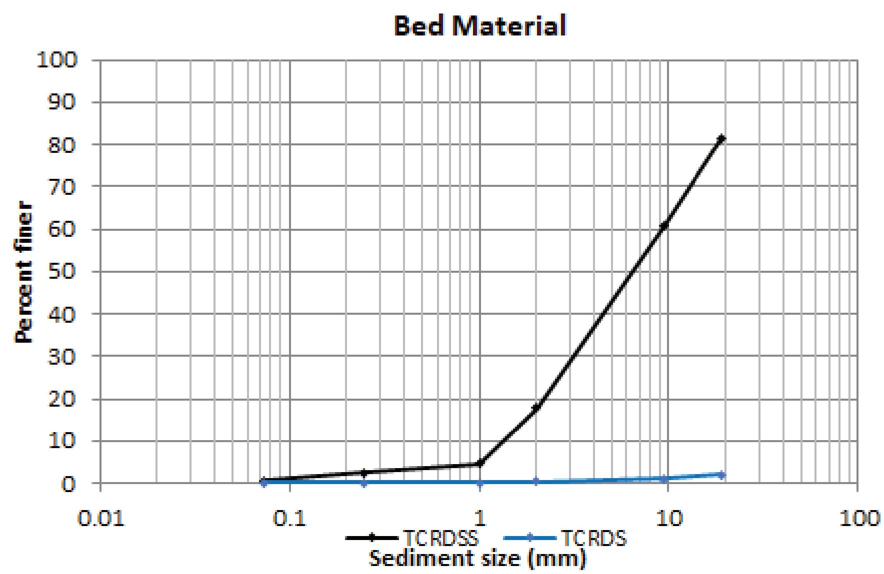


River Mile 2.74–2.98

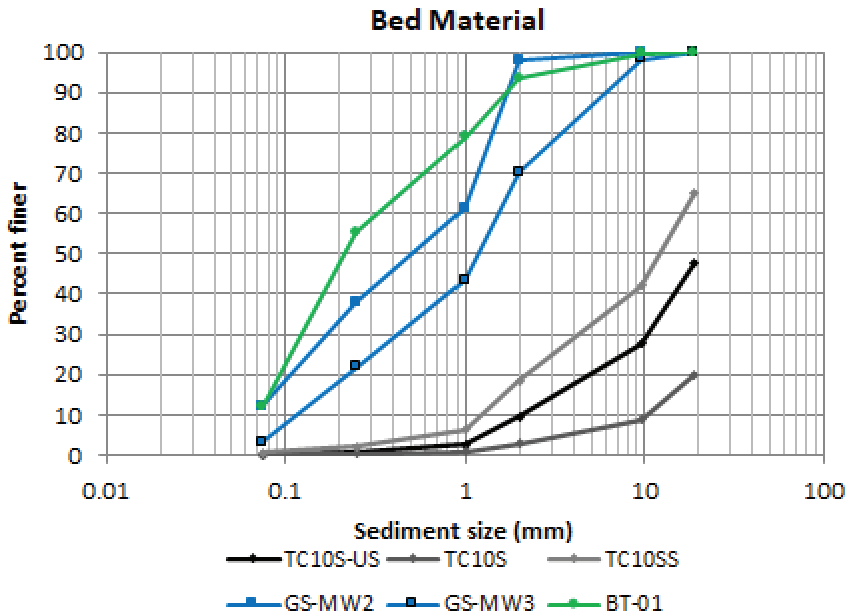


Note: BW: backwater

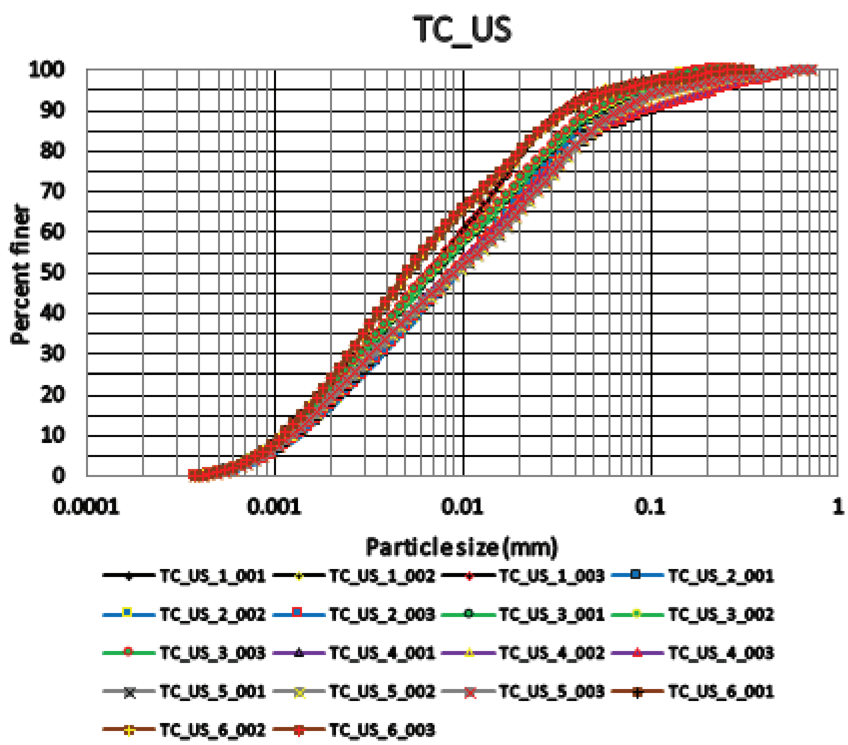
River Mile 2.23



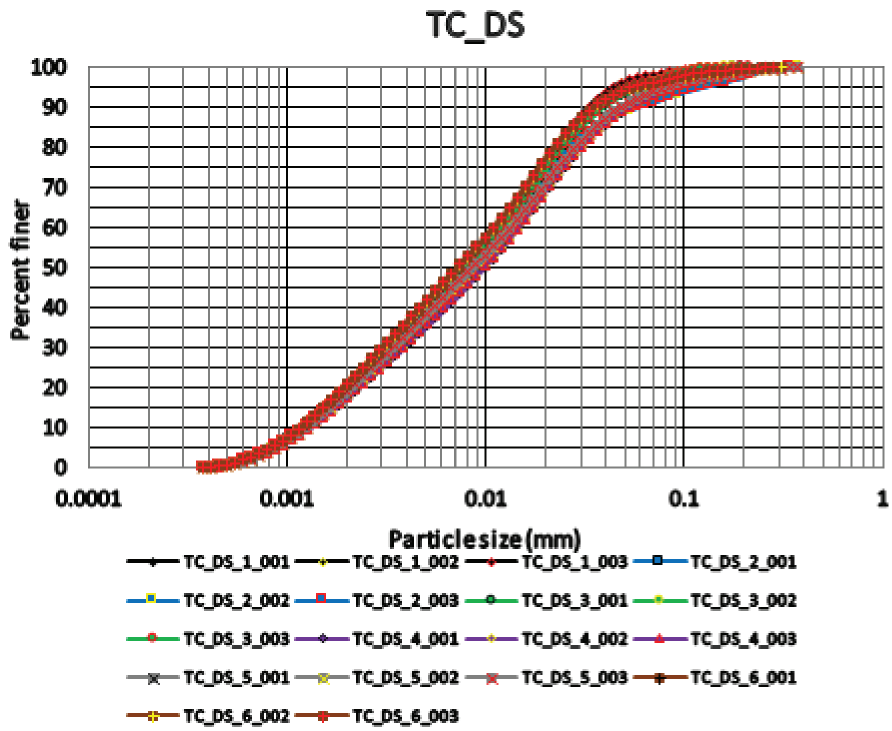
River Mile 1.6



River Mile 1.6

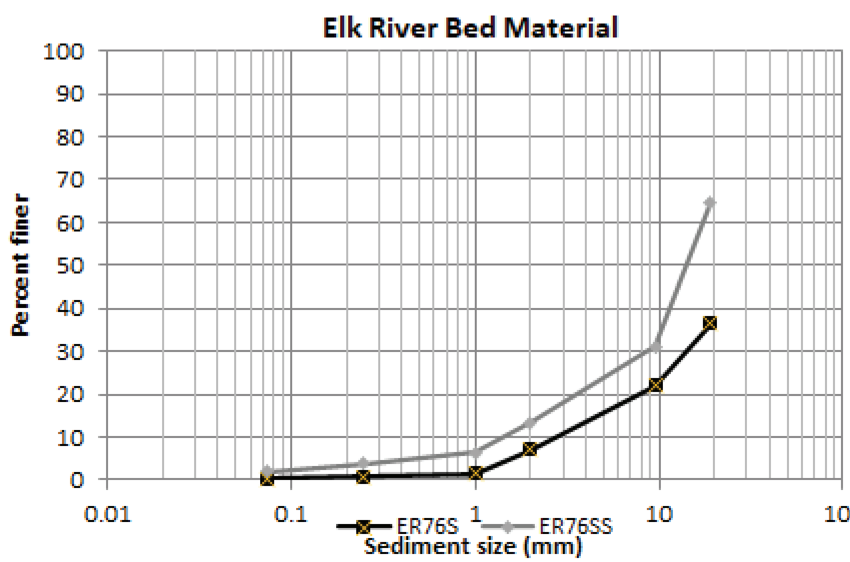


River Mile 1.6

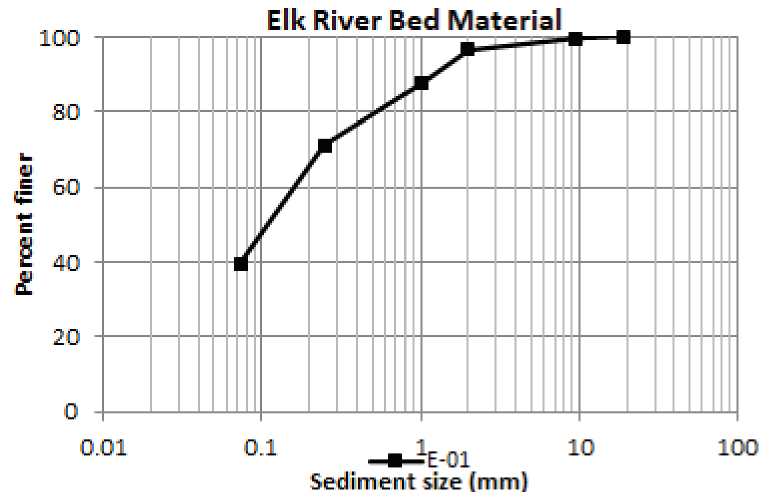


Elk River

River Mile 14.22



River Mile 8.8



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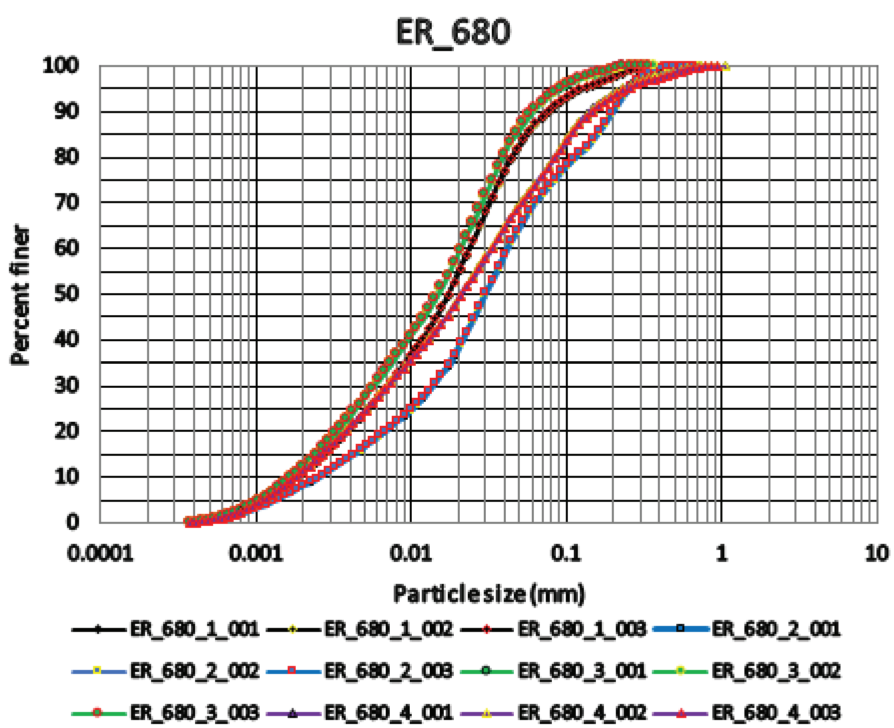

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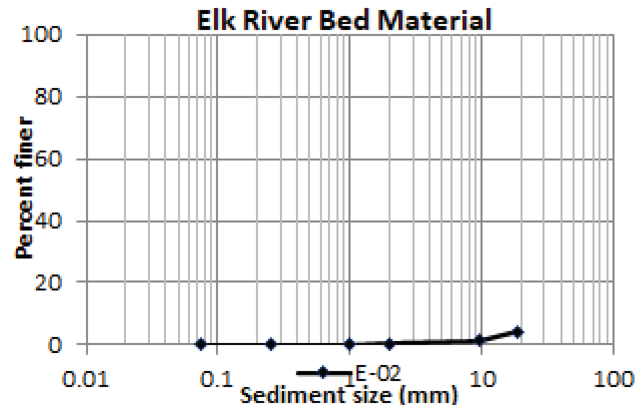

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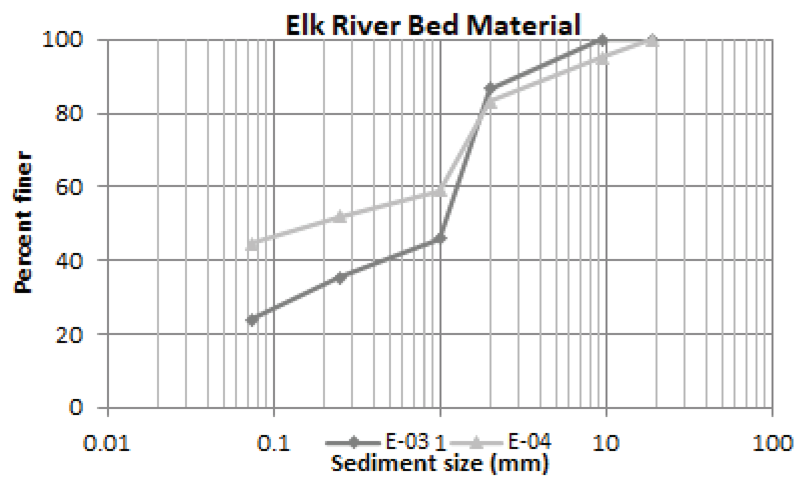

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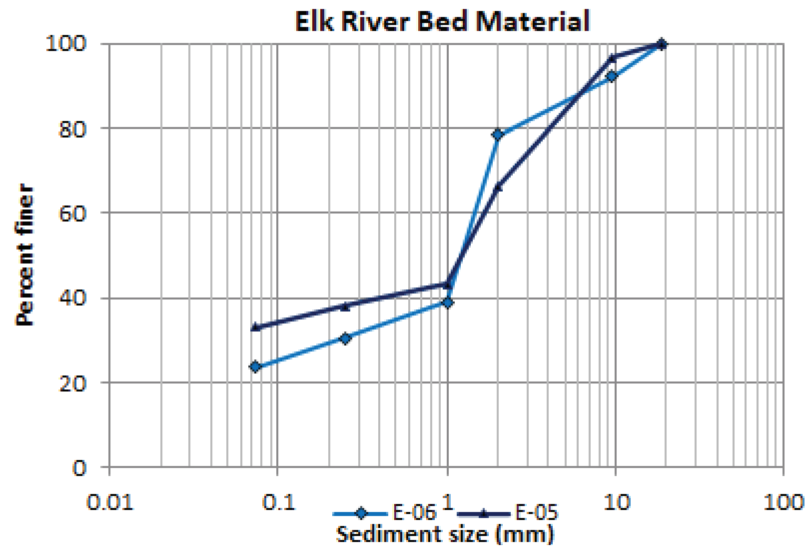

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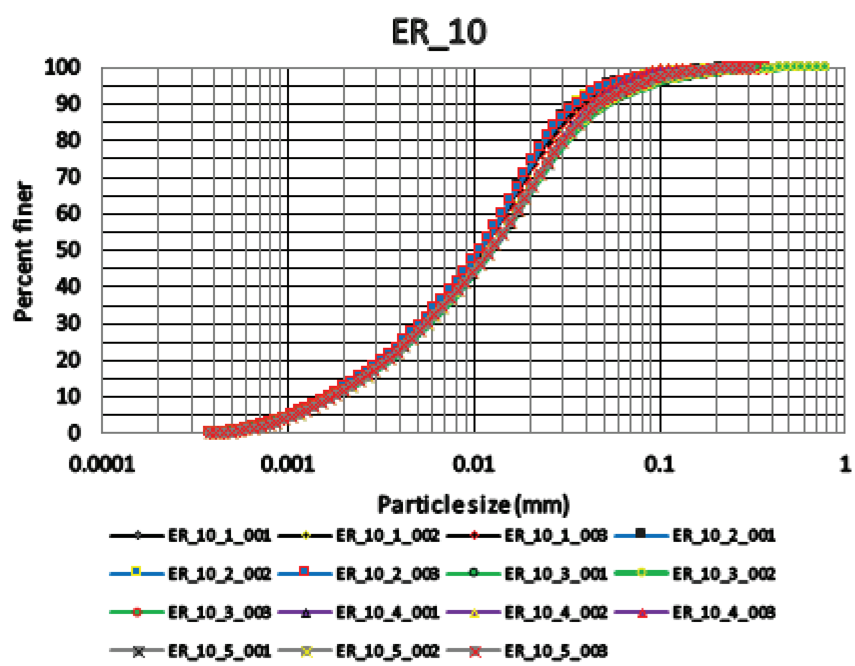

Appendix C
SEDflume Core Sampling

GRAND LAKE WATERWAYS SEDFLUME ANALYSIS

Grand Lake o' the Cherokees, OK

Prepared for

FreshWater Engineering

Prepared by

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May 2020

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ACRONYMS AND ABBREVIATIONS

Grand Lake	Grand Lake o' the Cherokees
Integral	Integral Consulting Inc.
LISST	laser *in situ* scattering and transmissometry
SEDflume	sediment-erosion-at-depth flume

EXECUTIVE SUMMARY

The complex and dynamically linked relationships between biological activity, hydrodynamic forcing, and sediment properties can regulate morphological bed changes in aquatic systems. The ongoing investigation of sediment mobility within the tributaries and waterways of the Grand Lake o' the Cherokees (Grand Lake) calls for the development of a site-specific sediment transport model. Quantification of the erosional and physical characteristics of a sediment bed can help define ranges of values to bound uncertainty in sediment transport models. Integral Consulting Inc. collected and conducted a sediment-erosion at depth flume (SEDflume) analysis on 14 sediment cores representing a range of bed types and areas within the system. SEDflume analysis produced erosion rate data, determined critical bed shear stresses, and measured particle size distribution and bulk density across multiple sediment types and depths within the sediment bed.

This report provides a summary of the SEDflume analysis for each SEDflume core collected during field sampling efforts. Laboratory measurements of erosion rates at applied shear stresses, ranging from 0.1 to 12.8 Pa, were used to determine the critical shear stress for erosion at multiple depth intervals within each sediment core. The critical shear stress for erosion governs the threshold at which sediment may become suspended. Coefficients relating shear stress and erosion rate based on a power law fit are provided. Supplemental data of grain size distributions via laser diffraction and bulk density measurements at each depth interval are also provided to characterize the physical characteristics of the sediment bed.

In general, sediment consisted of silt and clay with a surface layer of unconsolidated, relatively mobile sediment. Below the surface layer, sediment became more consolidated resulting in larger computed critical shear stresses. Prominent biotic activity, such as invertebrate burrows, extended up to 10 cm from the surface, resulting in a range of erosion conditions. Leaves and root structures present within some samples also modified the erosional properties of the surrounding sediment. Measured and computed parameters varied between different water bodies. It is advised that SEDflume results be analyzed in conjunction with other system characteristics, such as hydrodynamic forcing, to assess overall site stability and sediment transport trends.

1 INTRODUCTION TO SEDFLUME

Analysis of sediment erosion properties using SEDflume can provide quantitative information on sediment bed characteristics. The sediment bed is governed by a complex and dynamically linked relationship between biologic activity, hydrodynamic forcing, and the physical and chemical makeup of the bed. SEDflume provides measurements of erosion rates to inform how the bedded sediment responds to controlled, measurable hydrodynamic flow. The following section outlines collection efforts of 16 cores within the Grand Lake connected waters. An overview of SEDflume setup and processing procedures, as well as methods used for determining the critical shear stresses for erosion. Supplemental information regarding physical characteristic analyses including particle size distribution and bulk density is also provided.

1.1 SAMPLE COLLECTION

Sample collection occurred between March 9 and March 12, 2020. Samples were collected via a box-core collection system by staff from Integral Consulting Inc. (Integral) and FreshWater Engineering. A summary of samples collected and their locations is provided in Table 1. Of the 16 proposed sampling sites, 14 were successfully collected. Alterations to originally proposed locations were determined based on viability of collection on site. The presence of tree limbs and gravel at some sites necessitated the field team to move to more conducive sampling areas. Soft, sediment-rich banks of the river were targeted rather than deeper center channels where gravel and cobble are present.

Samples were collected using a push coring system to penetrate clear acrylic box cores into the sediment bed. When pushing by hand did not result in sufficient penetration, blows from a post-hole hammer were applied. At some sites, such as ER-680, multiple attempts to collect a sufficient sample were performed. Further description of sampling efforts is provided on a core-by-core basis in Sections 2.1 through 2.16.

Table 1. Summary of SEDflume samples

Sample ID	Date	Time	Water depth (ft)	Length (cm)	Latitude	Longitude
SED-ER-10	3/12/2020	3:30:00 PM	8	30	36.64759	-94.704862
SED-ER-640	3/12/2020	----	----	----	36.65529	-94.728458
SED-ER-680	3/9/2020	5:30:00 PM	5	22	36.65639	-94.656731
SED-NR-130	3/11/2020	4:00:00 PM	1	17	36.82961	-94.808654
SED-NR-164	3/10/2020	6:00:00 PM	5	41	36.7801	-94.774844
SED-NR-202	3/10/2020	4:35:00 PM	5	23	36.72824	-94.772617

Sample ID	Date	Time	Water depth (ft)	Length (cm)	Latitude	Longitude
SED-NR-CB	3/11/2020	5:02:00 PM	1	32	36.79897	-94.819643
SED-NR-FG	3/11/2020	11:00:00 AM	1	23	36.85977	-94.875079
SED-NR-HP	3/12/2020	---	---	---	36.64564	-94.779563
SED-NR-SB	3/10/2020	2:00:00 PM	6	37	36.69502	-94.748474
SED-NR-SC	3/10/2020	5:10:00 PM	6	27	36.73894	-94.726088
SED-SR-100	3/10/2020	11:40:00 AM	5	43	36.86481	-94.762871
SED-SR-114	3/10/2020	12:30:00 PM	5	41	36.85253	-94.721566
SED-SR-TB	3/10/2020	11:10:00 AM	4	32	36.8039	-94.754402
SED-TC-DS	3/11/2020	2:30:00 PM	8	44	36.85475	-94.858931
SED-TC-US	3/11/2020	2:00:00 PM	6	44	36.85717	-94.860699

1.2 EXPERIMENTAL PROCEDURES

Detailed descriptions of SEDflume analysis and its application are given in McNeil et al. (1996), Jepsen et al. (1997), and Roberts et al. (1998). The following sections supplement those reports with a general description of the SEDflume analysis procedures used in this study. Supplemental analyses of grain size distribution using laser diffraction (ISO Standard 13-320), water content (ASTM Method D2216-05), and bulk density (ASTM Method D2216-10; Håkanson and Jansson 1983), and loss on ignition (ASTM Method D7348-13) were also implemented at the beginning of each interval to quantify physical sediment characteristics.

1.2.1 SEDflume Setup

A SEDflume is essentially a straight flume with an open bottom section through which a rectangular, cross-sectional core barrel containing sediment can be inserted (Figure 1). The main components of the flume are the water tank, pump, inlet flow converter (which establishes uniform, fully developed, turbulent flow), the main duct, test section, hydraulic jack, and the core barrel containing sediment (Figure 2). The core barrel, test section, flow inlet section, and flow exit section are made of transparent acrylic so that the sediment–water interactions can be observed visually. The core barrel has a rectangular cross section, 10 by 15 cm, and a length of 60 cm.

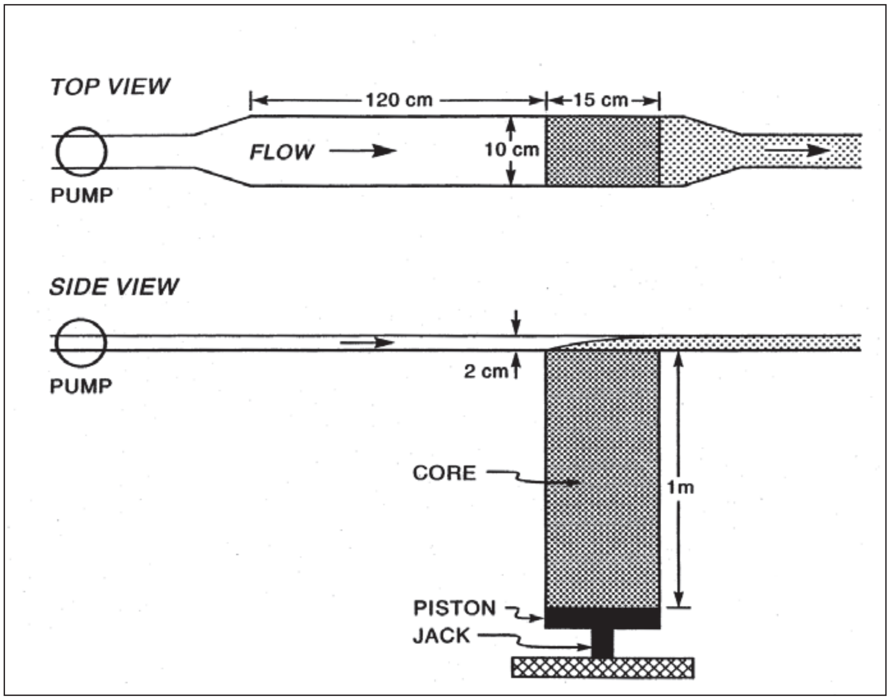

Figure 1. Schematic of SEDflume setup showing top and side views

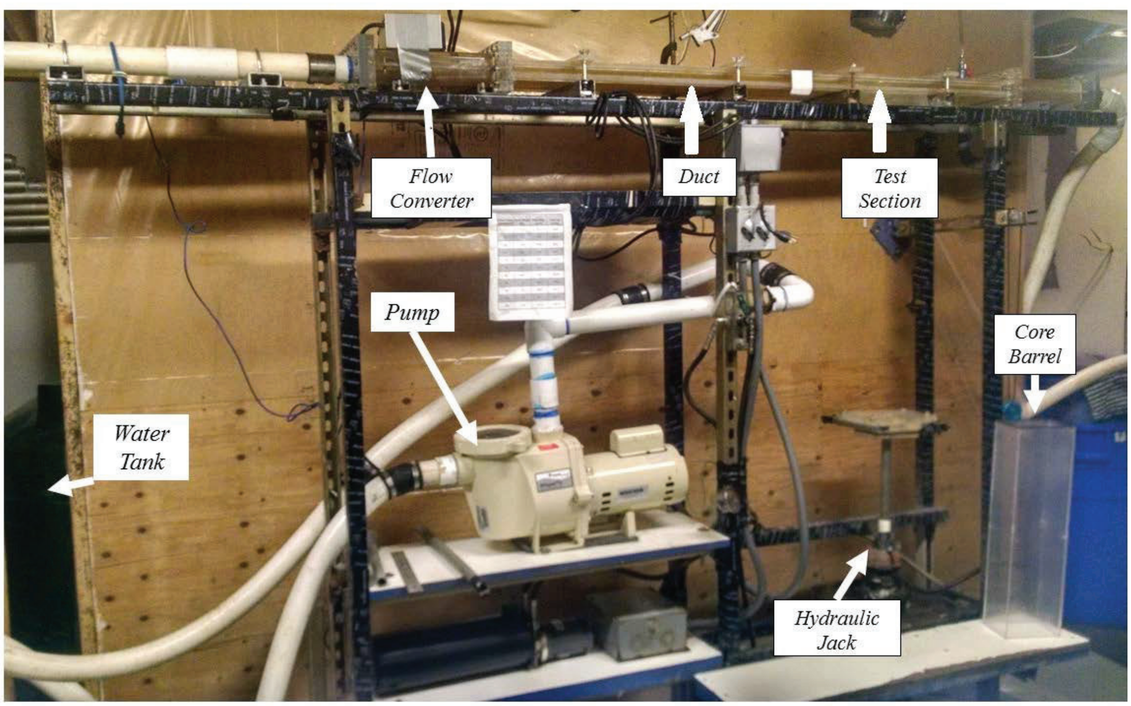

Figure 2. SEDflume in Integral's laboratory, Santa Cruz, California

Water is pumped from a 300-gallon storage tank into a 5-cm-diameter pipe and then through the flow converter into the main duct. The duct is rectangular, 2 cm in height, 10 cm in width, and 120 cm in length; it connects to the test section, which has the same cross-sectional area (2 by 10 cm) and is 15 cm long. The flow converter changes the shape of the cross section from circular to rectangular while maintaining a constant cross-sectional area. A ball valve regulates the amount of water entering the flume so that the flow rates can be carefully controlled. The flume also has a small valve immediately downstream from the test section that opens to the atmosphere, preventing a pressure vacuum from forming and enhancing erosion.

At the start of each test, a core barrel and the sediment it contains are inserted into the bottom of the test section. The sediment surface is aligned with the bottom of the SEDflume channel. When fully enclosed, water is forced through the duct and test section over the surface of the sediment. The shear stress produced by the flow and imparted on the particles causes sediment erosion. As the sediment on the surface of the core erodes, the remaining sediment in the core barrel is slowly moved upward so that the sediment–water interface remains level with the bottom of the flume.

An operator moves the sediment upward using a hydraulically controlled piston that is inside the core barrel. The jack is driven by a release of pressure that is regulated with a switch and valve system. In this manner, the sediment can be raised and made level with the bottom of the test section. The movement of the hydraulic jack can be controlled for measurable increments as small as 0.5 mm.

1.2.2 Measurements of Sediment Erosion Rate

At the start of each core analysis, an initial reference measurement is made of the starting core length. The flume is then operated at a specific flow rate corresponding to a particular shear stress, and sediment is eroded (McNeil et al. 1996; Jepsen et al. 1997). As erosion proceeds, the core is raised if needed to keep the core's surface level with the bottom of the flume. This process is continued until either 10 minutes has elapsed or the core has been raised roughly 2 cm. The erosion rate for the applied shear stress is then calculated as:

$$E = \frac{\Delta z}{T} \qquad [1]$$

Where:

E	=	erosion rate
Δz	=	distance that sediment is raised during a particular measurement period
T	=	measurement time interval

Because material is eroded and the core structure is broken down, repetitive erosion measurements at a given depth are not possible. The following procedures were performed for all Grand Lake waterway cores to best determine the erosion rate at several different shear stresses and depths using only one core:

1. The core was inserted into the bottom of the SEDflume test section.
2. The total length of sediment in the core barrel was measured and recorded.
3. Two 5 g (approximately) subsamples of sediment from the core surface were collected using a clean spoon. Sediment sampling was constrained to the downstream (relative to the SEDflume flow direction) end of the sediment surface, to minimize potential scour effects.
4. Shear stresses (from low to high) were applied to the core's surface, and sediment erosion was measured (if it occurred; 0.5 mm of erosion in 10 minutes was considered quantifiable). Applied shear stresses started at 0.1 Pa and were sequentially doubled until a given shear stress caused approximately 2 cm of erosion in 20 seconds, or a maximum of 5 cm was eroded in a given interval (defined as a continuous succession of increasing shear stress cycles where erosion is measured). Each shear stress cycle was applied for a minimum of 20 seconds and a maximum of 10 minutes. To the extent possible, no more than 2 cm of sediment was allowed to erode at a single shear stress.
5. Once the threshold—2 cm of erosion in 20 seconds, or a maximum of 5 cm of erosion in a single interval—was met, a new depth interval was started. Steps 3 and 4 were repeated.[1] Also, if the sediment composition changed noticeably in appearance or erosion properties, the depth interval was stopped, sediment subsamples were collected, and a new depth interval was started (Step 4).
6. Where practicable, at least three and up to five depth intervals were tested per core.

1.2.2.1 Determination of Critical Shear Stress

The critical shear stress of a sediment bed, τ_{cr}, is the applied shear stress at which sediment motion is initiated. In this study, it is operationally defined as the shear stress required to produce 0.001 mm of erosion in 1 second. This represents an erosion rate of 10^{-4} cm/s, or roughly 1 mm of erosion in 15 minutes.[2]

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[1] If a particular shear stress did not cause any observable erosion over a 10-minute period for consecutive depth intervals (e.g., less than 0.5 mm eroded in 10 minutes), that shear stress was removed from subsequent testing cycles; higher shear stresses were added, as appropriate, to attempt to measure at least three erosion rates.

[2] Though other definitions of critical shear stress erosion rate thresholds can be argued (and considered valid), the value of 10^{-4} cm/s threshold is used here for consistency with previous SEDflume efforts and to keep testing times to a practical duration.

Because it is difficult to measure τ_{cr} exactly at the 10^{-4} cm/s threshold, erosion was instead measured over a range of shear stresses designed to bracket the initiation of erosion threshold. The highest applied shear stress where erosion *did not occur* is defined by τ_{no}, and τ_{first} is the lowest applied shear stress where erosion *did occur*.

Using the measured erosion rate data in each depth interval, a power law regression analysis (described below) was employed to determine the shear stress (τ_{power}) required to cause 10^{-4} cm/s of erosion. Assimilating the bracketed shear stress values (τ_0 and τ_1) and τ_{power}, the critical shear stress of each interval was then chosen according to the following criteria (where τ_{no} and τ_{first} are determined directly from the SEDflume measurements):

- If $\tau_{no} \leq \tau_{power} \leq \tau_{first}$, then τ_{power} was the selected critical shear stress, τ_{cr}, for the interval.
- If $\tau_{no} \geq \tau_{power}$, then τ_{no} was the selected critical shear stress for the interval.
- If $\tau_{power} \geq \tau_{first}$, then τ_{first} was the selected critical shear stress for the interval.
- If $r^2 < r^2_{thresh}$, then τ_{linear} was selected as the critical shear stress for the interval.

The τ_{cr} criteria allowed for selection of critical shear stresses using the power law results where the regression analysis was in agreement with measured erosion rate data.

1.2.2.2 Power Law Regression

Following the methods of Roberts et al. (1998), the erosion rates for sediment can be approximated by the power law regression:

$$E = A\tau^n \rho^m \qquad [2]$$

Where:

E	=	erosion rate (cm/s)
τ	=	bed shear stress (Pa)
ρ	=	sediment bulk density (g/cm^3)
A, n, and m	=	constants that depend on sediment characteristics

The equation used in the present analysis is an abbreviated variation of Equation 2:

$$E = A\tau^n \qquad [3]$$

where the constant A is a function of the sediment bulk density and other difficult properties to measure, such as sediment geochemistry and biological influences. The variation of erosion rate with density typically cannot be determined for field sediment because of natural variation in other sediment properties (e.g., mineralogy, particle size, and electrochemical forces). Therefore, the density term from the equation above, for a particular interval of approximately constant density, is incorporated into the constant *A*.

For each depth interval, the measured erosion rates (*E*) and applied shear stresses (τ) were used to determine the *A* and *n* constants that provide a best-fit power law curve to the data for that interval. Good regression fits of these parameters, where they existed, were then used to estimate the critical shear stress for the respective intervals. A coefficient of determination (r^2) of 0.70 was used as a threshold criterion for acceptance.[3]

1.2.3 Measurement of Sediment Bulk Properties

In addition to the measurement of erosion rates during the analysis, sediment subsamples were periodically collected at depth to determine the water content, particle size distribution, and loss on ignition of the sediment in each core. Water content and loss on ignition values are incorporated into the determination of wet and dry bulk densities. Subsamples were collected from the undisturbed core surface (prior to analysis) as well as the sediment surface at the beginning of each subsequent depth interval. Samples were weighed, dried, and reweighed to determine the mass of water. Samples were then subjected to sufficient heat to ignite the organic material to determine loss on ignition.

Wet bulk density was determined by first measuring the wet and dry weight of the collected sample to determine the water content (*W)* as described in Håkanson and Jansson (1983):

$$W = \frac{M_w - M_d}{M_w} * 100\% \qquad [4]$$

Where:

W = water content
M_w = wet weight of sample
M_d = dry weight of sample

For the determination of wet bulk density, water content in this formulation have value from 0 to 1. Wet bulk densities were then determined using the method described by Håkanson and Jansson (1983):

[3]The coefficient of determination, r^2, is a function of Pearson's *r*, which is a measure of the linear dependence (correlation) between two variables. Pearson's *r* can be positive or negative, and is a value between –1 and +1. The more common usage of the correlation coefficient is to square Pearson's *r*, r^2, and report that value.

$$\rho_{wet} = \frac{(100 * \rho_s)}{100 + (W + IG)(\rho_s - 1)} \quad [5]$$

Where

ρ_w	=	density of water (assumed 1 g/cm^3)
ρ_s	=	density of sediment particle (assumed 2.65 g/cm^3)
IG	=	% loss on ignition based on wet weight (ASTM Method D7348-13)

Dry bulk densities are based on the moisture content (*MC*) defined by ASTM D2216-05 as

$$MC = \frac{M_w - M_d}{M_d} \quad [6]$$

This formulation represents the ratio of water to solids. Using the moisture content value, dry bulk densities were calculated using the following relationship:

$$\rho_{dry} = \frac{\rho_{wet}}{1 + MC} \quad [7]$$

Particle size distributions were determined using laser diffraction analysis at Integral's laboratory in Santa Cruz, California. Sediment samples were screened with a 2,000-μm sieve to remove large pieces of organic material, dispersed in water, and inserted into a Beckman Coulter LS 13-320 laser diffraction analyzer. Each sample was analyzed in three 1-minute intervals, and the results of the three analyses were averaged automatically by the instrument. The Beckman Coulter LS 13-320 measures volumetric distribution of particles from 0.4 to 2,000 μm. Caution should be taken when comparing directly to more narrowly ranged instruments such as a laser *in situ* scattering and transmissometry (LISST) instrument or traditional mass-based sieve and hydrometer studies. A LISST measures aggregated particles in the natural environment and has detection ranges different from that of the desktop instrument. Use of the Beckman Coulter involves the disaggregation of particles so any direct comparison must consider these factors.

The relationships used to determine sediment bulk properties are summarized in Table 2.

Table 2. Parameters measured and computed during the SEDflume analysis

Measurement	Definition	Units	Detection Limit	Internal Consistency
Water Content	$W = \frac{M_w - M_d}{M_w}$	Dimensionless	0.001 g in sample weight ranging from 1 to 50 g	0 < W < 1
Moisture Content	$MC = \frac{M_w - M_d}{M_d}$	Dimensionless	0.001 g in sample weight ranging from 1 to 50 g	
Wet Bulk Density	$\rho_{wet} = \frac{(100 * \rho_s)}{100 + (W + IG)(\rho_s - 1)}$	g/cm^3	0.001 g in sample weight ranging from 1 to 50 g	$\rho_w < \rho_{wet} < 2.6\ \rho_w$
Dry Bulk Density	$\rho_{dry} = \frac{\rho_{wet}}{1 + MC}$	g/cm^3	0.001 g in sample weight ranging from 1 to 50 g	$\rho_w < \rho_{dry} < \rho_{wet}$
Particle size distribution below 2,000 µm	Distribution of particle sizes by volume percentage using laser diffraction	µm	Method specific	1 µm < grain size < 2,000 µm

Notes:
M_w = wet weight of sample
M_d = dry weight of sample
ρw = density of water (assumed 1 g/cm^3)
ρs = density of sediment particle (assumed 2.65 g/cm^3)

1.2.4 Intra- and Intercore Comparisons

A potentially useful method of comparing sediment characteristics at a specific site is to compute intracore and intercore erosion rates. This method provides a means to quantify the erosion rates within each core (intracore) as well as the general erosion rates of the cores across the site (intercore).

1.2.4.1 Intracore Erosion Rate Ratios

Once the power law regression *A* and *n* coefficients for each depth interval within an individual core were known, the *interval-average* erosion rate for the core was determined using Equation 3 and the logarithmic average of the range of shear stresses tested in the SEDflume analysis.[4] C*ore-average* erosion rates were then computed by:

1. Log-averaging the *A* coefficient values from each depth interval within a core to arrive at an average *A* coefficient for the entire core
2. Arithmetically averaging the *n* coefficient values from each depth interval within a core to arrive at an average *n* coefficient for the entire core
3. Solving for the core-average erosion rate following Equation 3 and using the log-average of the range of shear stresses applied to the depth interval (1.13 Pa).

An intracore erosion-rate-ratio was then defined by dividing the interval-average erosion rate by the core-average erosion rate, providing a quantitative estimation of the relative erosion susceptibility of each depth interval. This method highlights the core intervals that are more or less susceptible to erosion within a particular core, and may indicate layering within a core.

1.2.4.2 Intercore Erosion Rate Ratios

Two additional ratios were computed to evaluate large-scale spatial erosion susceptibility. An intercore erosion rate ratio was computed by comparing the individual core-average erosion rate with a site-wide average erosion rate. The site-wide average erosion rate was computed by:

1. Log-averaging the core-average *A* coefficient values from each core to arrive at an average *A* coefficient for the entire site
2. Arithmetically averaging the core-average *n* coefficient values in each core to arrive at an average *n* coefficient for the entire site
3. Solving for the site-wide average erosion rate following Equation 3 and using the log-average of the range of shear stresses (1.13 Pa).

The intercore erosion rate ratio computed in this manner provided a qualitative estimate of the erosion susceptibility of each core (as a whole) relative to other cores in the site, potentially indicating spatial locations that are more or less susceptible to erosion than other locations.

[4]The shear stress values averaged were 0.1, 0.2, 0.4, 0.8, 1.6, 3.2, 6.4, and 12.8 Pa. The logarithmic average of these, used to compute erosion rate ratios, was 1.13 Pa.

2 RESULTS

This section of the report contains both qualitative and quantitative findings from the SEDflume analysis. Results are presented on a core-by-core basis. Appendix A contains additional grain size statistics and distribution plots for each interval in each core. Raw data from the grain size analysis can be provided upon request.

Results are presented both graphically and in tabular form. Erosion rates at applied shear stresses are presented with depths adjacent to an image of the core. The indication of no erosion measured refers to the thin dotted line at 10^{-5} cm/s. As described in the previous sections, values of 10^{-4} cm/s are defined as the erosion rate related to minimum measurable critical shear stress. Tables of the derived constants A and n are provided with the r^2 value. Mean values are also presented over the entire core. The coefficient A is log-averaged because of the order of magnitude variations that can occur within its values, while n is arithmetically averaged because its range is narrow. Values of n typically range from 1 to 4, and values outside of this range may also indicate a spurious data fit.

A table of particle sizes, wet and dry bulk densities, loss on ignition, greatest applied shear with no erosion measured, first applied shear with erosion measured, and power law derived critical shear is also presented. The power law-derived critical shear was determined using the A and n values from tables also provided for each sample. A column labeled "Final Critical Shear" provides the recommended value based on the criteria outlined in Section 1.2.2.1.

Qualitative descriptions of the type of erosion are included when necessary to highlight changing processes. Erosion of the core surface generally occurs via individual particles becoming suspended, aggregated clumps of sediment (clump erosion) breaking off causing an uneven surface, or sheets of material peeling off the sediment bed. Noncohesive materials such as sands, in the absence of any organic matter acting as a "glue," will erode as individual particles. Fine-grained sediment such as silts and clays can bind together and will move together under an applied shear. Cracks and uneven sedimentation may cause these bonded sediments to move together as clumps. Sediment deposited cyclically may deposit in uniform layers and can erode as thin sheets.

Cores were processed according to the procedures in Section 1.2.2. Cores were processed until at least five intervals were completed or processing came within 5 cm from the end of the core.

2.1 SED-ER-10

Core ER-10 was collected on March 12, 2020, at 3:30 p.m. in 8 ft of water. The 30 cm length of core was collected east of the Highway 10 Bridge using a combination of hand pressure and post-hammer blows. Collected sediment consisted of olive, brown silty material with a uniform fine texture throughout with a lighter oxidized layer extending up to 3 cm from the surface. Worm tubes and possible feeding voids 0.25 to 0.5 cm in diameter were observed up to 15 cm below the surface. Sediment below the biotic influenced zone was uniform in olive color and silty texture. Leaves and stems were uncovered 25 cm below the surface but were not observed prior to that depth.

A photograph of the recovered sediment aligned with applied shear stresses and resulting erosion rates is presented in Figure 3. Shear stresses ranging from 0.1 to 12.8 Pa were applied during five shear stress intervals. Not all shear stresses were included in each interval as described in Section 1.2.2. The surface was more erodible than underlying sediment. Intervals 2, 3, and 4 exhibited uniform erosion rates and erodibility while interval 5 encompassed the least erodible sediment analyzed in ER-10 (Figure 4). In interval 1 extending 5.3 cm from the surface, sediment eroded evenly across the bed as individual grains or pieces of the surface were suspended. As depth and shear stress increased, erosion occurred when pieces or larger clumps of the surface broke free. Pieces ranged in size relative to applied shear stress and the surface eroded unevenly.

Sediment properties were relatively uniform throughout the core with the exception of low-density sediment at the surface (Figure 5, Table 3). The low-density material is associated with the lowest critical shear stresses determined from the measured erosion rates. Table 3 provides a summary of shear stress measurement as well the final critical shear stress based on the criteria outlined in Section 1.2.2.1. Derived critical shear stresses ranged from 0.25 to 1.73 Pa. Power law fit parameters relating the erosion rate to applied shear stress are presented in Table 4.

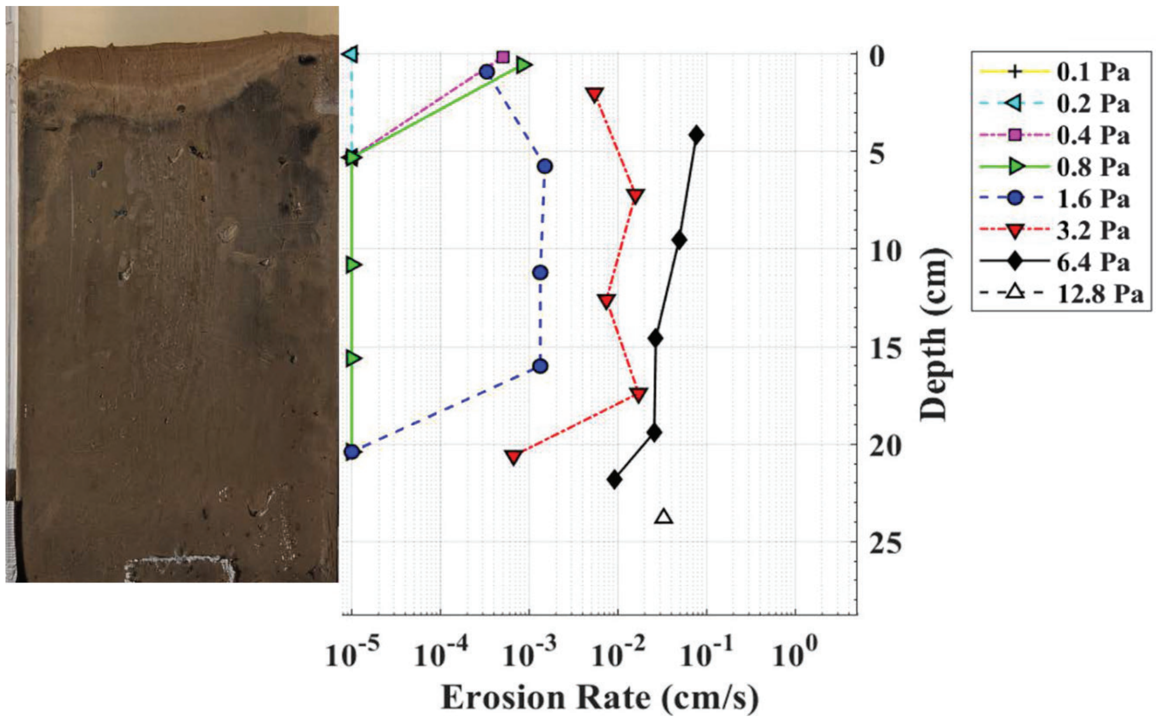


Figure 3. Photograph of Core ER-10 aligned with applied shear stresses and associated erosion rates

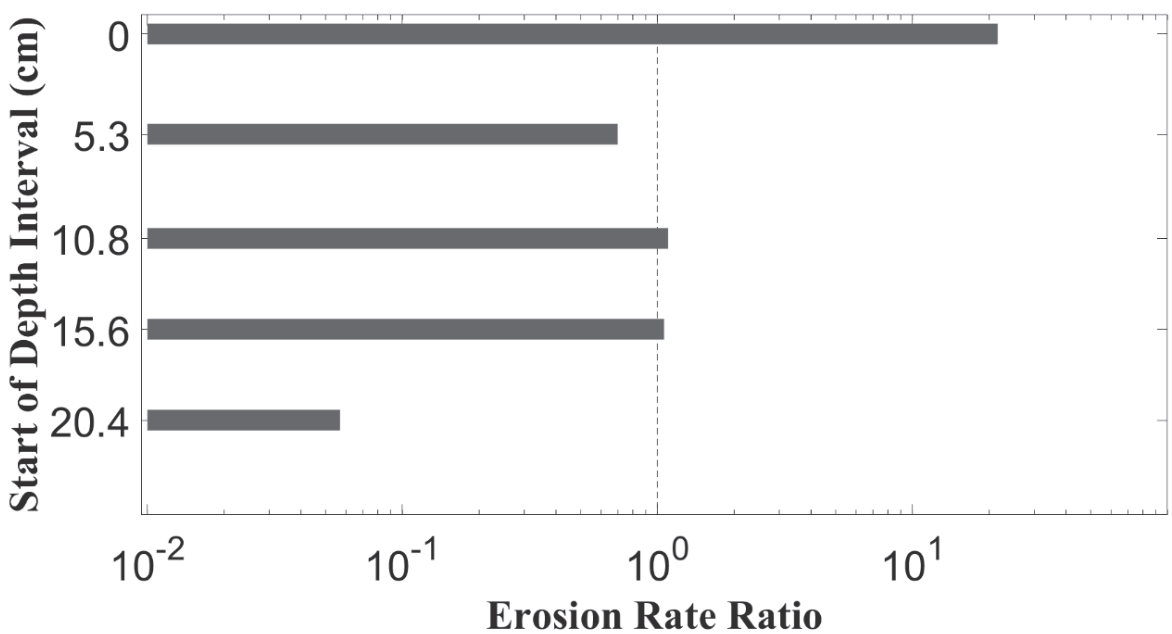


Figure 4. Intracore erosion rates of ER-10

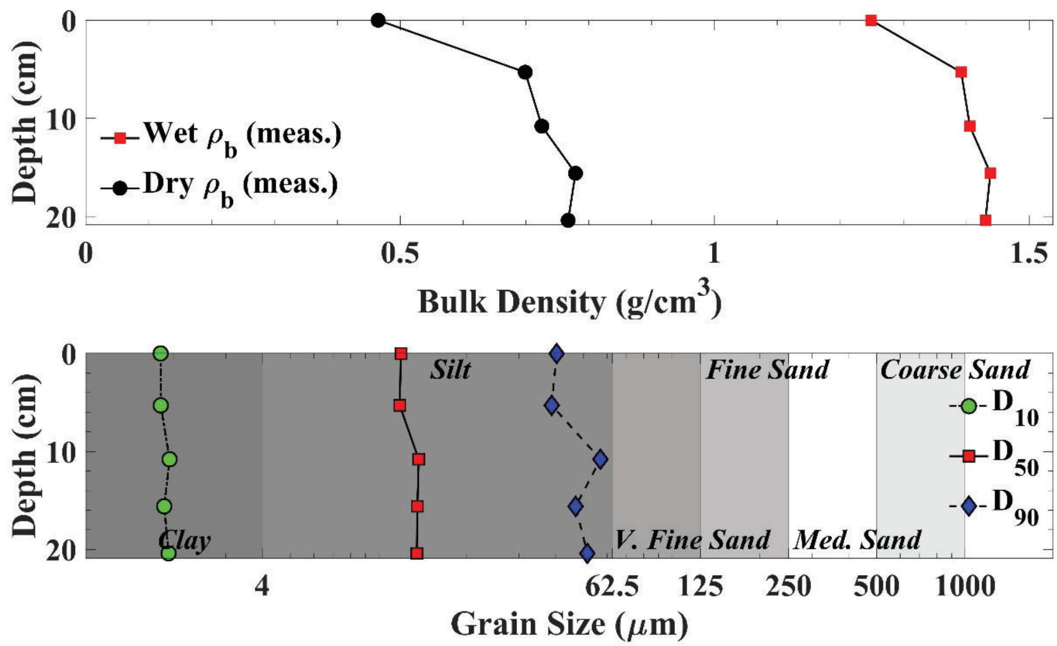


Figure 5. Physical properties of ER-10 with depth

Table 3. Physical properties and derived critical shear stresses of ER-10

Sample Depth (cm)	Median Grain Size (µm)	Wet Bulk Density (g/cm^3)	Dry Bulk Density (g/cm^3)	Loss on Ignition (%)	Tau_no (Pa)	Tau_first (Pa)	Tau Crit Linear (Pa)	Tau Crit Power (Pa)	Final Critical Shear (Pa)
0.0	11.89	1.25	0.46	5.2%	0.2	0.4	0.24	0.25	0.25
5.3	11.78	1.39	0.7	5.0%	0.8	1.6	0.86	0.75	0.8
10.8	13.68	1.41	0.73	5.2%	0.8	1.6	0.86	0.74	0.8
15.6	13.54	1.44	0.78	5.2%	0.8	1.6	0.86	0.72	0.8
20.4	13.47	1.43	0.77	5.3%	1.6	3.2	1.84	1.73	1.73
Mean	12.87	1.38	0.69	5.2%	0.84	1.68	0.93	0.84	0.88

Table 4. Power law fit parameters for SED-ER-10

Interval	Depth Start (cm)	Depth Finish (cm)	A	n	r^2
1	0.0	5.3	2.1E-05	1.69	0.79
2	5.3	10.8	1.93E-07	3.1	0.96
3	10.8	15.6	4.21E-07	2.74	0.97
4	15.6	20.4	3.71E-07	2.84	0.92
5	20.4	24.8	1.64E-08	3.06	0.98

2.2 SED-ER-680

Core ER-680 was collected on March 9, 2020, at 5:30 p.m. in 5 ft of water and is the easternmost sample in the Elk River. This was the first core collected during the study and required multiple attempts and the use of a post-hammer to achieve adequate penetration resulting in 22 cm of sediment collected. The sample contained evidence of biotic activity at the surface in the upper 10 cm of the sample in form of tubes and possible feeding voids. Below a 1–3 cm surface layer of lighter sediment, an olive gray mixture of silt and sand extended throughout the sample. On the surface, the sediment was unconsolidated, yellow-tan material with some biotic mounds present. A translucent fish approximately 2 cm in length was also observed in the overlying water and burrowed into the sand when disturbed.

A photograph of the recovered sediment aligned with applied shear stress and associated erosion rates is presented in Figure 6. Shear stresses of 0.1 to 6.4 Pa were applied in three intervals utilizing 13.7 cm of material. The unconsolidated surface material eroded more easily than the underlying material possibly due to bioturbation (Figure 7). Sediment eroded in streams of individual grains as the loose sandy material eroded from the surface. Below the surface interval, sediment eroded as individual grains giving way to larger pieces of the surface 1–3 mm in diameter breaking away. Pockets of interspersed sandy material eroded as individual grains causing the exposed sediment level to erode unevenly. Critical shear stresses ranged from 0.12 to 0.4 Pa from the first to third interval (Table 5). Intervals 2 and 3 had similar properties resulting in an average critical shear stress of 0.3 Pa. Power law fit parameters governing the relationship between shear stress and erosion rate are provided in Table 6. The r^2 values show an excellent fit relating the two variables.

Four subsamples of material were collected for density and particle size distribution testing. The first three correlate to the beginning of each shear stress interval and the fourth corresponds to the end of the third interval. The low-density surface material comprised sand, silt, and clay

(Figure 8, Table 5). Below, sediment had a larger density and the proportions of sand, silt, and clay varied.

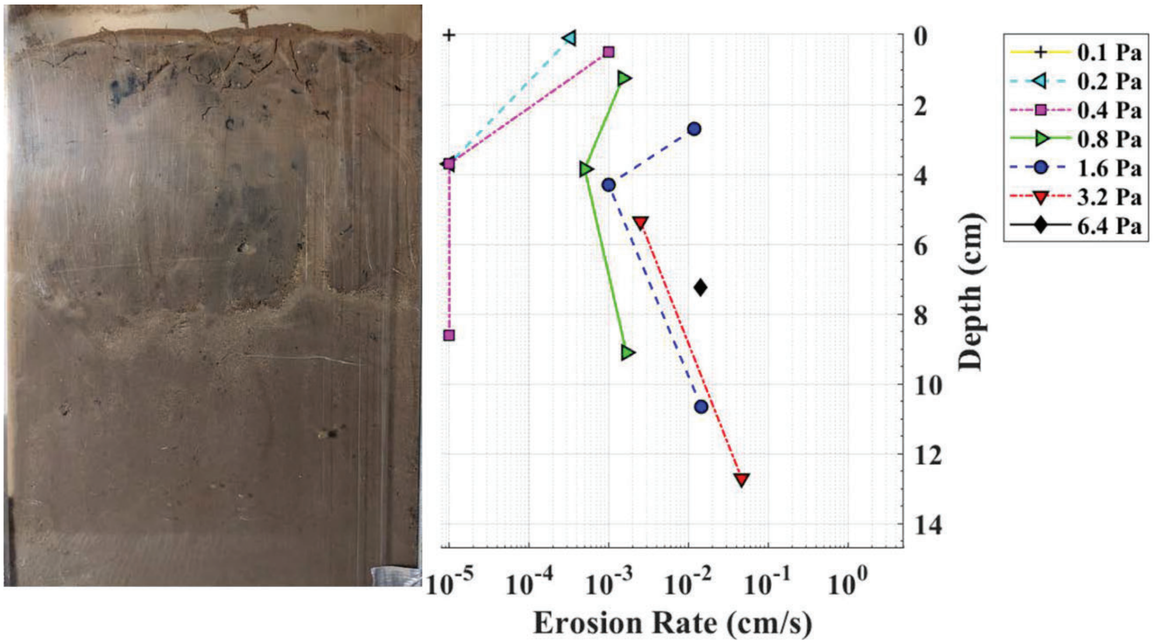


Figure 6. Photograph of Core ER-680 aligned with applied shear stresses and associated erosion rates

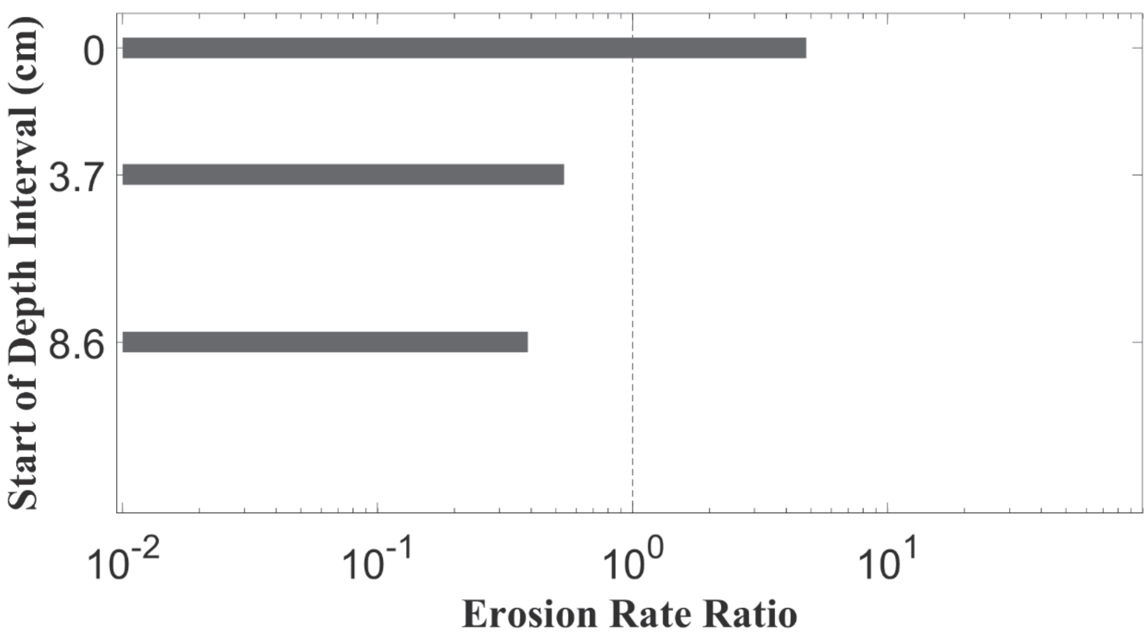


Figure 7. Intracore erosion rates in ER-680

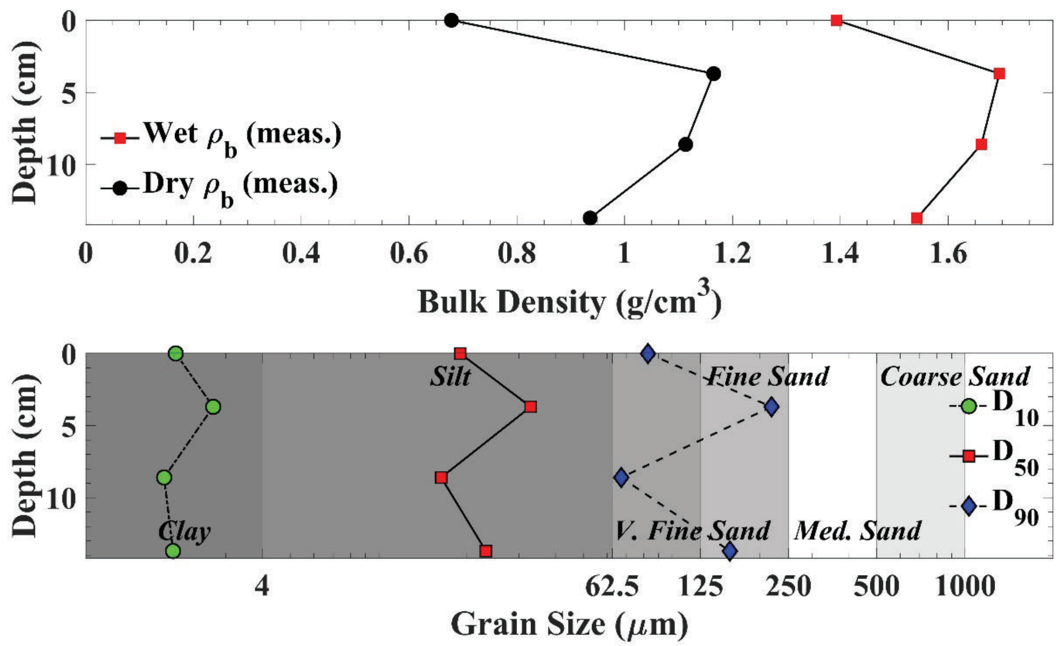


Figure 8. Physical properties of ER-680 with depth

Table 5. Physical properties and derived critical shear stresses of ER-680

Sample Depth (cm)	Median Grain Size (μm)	Wet Bulk Density (g/cm³)	Dry Bulk Density (g/cm³)	Loss on Ignition (%)	Tau_no (Pa)	Tau_first (Pa)	Tau Crit Linear (Pa)	Tau Crit Power (Pa)	Final Critical Shear (Pa)
0	18.95	1.39	0.68	3.4%	0.1	0.2	0.13	0.12	0.12
3.7	32.96	1.7	1.16	2.9%	0.4	0.8	0.48	0.42	0.42
8.6	16.32	1.66	1.11	3.0%	0.4	0.8	0.43	0.37	0.4
13.7	23.18	1.54	0.94	4.2%	---	---	---	---	---
Mean	22.85	1.57	0.97	3.4%	0.3	0.6	0.35	0.30	0.31

Table 6. Power law fit parameters of ER-680

Interval	Depth Start (cm)	Depth Finish (cm)	A	n	r^2
1	0.0	3.7	7.64E-05	1.71	0.95
2	3.7	8.4	8.35E-06	1.74	0.97
3	8.6	13.7	1.88E-06	3.05	0.96

2.3 SED-NR-130

Core NR-130 was collected on March 11, 2020, at 4:00 p.m. on the east bank of the Neosho River. The sample was collected along the bank due to the flow of the river. The core recovery length was 17 cm, and a post-hammer was required to achieve penetration through the sediment. Shown in Figure 9, the collected sediment contained invertebrate burrows and tubes that extended and criss-crossed throughout the sample. An example of the worm observed in this core as well as other collected samples and presumably responsible for these burrows is shown in Figure 10. Patches of oxic sediment associated with the presence of worm tubes extended 10−12 cm below the surface. Darker patches of olive silt were present in the absence of worm tubes.

A photograph of the collected sediment core and applied shear stresses is provided in Figure 9. Due to the limited material collected at NR-130, shear stresses ranging from 0.1 to 6.4 Pa were applied to only two intervals of the sediment. Both intervals exhibited similar erosive (Figure 11) and physical properties as summarized in Table 7 and visualized in Figure 12. Critical shear stresses ranged from 0.33 to 0.4 Pa and fit parameters suggest good agreement with a power law relationship relating shear stress and erosion rate (Table 8). Grain sizes were consistent down-core, and densities increased with depth.

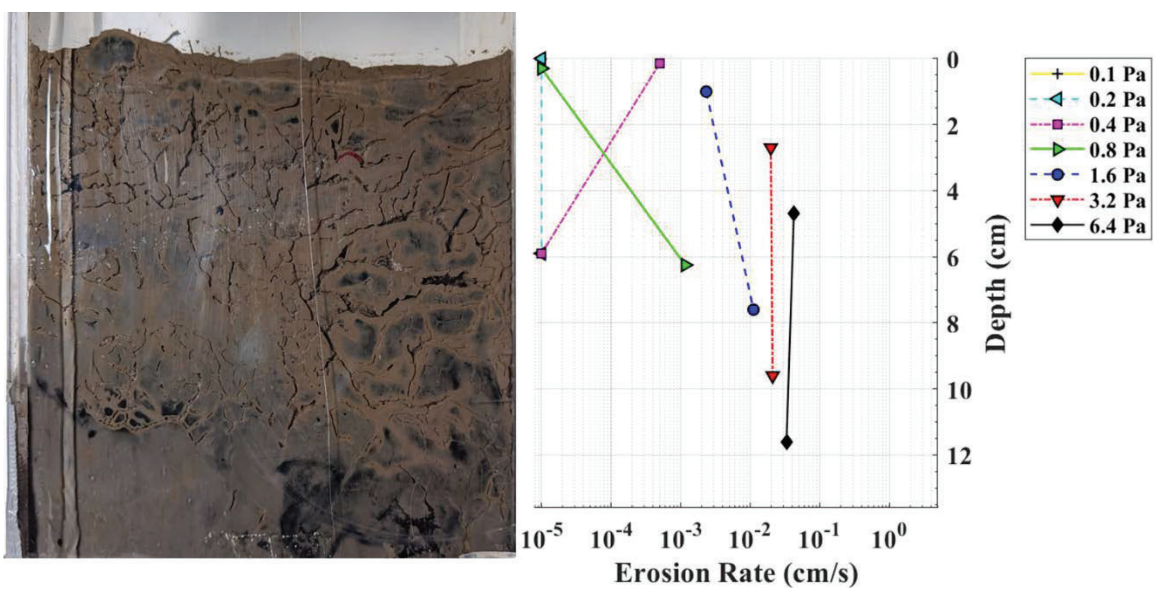


Figure 9. Photograph of Core NR-130 aligned with applied shear stresses and associated erosion rates

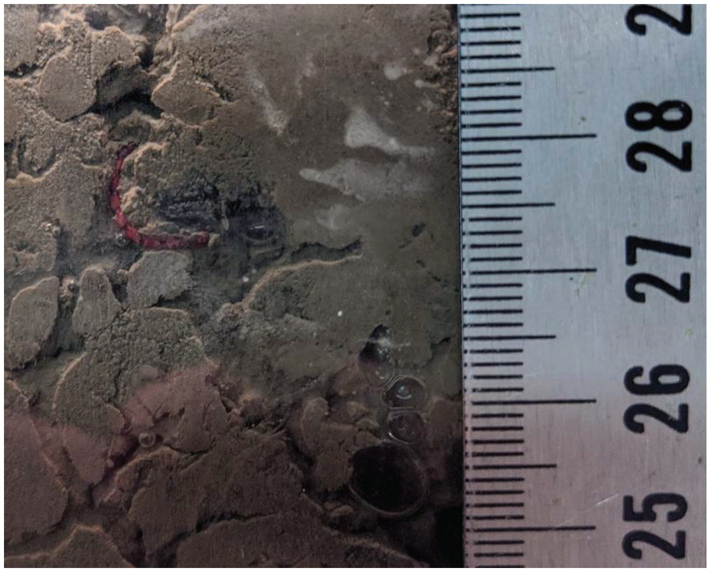


Figure 10. Invertebrate in burrow in NR-130

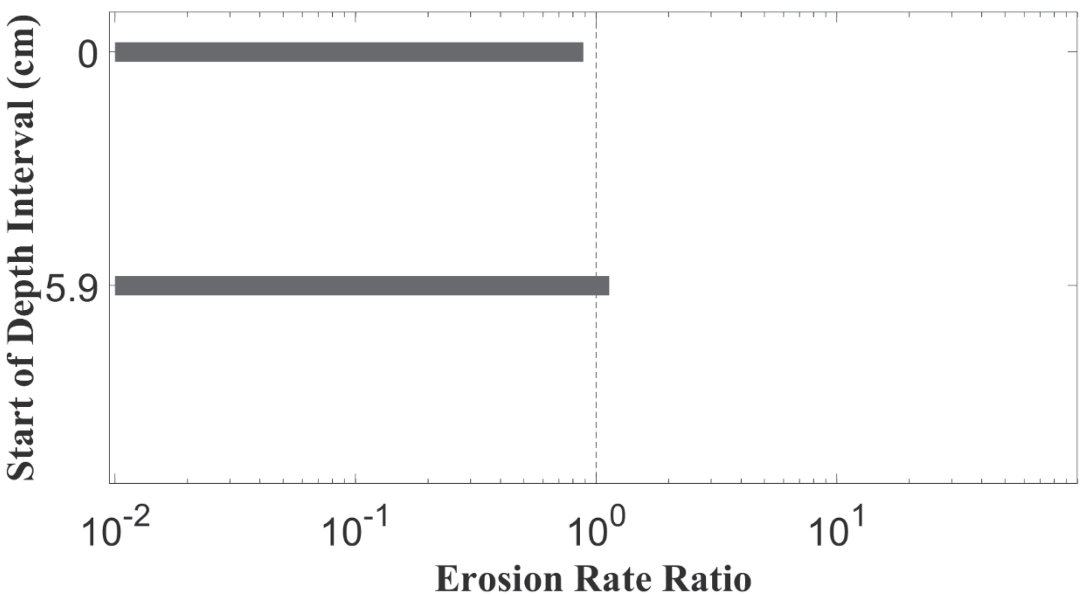


Figure 11. Intracore erosion rates in NR-130

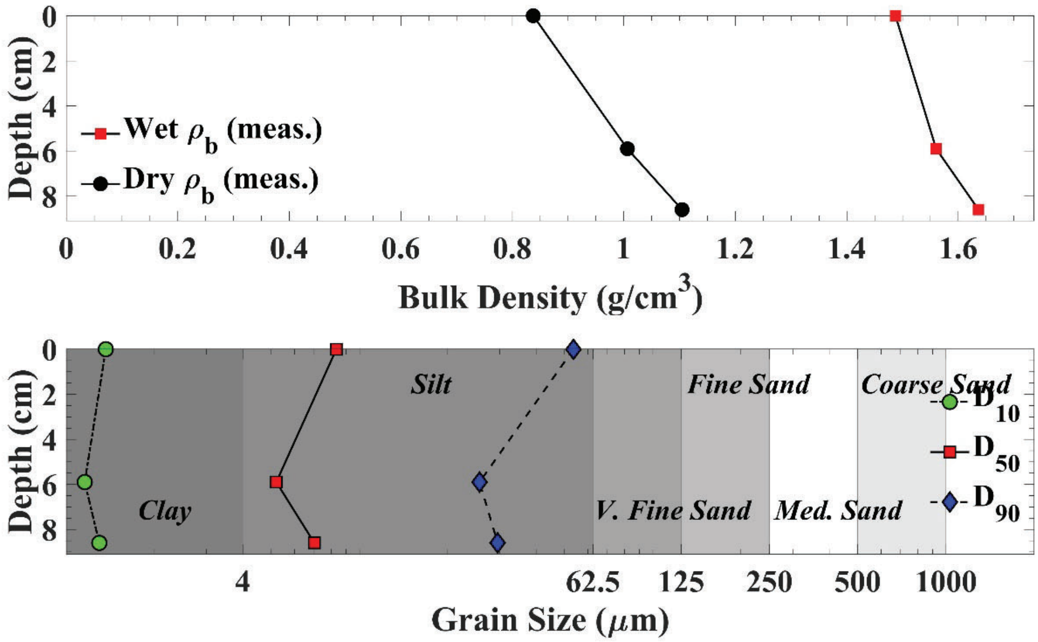


Figure 12. Physical properties of NR-130 with depth

Table 7. Physical properties and derived critical shear stresses of NR-130

Sample Depth (cm)	Median Grain Size (µm)	Wet Bulk Density (g/cm^3)	Dry Bulk Density (g/cm^3)	Loss on Ignition (%)	Tau_no (Pa)	Tau_first (Pa)	Tau Crit Linear (Pa)	Tau Crit Power (Pa)	Final Critical Shear (Pa)
0.0	8.34	1.49	0.84	3.7%	0.2	0.4	0.84	0.33	0.33
5.9	5.2	1.56	1.01	6.8%	0.4	0.8	0.44	0.29	0.4
8.6	7.01	1.64	1.1	5.0%	---	---	---	---	---
Mean	6.85	1.56	0.98	5.2%	0.30	0.60	0.64	0.31	0.37

Table 8. Power law fit parameters for NR-130

Interval	Depth Start (cm)	Depth Finish (cm)	A	n	r^2
1	0.0	5.7	8.57E-06	2.04	0.78
2	5.9	12.6	1.01E-05	2.13	0.88

2.4 SED-NR-164

Core NR-164 was collected on the eastern bank of the Neosho River downstream of the confluence of the Neosho and Spring rivers. Sampling required light blows from the post-hammer and resulted in the recovery of 41 cm of sediment. Recovered material appeared dark brown or olive in color with a lighter oxidized layer 1–2 cm on the surface. Sediment less than 10 cm from the surface showed signs of biotic activity and contained leaves and twigs.

A photograph of the recovered sediment aligned with applied shear stresses and resulting erosion rates is presented in Figure 13. Shear stresses ranging from 0.1 to 12.8 Pa were applied to six intervals of sediment in the upper 25 cm of sample. The first interval extended 1.8 cm from the original surface and ended when the unconsolidated material was eroded away leaving a much firmer looking, gray material. In subsequent intervals, bedded material did not respond to applied shear stresses less than 1.6 Pa. The material contained worms (Figure 14) and their structures and eroded in pieces or in some instances larger episodes of multiple millimeters of sediment peeled away. The sediment in intervals 2 through 6 behaved in a similar way to the applied shear stresses (Figure 15).

Low-density surface material gave way to generally denser material down-core. Sediment grain size distributions varied with some sand present intermittently around 10 cm below the recovered surface (Figure 16, Table 9). Derived critical shear stresses ranged from 0.12 at the surface to a uniform 0.8 Pa at deeper intervals. The 0.8 value was determined using the criteria in Section 1.2.2.1 because the critical shear stress derived using the power law fell below the *tau_no* value. Power law fit parameters indicate that despite the critical shear stress values being lower than the *tau_no*, there is still generally good agreement with the erosion rates and shear stresses (Table 10).

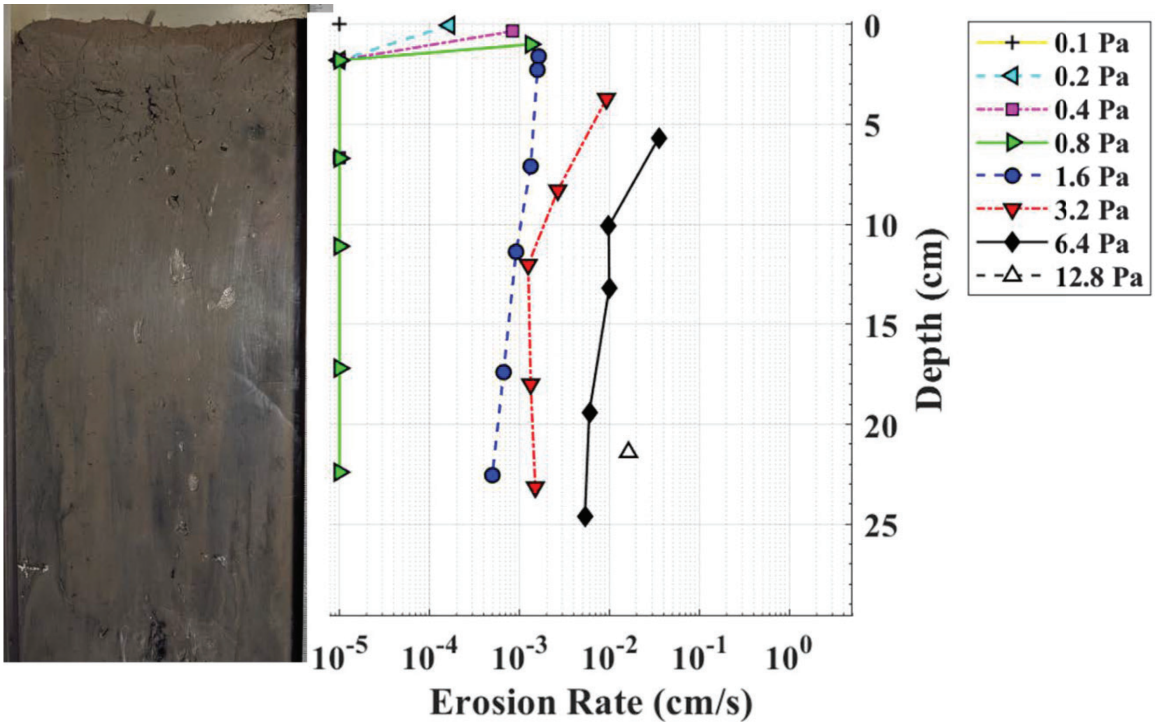


Figure 13. Photograph of Core NR-164 aligned with applied shear stresses and associated erosion rates

Figure 14. Grouping of invertebrates in NR-164

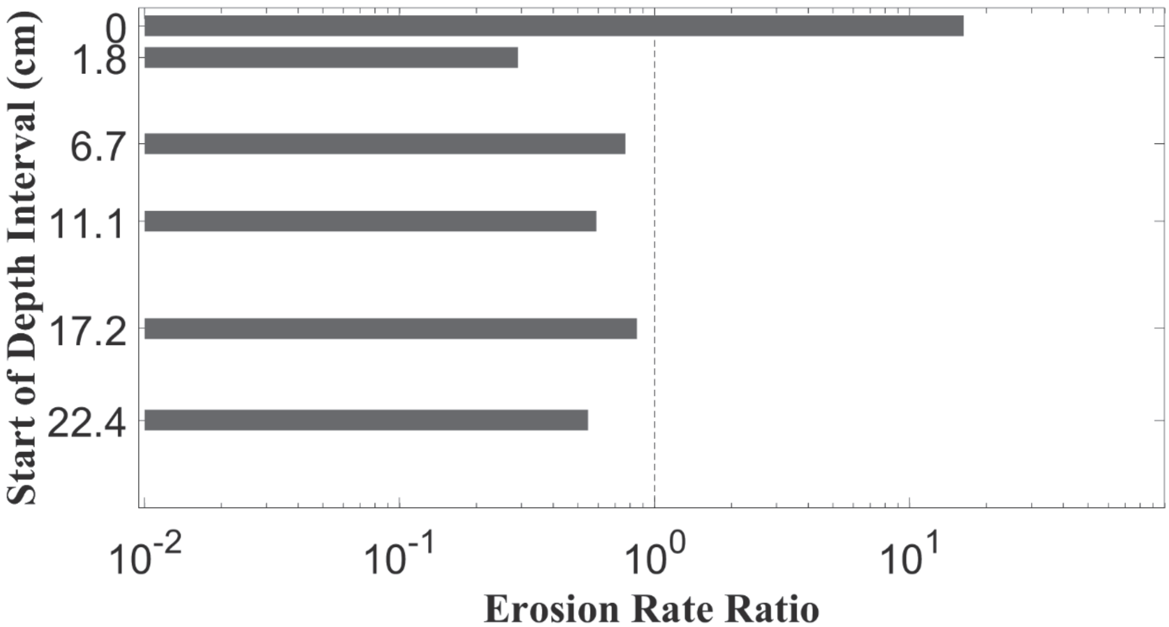


Figure 15. Intracore erosion rates in NR-164

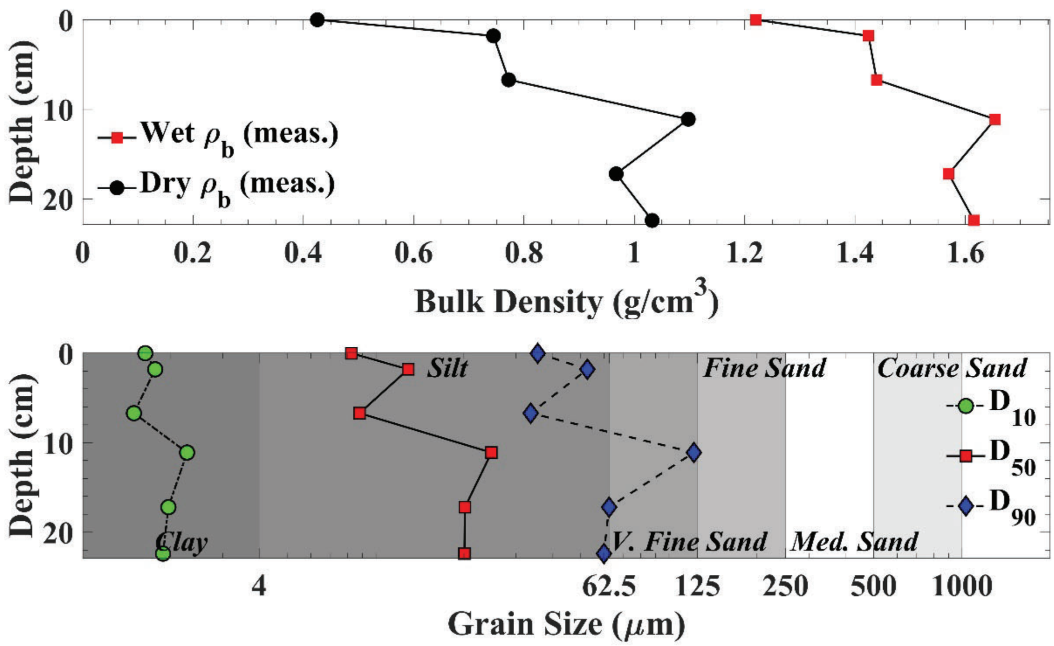


Figure 16. Physical properties of NR-164 with depth

Table 9. Physical properties and derived critical shear stresses of NR-164

Sample Depth (cm)	Median Grain Size (µm)	Wet Bulk Density (g/cm^3)	Dry Bulk Density (g/cm^3)	Loss on Ignition (%)	Tau_no (Pa)	Tau_first (Pa)	Tau Crit Linear (Pa)	Tau Crit Power (Pa)	Final Critical Shear (Pa)
0.0	8.25	1.22	0.43	5.9%	0.1	0.2	0.16	0.12	0.12
1.8	12.89	1.42	0.74	4.4%	0.8	1.6	0.86	0.73	0.8
6.7	8.8	1.44	0.77	4.6%	0.8	1.6	0.86	0.68	0.8
11.1	24.8	1.65	1.1	2.9%	0.8	1.6	0.89	0.77	0.8
17.2	20.15	1.57	0.97	3.3%	0.8	1.6	0.92	0.75	0.8
22.4	20.05	1.62	1.03	2.7%	0.8	1.6	0.96	0.85	0.85
Mean	15.82	1.49	0.84	4.0%	0.68	1.37	0.78	0.65	0.70

Table 10. Power law fit parameters in NR-164

Interval	Depth Start (cm)	Depth Finish (cm)	A	n	r^2
1	0.0	1.8	7.93E-05	1.24	0.88
2	1.8	6.7	3.32E-07	2.87	0.96
3	6.7	11.1	1.68E-06	2.14	0.92
4	11.1	14	1.31E-06	2.12	0.93
5	17.2	22.4	2.41E-06	1.85	0.97
6	22.4	25.6	1.33E-06	2.02	0.98

2.5 SED-NR-202

Core NR-202 was collected on March 10, 2020, at 4:35 p.m. in 5 ft of water. The sediment bed resisted penetration and required multiple blows from a post-hammer to achieve a core recovery length of 23 cm from the eastern bank along the inside bend of the Neosho River. A 3.5 cm layer of oxidized, unconsolidated sediment covered dark, anoxic silty material. The presence of visible worm tubes in the upper 7 cm of sediment suggests that observations on the undisturbed surface are the result of bioturbation and biotic mounds.

A photograph of NR-202 aligned with applied shear stresses and resulting shear stresses highlights the reduction in erodibility with depth (Figure 17). The surface sediment eroded at lower shear stresses and more easily than the material below (Figure 15). The reduction in erodibility correlates with the increase in density with depth (Figure 16, Table 11). Critical shear stresses ranges from 0.15 to 1.14 and fit parameters indicate excellent agreement in measurements and the use of a power law relationship (Table 12). When erosion occurred, sediment suspended in the form of cloud erosion at the surface and individual grains and pieces of the bed as depth increased.

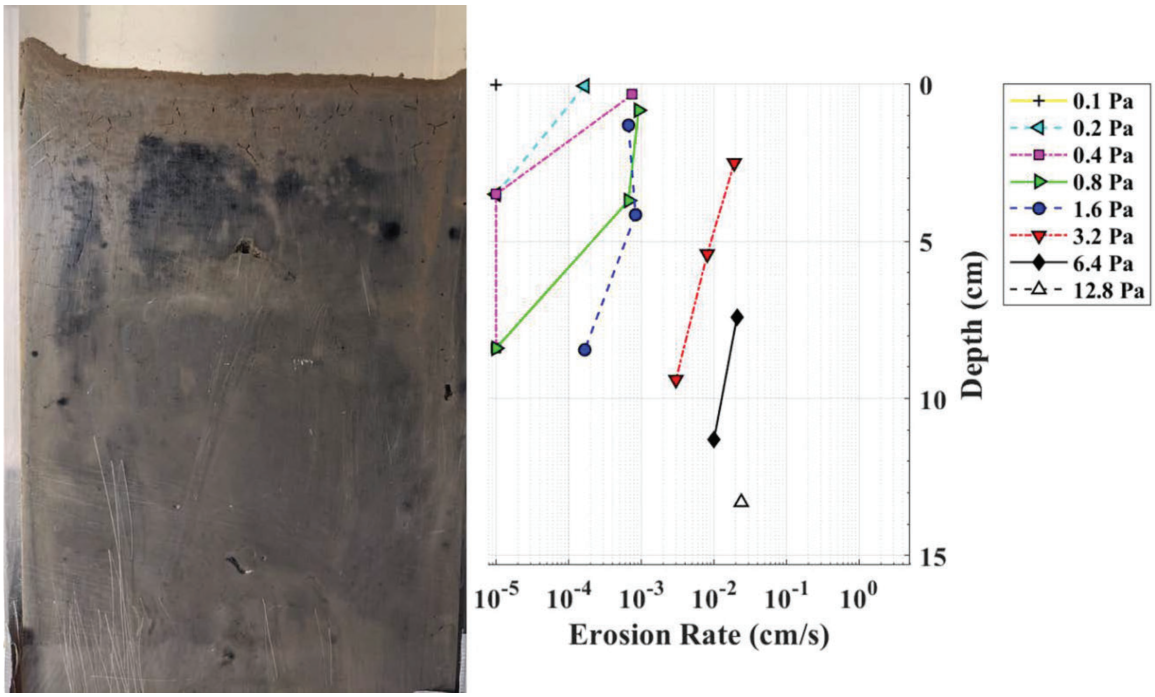


Figure 17. Photograph of Core NR-202 aligned with applied shear stresses and associated erosion rates

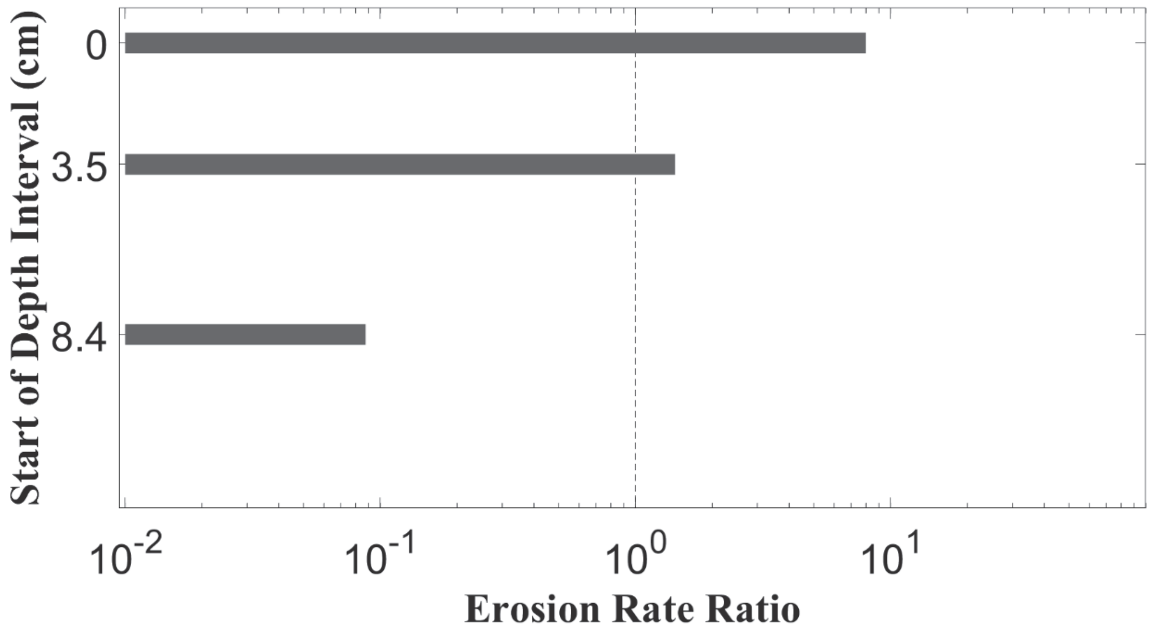


Figure 18. Intracore erosion rates in NR-202

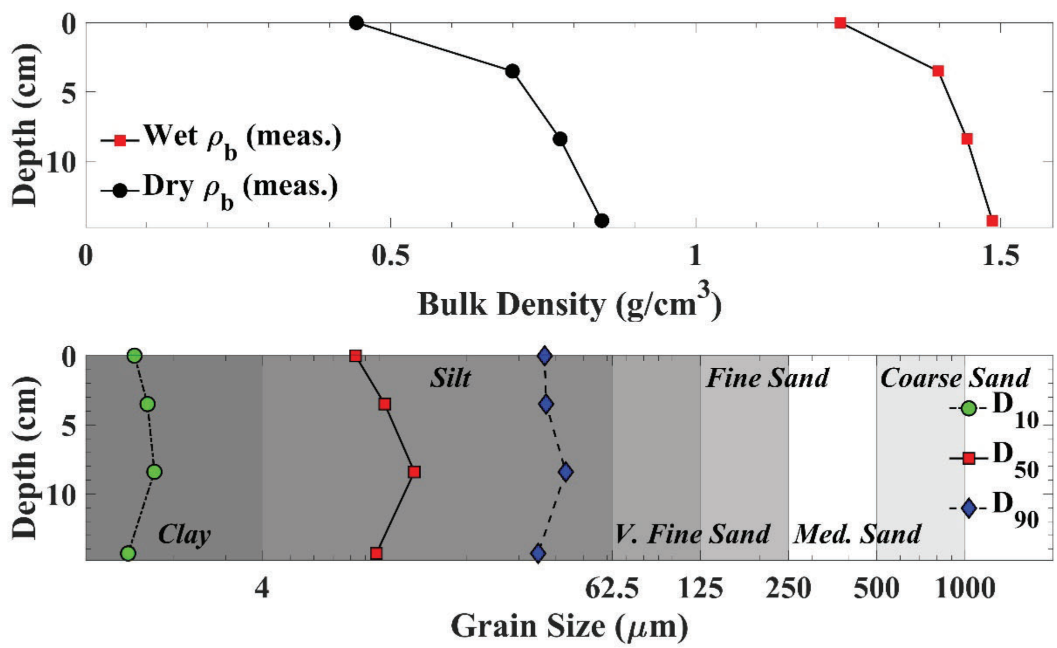


Figure 19. Physical properties of NR-202 with depth

Table 11. Physical properties and derived critical shear stresses of NR-202

Sample Depth (cm)	Median Grain Size (µm)	Wet Bulk Density (g/cm³)	Dry Bulk Density (g/cm³)	Loss on Ignition (%)	Tau_no (Pa)	Tau_first (Pa)	Tau Crit Linear (Pa)	Tau Crit Power (Pa)	Final Critical Shear (Pa)
0.0	8.33	1.24	0.44	5.1%	0.1	0.2	0.16	0.15	0.15
3.5	10.47	1.4	0.7	4.3%	0.4	0.8	0.46	0.41	0.41
8.4	13.22	1.44	0.78	4.4%	0.8	1.6	1.28	1.14	1.14
14.3	9.81	1.49	0.85	4.4%	---	---	---	---	---
Mean	10.46	1.39	0.69	4.6%	0.43	0.87	0.63	0.57	0.57

Table 12. Power law fit parameters for NR-202

Interval	Depth Start (cm)	Depth Finish (cm)	A	n	r^2
1	0.0	3.5	5.85E-05	1.39	0.8
2	3.5	8.4	6.22E-06	1.97	0.95
3	8.4	14.3	2.43E-07	2.48	0.95

2.6 SED-NR-CB

Core NR-CB was collected on the Neosho River north of Connors Bridge at 5:02 p.m. on March 11, 2020. Sampling occurred on the bank of the river away from the known gravel and rocky substrate in the center of the river. The steep slope of the bank resulted in multiple attempts to collect a sample. Samples were pushed by hand in the upper 10 cm but required post-hammer blows to recover 32 cm of sediment.

A photograph of NR-CB aligned with applied shear stresses and resulting erosion rates is presented in Figure 20. Light gray sediment at the surface contained evidence of biotic activity that extended up to 12 cm into the sediment bed. Below the surface layer, sediment was silty in texture and transitioned from olive to dark gray material approximately 15 cm below the surface. Resulting erosion rates varied with the most erodible sediment occurring in the second interval (Figure 21). This may be due to the effects of wetting and drying associated with the shallow bank where the core was collected.

Variations in density mimic trends in erodibility but median grain sizes generally increased throughout the sample (Figure 22, Table 13). Critical shear stresses also varied in a similar manner to density ranging from 0.2 in interval 2 to 0.8 Pa at interval 5. Fit parameters indicate good and excellent fits relating shear stress to erosion rate (Table 14).

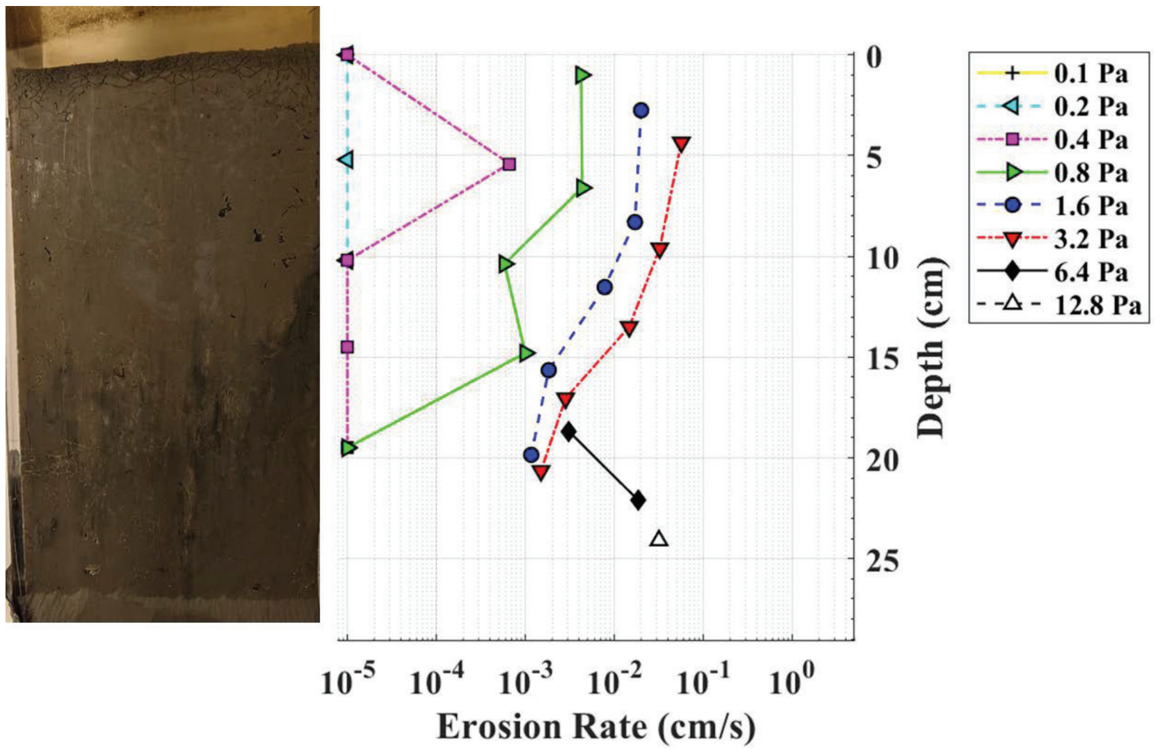


Figure 20. Photograph of Core NR-CB aligned with applied shear stresses and associated erosion rates

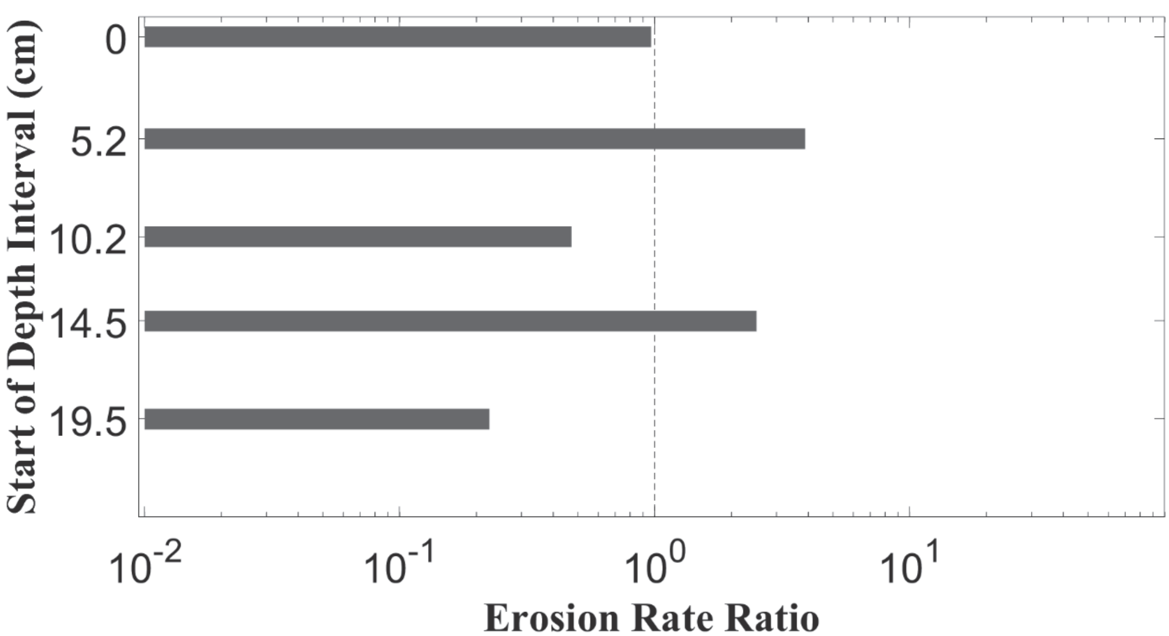


Figure 21. Intracore erosion rates in NR-CB

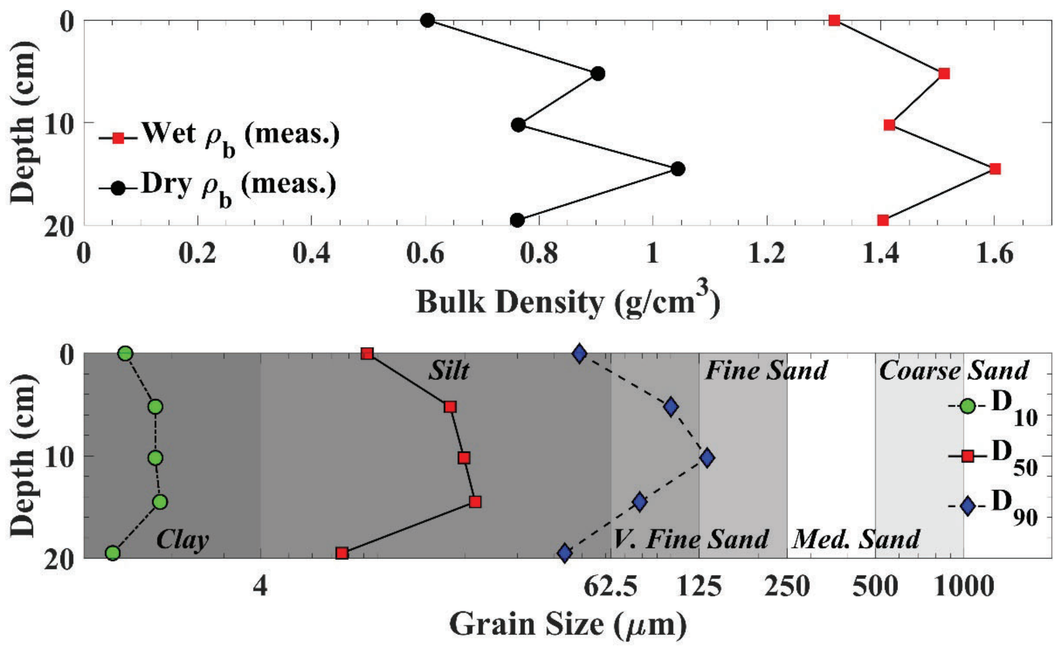


Figure 22. Physical properties of NR-CB with depth

Table 13. Physical properties and derived critical shear stresses of NR-CB

Sample Depth (cm)	Median Grain Size (µm)	Wet Bulk Density (g/cm^3)	Dry Bulk Density (g/cm^3)	Loss on Ignition (%)	Tau_no (Pa)	Tau_first (Pa)	Tau Crit Linear (Pa)	Tau Crit Power (Pa)	Final Critical Shear (Pa)
0.0	9.23	1.32	0.6	7.0%	0.4	0.8	0.41	0.31	0.4
5.2	17.73	1.51	0.9	5.4%	0.2	0.4	0.23	0.18	0.2
10.2	19.76	1.42	0.76	6.8%	0.4	0.8	0.47	0.42	0.42
14.5	21.58	1.6	1.04	4.9%	0.4	0.8	0.45	0.21	0.4
19.5	7.58	1.4	0.76	8.0%	0.8	1.6	0.87	0.7	0.8
Mean	15.18	1.45	0.81	6.4%	0.44	0.88	0.49	0.36	0.44

Table 14. Power law fit parameters in NR-CB

Interval	Depth Start (cm)	Depth Finish (cm)	A	n	r^2
1	0.0	5.2	3.24E-06	2.99	0.91
2	5.2	10.2	2.62E-05	2.21	0.96
3	10.2	14.5	2.05E-06	2.7	0.94
4	14.5	19.5	4.31E-05	1.16	0.75
5	19.5	25.1	1.66E-06	2.1	0.94

2.7 SED-NR-FG

Core NR-FG was collected near the Miami fairgrounds on March 11, 2020, at 11:00 a.m. The 23 cm length of core was collected from the east bank of the river. The area was noted to be seasonally wet and dry by the FreshWater Engineering team members. The surface was covered in clumps of sediment and resisted penetration from the coring system due to the presence of stiff sediment. Sediment at NR-FG was light gray or tan with evidence of anoxic patches as depth increased.

A photograph of NR-FG with applied shear stresses and resulting erosion rates is presented in Figure 23. Shear stress was applied successfully to three intervals of the sample. The loose surface material that formed broken clumps was tested for grain size distribution and density but was not considered for critical shear stress determination. To reduce anthropogenic disturbance, the clumpy material was subjected to a 1.6 Pa flow that removed the clumps from the surface. After their removal, processing took place as normal. Sediment properties remained relatively constant with depth but erodibility (and subsequently critical shear stress) declined as depth increased (Figure 24, Figure 25).

Critical shear stresses increased an order of magnitude from 0.4 Pa at interval 1 to 2.46 Pa in interval 3 located 10 cm below the surface (Table 15). Sediment eroded unevenly across the surface and sporadically during the application of shear stresses. The sediment appeared to be crumbly and eroded by pieces breaking away often resulting in a subsequent event occurring where more particles or pieces eroded. Power law fit parameters provided in Table 16 were used to determine the critical shear stresses for each successful interval.

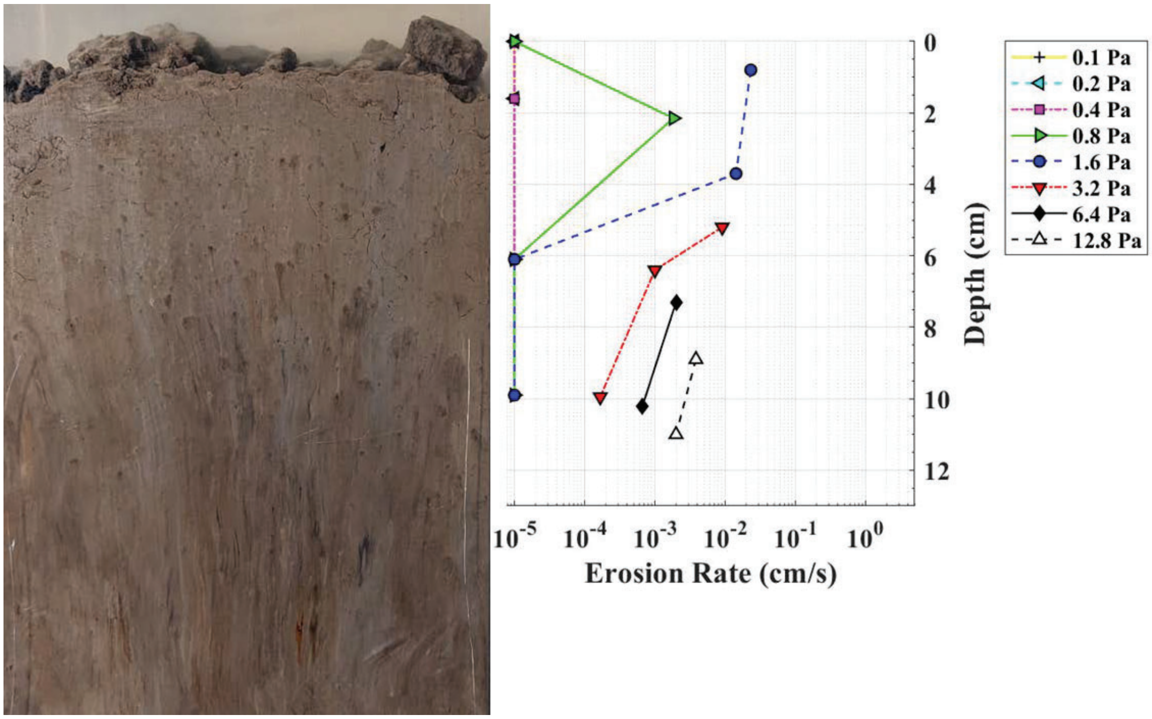


Figure 23. Photograph of Core NR-FG aligned with applied shear stresses and associated erosion rates

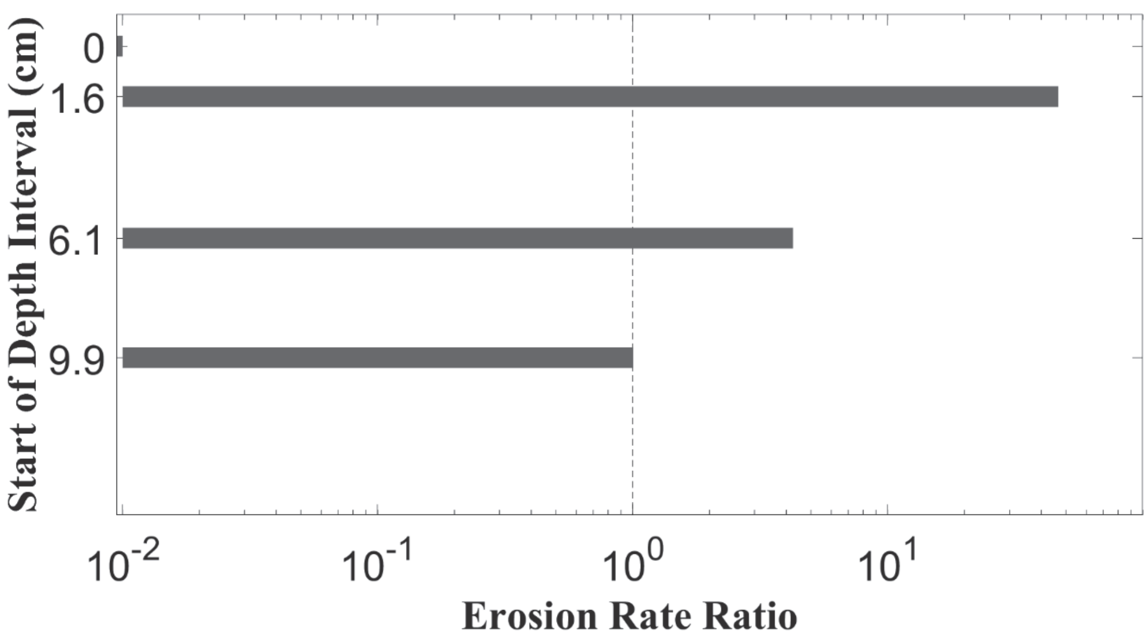


Figure 24. Intracore erosion rates in NR-FG

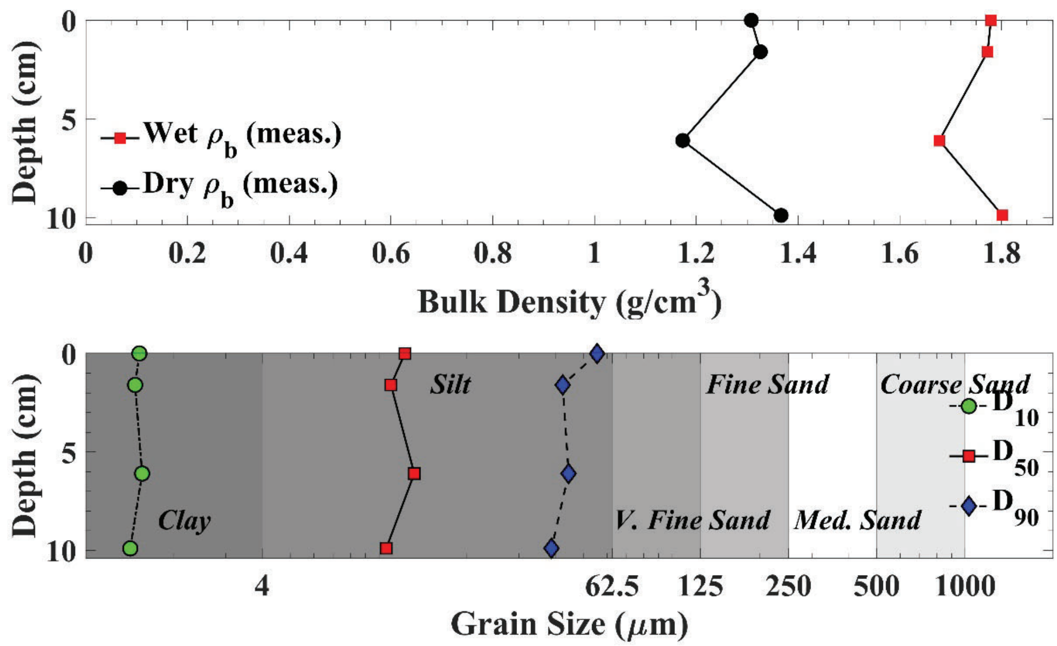


Figure 25. Physical properties of NR-FG with depth

Table 15. Physical properties and derived critical shear stresses of NR-FG

Sample Depth (cm)	Median Grain Size (µm)	Wet Bulk Density (g/cm^3)	Dry Bulk Density (g/cm^3)	Loss on Ignition (%)	Tau_no (Pa)	Tau_first (Pa)	Tau Crit Linear (Pa)	Tau Crit Power (Pa)	Final Critical Shear (Pa)
0.0	12.27	1.78	1.31	3.2%	---	---	---	---	---
1.6	11	1.77	1.33	4.8%	0.4	0.8	0.43	0.3	0.4
6.1	13.21	1.68	1.17	5.1%	1.6	3.2	1.77	1.27	1.6
9.9	10.6	1.8	1.37	4.4%	1.6	3.2	2.56	2.46	2.46
Mean	11.77	1.76	1.30	4.4%	1.1	2.2	1.39	1.21	1.32

Table 16. Power law fit parameters in NR-FG

Interval	Depth Start (cm)	Depth Finish (cm)	A	n	r^2
1	---	---	---	---	---
2	1.6	5.7	8.1E-06	2.29	0.79
3	6.1	9.9	1.22E-06	1.73	0.87
4	9.9	11.6	2.57E-07	1.86	1.0

2.8 SED-NR-SB

Core NR-SB was collected in the Neosho River on March 10, 2020, at 2:00 p.m. On the second collection attempt, a 37 cm length of sediment core was collected in 6 ft of water from the center of the river. The sample contained silty, gray sediment with a 2- to 3-cm oxic surface layer and evidence of biotic activity in the upper 10 cm.

Shear stresses ranging from 0.1 to 12.8 Pa were applied to the upper 24.6 cm of collected sediment (Figure 26). The unconsolidated surface layer was easily eroded relative to the rest of the sample. Properties such as erodibility varied with depth (Figure 27). During testing, erosion processes varied from individual grains producing even erosion across the surface to clumps of sediment breaking away leaving an uneven surface. The change in behavior was attributed to variations in grain size within the sediment bed (Figure 28, Table 17). Density increased with depth up to 20 cm below the surface.

Critical shear stresses ranged from 0.27 to 1.6 Pa and generally increased with depth.
Core NR-SB exhibits properties consistent with others from the site by having an erodible, unconsolidated surface layer and more uniform properties in the firmer sediments below. Parameters relating to erosion rate and shear stress suggest good agreement between measurements using a power law fit (Table 18).

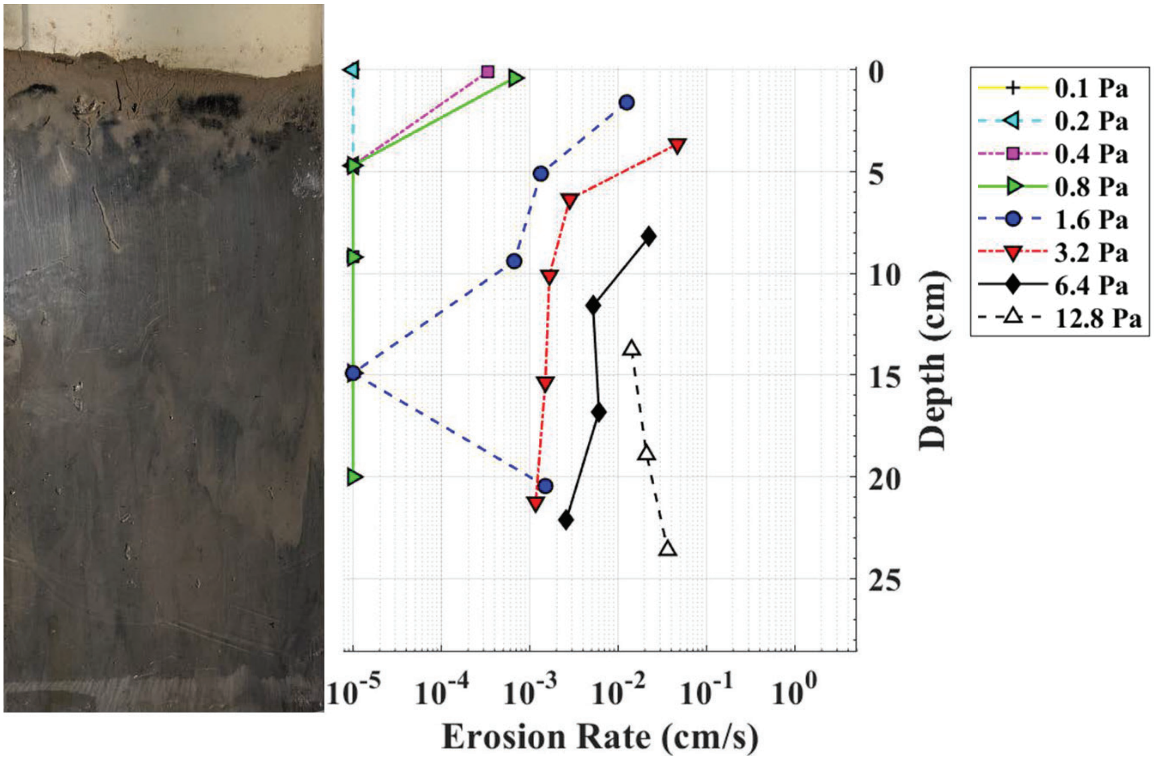


Figure 26. Photograph of Core NR-SB aligned with applied shear stresses and associated erosion rates

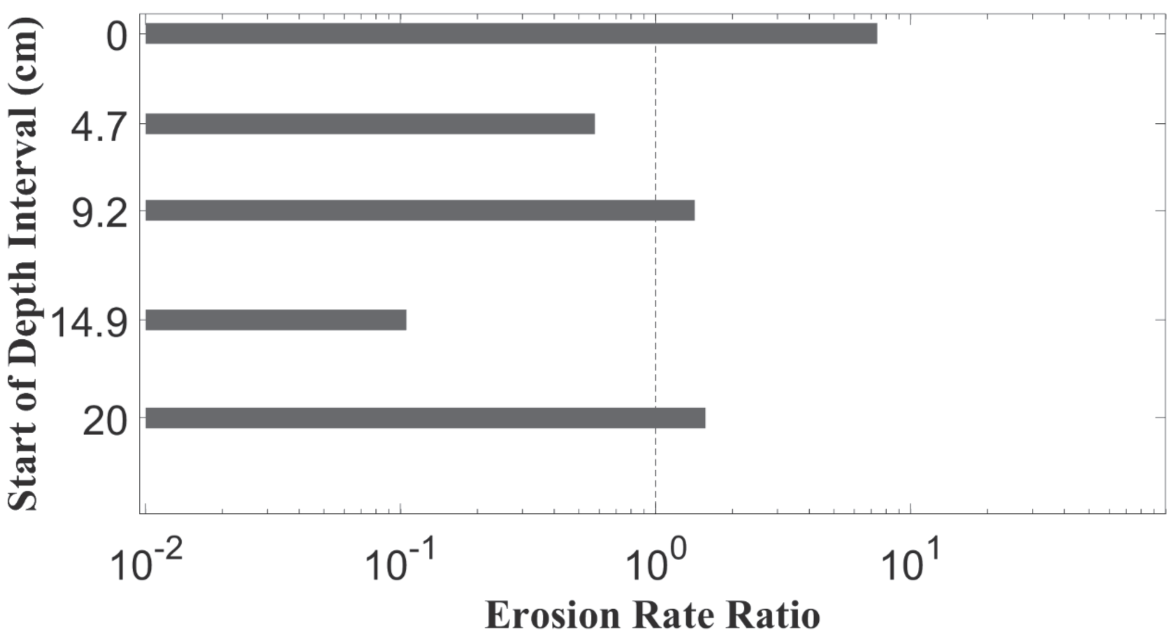


Figure 27. Intracore erosion rates for NR-SB

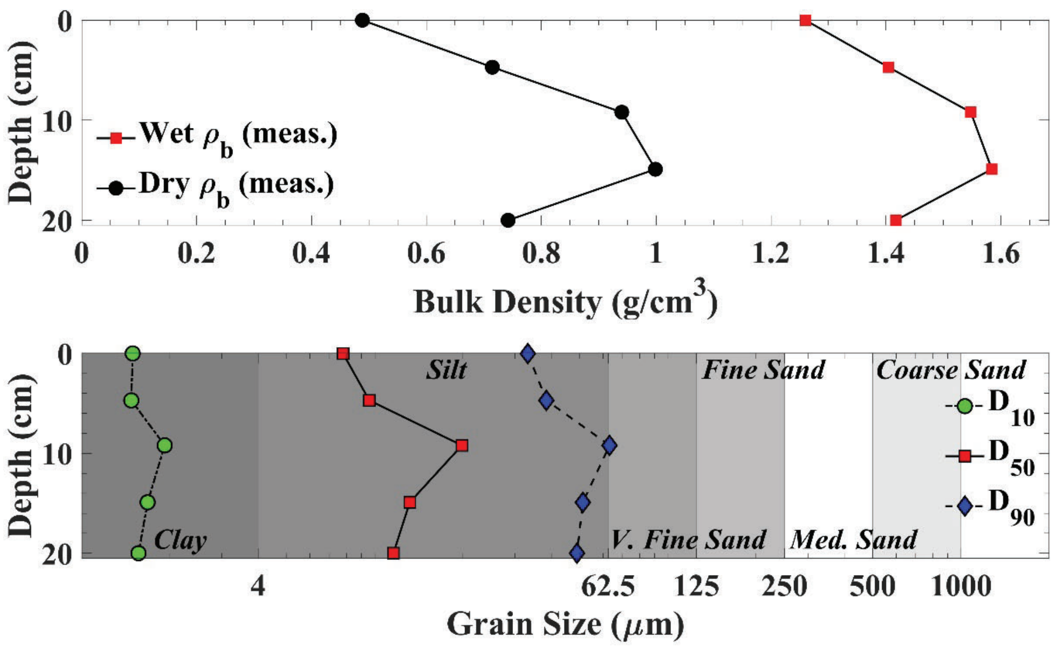


Figure 28. Physical properties of NR-SB with depth

Table 17. Physical properties and derived critical shear stresses of NR-SB

Sample Depth (cm)	Median Grain Size (µm)	Wet Bulk Density (g/cm³)	Dry Bulk Density (g/cm³)	Loss on Ignition (%)	Tau_no (Pa)	Tau_first (Pa)	Tau Crit Linear (Pa)	Tau Crit Power (Pa)	Final Critical Shear (Pa)
0.0	7.79	1.26	0.49	5.6%	0.2	0.4	0.26	0.27	0.27
4.7	9.57	1.4	0.71	4.6%	0.8	1.6	0.86	0.75	0.8
9.2	19.82	1.55	0.94	3.9%	0.8	1.6	0.92	0.72	0.8
14.9	13.16	1.58	1.00	3.8%	1.6	3.2	1.71	1.41	1.6
20.0	11.57	1.42	0.74	5.1%	0.8	1.6	0.86	0.67	0.8
Mean	12.38	1.44	0.78	4.6%	0.84	1.68	0.92	0.76	0.85

Table 18. Power law fit parameters of NR-SB

Interval	Depth Start (cm)	Depth Finish (cm)	A	n	r^2
1	0.0	4.7	8.24E-06	2.49	0.97
2	4.7	9.2	6.28E-07	2.52	0.95
3	9.2	14.9	2.98E-06	1.79	0.97
4	14.9	20	1.09E-07	2.58	0.95
5	20	24.6	3.21E-06	1.81	0.85

2.9 SED-NR-SC

Core NR-SC was collected on the Neosho River on March 10, 2020, at 5:10 p.m. Located on the outer portion of a bend in the river, collection efforts in 6 ft of water resulted in a core recovery length of 27 cm. Unlike other samples from the Neosho River, NR-SC did not present evidence of biotic activity such as worm tubes, but upon processing, worms and their pathways were intermittently uncovered. In the upper 10 cm, sandier material was mixed with olive silty material (Figure 29).

Applied shear stresses ranged from 0.1 to 12.8 Pa in five intervals. Erosion rates at a given shear stress did not exhibit a consistent trend (Figure 29). The first and fifth intervals are shown to be most erodible but critical shear stresses across the sample ranged from 0.65 Pa, peaking in interval 3 at 1.6 Pa and then decreasing again to 0.8 (Figure 30, Table 19). The changes to critical shear stresses did not follow an obvious pattern with physical properties (Figure 31). Coefficients and fit parameters linking erosion rate and shear stress suggest an excellent power law relationship between the two variables (Table 20).

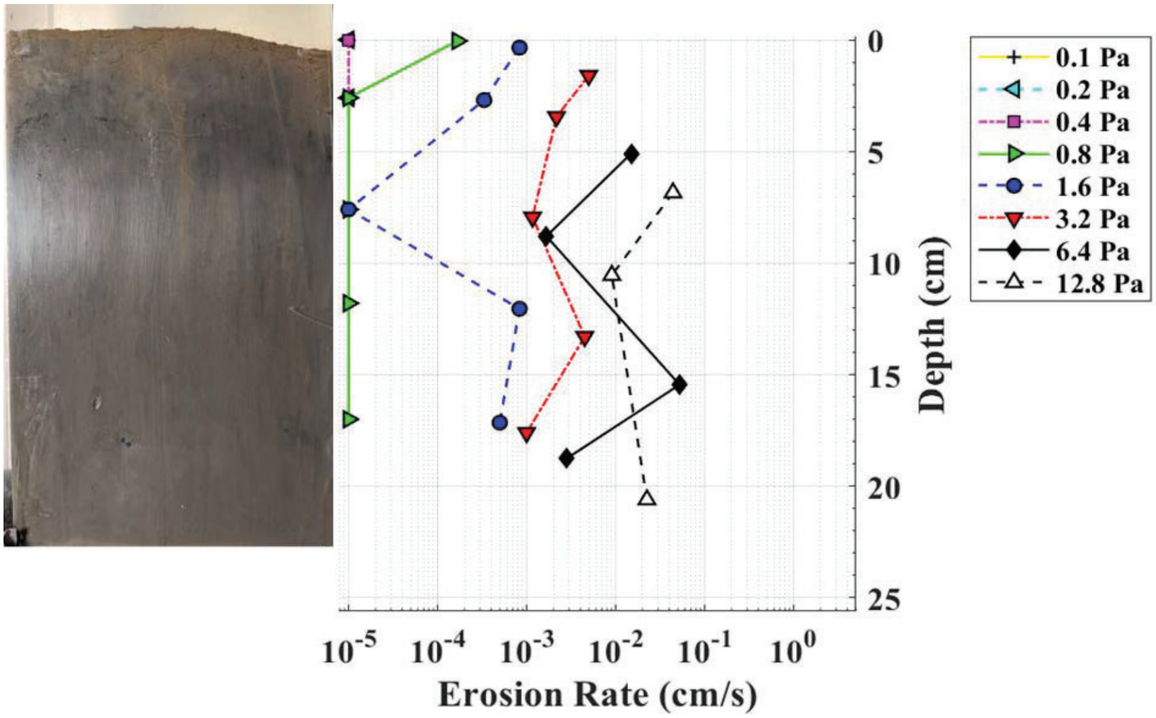


Figure 29. Photograph of Core NR-SC aligned with applied shear stresses and associated erosion rates

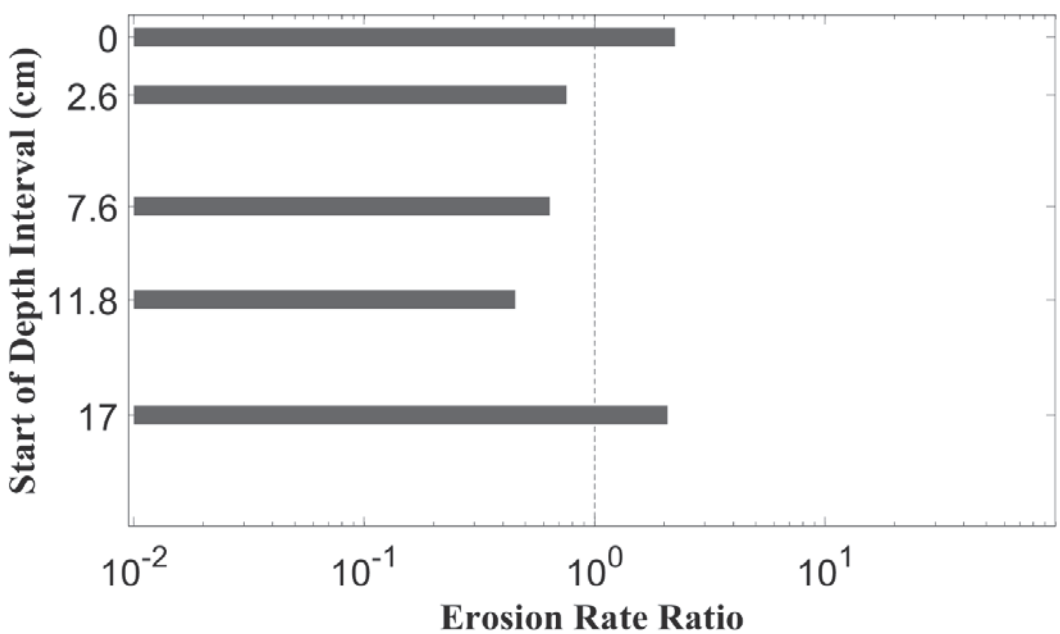


Figure 30. Intracore erosion rates of NR-SC

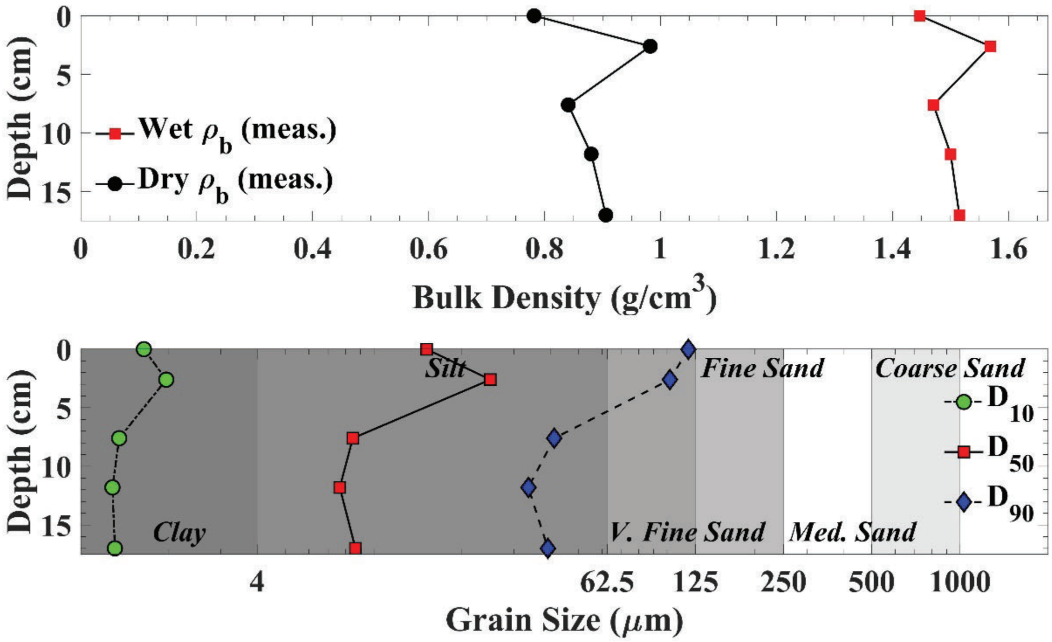


Figure 31. Physical properties of NR-SC with depth

Table 19. Physical properties and derived critical shear stresses of NR-SC

Sample Depth (cm)	Median Grain Size (µm)	Wet Bulk Density (g/cm^3)	Dry Bulk Density (g/cm^3)	Loss on Ignition (%)	Tau_no (Pa)	Tau_first (Pa)	Tau Crit Linear (Pa)	Tau Crit Power (Pa)	Final Critical Shear (Pa)
0.0	15.14	1.45	0.78	4.4%	0.4	0.8	0.64	0.65	0.65
2.6	24.98	1.57	0.98	4.4%	0.8	1.6	1.04	0.98	0.98
7.6	8.48	1.47	0.84	5.8%	1.6	3.2	1.74	1.41	1.6
11.8	7.65	1.5	0.88	5.1%	0.8	1.6	0.9	0.87	0.87
17.0	8.65	1.52	0.91	5.1%	0.8	1.6	0.96	0.88	0.88
Mean	12.98	1.50	0.88	5.0%	0.88	1.76	1.06	0.96	1.00

Table 20. Power law fit parameters of NR-SC

Interval	Depth Start (cm)	Depth Finish (cm)	A	n	r^2
1	0.0	2.6	1.08E-06	2.42	1.0
2	2.6	7.6	3.45E-07	2.49	0.99
3	7.6	11.8	4.26E-07	2.06	0.92
4	11.8	16.6	1.19E-07	3.11	0.99
5	17.0	21.6	1.59E-06	1.91	0.97

2.10 SED-SR-100

Core SR-100 was collected in 5 ft of water on March 10, 2020, at 11:40 a.m. SR-100 is located on the Spring River and is the northernmost sample collected. Sampling took place on the eastern bank to avoid the steep slope and rocky bed on the western bank and resulted in the collection of 43 cm of sediment. Soft, brown sediment with pockets of sand and leafy debris extended throughout the sample (Figure 32). The surface contained evidence of invertebrate activity but evidence down-core was difficult to ascertain due to the presence of leaves and plant matter. Pockets present in the photograph may be attributed to biotic activity or gas pockets of decaying matter.

Applied shear stresses ranging from 0.1 to 6.4 Pa were applied to SR-100 over 26.2 cm of the recovered sample (Figure 33). Erosion rates at a specified shear stress generally decreased with depth (Figure 36). Because of the sandy material present, sediment eroded in individual grains in bedload and "clouds" as shear stress increased. Leaves and plant matter affected the sediment by alternatively sheltering sediment below and then eroding in events as the leaves broke away from the surface. The concentration of leafy material increased with depth.

Physical properties varied with depth with density increasing and grain size changing depending on the quantity of sand present (Figure 37, Table 21). Critical shear stresses increased with depth and ranged from 0.11 to 0.41 Pa. Each interval spanned approximately 5 cm of sediment and fit parameters suggest an excellent relationship using a power law relationship between erosion rate and critical shear stress (Table 22).

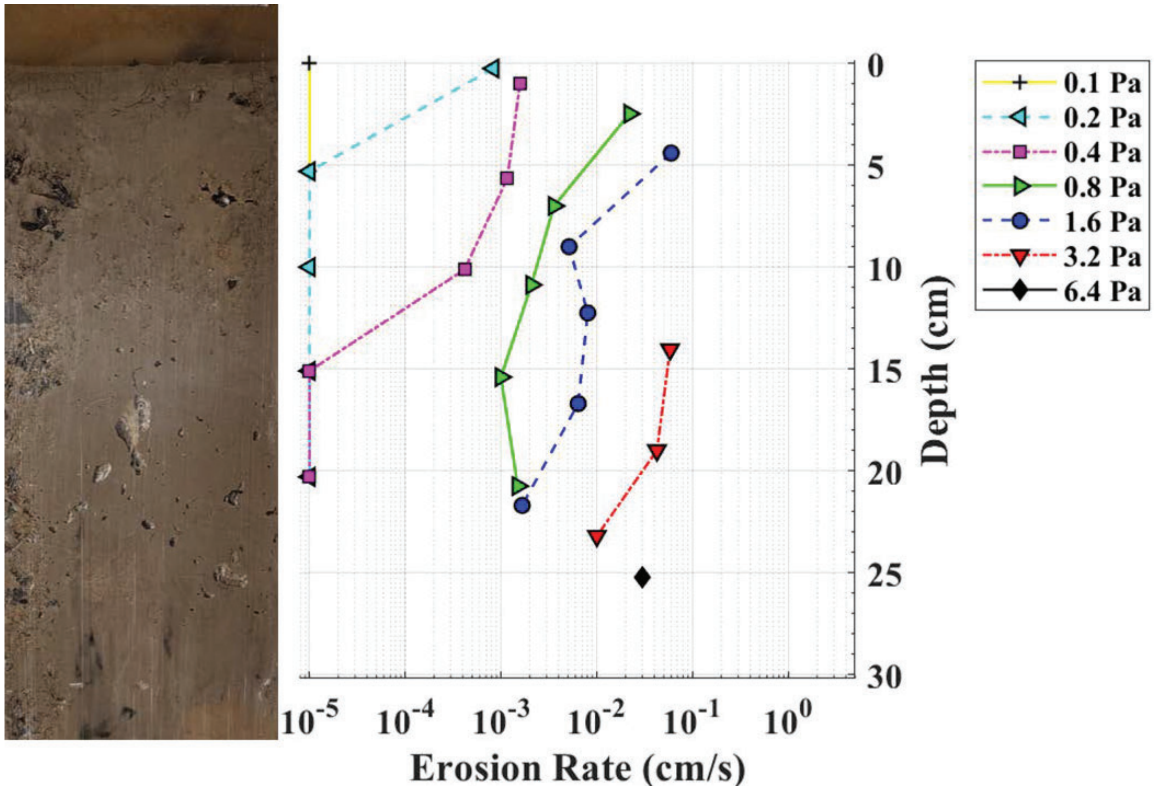


Figure 32. Photograph of Core SR-100 aligned with applied shear stresses and associated erosion rates

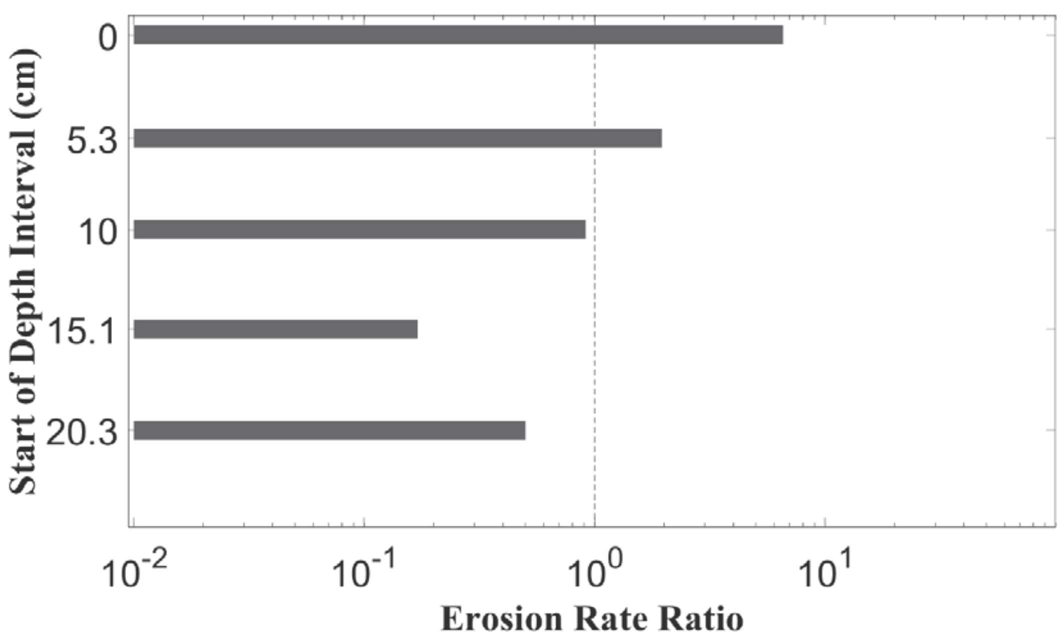


Figure 33. Intracore erosion rates for SR-100

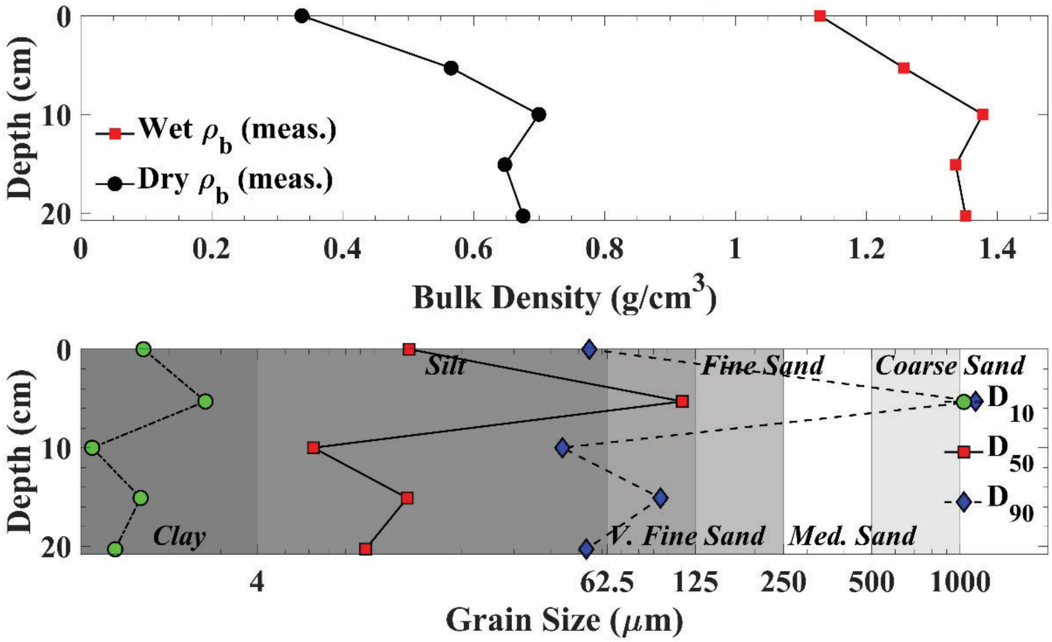


Figure 34. Physical properties of SR-100 with depth

Table 21. Physical properties and derived critical shear stresses of SR-100

Sample Depth (cm)	Median Grain Size (µm)	Wet Bulk Density (g/cm³)	Dry Bulk Density (g/cm³)	Loss on Ignition (%)	Tau_no (Pa)	Tau_first (Pa)	Tau Crit Linear (Pa)	Tau Crit Power (Pa)	Final Critical Shear (Pa)
0.0	13.2	1.13	0.34	11.6%	0.1	0.2	0.12	0.11	0.11
5.3	112.8	1.26	0.57	12.1%	0.2	0.4	0.22	0.16	0.2
10	6.22	1.38	0.7	6.8%	0.2	0.4	0.25	0.24	0.24
15.1	13	1.34	0.65	8.1%	0.4	0.8	0.45	0.41	0.41
20.3	9.37	1.35	0.68	8.2%	0.4	0.8	0.43	0.32	0.4
Mean	30.92	1.29	0.59	9.4%	0.26	0.52	0.29	0.25	0.27

Table 22. Power law fit parameters of SR-100

Interval	Depth Start (cm)	Depth Finish (cm)	A	n	r^2
1	0.0	5.3	8.79E-05	2.43	0.97
2	5.3	10.0	4.14E-05	1.92	0.86
3	10.0	15.1	1.24E-05	2.41	1.0
4	15.1	20.3	1.34E-06	3.03	0.99
5	20.3	26.2	1.03E-05	1.95	0.93

2.11 SED-SR-114

Core SR-114 was collected on the Spring River on March 10, 2020, at 12:30 p.m. Located on the western bank in 5 ft of water, the bed allowed easy penetration and only one attempt was needed to recover 41 cm of sediment. The sample contained a variable mixture of organic matter, biotic activity, and sandy regions amid the predominantly silty material. A thin surface layer less than 1 cm of lighter, unconsolidated sediment was present over the olive colored mixture of silt, sand, and clay.

Applied shear stresses aligned with the core SR-114 ranged from 0.1 to 3.2 Pa in five intervals (Figure 35). Responses to individual shear stresses did not follow a consistent pattern relative to depth but overall erodibility decreased with depth (Figure 35, Figure 36). Resulting critical shear stresses determined from the power law fit and *tau_no* values ranged from 0.2 to 0.4 Pa. The under-prediction of critical shear stress by the power law fit method is attributed to the volume of organic matter in the core that can alter erosion mechanisms. The organic matter at times shielded the bed from erosion until giving way in larger events, slowing the rate of erosion measured in the 10-minute period of applied shear stress. An example of the woody debris found in the core is shown in Figure 38. However, the fit parameters still suggest that a power law relationship provides a good relationship overall for erosion rate and applied shear stress once the critical shear stress has been met (Table 24). The sandy sediment eroded in individual grains and streams of grains around the organic matter and left uneven surfaces of the firmer silt and clay mixtures. Erodibility trends correlated with the increase in density and grain size distributions. The noted trends were potentially modulated by the amount of sandy material in the interval (Figure 37, Table 23).

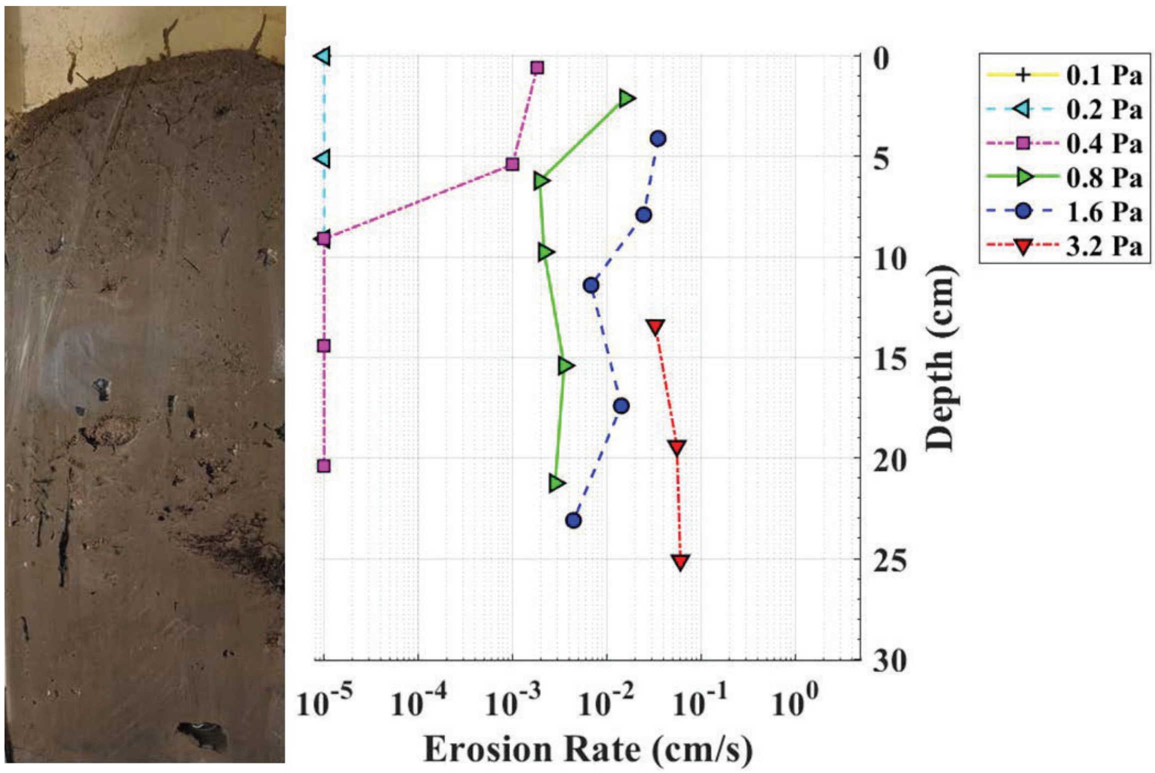


Figure 35. Photograph of Core SR-114 aligned with applied shear stresses and associated erosion rates

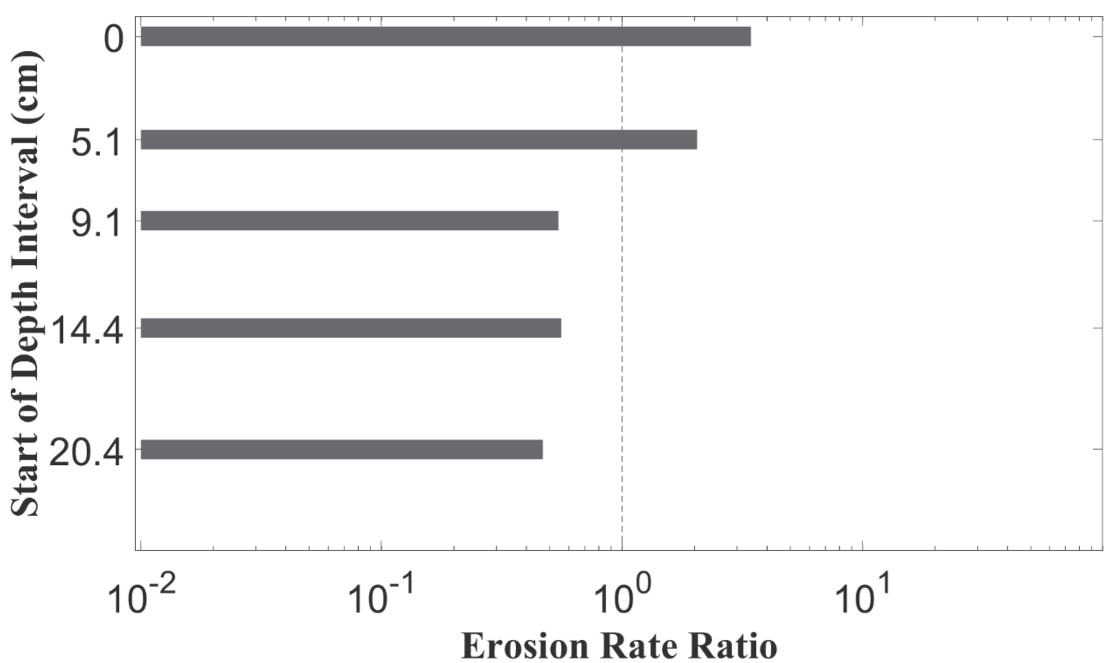


Figure 36. Intracore erosion rates of SR-114

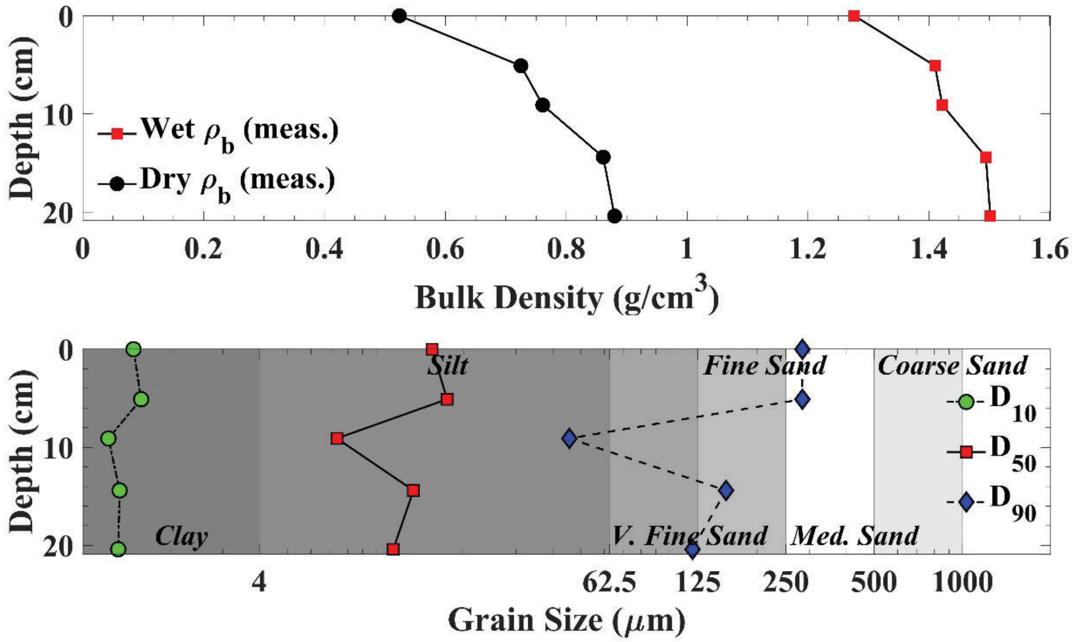


Figure 37. Physical properties of SR-114 with depth

Figure 38. Wood chips found in SR-114

Table 23. Physical properties and derived critical shear stresses of SR-114

Sample Depth (cm)	Median Grain Size (µm)	Wet Bulk Density (g/cm³)	Dry Bulk Density (g/cm³)	Loss on Ignition (%)	Tau_no (Pa)	Tau_first (Pa)	Tau Crit Linear (Pa)	Tau Crit Power (Pa)	Final Critical Shear (Pa)
0.0	15.53	1.28	0.52	6.2%	0.2	0.4	0.22	0.18	0.2
5.1	17.47	1.41	0.72	4.7%	0.2	0.4	0.23	0.21	0.21
9.1	7.36	1.42	0.76	5.8%	0.4	0.8	0.42	0.34	0.4
14.4	13.42	1.49	0.86	4.5%	0.4	0.8	0.42	0.33	0.4
20.4	11.45	1.5	0.88	4.9%	0.4	0.8	0.42	0.35	0.4
Mean	13.05	1.42	0.75	5.2%	0.32	0.64	0.34	0.28	0.32

Table 24. Power law fit parameters of SR-114

Interval	Depth Start (cm)	Depth Finish (cm)	A	n	r^2
1	0.0	5.1	1.8E-05	2.94	0.93
2	5.1	9.1	1.43E-05	2.63	0.95
3	9.1	14.4	3.49E-06	2.72	0.95
4	14.4	20.4	2.83E-06	2.99	0.93
5	20.4	26.1	2.58E-06	2.89	0.93

2.12 SED-SR-TB

Core SR-TB was collected on March 10, 2020, at 11:10 a.m. in an area north of Highway 60 in the Spring River. The 32 cm long sample was collected on the second attempt after stiff material resisted initial efforts to produce a sufficient recovery length. Recovered sediment contained an unconsolidated surface layer with evidence of biotic activity such as excavation mounds seen in Figure 39. Sediment appeared to have a homogenous, fine texture, with varied color ranging from light gray to olive gray, and contained scattered gas or feeding voids.

Shear stresses applied to SR-TB produced erosion rates that decreased with depth for each shear value (Figure 40). The resulting computed critical shear stresses increased with depth, ranging from 0.2 to 1.73 Pa and correlated to an increase in sediment density (Table 25, Figure 45). While density varied with depth, the particle size distributions remained constant throughout the core (Figure 42).

The surface eroded in clouds and streams of individual grains and small (<0.5 mm) pieces of the surface. During the first interval, an event occurred at the application of 1.6 Pa resulting in a 0.7 cm layer of sediment eroding in less than 10 seconds. After the first interval, sediment eroded sporadically in fractured pieces of the surface initialized around invertebrate structures and intermittent leafy debris. Parameters relating shear stress and erosion rates suggest a good correlation using a power law fit between the two variables (Table 26).

Figure 39. Evidence of biotic activity on surface of SR-TB

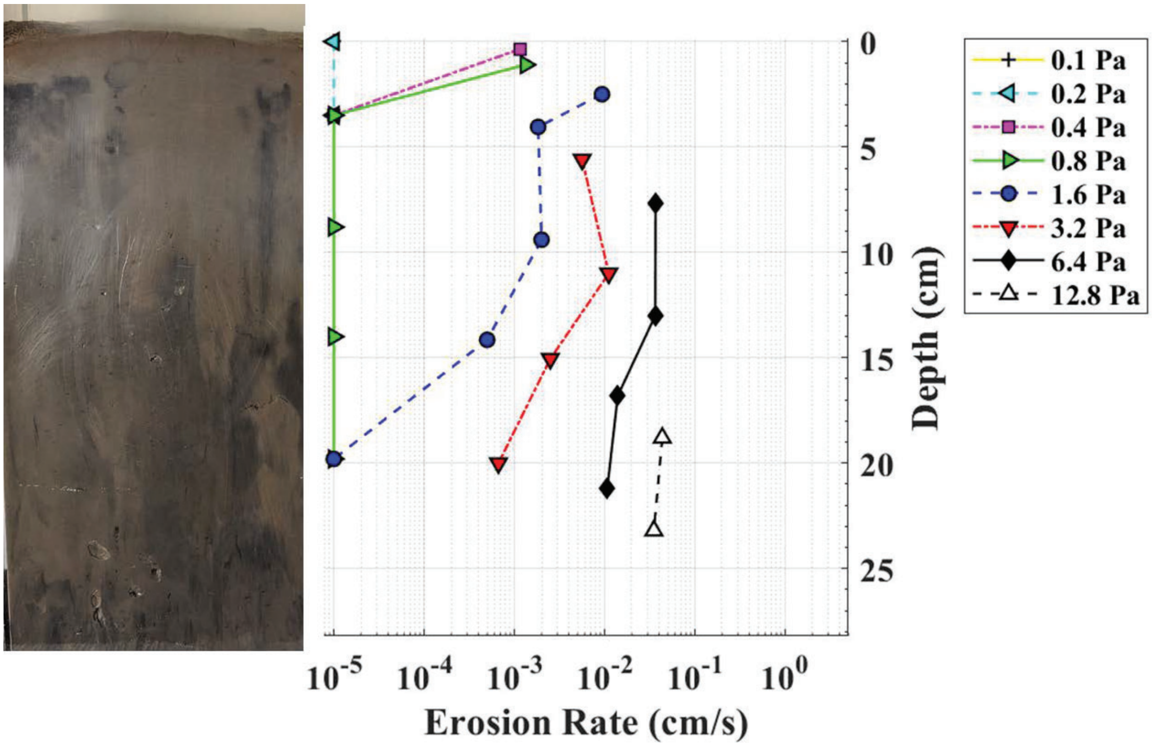


Figure 40. Photograph of Core SR-TB aligned with applied shear stresses and associated erosion rates

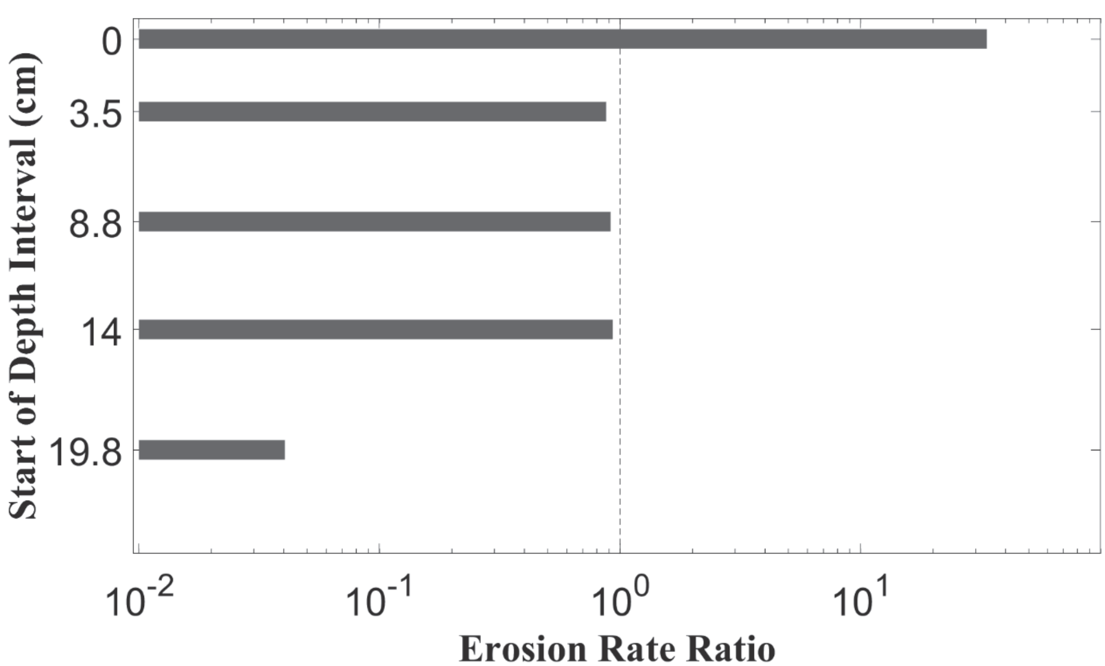


Figure 41. Intracore erosion rate of SR-TB

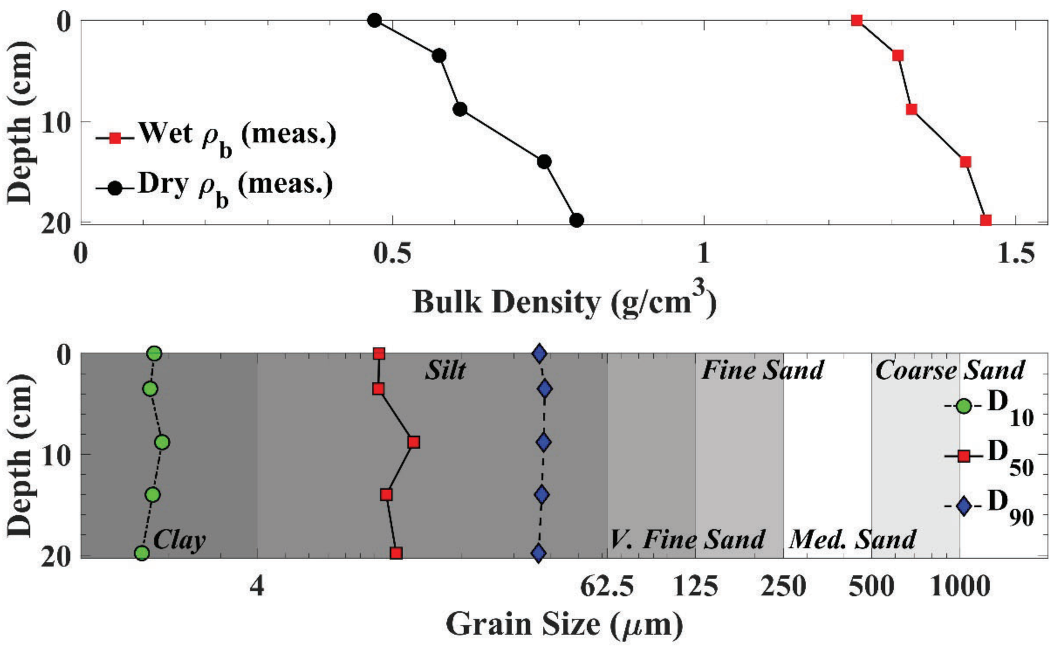


Figure 42. Physical properties of SR-TB with depth

Table 25. Physical properties and derived critical shear stresses of SR-TB

Sample Depth (cm)	Median Grain Size (µm)	Wet Bulk Density (g/cm³)	Dry Bulk Density (g/cm³)	Loss on Ignition (%)	Tau_no (Pa)	Tau_first (Pa)	Tau Crit Linear (Pa)	Tau Crit Power (Pa)	Final Critical Shear (Pa)
0.0	10.42	1.24	0.47	6.3%	0.2	0.4	0.22	0.18	0.2
3.5	10.37	1.31	0.58	5.8%	0.8	1.6	0.85	0.72	0.8
8.8	13.67	1.33	0.61	5.6%	0.8	1.6	0.84	0.69	0.8
14	11.03	1.42	0.74	5.0%	0.8	1.6	0.96	0.86	0.86
19.8	11.92	1.45	0.8	4.8%	1.6	3.2	1.84	1.73	1.73
Mean	11.48	1.35	0.64	5.5%	0.84	1.68	0.94	0.84	0.88

Table 26. Power law fit parameters of SR-TB

Interval	Depth Start (cm)	Depth Finish (cm)	A	n	r^2
1	0.0	3.5	2.99E-05	2.05	0.9
2	3.5	8.8	4.09E-07	2.78	0.96
3	8.8	14	4.01E-07	2.85	0.95
4	14	19.8	6.4E-07	2.35	0.99
5	19.8	24.2	1.4E-08	3.11	0.97

2.13 SED-TC-DS

Core TC-DS was collected on March 11, 2020, at 2:30 p.m. from Tar Creek. Relative to TC-US, TC-DS is downstream closer to the Neosho River. TC-DS was collected in 8 ft of water in the center of the channel. Soft, easy to penetrate material containing leaves and twigs was collected resulting in a recovery length of 44 cm. Recovered sediment consisted of dark gray silt with pockets of leaves throughout and voids in the upper 10 cm.

Shear stresses ranging from 0.1 to 0.64 Pa were applied to the sediment core shown in Figure 43. Erosion rates were greatest at the surface, decreasing with depth but stabilizing below 20 cm (Figure 43, Figure 44). The surface responded to the lowest applied shear (0.1 Pa), which resulted in a critical shear stress determination of 0.05 Pa. The material at the surface was very soft, unconsolidated silt. Further down-core, density increased while particle size distributions stayed relatively constant (Figure 48, Table 27). Erosion in the first two intervals occurred evenly and consistently as loose particles were suspended. As depth increased, erosion was affected by the presence of leafy debris and changes in density resulting in more sporadic erosion events. A power law relationship between erosion rate and shear stress is applicable as shown by the high r^2 values and coefficients that fall into ranges typical of cohesive sediment (Table 28).

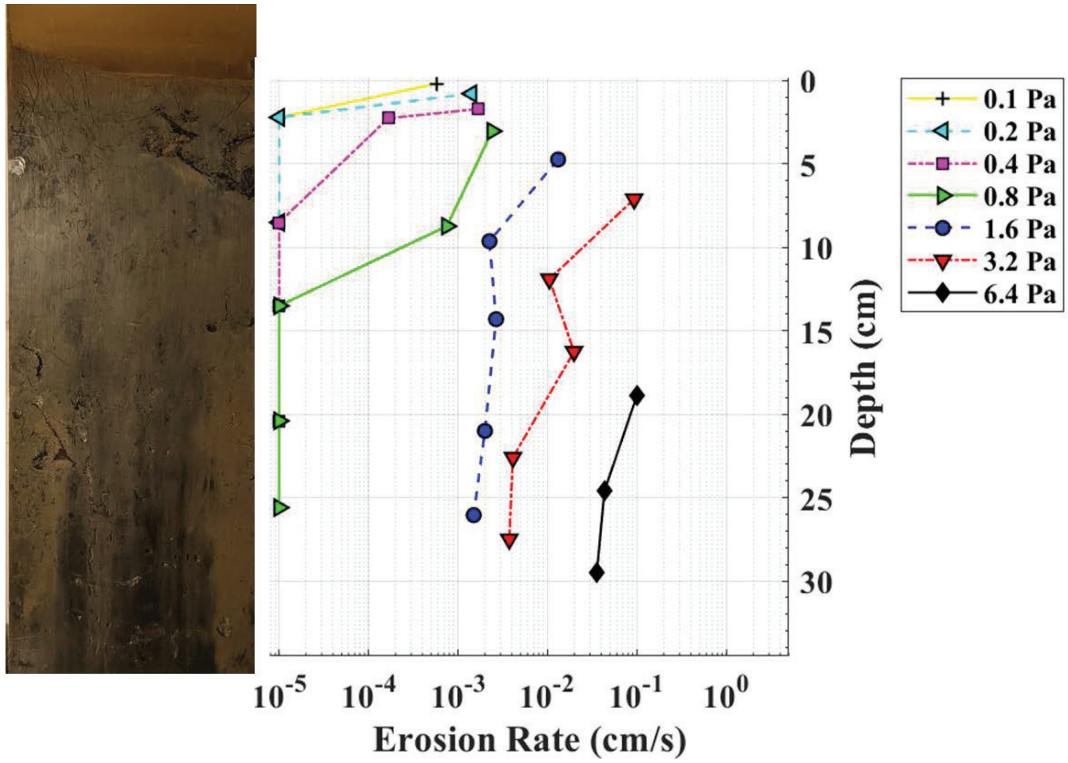


Figure 43. Photograph of Core TC-DS aligned with applied shear stresses and associated erosion rates

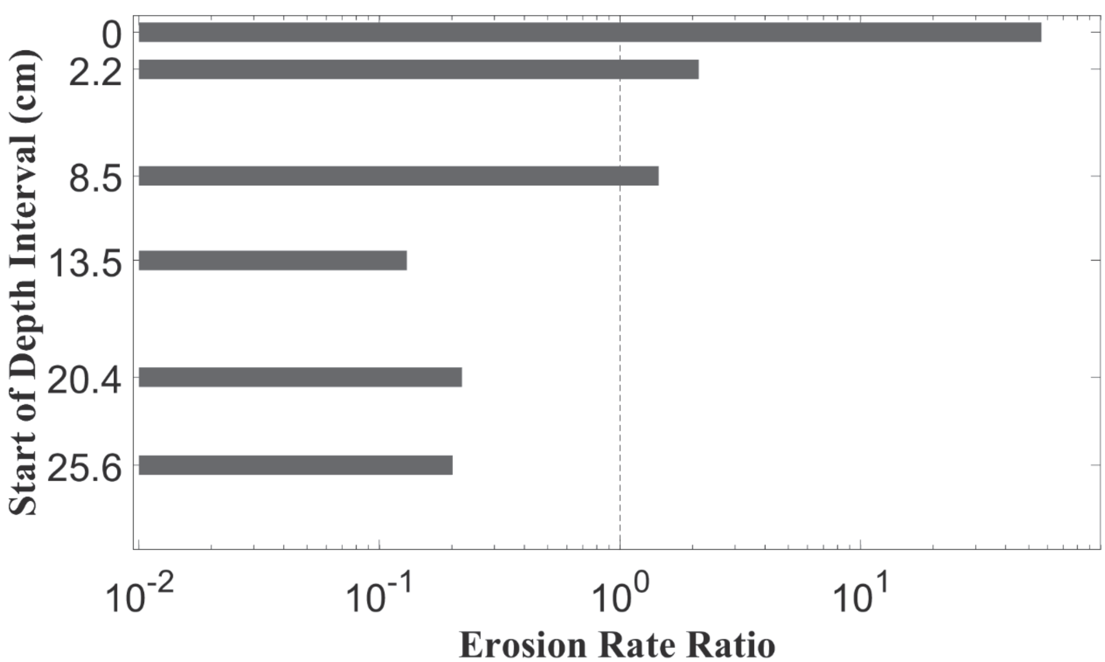


Figure 44. Intracore erosion rates of TC-DS

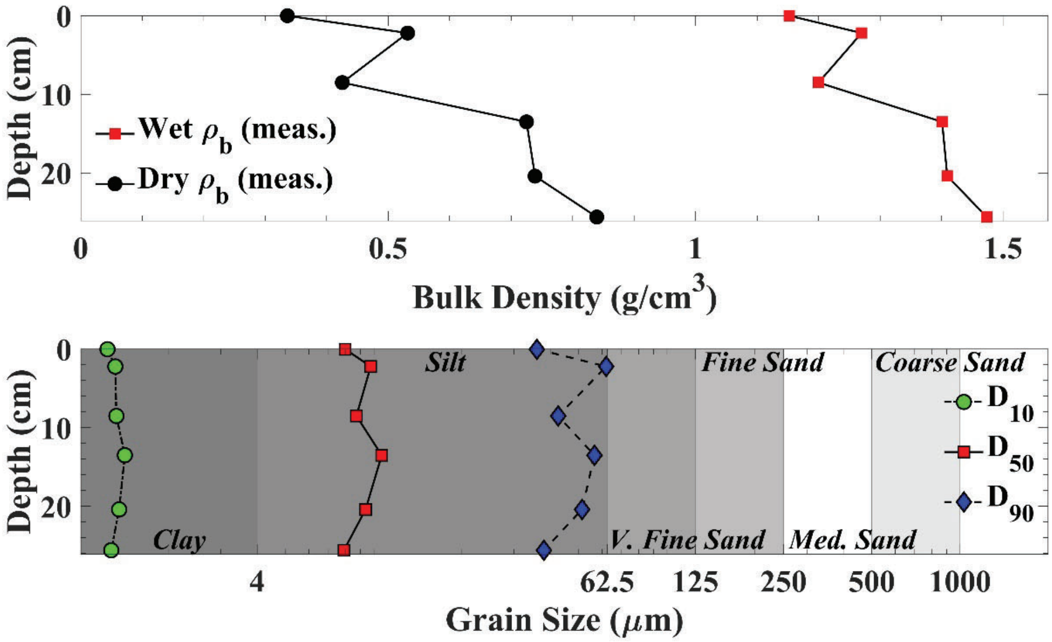


Figure 45. Physical properties of TC-DS with depth

Table 27. Physical properties and derived critical shear stresses of TC-DS

Sample Depth (cm)	Median Grain Size (μm)	Wet Bulk Density (g/cm^3)	Dry Bulk Density (g/cm^3)	Loss on Ignition (%)	Tau_no (Pa)	Tau_first (Pa)	Tau Crit Linear (Pa)	Tau Crit Power (Pa)	Final Critical Shear (Pa)
0.0	7.99	1.15	0.34	8.0%	0.05	0.1	0.06	0.04	0.05
2.2	9.76	1.27	0.53	7.7%	0.2	0.4	0.32	0.32	0.32
8.5	8.72	1.2	0.43	8.7%	0.4	0.8	0.46	0.4	0.4
13.5	10.64	1.4	0.72	5.8%	0.8	1.6	0.83	0.71	0.8
20.4	9.37	1.41	0.74	5.8%	0.8	1.6	0.84	0.73	0.8
25.6	7.91	1.47	0.84	5.3%	0.8	1.6	0.86	0.76	0.8
Mean	9.07	1.32	0.60	6.9%	0.51	1.02	0.56	0.49	0.53

Table 28. Power law fit parameters of TC-DS

Interval	Depth Start (cm)	Depth Finish (cm)	A	n	r^2
1	0.0	2.2	3.49E-04	1.42	0.82
2	2.2	8.5	3.17E-06	3.01	0.99
3	8.5	13.5	4.07E-06	2.3	0.97
4	13.5	20.4	1.46E-07	3.32	0.97
5	20.4	25.6	4.0E-07	2.78	0.95
6	25.6	30.5	3.77E-07	2.75	0.96

2.14 SED-TC-US

Core TC-US was collected on March 11, 2020, at 2:00 p.m. TC-US is located upstream of TC-DS in Tar Creek. Sampling efforts produced 44 cm of sediment without the need for added force via use of a post-hammer. Root structures along the bank necessitated multiple attempts before successful collection was achieved. A 2 cm layer of unconsolidated, light colored, oxidized silt blanketed darker sediment containing voids, leaves, and sticks.

Shear stresses, ranging from 0.1 to 6.4 Pa were applied to TC-US over six intervals (Figure 46). The unconsolidated surface layer was shown to be the most erodible, consistent with many other cores processed in this study (Figure 47). As depth increased, erodibility relative to the core average varied as did grain size and density (Figure 47, Figure 48, Table 29). The unconsolidated and sandier sections of the core eroded in streams of particles or clouds of suspended sediment depending on shear stress magnitude. Finer sediment regimes tended to erode in larger pieces or clumps unevenly across the surface.

Derived critical shear stresses varied from 0.17 to 0.8 Pa from the first to the sixth interval. Parameters defining the relationship between erosion rate and shear stress indicate a good power law relationship between the two variables (Table 30).

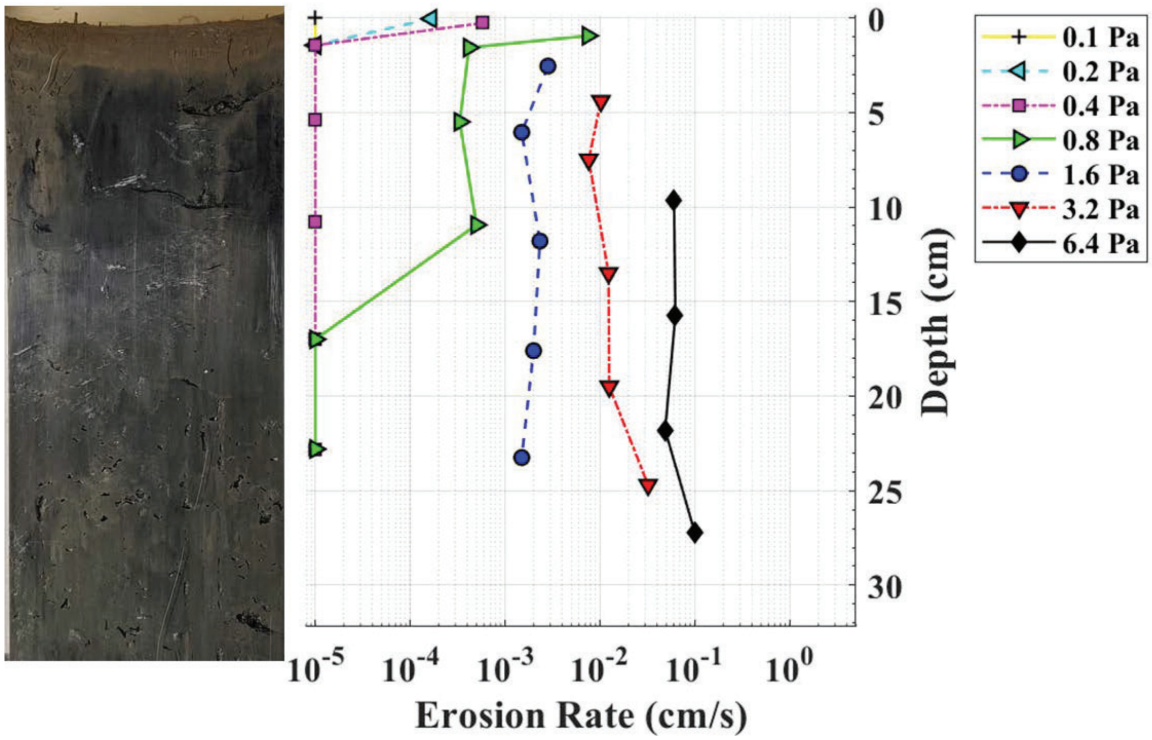


Figure 46. Photograph of Core TC-US aligned with applied shear stresses and associated erosion rates

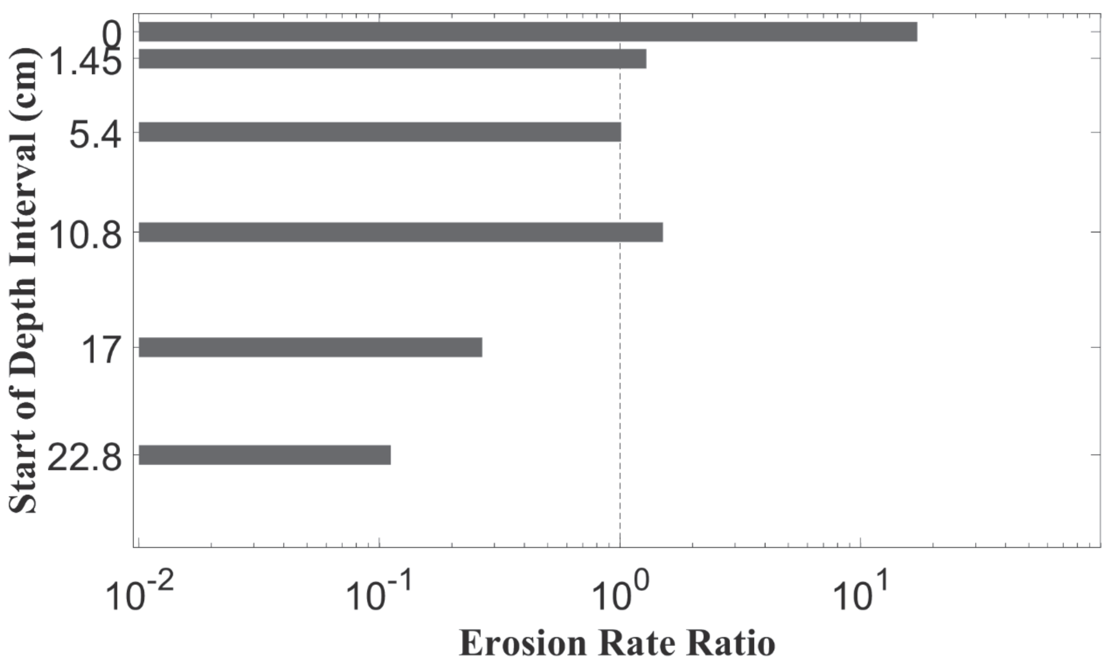


Figure 47. Intracore erosion rates for TC-US

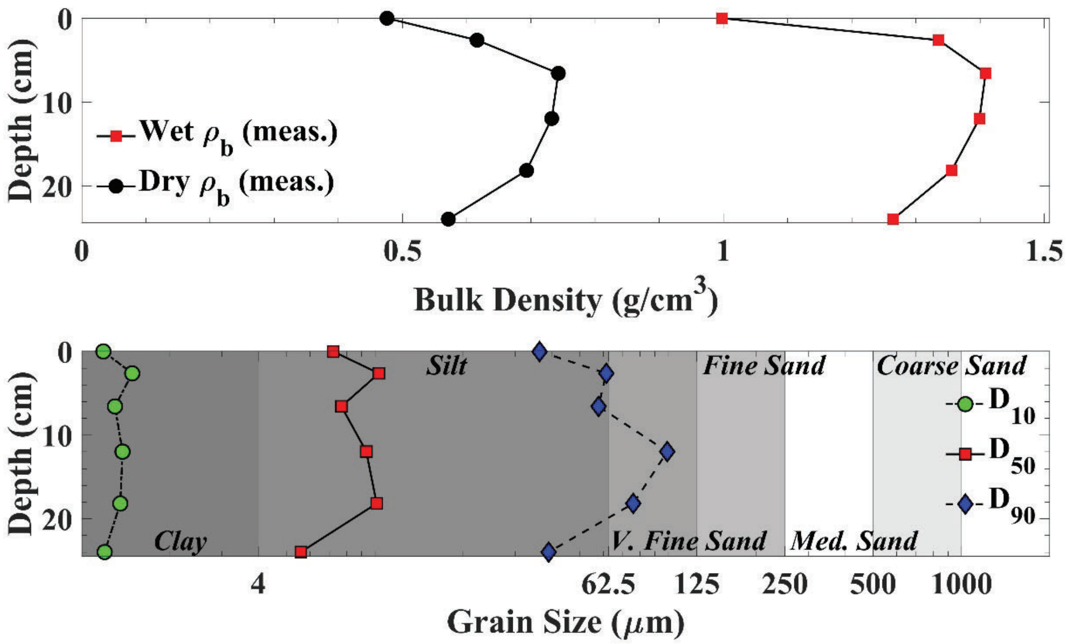


Figure 48. Physical properties of TC-US with depth

Table 29. Physical properties and derived critical shear stresses of TC-US

Sample Depth (cm)	Median Grain Size (µm)	Wet Bulk Density (g/cm^3)	Dry Bulk Density (g/cm^3)	Loss on Ignition (%)	Tau_no (Pa)	Tau_first (Pa)	Tau Crit Linear (Pa)	Tau Crit Power (Pa)	Final Critical Shear (Pa)
0.0	7.2	1	0.48	48.1%	0.1	0.2	0.16	0.17	0.17
1.45	10.31	1.34	0.62	5.8%	0.4	0.8	0.5	0.47	0.47
5.4	7.68	1.41	0.74	6.1%	0.4	0.8	0.52	0.52	0.52
10.8	9.34	1.4	0.73	6.5%	0.4	0.8	0.48	0.45	0.45
17.0	10.13	1.36	0.69	9.0%	0.8	1.6	0.84	0.71	0.8
22.8	5.58	1.26	0.57	11.6%	0.8	1.6	0.86	0.78	0.8
Mean	8.37	1.30	0.64	14.5%	0.48	0.97	0.56	0.52	0.54

Table 30. Power law fit parameters of TC-US

Interval	Depth Start (cm)	Depth Finish (cm)	A	n	r^2
1	0.0	1.45	2.55E-05	2.61	0.97
2	1.45	5.4	2.08E-06	2.51	0.99
3	5.4	10.8	1.66E-06	2.49	1.0
4	10.8	17.0	2.58E-06	2.44	1.0
5	17.0	22.8	2.79E-07	3.0	0.96
6	22.8	28.7	7.23E-08	3.53	0.96

2.15 SED-ER-640

No sample was recovered at ER-640, located west of the Highway 10 Bridge. The sediment bed near ER-640 was known to contain substantial portions of gravel and rock that would limit the effectiveness of collecting a sample.

2.16 SED-NR-HB

No sample was collected at ER-640. Multiple attempts were made to collect a sample, but no viable sample was produced. Despite ample penetration, recovered material was either not intact or absent in recovery of the core barrel. Unfavorable weather conditions of high winds and waves resulted in the field team aborting further attempts.

3 SUMMARY

Integral conducted a SEDflume analysis on 14 sediment cores collected from waterways connected to Grand Lake o' the Cherokees in northeast Oklahoma. The goal of this work was to characterize the erosion rates, critical shear stresses for erosion, and physical properties of the bedded sediment within the Elk River, Neosho River, Spring River, and Tar Creek. The SEDflume study results provide a baseline for the development of site-specific sediment parameters to support transport studies and bolster the conceptual understanding of dynamics within the system.

The cores were subjected to shear stresses ranging from 0.1 to 12.8 Pa to determine erosion rates as a function of shear stress and depth. In addition, cores were subsampled during the analysis to determine sediment bulk density, loss on ignition, and particle size distributions related to each shear stress interval. Critical shear stresses were calculated from the measured erosion rate data and ranged from less than 0.1 Pa in surface sediment to 2.46 Pa in deeper bedded sediment.

To better visualize the relative erodibility of the sediment throughout the system, the ratio of the mean erosion rate of each core (core vertically averaged erosion rate) to the average mean erosion rate of all cores at the site was calculated and plotted in Figure 49. The dashed line denotes a site-wide average erosion rate ratio of 1.0 Pa. A value above this line generally means that the core is more susceptible to erosion than those cores below. A similar figure to compare individual intervals between cores is also provided in Figure 50.

A few trends of note were observed. Surface intervals were the most erosive due to the presence of an unconsolidated layer up to 3 cm thick (see green bars in Figure 50). Below the "fluff" layer, sediment was pitted and pockmarked from the invertebrates present, and the sediment tended to erode in clumps nucleated by the biotic structures. The presence of leaves, twigs, stems, and worm burrows also influenced the sediment erosion by breaking away and drawing material away from the surface. Similar properties were observed in some cores collected from the same waterway. This was most obvious in the Tar Creek samples, TC-US and TC-DS. However, samples from the Neosho River exhibited a wider range of erodibility and sediment properties. Samples such as NR-FG, taken near the fairgrounds and in an area known to have wet and dry cycles, were less erosive than samples from further downriver such as NR-CB or NR-202. While predominantly silt, the presence of some fine sand in cores such as NR-CB and the Spring River samples may influence erodibility as it moves through the system.

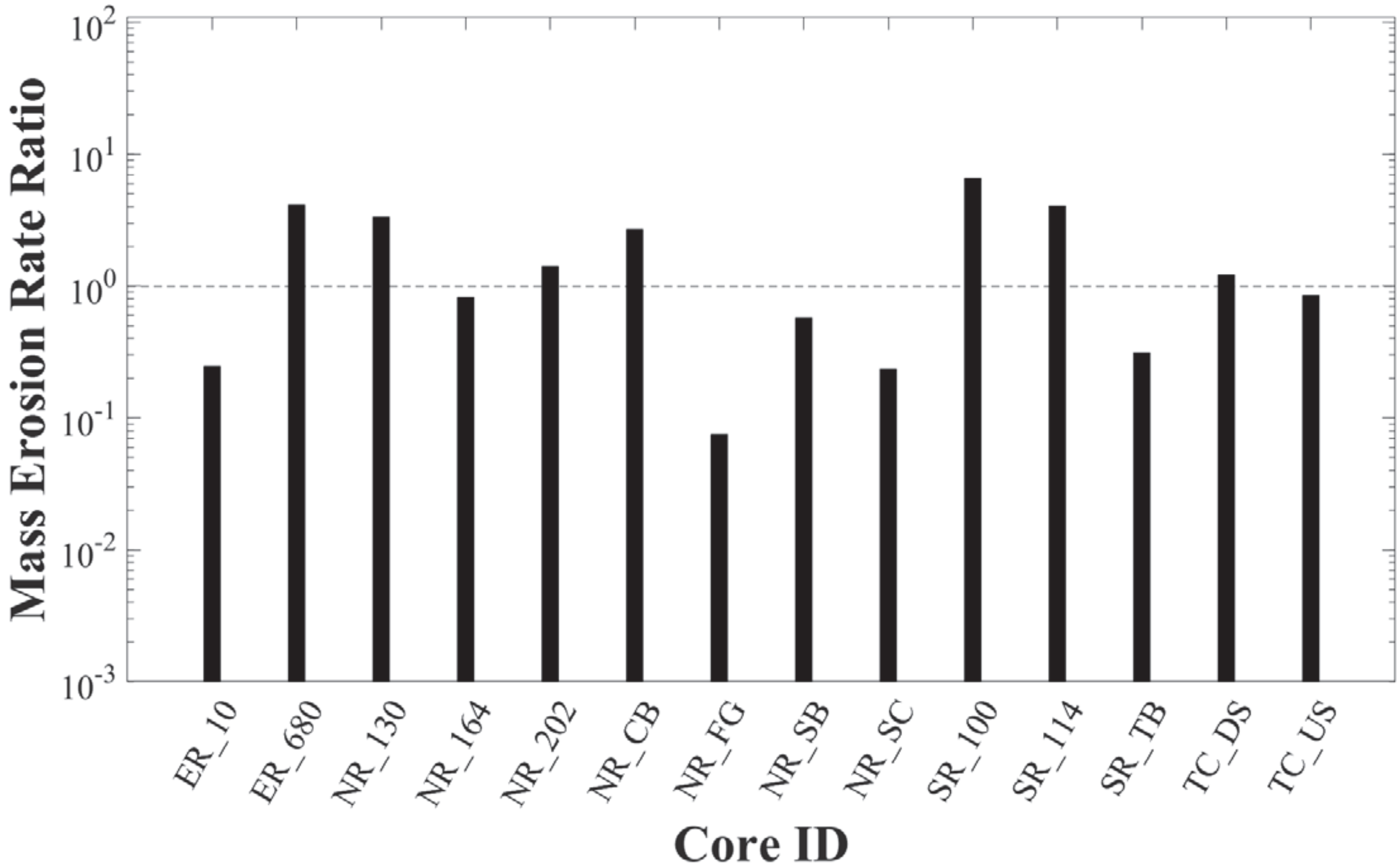


Figure 49. Intercore erosion rate ratios: Depth-averaged core erosion rates compared to the site-wide average erosion rates.

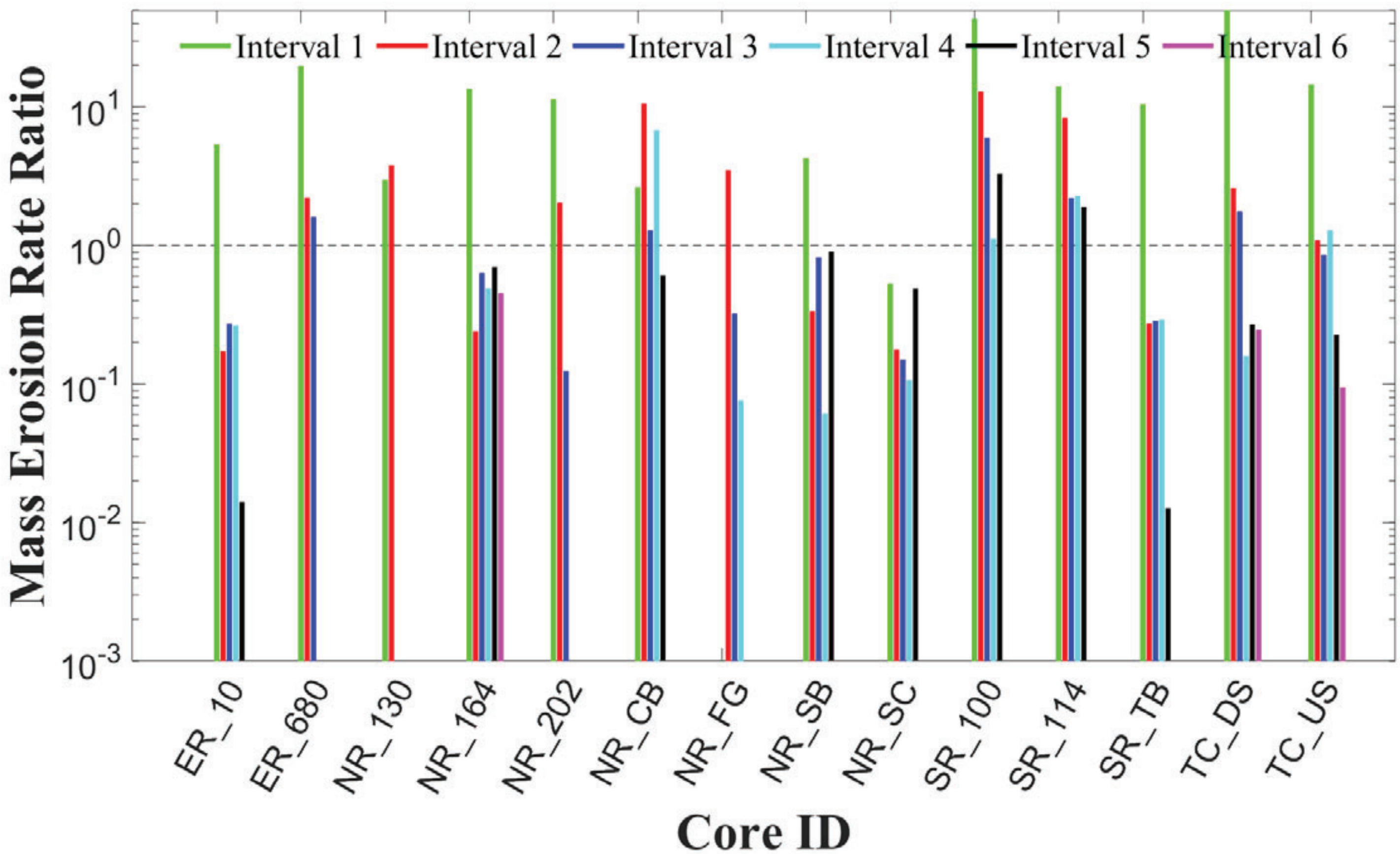


Figure 50. Intracore erosion rate by interval for each core.

4 REFERENCES

ASTM. 2007. *Annual book of ASTM standards.* Vol. 04.08, Soil and Rock (I): D420–D5611. ASTM International, West Conshohocken, PA. pp. 314–315.

Håkanson, L., and M. Jansson. 1983. *Principles of Lake Sedimentology*. 320 pp. Berlin–New York: Springer-Verlag. ISBN 3–540 (Berlin) 0–387 (New York)–12645–7. DM 98, *Int. Revue ges. Hydrobiol.*

Jepsen, R., J. Roberts, and W. Lick. 1997. Effects of bulk density on sediment erosion rates. *Water Air Soil Pollut.* 99:21–31.

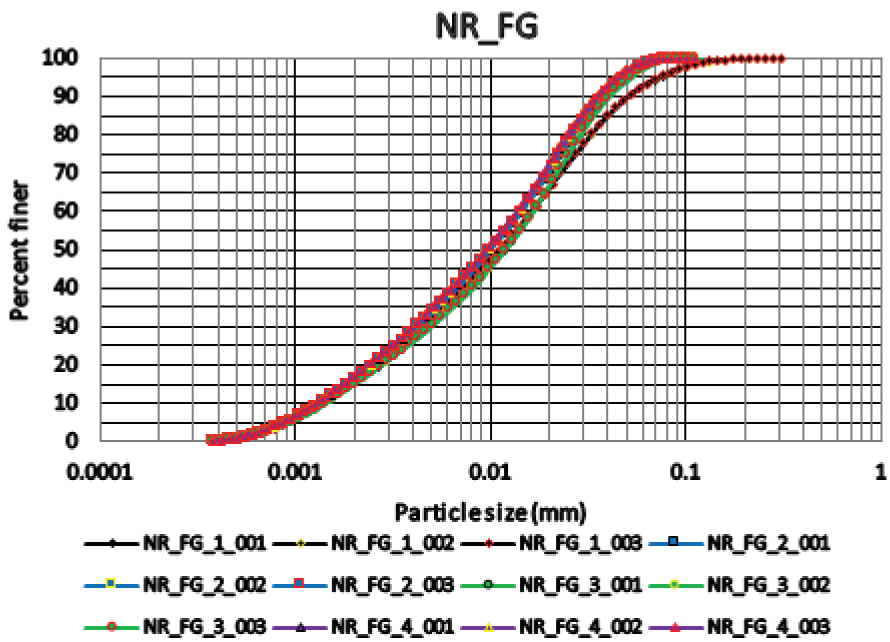
McNeil, J., C. Taylor, and W. Lick. 1996. Measurements of erosion of undisturbed bottom sediments with depth. *J. Hydr. Engr.* 122(6):316–324.

Roberts, J., R. Jepsen, D. Gotthard, and W. Lick. 1998. Effects of particle size and bulk density on erosion of quartz particles. *J. Hydr. Engr.* 124(12):1261–1267.

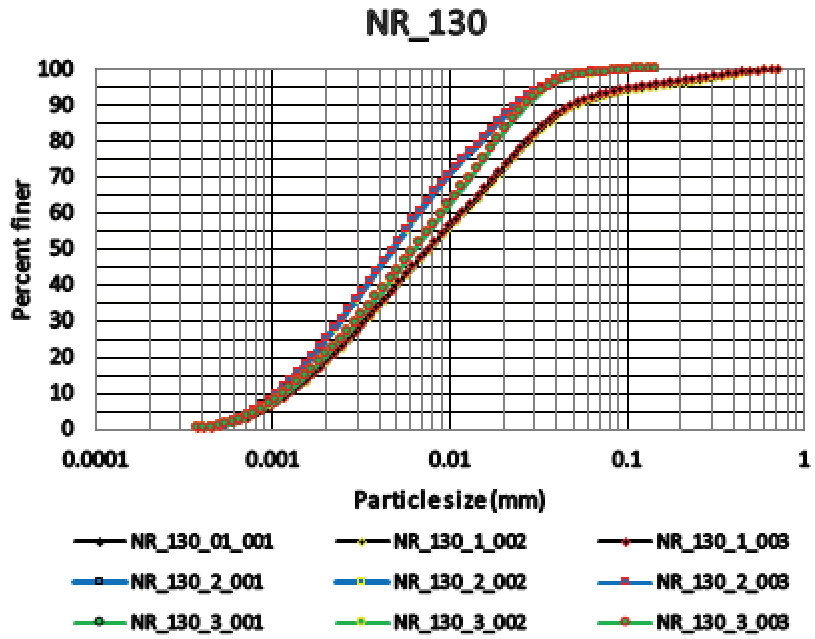
Particle Size Distribution Results

Neosho River above Tar Creek

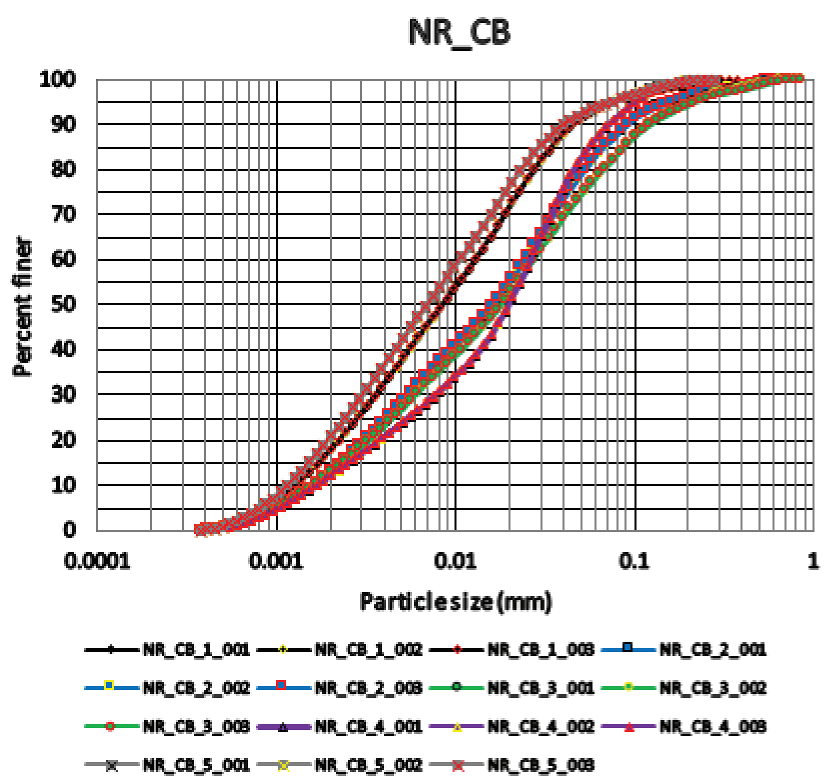
River Mile 135.15



River Mile 130.54

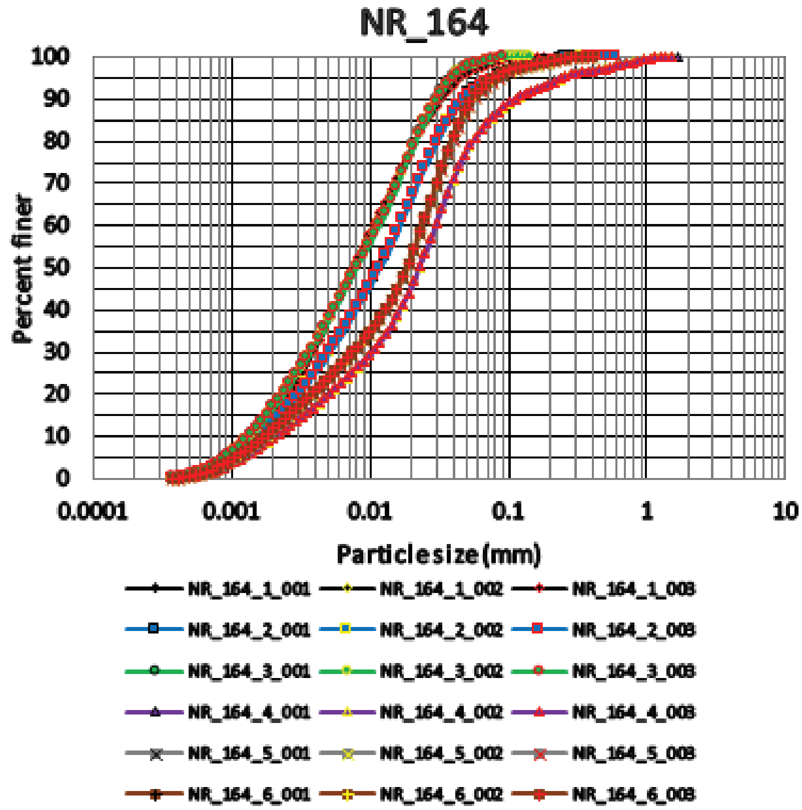


River Mile 126.69

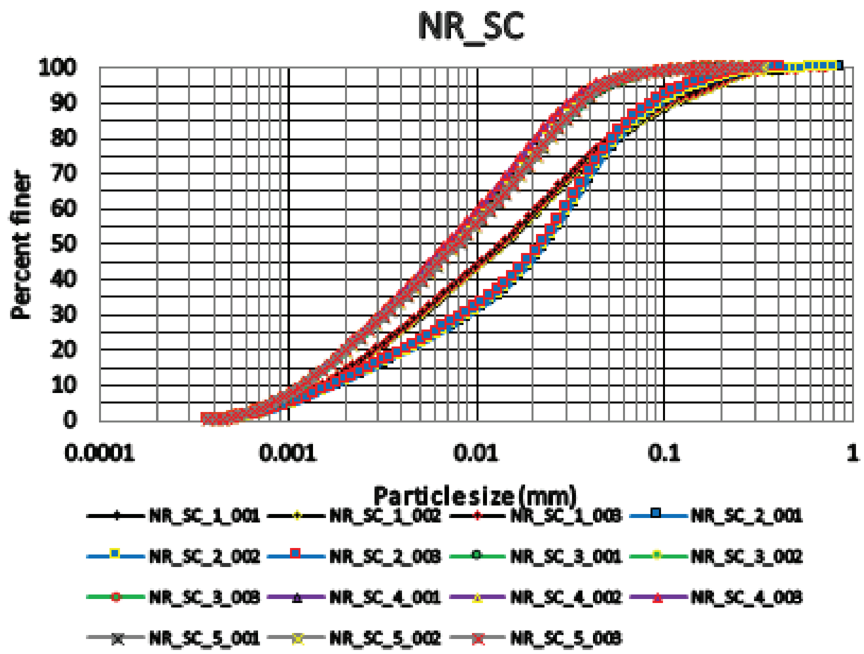


Neosho River – Grand Lake

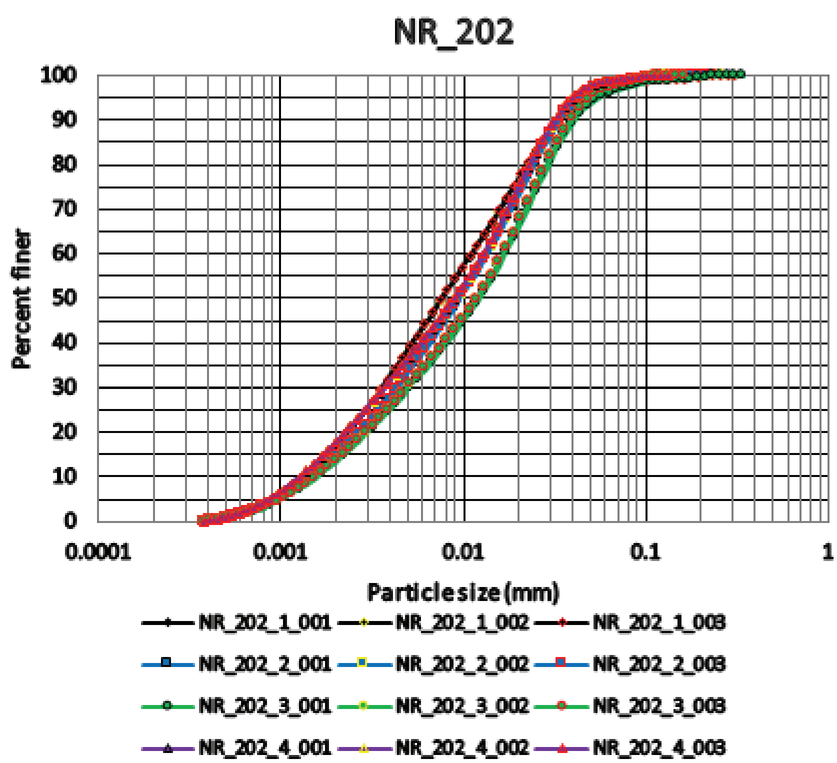
River Mile 120.43



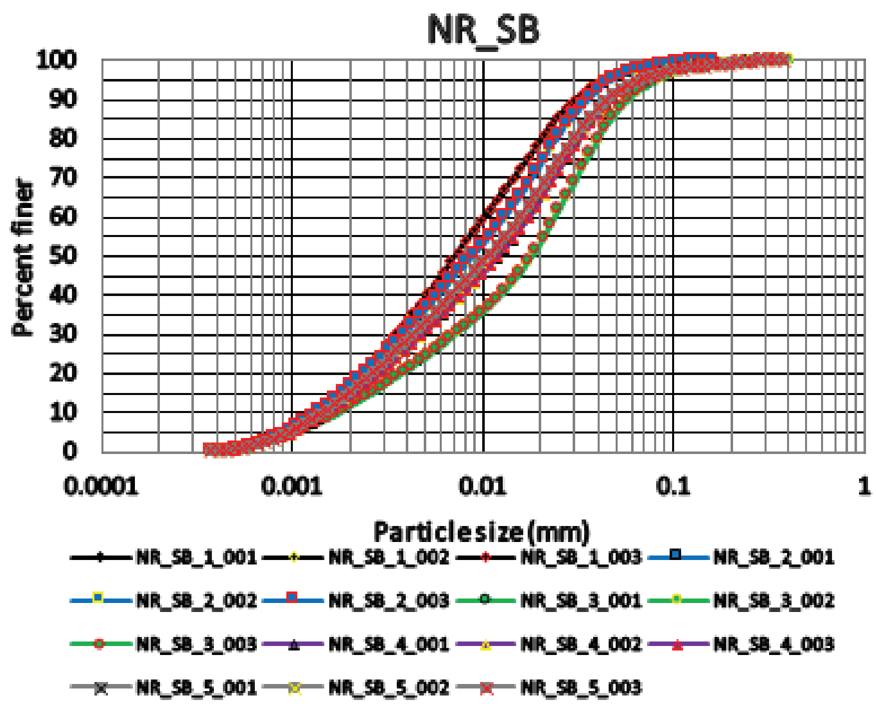
River Mile 115.81



River Mile 112.69

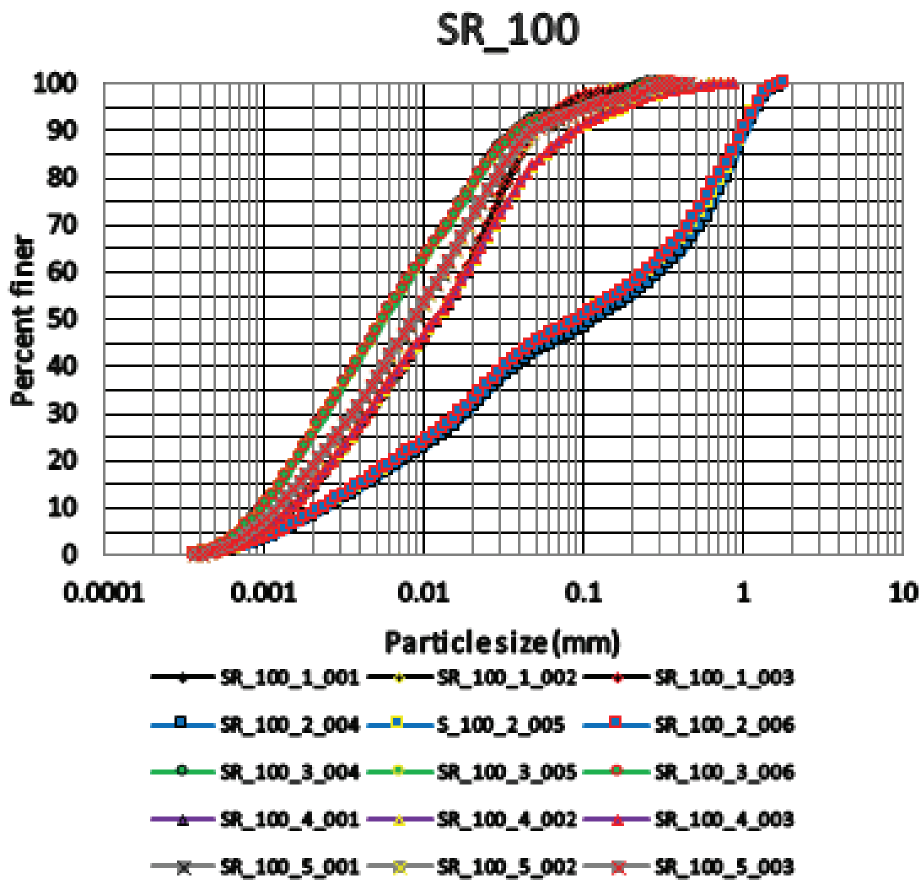


River Station 109.65

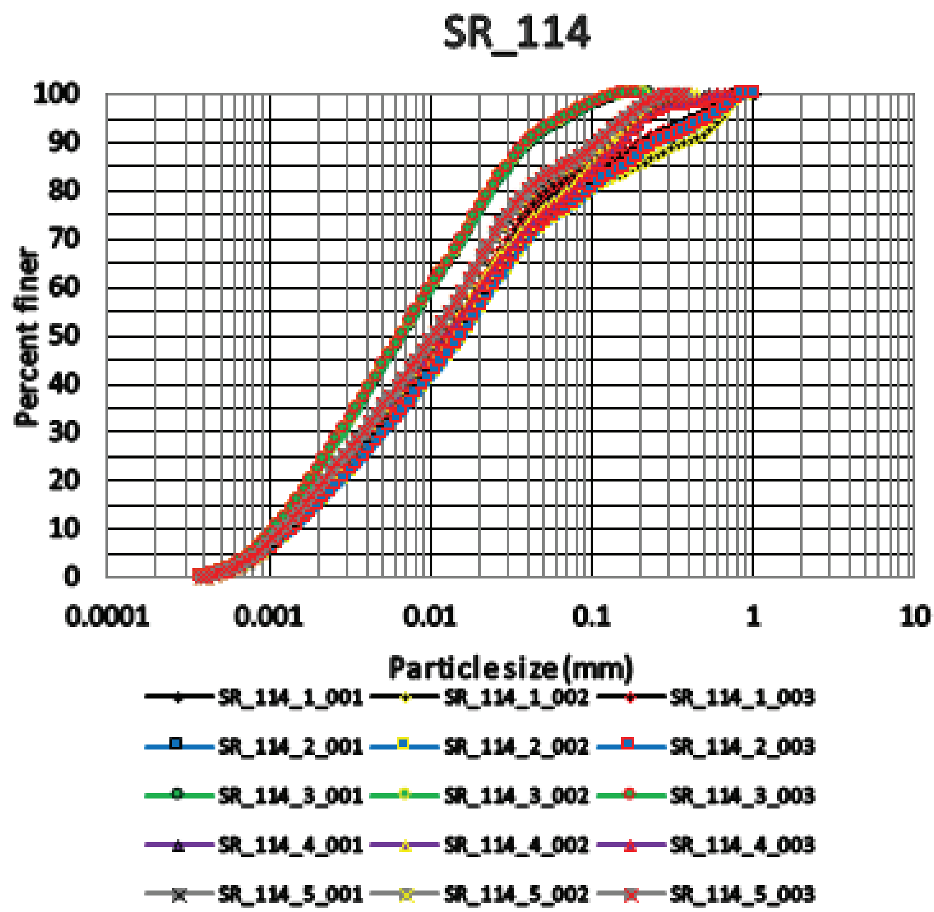


Spring River

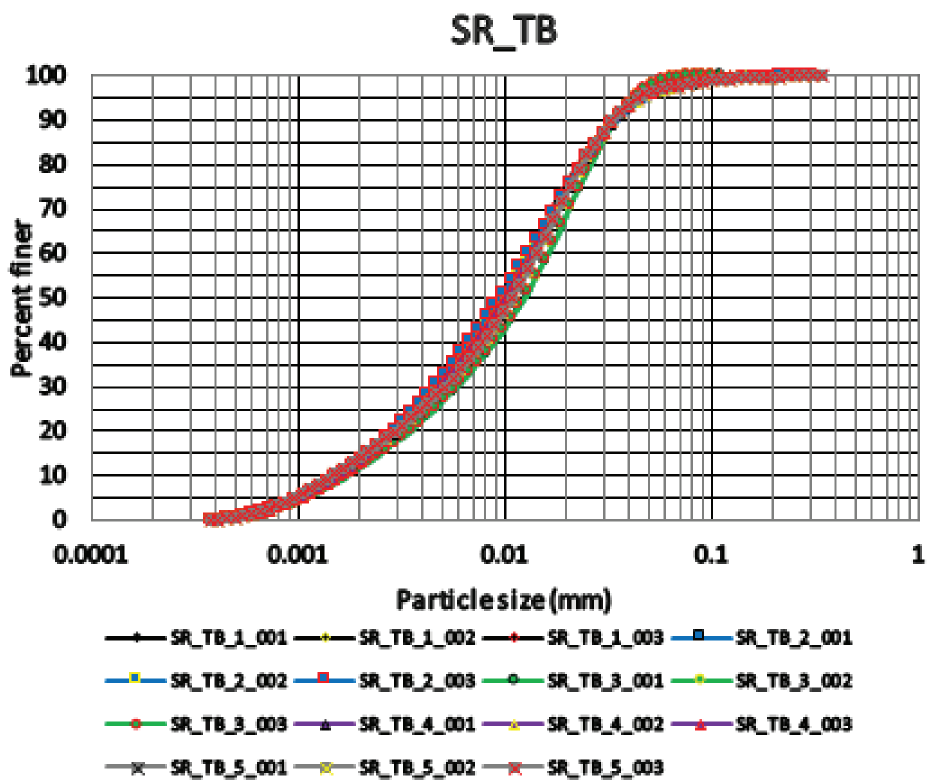
River Mile 7.5



River Mile 4.82

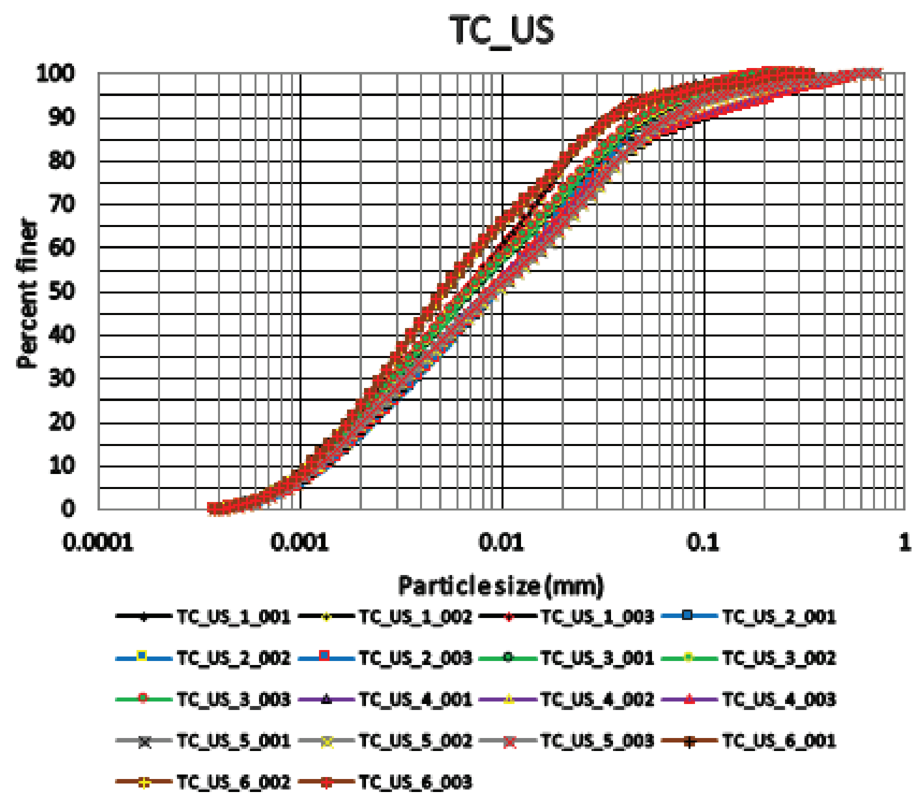


River Mile 0.79

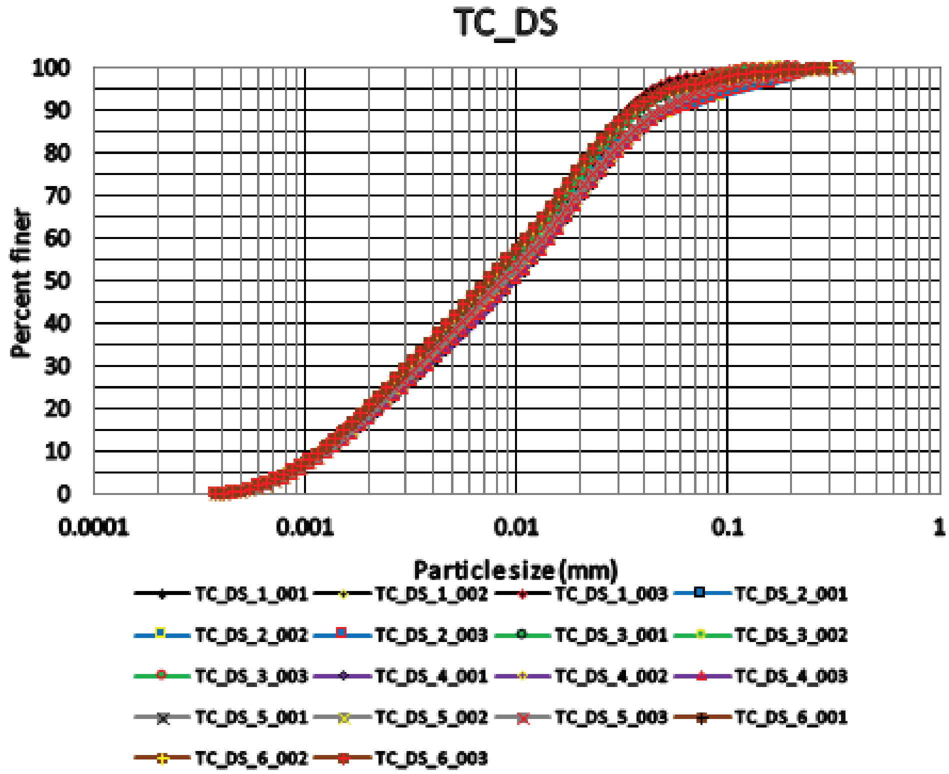


Tar Creek

Downstream of River Mile 1.6

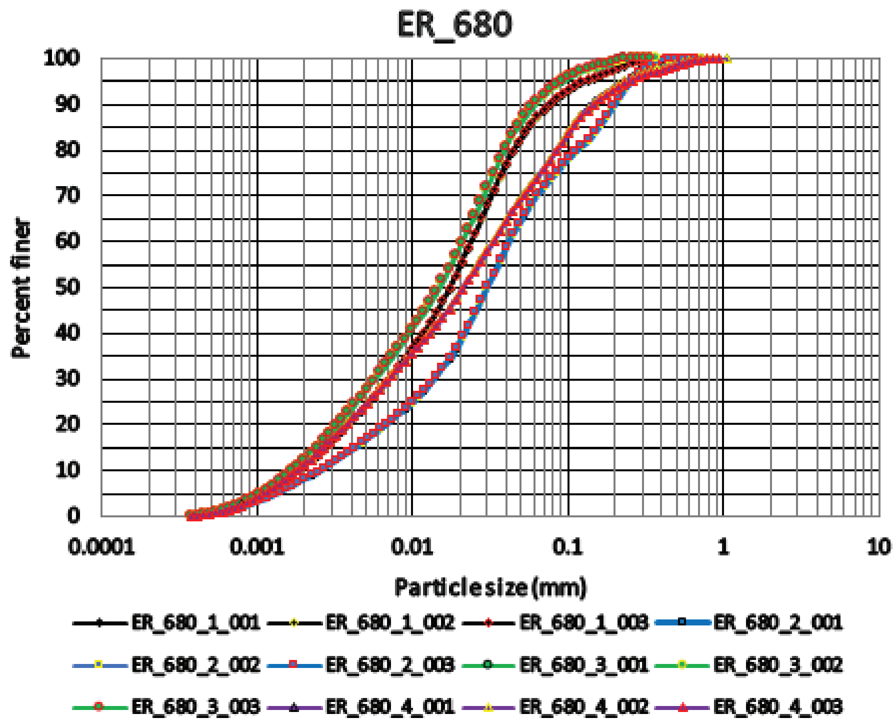


Downstream of River Mile 1.6

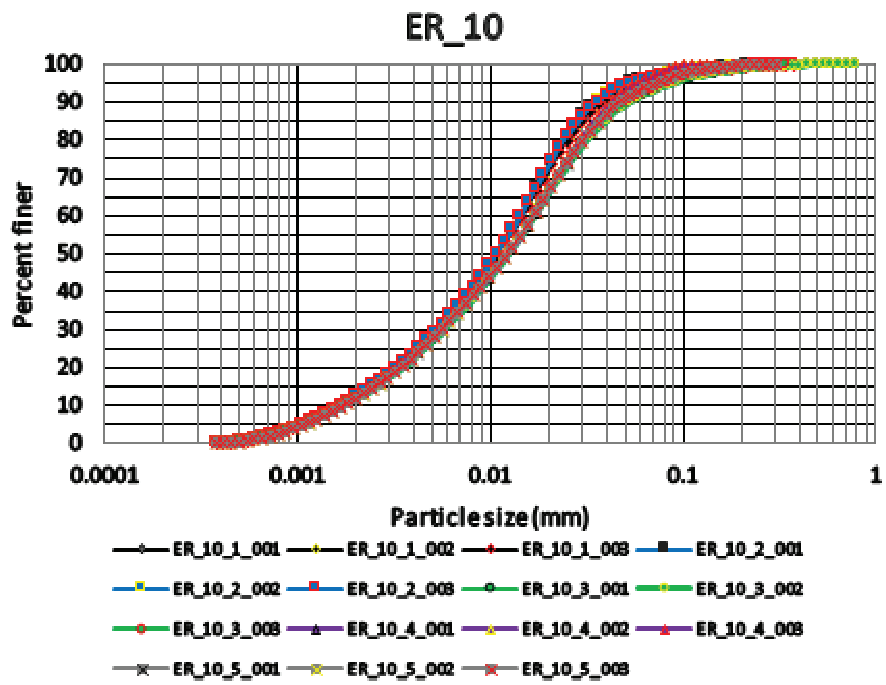


Elk River

River Mile 8.41



River Mile 4.67



Appendix D
Suspended Sediment Concentration Measurements

Wisconsin State Laboratory of Hygiene
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Wisconsin State Laboratory of Hygiene
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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 452226001

Report To:
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MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
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616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: NEOSHO R
Project No:
Collection End: 5/29/2019 3:30:00 PM
Collection Start:
Collected By: LAURA ROZUNALSKI
Date Received: 6/18/2019
Date Reported: 6/28/2019
Sample Reason:

ID#: NA
Sample Location: NEOSHO ROAD CONFLUENCE
Sample Description:
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

NON-WSLH BOTTLES USED. RESULTS APPROXIMATE

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/20/19 00:00	Analysis Date: 06/20/19 00:00				
SUSPENDED SEDIMENT	ASTM D3977-97B	137	mg/L	2.0	2.0

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Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 452226001

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

Test results for NELAP accredited tests are certified to meet the requirements of the NELAC standards. For a list of accredited analytes see http://www.slh.wisc.edu/about/compliance/nelac-laboratory-accreditation
Results, LOD and LOQ values have been adjusted for analytical dilutions and percent moisture where applicable.
Results relate only to the items tested.
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Responsible Party

Inorganic chemistry: Graham Anderson 608-224-6281
Metals: Graham Anderson 608-224-6280
Organics: Erin Mani 608-224-6269
Environmental Toxicology: David Webb 608-224-6230
Water microbiology: Martin Collins 608-224-6239
Radiochemistry: David Webb 608-224-6227

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 452226002

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MADISON, WI 53711
Customer ID: 349767

Field #: TAR CREEK
Project No:
Collection End: 5/29/2019 1:15:00 PM
Collection Start:
Collected By: LAURA ROZUNALSKI
Date Received: 6/18/2019
Date Reported: 6/28/2019
Sample Reason:

ID#: NA
Sample Location: TAR CREEK AT HWY 69
Sample Description:
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

NON-WSLH BOTTLES USED. RESULTS APPROXIMATE

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/20/19 00:00	Analysis Date: 06/20/19 00:00				
SUSPENDED SEDIMENT	ASTM D3977-97B	12.2	mg/L	2.0	2.0

WSLH Sample: 452226002

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 452226003

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Customer ID: 349767

Field #: NEOSHO R @ COMMERCE
Project No:
Collection End: 5/29/2019 12:30:00 PM
Collection Start:
Collected By: LAURA ROZUNALSKI
Date Received: 6/18/2019
Date Reported: 6/28/2019
Sample Reason:

ID#: NA
Sample Location: NEOSHO ROAD AT COMMERCE
Sample Description:
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

NON-WSLH BOTTLES USED. RESULTS APPROXIMATE

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/20/19 00:00	Analysis Date: 06/20/19 00:00				
SUSPENDED SEDIMENT	ASTM D3977-97B	135	mg/L	2.0	2.0

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Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 452226003

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Water microbiology: Martin Collins 608-224-6239
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Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 452226004

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616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: SPRING R @ E 57 RD
Project No:
Collection End: 5/29/2019 2:30:00 PM
Collection Start:
Collected By: LAURA ROZUNALSKI
Date Received: 6/18/2019
Date Reported: 6/28/2019
Sample Reason:

ID#: NA
Sample Location: SPRING ROAD AT E 57 ROAD
Sample Description:
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

NON-WSLH BOTTLES USED. RESULTS APPROXIMATE

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/20/19 00:00	Analysis Date: 06/20/19 00:00				
SUSPENDED SEDIMENT	ASTM D3977-97B	58.0	mg/L	2.0	2.0

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WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 452226004

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 452226005

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LAURA ROZUMALSKI
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MADISON, WI 53711
Customer ID: 349767

Field #: NEOSHO R @ COMMERCE
Project No:
Collection End: 5/2/2019 10:45:00 AM
Collection Start:
Collected By: LAURA ROZUNALSKI
Date Received: 6/18/2019
Date Reported: 6/28/2019
Sample Reason:

ID#: NA
Sample Location: NEOSHO ROAD AT COMMERCE
Sample Description:
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

NON-WSLH BOTTLES USED. RESULTS APPROXIMATE

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Analyzed past the 40 days holding time: Method ASTM D3977-97B analyzed on 06/20/19 0000

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/20/19 00:00	Analysis Date: 06/20/19 00:00				
Comments: Analyzed past the 40 days holding time.					
SUSPENDED SEDIMENT	ASTM D3977-97B	213	mg/L	2.0	2.0

WSLH Sample: 452226005

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
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Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 452226006

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Invoice To:
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616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: SPRING R @ E 57 RD
Project No:
Collection End: 5/2/2019 12:40:00 PM
Collection Start:
Collected By: LAURA ROZUNALSKI
Date Received: 6/18/2019
Date Reported: 6/28/2019
Sample Reason:

ID#: NA
Sample Location: SPRING ROAD AT EAST 57 ROAD
Sample Description:
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

NON-WSLH BOTTLES USED. RESULTS APPROXIMATE

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Analyzed past the 40 days holding time: Method ASTM D3977-97B analyzed on 06/20/19 0000

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/20/19 00:00	Analysis Date: 06/20/19 00:00				
Comments: Analyzed past the 40 days holding time.					
SUSPENDED SEDIMENT	ASTM D3977-97B	215	mg/L	2.0	2.0

Wisconsin State Laboratory of Hygiene
2601 Agriculture Drive, PO Box 7996
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(800)442-4618 - FAX (608)224-6213
http://www.slh.wisc.edu

Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 452226006

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Results, LOD and LOQ values have been adjusted for analytical dilutions and percent moisture where applicable.
Results relate only to the items tested.
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The water microbiology unit analyzes samples as received and not all samples are tested for preservation before analysis is performed.

Responsible Party

Inorganic chemistry: Graham Anderson 608-224-6281
Metals: Graham Anderson 608-224-6280
Organics: Erin Mani 608-224-6269
Environmental Toxicology: David Webb 608-224-6230
Water microbiology: Martin Collins 608-224-6239
Radiochemistry: David Webb 608-224-6227

Wisconsin State Laboratory of Hygiene
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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 452226007

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: NEOSHO R MIAMI EAST ST
Project No:
Collection End: 5/2/2019 10:10:00 AM
Collection Start:
Collected By: LAURA ROZUNALSKI
Date Received: 6/18/2019
Date Reported: 6/28/2019
Sample Reason:

ID#: NA
Sample Location: NEOSHO ROAD MIAMI EAST ST SW BRIDGE
Sample Description:
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

NON-WSLH BOTTLES USED. RESULTS APPROXIMATE

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Analyzed past the 40 days holding time: Method ASTM D3977-97B analyzed on 06/20/19 0000

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/20/19 00:00	Analysis Date: 06/20/19 00:00				
Comments: Analyzed past the 40 days holding time.					
SUSPENDED SEDIMENT	ASTM D3977-97B	203	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 452226007

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic chemistry: Graham Anderson 608-224-6281
Metals: Graham Anderson 608-224-6280
Organics: Erin Mani 608-224-6269
Environmental Toxicology: David Webb 608-224-6230
Water microbiology: Martin Collins 608-224-6239
Radiochemistry: David Webb 608-224-6227

Wisconsin State Laboratory of Hygiene
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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 452226008

Report To:	Invoice To:
LAURA ROZUMALSKI	LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC	FRESHWATER ENGINEERING LLC
616 CRANDALL ST	616 CRANDALL ST
MADISON, WI 53711	MADISON, WI 53711
	Customer ID: 349767

Field #: NEOSHO D/S CONFLUENCE
Project No:
Collection End: 5/2/2019 2:15:00 PM
Collection Start:
Collected By: LAURA ROZUNALSKI
Date Received: 6/18/2019
Date Reported: 6/28/2019
Sample Reason:

ID#: NA
Sample Location: NEOSHO D/S CONFLUENCE E 157 ROAD
Sample Description:
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

NON-WSLH BOTTLES USED. RESULTS APPROXIMATE

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Analyzed past the 40 days holding time: Method ASTM D3977-97B analyzed on 06/20/19 0000

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/20/19 00:00	Analysis Date: 06/20/19 00:00				
Comments: Analyzed past the 40 days holding time.					
SUSPENDED SEDIMENT	ASTM D3977-97B	262	mg/L	2.0	2.0

WSLH Sample: 452226008

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Metals: Graham Anderson 608-224-6280
Organics: Erin Mani 608-224-6269
Environmental Toxicology: David Webb 608-224-6230
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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 452226009

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711
	Customer ID: 349767

Field #: SPRING R @ HWY 10
Project No:
Collection End: 5/2/2019 1:00:00 PM
Collection Start:
Collected By: LAURA ROZUNALSKI
Date Received: 6/18/2019
Date Reported: 6/28/2019
Sample Reason:

ID#: NA
Sample Location: SPRING ROAD AT HWY 10
Sample Description:
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

NON-WSLH BOTTLES USED. RESULTS APPROXIMATE

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Analyzed past the 40 days holding time: Method ASTM D3977-97B analyzed on 06/20/19 0000

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/20/19 00:00	Analysis Date: 06/20/19 00:00				
Comments: Analyzed past the 40 days holding time.					
SUSPENDED SEDIMENT	ASTM D3977-97B	55.1	mg/L	2.0	2.0

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 452226009

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic chemistry: Graham Anderson 608-224-6281
Metals: Graham Anderson 608-224-6280
Organics: Erin Mani 608-224-6269
Environmental Toxicology: David Webb 608-224-6230
Water microbiology: Martin Collins 608-224-6239
Radiochemistry: David Webb 608-224-6227

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 452226010

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: TAR CREEK @ HWY 10
Project No:
Collection End: 5/2/2019 12:00:00 PM
Collection Start:
Collected By: LAURA ROZUNALSKI
Date Received: 6/18/2019
Date Reported: 6/28/2019
Sample Reason:

ID#: NA
Sample Location: TAR CREEK AT HWY 10
Sample Description:
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

NON-WSLH BOTTLES USED. RESULTS APPROXIMATE

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Analyzed past the 40 days holding time: Method ASTM D3977-97B analyzed on 06/20/19 0000

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/20/19 00:00	Analysis Date: 06/20/19 00:00				
Comments: Analyzed past the 40 days holding time.					
SUSPENDED SEDIMENT	ASTM D3977-97B	38.3	mg/L	2.0	2.0

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 452226010

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Metals: Graham Anderson 608-224-6280
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Water microbiology: Martin Collins 608-224-6239
Radiochemistry: David Webb 608-224-6227

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 452226011

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: NEOSHO R MIAMI E ST SW
Project No:
Collection End: 5/28/2019 8:25:00 PM
Collection Start:
Collected By: LAURA ROZUNALSKI
Date Received: 6/18/2019
Date Reported: 6/28/2019
Sample Reason:

ID#: NA
Sample Location: NEOSHO ROAD MIAMI E ST SW
Sample Description:
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

NON-WSLH BOTTLES USED. RESULTS APPROXIMATE

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/26/19 00:00 Analysis Date: 06/26/19 00:00					
SUSPENDED SEDIMENT	ASTM D3977-97B	86.2	mg/L	2.0	2.0

Wisconsin State Laboratory of Hygiene
2601 Agriculture Drive, PO Box 7996
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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 452226011

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic chemistry: Graham Anderson 608-224-6281
Metals: Graham Anderson 608-224-6280
Organics: Erin Mani 608-224-6269
Environmental Toxicology: David Webb 608-224-6230
Water microbiology: Martin Collins 608-224-6239
Radiochemistry: David Webb 608-224-6227

Wisconsin State Laboratory of Hygiene
University of Wisconsin–Madison

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 452226012

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: SPRING R @ HWY 10
Project No:
Collection End: 5/28/2019 7:30:00 PM
Collection Start:
Collected By: LAURA ROZUNALSKI
Date Received: 6/18/2019
Date Reported: 6/28/2019
Sample Reason:

ID#: NA
Sample Location: SPRING ROAD AT HWY 10
Sample Description:
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

NON-WSLH BOTTLES USED. RESULTS APPROXIMATE

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/26/19 00:00	Analysis Date: 06/26/19 00:00				
SUSPENDED SEDIMENT	ASTM D3977-97B	34.0	mg/L	2.0	2.0

Wisconsin State Laboratory of Hygiene
2601 Agriculture Drive, PO Box 7996
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(800)442-4618 - FAX (608)224-6213
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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 452226012

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic chemistry: Graham Anderson 608-224-6281
Metals: Graham Anderson 608-224-6280
Organics: Erin Mani 608-224-6269
Environmental Toxicology: David Webb 608-224-6230
Water microbiology: Martin Collins 608-224-6239
Radiochemistry: David Webb 608-224-6227

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UNIVERSITY OF WISCONSIN–MADISON

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 452226013

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: SPRING AT E 57 RD
Project No:
Collection End: 5/28/2019 7:10:00 PM
Collection Start:
Collected By: LAURA ROZUNALSKI
Date Received: 6/18/2019
Date Reported: 6/28/2019
Sample Reason:

ID#: NA
Sample Location: SPRING AT E 57 ROAD
Sample Description:
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

NON-WSLH BOTTLES USED. RESULTS APPROXIMATE

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/26/19 00:00	Analysis Date: 06/26/19 00:00				
SUSPENDED SEDIMENT	ASTM D3977-97B	83.7	mg/L	2.0	2.0

Wisconsin State Laboratory of Hygiene
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Wisconsin State Laboratory of Hygiene
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Laboratory Report

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Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 452226013

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic chemistry: Graham Anderson 608-224-6281
Metals: Graham Anderson 608-224-6280
Organics: Erin Mani 608-224-6269
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Water microbiology: Martin Collins 608-224-6239
Radiochemistry: David Webb 608-224-6227

Wisconsin State Laboratory of Hygiene
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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 452226014

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: NEOSHO R @ COMMERCE
Project No:
Collection End: 5/28/2019 8:05:00 PM
Collection Start:
Collected By: LAURA ROZUNALKSI
Date Received: 6/18/2019
Date Reported: 6/28/2019
Sample Reason:

ID#: NA
Sample Location: NEOSHO ROAD AT COMMERCE
Sample Description:
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

NON-WSLH BOTTLES USED. RESULTS APPROXIMATE

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/26/19 00:00	Analysis Date: 06/26/19 00:00				
SUSPENDED SEDIMENT	ASTM D3977-97B	182	mg/L	2.0	2.0

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 452226014

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

Test results for NELAP accredited tests are certified to meet the requirements of the NELAC standards. For a list of accredited analytes see http://www.slh.wisc.edu/about/compliance/nelac-laboratory-accreditation
Results, LOD and LOQ values have been adjusted for analytical dilutions and percent moisture where applicable.
Results relate only to the items tested.
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The water microbiology unit analyzes samples as received and not all samples are tested for preservation before analysis is performed.

Responsible Party

Inorganic chemistry: Graham Anderson 608-224-6281
Metals: Graham Anderson 608-224-6280
Organics: Erin Mani 608-224-6269
Environmental Toxicology: David Webb 608-224-6230
Water microbiology: Martin Collins 608-224-6239
Radiochemistry: David Webb 608-224-6227

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352001

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711
	Customer ID: 349767

Field #: NEOSHO RIVER@COMMERCE
Project No:
Collection End: 8/14/2019 4:28:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/28/2019
Date Reported: 9/25/2019
Sample Reason:

ID#: 364.5A
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 09/18/19 14:25	Analysis Date: 09/18/19 14:25				
SUSPENDED SEDIMENT	ASTM D3977-97B	140	mg/L	2.0	2.0

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352001

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352002

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: SPRING RIVER 117A&B
Project No:
Collection End: 8/15/2019 3:24:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/28/2019
Date Reported: 9/25/2019
Sample Reason:

ID#: 117A
Sample Location: SPRING RIVER AT E 57 RD NEAR QUAPAW, OK
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 09/18/19 14:25	Analysis Date: 09/18/19 14:25				
SUSPENDED SEDIMENT	ASTM D3977-97B	12.5	mg/L	2.0	2.0

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352003

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LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711
	Customer ID: 349767

Field #: NEOSHO
Project No:
Collection End: 8/14/2019 4:17:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/28/2019
Date Reported: 9/25/2019
Sample Reason:

ID#: 315.9A
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 09/18/19 14:25	Analysis Date: 09/18/19 14:25				
SUSPENDED SEDIMENT	ASTM D3977-97B	143	mg/L	2.0	2.0

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352003

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352004

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
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MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: SPRING RIVER 143A&B
Project No:
Collection End: 8/15/2019 3:34:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/28/2019
Date Reported: 9/25/2019
Sample Reason:

ID#: 143A
Sample Location: SPRING RIVER AT E 57 RD NEAR QUAPAW, OK
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 09/18/19 14:25	Analysis Date: 09/18/19 14:25				
SUSPENDED SEDIMENT	ASTM D3977-97B	19.2	mg/L	2.0	2.0

WSLH Sample: 466352004

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352005

Report To:
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616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
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616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: NEOSHO
Project No:
Collection End: 8/14/2019 4:05:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/28/2019
Date Reported: 9/25/2019
Sample Reason:

ID#: 267.3A
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 09/18/19 14:25	Analysis Date: 09/18/19 14:25				
SUSPENDED SEDIMENT	ASTM D3977-97B	164	mg/L	2.0	2.0

WSLH Sample: 466352005

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352006

Report To:
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FRESHWATER ENGINEERING LLC
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MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: SPRING RIVER 195A&B
Project No:
Collection End: 8/15/2019 3:48:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/28/2019
Date Reported: 9/25/2019
Sample Reason:

ID#: 195A
Sample Location: SPRING RIVER AT E 57 RD NEAR QUAPAW, OK
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 09/18/19 14:25	Analysis Date: 09/18/19 14:25				
SUSPENDED SEDIMENT	ASTM D3977-97B	12.9	mg/L	2.0	2.0

WSLH Sample: 466352006

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

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Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352007

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: SPRING RIVER 91A&B
Project No:
Collection End: 8/15/2019 3:12:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/28/2019
Date Reported: 9/25/2019
Sample Reason:

ID#: 91A
Sample Location: SPRING RIVER AT E 57 RD NEAR QUAPAW, OK
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 09/18/19 14:25	Analysis Date: 09/18/19 14:25				
SUSPENDED SEDIMENT	ASTM D3977-97B	15.7	mg/L	2.0	2.0

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352007

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352008

Report To:
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616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: NEOSHO
Project No:
Collection End: 8/14/2019 3:39:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/28/2019
Date Reported: 9/25/2019
Sample Reason:

ID#: 170.1A
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 09/18/19 14:25	Analysis Date: 09/18/19 14:25				
SUSPENDED SEDIMENT	ASTM D3977-97B	161	mg/L	2.0	2.0

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Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352008

List of Abbreviations:

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LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
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D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352009

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711
	Customer ID: 349767

Field #: NEOSHO
Project No:
Collection End: 8/14/2019 3:51:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/28/2019
Date Reported: 9/25/2019
Sample Reason:

ID#: 218.7A
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 09/18/19 14:25	Analysis Date: 09/18/19 14:25				
SUSPENDED SEDIMENT	ASTM D3977-97B	157	mg/L	2.0	2.0

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352009

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

Test results for NELAP accredited tests are certified to meet the requirements of the NELAC standards. For a list of accredited analytes see http://www.slh.wisc.edu/about/compliance/nelac-laboratory-accreditation
Results, LOD and LOQ values have been adjusted for analytical dilutions and percent moisture where applicable.
Results relate only to the items tested.
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The water microbiology unit analyzes samples as received and not all samples are tested for preservation before analysis is performed.

Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352010

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: ELK RIVER 36A&B
Project No:
Collection End: 8/15/2019 9:51:00 AM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/28/2019
Date Reported: 9/25/2019
Sample Reason:

ID#: 36A
Sample Location: ELK RIVER AT HWY 43 BRIDGE NEAR TIFF, MO
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 09/18/19 14:25	Analysis Date: 09/18/19 14:25				
SUSPENDED SEDIMENT	ASTM D3977-97B	35.6	mg/L	2.0	2.0

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352010

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352011

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: ELK RIVER 12A&B
Project No:
Collection End: 8/15/2019 9:45:00 AM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/28/2019
Date Reported: 9/25/2019
Sample Reason:

ID#: 12A
Sample Location: ELK RIVER AT HWY 43 BRIDGE NEAR TIFF, MO
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 09/18/19 14:25	Analysis Date: 09/18/19 14:25				
SUSPENDED SEDIMENT	ASTM D3977-97B	10.6	mg/L	2.0	2.0

WSLH Sample: 466352011

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352012

Report To:
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FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
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MADISON, WI 53711
Customer ID: 349767

Field #: ELK RIVER 60A&B
Project No:
Collection End: 8/15/2019 9:57:00 AM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/28/2019
Date Reported: 9/25/2019
Sample Reason:

ID#: 60A
Sample Location: ELK RIVER AT HWY 43 BRIDGE NEAR TIFF, MO
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 09/18/19 14:25	Analysis Date: 09/18/19 14:25				
SUSPENDED SEDIMENT	ASTM D3977-97B	7.90	mg/L	2.0	2.0

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352012

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352013

Report To:
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MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
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MADISON, WI 53711
Customer ID: 349767

Field #: SPRING RIVER 39A&B
Project No:
Collection End: 8/15/2019 2:57:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/28/2019
Date Reported: 9/25/2019
Sample Reason:

ID#: 39A
Sample Location: SPRING RIVER AT E 57 RD NEAR QUAPAW, OK
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 09/18/19 14:25	Analysis Date: 09/18/19 14:25				
SUSPENDED SEDIMENT	ASTM D3977-97B	13.6	mg/L	2.0	2.0

WSLH Sample: 466352013

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352014

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FRESHWATER ENGINEERING LLC
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MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: ELK RIVER 286A&B
Project No:
Collection End: 8/15/2019 10:57:00 AM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/28/2019
Date Reported: 9/25/2019
Sample Reason:

ID#: 286A
Sample Location: ELK RIVER AT HWY 43 BRIDGE NEAR TIFF, MO
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 09/18/19 14:25	Analysis Date: 09/18/19 14:25				
SUSPENDED SEDIMENT	ASTM D3977-97B	3.97	mg/L	2.0	2.0

WSLH Sample: 466352014

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

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Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352015

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
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MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: NEOSHO
Project No:
Collection End: 8/14/2019 3:06:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/28/2019
Date Reported: 9/25/2019
Sample Reason:

ID#: 24.3A
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 09/18/19 14:25	Analysis Date: 09/18/19 14:25				
SUSPENDED SEDIMENT	ASTM D3977-97B	164	mg/L	2.0	2.0

WSLH Sample: 466352015

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352016

Report To:
LAURA ROZUMALSKI
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616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: NEOSHO
Project No:
Collection End: 8/14/2019 3:23:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/28/2019
Date Reported: 9/25/2019
Sample Reason:

ID#: 72.9A
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 09/18/19 14:25	Analysis Date: 09/18/19 14:25				
SUSPENDED SEDIMENT	ASTM D3977-97B	167	mg/L	2.0	2.0

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352016

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
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Laboratory Report

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Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352017

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
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FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: SPRING RIVER 65A&B
Project No:
Collection End: 8/15/2019 3:04:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/28/2019
Date Reported: 9/25/2019
Sample Reason:

ID#: 65A
Sample Location: SPRING RIVER AT E 57 RD NEAR QUAPAW, OK
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 09/18/19 14:25	Analysis Date: 09/18/19 14:25				
SUSPENDED SEDIMENT	ASTM D3977-97B	48.5	mg/L	2.0	2.0

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(800)442-4618 - FAX (608)224-6213
http://www.slh.wisc.edu

Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352017

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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The water microbiology unit analyzes samples as received and not all samples are tested for preservation before analysis is performed.

Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

Wisconsin State Laboratory of Hygiene
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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352018

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: NEOSHO
Project No:
Collection End: 8/14/2019 3:31:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/28/2019
Date Reported: 9/25/2019
Sample Reason:

ID#: 121.5A
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 09/18/19 14:25	Analysis Date: 09/18/19 14:25				
SUSPENDED SEDIMENT	ASTM D3977-97B	136	mg/L	2.0	2.0

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790   NELAP LAB ID: 2091   EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352018

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352019

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711
	Customer ID: 349767

Field #: SPRING RIVER 247A&B
Project No:
Collection End: 8/15/2019 4:02:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/28/2019
Date Reported: 9/25/2019
Sample Reason:

ID#: 247A
Sample Location: SPRING RIVER AT E 57 RD NEAR QUAPAW, OK
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Prep Date: 09/18/19 14:25 Analysis Date: 09/18/19 14:25

Analyte	Analysis Method	Result	Units	LOD	LOQ
SUSPENDED SEDIMENT	ASTM D3977-97B	11.9	mg/L	2.0	2.0

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352019

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

Test results for NELAP accredited tests are certified to meet the requirements of the NELAC standards. For a list of accredited analytes see http://www.slh.wisc.edu/about/compliance/nelac-laboratory-accreditation
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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352020

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: SPRING RIVER 169A&B247A
Project No:
Collection End: 8/15/2019 3:43:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/28/2019
Date Reported: 9/25/2019
Sample Reason:

ID#: 169A
Sample Location: SPRING RIVER AT E 57 RD NEAR QUAPAW, OK
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 09/18/19 14:25	Analysis Date: 09/18/19 14:25				
SUSPENDED SEDIMENT	ASTM D3977-97B	15.7	mg/L	2.0	2.0

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352020

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352021

Report To:
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616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: SPRING RIVER 221A&B
Project No:
Collection End: 8/15/2019 3:55:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/28/2019
Date Reported: 9/25/2019
Sample Reason:

ID#: 221A
Sample Location: SPRING RIVER AT E 57 RD QUAPAW, OK
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 09/18/19 14:25	Analysis Date: 09/18/19 14:25				
SUSPENDED SEDIMENT	ASTM D3977-97B	11.5	mg/L	2.0	2.0

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Laboratory Report

WSLH Sample: 466352021

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

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Organics: Erin Mani, Supervisor 608-224-6269
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Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352022

Report To:
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MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: SPRING RIVER 13A&B
Project No:
Collection End: 8/15/2019 2:48:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/28/2019
Date Reported: 9/25/2019
Sample Reason:

ID#: 13A
Sample Location: SPRING RIVER AT E 57 RD NEAR QUAPAW, OK
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 09/18/19 14:25	Analysis Date: 09/18/19 14:25				
SUSPENDED SEDIMENT	ASTM D3977-97B	14.5	mg/L	2.0	2.0

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352022

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

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Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352023

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: ELK RIVER 180A&B
Project No:
Collection End: 8/15/2019 10:40:00 AM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/28/2019
Date Reported: 9/25/2019
Sample Reason:

ID#: 180A
Sample Location: ELK RIVER AT HWY 43 BRDIGE NEAR TIFF, MO
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 09/18/19 14:25	Analysis Date: 09/18/19 14:25				
SUSPENDED SEDIMENT	ASTM D3977-97B	ND	mg/L	2.0	2.0

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352023

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

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Metals: Graham Anderson, Supervisor 608-224-6281
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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352024

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: ELK RIVER 262A&B
Project No:
Collection End: 8/15/2019 10:50:00 AM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/28/2019
Date Reported: 9/25/2019
Sample Reason:

ID#: 262A`
Sample Location: ELK RIVER AT HWY 43 BRIDGE NEAR TIFF, MO
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 09/18/19 14:25	Analysis Date: 09/18/19 14:25				
SUSPENDED SEDIMENT	ASTM D3977-97B	ND	mg/L	2.0	2.0

Wisconsin State Laboratory of Hygiene
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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352024

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

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Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
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Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352025

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: TAR CREEK 69A&B
Project No:
Collection End: 8/16/2019 2:51:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/28/2019
Date Reported: 9/25/2019
Sample Reason:

ID#: A
Sample Location: TAR CREEK AT HWY 69 NEAR COMMERCE, OK
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 09/18/19 14:25	Analysis Date: 09/18/19 14:25				
SUSPENDED SEDIMENT	ASTM D3977-97B	43.0	mg/L	2.0	2.0

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University of Wisconsin–Madison

Wisconsin State Laboratory of Hygiene
2601 Agriculture Drive, PO Box 7996
Madison, WI 53707-7996
(800)442-4618 - FAX (608)224-6213
http://www.slh.wisc.edu

Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352025

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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The water microbiology unit analyzes samples as received and not all samples are tested for preservation before analysis is performed.

Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352026

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: NEOSHO
Project No:
Collection End: 8/14/2019 4:48:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/28/2019
Date Reported: 9/25/2019
Sample Reason:

ID#: 413.1A
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 09/18/19 14:25	Analysis Date: 09/18/19 14:25				
SUSPENDED SEDIMENT	ASTM D3977-97B	158	mg/L	2.0	2.0

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352026

List of Abbreviations:

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LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
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if LOD=LOQ, Limits were not statistically derived

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352027

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: NEOSHO
Project No:
Collection End: 8/14/2019 4:48:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/28/2019
Date Reported: 9/25/2019
Sample Reason:

ID#: 461.7A
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 09/18/19 14:25	Analysis Date: 09/18/19 14:25				
SUSPENDED SEDIMENT	ASTM D3977-97B	910	mg/L	2.0	2.0

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352027

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
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F next to result = Result is between LOD and LOQ
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if LOD=LOQ, Limits were not statistically derived

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352028

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: ELK RIVER 84A&B
Project No:
Collection End: 8/15/2019 10:03:00 AM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/28/2019
Date Reported: 9/25/2019
Sample Reason:

ID#: 84A
Sample Location: ELK RIVER AT HWY 43 BRIDGE NEAR TIFF, MO
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 09/18/19 14:25	Analysis Date: 09/18/19 14:25				
SUSPENDED SEDIMENT	ASTM D3977-97B	8.75	mg/L	2.0	2.0

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352028

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
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Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352029

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711
	Customer ID: 349767

Field #: NEOSHO
Project No:
Collection End: 8/14/2019 5:03:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/28/2019
Date Reported: 9/25/2019
Sample Reason:

ID#: 520.3A
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 09/18/19 14:25	Analysis Date: 09/18/19 14:25				
SUSPENDED SEDIMENT	ASTM D3977-97B	370	mg/L	2.0	2.0

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D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352029

List of Abbreviations:

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LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352030

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: ELK RIVER 108A&B
Project No:
Collection End: 8/15/2019 10:10:00 AM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/28/2019
Date Reported: 9/25/2019
Sample Reason:

ID#: 108A
Sample Location: ELK RIVER AT HWY 43 BRIDGE NEAR TIFF, MO
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 09/18/19 14:25	Analysis Date: 09/18/19 14:25				
SUSPENDED SEDIMENT	ASTM D3977-97B	3.58	mg/L	2.0	2.0

WSLH Sample: 466352030

List of Abbreviations:

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LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
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Responsible Party

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Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352031

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: ELK RIVER 132A&B
Project No:
Collection End: 8/15/2019 10:20:00 AM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/28/2019
Date Reported: 9/25/2019
Sample Reason:

ID#: 132A
Sample Location: ELK RIVER AT HWY 43 BRIDGE NEAR TIFF, MO
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 09/18/19 14:25	Analysis Date: 09/18/19 14:25				
SUSPENDED SEDIMENT	ASTM D3977-97B	6.25	mg/L	2.0	2.0

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Laboratory Report

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Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352031

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
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Laboratory Report

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352032

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: ELK RIVER 156A&B
Project No:
Collection End: 8/15/2019 10:28:00 AM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/28/2019
Date Reported: 9/25/2019
Sample Reason:

ID#: 156A
Sample Location: ELK RIVER AT HWY 43 BRIDGE NEAR TIFF, MO
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Sample Comments

ICE MELTED/NOT ICED. RESULTS APPROXIMATE.

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 09/18/19 14:25	Analysis Date: 09/18/19 14:25				
SUSPENDED SEDIMENT	ASTM D3977-97B	2.54	mg/L	2.0	2.0

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Environmental Health Division

WDNR LAB ID: 113133790 NELAP LAB ID: 2091 EPA LAB ID: WI00007, WI00008 WI DATCP ID: 105-415

WSLH Sample: 466352032

List of Abbreviations:

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University of Wisconsin–Madison

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753001

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711 Customer ID: 349767

Field #:	ELK RIVER AT HWY 43 40A	ID#:	
Project No:		Sample Location:	
Collection End:	5/17/2020 5:02:00 PM	Sample Description:	
Collection Start:		Sample Type:	
Collected By:		Waterbody:	
Date Received:	6/22/2020	Point or Outfall:	
Date Reported:	6/24/2020	Sample Depth:	
Sample Reason:		Program Code:	
		Region Code:	
		County:	

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/23/20 13:24	Analysis Date: 06/23/20 13:24				
SUSPENDED SEDIMENT	ASTM D3977-97B	91.6	mg/L	2.0	2.0

Wisconsin State Laboratory of Hygiene
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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753001

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

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LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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see http://www.slh.wisc.edu/about/compliance/nelac-laboratory-accreditation
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Results relate only to the items tested.
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The water microbiology unit analyzes samples as received and not all samples are tested for preservation before analysis is performed.

Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

Wisconsin State Laboratory of Hygiene
UNIVERSITY OF WISCONSIN–MADISON

Wisconsin State Laboratory of Hygiene
2601 Agriculture Drive, PO Box 7996
Madison, WI 53707-7996
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http://www.slh.wisc.edu

Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753003

Report To:

LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:

LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Customer ID: 349767

Field #: ELK RIVER AT HWY 43 70A
Project No:
Collection End: 5/17/2020 5:16:00 PM
Collection Start:
Collected By:
Date Received: 6/22/2020
Date Reported: 6/24/2020
Sample Reason:

ID#:
Sample Location:
Sample Description:
Sample Type:
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/23/20 13:24	Analysis Date: 06/23/20 13:24				
SUSPENDED SEDIMENT	ASTM D3977-97B	136	mg/L	2.0	2.0

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

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Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753005

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711 Customer ID: 349767

Field #: ELK RIVER AT HWY 43 100A
Project No:
Collection End: 6/17/2020 5:25:00 PM
Collection Start:
Collected By:
Date Received: 6/22/2020
Date Reported: 6/24/2020
Sample Reason:

ID#:
Sample Location:
Sample Description:
Sample Type:
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/23/20 13:24	Analysis Date: 06/23/20 13:24				
SUSPENDED SEDIMENT	ASTM D3977-97B	35.4	mg/L	2.0	2.0

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
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Responsible Party

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Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753007

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711 Customer ID: 349767

Field #:	ELK RIVER AT HWY 43 130A	ID#:	
Project No:		Sample Location:	
Collection End:	6/17/2020 5:39:00 PM	Sample Description:	
Collection Start:		Sample Type:	
Collected By:		Waterbody:	
Date Received:	6/22/2020	Point or Outfall:	
Date Reported:	6/24/2020	Sample Depth:	
Sample Reason:		Program Code:	
		Region Code:	
		County:	

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/23/20 13:24	Analysis Date: 06/23/20 13:24				
SUSPENDED SEDIMENT	ASTM D3977-97B	26.4	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753007

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
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Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753009

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: ELK RIVER AT HWY 43 160A
Project No:
Collection End: 5/17/2020 5:46:00 PM
Collection Start:
Collected By:
Date Received: 6/22/2020
Date Reported: 6/24/2020
Sample Reason:

ID#:
Sample Location:
Sample Description:
Sample Type:
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/23/20 13:24	Analysis Date: 06/23/20 13:24				
SUSPENDED SEDIMENT	ASTM D3977-97B	22.9	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753009

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
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Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753011

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711
	Customer ID: 349767

Field #: ELK RIVER AT HWY 43 190A
Project No:
Collection End: 5/17/2020 5:51:00 PM
Collection Start:
Collected By:
Date Received: 6/22/2020
Date Reported: 6/24/2020
Sample Reason:

ID#:
Sample Location:
Sample Description:
Sample Type:
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/23/20 13:24	Analysis Date: 06/23/20 13:24				
SUSPENDED SEDIMENT	ASTM D3977-97B	26.4	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753011

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

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Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
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Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753013

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: ELK RIVER AT HWY 43 220A
Project No:
Collection End: 5/17/2020 6:00:00 PM
Collection Start:
Collected By:
Date Received: 6/22/2020
Date Reported: 6/24/2020
Sample Reason:

ID#:
Sample Location:
Sample Description:
Sample Type:
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/23/20 13:24	Analysis Date: 06/23/20 13:24				
SUSPENDED SEDIMENT	ASTM D3977-97B	23.6	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753013

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
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Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753015

Report To:

LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:

LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Customer ID: 349767

Field #: ELK RIVER AT HWY 43 250A
Project No:
Collection End: 5/17/2020 6:09:00 PM
Collection Start:
Collected By:
Date Received: 6/22/2020
Date Reported: 6/24/2020
Sample Reason:

ID#:
Sample Location:
Sample Description:
Sample Type:
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/23/20 13:24	Analysis Date: 06/23/20 13:24				
SUSPENDED SEDIMENT	ASTM D3977-97B	23.3	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753015

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
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Wisconsin State Laboratory of Hygiene
University of Wisconsin–Madison

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753017

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711
	Customer ID: 349767

Field #:	ELK RIVER AT HWY 43 280A	ID#:	
Project No:		Sample Location:	
Collection End:	5/17/2020 6:19:00 PM	Sample Description:	
Collection Start:		Sample Type:	
Collected By:		Waterbody:	
Date Received:	6/22/2020	Point or Outfall:	
Date Reported:	6/24/2020	Sample Depth:	
Sample Reason:		Program Code:	
		Region Code:	
		County:	

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/23/20 13:24	Analysis Date: 06/23/20 13:24				
SUSPENDED SEDIMENT	ASTM D3977-97B	25.0	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753017

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753019

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711 Customer ID: 349767

Field #:	ELK RIVER AT HWY 43 310A	ID#:	
Project No:		Sample Location:	
Collection End:	5/17/2020 6:28:00 PM	Sample Description:	
Collection Start:		Sample Type:	
Collected By:		Waterbody:	
Date Received:	6/22/2020	Point or Outfall:	
Date Reported:	6/24/2020	Sample Depth:	
Sample Reason:		Program Code:	
		Region Code:	
		County:	

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/23/20 13:24	Analysis Date: 06/23/20 13:24				
SUSPENDED SEDIMENT	ASTM D3977-97B	24.5	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753019

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Results relate only to the items tested.
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The water microbiology unit analyzes samples as received and not all samples are tested for preservation before analysis is performed.

Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

Wisconsin State Laboratory of Hygiene
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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753021

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711 Customer ID: 349767

Field #: NEOSHO RIVER AT COMMERCE
Project No:
Collection End: 5/17/2020 11:34:00 AM
Collection Start:
Collected By:
Date Received: 6/22/2020
Date Reported: 6/24/2020
Sample Reason:

ID#:
Sample Location:
Sample Description:
Sample Type:
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/23/20 13:24	Analysis Date: 06/23/20 13:24				
SUSPENDED SEDIMENT	ASTM D3977-97B	259	mg/L	2.0	2.0

Wisconsin State Laboratory of Hygiene
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Wisconsin State Laboratory of Hygiene
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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753021

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753023

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: NEOSHO RIVER AT COMMERCE
Project No:
Collection End: 5/17/2020 12:12:00 PM
Collection Start:
Collected By:
Date Received: 6/22/2020
Date Reported: 6/24/2020
Sample Reason:

ID#:
Sample Location:
Sample Description:
Sample Type:
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/23/20 13:24	Analysis Date: 06/23/20 13:24				
SUSPENDED SEDIMENT	ASTM D3977-97B	307	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753023

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Results relate only to the items tested.
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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753025

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711
	Customer ID: 349767

Field #:	NEOSHO RIVER AT COMMERCE	ID#:	
Project No:		Sample Location:	
Collection End:	5/17/2020 12:28:00 PM	Sample Description:	
Collection Start:		Sample Type:	
Collected By:		Waterbody:	
Date Received:	6/22/2020	Point or Outfall:	
Date Reported:	6/24/2020	Sample Depth:	
Sample Reason:		Program Code:	
		Region Code:	
		County:	

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/23/20 13:24	Analysis Date: 06/23/20 13:24				
SUSPENDED SEDIMENT	ASTM D3977-97B	304	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753025

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
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Laboratory Report

Environmental Health Division
D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753027

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711 Customer ID: 349767

Field #: NEOSHO RIVER AT COMMERCE
Project No:
Collection End: 5/17/2020 12:44:00 PM
Collection Start:
Collected By:
Date Received: 6/22/2020
Date Reported: 6/24/2020
Sample Reason:

ID#:
Sample Location:
Sample Description:
Sample Type:
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/23/20 13:24	Analysis Date: 06/23/20 13:24				
SUSPENDED SEDIMENT	ASTM D3977-97B	277	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753027

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
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Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753029

Report To:

LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:

LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Customer ID: 349767

Field #: NEOSHO RIVER AT COMMERCE
Project No:
Collection End: 5/17/2020 1:00:00 PM
Collection Start:
Collected By:
Date Received: 6/22/2020
Date Reported: 6/24/2020
Sample Reason:

ID#:
Sample Location:
Sample Description:
Sample Type:
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/23/20 13:24	Analysis Date: 06/23/20 13:24				
SUSPENDED SEDIMENT	ASTM D3977-97B	240	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753029

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
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if LOD=LOQ, Limits were not statistically derived

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Responsible Party

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Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753031

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711
	Customer ID: 349767

Field #:	NEOSHO RIVER AT COMMERCE	ID#:	
Project No:		Sample Location:	
Collection End:	5/17/2020 1:14:00 PM	Sample Description:	
Collection Start:		Sample Type:	
Collected By:		Waterbody:	
Date Received:	6/22/2020	Point or Outfall:	
Date Reported:	6/24/2020	Sample Depth:	
Sample Reason:		Program Code:	
		Region Code:	
		County:	

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/23/20 13:24	Analysis Date: 06/23/20 13:24				
SUSPENDED SEDIMENT	ASTM D3977-97B	223	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753031

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

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Metals: Graham Anderson, Supervisor 608-224-6281
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Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
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Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753033

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: NEOSHO RIVER AT COMMERCE
Project No:
Collection End: 5/17/2020 1:30:00 PM
Collection Start:
Collected By:
Date Received: 6/22/2020
Date Reported: 6/24/2020
Sample Reason:

ID#:
Sample Location:
Sample Description:
Sample Type:
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/23/20 13:24	Analysis Date: 06/23/20 13:24				
SUSPENDED SEDIMENT	ASTM D3977-97B	237	mg/L	2.0	2.0

Wisconsin State Laboratory of Hygiene
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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753033

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
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if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753035

Report To:

LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:

LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Customer ID: 349767

Field #: NEOSHO RIVER AT COMMERCE
Project No:
Collection End: 5/17/2020 1:44:00 PM
Collection Start:
Collected By:
Date Received: 6/22/2020
Date Reported: 6/24/2020
Sample Reason:

ID#:
Sample Location:
Sample Description:
Sample Type:
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/23/20 13:24	Analysis Date: 06/23/20 13:24				
SUSPENDED SEDIMENT	ASTM D3977-97B	239	mg/L	2.0	2.0

Wisconsin State Laboratory of Hygiene
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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753035

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753037

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: NEOSHO RIVER AT COMMERCE
Project No:
Collection End: 5/17/2020 2:14:00 PM
Collection Start:
Collected By:
Date Received: 6/22/2020
Date Reported: 6/24/2020
Sample Reason:

ID#:
Sample Location:
Sample Description:
Sample Type:
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/23/20 13:24	Analysis Date: 06/23/20 13:24				
SUSPENDED SEDIMENT	ASTM D3977-97B	226	mg/L	2.0	2.0

Wisconsin State Laboratory of Hygiene
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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753037

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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see http://www.slh.wisc.edu/about/compliance/nelac-laboratory-accreditation
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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

Wisconsin State Laboratory of Hygiene
UNIVERSITY OF WISCONSIN–MADISON

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Madison, WI 53707-7996
(800)442-4618 - FAX (608)224-6213
http://www.slh.wisc.edu

Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753039

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711
	Customer ID: 349767

Field #:	NEOSHO RIVER AT COMMERCE	ID#:	
Project No:		Sample Location:	
Collection End:	5/17/2020 2:25:00 PM	Sample Description:	
Collection Start:		Sample Type:	
Collected By:		Waterbody:	
Date Received:	6/22/2020	Point or Outfall:	
Date Reported:	6/24/2020	Sample Depth:	
Sample Reason:		Program Code:	
		Region Code:	
		County:	

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/23/20 13:24	Analysis Date: 06/23/20 13:24				
SUSPENDED SEDIMENT	ASTM D3977-97B	208	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753039

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
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Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753041

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711
	Customer ID: 349767

Field #: SPRING RIVER AT E 57RD 14A
Project No:
Collection End: 5/18/2020 10:30:00 AM
Collection Start:
Collected By:
Date Received: 6/22/2020
Date Reported: 6/24/2020
Sample Reason:

ID#:
Sample Location:
Sample Description:
Sample Type:
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/23/20 13:24	Analysis Date: 06/23/20 13:24				
SUSPENDED SEDIMENT	ASTM D3977-97B	45.7	mg/L	2.0	2.0

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http://www.slh.wisc.edu

Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753041

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
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Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753043

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: SPRING RIVER AT E 57RD 42A
Project No:
Collection End: 5/18/2020 10:40:00 AM
Collection Start:
Collected By:
Date Received: 6/22/2020
Date Reported: 6/24/2020
Sample Reason:

ID#:
Sample Location:
Sample Description:
Sample Type:
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/23/20 13:24	Analysis Date: 06/23/20 13:24				
SUSPENDED SEDIMENT	ASTM D3977-97B	41.4	mg/L	2.0	2.0

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753045

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711
	Customer ID: 349767

Field #: SPRING RIVER AT E 57RD 70A
Project No:
Collection End: 5/18/2020 10:48:00 AM
Collection Start:
Collected By:
Date Received: 6/22/2020
Date Reported: 6/24/2020
Sample Reason:

ID#:
Sample Location:
Sample Description:
Sample Type:
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/23/20 13:24	Analysis Date: 06/23/20 13:24				
SUSPENDED SEDIMENT	ASTM D3977-97B	40.8	mg/L	2.0	2.0

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753047

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: SPRING RIVER AT E 57RD 98A
Project No:
Collection End: 5/18/2020 10:55:00 AM
Collection Start:
Collected By:
Date Received: 6/22/2020
Date Reported: 6/24/2020
Sample Reason:

ID#:
Sample Location:
Sample Description:
Sample Type:
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/23/20 13:24	Analysis Date: 06/23/20 13:24				
SUSPENDED SEDIMENT	ASTM D3977-97B	39.4	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753047

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

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LOQ = Level of quantification
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if LOD=LOQ, Limits were not statistically derived

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Responsible Party

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Metals: Graham Anderson, Supervisor 608-224-6281
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Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753049

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: SPRING RIVER AT E 57RD 126A
Project No:
Collection End: 5/18/2020 11:04:00 AM
Collection Start:
Collected By:
Date Received: 6/22/2020
Date Reported: 6/24/2020
Sample Reason:

ID#:
Sample Location:
Sample Description:
Sample Type:
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/23/20 13:24	Analysis Date: 06/23/20 13:24				
SUSPENDED SEDIMENT	ASTM D3977-97B	41.9	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753049

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

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LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753051

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: SPRING RIVER AT E 57RD 154A
Project No:
Collection End: 5/18/2020 11:13:00 AM
Collection Start:
Collected By:
Date Received: 6/22/2020
Date Reported: 6/24/2020
Sample Reason:

ID#:
Sample Location:
Sample Description:
Sample Type:
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/23/20 13:24	Analysis Date: 06/23/20 13:24				
SUSPENDED SEDIMENT	ASTM D3977-97B	40.2	mg/L	2.0	2.0

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Wisconsin State Laboratory of Hygiene
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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753051

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

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LOQ = Level of quantification
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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
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Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753053

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: SPRING RIVER AT E 57RD 182A
Project No:
Collection End: 5/18/2020 11:21:00 AM
Collection Start:
Collected By:
Date Received: 6/22/2020
Date Reported: 6/24/2020
Sample Reason:

ID#:
Sample Location:
Sample Description:
Sample Type:
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/23/20 13:24	Analysis Date: 06/23/20 13:24				
SUSPENDED SEDIMENT	ASTM D3977-97B	40.4	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753053

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

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LOQ = Level of quantification
ND = None detected. Results are less than the LOD
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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753055

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: SPRING RIVER AT E 57RD 210A
Project No:
Collection End: 5/18/2020 11:28:00 AM
Collection Start:
Collected By:
Date Received: 6/22/2020
Date Reported: 6/24/2020
Sample Reason:

ID#:
Sample Location:
Sample Description:
Sample Type:
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/23/20 13:24	Analysis Date: 06/23/20 13:24				
SUSPENDED SEDIMENT	ASTM D3977-97B	40.8	mg/L	2.0	2.0

Wisconsin State Laboratory of Hygiene
2601 Agriculture Drive, PO Box 7996
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http://www.slh.wisc.edu

Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753055

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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see http://www.slh.wisc.edu/about/compliance/nelac-laboratory-accreditation
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Results relate only to the items tested.
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The water microbiology unit analyzes samples as received and not all samples are tested for preservation before analysis is performed.

Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753057

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: SPRING RIVER AT E 57RD 238A
Project No:
Collection End: 5/18/2020 11:35:00 AM
Collection Start:
Collected By:
Date Received: 6/22/2020
Date Reported: 6/24/2020
Sample Reason:

ID#:
Sample Location:
Sample Description:
Sample Type:
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/23/20 13:24	Analysis Date: 06/23/20 13:24				
SUSPENDED SEDIMENT	ASTM D3977-97B	36.5	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753057

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
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Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753059

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711
	Customer ID: 349767

Field #: SPRING RIVER AT E 57RD 266A
Project No:
Collection End: 5/18/2020 11:44:00 AM
Collection Start:
Collected By:
Date Received: 6/22/2020
Date Reported: 6/24/2020
Sample Reason:

ID#:
Sample Location:
Sample Description:
Sample Type:
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/23/20 13:24	Analysis Date: 06/23/20 13:24				
SUSPENDED SEDIMENT	ASTM D3977-97B	29.3	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 510753059

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

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Metals: Graham Anderson, Supervisor 608-224-6281
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Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356001

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: NEOSHO RIVER AT COMMERCE
Project No:
Collection End: 7/31/2020 5:15:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/21/2020
Date Reported: 9/4/2020
Sample Reason:

ID#: 10A
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 08/25/20 12:16	Analysis Date: 08/25/20 12:16				
SUSPENDED SEDIMENT	ASTM D3977-97B	148	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356001

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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see http://www.slh.wisc.edu/about/compliance/nelac-laboratory-accreditation
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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356003

Report To:

LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:

LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Customer ID: 349767

Field #: NEOSHO RIVER AT COMMERCE
Project No:
Collection End: 7/31/2020 5:30:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/21/2020
Date Reported: 9/4/2020
Sample Reason:

ID#: 63A
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 08/25/20 12:16	Analysis Date: 08/25/20 12:16				
SUSPENDED SEDIMENT	ASTM D3977-97B	245	mg/L	2.0	2.0

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Results, LOD and LOQ values have been adjusted for analytical dilutions and percent moisture where applicable.
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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356005

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Customer ID: 349767

Field #: NEOSHO RIVER AT COMMERCE
Project No:
Collection End: 7/31/2020 5:39:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/21/2020
Date Reported: 9/4/2020
Sample Reason:

ID#: 116A
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 08/25/20 12:16	Analysis Date: 08/25/20 12:16				
SUSPENDED SEDIMENT	ASTM D3977-97B	197	mg/L	2.0	2.0

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

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LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356007

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: NEOSHO RIVER AT COMMERCE
Project No:
Collection End: 7/31/2020 5:52:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/21/2020
Date Reported: 9/4/2020
Sample Reason:

ID#: 169A
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description:
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 08/25/20 12:16	Analysis Date: 08/25/20 12:16				
SUSPENDED SEDIMENT	ASTM D3977-97B	211	mg/L	2.0	2.0

Report ID: 7949234

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

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LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356009

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711
	Customer ID: 349767

Field #: NEOSHO RIVER AT COMMERCE
Project No:
Collection End: 7/31/2020 6:05:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/21/2020
Date Reported: 9/4/2020
Sample Reason:

ID#: 222A
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description:
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 08/25/20 12:16	Analysis Date: 08/25/20 12:16				
SUSPENDED SEDIMENT	ASTM D3977-97B	183	mg/L	2.0	2.0

Report ID: 7949234

0000.25.2.WSLH.0

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356009

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

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Metals: Graham Anderson, Supervisor 608-224-6281
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Water Microbiology: Martin Collins, Supervisor 608-224-6239
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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356011

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: NEOSHO RIVER AT COMMERCE
Project No:
Collection End: 7/31/2020 6:23:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/21/2020
Date Reported: 9/4/2020
Sample Reason:

ID#: 275A
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description:
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 08/25/20 12:16	Analysis Date: 08/25/20 12:16				
SUSPENDED SEDIMENT	ASTM D3977-97B	230	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356011

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
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Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356013

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: NEOSHO RIVER AT COMMERCE
Project No:
Collection End: 7/31/2020 6:34:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/21/2020
Date Reported: 9/4/2020
Sample Reason:

ID#: 313A
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 08/25/20 12:16	Analysis Date: 08/25/20 12:16				
SUSPENDED SEDIMENT	ASTM D3977-97B	170	mg/L	2.0	2.0

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Madison, WI 53707-7996
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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356013

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

Test results for NELAP accredited tests are certified to meet the requirements of the NELAC standards. For a list of accredited analytes
see http://www.slh.wisc.edu/about/compliance/nelac-laboratory-accreditation
Results, LOD and LOQ values have been adjusted for analytical dilutions and percent moisture where applicable.
Results relate only to the items tested.
This Laboratory Report shall not be reproduced except in full, without written approval of the laboratory.
The water microbiology unit analyzes samples as received and not all samples are tested for preservation before analysis is performed.

Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

Wisconsin State Laboratory of Hygiene
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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356015

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711
	Customer ID: 349767

Field #: NEOSHO RIVER AT COMMERCE
Project No:
Collection End: 7/31/2020 6:47:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/21/2020
Date Reported: 9/4/2020
Sample Reason:

ID#: 381A
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description:
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 08/25/20 12:16	Analysis Date: 08/25/20 12:16				
SUSPENDED SEDIMENT	ASTM D3977-97B	182	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356015

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356017

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: NEOSHO RIVER AT COMMERCE
Project No:
Collection End: 7/31/2020 6:56:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/21/2020
Date Reported: 9/4/2020
Sample Reason:

ID#: 424A
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description:
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 08/25/20 12:16	Analysis Date: 08/25/20 12:16				
SUSPENDED SEDIMENT	ASTM D3977-97B	179	mg/L	2.0	2.0

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356019

Report To:

LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:

LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Customer ID: 349767

Field #: NEOSHO RIVER AT COMMERCE
Project No:
Collection End: 7/31/2020 7:10:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/21/2020
Date Reported: 9/4/2020
Sample Reason:

ID#: 519A
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description:
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 08/25/20 12:16	Analysis Date: 08/25/20 12:16				
SUSPENDED SEDIMENT	ASTM D3977-97B	172	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356019

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356021

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: SPRING RIVER AT E 57 ROAD 10A
Project No:
Collection End: 7/31/2020 11:45:00 AM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/21/2020
Date Reported: 9/4/2020
Sample Reason:

ID#: 10A
Sample Location: SPRING RIVER AT E 57 ROAD
Sample Description:
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 08/25/20 12:16	Analysis Date: 08/25/20 12:16				
SUSPENDED SEDIMENT	ASTM D3977-97B	55.3	mg/L	2.0	2.0

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Laboratory Report

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356023

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: SPRING RIVER AT E 57 ROAD 28A
Project No:
Collection End: 7/31/2020 12:05:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/21/2020
Date Reported: 9/4/2020
Sample Reason:

ID#: 28A
Sample Location: SPRING RIVER AT E 57 RD
Sample Description:
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 08/25/20 12:16	Analysis Date: 08/25/20 12:16				
SUSPENDED SEDIMENT	ASTM D3977-97B	54.2	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356023

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356025

Report To:

LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:

LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Customer ID: 349767

Field #: SPRING RIVER AT E 57 ROAD 56A
Project No:
Collection End: 7/31/2020 12:18:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/21/2020
Date Reported: 9/4/2020
Sample Reason:

ID#: 56A
Sample Location: SPRING RIVER AT E 57 RD
Sample Description:
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 08/25/20 12:16	Analysis Date: 08/25/20 12:16				
SUSPENDED SEDIMENT	ASTM D3977-97B	52.7	mg/L	2.0	2.0

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356027

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: SPRING RIVER AT E 57 ROAD 84A
Project No:
Collection End: 7/31/2020 12:28:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/21/2020
Date Reported: 9/4/2020
Sample Reason:

ID#: 84A
Sample Location: SPRING RIVER E 57 RD
Sample Description:
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 08/25/20 12:16	Analysis Date: 08/25/20 12:16				
SUSPENDED SEDIMENT	ASTM D3977-97B	47.6	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356027

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
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Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356029

Report To:

LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:

LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Customer ID: 349767

Field #: SPRING RIVER AT E 57 ROAD
Project No:
Collection End: 7/31/2020 12:40:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/21/2020
Date Reported: 9/4/2020
Sample Reason:

ID#: 112A
Sample Location: SPRING RIVER AT E 57 RD
Sample Description:
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 08/25/20 12:16	Analysis Date: 08/25/20 12:16				
SUSPENDED SEDIMENT	ASTM D3977-97B	51.4	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356029

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

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Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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University of Wisconsin–Madison

Wisconsin State Laboratory of Hygiene
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(800)442-4618 - FAX (608)224-6213
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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356031

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: SPRING RIVER AT E 57 ROAD
Project No:
Collection End: 7/31/2020 1:28:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/21/2020
Date Reported: 9/4/2020
Sample Reason:

ID#: 140A
Sample Location: SPRING RIVER AT E 57 RD
Sample Description:
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 08/25/20 12:16	Analysis Date: 08/25/20 12:16				
SUSPENDED SEDIMENT	ASTM D3977-97B	50.2	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356031

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

Test results for NELAP accredited tests are certified to meet the requirements of the NELAC standards. For a list of accredited analytes
see http://www.slh.wisc.edu/about/compliance/nelac-laboratory-accreditation
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Results relate only to the items tested.
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The water microbiology unit analyzes samples as received and not all samples are tested for preservation before analysis is performed.

Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356033

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: SPRING RIVER AT E 57 ROAD
Project No:
Collection End: 7/31/2020 1:42:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/21/2020
Date Reported: 9/4/2020
Sample Reason:

ID#: 168A
Sample Location: SPRING RIVER AT E 57 RD
Sample Description:
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 08/25/20 12:16	Analysis Date: 08/25/20 12:16				
SUSPENDED SEDIMENT	ASTM D3977-97B	45.4	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356033

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356035

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: SPRING RIVER AT E 57 ROAD
Project No:
Collection End: 7/31/2020 1:49:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/21/2020
Date Reported: 9/4/2020
Sample Reason:

ID#: 196A
Sample Location: SPRING RIVER AT E 57 RD
Sample Description:
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 08/25/20 12:16	Analysis Date: 08/25/20 12:16				
SUSPENDED SEDIMENT	ASTM D3977-97B	45.5	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356035

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356037

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: SPRING RIVER AT E 57 ROAD
Project No:
Collection End: 7/31/2020 2:00:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/21/2020
Date Reported: 9/4/2020
Sample Reason:

ID#: 224A
Sample Location: SPRING RIVER AT E 57 RD
Sample Description:
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 08/25/20 12:16	Analysis Date: 08/25/20 12:16				
SUSPENDED SEDIMENT	ASTM D3977-97B	53.1	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356037

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356039

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: SPRING RIVER AT E 57 ROAD
Project No:
Collection End: 7/31/2020 2:15:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/21/2020
Date Reported: 9/4/2020
Sample Reason:

ID#: 252A
Sample Location: SPRING RIVER AT E 57 RD
Sample Description:
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 08/25/20 12:16	Analysis Date: 08/25/20 12:16				
SUSPENDED SEDIMENT	ASTM D3977-97B	52.3	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356039

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356041

Report To:

LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:

LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Customer ID: 349767

Field #: TAR CREEK AT HWY 69 9A
Project No:
Collection End: 7/31/2020 3:20:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 8/21/2020
Date Reported: 9/4/2020
Sample Reason:

ID#: 9A
Sample Location: TAR CREEK AT HWY 69
Sample Description:
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 08/25/20 12:16	Analysis Date: 08/25/20 12:16				
SUSPENDED SEDIMENT	ASTM D3977-97B	ND	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

D.F. Kurtycz, M.D., Medical Director - Prof. James J. Schauer, Ph.D., Director

WSLH Sample: 521356041

WDNR LAB ID:113133790   NELAP LAB ID:2091   EPA LAB ID:WI00007, WI00008   WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944001

Report To:

LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:

LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Customer ID: 349767

Field #: 350B
Project No:
Collection End: 4/30/2021 4:52:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: 350B
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

No Charge

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/15/21 11:18	Analysis Date: 06/15/21 11:18				
No Analysis	IC CA Analysis	SSC <63um results pending.			

Wisconsin State Laboratory of Hygiene
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Laboratory Report

Environmental Health Division

WSLH Sample: 560944001

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944002

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: 350A
Project No:
Collection End: 4/30/2021 4:49:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: 350A
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 05/12/21 13:57	Analysis Date: 05/12/21 13:57				
SUSPENDED SEDIMENT	ASTM D3977-97B	118	mg/L	2.0	2.0

Laboratory Report

Environmental Health Division

WSLH Sample: 560944002

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
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2601 Agriculture Drive, PO Box 7996
Madison, WI 53707-7996
(800)442-4618 - FAX (608)224-6213
http://www.slh.wisc.edu

Laboratory Report

Environmental Health Division

WSLH Sample: 560944003

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: 300B
Project No:
Collection End: 4/30/2021 4:38:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: 300B
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

No Charge

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/15/21 11:19	Analysis Date: 06/15/21 11:19				
No Analysis	IC CA Analysis	SSC <63um results pending.			

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Madison, WI 53707-7996
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Laboratory Report

Environmental Health Division

WSLH Sample: 560944003

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
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Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944004

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711 Customer ID: 349767

Field #: 300A
Project No:
Collection End: 4/30/2021 4:35:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: 300A
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 05/12/21 13:57	Analysis Date: 05/12/21 13:57				
SUSPENDED SEDIMENT	ASTM D3977-97B	139	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944004

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

Test results for NELAP accredited tests are certified to meet the requirements of the NELAC standards. For a list of accredited analytes
see http://www.slh.wisc.edu/about/compliance/nelac-laboratory-accreditation
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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944005

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711
	Customer ID: 349767

Field #: 250B
Project No:
Collection End: 4/30/2021 4:28:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

No Charge

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/15/21 11:20	Analysis Date: 06/15/21 11:20				
No Analysis	IC CA Analysis	SSC <63um results pending.			

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
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Z next to result = Result is between 0 (zero) and LOD
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Responsible Party

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944006

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: 250A
Project No:
Collection End: 4/30/2021 4:25:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 05/12/21 13:57	Analysis Date: 05/12/21 13:57				
SUSPENDED SEDIMENT	ASTM D3977-97B	104	mg/L	2.0	2.0

Report ID: 8733841

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944006

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

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LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
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Z next to result = Result is between 0 (zero) and LOD
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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
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Laboratory Report

Environmental Health Division

WSLH Sample: 560944007

Report To:

LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:

LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Customer ID: 349767

Field #: 200B
Project No:
Collection End: 4/30/2021 4:20:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

No Charge

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/15/21 11:20	Analysis Date: 06/15/21 11:20				
No Analysis	IC CA Analysis	SSC <63um results pending.			

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944007

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

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LOQ = Level of quantification (for PFAS the LOQ = MRL)
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Laboratory Report

Environmental Health Division

WSLH Sample: 560944008

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: 200A
Project No:
Collection End: 4/30/2021 4:17:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 05/12/21 13:57	Analysis Date: 05/12/21 13:57				
SUSPENDED SEDIMENT	ASTM D3977-97B	104	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944008

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
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Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944009

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711
	Customer ID: 349767

Field #: 150B
Project No:
Collection End: 4/30/2021 4:13:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: NEOSHO ROAD AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

No Charge

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/15/21 11:21	Analysis Date: 06/15/21 11:21				
No Analysis	IC CA Analysis	SSC <63um results pending.			

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944009

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
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Responsible Party

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944010

Report To:	Invoice To:
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Field #: 150A
Project No:
Collection End: 4/30/2021 4:10:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: NEOSHO ROAD AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 05/12/21 13:57	Analysis Date: 05/12/21 13:57				
SUSPENDED SEDIMENT	ASTM D3977-97B	98.5	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944010

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

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LOQ = Level of quantification (for PFAS the LOQ = MRL)
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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
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Laboratory Report

Environmental Health Division

WSLH Sample: 560944011

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: 100B
Project No:
Collection End: 4/30/2021 4:03:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: NEOSHO ROAD AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

No Charge

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/15/21 11:22	Analysis Date: 06/15/21 11:22				
No Analysis	IC CA Analysis	SSC <63um results pending.			

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944011

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
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Responsible Party

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944012

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: 100A
Project No:
Collection End: 4/30/2021 4:00:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: NEOSHO ROAD AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 05/12/21 13:57	Analysis Date: 05/12/21 13:57				
SUSPENDED SEDIMENT	ASTM D3977-97B	98.0	mg/L	2.0	2.0

Report ID: 8733841

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944012

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

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LOQ = Level of quantification (for PFAS the LOQ = MRL)
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Responsible Party

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Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944013

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711
	Customer ID: 349767

Field #: 230B
Project No:
Collection End: 4/30/2021 1:15:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: SPRING RIVER AT E 57 ROAD
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

No Charge

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/15/21 11:22	Analysis Date: 06/15/21 11:22				
No Analysis	IC CA Analysis	SSC <63um results pending.			

Wisconsin State Laboratory of Hygiene
UNIVERSITY OF WISCONSIN–MADISON

Wisconsin State Laboratory of Hygiene
2601 Agriculture Drive, PO Box 7996
Madison, WI 53707-7996
(800)442-4618 - FAX (608)224-6213
http://www.slh.wisc.edu

Laboratory Report

Environmental Health Division

WSLH Sample: 560944013

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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see http://www.slh.wisc.edu/about/compliance/nelac-laboratory-accreditation
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Results relate only to the items tested.
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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944014

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: 230A
Project No:
Collection End: 4/30/2021 1:12:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: SPRING RIVER AT E 57 ROAD
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 05/12/21 13:57	Analysis Date: 05/12/21 13:57				
SUSPENDED SEDIMENT	ASTM D3977-97B	21.0	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944014

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
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Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
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Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944015

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: 203A
Project No:
Collection End: 4/30/2021 1:02:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: SPRING RIVER AT E 57 ROAD
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 05/12/21 13:57	Analysis Date: 05/12/21 13:57				
SUSPENDED SEDIMENT	ASTM D3977-97B	18.7	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944015

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

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Wisconsin State Laboratory of Hygiene
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Madison, WI 53707-7996
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Laboratory Report

Environmental Health Division

WSLH Sample: 560944016

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711 Customer ID: 349767

Field #: 203B
Project No:
Collection End: 4/30/2021 1:08:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: SPRING RIVER AT E 57 ROAD
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

No Charge

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/15/21 11:23	Analysis Date: 06/15/21 11:23				
No Analysis	IC CA Analysis	SSC <63um results pending.			

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944016

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
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Laboratory Report

Environmental Health Division

WSLH Sample: 560944017

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711
	Customer ID: 349767

Field #: 68B
Project No:
Collection End: 4/30/2021 12:26:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: SPRING RIVER AT E 57 ROAD
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

No Charge

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/15/21 11:23	Analysis Date: 06/15/21 11:23				
No Analysis	IC CA Analysis	SSC <63um results pending.			

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944017

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
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Organics: Erin Mani, Supervisor 608-224-6269
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Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944018

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711
	Customer ID: 349767

Field #: 68A
Project No:
Collection End: 4/30/2021 12:23:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: SPRING RIVER AT E 57 ROAD
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 05/12/21 13:57	Analysis Date: 05/12/21 13:57				
SUSPENDED SEDIMENT	ASTM D3977-97B	20.1	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944018

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
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Responsible Party

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Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
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Laboratory Report

Environmental Health Division

WSLH Sample: 560944019

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: 41B
Project No:
Collection End: 4/30/2021 12:18:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: SPRING RIVER AT E 57 ROAD
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

No Charge

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/15/21 11:29	Analysis Date: 06/15/21 11:29				
No Analysis	IC CA Analysis	SSC <63um results pending.			

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944019

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
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Laboratory Report

Environmental Health Division

WSLH Sample: 560944020

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711
	Customer ID: 349767

Field #: 41A
Project No:
Collection End: 4/30/2021 12:14:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: SPRING RIVER AT E 57 ROAD
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 05/12/21 13:57	Analysis Date: 05/12/21 13:57				
SUSPENDED SEDIMENT	ASTM D3977-97B	22.2	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944020

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
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Laboratory Report

Environmental Health Division

WSLH Sample: 560944021

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: 450B
Project No:
Collection End: 4/30/2021 5:09:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: NEOSHO ROAD AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

No Charge

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/15/21 11:30	Analysis Date: 06/15/21 11:30				
No Analysis	IC CA Analysis	SSC <63um results pending.			

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944021

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
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Responsible Party

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944022

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711
	Customer ID: 349767

Field #: 450A
Project No:
Collection End: 4/30/2021 5:06:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: NEOSHO ROAD AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 05/12/21 13:57	Analysis Date: 05/12/21 13:57				
SUSPENDED SEDIMENT	ASTM D3977-97B	112	mg/L	2.0	2.0

Wisconsin State Laboratory of Hygiene
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Laboratory Report

Environmental Health Division

WSLH Sample: 560944022

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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see http://www.slh.wisc.edu/about/compliance/nelac-laboratory-accreditation
Results, LOD and LOQ values have been adjusted for analytical dilutions and percent moisture where applicable.
Results relate only to the items tested.
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The water microbiology unit analyzes samples as received and not all samples are tested for preservation before analysis is performed.

Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944023

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: 400B
Project No:
Collection End: 4/30/2021 5:01:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: NEOSHO ROAD AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

No Charge

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/15/21 11:30	Analysis Date: 06/15/21 11:30				
No Analysis	IC CA Analysis	SSC <63um results pending.			

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944023

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
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Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

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Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944024

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711
	Customer ID: 349767

Field #: 400A
Project No:
Collection End: 4/30/2021 4:58:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: NEOSHO ROAD AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 05/12/21 13:57	Analysis Date: 05/12/21 13:57				
SUSPENDED SEDIMENT	ASTM D3977-97B	114	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944024

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

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Organics: Erin Mani, Supervisor 608-224-6269
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Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944025

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711
	Customer ID: 349767

Field #: 176A
Project No:
Collection End: 4/30/2021 12:55:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: SPRING RIVER AT E 57 ROAD
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 05/12/21 13:57	Analysis Date: 05/12/21 13:57				
SUSPENDED SEDIMENT	ASTM D3977-97B	21.3	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944025

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
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Laboratory Report

Environmental Health Division

WSLH Sample: 560944026

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711
	Customer ID: 349767

Field #: 176B
Project No:
Collection End: 4/30/2021 12:59:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: SPRING RIVER AT E 57 ROAD
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

No Charge

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/15/21 11:31	Analysis Date: 06/15/21 11:31				
No Analysis	IC CA Analysis	SSC <63um results pending.			

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944026

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944027

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711
	Customer ID: 349767

Field #: 149B
Project No:
Collection End: 4/30/2021 12:49:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: SPRING RIVER AT E 57 ROAD
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

No Charge

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/15/21 11:31	Analysis Date: 06/15/21 11:31				
No Analysis	IC CA Analysis	SSC <63um results pending.			

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944027

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
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Z next to result = Result is between 0 (zero) and LOD
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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944028

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: 149A
Project No:
Collection End: 4/30/2021 12:46:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: SPRING RIVER AT E 57 ROAD
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 05/12/21 13:57	Analysis Date: 05/12/21 13:57				
SUSPENDED SEDIMENT	ASTM D3977-97B	18.8	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944028

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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The water microbiology unit analyzes samples as received and not all samples are tested for preservation before analysis is performed.

Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
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Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944029

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711
	Customer ID: 349767

Field #: 122A
Project No:
Collection End: 4/30/2021 12:40:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: SPRING RIVER AT E 57 ROAD
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 05/12/21 13:57	Analysis Date: 05/12/21 13:57				
SUSPENDED SEDIMENT	ASTM D3977-97B	20.0	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944029

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
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Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
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Laboratory Report

Environmental Health Division

WSLH Sample: 560944030

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: 122B
Project No:
Collection End: 4/30/2021 12:43:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: SPRING RIVER AT E 57 ROAD
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

No Charge

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/15/21 11:32	Analysis Date: 06/15/21 11:32				
No Analysis	IC CA Analysis	SSC <63um results pending.			

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944030

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944031

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711
	Customer ID: 349767

Field #: 95B
Project No:
Collection End: 4/30/2021 12:35:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: SPRING RIVER AT E 57 ROAD
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

No Charge

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/15/21 11:33	Analysis Date: 06/15/21 11:33				
No Analysis	IC CA Analysis	SSC <63um results pending.			

Wisconsin State Laboratory of Hygiene
2601 Agriculture Drive, PO Box 7996
Madison, WI 53707-7996
(800)442-4618 - FAX (608)224-6213
http://www.slh.wisc.edu

Laboratory Report

Environmental Health Division

WSLH Sample: 560944031

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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see http://www.slh.wisc.edu/about/compliance/nelac-laboratory-accreditation
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Results relate only to the items tested.
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The water microbiology unit analyzes samples as received and not all samples are tested for preservation before analysis is performed.

Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

Wisconsin State Laboratory of Hygiene
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http://www.slh.wisc.edu

Laboratory Report

Environmental Health Division

WSLH Sample: 560944032

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: 95A
Project No:
Collection End: 4/30/2021 12:32:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: SPRING RIVER AT E 57 ROAD
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 05/12/21 13:57	Analysis Date: 05/12/21 13:57				
SUSPENDED SEDIMENT	ASTM D3977-97B	19.0	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944032

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

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LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
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Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944033

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: 14B
Project No:
Collection End: 4/30/2021 12:03:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: SPRING RIVER AT E 57 ROAD
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

No Charge

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/15/21 11:33	Analysis Date: 06/15/21 11:33				
No Analysis	IC CA Analysis	SSC <63um results pending.			

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944033

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
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Laboratory Report

Environmental Health Division

WSLH Sample: 560944034

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: 14A
Project No:
Collection End: 4/30/2021 12:00:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: SPRING RIVER AT E 57 ROAD
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 05/12/21 13:57	Analysis Date: 05/12/21 13:57				
SUSPENDED SEDIMENT	ASTM D3977-97B	35.0	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944034

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

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LOQ = Level of quantification (for PFAS the LOQ = MRL)
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Laboratory Report

Environmental Health Division

WSLH Sample: 560944035

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: 257A
Project No:
Collection End: 4/30/2021 1:21:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: SPRING RIVER AT E 57 ROAD
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 05/12/21 13:57	Analysis Date: 05/12/21 13:57				
SUSPENDED SEDIMENT	ASTM D3977-97B	31.0	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944035

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

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Responsible Party

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944036

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: 257B
Project No:
Collection End: 4/30/2021 1:25:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: SPRING RIVER AT E 57 ROAD
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

No Charge

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/15/21 11:34	Analysis Date: 06/15/21 11:34				
No Analysis	IC CA Analysis	SSC <63um results pending.			

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Laboratory Report

Environmental Health Division

WSLH Sample: 560944036

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

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Responsible Party

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Metals: Graham Anderson, Supervisor 608-224-6281
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Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
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Laboratory Report

Environmental Health Division

WSLH Sample: 560944037

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
616 CRANDALL ST
MADISON, WI 53711
Customer ID: 349767

Field #: 50B
Project No:
Collection End: 4/30/2021 3:57:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

No Charge

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/15/21 11:34	Analysis Date: 06/15/21 11:34				
No Analysis	IC CA Analysis	SSC <63um results pending.			

Wisconsin State Laboratory of Hygiene
2601 Agriculture Drive, PO Box 7996
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Laboratory Report

Environmental Health Division

WSLH Sample: 560944037

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

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LOQ = Level of quantification (for PFAS the LOQ = MRL)
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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
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Wisconsin State Laboratory of Hygiene
University of Wisconsin–Madison

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2601 Agriculture Drive, PO Box 7996
Madison, WI 53707-7996
(800)442-4618 - FAX (608)224-6213
http://www.slh.wisc.edu

Laboratory Report

Environmental Health Division

WSLH Sample: 560944038

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711
	Customer ID: 349767

Field #: 50A
Project No:
Collection End: 4/30/2021 3:55:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 05/12/21 13:57	Analysis Date: 05/12/21 13:57				
SUSPENDED SEDIMENT	ASTM D3977-97B	99.1	mg/L	2.0	2.0

Wisconsin State Laboratory of Hygiene
2601 Agriculture Drive, PO Box 7996
Madison, WI 53707-7996
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http://www.slh.wisc.edu

Laboratory Report

Environmental Health Division

WSLH Sample: 560944038

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

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LOQ = Level of quantification (for PFAS the LOQ = MRL)
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Responsible Party

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Wisconsin State Laboratory of Hygiene
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(800)442-4618 - FAX (608)224-6213
http://www.slh.wisc.edu

Laboratory Report

Environmental Health Division

WSLH Sample: 560944039

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711
	Customer ID: 349767

Field #: 0B
Project No:
Collection End: 4/30/2021 3:48:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: NEOSHO ROAD AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

No Charge

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 06/15/21 11:34	Analysis Date: 06/15/21 11:34				
No Analysis	IC CA Analysis	SSC <63um results pending.			

Wisconsin State Laboratory of Hygiene
UNIVERSITY OF WISCONSIN–MADISON

Wisconsin State Laboratory of Hygiene
2601 Agriculture Drive, PO Box 7996
Madison, WI 53707-7996
(800)442-4618 - FAX (608)224-6213
http://www.slh.wisc.edu

Laboratory Report

Environmental Health Division

WSLH Sample: 560944039

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

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Responsible Party

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http://www.slh.wisc.edu

Laboratory Report

Environmental Health Division

WSLH Sample: 560944040

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 616 CRANDALL ST MADISON, WI 53711
	Customer ID: 349767

Field #: 0A
Project No:
Collection End: 4/30/2021 3:45:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 5/11/2021
Date Reported: 6/15/2021
Sample Reason:

ID#: NA
Sample Location: NEOSHO ROAD AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 05/12/21 13:57	Analysis Date: 05/12/21 13:57				
SUSPENDED SEDIMENT	ASTM D3977-97B	125	mg/L	2.0	2.0

Wisconsin State Laboratory of Hygiene
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Laboratory Report

Environmental Health Division

WSLH Sample: 560944040

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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see http://www.slh.wisc.edu/about/compliance/nelac-laboratory-accreditation
Results, LOD and LOQ values have been adjusted for analytical dilutions and percent moisture where applicable.
Results relate only to the items tested.
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The water microbiology unit analyzes samples as received and not all samples are tested for preservation before analysis is performed.

Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634001

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
30 W MIFFLIN ST SUITE 801
MADISON, WI 53703

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
30 W MIFFLIN ST SUITE 801
MADISON, WI 53703
Customer ID: 349767

Field #: NEOSHO 32
Project No:
Collection End: 7/1/2021 4:54:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 7/15/2021
Date Reported: 8/3/2021
Sample Reason:

ID#: NA
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 07/20/21 15:09	Analysis Date: 07/20/21 15:09				
SUSPENDED SEDIMENT	ASTM D3977-97B	102	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634001

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
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Responsible Party

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Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634002

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
30 W MIFFLIN ST SUITE 801
MADISON, WI 53703

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
30 W MIFFLIN ST SUITE 801
MADISON, WI 53703
Customer ID: 349767

Field #: NEOSHO 95.5
Project No:
Collection End: 7/1/2021 5:01:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 7/15/2021
Date Reported: 8/3/2021
Sample Reason:

ID#: NA
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 07/20/21 15:09	Analysis Date: 07/20/21 15:09				
SUSPENDED SEDIMENT	ASTM D3977-97B	109	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634002

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
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F next to result = Result is between LOD and LOQ
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Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634003

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
30 W MIFFLIN ST SUITE 801
MADISON, WI 53703

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
30 W MIFFLIN ST SUITE 801
MADISON, WI 53703
Customer ID: 349767

Field #: NEOSHO 159
Project No:
Collection End: 7/1/2021 5:07:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 7/15/2021
Date Reported: 8/3/2021
Sample Reason:

ID#: NA
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 07/20/21 15:09	Analysis Date: 07/20/21 15:09				
SUSPENDED SEDIMENT	ASTM D3977-97B	135	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634003

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Results relate only to the items tested.
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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
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Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634004

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 30 W MIFFLIN ST SUITE 801 MADISON, WI 53703	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 30 W MIFFLIN ST SUITE 801 MADISON, WI 53703 Customer ID: 349767

Field #: NEOSHO 222.5
Project No:
Collection End: 7/1/2021 5:14:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 7/15/2021
Date Reported: 8/3/2021
Sample Reason:

ID#: NA
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 07/20/21 15:09	Analysis Date: 07/20/21 15:09				
SUSPENDED SEDIMENT	ASTM D3977-97B	141	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634004

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634005

Report To:	Invoice To:
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	Customer ID: 349767

Field #: NEOSHO 286
Project No:
Collection End: 7/1/2021 5:18:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 7/15/2021
Date Reported: 8/3/2021
Sample Reason:

ID#: NA
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 07/20/21 15:09	Analysis Date: 07/20/21 15:09				
SUSPENDED SEDIMENT	ASTM D3977-97B	130	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634005

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634006

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
30 W MIFFLIN ST SUITE 801
MADISON, WI 53703

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
30 W MIFFLIN ST SUITE 801
MADISON, WI 53703
Customer ID: 349767

Field #: NEOSHO 349.5
Project No:
Collection End: 7/1/2021 5:27:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 7/15/2021
Date Reported: 8/3/2021
Sample Reason:

ID#: NA
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 07/20/21 15:09	Analysis Date: 07/20/21 15:09				
SUSPENDED SEDIMENT	ASTM D3977-97B	109	mg/L	2.0	2.0

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

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LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

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Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634007

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 30 W MIFFLIN ST SUITE 801 MADISON, WI 53703	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 30 W MIFFLIN ST SUITE 801 MADISON, WI 53703
	Customer ID: 349767

Field #: NEOSHO 413
Project No:
Collection End: 7/1/2021 5:34:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 7/15/2021
Date Reported: 8/3/2021
Sample Reason:

ID#: NA
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 07/20/21 15:09	Analysis Date: 07/20/21 15:09				
SUSPENDED SEDIMENT	ASTM D3977-97B	90.1	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634007

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

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Metals: Graham Anderson, Supervisor 608-224-6281
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http://www.slh.wisc.edu

Laboratory Report

Environmental Health Division

WSLH Sample: 572634008

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 30 W MIFFLIN ST SUITE 801 MADISON, WI 53703	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 30 W MIFFLIN ST SUITE 801 MADISON, WI 53703
	Customer ID: 349767

Field #: NEOSHO 476.5
Project No:
Collection End: 7/1/2021 5:43:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 7/15/2021
Date Reported: 8/3/2021
Sample Reason:

ID#: NA
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 07/20/21 15:09	Analysis Date: 07/20/21 15:09				
SUSPENDED SEDIMENT	ASTM D3977-97B	95.4	mg/L	2.0	2.0

Report ID: 8897154

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634008

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
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F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

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Metals: Graham Anderson, Supervisor 608-224-6281
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Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634009

Report To:
LAURA ROZUMALSKI
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30 W MIFFLIN ST SUITE 801
MADISON, WI 53703

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
30 W MIFFLIN ST SUITE 801
MADISON, WI 53703
Customer ID: 349767

Field #: NEOSHO 540
Project No:
Collection End: 7/1/2021 5:48:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 7/15/2021
Date Reported: 8/3/2021
Sample Reason:

ID#: NA
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 07/20/21 15:09	Analysis Date: 07/20/21 15:09				
SUSPENDED SEDIMENT	ASTM D3977-97B	81.7	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634009

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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see http://www.slh.wisc.edu/about/compliance/nelac-laboratory-accreditation
Results, LOD and LOQ values have been adjusted for analytical dilutions and percent moisture where applicable.
Results relate only to the items tested.
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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634010

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 30 W MIFFLIN ST SUITE 801 MADISON, WI 53703	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 30 W MIFFLIN ST SUITE 801 MADISON, WI 53703 Customer ID: 349767

Field #: NEOSHO 572
Project No:
Collection End: 7/1/2021 5:55:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 7/15/2021
Date Reported: 8/3/2021
Sample Reason:

ID#: NA
Sample Location: NEOSHO RIVER AT COMMERCE
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 07/20/21 15:09	Analysis Date: 07/20/21 15:09				
SUSPENDED SEDIMENT	ASTM D3977-97B	81.4	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634010

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
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Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634011

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
30 W MIFFLIN ST SUITE 801
MADISON, WI 53703

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
30 W MIFFLIN ST SUITE 801
MADISON, WI 53703
Customer ID: 349767

Field #: SPRING 14
Project No:
Collection End: 7/1/2021 7:26:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 7/15/2021
Date Reported: 8/3/2021
Sample Reason:

ID#: NA
Sample Location: SPRING RIVER AT E 57 ROAD
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 07/20/21 15:09	Analysis Date: 07/20/21 15:09				
SUSPENDED SEDIMENT	ASTM D3977-97B	113	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634011

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
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Responsible Party

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Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634012

Report To:
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30 W MIFFLIN ST SUITE 801
MADISON, WI 53703

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
30 W MIFFLIN ST SUITE 801
MADISON, WI 53703
Customer ID: 349767

Field #: SPRING 42
Project No:
Collection End: 7/1/2021 7:36:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 7/15/2021
Date Reported: 8/3/2021
Sample Reason:

ID#: NA
Sample Location: SPRING RIVER AT E 57 ROAD
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 07/20/21 15:09	Analysis Date: 07/20/21 15:09				
SUSPENDED SEDIMENT	ASTM D3977-97B	115	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634012

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

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LOQ = Level of quantification (for PFAS the LOQ = MRL)
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Z next to result = Result is between 0 (zero) and LOD
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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
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Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634013

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
30 W MIFFLIN ST SUITE 801
MADISON, WI 53703

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
30 W MIFFLIN ST SUITE 801
MADISON, WI 53703
Customer ID: 349767

Field #: SPRING 70
Project No:
Collection End: 7/1/2021 7:42:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 7/15/2021
Date Reported: 8/3/2021
Sample Reason:

ID#: NA
Sample Location: SPRING RIVER AT E 57 ROAD
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 07/20/21 15:09	Analysis Date: 07/20/21 15:09				
SUSPENDED SEDIMENT	ASTM D3977-97B	114	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634013

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
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Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634014

Report To:	Invoice To:
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	Customer ID: 349767

Field #: SPRING 98
Project No:
Collection End: 7/1/2021 7:46:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 7/15/2021
Date Reported: 8/3/2021
Sample Reason:

ID#: NA
Sample Location: SPRING RIVER AT E 57 ROAD
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 07/20/21 15:09	Analysis Date: 07/20/21 15:09				
SUSPENDED SEDIMENT	ASTM D3977-97B	119	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634014

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
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Z next to result = Result is between 0 (zero) and LOD
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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634015

Report To:	Invoice To:
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Field #: SPRING 126
Project No:
Collection End: 7/1/2021 7:52:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 7/15/2021
Date Reported: 8/3/2021
Sample Reason:

ID#: NA
Sample Location: SPRING RIVER AT E 57 ROAD
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 07/20/21 15:09	Analysis Date: 07/20/21 15:09				
SUSPENDED SEDIMENT	ASTM D3977-97B	116	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634015

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

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LOQ = Level of quantification (for PFAS the LOQ = MRL)
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F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634016

Report To:	Invoice To:
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Field #: SPRING 154
Project No:
Collection End: 7/1/2021 7:57:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 7/15/2021
Date Reported: 8/3/2021
Sample Reason:

ID#: NA
Sample Location: SPRING RIVER AT E 57 ROAD
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 07/20/21 15:09	Analysis Date: 07/20/21 15:09				
SUSPENDED SEDIMENT	ASTM D3977-97B	116	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634016

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

Wisconsin State Laboratory of Hygiene
University of Wisconsin–Madison

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634017

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 30 W MIFFLIN ST SUITE 801 MADISON, WI 53703	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 30 W MIFFLIN ST SUITE 801 MADISON, WI 53703 Customer ID: 349767

Field #: SPRING 182
Project No:
Collection End: 7/1/2021 8:04:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 7/15/2021
Date Reported: 8/3/2021
Sample Reason:

ID#: NA
Sample Location: SPRING RIVER AT E 57 ROAD
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 07/20/21 15:09	Analysis Date: 07/20/21 15:09				
SUSPENDED SEDIMENT	ASTM D3977-97B	118	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634017

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

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LOQ = Level of quantification (for PFAS the LOQ = MRL)
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Responsible Party

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Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634018

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 30 W MIFFLIN ST SUITE 801 MADISON, WI 53703	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 30 W MIFFLIN ST SUITE 801 MADISON, WI 53703
	Customer ID: 349767

Field #: SPRING 210
Project No:
Collection End: 7/1/2021 8:07:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 7/15/2021
Date Reported: 8/3/2021
Sample Reason:

ID#: NA
Sample Location: SPRING RIVER AT E 57 ROAD
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 07/20/21 15:09	Analysis Date: 07/20/21 15:09				
SUSPENDED SEDIMENT	ASTM D3977-97B	116	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634018

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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see http://www.slh.wisc.edu/about/compliance/nelac-laboratory-accreditation
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Results relate only to the items tested.
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The water microbiology unit analyzes samples as received and not all samples are tested for preservation before analysis is performed.

Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634019

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 30 W MIFFLIN ST SUITE 801 MADISON, WI 53703	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 30 W MIFFLIN ST SUITE 801 MADISON, WI 53703 Customer ID: 349767

Field #: SPRING 238
Project No:
Collection End: 7/1/2021 8:12:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 7/15/2021
Date Reported: 8/3/2021
Sample Reason:

ID#: NA
Sample Location: SPRING RIVER AT E 57 ROAD
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 07/20/21 15:09	Analysis Date: 07/20/21 15:09				
SUSPENDED SEDIMENT	ASTM D3977-97B	112	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634019

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

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LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634020

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
30 W MIFFLIN ST SUITE 801
MADISON, WI 53703

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
30 W MIFFLIN ST SUITE 801
MADISON, WI 53703
Customer ID: 349767

Field #: SPRING 266
Project No:
Collection End: 7/1/2021 8:18:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 7/15/2021
Date Reported: 8/3/2021
Sample Reason:

ID#: NA
Sample Location: SPRING RIVER AT E 57 ROAD
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 07/20/21 15:09	Analysis Date: 07/20/21 15:09				
SUSPENDED SEDIMENT	ASTM D3977-97B	113	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634020

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

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LOQ = Level of quantification (for PFAS the LOQ = MRL)
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F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
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Laboratory Report

Environmental Health Division

WSLH Sample: 572634021

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
30 W MIFFLIN ST SUITE 801
MADISON, WI 53703

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
30 W MIFFLIN ST SUITE 801
MADISON, WI 53703
Customer ID: 349767

Field #: TAR 23
Project No:
Collection End: 7/1/2021 12:11:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 7/15/2021
Date Reported: 8/3/2021
Sample Reason:

ID#: NA
Sample Location: TAR CREEK AT HWY 69
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 07/20/21 15:09	Analysis Date: 07/20/21 15:09				
SUSPENDED SEDIMENT	ASTM D3977-97B	33.1	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634021

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
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Laboratory Report

Environmental Health Division

WSLH Sample: 572634022

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
30 W MIFFLIN ST SUITE 801
MADISON, WI 53703

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
30 W MIFFLIN ST SUITE 801
MADISON, WI 53703
Customer ID: 349767

Field #: TAR 68.5
Project No:
Collection End: 7/1/2021 12:22:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 7/15/2021
Date Reported: 8/3/2021
Sample Reason:

ID#: NA
Sample Location: TAR CREEK AT HWY 69
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 07/20/21 15:09	Analysis Date: 07/20/21 15:09				
SUSPENDED SEDIMENT	ASTM D3977-97B	31.3	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634022

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
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Z next to result = Result is between 0 (zero) and LOD
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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634023

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
30 W MIFFLIN ST SUITE 801
MADISON, WI 53703

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
30 W MIFFLIN ST SUITE 801
MADISON, WI 53703
Customer ID: 349767

Field #: TAR 114
Project No:
Collection End: 7/1/2021 12:29:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 7/15/2021
Date Reported: 8/3/2021
Sample Reason:

ID#: NA
Sample Location: TAR CREEK AT HWY 69
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 07/20/21 15:09	Analysis Date: 07/20/21 15:09				
SUSPENDED SEDIMENT	ASTM D3977-97B	31.6	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634023

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

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LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

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Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634024

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
30 W MIFFLIN ST SUITE 801
MADISON, WI 53703

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
30 W MIFFLIN ST SUITE 801
MADISON, WI 53703
Customer ID: 349767

Field #: TAR 159.5
Project No:
Collection End: 7/1/2021 12:35:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 7/15/2021
Date Reported: 8/3/2021
Sample Reason:

ID#: NA
Sample Location: TAR CREEK AT HWY 69
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 07/20/21 15:09	Analysis Date: 07/20/21 15:09				
SUSPENDED SEDIMENT	ASTM D3977-97B	31.9	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634024

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634025

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
30 W MIFFLIN ST SUITE 801
MADISON, WI 53703

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
30 W MIFFLIN ST SUITE 801
MADISON, WI 53703
Customer ID: 349767

Field #: TAR 205
Project No:
Collection End: 7/1/2021 12:40:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 7/15/2021
Date Reported: 8/3/2021
Sample Reason:

ID#: NA
Sample Location: TAR CREEK AT HWY 69
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 07/20/21 15:09	Analysis Date: 07/20/21 15:09				
SUSPENDED SEDIMENT	ASTM D3977-97B	30.6	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634025

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

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LOQ = Level of quantification (for PFAS the LOQ = MRL)
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Responsible Party

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Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
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Laboratory Report

Environmental Health Division

WSLH Sample: 572634026

Report To:
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FRESHWATER ENGINEERING LLC
30 W MIFFLIN ST SUITE 801
MADISON, WI 53703

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
30 W MIFFLIN ST SUITE 801
MADISON, WI 53703
Customer ID: 349767

Field #: TAR 250.5
Project No:
Collection End: 7/1/2021 12:46:00 PM
Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 7/15/2021
Date Reported: 8/3/2021
Sample Reason:

ID#: NA
Sample Location: TAR CREEK AT HWY 69
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 07/20/21 15:09	Analysis Date: 07/20/21 15:09				
SUSPENDED SEDIMENT	ASTM D3977-97B	31.6	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634026

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

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LOQ = Level of quantification (for PFAS the LOQ = MRL)
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Responsible Party

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Metals: Graham Anderson, Supervisor 608-224-6281
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Wisconsin State Laboratory of Hygiene
UNIVERSITY OF WISCONSIN-MADISON

Wisconsin State Laboratory of Hygiene
2601 Agriculture Drive, PO Box 7996
Madison, WI 53707-7996
(800)442-4618 - FAX (608)224-6213
http://www.slh.wisc.edu

Laboratory Report

Environmental Health Division

WSLH Sample: 572634027

Report To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
30 W MIFFLIN ST SUITE 801
MADISON, WI 53703

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
30 W MIFFLIN ST SUITE 801
MADISON, WI 53703
Customer ID: 349767

Field #: TAR 296
Project No:
Collection End: 7/1/2021 12:51:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 7/15/2021
Date Reported: 8/3/2021
Sample Reason:

ID#: NA
Sample Location: TAR CREEK AT HWY 69
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 07/20/21 15:09	Analysis Date: 07/20/21 15:09				
SUSPENDED SEDIMENT	ASTM D3977-97B	29.3	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634027

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification (for PFAS the LOQ = MRL)
ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
if LOD=LOQ, Limits were not statistically derived

Test results for NELAP accredited tests are certified to meet the requirements of the NELAC standards. For a list of accredited analytes
see http://www.slh.wisc.edu/about/compliance/nelac-laboratory-accreditation
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Responsible Party

Inorganic Chemistry: Graham Anderson, Supervisor 608-224-6281
Metals: Graham Anderson, Supervisor 608-224-6281
Organics: Erin Mani, Supervisor 608-224-6269
Environmental Toxicology: Dawn Perkins, Supervisor 608-224-6230
Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634028

Report To:

LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
30 W MIFFLIN ST SUITE 801
MADISON, WI 53703

Invoice To:

LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
30 W MIFFLIN ST SUITE 801
MADISON, WI 53703

Customer ID: 349767

Field #: TAR 341.5
Project No:
Collection End: 7/1/2021 12:56:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 7/15/2021
Date Reported: 8/3/2021
Sample Reason:

ID#: NA
Sample Location: TAR CREEK AT HWY 69
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 07/20/21 15:09	Analysis Date: 07/20/21 15:09				
SUSPENDED SEDIMENT	ASTM D3977-97B	29.4	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634028

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

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ND = None detected. Results are less than the LOD
F next to result = Result is between LOD and LOQ
Z next to result = Result is between 0 (zero) and LOD
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Laboratory Report

Environmental Health Division

WSLH Sample: 572634029

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FRESHWATER ENGINEERING LLC
30 W MIFFLIN ST SUITE 801
MADISON, WI 53703

Invoice To:
LAURA ROZUMALSKI
FRESHWATER ENGINEERING LLC
30 W MIFFLIN ST SUITE 801
MADISON, WI 53703
Customer ID: 349767

Field #: TAR 387
Project No:
Collection End: 7/1/2021 1:02:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 7/15/2021
Date Reported: 8/3/2021
Sample Reason:

ID#: NA
Sample Location: TAR CREEK AT HWY 69
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 07/20/21 15:09	Analysis Date: 07/20/21 15:09				
SUSPENDED SEDIMENT	ASTM D3977-97B	27.7	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634029

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634030

Report To:	Invoice To:
LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 30 W MIFFLIN ST SUITE 801 MADISON, WI 53703	LAURA ROZUMALSKI FRESHWATER ENGINEERING LLC 30 W MIFFLIN ST SUITE 801 MADISON, WI 53703 Customer ID: 349767

Field #: TAR 410
Project No:
Collection End: 7/1/2021 1:07:00 PM

Collection Start:
Collected By: LAURA ROZUMALSKI
Date Received: 7/15/2021
Date Reported: 8/3/2021
Sample Reason:

ID#: NA
Sample Location: TAR CREEK AT HWY 69
Sample Description: D-74, SUSPENDED SEDIMENT SAMPLER
Sample Type: SU-SURFACE WATER
Waterbody:
Point or Outfall:
Sample Depth:
Program Code:
Region Code:
County:

Inorganic Chemistry

Analyte	Analysis Method	Result	Units	LOD	LOQ
Prep Date: 07/20/21 15:09	Analysis Date: 07/20/21 15:09				
SUSPENDED SEDIMENT	ASTM D3977-97B	27.8	mg/L	2.0	2.0

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Laboratory Report

Environmental Health Division

WSLH Sample: 572634030

WDNR LAB ID:113133790 NELAP LAB ID:2091 EPA LAB ID:WI00007, WI00008 WI DATCP ID:105-415

List of Abbreviations:

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Water Microbiology: Martin Collins, Supervisor 608-224-6239
Radiochemistry: David Webb, Division Director 608-224-6227

Table D-1
Suspended Sediment Concentrations (July 8, 2018)

Sample	Location (Stream, Station in feet)	Concentration (mg/L)		% < 63 µm
		Total	< 63 µm	
452226001	Neosho River Confluence	137.0	125.31	91%
452226002	***Tar Creek at HWY 69***	***12.2***	***77.45***	***635%***
452226003	***Neosho River at Commerce***	***135.0***	***153.19***	***113%***
452226004	Spring River at E 57 Road	58.0	27.18	47%
452226005	***Neosho River at Commerce***	***213.0***	***225.93***	***106%***
452226006	***Spring River at E 57 Road***	***215.0***	***250.00***	***116%***
452226007	Neosho River at Miami E St SW Bridge	203.0	156.64	77%
452226008	***Neosho D/S Confluence E 157 Road***	***262.0***	***264.09***	***101%***
452226009	Spring River at HWY 10	55.1	45.08	82%
452226010	Tar Creek at HWY 10	38.3	15.87	41%
452226011	Neosho River at Miami E St SW	86.2	73.01	85%
452226012	Spring River at HWY 10	34.0	21.17	62%
452226013	Spring River at E 57 Road	83.7	28.78	34%
452226014	Neosho River at Commerce	182.0	134.80	74%
		Average sheet		66%
		Average all samples		81%

Sampling Locations:

Neosho River near Commerce, OK; E 60 Rd Bridge - USGS 07185000

Tar Creek near Commerce, OK; HWY 69 Bridge - USGS 07185090

Spring River near Quapaw, OK; E 57 Rd Bridge - USGS 07188000

Elk River near Tiff City, MO; HWY 43 Bridge - USGS 07189000

Notes:

Bold indicates data are invalid and were not used in analysis.

mg/L: milligram per liter

µm: micrometer

Table D-2
Suspended Sediment Concentrations (September 27, 2019)

Sample	Location (Stream, Station in feet)	Concentration (mg/L)		% < 63 µm
		Total	< 63 µm	
466352011	***Elk River 012***	***10.6***	***155.04***	***1463%***
466352010	Elk River 036	35.6	33.72	95%
466352012	***Elk River 060***	***7.9***	***18.92***	***239%***
466352028	***Elk River 084***	***8.8***	***45.41***	***519%***
466352030	***Elk River 108***	***3.6***	***13.20***	***369%***
466352031	Elk River 132	6.3	2.99	48%
466352032	Elk River 156	2.5	2.08	82%
466352023	Elk River 180	ND	2.10	N/A
466352024	Elk River 262	ND	3.38	N/A
466352014	Elk River 286	4.0	2.82	71%
466352015	Neosho River 024.3	164.0	131.40	80%
466352016	Neosho River 072.9	167.0	153.14	92%
466352018	Neosho River 121.5	136.0	118.41	87%
466352008	Neosho River 170.1	161.0	150.63	94%
466352005	Neosho River 267.3	164.0	150.86	92%
466352003	Neosho River 315.9	143.0	130.51	91%
466352001	Neosho River 364.5	140.0	111.92	80%
466352026	Neosho River 413.1	158.0	142.63	90%
466352027	Neosho River 461.7	910.0	289.83	32%
466352029	Neosho River 520.3	370.0	164.14	44%
466352009	Noesho River 218.7	157.0	143.11	91%
466352022	Spring River 013	14.5	10.26	71%
466352013	Spring River 039	13.6	11.98	88%
466352017	Spring River 065	48.5	11.56	24%
466352007	Spring River 091	15.7	10.24	65%
466352002	Spring River 117	12.5	9.42	75%
466352004	Spring River 143	19.2	14.12	74%
466352020	Spring River 169	15.7	10.73	68%
466352006	Spring River 195	12.9	8.97	70%
466352021	***Spring River 221***	***11.5***	***12.50***	***109%***
466352019	***Spring River 247***	***11.9***	***14.46***	***122%***
466352025	Tar Creek 069	43.0	21.69	50%
		Average sheet		73%

Sampling Locations:

Neosho River near Commerce, OK; E 60 Rd Bridge - USGS 07185000

Tar Creek near Commerce, OK; HWY 69 Bridge - USGS 07185090

Spring River near Quapaw, OK; E 57 Rd Bridge - USGS 07188000

Elk River near Tiff City, MO; HWY 43 Bridge - USGS 07189000

Notes:

Bold indicates data are invalid and were not used in analysis.

mg/L: milligram per liter

µm: micrometer

Table D-3

Suspended Sediment Concentrations (May 17, 2020)

Sample	Location (Stream, Station in feet)	Concentration (mg/L)		% < 63 µm
		Total	< 63 µm	
510753002	***Elk River 40***	***91.6***	***132.99***	***145%***
510753004	Elk River 70	136.0	45.81	34%
510753006	Elk River 100	35.4	24.30	69%
510753008	Elk River 130	26.4	17.02	64%
510753010	Elk River 160	22.9	22.20	97%
510753012	Elk River 190	26.4	15.53	59%
510753014	Elk River 220	23.6	19.10	81%
510753016	Elk River 250	23.3	18.67	80%
510753018	Elk River 280	25.0		N/A
510753020	Elk River 310	24.5		N/A
510753022	Neosho River 30	259.0	257.75	100%
510753024	Neosho River 90	307.0	276.34	90%
510753026	Neosho River 150	304.0	274.69	90%
510753028	Neosho River 210	277.0	236.98	86%
510753030	Neosho River 270	240.0	237.15	99%
510753032	Neosho River 330	223.0	216.38	97%
510753034	Neosho River 390	237.0	230.83	97%
510753036	Neosho River 450	239.0	215.52	90%
510753038	Neosho River 510	226.0	224.02	99%
510753040	Neosho River 570	208.0	190.90	92%
510753042	***Spring River 14***	***45.7***	***45.95***	***101%***
510753044	Spring River 42	41.4	41.29	100%
510753046	Spring River 70	40.8	38.52	94%
510753048	Spring River 98	39.4	38.52	98%
510753050	***Spring River 126***	***41.9***	***44.04***	***105%***
510753052	Spring River 154	40.2	38.61	96%
510753054	Spring River 182	40.4	39.86	99%
510753056	***Spring River 210***	***40.8***	***40.91***	***100%***
510753058	***Spring River 238***	***36.5***	***40.73***	***112%***
510753060	***Spring River 266***	***29.3***	***41.49***	***142%***
		Average sheet		87%

Sampling Locations:

Neosho River near Commerce, OK; E 60 Rd Bridge - USGS 07185000

Tar Creek near Commerce, OK; HWY 69 Bridge - USGS 07185090

Spring River near Quapaw, OK; E 57 Rd Bridge - USGS 07188000

Elk River near Tiff City, MO; HWY 43 Bridge - USGS 07189000

Notes:

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mg/L: milligram per liter

µm: micrometer

Table D-4
Suspended Sediment Concentrations (July 31, 2020)

Sample	Location (Stream, Station in feet)	Concentration (mg/L)		% < 63 µm
		Total	< 63 µm	
521356002	***Neosho River 10***	***148.0***	***188.05***	***127%***
521356004	Neosho River 63	245.0	165.83	68%
521356006	***Neosho River 116***	***197.0***	***211.20***	***107%***
521356008	Neosho River 169	211.0	175.31	83%
521356010	Neosho Rivver 222	183.0	164.07	90%
521356012	Neosho River 275	230.0	177.06	77%
521356014	Neosho River 313	170.0	153.32	90%
521356016	Neosho River 381	182.0	140.34	77%
521356018	Neosho River 424	179.0	164.66	92%
521356020	Neosho River 519	172.0	158.16	92%
521356022	Spring River 10	55.3	44.96	81%
521356024	Spring River 28	54.2	35.76	66%
521356026	Spring River 56	52.7	46.06	87%
521356028	Spring River 84	47.6	45.78	96%
521356030	***Spring River 112***	***51.4***	***47.89***	***93%***
521356032	Spring River 140	50.2	41.32	82%
521356034	Spring River 168	45.4	40.36	89%
521356036	Spring River 196	45.5	45.17	99%
521356038	***Spring River 224***	***53.1***	***51.23***	***96%***
521356040	Spring River 252	52.3	42.99	82%
521356042	***Tar Creek 9***	***ND***	***1.08***	***N/A***
QCS		***ND***	***33.90***	***N/A***
BLANK		***ND***	***-0.20***	***N/A***
		Average sheet		85%

Sampling Locations:

Neosho River near Commerce, OK; E 60 Rd Bridge - USGS 07185000

Tar Creek near Commerce, OK; HWY 69 Bridge - USGS 07185090

Spring River near Quapaw, OK; E 57 Rd Bridge - USGS 07188000

Elk River near Tiff City, MO; HWY 43 Bridge - USGS 07189000

Notes:

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mg/L: milligram per liter

µm: micrometer

Table D-5

Suspended Sediment Concentrations (April 30, 2021)

Sample	Location (Stream, Station in feet)	Concentration (mg/L) Total	Concentration (mg/L) < 63 µm	% < 63 µm
560944001/2	Neosho River 350	118.0	108.31	92%
560944003/4	Neosho River 300	139.0	86.64	62%
560944005/6	Neosho River 250	104.0	85.42	82%
560944007/8	Neosho River 200	104.0	91.92	88%
560944009/10	Neosho River 150	98.5	87.21	89%
560944011/12	Neosho River 100	98.0	83.78	85%
560944013/14	Spring River 230	21.0	16.27	77%
560944015/16	Spring River 203	18.7	15.21	81%
560944017/18	Spring River 68	20.1	17.50	87%
560944019/20	Spring River 41	22.2	17.33	78%
560944021/22	Neosho River 450	112.0	103.40	92%
560944023/24	Neosho River 400	114.0	105.73	93%
560944025/26	Spring River 176	21.3	15.23	71%
560944027/28	Spring River 149	18.8	15.90	85%
560944029/30	Spring River 122	20.0	16.28	81%
560944031/32	Spring River 95	19.0	15.55	82%
560944033/34	Spring River 14	35.0	16.54	47%
560944035/36	Spring River 257	31.0	22.98	74%
560944037/38	Neosho River 50	99.1	86.94	88%
560944039/40	Neosho River 0	125.0	95.74	77%
		Average sheet		81%

Sampling Locations:

Neosho River near Commerce, OK; E 60 Rd Bridge - USGS 07185000

Tar Creek near Commerce, OK; HWY 69 Bridge - USGS 07185090

Spring River near Quapaw, OK; E 57 Rd Bridge - USGS 07188000

Elk River near Tiff City, MO; HWY 43 Bridge - USGS 07189000

Notes:

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mg/L: milligram per liter

µm: micrometer

Table D-6

Suspended Sediment Concentrations (May 28, 2021)

Sample	Location (Stream, Station in feet)	Concentration (mg/L) Total	Concentration (mg/L) < 63 µm	% < 63 µm	Sample Comments
565116001	Spring River 14	176.0	163.1	93%	14
565116002	Spring River 25	190.0	178.3	94%	25
565116003	Spring River 68	182.0	169.5	93%	68
565116004	Spring River 95	188.0	177.3	94%	95
565116005	Spring River 122	188.0	177.1	94%	122
565116006	Spring River 149	189.0	177.7	94%	149
565116007	Spring River 176	178.0	160.9	90%	176
565116008	Spring River 203	181.0	168.6	93%	203
565116009	Spring River 230	172.0	169.3	98%	230
565116010	Spring River 257	167.0	149.7	90%	257
565116011	Spring River 25	274.0	259.4	95%	25
565116012	Spring River 50	296.0	250.1	84%	50
565116013	Spring River 100	297.0	268.9	91%	100
565116014	***Spring River 125***	***236.0***	***384.1***	***163%***	***125***
565116015	Spring River 150	324.0	166.6	51%	150
565116016	Spring River 175	267.0	238.5	89%	175
565116017	Spring River 200	255.0	222.5	87%	200
565116018	Spring River 225	242.0	206.1	85%	225
565116019	Spring River 250	251.0	216.3	86%	250
565116020	Spring River 275	225.0	216.0	96%	275
565116021	***Neosho River 58***	***301.0***	***434.9***	***144%***	***58***
565116022	Neosho River 116	424.0	360.8	85%	116
565116023	Neosho River 174	367.0	346.3	94%	174
565116024	Neosho River 232	367.0	349.6	95%	232
565116025	Neosho River 290	351.0	341.0	97%	290
565116026	Neosho River 348	334.0	331.7	99%	348
565116027	Neosho River 406	321.0	312.0	97%	406
565116028	Neosho River 464	347.0	341.2	98%	464
565116029	Neosho River 522	344.0	333.0	97%	522
565116030	Neosho River 580	313.0	290.7	93%	580
565116031	Tar Creek 22	32.9	26.7	81%	22
565116032	Tar Creek 29	36.7	15.8	43%	29
565116033	***Tar Creek 44***	***16.0***	***-3.0***	***-19%***	***44***
565116034	Tar Creek 59	23.2	22.2	96%	59
565116035	Tar Creek 74	28.3	25.4	90%	74
565116036	Tar Creek 89	31.7	27.4	86%	89
565116037	Tar Creek 104	30.0	27.1	90%	104
565116038	***Tar Creek 119***	***23.1***	***26.1***	***113%***	***119***
565116039	Tar Creek 134	23.1	12.5	54%	134
565116040	***Tar Creek 149***	***9.4***	***-9.9***	***-105%***	***149***
		Average sheet			88%

Table D-6
Suspended Sediment Concentrations (May 28, 2021)

Sampling Locations:

Neosho River near Commerce, OK; E 60 Rd Bridge - USGS 07185000

Tar Creek near Commerce, OK; HWY 69 Bridge - USGS 07185090

Spring River near Quapaw, OK; E 57 Rd Bridge - USGS 07188000

Elk River near Tiff City, MO; HWY 43 Bridge - USGS 07189000

Notes:

Bold indicates data are invalid and were not used in analysis.

mg/L: milligram per liter

µm: micrometer

Table D-7
Suspended Sediment Concentrations (June 15, 2021)

Sample	Location (Stream, Station in feet)	Concentration (mg/L) Total	Concentration (mg/L) < 63 µm	% < 63 µm
560944001/2	Neosho River 350	118.0	108.31	92%
560944003/4	Neosho River 300	139.0	86.64	62%
560944005/6	Neosho River 250	104.0	85.42	82%
560944007/8	Neosho River 200	104.0	91.92	88%
560944009/10	Neosho River 150	98.5	87.21	89%
560944011/12	Neosho River 100	98.0	83.78	85%
560944013/14	Spring River 230	21.0	16.27	77%
560944015/16	Spring River 203	18.7	15.21	81%
560944017/18	Spring River 68	20.1	17.50	87%
560944019/20	Spring River 41	22.2	17.33	78%
560944021/22	Neosho River 450	112.0	103.40	92%
560944023/24	Neosho River 400	114.0	105.73	93%
560944025/26	Spring River 176	21.3	15.23	71%
560944027/28	Spring River 149	18.8	15.90	85%
560944029/30	Spring River 122	20.0	16.28	81%
560944031/32	Spring River 95	19.0	15.55	82%
560944033/34	Spring River 14	35.0	16.54	47%
560944035/36	Spring River 257	31.0	22.98	74%
560944037/38	Neosho River 50	99.1	86.94	88%
560944039/40	Neosho River 0	125.0	95.74	77%
560944041/42	Tar Creek 9			
		Average sheet		81%

Sampling Locations:

Neosho River near Commerce, OK; E 60 Rd Bridge - USGS 07185000

Tar Creek near Commerce, OK; HWY 69 Bridge - USGS 07185090

Spring River near Quapaw, OK; E 57 Rd Bridge - USGS 07188000

Elk River near Tiff City, MO; HWY 43 Bridge - USGS 07189000

Notes:

Bold indicates data are invalid and were not used in analysis.

mg/L: milligram per liter

µm: micrometer

Table D-8

Suspended Sediment Concentrations (July 1, 2021)

Sample	Location (Stream, Station in feet)	Concentration (mg/L)		% < 63 µm
		Total	< 63 µm	
572634001	Neosho River 32	102.0	42.90	42%
572634002	Neosho River 95.5	109.0	97.29	89%
572634003	Neosho River 159	135.0	108.55	80%
572634004	Neosho River 222.5	141.0	110.08	78%
572634005	Neosho River 286	130.0	108.31	83%
572634006	Neosho River 349.5	109.0	105.12	96%
572634007	***Neosho River 413***	***90.1***	***90.84***	***101%***
572634008	Neosho River 476.5	95.4	72.09	76%
572634009	Neosho River 540	81.7	65.26	80%
572634010	Neosho River 572	81.4	64.17	79%
572634011	Spring River 14	113.0	99.34	88%
572634012	Spring River 42	115.0	101.57	88%
572634013	Spring River 70	114.0	94.39	83%
572634014	Spring River 98	119.0	99.04	83%
572634015	Spring River 126	116.0	102.44	88%
572634016	Spring River 154	116.0	101.33	87%
572634017	Spring River 182	118.0	104.10	88%
572634018	Spring River 210	116.0	105.06	91%
572634019	Spring River 238	112.0	102.32	91%
572634020	Spring River 266	113.0	97.64	86%
572634021	Tar Creek 23	33.1	21.74	66%
572634022	Tar Creek 68.5	31.3	23.32	75%
572634023	Tar Creek 114	31.6	22.45	71%
572634024	Tar Creek 159.5	31.9	25.76	81%
572634025	Tar Creek 205	30.6	24.07	79%
572634026	Tar Creek 250.5	31.6	22.19	70%
572634027	Tar Creek 296	29.3	23.46	80%
572634028	Tar Creek 341.5	29.4	23.87	81%
572634029	Tar Creek 387	27.7	21.05	76%
572634030	Tar Creek 410	27.8	20.40	73%
		Average sheet		80%

Sampling Locations:

Neosho River near Commerce, OK; E 60 Rd Bridge - USGS 07185000

Tar Creek near Commerce, OK; HWY 69 Bridge - USGS 07185090

Spring River near Quapaw, OK; E 57 Rd Bridge - USGS 07188000

Elk River near Tiff City, MO; HWY 43 Bridge - USGS 07189000

Notes:

Bold indicates data are invalid and were not used in analysis.

mg/L: milligram per liter

µm: micrometer

Appendix E

Proposed Modified Study Plan for Sedimentation Study

Pensacola Hydroelectric Project, FERC No. 1494

Proposed Modified Study Plan

Sedimentation Study

Prepared for

Prepared by

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December 2021

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LIST OF ACRONYMS

ADCP........................ Acoustic Doppler Current Profiler
FERC........................ Federal Energy Regulatory Commission
GRDA .... Grand River Dam Authority
H&H Study .... Hydrologic and Hydraulic Modeling Study
ISR............................ Initial Study Report
OWRB .... Oklahoma Water Resources Board
Project .... Pensacola Hydroelectric Project
RSP .... Revised Study Plan
SPD .... Study Plan Determination
SSC .... Suspended Sediment Concentration
UHM .... Upstream Hydraulic Model
USACE .... U.S. Army Corps of Engineers
USGS .... U.S. Geological Survey
USR .... Updated Study Report
WSE .... Water Surface Elevation

1.0 INTRODUCTION

Based on GRDA's very recently completed efforts to calibrate the Sediment Transport Model, GRDA is proposing significant changes to the Commission-approved Sediment Study. Because GRDA's calibration efforts were ongoing at the time GRDA completed the Initial Study Report (ISR), as well as during the ensuing meetings and comment period and only completed this work within the last couple of weeks, GRDA has filed with the Commission an updated Grand Lake Sedimentation Study report.

As a result of the findings during the first study period, GRDA proposes to conduct a modified Sedimentation Study in the second study period to determine whether operation of the Project influences sediment transport and sedimentation within the Neosho River/Grand Lake upstream and within Grand Lake to assess the effects of Project operations on sediment erosion, transport, and deposition in the lower reaches of the tributaries to Grand Lake and to characterize the impact that sedimentation has on flooding upstream of Pensacola Dam and the conservation pool.

This Proposed Modified Study Plan (PMSP) has been deemed necessary due to new information discovered as GRDA followed the study plan required in the FERC's Study Plan Determination (SPD). These findings are largely based on sediment conditions in the study area identified through field sampling in the first study period.

Specifically, there is a discrepancy between the City's assertions that sediment was primarily composed of non-cohesive materials such as sand and gravel and actual conditions. Despite repeated claims to the contrary by the City of Miami in their comments on GRDA's RSP (2018), field data collected during the sedimentation study has shown that cohesive sediment is the primary component moving through the system. In their comments on the RSP, the City stated, "the median bed material size at and upstream from Miami ranged from 3 mm to 12 mm," which falls into the sand-gravel size range rather than cohesive silt or clay. They also claimed that "sand load is the most critical to this study." Contrary to these claims, recent field sampling conducted by GRDA in furtherance of the FERC-approved study plan has demonstrated that the City's claims are incorrect and are not at all representative of actual sediment composition. Field data has shown cohesive sediment to be the dominant type present in the system and could be a factor in characterizing the impacts of sedimentation to the operation of the project.

As discussed in the Sedimentation Study ISR, the cohesive sediments pose a significant problem for accurately modeling sediment transport within HEC-RAS. The wide variability of sediment parameters, confirmed by field data to vary significantly within close proximity to each other; the simplifying assumptions required by HEC-RAS sediment modeling routines; and the complexity of modeling a system with both cohesive and non-cohesive sediment are simply beyond the capabilities of current HEC-RAS sediment transport modeling. As a result, any calibration of the STM for sediment deposition and erosion patterns has limited or no reliable use as a predictive tool for determining sedimentation trends, patterns, or effects on the study area.

Calibration efforts for sediment transport within the STM have been hampered by several factors. These include the misleading claims about sediment properties in the system, widely varying sediment characteristics both spatially and temporally, and limitations of the modeling system that result in considerable errors in predictive simulations.

Information provided by the City of Miami (City of Miami 2018) indicated that the bed consisted primarily of sand and non-cohesive materials. Field data proved that a majority of sediment moving through the study area was in fact cohesive silts and clays. This required additional field and laboratory efforts in the form of core sampling and SEDflume analysis to determine additional sediment parameters.

SEDflume analysis showed that the silts and clays varied widely within the study area. They vary spatially and with depth in the sediment column; density, critical shear stress, and erosion rate have ranges of 485%, 3,000%, and 1,000,000%, respectively. Because these characteristics also vary over time as they consolidate and gain additional strength, simulating such a system requires a powerful, flexible modeling package.

HEC-RAS is not a suitable modeling package for simulating cohesive sediment transport over decades of flow conditions. It allows sediment density to change over time, but critical shear stress and erosion characteristics are static within the model. These parameters also do not vary with depth in the sediment column, and this over-simplification greatly reduces the reliability of HEC-RAS as a predictive tool for the purposes of this study.

The sediment team performed simulations described above to test the potential range of outcomes while making reasonable simplified assumptions about sediment characteristics. The model failed to accurately predict sediment transport and realistically simulate the transport of a mixture of cohesive and non-cohesive sediments, indicating that HEC-RAS is not a viable option for the goals of predicting sediment transport within the Grand Lake study area.

GRDA is instead proposing to move forward with analysis using the relationship between hydraulic shear stress and sediment transport rates. Using the STM to produce shear stress outputs will provide the required information for this study without relying on a questionable model that over-simplifies reality and has been shown to be incapable of predicting sediment transport. Full details of the plan have been included in this PMSP.

As stated by the City of Miami in their response to GRDA's RSP (City of Miami 2018), while citing the ASCE Manual on Sedimentation: "ASCE notes that where full calibration is not possible, 'model tests are devised so that engineering judgment can be used to assess the credibility of the calculated results.'"

This is consistent with the approach discussed by Simons & Simons (1997), in which they stated, "If it is not possible to adequately calibrate and verify a model in a given application, it is appropriate to utilize interpretations of available data, geomorphic and other analysis techniques for prediction purposes. Even when a model can successfully be calibrated and verified, it is appropriate to use these other techniques as an independent check on the modeling results."

This concept was further explained in Civil Engineering, September 1996, "Modeling Contaminated Sediments." (Robert K. Simons and Daryl B. Simons):

> *Using a computer model to analyze and predict sediment transport only works when the analyst considers the model's limitations and the physical processes involved, and conducts adequate calibration and verification.*

The article cites from a document published by FERC (1988):

> *Computer modeling has long been used by scientists and engineers to aid in the design and operation of water resource projects. While models are highly useful tools, they can also be a source of misinformation for users and project reviewers who do not understand*

> *all the assumptions, capabilities and limitations of a particular computer model. Such is the case with computerized sedimentation models.*

The cited document from FERC (1988) further states, regarding computer models, that "[i]t cannot be a substitute for professional experience."

For two projects evaluated in the 1996 article by Simons and Simons, the following approach was discussed:

> *Quantitative analysis without actual sediment modeling has been applied on the Hudson and Ashtabula Rivers. These analyses used the hydraulic model RMA-2, typically associated with STUDH, but simply applied the hydraulic stresses from the model to calculate potential erosion based on shear and erosion equations. . .*

The model's limitations and the physical processes governing the transport and deposition of cohesive and non-cohesive sediment have been carefully considered in coming to the approach being proposed in this PMSP. Since reasonable calibration was not possible with the STM, based on the ASCE Sedimentation Manual, scientific literature, as well as guidance from FERC, GRDA proposes to use engineering judgment using interpretations of available data and other analysis techniques, including the calibrated hydraulics portion of the STM regarding hydraulic shear stress related to actual bathymetric change for prediction purposes.

2.0 STUDY PLAN ELEMENTS

2.1 Study Goals and Objectives

Consistent with the SPD, the goal of the Sedimentation Study is to investigate the overall trends and impact of sedimentation within the Project Boundary. Specifically, this study will analyze the amount of sedimentation that has occurred in the reservoir; evaluate sediment transport, erosion, and deposition in Grand Lake and its tributaries; and characterize the impact that sedimentation may have on flood extents and duration throughout the study area under potential future operation scenarios.

Specific Tasks

The following tasks are considered part of this PMSP:

<u>Bathymetric Change Analysis</u>

- Continue to compare spatial and temporal changes associated with previously collected bathymetry survey data in the study area.
- Continue to analyze sediment bed changes relative to velocities from existing and collected Acoustic Doppler Current Profiler (ADCP) data.
- Define areas of deposition and erosion.
- Continue to conduct specific-gage analysis at U.S. Geological Survey (USGS) gages to understand trends in stage over time due to changes in cross-section.
- Continue to develop spatial and temporal understanding of geomorphological changes and rate of change.

Field Measurements

- Collect sediment grab/core samples for material property analysis and for flume testing.

Sediment Transport Evaluation

- Determine site-specific sediment transport mobility criteria for locations in the study area.
- Develop relationships between flow and suspended sediment transport using regression or other curve-fitting techniques and/or sediment transport relations/equations.
- Evaluate sediment transport at key locations in the study area using the hydraulic bed shear stress values reported by the calibrated Sediment Transport Model (STM) under select operations scenarios.
- Develop incoming sediment supply between bathymetric survey areas using historic hydrologic data to compare computed sediment supply to changes in cross-section area (Sediment Balance Analysis).

Characterization of Sedimentation Impacts on Flooding

- Continue to use the calibrated STM to provide bed shear stress values at the specified locations within the study area. Shear stress outputs are still reliable, even if the cohesive sediment transport modeling capabilities are not reliable due to the complexity of modeling widely-variable sediment parameters. The model will also be used to provide WSE within the study area. The hydraulics of the STM have been calibrated for the same six flood events as the upstream hydraulic model (UHM) using water level measurements, specifically events that occurred in:
    - July 2007
    - October 2009
    - December 2015
    - January 2017
    - April 2017
    - May 2019
- Compare hydraulics based on modified Project operation scenarios to historic hydraulics.
- Estimate sedimentation based on sediment transport analysis considering modified reservoir hydraulics compared to historic operation and sedimentation.
- Evaluate changes to flood extent and duration using STM and approximate channel bed changes considering Project operations.

Data Synthesis and Reporting

- Synthesize findings of bathymetric change analysis and sediment transport evaluation to inform hydraulic modeling efforts.
- Provide an understanding of effects of Project operations on sediment transport characteristics and projected distribution of sediment related to flood extent and duration in the study area.

- Use sediment transport relations and historic trends of sedimentation to make projection of sedimentation considering modified Project operation scenarios.
- Summarize study results and conclusions in an Updated Study Report (USR).

2.2 Agency and Native American Tribe Resource Management Goals

The Sedimentation Study results can inform separate analyses to assess Project effects on resources such as geology and soils, water resources, fisheries and aquatic resources, terrestrial resources, threatened and endangered resources, and cultural resources. Such analyses, in turn, can inform agency decision-making pursuant to statutory obligations.

2.3 Background and Existing Information

The primary source of data is provided by USGS stream gage monitoring stations located throughout the watershed, supported by periodic surveying and bathymetric mapping of Grand Lake and its tributaries. Previous studies have also evaluated sediment within the Neosho and Spring rivers.

2.4 Nexus between Project Operations and Effects on Resources

The operation of the Pensacola Project affects the elevations of Grand Lake. The Sedimentation Study will allow relicensing participants to understand the relationship between Project operations and sedimentation pertaining to the extent and duration of inundation.

The Sedimentation Study will also provide an understanding of the magnitude and extent of sedimentation and subsequent sediment transport associated with Project operations on upstream flooding, if any.

2.5 Study Area

This Sedimentation Study will have similar extents to the existing H&H study. It includes Grand Lake/Neosho River from Pensacola Dam to approximately the Kansas state line, the Spring River from its confluence with the Neosho to approximately the Kansas state line, and upstream along the Elk River. The study area encompasses the lower reaches of the Neosho, Spring, and Elk rivers where interactions between the reservoir and tributaries are likely greatest. The study area will also include a portion of Tar Creek.

2.6 Methodology

Background Data and Literature Review

All relevant previous reports and historic sediment sampling investigations known to have been conducted within the basin have been reviewed. GRDA will continue to develop an organized database to store the data collected as a part of the existing data review and analysis. All data will be fully documented. This information will be provided in the USR describing the type and quality of data available.

Any data gaps identified as part of the effort in the first study period have been filled by initial development of the STM and an initial evaluation of sediment transport and documented in the ISR. Sediment concentration, channel sediment properties, and flow velocity within the river channel are three pieces of information necessary for sediment analysis in the Grand Lake watershed which were collected in the initial study period. Suspended sediment concentration (SSC) measurements allow estimation of sediment transport through a given point in the system, sediment grab and core sampling provides information about material properties of bed sediments, and current velocity profiles were used in conjunction with SSC and sediment properties to calculate sediment flux at sampling locations on the rivers. Except as further discussed in this section, the necessary field data required to fill these data gaps was collected during the first study period included: bathymetry surveys, sediment cores and grab samples, suspended sediment samples, discharge and velocity measurements, and water level measurements.

Bathymetric Change Analysis

Bathymetric changes can provide valuable information about sedimentation and erosion. Reaches or cross-sections where sediment has accumulated or eroded over time will be apparent when looking at bathymetric changes from one survey to the next. The extent and rate of change may indicate areas where sediment deposition or erosion is likely to have some effect on flood duration and severity.

Bathymetric Comparisons
Bathymetric comparisons will be performed based on the type of data available. The 2017 and 2008/9 surveys performed by the USGS and Oklahoma Water Resources Board (OWRB) overlap in the lowest 3-5 river miles of the Neosho, Spring, and Elk rivers. Survey data will be compared using surface differencing to evaluate erosion and deposition in those reaches.

Elsewhere, channel survey data is limited to cross sections surveyed infrequently since the construction of Pensacola Dam in 1940. The long-term range of the data will permit broader analysis regarding channel aggradation, erosion, or migration. Where data is limited to cross-sections, bathymetric changes at each cross-section will be analyzed (see example in Figure 2.6-1), then volumetric changes will be computed between cross sections to find the volume of sediment accreted or eroded.

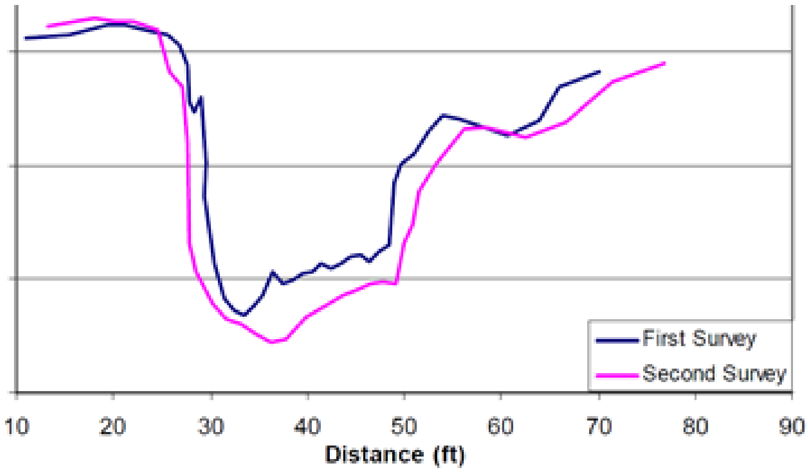

Figure 2.6-1. Example: Bathymetric cross-section comparison.

Additionally, ADCP surveys conducted by the USGS at the four gaging stations in the study area have collected highly accurate bathymetry data across each channel cross section. These surveys have been repeated between 5 and 25 times, depending on the site. These channel cross sections will be analyzed based on the accompanying flow data for volume changes, channel migration, and effects of flood events.

Stage and flow volume measurements will also be used during bathymetric change analysis. The relationship between water surface elevation and flow rate through time will be analyzed and related to observed bathymetric changes. This evaluation will provide an indication of the effects of sedimentation and erosion on water levels in the specified reach.

Synthesis

The bathymetric comparison analysis will be synthesized into the USR detailing the temporal and spatial sedimentation patterns. Volume changes will be reported on a reach and cross section-scale. Reaches with significant changes will be highlighted as potential areas of interest for further investigation.

Water Surface Elevation Monitoring

GRDA has maintained water level monitors throughout the study area since December 2016. The water surface elevations have been recorded by HOBO pressure loggers and were used to calibrate both the UHM and STM. More information is available in the Sedimentation Study ISR.

Sediment Transport Rate Measurements

Sediment transport rate measurements provide important insight into sediment movement along streams. These are broken into SSC and bedload measurements.

GRDA collected SSC and bedload samples using a D-74 SSC sampler and Helley-Smith bedload sampler, respectively, suspended from bridges at the locations of the following USGS gages:

- 07185000 Neosho River near Commerce, Oklahoma
- 07185090 Tar Creek near Commerce, Oklahoma

- 07188000 Spring River near Quapaw, Oklahoma
- 07189000 Elk River near Tiff City, Missouri

SSC measurements were supplemented with USGS records. Sampling trips were planned around specific targeted flow events to fill gaps in the USGS datasets. Once all samplings were collected, GRDA was able to relate sediment discharge to stream flow rates for use in model development.

Bedload transport was found to be negligible during the sampling events. As discussed in the Sedimentation Study ISR, the sampling efforts covered a wide range of discharge rates and produced no measurable bedload transport. This is an important set of data because it demonstrates the lack of transport of non-cohesive sediment in the sand and gravel size range.

Sediment Samples

Substrate properties are an important variable in determining sediment transport rates. Sediment grab and core samples were analyzed to determine bulk density, grain size, composition, and critical shear stress.

A total of 62 sediment grab samples were collected and analyzed to parameterize sediment characteristics within the river system. Sampling occurred in the Neosho, Spring, and Elk rivers as well as Tar, Sycamore, and Horse creeks.

Table 2.6-1. Sediment grab sample locations.

Stream	Samples Collected
Neosho River North of Spring River	20
Neosho River South of Spring River	9
Tar Creek	13
Spring River	10
Elk River	8
Sycamore Creek	1
Horse Creek	1

Where grab samples showed substantial cohesive sediments, core samples were taken for additional analysis. Core samples were tested using SEDflume by Integral Consulting (2020) following procedures developed by McNeil et al. (1996). Testing determined critical shear stress (the minimum bed shear necessary to initiate sediment grain motion), an important parameter for analysis of cohesive sediment transport in fluvial systems as a function of depth in the sediment column.

Grab samples showing predominant sand or gravel did not require additional core sampling. Where sediment was non-cohesive, the above geotechnical testing results provided sufficient information for sediment transport calculations.

STM Development

GRDA has created an STM using geometry information available from several surveys. The model has been calibrated hydraulically to the same six events used for the UHM. The water surface elevation values predicted by the model agree well with those recorded at USGS gaging stations, at high water marks compiled by Tetra Tech (2016), and at monitoring stations operated by Anchor QEA (see Sedimentation Study ISR for additional details).

Proposed Field Work

GRDA continues to collect field data that will ensure more accurate understanding of sediment transport in the study area.

This ongoing effort has been developed in response to perceived discrepancies between bathymetric datasets used in the Pensacola Dam relicensing study. Between Twin Bridges and the Elk River, the available datasets showed approximately 30 feet of deposition between the 1998 REAS and 2009 OWRB surveys, with just a few feet of deposition between 2009 and the 2019 USGS survey (see Sedimentation Study ISR for more information). Coupled with sediment loading estimates, this has raised questions about the validity of the 1998 REAS survey. As presented in the ISR, GRDA's consultants have analyzed the 1998 REAS bathymetric dataset and found the dataset to be unreliable for the purposes of the Sedimentation Study.

There are two common ways to evaluate sediment layer thicknesses that GRDA is using to support this study. The first is sub-bottom profiling, and the second is vibracore sampling.

Sub-Bottom Profiling

GRDA will use a sub-bottom profiler (SBP) to measure sediment layer thicknesses along cross sections where core samples will be collected. SBPs use sonar technology to locate the transitions between different layers of sediment. Outputs can readily distinguish silt and clay layers from sandy or rocky material, allowing estimates of layer thicknesses. Data from these systems are frequently used to calculate sediment volumes. Following collection of the SBP data, GRDA will compile layer thicknesses measurements to compare against vibracore sample measurements.

Vibracore Sampling

GRDA is planning to collect vibracore samples at the locations shown below:

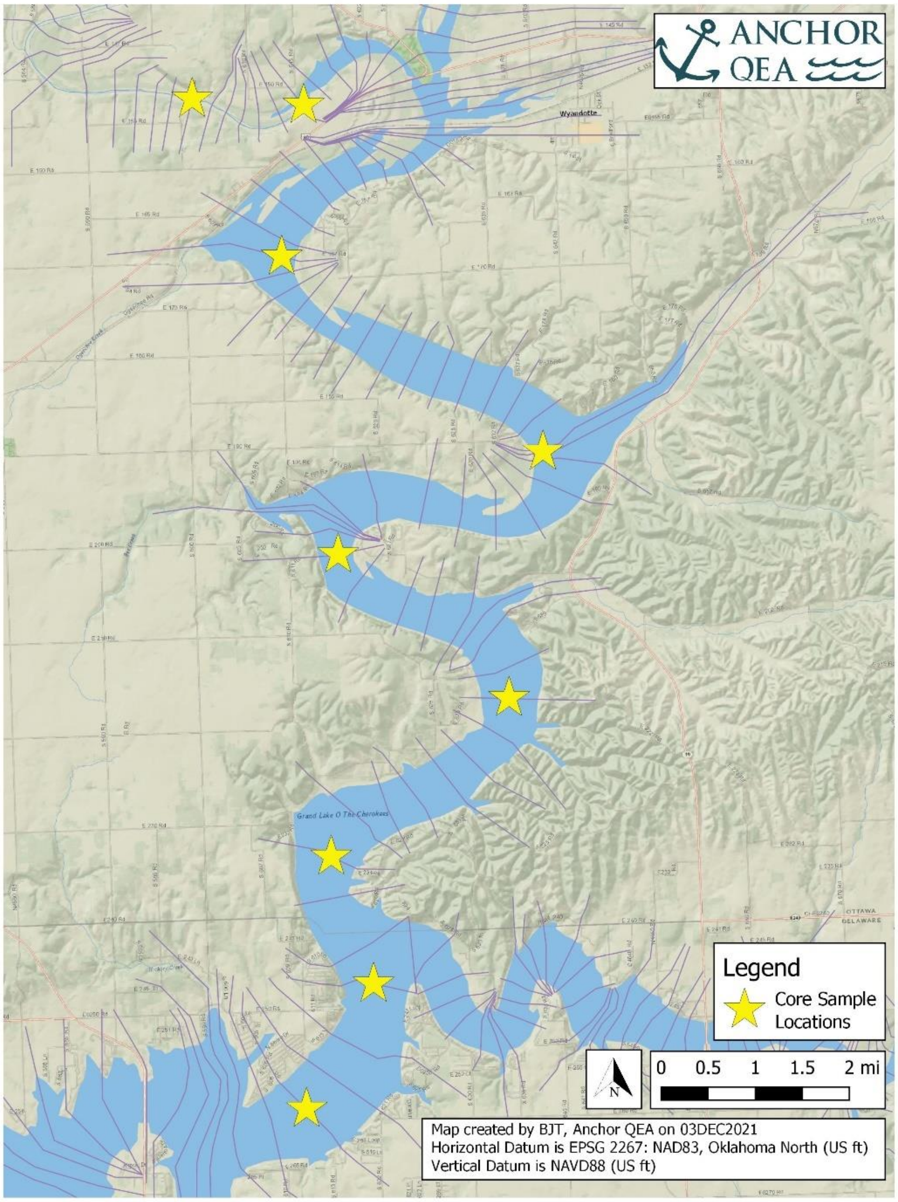

Figure 2.6-2. Vibracore sampling locations.

Vibracoring will allow GRDA to collect sediment cores for analysis to determine the actual depth of accumulation at sample sites. A vibracore rig can collect samples through soft sediments and sand, and rocky soils typically stop the sampler. Assuming pre-dam conditions featured rocky soils or bedrock near the land surface, vibracoring to refusal will provide a reasonable estimate of total sediment deposition at the sampling site.

GRDA selected nine locations for core sampling. Each sample is along a transect that will be measured with the SBP. Areas of particular interest are those where the change from the 1998 REAS dataset to the 2009 OWRB survey shows significant deposition. The samples will be taken at specific river cross-sections, with two cores planned at each cross-section. Samples will be stored for laboratory analysis to determine grain size distributions within the sediment column for use in sediment transport model development.

Core sample evaluation will determine the approximate sediment deposition depth to the pre-dam land surface. Where possible, GRDA will provide estimates for cumulative deposition thicknesses since dam construction.

Sediment Transport Evaluation

The STM will be used to produce hydraulic bed shear stress values within the study area. These shear stress results can be used to evaluate whether sediment deposits or is continually moved downstream under given flow conditions.

This analysis will be coupled with an analysis of potential deposition rates based on sediment concentration and sediment settling rates.

Non-cohesive sediments

Transport of non-cohesive sediments will be determined at all sites where the channel bed is composed of sand or gravel. Non-cohesive sediment transport functions in general rely on regression, probabilistic, or deterministic functions to estimate sediment transport. These formulas are derived from specific sets of laboratory or field data, and caution will be used in selecting approaches suitable for use given conditions in the Neosho, Spring, and Elk rivers following guidance provided in Yang (2006) and ASCE (1982).

The main criterion used to select formulas will be sediment grain size. Other criteria considered will include dimensionless parameters such as dimensionless particle diameter, relative depth, Froude number, relative shear velocity, and dimensionless unit stream power as suggested by the US Bureau of Reclamation in the *Erosion and Sedimentation Manual* (Yang 2006). If bed materials in the study area consist of sand-sized particles, formulas considered for use will include those of Yang (1973, 1979, and 1984), Ackers and White (1973), and Engelund and Hansen (1967). Yang's formulas are derived from the unit stream power theory, while the others are obtained from the stream power concept.

Given the significant quantity of gravel in the non-cohesive bed samples, the Meyer-Peter-Muller (1948) approach will also be considered. The Meyer-Peter-Muller (MPM) equation is well-suited to modeling sediment transport in non-cohesive systems. The existing bed in several of the tributaries is composed of non-cohesive gravel, and the MPM relationship can be used to model transport of those sediments. It is noteworthy, however, that the bedload transport measured by GRDA found no significant movement of the non-cohesive materials, so it is expected that the MPM equation will show limited, if any, sediment transport.

One problem noted with the STM as developed in HEC-RAS is the fact that the MPM equation is being used to model cohesive sediment transport as well as non-cohesive. It is not suitable for use in this fashion, as it was never intended to predict cohesive sediment transport. This finding provides further evidence that the software package used for STM development is not suitable for the conditions present in the study area.

Sediment transport formulas will be compared with existing and measured SSC data to compare their suitability. Agreement between measured and calculated values of sediment loads will be evaluated across a range of flows and sediment fluxes to determine their suitability.

Cohesive sediments

Cohesive sediments, composed of fine-grained clay and silt particles, have strong interparticle forces which largely determine the resistance of sediments to shear stresses. Since grain size cannot be used to determine the shear strength of sediments, the critical shear stress of the sediment must be experimentally determined to evaluate sediment transport potential. In general, erosion of cohesive sediments occurs when the bottom shear stress is greater than sediment critical shear stress and deposition occurs when bottom shear stress is less than the critical shear.

No comprehensive theory exists regarding the erosion of cohesive soils. The equations used to determine the erosion rate of cohesive soils are empirical and require a laboratory or field measurement of critical shear stress. Attempts to correlate erodibility with traditional soil parameters, such as bulk density or plasticity indices, are less useful to determine erodibility due to the large number of factors and their complex interactions. The following process for estimating cohesive sediment transport is derived from the US Bureau of Reclamation's *Erosion and Sedimentation Manual* (Yang 2006).

Laboratory analysis of critical shear stress depended on core sampling in locations where cohesive sediment is present. Core samples were evaluated by Integral Consulting (2020) in accordance with standard SEDflume procedures (McNeil, Tayler, and Lick 1996). The critical shear measurements were then used to determine erosion/deposition and transportation rates.

Erosion rates of cohesive sediments were determined by fitting experimentally determined erosion rates to applied shear stress using the formula given by Ariathurai (1974):

$$Q_{se} = \begin{cases} M_{se} \dfrac{\tau - \tau_{se}^{c}}{\tau_{se}^{c}}, & \tau \geq \tau_{se}^{c} \\ 0, & \tau < \tau_{se}^{c} \end{cases}$$

where Q_{se} = surface erosion rate,

τ and τ_{se}^{c} = bed shear stress and critical surface erosion shear stress, respectively, and

M_{se} = surface erosion rate constant.

The quantity $\boldsymbol{\tau}$-$\boldsymbol{\tau}_c$ is known as excess shear stress and primarily determines erodibility. The surface erosion rate constant, M_{se} is determined from laboratory analysis and is illustrated in Figure 2.6-3.

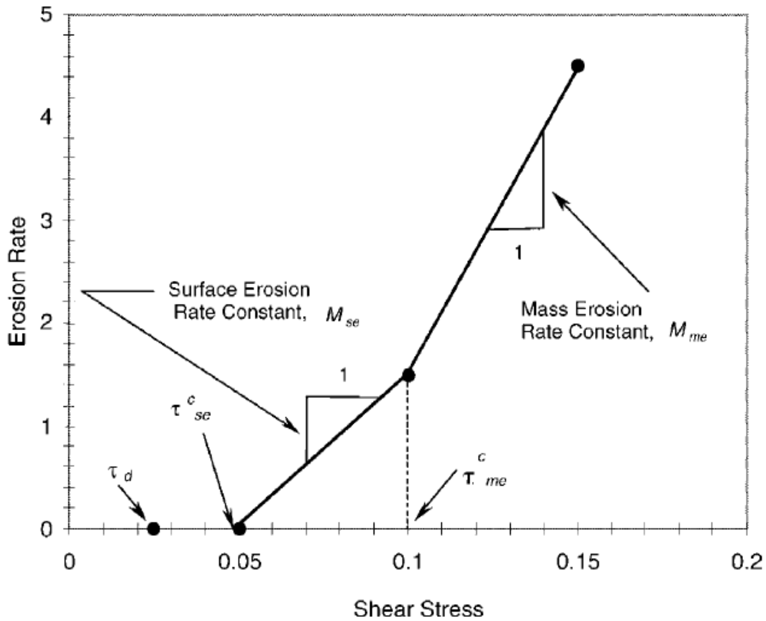

Figure 2.6-3. Determination of M_{se} from graphical analysis.

Cohesive sediment erosion or deposition will be determined at areas where sediment sampling shows cohesive sediments are dominant. Erosion rates will be determined for specific scenarios and compared with field observations, SSC measurements, and bathymetric changes.

Evaluation of sediment loading

GRDA will evaluate sediment erosion and deposition by developing a mass balance sediment budget for duration of the proposed license period. The sediment budget tracks sediment into and out of the system. Using sediment parameters and STM results (described in the following section), GRDA will establish relationships between flow rates and sediment transport. This will allow estimates of sedimentation to be calculated within the study area throughout the range of historic hydraulic conditions. The difference between total inflow and total outflow over the period of record will be the change in sediment storage within the study area. The change in storage will be compared to sediment accumulation calculated during bathymetric change analysis to validate the transport equations used. Finer resolution can be achieved by analyzing individual reaches of a stream as well, providing more information about spatial sediment deposition and erosion patterns.

The STM was developed in HEC-RAS and has been hydraulically calibrated. It produces reliable and accurate water surface elevations over a range of flow and reservoir conditions. From the sediment transport modeling portion of HEC-RAS, using calibrated hydraulics, hydraulic shear stresses are computed and can be relied on to reasonably represent the forces which either cause sediment to be transported or deposited along these rivers and in the reservoir. There is a direct relationship between the hydraulic shear stress and the transport or deposition of cohesive sediment as it flows down the rivers and into the reservoir. The analysis of this relationship can be utilized to understand the pattern of historic sedimentation and make projections into the future using any change in the historic distribution of shear stress as it may vary with operational alternatives and change in sedimentation patterns.

For the time period from 2009 to 2019, hydraulic shear stresses are calculated for each day and corresponding flow by the STM. At a number of locations along the river and reservoir, a hydraulic shear-duration curve will be developed over the 2009 to 2019 time period, similar to a flow-duration curve (One set of curves will be developed based on the 2009 data and another set on the 2019 data so the change in shear distribution will be determined at the various locations along the river and reservoir). Based on the incoming sediment load and sediment deposition patterns from the change in cross-sections or bathymetry, the quantity of sediment being deposited between key locations or passing farther downstream will be calculated. This will establish the historic deposition of sediment at various locations along the river and reservoir and the corresponding distribution of hydraulic shear stresses that caused the sediment to deposit where it did over this time period. At each location, the hydraulic shear distribution will be known and the quantity of sediment deposited between any particular location and the next location upstream. The number and actual location of these particular locations will be selected based on significant shifts in the hydraulic shear distributions, historic sedimentation patterns as well as intermediate locations to develop an adequate set of information to define how the variation in hydraulic shear affects the sedimentation pattern. Relationships will then be developed for the distribution of hydraulic shear and how it varies in the downstream direction correlated to the amount of sediment deposited between each successive location. These relationships define the historic pattern of sedimentation as dictated by hydraulic shear stress and how it varies along the river and reservoir as compared to the quantity of incoming sediment load based on the historic hydrology and sediment rating curves applied to that hydrology.

GRDA will evaluate sediment deposition using the distribution of STM bed shear stress outputs. This will be an iterative process that will use incoming sediment loads, future flows, and proposed Project operations to drive the STM. Bed shear stress distributions will be analyzed to determine locations where sediment is likely to drop out of suspension and where sediment will be transported further downstream. Initial simulations will focus on changes to hydraulic shear stress distributions between the 2009 and 2019 terrain files under identical flow and operational scenarios.

Starting with 2019 cross-sections and bathymetry, the distribution of hydraulic shear stress will be computed at the same locations as the 2009 – 2019 analysis. The new distributions of hydraulic shear will be developed for a specific flow and operation scenario (for example a 50-year time period with reservoir operation as prescribed for the scenario). The incoming sediment load will be computed using the upstream hydrology for the 50-year time period using the sediment transport rating curves. This will define the total quantity of sediment to distribute. Using the starting hydraulic shear stress distribution relationships with sedimentation relationships developed for the 2009 – 2019 time period, an initial distribution of the computed amount of sediment will be made. Based on this geometry, updated distributions of hydraulic shear will be developed to refine the initial distribution of the quantity of sediment for the 50-year time period. This iteration of refinement will result in the expected distribution of sediment for that particular scenario. With a range of sedimentation patterns based on the proposed operating regime for each of the scenarios, the hydraulic model will then be run to evaluate the flooding potential upstream along the various rivers to show the effects of sedimentation on flooding.

This approach focuses on key data and direct physical relationships between hydraulic shear stress and sedimentation patterns. This approach does not have to rely on the complexities of cohesive sediment characteristics as previously discussed regarding modeling issues because the simple relationship between hydraulic shear stress and sedimentation already integrates and explains these complexities without having to delve directly into them through use of an overly simplistic sediment transport modeling approach.

Characterization of Sedimentation Impacts on Flooding

The STM will be used to determine the effects of Project operations on sediment transport in the study area. The formulas and methods selected for cohesive and non-cohesive transport will be applied to modeled flow parameters (i.e., discharge, average velocity, bed shear stress) obtained from the STM for flow events at the study locations to evaluate sediment transport phenomena.

The STM was calibrated for the same flow events as the UHM that was created as part of the H&H study using water level observations collected at USGS gaging station, high water marks collected during specific events, and water surface elevation measurements at the 16 locations monitored by GRDA.

The historic pattern of sedimentation is the result of the historic hydrology and sediment inflow coupled with the historic Project operation. Historic elevation-duration and velocity-duration (based on the UHM) will be related to the historic temporal and spatial distribution of sedimentation. A comparison between future elevation-duration and velocity-duration using proposed Project operations will be utilized to develop the potential future distribution of sedimentation. This analysis will be compared to potential sediment transport.

Applicable sediment transport formulas previously discussed will be used to evaluate the effects of Project operations on sedimentation and sediment transport. Reservoir operation modeling will be based on scenarios chosen by GRDA. Sediment transport rates will first be calculated using appropriate methods for non-cohesive and cohesive sediments at the specific sampling locations using flow information obtained from the CHM for each scenario. Results from each exercise will be compared against each other and to any existing field data that closely approximates the selected condition.

Evaluation of Project operations will compare field observation to calculated results. These sources of information will be able to constrain outcomes of Project operation which can be used to inform investigations of Project impacts on sedimentation and subsequent extent and duration of flooding.

After the CHM has been evaluated with respect to sediment transport, a sensitivity analysis will be conducted to characterize the effects of Project operations on sedimentation and flooding along upstream reaches. The Sedimentation Study will be informed from results of the bathymetric changes and sediment transport analyses to bound reasonable long-term (i.e., annual) rates of sedimentation or erosion. These rates will provide the information needed to develop several sedimentation scenarios which will be evaluated in the CHM to determine flood extents and duration. For example, if a sedimentation rate is found to average 1 foot per year in a reach, the CHM would be modified to reflect possible channel bed configurations every 5 years for 50 years in that reach. Spatial differences in sediment bed changes will be used in this analysis to approximate observed historical changes and current transport processes. The analysis will consider several flow conditions and Project operation scenarios to determine the relative change in flood extent and duration.

Data Synthesis and Reporting

The Sedimentation Study will assimilate and synthesize all findings, including existing data analysis, bathymetric changes, field measurements, sediment transport evaluation, operations impacts, and sediment loading into an understanding of the sediment transport trends within the study area. GRDA is following the type of approach called for in ASCE (2008), Simons and Simons (1996 and 1997) as well as FERC (1988) when realistic calibration cannot be achieved.

Findings of the review of existing data will be documented in the ISR detailing the types, sources, and quality of data. An organized database of all data will be created and made available.

Results of measurements of sediment data, ADCP measurements, suspended sediment measurements, and water levels will be summarized in the USR following the conclusion of field data collection. ADCP and water level data will be provided to GRDA for use in UHM calibration and validation. The USR will detail the methods, analysis techniques, and results of field measurements.

All findings will be compared against each other to determine the sediment transport regime in the study area. Bathymetric changes, modeled sediment loading, and calculated sediment transport rates will be analyzed to create a mass balance sediment budget for the study area. This analysis will provide a high-level conceptual understanding of sediment movement through the watershed.

Findings of the investigation of sedimentation on flooding will be presented in the USR with maps and figures of simulated flooding extents, profiles, and depths.

Calculated sediment transport rates obtained from field measurement data and hydraulic modeling of Project operations will inform the impacts of Project operations on sedimentation in the study area. The USR will include a detailed description of sediment transport evaluation methods and results. Calculations and results will be made available in the USR.

2.7 Consistency with Generally Accepted Scientific Practice

The Sedimentation Study follows generally accepted scientific practice regarding field data collection, sediment transport analysis, and hydraulic modeling. Debates and criticisms abound over how sediment transport models are calibrated and what the implications are for the predictive use of said model where sediments are primarily cohesive. Due to the complex nature of modeling cohesive sediment transportation and the significant limitations imposed by HEC-RAS capabilities, it is not possible to develop a reliable, predictive STM as initially planned. This modified study plan will provide the FERC with more reliable results for sediment erosion and deposition patterns within the study area. Therefore, GRDA is proposing to follow the approach suggested by ASCE (2008), Simons and Simons (1996 and 1997), and FERC (1988) when realistic model calibrations are not possible. The scope of the study will include data collection at locations in the Neosho, Spring, and Elk rivers, Tar Creek, other tributaries to Grand Lake, and Grand Lake itself.

Field data collection will be conducted using methodologies consistent with those used by the USGS and other accepted scientific practices. For instance, sediment transport evaluations will use widely accepted sediment transport functions provided in literature including the Bureau of Reclamation Erosion and Sedimentation Manual (Yang 2006).

2.8 Schedule

The schedule of the Sedimentation Study is displayed in Table 2.8-1.

Table 2.8-1. Sedimentation study schedule.

Task	Completion Date
Anticipated Technical Conference	01/14/2022
Field Data Collection (SBP & Core Samples)	02/28/2022
Sediment Transport Rate Evaluation	09/30/2022
(Technical) Report (USR)	09/30/2022

2.9 Level of Effort and Cost

The estimated cost for completion of the Sedimentation Study is approximately $875,000.

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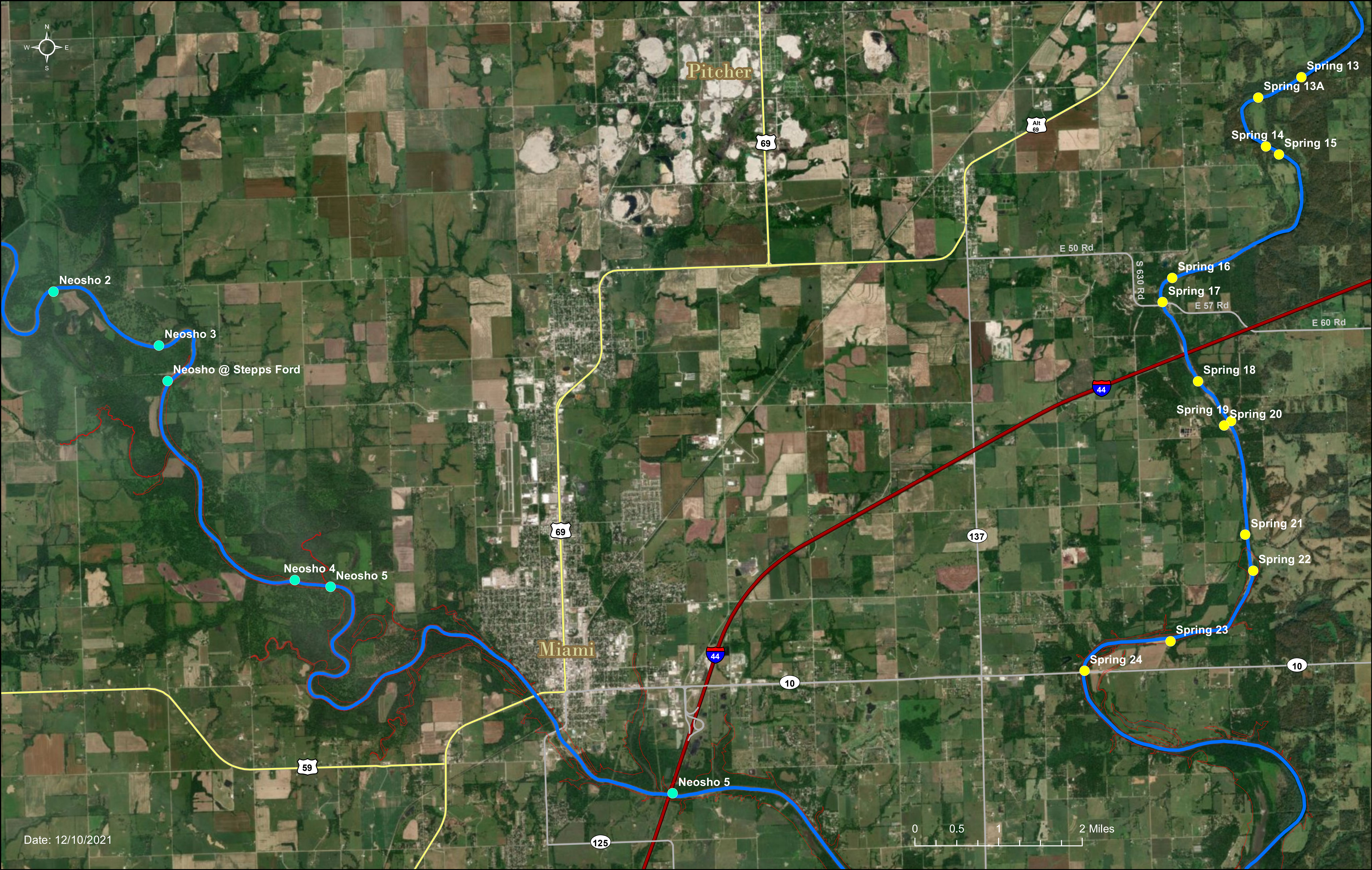
Appendix F

Information Supporting Aquatic Species of Concern Study

Location	Coordinates	Project Boundary?	Habitat Characteristics	Habitat Area (m^2)	Species Found (All Surveys)	CPUE (unionids/10min)	Notes
Spring 13	36.973150 -94.714440	No	0.1-0.5 m depth, LG, G, C, Sa	8,300	P. purpuratus L. cardium O. reflexa T. donaciformis	1.7	
Spring 13A	36.969859 -94.723878	No	Ri, Ra, Bo	NA	L. cardium O. reflexa	NA	
Spring 14	36.961355 -94.722602	No	2.0 m, LG, C, Sa, Ri, GB	NA	L. cardium **L. rafinesqueana** P. purpuratus	NA	
Spring 15	36.959889 -94.719829	No	2.0 m, LG, C, Sa, Ri, GB	NA	L. cardium **L. rafinesqueana** P. purpuratus	NA	
Spring 16	36.939119 -94.743741	No	BR, UG	NA	None observed	NA	Unsuitable Habitat
Spring 17	36.934984 -94.746023	No	7 m depth, BR, LG, Si, Cl, C	NA	None observed	NA	Unsuitable Habitat
Spring 18	36.921069 -94.738960	No	Depth 2 m UG, C, Ri	NA	L. cardium L. fragilis	NA	Poor Habitat
Spring 19	36.913964 -94.732117	No	CG, LG, C	390	L. cardium P. Purpuratus **L.rafinesqueana** O. reflexa	9.0	Unionids evenly distributed
Spring 20	36.913243 -94.733629	No	0.6 m depth G, C, Sa, Ri, Ru	3,300	L. cardium P. purpuratus L. teres L. fragilis O. reflexa T. verrucosa T. donaciformis P. occidentalis	4.8	
Spring 21	36.894199 -94.729871	Yes	1.0 depth, low flow, LG, C BR, Si	NA	P. purpuratus	NA	Unsuitable Habitat
Spring 22	36.887940 -94.728440	Yes	G, LG, S, BR, Ri	650	L. cardium P. purpuratus O. reflexa	0.3	Suitable mussel habitat
Spring 23	36.876171 -94.746768	Yes	3 m depth LG, C	NA	None Observed	NA	Unsuitable Habitat
Spring 24	36.871541 -94.765506	Yes	7 m depth LG, BR	NA	None observed	NA	Unsuitable Habitat
Neosho 2	36.943015, -94.985225	No	LG, Sa, BR	NA	L. fragilis	NA	
Neosho 3	36.933105, -94.962829	No	LG, BR, C	NA	P. ohiensis P. purpuratus	0.1	
Neosho @ Stepps Ford	36.926907, -94.961200	Yes	0.5 m Depth, BR, C, GR	3,250	T. metanevra C. pustulosa T. verrucosa L. cardium O. reflexa P. sintoxia P. Purpuratus	35.3	Swift current
Neosho 4	36.891738, -94.935150	Yes	LG, Si, Cl, BR	480	P.purpuratus L. fragilis L. complanata T. verrucosa	3.0	Low Flow
Neosho 5	36.890343, -94.927493	Yes	Cl, Si, LG, C	NA	P. Purpuratus	0.3	Low Flow
Neosho 6	36.852684, -94.855155	Yes	Cl, Si, LG	210	P. Purpuratus O. Reflexa L. fragilis P. Ohiensis T. donaciformis	5.3	Low Flow, Unionids found in protected flow

Table 1. Mussels Survey Locations from EcoAnalysts (2018). Location ID, Coordinates (X,Y), Within Project Boundary (Y/N), Habitat Characteristics (LG-Loose Gravel, G-Gravel, C-Cobble, Sa-Sand, Ri-Riffle, Ra-Rapids, Bo-Boulders, GB-Gravel Bar, UG-Unstable Gravel, BR-Bedrock, Si-Silt, Cl-Clay, CG-Consolidated Gravel, Ru-Run), Habitat Area (m^2), Species found in both quantitative and qualitative searches, Catch Per Unit Effort Rate (live unionids /10 min), and applicable notes.



N
S
E
W
Pitcher
Miami
Neosho 2
Neosho 3
Neosho @ Stepps Ford
Neosho 4
Neosho 5
Neosho 5
Spring 13
Spring 13A
Spring 14
Spring 15
Spring 16
Spring 17
Spring 18
Spring 19
Spring 20
Spring 21
Spring 22
Spring 23
Spring 24
E 50 Rd
S 630 Rd
E 57 Rd
E 60 Rd
69
Alt 69
44
137
10
59
125
0 0.5 1 2 Miles
Date: 12/10/2021